The GLMRIS Report

Appendix D - Economic Analyses

USACE
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Navigation and Economics

Baseline, Future Without-Project, and Future With-Project Conditions

October 2013

U.S. Army Corps of Engineers

Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

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LIST OF ACRONYMS

ANS	Aquatic Nuisance Species
Cal-Sag	Calumet-Saganashkee
CAWS	Chicago Area Waterway System
CSA	Combined Statistical Area
CSSC	Chicago Sanitary and Ship Canal
EAD	Expected Annual Damages
EEAD	Equivalent Expected Annual Damages
EIA	Energy Information Agency
EPA	U.S. Environmental Protection Agency
EQ	Environmental Quality
FERC	Federal Energy and Regulation Commission
FRM	Flood Risk Management
FWOP	Future Without-Project
FWP	Future With-Project
FY	Fiscal Year
GL	Great Lakes
GLMRIS	Great Lakes & Mississippi River Interbasin Study
GWh	Gigawatt Hours
LMP	Locational Marginal Price
LPMS	Lock Performance Monitoring System
MWh	Megawatt Hours
MWRD	Metropolitan Water Reclamation District
NED	National Economic Development
NREL	National Renewable Energy Lab
O&M	Operations and Maintenance
OHR	Ohio River
OSE	Other Social Effects
P&G	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
PDT	Product Delivery Team
RED	Regional Economic Development
REMI PI^{+}	Regional Economic Models, Inc. - Policy Insight Plus
UMR	Upper Mississippi River

USACE	United States Army Corps of Engineers
WCS	Waterborne Commerce Statistics
WWTP	Waste Water Treatment Plant

D.1 INTRODUCTION

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) authorizes the Secretary to evaluate a range of options and technologies to prevent the transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River Basins by aquatic pathways. To accomplish this task, the GLMRIS Project Delivery Team developed an array of alternatives that can be assembled into two categories: (1) the future without-project (FWOP) condition — the case where no new Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins, and (2) the future with-project (FWP) condition — the case where new Federal action is taken to prevent the transfer of ANS between the basins.

The *Economic and Environmental Principles & Guidelines for Water and Related Land Resources Implementation Studies* (P&G) established the four accounts for water resources planning to include — national economic development (NED); environmental quality (EQ); other social effects (OSE); and regional economic development (RED) — which, in typical USACE studies, are used to categorize economic benefits. However, GLMRIS is atypical in the way that the GLMRIS Project Delivery Team did not portray benefits, but rather, described economic values within the GLMRIS study area that *could* change in the FWOP condition and those that *could* change in the FWP condition.

This economic appendix first explores economic activities that *could* change in the FWOP condition *and/or* the FWP condition. In the FWOP condition, *no* new Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins. Since future ANS transfer could impact the quality or quantity of fisheries within invaded waters, fisheries-dependent economic activities could be altered. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. In the FWP condition, new Federal action *is* taken to prevent the transfer of ANS between the basins. However, this does not preclude the possibility for changes in fisheries-dependent economic activities since various factors, such as fisheries management techniques, could change the quality or quantity of available fisheries. *The key fishing activities identified by the PDT that could change in FWOP and/or FWP conditions include: commercial fishing, recreational fishing, charter fishing, subsistence fishing, and professional fishing tournaments — exclusively within the GLMRIS Detailed Study Area — to include the U.S. waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins. These assessments are not intended to serve as a comprehensive valuation of monetary and non-monetary features of the three basins, but rather, to provide an indication of select economic activities that could change in the future, given the implementation (or lack of) ANS Controls.*

This appendix exhibits the economic activities that could change in the FWP condition. In particular, the PDT evaluated the changes to economic activities that could result from the implementation of ANS Controls (hydrologic separation, increased lockages, changed waterway operations) within the Chicago Area Waterway System (CAWS). *The majority of the ANS control technologies would be implemented within CAWS, and therefore, the PDT assessed economic activities within this region that could experience a change in the FWP condition — to include: commercial cargo and non-cargo navigation (passenger vessels, etc.), flood risk management, water quality, water supply, and hydropower.*

An assessment of the regional economic activity associated with fishing activities within the GL, UMR, and OHR Basins, and the navigation activities within the CAWS was evaluated. This evaluation serves as an indicator of what regional economic activity (e.g., sales, employment) are at risk in the FWOP and/or FWP conditions.

The PDT exhibits an array of economic parameters that *could* change in the future, and therefore, it provides important information for fully describing the economic implications of the alternatives considered in GLMRIS.

D.2 GLMRIS BACKGROUND INFORMATION

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as ANS Controls) to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River basins by aquatic pathways. An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural, or recreational activities that are dependent on such waters. See 16 U.S.C. § 4702(1) (FY13).

As a result of international commerce, travel, and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.

USACE is conducting a comprehensive analysis of ANS Controls and will analyze the effects that each ANS Control or combination of ANS Controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS Controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS Control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and

Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS Controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower, and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

D.3 GLMRIS STUDY AREA

The GLMRIS study area includes portions of the Great Lakes, Mississippi River, and Ohio River Basins that fall within the United States. The study area is the combined continental United States Great Lakes, Upper Mississippi River, and Ohio River watershed.

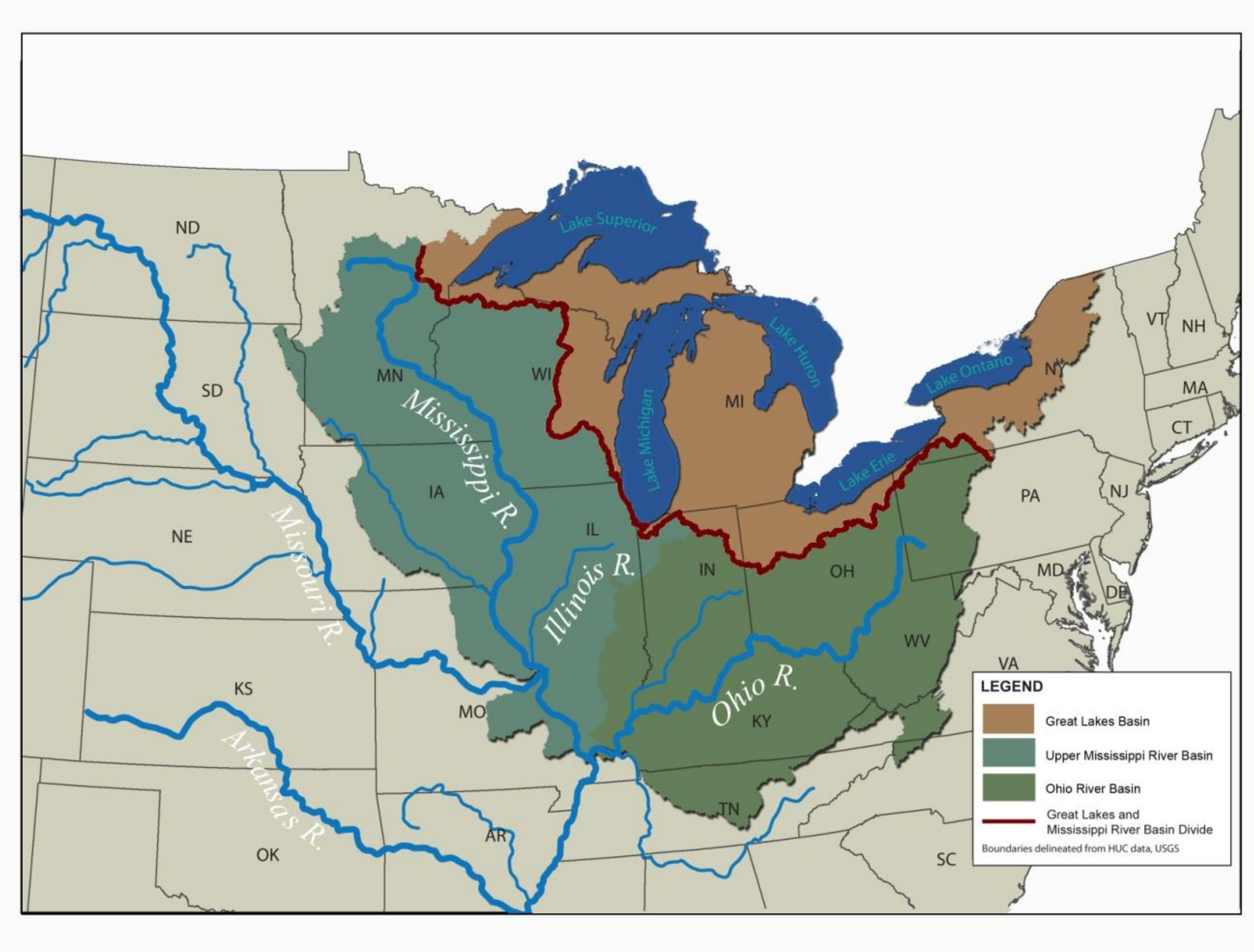

FIGURE D.1 GLMRIS Study Area Map

Potential aquatic pathways between the Great Lakes, Mississippi River, and Ohio River Basins exist along the basins' shared boundary (illustrated in Figure D.1). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental, and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi and Ohio River Basins (green shaded areas) and the Great Lakes Basin (brown shaded area).

Focus Area I, the Chicago Area Waterway System (CAWS), as shown in Figure D.2, is the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins, and therefore, it poses the greatest potential risk of aquatic nuisance species (ANS) transfer between the basins, via an aquatic pathway.

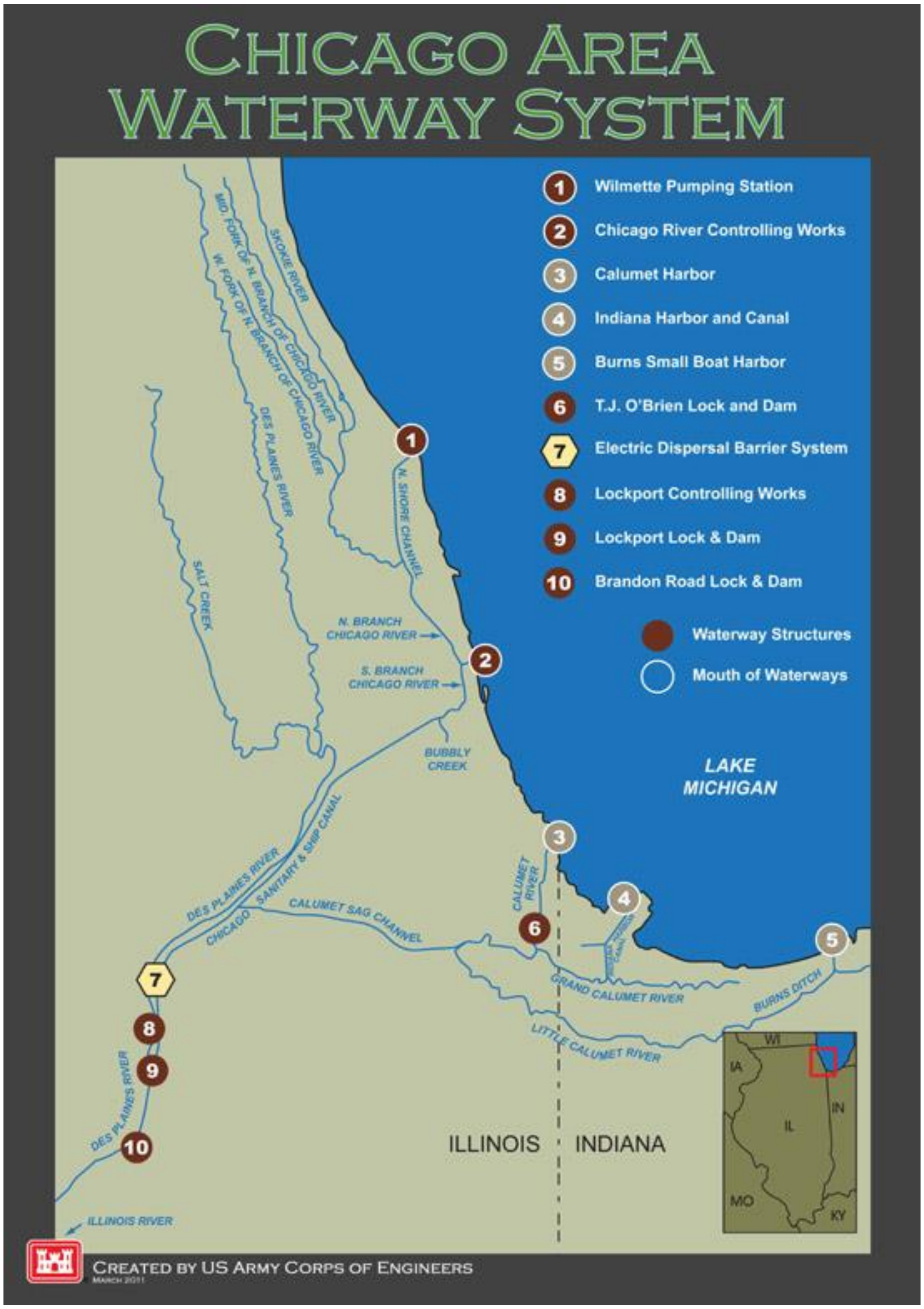

FIGURE D.2 Chicago Area Waterway System (CAWS)

D.4 GLMRIS NAVIGATION AND ECONOMICS PDT

GLMRIS authorizes the Secretary to evaluate a range of ANS Controls to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River basins by aquatic pathways. Therefore, the GLMRIS Project Delivery Team developed eight alternative plans to complete this task, each of which can be assembled into one of two categories: (1) the FWOP condition — the case where no new Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins and (2) the FWP condition — the case where new Federal action is taken to prevent the transfer of ANS between the basins. As a part of the overall GLMRIS Project Delivery Team, the Navigation and Economics Product Delivery Team (PDT) was formed to assess various economic activities within the GLMRIS study area that *could* change in the FWOP and/or FWP conditions.

The Navigation and Economics PDT is comprised of eight economic sub-teams, which focus on the following economic categories: fishing, commercial cargo navigation, non-cargo navigation (i.e., passenger vessels, government vessels, etc.), flood risk management, water quality, water supply, hydropower, and regional economics. *These eight teams represent **key** economic activities that could change given the implementation (FWP condition) or lack of implementation (FWOP condition) of a GLMRIS project.*

Table D.1exhibits the various products produced by the Navigation and Economics PDT.

TABLE D.1 GLMRIS Navigation and Economics PDT Products

Sub-Team	Focus	Study Area[1]	Baseline	FWOP	FWP
Fisheries Economics	Commercial Fishing	GL, UMR, OHR	×		
	Recreational Fishing	GL, UMR, OHR	×		
	Charter Fishing	GL	×		
	Subsistence Fishing	GL, UMR, OHR	×		
	Pro-Fishing Tournaments	GL, UMR, OHR	×		
Cargo Navigation	Cargo navigation activities	CAWS	×	×	×
Non-Cargo Navigation	Non-cargo navigation activities	CAWS	×	×	×
Flood Risk Management	Flooding impacts	CAWS	×	×	×
Water Quality	Water Quality	CAWS	×	×	
Water Supply	Water Supply	CAWS	×		
Hydropower	Lockport Lock and Dam hydropower generation	CAWS	×	×	×
Regional Economics	Economic contribution	CAWS, GL, UMR, OHR	×		

[1] GL – Great Lakes Basin; UMR – Upper Mississippi River Basin; OHR – Ohio River Basin; CAWS – Chicago Area Waterway System; Baseline – baseline condition; FWOP – future without-project condition; FWP – future with-project condition.

The P&G established the four accounts for water resources planning to include national economic development (NED), environmental quality (EQ), regional economic development (RED), and other social effects (OSE).

Table D.2 displays the economic activities considered, as well as their categorization in the four accounts.

TABLE D.2 NED, EQ, RED, OSE Accounts

Study Area[1]	Economic Category[2]	NED	EQ	RED	OSE
GL, UMR, & OHR Basins	Commercial Fishing	✓		✓	
	Recreational Fishing	✓		✓	✓
	Charter Fishing (GL only)	✓		✓	
	Subsistence Fishing	✓	✓	✓	✓
	Pro-Fishing Tournaments	✓		✓	
CAWS	Commercial Cargo Navigation	✓		✓	
	Non-Cargo Navigation	✓		✓	
	Flood Risk Management	✓		✓	✓
	Water Quality	✓	✓	✓	✓
	Water Supply	✓		✓	✓
	Hydropower	✓		✓	

[1] Each economic activity focused on one of two study areas: (1) the Great Lakes (GL), Upper Mississippi River (UMR), and Ohio River (OHR) Basins or (2) the Chicago Area Waterway System (CAWS). While fishing activities within the three basins could be affected by future without-project (FWOP) and/or future with-project (FWP) conditions, the remaining economic categories could potentially experience changes due to FWP conditions. The implications of the FWOP and FWP conditions for each of these economic activities are explored in the forthcoming sections of this economic appendix.

[2] Baseline economic assessments were generated for each economic activity considered by the GLMRIS Navigation and Economics PDT. This establishes the threshold of what could change due to the various alternative plans considered in GLMRIS — to include both the No New Federal Action alternative plan (FWOP condition) and various FWP conditions. Economic activities could experience changes in one or more of the accounts. *Detailed assessments to differentiate changes to national economic development (NED), environmental quality (EQ), regional economic development (RED), and other social effects (OSE) accounts were not completed for all economic categories in this report.*

D.4.1 Fisheries Economics Team

The Fisheries Economics Team focused on fishing activities within the US waters of the Great Lakes (GL), Upper Mississippi River (UMR), and Ohio River (OHR) Basins (i.e., the GLMRIS Detailed Study Area) that are at threat in the FWOP and/or FWP condition.

Five baseline economic assessments, which quantitatively or qualitatively describe the current economic activities dependent on fisheries, were developed. The reports focus on the following categories: commercial, recreational, charter, and subsistence fishing, as well as professional fishing tournaments. Each baseline assessment focuses exclusively on the specified fishing activity within the GLMRIS Detailed Study Area — to include the US waters of the GL, UMR, and OHR Basins. It is imperative to note that collectively, these values do *not* represent a comprehensive value of the GL, UMR, or OHR Basins. Each basin has further economic (e.g., non-use values) and environmental values that are not captured in this economic appendix. Rather, the fishing-related economic activities identified by the

Navigation and Economics PDT serve as indicators of economic activities that are at threat in the future, with (FWP condition) or without (FWOP condition) the implementation of a GLMRIS project. Baseline evaluations demonstrate the threshold of potential changes to the NED, EQ, RED, and OSE accounts that *could* occur in the FWOP and/or FWP conditions.

In the FWOP condition, no *new* Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins. The *impacts* associated with the FWOP condition are not presented. Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high- or medium-risk to the receiving basin, if they were to transfer and become established. Since targeted fish species have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, the baseline economic assessment demonstrates the fishing activities within the GL, UMR, and OHR Basins that *could* be affected in the FWOP condition.

In the FWP condition, *new* Federal action is taken to prevent the transfer of ANS between the basins. However, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future resource availability regarding fishing activities in the FWP condition. Since these management plans were not available, this assessment serves as a baseline of the commercial fishing industry within the GL, UMR, and OHR Basins that *could* be affected in the FWP condition.

Note that commercial, recreational, charter, subsistence, and professional fishing are the sole economic categories *that were evaluated by the PDT* that are assumed to be at threat in both the FWOP *and* FWP conditions and were examined on a basin-wide scale.

D.4.2 Commercial Cargo Navigation Team

The remaining Navigation and Economics sub-teams explored economic activities that could experience the greatest change in the FWP condition — the case where new Federal action is taken to prevent ANS transfer between the basins. Since the ANS control measures explored in GLMRIS would be primarily implemented within the CAWS area, the remaining sub-teams focus on activities within this region that could change in the FWP condition.

Specifically, the Commercial Cargo Navigation Team assessed the commodity types, tonnages, and transportation cost savings associated with moving commercial cargo via the CAWS versus truck or rail. Since many of the GLMRIS alternative plans include ANS control measures that could alter CAWS operations (e.g., hydrologic separation, additional locks, etc.), the Commercial Cargo Navigation Team was tasked with quantifying the effects of implementing an alternative plan.

The team accomplished this in three steps. First a baseline economic assessment was generated to establish current commodity types, tonnages, and lock usage statistics associated with the CAWS. The team then forecasted these values for the FWOP and FWP conditions. The difference between the FWOP and FWP conditions yielded the net impacts associated with implementing a GLMRIS alternative plan. Net impacts depict the changes in NED that could occur due to the various alternative plans considered in GLMRIS, but could also result in changes in RED.

D.4.3 Non-Cargo Navigation Team

The Non-Cargo Navigation team was tasked with assessing the current lock usage of passenger, recreational, and government vessels within the CAWS via a baseline economic assessment. FWOP and FWP conditions were also developed. While the FWOP condition explored future lock usage and passenger vessel revenues, the FWP condition *qualitatively* addressed the impacts to non-cargo vessels within the CAWS. Net impacts depict the changes in NED that could occur due to the various alternative plans considered in GLMRIS, but could also result in changes in RED.

D.4.4 Flood Risk Management Team

The Flood Risk Management Team was tasked with characterizing the flood risk in the Chicago Metro Area from both overland flooding and sewer backup flooding, measured via expected annual damages. FWOP condition estimates were compared to FWP condition estimations to arrive at the net change in equivalent expected annual damages (EEAD). This analysis yielded an estimate of induced EEAD associated with each GLMRIS alternative plan. Changes in EEAD represented changes in NED that could occur due to the various alternative plans considered in GLMRIS, and result in changes to RED and OSE.

D.4.5 Water Quality Team

The Water Quality Team generated a baseline economic assessment of water quality for the CAWS, as well as for Lake Michigan beaches along the Chicago shoreline.

The CAWS baseline assessment establishes a baseline of water quality for users in the CAWS, as well as the costs associated with that water usage. Specifically, this report exhibits estimates of the operation and maintenance costs associated with three waste water treatment plants (WWTPs) in the CAWS (Stickney, Calumet, and North Side). The Lake Michigan beaches baseline economic assessment identifies the number of beaches that currently exist in Chicago’s 28 miles of shoreline. This document provides the location and amenities offered at these beaches, as well as an estimate of beach usage and its associated value.

Baseline evaluations demonstrate the threshold of potential changes to NED, EQ, RED, and OSE that *could* occur in the FWOP and/or FWP conditions.

FWOP condition assessments were also produced by this team. The FWOP condition for CAWS identifies an estimate of annual operation and maintenance costs that are associated with the three WWTPs in the CAWS. The FWOP condition for Lake Michigan beaches (along Chicago’s shoreline) estimates a future value of beach usage. This information was not available at the time of the study.

At the time of the economic study, water quality modeling for the FWP conditions was in the process of being developed. Therefore, the Navigation and Economics PDT’s Water Quality Team did not make any premature assumptions regarding water quality for the FWP condition, as it was possible that assumptions would not align with actual WQ modeling results.

D.4.6 Water Supply Team

The Water Supply Team was formed to establish a baseline of water use for water originating from Lake Michigan, diverted via cribs along the Illinois shoreline, and distributed to users in the Chicago Area. The assessment also summarizes the Supreme Court Decree which specifies several limitations on the diversion of Lake Michigan water by the State of Illinois. Direct diversion consists of lockage, leakage, navigational makeup flow and water quality dilution. Given the qualitative nature of the baseline assessment, FWOP and FWP condition reports were not generated. Rather, the baseline assessment serves as an indicator of aspects of water supply within the CAWS that *could* change given the implementation of a GLMRIS alternative plan. The Water Supply Team, which focused on the current demand for water within the Chicago area, did not generate a FWOP or FWP condition assessment. The baseline economic assessment was based on readily-available secondary data sources. Future condition assessments would involve coordination with the major water providers in the area as well as an estimate of future water demand. This information was not available at the time of the study. Baseline evaluations demonstrate the threshold of potential changes to the NED, RED, and OSE accounts that *could* occur in the FWOP and/or FWP conditions.

D.4.7 Hydropower Team

The Hydropower Team was tasked with exhibiting the current hydropower revenues that are associated with Lockport Powerhouse via a baseline economic assessment. A FWOP condition document highlights the future revenues associated with hydropower generation, while the FWP condition summarizes the alternative plans considered in GLMRIS and the implications for hydropower generation at Lockport Powerhouse. Net changes between the FWP and FWOP condition yield changes to NED, and could also result in changes in RED.

D.4.8 Regional Economics Team

The Regional Economics Team was tasked with estimating how the fishing and navigation activities considered in GLMRIS contribute to the regional and national economy’s value added (i.e., contribution to GDP), sales, jobs, and income. Impacts to the economy based on the FWOP and FWP conditions described in GLMRIS were not generated. Rather, the baseline economic assessment serves as an indicator of what *could* change given the implementation or lack of implementation of a GLMRIS project, and therefore, provides estimates of potential changes in RED.

It is important to note that the economic activities considered in GLMRIS do not entail a comprehensive analysis of all economic activities that *could* change given the implementation or lack of implementation of a GLMRIS alternative plan. However, the Navigation and Economics PDT considers key economic activities within the GLMRIS Detailed Study Area that *could* change in the FWOP and/or FWP conditions.

D.5 COMMERCIAL FISHING

D.5.1 Baseline Condition

D.5.1.1 Focus

The Fisheries Economics Team generated the *Commercial Fisheries Baseline Economic Assessment – U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins*, which establishes the current economic value of the commercial fisheries in the US waters of the GL, UMR, and OHR Basins based on the most recent annual harvest data available from state agencies (or equivalents) and inter-tribal agencies or organizations. This document is an assessment of the harvest value of commercial fisheries in these basins. This includes both tribal and state-licensed commercial harvests. The value of commercial fishing serves as an indicator of a key aspect of the economy that is at threat in the future with or without the implementation of a GLMRIS project.

D.5.1.2 Method

State agencies were requested to provide annual harvest levels and the associated dockside values for the years between 1989 through 2009 to generate analyses of harvesting trends over time. Due to lags in data entry, most states were not able to provide harvest data for years 2010 and 2011. The most recent year for which most state agencies were able to provide harvest data was 2009 in the GL Basin and 2005 in the UMR and OHR Basins. The average of the most recent five years of harvest level and harvest value data for each basin yielded the current value of the commercial fisheries in each basin.

D.5.1.3 Key Findings

Values for the commercial fisheries in the US waters of the GL, UMR, and OHR Basins are as follows:

- *Great Lakes Basin*
  The average harvest level from the most recent 5 years (2005 through 2009) for the US waters of the GL Basin was determined to be approximately 20.24 million pounds with an associated ex-vessel value of about $21.79 million in Fiscal Year 2013 (FY13) dollars. Changes in these values that would occur due to the implementation of a GLMRIS alternative plan would yield the change in national economic development.
- *Upper Mississippi River Basin*
  The average harvest level from the most recent 5 years (2001 through 2005) for the UMR Basin was determined to be approximately 10.0 million pounds with an associated ex-vessel value of about $3.84 million in FY13 dollars. Changes in these values that would occur due to the implementation of a GLMRIS alternative plan would yield the change in national economic development.
- *Ohio River Basin*
  The average harvest level from the most recent 5 years (2001 through 2005) for the OHR Basin was determined to be approximately 1.38 million pounds with an associated ex-vessel value of about $1.99 million in FY13 dollars.

Changes in these values that would occur due to the implementation of a GLMRIS alternative plan would yield the change in NED and RED.

D.5.1.4 Future Without-Project Condition

The *impacts* associated with the FWOP condition associated with commercial fishing are not presented. Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since the fish species targeted by commercial fishermen have not yet been exposed to the identified ANS, potential environmental, economic, and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than at an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, the commercial fisheries baseline economic assessment demonstrates the commercial fishing activities within the GL, UMR, and OHR Basins that *could* be affected in the FWOP condition.

D.5.1.5 Future With-Project Condition

The *impacts* associated with the FWP condition associated with commercial fishing are not presented. In the FWP condition, new Federal action *is* taken to prevent the transfer of ANS between the basins. However, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future resource availability regarding fishing activities in the FWP condition. Since these management plans were not available, this assessment serves as a baseline of the commercial fishing activities within the GL, UMR, and OHR Basins that *could* be affected in the FWP condition.

D.6 RECREATIONAL FISHING

D.6.1 Baseline Condition

D.6.1.1 Focus

As a part of the Fisheries Economics Team, Cornell University (CU) was tasked with generating a baseline assessment of recreational fishing to establish the current value of this activity in the US waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins. CU accomplished this task by completing three complimentary reports, including a: (1) literature review, (2) focus-group assessment, and (3) baseline economic assessment. The value of recreational fishing serves as an indicator of a key aspect of the economy that is at threat in the future, with or without the implementation of a GLMRIS project.

D.6.1.2 Method

The *Net Benefits of Recreational Fishing, Beachgoing, and Boating in the Great Lakes, Upper Mississippi River, and Ohio River Basins: A Review of the Literature* (literature review) provided a range of values for recreational angling in the Great Lakes Basin. This report reviewed the recreational valuation literature on fishing, beachgoing, and boating in the GL, UMR, and OHR Basins. Its purpose was to determine whether the existing literature is sufficient to: (a) estimate the current net value of these activities in the study region; and (b) estimate how these values might change with the introduction of aquatic nuisance species (ANS).

The *Potential Effects of Aquatic Nuisance Species on the Behavior of Recreational Anglers, Boaters, and Beachgoers* (focus group report) summarized the findings from a series of focus groups conducted as part of the United States Army Corps of Engineers/Cornell University Recreation Impacts of Aquatic Nuisance Species to the Great Lakes and Mississippi River Basins cooperative agreement. The overall purpose was to describe how and why aquatic nuisance species in the GL, UMR, and OHR Basins may affect recreational behaviors of anglers, boaters, and beachgoers. Understanding the ways that recreationists may respond to the presence of aquatic nuisance species and the particular effects of these species that may lead to this response is necessary for understanding the impacts of aquatic nuisance species on recreationists.

The *Net Benefits of Recreational Fishing in the Great Lakes, Upper Mississippi River, and Ohio River Basins* (baseline recreational fishing report) was developed to provide defensible economic benefit estimates associated with recreational fishing in each of the GL, UMR, and OHR Basins. CU surveyed recreational anglers in each basin by utilizing the travel cost method. The travel-cost approach involves surveying recreationists about where they live and where they go to recreate and then developing models to explain how travel costs and site attributes (such as resource quality and catch rates) contribute to these choices.

D.6.1.3 Key Findings

The findings for the literature review of recreational angling in the US waters of the GL, UMR, and OHR Basins include the following:

- Too few studies of the net value of beachgoing and boating have been conducted within the study region to establish the range of net values per day of these activities. Therefore, based on the existing literature, it is not possible to estimate the total annual net value of either beachgoing or boating in either the GL Basin or the UMR and OHR Basins.
- For the GL, however, a sufficient number of studies have been conducted to establish that the net value per day of recreational fishing likely falls between $20 and $75 (2012 dollars). When the endpoints of this range are multiplied by the USFWS estimate of about 18 million angler days in the GL in 2006, it results in an estimate of the aggregate annual net value of recreational fishing in the GL of $360 million to $1.35 billion (2012 dollars).
- It is important to note that this range is an estimate of *net value*, which is distinct from other economic measures that may have been reported such as *expenditures* and *economic impacts*. Cornell reports net values in this report because, according to economic theory and Federal regulation, net value is considered the appropriate measure for assessing the benefits of public policy alternatives.

The findings for the focus group report of recreational angling, boating, and beachgoing in the US waters of the GL, UMR, and OHR Basins include the following:

- A number of factors including, but not limited to aquatic nuisance species, influenced the recreational behavior of anglers, boaters, and beachgoers. In each user group, the factors cited most often by focus group participants as affecting fishing, boating, and beachgoing behavior were related to the potential effects of aquatic nuisance species. Anglers expressed concerns about catch rate and fish size — and fishing quality more generally — based on impacts from aquatic nuisance species. Secondary effects of aquatic nuisance species — such as the inconvenience or expense of shifting fishing location — were also described. Other influences on behavior were identified that did not link to aquatic nuisance species (e.g., weather, access to fishing sites). Boater and beachgoer behavior were tied to aquatic nuisance species-related issues such as water clarity, health and safety, and visual beauty.
- Most of the potential impacts of aquatic nuisance species on recreation seemed to be negative, such as limiting the number of locations in which recreation is desirable, causing some forms of recreation to become more difficult, less fun, or less safe, and perhaps leading some people to forsake certain activities altogether. Nevertheless, a few impacts from aquatic nuisance species could be positive. For example, the increased water clarity provided by zebra mussels appealed to many focus group participants.
- Even though the focus group participants seemed to be affected primarily negatively by aquatic nuisance species, they frequently showed a willingness to adapt rather than become frustrated to the point that they would cease participation entirely. Substituting different locations or forms of preferred recreational activities (e.g., types of fishing, uses of beaches, etc.) for current ones was a frequently cited approach to dealing with aquatic nuisance species. Recreationists repeatedly asserted that they would adapt and continue to recreate, even if it left them with a diminished experience.

The findings for the baseline recreational fishing report include the following:

- Based on fishing license sales data provided by the states, it was estimated that 6.6 million anglers lived and fished in the 12-state study area in 2011. These anglers spent an estimated 62.9 million days fishing in those portions of the Great Lakes basin below barriers that are impassable to fish. They spent 57.6 million days fishing in those portions of the UMR and OHR Basins that are below barriers that are impassable to fish.
- The average net value per angler day, estimated from CU's recreational fishing model, was $19.52 (2012 dollars). The aggregate net value of recreational fishing in those portions of the Great Lakes basin below barriers impassable to fish is estimated to be $1.228 billion for calendar year 2011. The corresponding aggregate net value of recreational fishing in those portions of the UMR and OHR Basins below barriers impassable to fish is estimated to be $1.124 billion (2012 dollars). Changes in these values that would occur due to the implementation of a GLMRIS alternative plan would yield the change in NED and RED.

D.6.1.4 Future Without-Project Condition

The *impacts* associated with the FWOP condition associated with recreational fishing are not presented. Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since the fish species targeted by recreational fishermen have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, the baseline recreational fishing report demonstrates the value of recreational fishing activities within the GL, UMR, and OHR Basins that *could* be affected in the FWOP condition.

D.6.1.5 Future With-Project Condition

The *impacts* associated with the FWP condition associated with recreational fishing are not presented. In the FWP condition, new Federal action *is* taken to prevent the transfer of ANS between the basins. However, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future resource availability regarding fishing activities in the FWP condition. Since these management plans were not available, this assessment serves as a baseline of the recreational fishing activities within the GL, UMR, and OHR Basins that *could* be affected in the FWP condition.

D.7 CHARTER FISHING

D.7.1 Baseline Condition

D.7.1.1 Focus

As a part of the Fisheries Economics Team, Ohio State University's Sea Grant Extension Office generated the charter fishing baseline economic assessment that established the current economic value of the charter fishing industry in the US waters of the GL Basin. Due to the low number of respondents to the Mississippi River Basin river guide survey, statistically reliable information is not presented for this group. The value of the Great Lakes charter fishing industry serves as an indicator of a key aspect of the economy that is at threat in the future, with (FWP condition) or without (FWOP condition) the implementation of a GLMRIS project.

D.7.1.2 Method

To generate the charter fishing baseline economic assessment, a survey instrument was developed to obtain information about the practices of charter fishing captains in the GL Basin. Data collected for this the GL charter captain survey effort included information such as: revenues received from operating charter boat(s), location of the charter captains' homeports, primary water bodies that they operate on, etc. Survey responses were analyzed to determine various aspects of the current charter fishing industry.

D.7.1.3 Key Findings

Findings for the GL Basin charter fishing baseline economic assessment included:

- In 2011, there were an estimated 1,904 active licensed charter captains in the Great Lakes.
- Of these, approximately 1,700 captains operated as an independent small business, while another estimated 200 were non-boat owning captains. Together they generated between $34.4 million and $37.8 million in annual sales and salary, in 2011 dollars.
- Changes in these values that would occur due to the implementation of a GLMRIS alternative plan would yield a change in NED and RED.

D.7.1.4 Future Without-Project Condition

The *impacts* associated with the FWOP condition associated with charter fishing are not presented. Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since the fish species targeted by charter fishermen have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, the baseline charter fishing report demonstrates the value of charter fishing activities within the GL Basin that *could* be affected in the FWOP condition.

D.7.1.5 Future With-Project Condition

The *impacts* associated with the FWP condition associated with charter fishing are not presented. In the FWP condition, new Federal action *is* taken to prevent the transfer of ANS between the basins. However, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future resource availability regarding fishing activities in the FWP condition. Since these management plans were not available, this assessment serves as a baseline of the charter fishing activities within the GL Basin that *could* be affected in the FWP condition.

D.8 SUBSISTENCE FISHING

D.8.1 Baseline Condition

D.8.1.1 Focus

In support of the Fisheries Economics Team, Argonne National Laboratories (Argonne) completed the *Treaty Rights and Subsistence Fishing in the U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins Report* (Subsistence Fishing Report), which describes the practices of Native American subsistence fishers on reservation lands and beyond reservation boundaries under reserved treaty rights within the GL, UMR, and OHR Basins. The Subsistence Fishing Report provides baseline information on the cultural and economic value of subsistence fishing by Native American tribes on the Great Lakes and tributaries with unimpeded flow into the GL, UMR, and the OHR. This assessment of the subsistence fishing activities serves as an indicator of key cultural and economic values within the GL, UMR, and OHR Basins that are at threat in the future, with or without the implementation of a GLMRIS project.

D.8.1.2 Method

Subsistence fishing harvest data and information on the cultural and economic importance of subsistence fishing in the study area were received from tribal subsistence fishers and tribal governments, inter-tribal organizations, and state agencies. Among others, these included the following:

- Bad River Band of Lake Superior Chippewa Indians
- Fond du Lac Band of Lake Superior Chippewa Indians
- Grand Portage Band of Lake Superior Chippewa Indians
- Red Cliff Band of Lake Superior Chippewa Indians
- Sault Ste. Marie Tribe of Chippewa
- Chippewa and Ottawa Resource Authority
- Great Lakes Fish and Wildlife Commission
- 1854 Treaty Authority
- Michigan Department of Natural Resources
- Wisconsin Department of Natural Resources

D.8.1.3 Key Findings

Findings from this study include:

- There are 37 federally recognized tribes in the study area
- Sixteen tribes engage in subsistence fishing under one of four treaties, mostly in the western Great Lakes Basin
- Subsistence harvesting is an important part of tribal cultural heritage that has value that extends beyond economics, and is an important element in maintaining the sovereign status of the tribes
- The annual value of subsistence fishing activities to an individual subsistence household would be between $15,000 and $16,500 (2011 dollars)
- While a small proportion of tribal members engage in subsistence fishing, the subsistence harvest is shared according to traditional priorities throughout the communities

- Non-treaty tribes engage in less subsistence fishing, especially those with reservations close to urban areas where water bodies are more likely to be polluted and tribal members are more likely to be employed off of the reservation
- The main target species for subsistence fishers are walleye, whitefish, yellow perch, and trout; lake sturgeon is culturally important

Future changes to subsistence fishing due to the alternative plans considered in GLMRIS could affect the NED, RED, and OSE accounts.

D.8.1.4 Future Without-Project Condition

The *impacts* associated with the FWOP condition associated with subsistence fishing are not presented. Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since the fish species targeted by subsistence fishermen have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, the baseline Subsistence Fishing Report demonstrates the subsistence fishing activities within the GL, UMR, and OHR Basins that *could* be affected in the FWOP condition.

D.8.1.5 Future With-Project Condition

The *impacts* associated with the FWP condition associated with subsistence fishing are not presented. In the FWP condition, new Federal action *is* taken to prevent the transfer of ANS between the basins. However, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future resource availability regarding fishing activities in the FWP condition. Since these management plans were not available, this assessment serves as a baseline of the subsistence fishing activities within the GL, UMR, and OHR Basins that *could* be affected in the FWP condition.

D.9 PRO-FISHING TOURNAMENTS

D.9.1 Baseline Condition

D.9.1.1 Focus

The Fisheries Economics Team produced the *Pro-Fishing Tournaments in the U.S. Waters of the Great Lakes, Mississippi River, and Ohio River Basins* report (Pro-Fishing Tournament Report), which summarizes the elements of fishing tournaments which occur on the GL, the UMR, and the OHR. Given the vast number of tournaments which occur on the Great Lakes, Ohio River, and Upper Mississippi River and the varying information available, the analysis provides a snapshot of the fishing tournaments. The Pro-Fishing Tournament report illustrates the details of the various types of tournaments which occur by examining a small sample of these tournaments. This assessment of the GL, UMR, and OHR Basins' professional fishing tournaments serves as an indicator of a key aspect of the economy that is at threat in the future, with (FWP condition) or without (FWOP condition) the implementation of a GLMRIS project.

D.9.1.2 Method

This document uses a common definition of fishing tournament as defined by the State of Wisconsin, Department of Natural Resources: an organized fishing event, in which anglers fish for prizes or recognition in addition to the satisfaction of catching fish. General tournament criteria are regulated by each state's government (Department of Natural Resources or equivalent), which determines the necessity of a tournament permit. These permits serve to cover administrative costs or as a limiting factor to the number of fishing events which may occur on a particular water-body.

Tournaments which occur on the GL are typically restricted to the state-specific area of each lake and anglers are responsible for determining their own position using global positioning system (GPS) devices. However, for fishing events held on the UMR and OHR, states have reciprocity with regard to individual fishing licenses and state boundaries are not as restrictive.

D.9.1.3 Key Findings

Each tournament is regulated by its own set of rules, which generally vary in specificity or strictness depending on the seriousness or size of the tournament. General elements covered by tournament rules include entry fees, tournament dates and times, fishing boundaries, team structures, boat size and equipment descriptions, catch limits, fish weighing or measuring procedures, and point calculation and winner determination.

Tournaments are held for the purpose of competing and winning prizes, or as fundraisers for charitable organizations. Formats for tournaments include one-day or weekend catch-and-release events, derby style events which span an entire season, or tournament trails where anglers compete in a series of weekend tournaments and obtain cumulative points to determine an overall winner.

The availability of information on tournament fishing varies by state. On the Great Lakes, it is estimated that states such as Wisconsin or Minnesota host 450 to 700 fishing tournaments per year. It is estimated that there are fewer tournaments in states such as Illinois or Indiana. Based on a cursory analysis of fishing tournaments, bass fishing events seem to be particularly popular in all water-bodies researched.

Future changes to subsistence fishing due to the alternative plans considered in GLMRIS could affect the NED and RED, and OSE accounts.

D.9.1.4 Future Without-Project Condition

The *impacts* associated with the FWOP condition associated with professional fishing tournaments are not presented. Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since the fish species targeted by charter fishermen have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, the baseline pro-fishing report demonstrates the value of pro-fishing activities within the GL, UMR, and OHR Basins that *could* be affected in the FWOP condition.

D.9.1.5 Future With-Project Condition

The *impacts* associated with the FWP condition associated with pro-fishing fishing tournaments are not presented. In the FWP condition, new Federal action *is* taken to prevent the transfer of ANS between the basins. However, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future resource availability regarding fishing activities in the FWP condition. Since these management plans were not available, this assessment serves as a baseline of the pro-fishing activities within the GL, UMR, and OHR Basins that *could* be affected in the FWP condition.

D.10 COMMERCIAL CARGO NAVIGATION

D.10.1 Baseline Condition

D.10.1.1 Focus

The Commercial Cargo Navigation Team was tasked with assessing the impacts to commercial cargo navigation within the CAWS associated with the potential implementation of a GLMRIS alternative plan. The first step of this analysis was to characterize the commodities moving in and out of the CAWS, the vessels transiting the CAWS, and lockage utilization statistics associated with CAWS cargo traffic, which is described in the baseline economic assessment.

D.10.1.2 Method

The data sources for the baseline commercial cargo report are the following USACE databases: the Waterborne Commerce Statistics (WCS) and the Lock Performance Monitoring System (LPMS). The WCS are compiled from confidential monthly reports submitted by individual towing companies. The WCS contains detailed vessel trip and cargo data, including dock-to-dock commodity movements by individual commodity groups. In addition to the WCS, USACE maintains a second commodity data collection system referred to as the LPMS. The LPMS provides information on the use and performance of the Corps' national system of locks and the data is collected at most Corps-owned and/or operated locks through visual inspection and direct communication with towboat operators. The data includes the number of vessels and barges locked; type and dates of lockages; barge type and size; commodity type; tons carried and direction of movement.

D.10.1.3 Key Findings

The key statistics reported in the CAWS baseline assessment are the following:

- Since a spike to 25 million tons in 1994, traffic on the CAWS has remained flat to declining. After achieving a five year low in recession year 2010 at 13.2 million tons, CAWS shallow draft traffic, vessels with a draft less than fifteen feet, experienced a slight increase to 13.6 million tons. However, deep draft traffic, vessels with a draft of fifteen feet or greater, increased from 6.5 million tons in 2010 to 8.4 million tons in 2011. Over the last ten years, the CAWS has averaged 17.2 million tons of shallow draft traffic and 6.6 million tons of deep draft tonnage.
- In 2011, the total traffic was 22.0 million tons with the three main shallow draft commodities in the CAWS being coal (33 percent), iron and steel (15 percent), and aggregates (12 percent) and the three main deep draft commodities being coal (45 percent), ores and minerals (19 percent), and all other group (13 percent).
- In 2011, approximately 73 percent of CAWS shallow draft commercial cargo traffic is traveling towards Lake Michigan. However, deep draft tonnage was almost evenly split with 56 percent traveling upbound and 44 percent moving downbound.
- LPMS tonnages are consistently higher than the WCS tonnages in the CAWS. At Lockport, the difference in 2009 was approximately 11 percent, at O'Brien it was 13 percent and at Chicago it was 230 percent. Similar percentage discrepancies exist between the WCS and LPMS barge counts. Since the barge counts are based on observation by Corps personnel, this would suggest that there is no underreporting occurring in the LPMS system. It would also point to a possible underreporting problem in the WCS system. Such underreporting is not uncommon on the inland

waterway system, particularly in situations such as the CAWS where barges are routinely transferred between line-haul carriers and local towing companies.
- The tonnage and number of tows and barges on the CAWS increases as one moves away from the Lake Michigan. Brandon Road and Lockport Lock have the highest tonnages, largest tows, and greatest number of tows, while the smallest tows, least tonnage, and the smallest numbers of tows and barges pass through Chicago Lock.
- The average jumbo barge, which was the most common barge size transiting the three CAWS locks, has a capacity of 1600 tons. The average tow through Lockport in 2010 consisted of 3.9 barges carrying 4,006 tons, compared to 3.3 barges loaded with 3,309 tons at O'Brien and 1.1 barges loaded with 614 tons at Chicago.
- Upbound tows typically re-fleet above Lockport and exchange towboats for other boats with retractable pilot houses. The retractable pilot houses are necessary to clear low-hanging bridges throughout the Chicago Area. Refleeting is necessary because of limited channel width, channel circuitry and other restrictions such as the limitation of two barges per tow on the Chicago River and the North and South branches. Shippers are sometimes forced to light load because of shoaling in certain areas of the CAWS.

D.10.1.4 Future Without-Project Condition

D.10.1.4.1 Focus

Once the baseline economic assessment of CAWS traffic was completed, a FWOP condition report was generated, which identified the future commodity movements and transportation cost savings associated with moving commodities via the CAWS versus other modes of transportation (e.g., truck or rail). This FWOP condition established a basis for which FWP conditions were compared. The difference between transportation cost savings in the FWOP and the FWP condition yields the net impacts to cargo navigation movements on the CAWS, given the implementation of a GLMRIS project.

D.10.1.4.2 Method

To generate future commodity movements and transportation cost savings, the CAWS movements within each commodity group were analyzed. For some commodity groups, general industry growth rates, obtained from news reports, industry newsletters, and government forecasts, were applied. Interviews with shippers conducted by the University of Tennessee, Center for Transportation Research (UT-CTR) provided information on the elimination of current movements and the addition of potential future movements. To project CAWS commercial cargo tonnage levels, these growth rates and tonnages for future movements were applied to historical tonnage levels.

D.10.1.4.3 Key Findings

The forecast of potential traffic reflects the level of traffic that would be expected to materialize if new ANS technologies on the CAWS were not implemented. The FWOP condition projects commercial cargo traffic to demonstrate the following trends:

- CAWS traffic is projected to increase by six million tons (45 percent) by 2020, allowing traffic to recover to pre-recessionary levels.
- The largest increases are projected to be in the aggregates commodity group, consisting of sands, pebbles and crushed stone, limestone, and other related commodities; the all other commodity group consists of crude petroleum, asphalt, wood, cement, iron or steel scraps, paper, autos,

machinery, and other related commodities; the iron and steel commodity group consists of iron ore, pig iron, iron and steel bars, and other related commodities.

- Several reasons are given for expecting an increase in future CAWS tonnage, including: tonnage currently not being counted, company plans for expansion, and reversal of tonnage declines due to the recession that began in 2007.

D.10.1.5 Future With-Project Condition

D.10.1.5.1 Focus

The future with-project (FWP) condition report analyzes the impact to future commercial cargo navigation traffic associated with the various alternative plans considered in GLMRIS. The impact of the ANS alternatives to Chicago Area Waterways (CAWS) commercial cargo was measured in terms of affected tonnage, increased shipping costs, and reduced transportation rate savings.

D.10.1.5.2 Method

To estimate potential changes to National Economic Development (NED), each GLMRIS alternative was evaluated based on the following: 1) the tonnage impacted by the alternatives and 2) the loss in transportation rate savings. To calculate these measurements, the Commercial Cargo Tool (CCT) was used to identify the commercial cargo movements affected by each of the proposed GLMRIS alternatives, to estimate the potential changes in rate savings caused by the alternatives, and to create tables for presentation. The CCT relies on historical movement data, projected movement data through year 2020, and cost and rate data from the University of Tennessee, Center for Transportation Research (CTR) study. The output of the CCT were the tonnage affected by the alternative and the loss in transportation rate savings (i.e., increase in costs) associated with each alternative.

D.10.1.5.3 Key Findings

Key findings of the future with-project condition report are presented in the Table D.3. Average annual commercial cargo impacts demonstrate losses in NED, but also could change values associated with RED.

TABLE D.3 Commercial Cargo Navigation Impacts

GLMRIS Alternative Plan	Average Annual Commercial Cargo Navigation Impacts[1] (Million $)	Notes
No New Federal Action	$0.00	No losses in transportation cost savings are expected for this alternative.
Non-Structural	Not Evaluated; Likely Minimal	This alternative was not evaluated due to uncertainty regarding which non-structural measures would be implemented. There would likely be some losses in transportation cost savings for commercial cargo navigation, but these losses would likely be minimal and less than the amounts other alternatives.
Control Technology without a Buffer Zone - Flow Bypass	$0.75	This alternative includes adding locks in the CAWS or modifying existing locks, so commercial cargo movements are likely to be impacted by increased lockage times. Increased lockage times translate into greater overall shipping times which translate into decreases in transportation cost savings.
Control Technology with a Buffer Zone	$0.50	This alternative includes adding locks in the CAWS or modifying existing locks, so commercial cargo movements are likely to be impacted by increased lockage times. Increased lockage times translate into greater overall shipping times which translate into decreases in transportation cost savings.
Lakefront Hydrologic Separation	$211.77	In this alternative, both shallow draft and deep draft commodity movements could no longer occur on the CAWS and would need to switch to truck or rail, find alternative sources for input, sell their output in different markets, or shut down. Since the tonnage moving past the Lakefront hydrologic separation barriers is less than the tonnage moving past the Mid-System hydrologic separation barriers, this alternative has less of an impact to commercial cargo transportation cost savings.
Mid-System Hydrologic Separation	$251.76	In this alternative, many shallow draft movements could no longer occur on the CAWS and would have to switch to truck or rail, find alternative sources for input, sell their output in different markets, or shut down. Deep draft movements not affected by physical barriers could still occur on the CAWS. Since the tonnage moving past the Mid-System hydrologic separation barriers is greater than the tonnage moving past Lakefront hydrologic separation barriers, this alternative has a greater impact on commercial cargo transportation cost savings.
Hybrid - Mid System Separation Cal-Sag Open	$7.30	In this alternative, some of the shallow draft movements could no longer move on the CAWS and would need to switch to truck or rail, find alternative sources for input, sell their output in different markets, or shut down. Some shallow draft movements that could still occur would need to take new routes in order to avoid the physical barriers. Since not all movements are forced off of the waterway, the loss in transportation cost savings is less than the alternatives recommending complete hydrological separation.
Hybrid - Mid System Separation CSSC Open	$8.83	In this alternative, some of the shallow draft movements could no longer move on the CAWS and would need to switch to truck or rail, find alternative sources for input, sell their output in different markets, or shut down. Some shallow draft movements that could still occur would need to take new routes in order to avoid the physical barriers. Since not all movements are forced off of the waterway, the loss in transportation cost savings is less than the alternatives recommending complete hydrological separation.

[1] Normally, it takes fewer resources to move bulk commodities via waterways (waterborne transportation) than it is on land (i.e., via truck and rail). The difference between the costs of moving commodities on land and the cost of moving them on the waterway is called "transportation cost savings." This column displays the *losses* in transportation cost savings if a GLMRIS alternative is implemented. Several of the GLMRIS alternative plans include measures that would decrease the efficiency of moving goods on the waterway, so the cost of shipping these goods via waterways increases. Therefore, there are fewer savings associated with moving the goods via water versus land. *The greater the losses in transportation cost savings, the greater the cargo navigation impacts. These impacts represent the losses of national economic development (NED).*

D.11 NON-CARGO NAVIGATION

D.11.1 Baseline Condition

D.11.1.1 Focus

The Non-Cargo Navigation Team was tasked with assessing the impacts to non-cargo navigation (i.e., passenger, recreational, and government vessels) given the potential implementation of the alternative plans considered in GLMRIS. The first step of this analysis was to establish a characterization of current non-cargo vessels and their lock usages via a baseline economic assessment. Specifically, the baseline economic assessment of non-cargo CAWS traffic includes an appraisal of historical commercial passenger, recreation, and governmental vessel traffic through the locks and a description of the lock operations.

D.11.1.2 Method

The primary sources of data for this report were the Lock Performance and Monitoring System (LPMS) and the Waterborne Commerce Statistics Center (WCSC). These data sources provided information on the number and kinds of vessels using the locks by year for the eleven-year period ending 2010. Additionally, users of the locks report passenger counts for commercial passenger vessels which are captured in this assessment.

D.11.1.3 Key Findings

Descriptions of the CAWS infrastructure including the Chicago Lock, the O'Brien Lock and Dam, Lockport Lock and Dam, Brandon Lock and Dam, and the Wilmette Pumping Station include construction year, size, lock type, operational status and responsibility, and other pertinent information. The locks examined have the following average one-way trips by non-cargo vessels on an annual basis:

- Chicago Lock has the majority of the non-cargo lock traffic of all the locks examined with about 41,000 one-way trips
- O'Brien Lock sees about 19,000 trips
- Lockport Lock sees about 1,000 trips
- Brandon Lock sees about 1,200 trips
- Wilmette Pumping Station does not have vessel crossings

Commercial passenger counts are provided by ship captains to the lock operators as they proceed through the locks. The Chicago Lock sees the majority of passengers traveling through the locks as they enjoy the various offerings of the commercial passenger vessels with sunset cruises, fireworks displays, and lake and city tours. Following is the average passenger counts for the 11 years examined:

- Chicago Lock had an annual average of 712,000 passengers
- O'Brien Lock had an annual average of 19,000 passengers
- Lockport Lock has very few passengers with annual average of 164 people
- Brandon Lock also has few passengers with annual average of 148 people
- Wilmette Pumping Station has no passengers
- The Chicago Park District has nine lakefront harbors that stretch from Lincoln Park in the northern part of the city to Jackson Park in the south. With accommodations for more than

5,000 boats, the Chicago Park District Harbors constitute the nation's largest municipal harbor system and feature state-of-the-art floating docks, moorings, star docks, fuel facilities and other amenities for Chicago boaters and their guests. The harbors are very popular with area boaters and have enjoyed occupancies in excess of 98 percent for the past several years.

D.11.1.4 Future Without-Project Condition

D.11.1.4.1 Focus

The Non-Cargo Navigation Team then completed a FWOP condition assessment. This effort serves to quantify the economic activity associated with the CAWS that is subject to damage as a result of implementation of the alternative plans considered in GLMRIS.

D.11.1.4.2 Method

The primary sources of data for this report were interviews conducted with passenger vessel companies and other non-cargo groups utilizing the CAWS, along with an electronic survey effort conducted between November 2011 and January 2012 of recreational boater CAWS users. These data sources provided information on how passenger vessel companies, government and public service organizations, and recreational boaters are likely to utilize the CAWS under without project conditions. Additionally, Census data was gathered for the population of Illinois in order to forecast growth in the recreational use of the CAWS over the project period, which is captured in this assessment.

D.11.1.4.3 Key Findings

Passenger vessel companies utilizing the CAWS provided round trip tours for an average of over 355 thousand passengers going through the lock between 2000 and 2010, with fairly consistent demand over that period. The passenger vessel companies interviewed for this analysis employed almost 1,100 workers in 2010 (including full time, part time, year round, and seasonal workers). Conditions are forecasted to remain flat for passenger vessel companies over the study period.

Based on revenue and expense information obtained from passenger vessel companies, the present value of revenues for commercial passenger businesses utilizing the Chicago Locks over the 50-year period of analysis is $776.2 million with an average annual value of $36.1 million. While the present value of expenses for commercial passenger businesses utilizing the Chicago Locks over the 50-year period of analysis is $643.9 million with an average annual value of $30 million.

The value of commercial passengers recreation experience under without-project conditions was estimated using the unit day value method. An average of 355,951 commercial passengers make round trips through the Chicago Lock annually. The present value for those passengers utilizing the Chicago Locks over the 50-year period of analysis is $69.5 million with an average annual value of $3.2 million.

Unit day value was also utilized to determine the value of recreational boating through the CAWS. Based on lock data and survey results, it was determined that an average of 64,795 passengers transit the Chicago Lock annually for recreational purposes. The present value of small craft recreation for those passengers utilizing the Chicago Locks over the 50-year period of analysis is $13.8 million with an average annual value of $645,000.

Recreational (small craft) owner willingness to pay to keep the locks open was also determined. According to GLMRIS Chicago Area Waterway System Non-Cargo Lock User Survey Results, 72 percent of respondents were mostly or fully against permanent lock closure (3,552 boats). The lower bound average willingness to pay was $1,591 per boater, and the upper bound was $2,127 per boater. Average annual willingness to pay for the estimated 3,552 boat owners that moor in the Chicago area ranged from $5.9 million to $7.9 million. Total present value ranged from $127 million to $169 million.

Recreational boaters in the Chicago area who transport their vessel between a winter storage location and summer moorage incur a transportation cost for the seasonal mobilization of their vessels. Using data for hourly operation costs for a charter vessel as a proxy, a low end estimate for hourly operation cost of $42 was determined for recreational vessels. However, costs could be estimated to go as high as $75 per hour. Therefore, average annual cost for seasonal mobilization for the estimated 3,359 boat owners ranged from $636,000 to $1.1 million. Total present value ranged from $13.7 million to $24.6 million.

The future without-project condition for the US Coast Guard, Chicago Marine Safety Station, Chicago Fire Department, Chicago Police Department, and the Illinois Department of Natural Resources are unchanged from the baseline conditions except for normal fluctuations in responses and funding.

A summary of the FWOP condition non-cargo lock user activity, including the total present value for each category, includes the following. Note that Present Value is calculated utilizing the FY13 discount rate of 3.75% and a 50-year period of analysis. Totals are rounded to the nearest hundred thousand.

- Commercial Passenger Business Revenues: $776,200,000
- Commercial Passenger Business Expenses: $643,900,000
- Commercial Passenger Unit Day Value: $69,500,000
- Recreational User Unit Day Value: $13,800,000
- Recreational User Willingness To Pay to Keep Locks Open: $127 million to $169 million
- Recreational User Transportation Cost (Seasonal Mobilization): $13.7 million to $24.6 million

D.11.1.5 Future With-Project Condition

D.11.1.5.1 Focus

The Non-Cargo Navigation Team completed a FWP condition assessment of non-cargo traffic within the CAWS. This assessment qualitatively describes the impacts to non-cargo users given the potential implementation of the various GLMRIS alternative plans.

D.11.1.5.2 Method

The primary sources of data for this FWP condition report were interviews conducted with passenger vessel companies and other non-cargo groups utilizing the CAWS, along with an electronic survey effort conducted between November 2011 and January 2012 of recreational boater CAWS users. These data sources provided information on the how passenger vessel companies, government and public service organizations, and recreational boaters are likely to change utilization of the CAWS under with-project conditions.

D.11.1.5.3 Key Findings

The Chicago Park District has nine lakefront harbors with accommodations for more than 5,000 boats. However, these 5,000 moorages spaces should not be considered an exhaustive list of moorage space within the CAWS. Between 2000 and 2010 there was an average of 50,000 recreation vessels using the Chicago River Controlling Works, the T J O'Brien, Lockport, and the Brandon Road locks and dams. Based on the boater survey conducted by Argonne and USACE, recreation boats generally have between 1 and 6 passengers. We also know that between 600,000 and 800,000 passengers go through the locks annually via one of the Passenger Vessel Association vessels. Government vessels (police, fire, rescue, and research vessels) made more than 2,000 trips through the locks during this same time. Most of these vessels pass through the Chicago River Controlling Works Lock. The number of vessels passing through the T.J. O'Brien, Lockport, and Brandon locks is much smaller but impacts are no less significant to those vessels that must modify their behavior for the alternatives under consideration.

The following basic assumptions are used to determine the impacts from each of the alternatives:

1. Historical vessel traffic forms the basis for future traffic.
2. Concrete dams will be impassable for non-cargo vessels.
3. Electric barrier measures are consistent with existing operations and include:
    a. Vessels 20-feet and less may not pass through the electric barriers.
    b. Kayaks may not pass through the electric barriers.
    c. Yachts and sailboats of sufficient length may pass through the electric barriers provided other operating criteria are met.
4. Treatment plants will be effective in addressing potential ANS transfer via aquatic pathways.
5. Non-structural measures currently under consideration will not interfere with vessel operations.
6. The number of people wanting to use the CAWS and Lake Michigan for recreation will not diminish as a result of implementation of any of these alternatives.

Highlights of the findings in decreasing order of magnitude are:

- Lakefront basin separation measures are the most damaging to the non-cargo users of the CAWS.
    - Some Passenger Vessel Association members will elect to shut down their businesses.
    - Recreation boat owners using the CAWS will have to find alternate means to transport boats to Lake Michigan.
    - Recreational experiences that highlight transport through the locks will be diminished as a result of basin separation measures.
    - Governmental operations and expenses will increase as duplicate services will need to be provided on both sides of the separation.
    - High water events will occur more frequently.
- Mid-system basin separation measures will cause similar damages to the non-cargo users of the CAWS but will not be as damaging as the lakefront separation measures.
- Electric barriers will cause damages to some users and may prohibit smaller vessels from passage.
- Non-structural measures may impact recreational boaters and fishers, additional fees may be borne by those wanting to use the CAWS or the adjoining lake waters.

These key findings are summarized in Table D.4. Impacts to non-cargo navigation would result in changes to NED, RED, and OSE.

TABLE D.4 Non-Cargo Navigation Impacts

GLMRIS Alternative Plan	Impacts	Notes
No New Federal Action	None	• Non-cargo vessels would continue current operations.
Non-Structural	Low	• Could require additional time/special license to operate in these environments. • May impact ability to harvest targeted fish species. • May be additional costs associated with the measures. • The net value of the recreational experience for tour boat passengers, recreational fishermen, and recreational boaters may decrease.
Control Technology without a Buffer Zone - Flow Bypass	Low	• The construction of 2 new locks will require additional time for vessels making the loop. • Passenger and government vessels will experience additional costs and delay when taking a trip through the location of the new locks. • Vessels under 20-feet will not be able to pass through the electronic barriers.
Control Technology with a Buffer Zone	Medium	• Two new physical barriers and three electronic barriers are added. • Police/fire/other government vessels will need to incur additional expense in order to maintain the same level of service. The potential impact to emergency response vessels represents a safety issue. • Additional effects to vessels that must travel through electric barriers. • Additional costs to non-cargo lock users as they attempt to maintain previous usage, find alternate means of reaching their destination, and/or find alternate destinations for boat repairs, fishing, or other recreation activity. • The physical barriers may increase the frequency of high water events on the CAWS. • The value of the recreation experience for tour boat passengers, recreational fishermen, and recreational boaters may decrease. Vessels under 20-feet will not be able to pass through the electronic barriers.
Lakefront Hydrologic Separation	High	• Four physical barriers are added. • High impacts to all lock users. • Passenger/non-cargo vessels currently utilizing the locks would be severely impacted. • Police/fire/other government vessels will need to incur additional expense in order to maintain the same level of service. Emergency response vessels will be impacted which is a safety issue. • There will be additional cost to non-cargo lock users as they attempt to maintain previous usage, find alternate means of reaching their destination, and/or find alternate destinations for boat repairs, fishing, or other recreation activity. • The physical barriers may increase the frequency of high water events on the CAWS. • The value of the recreation experience for tour boat passengers, recreational fishermen, and recreational boaters may decrease.
Mid-System Hydrologic Separation	Medium	• Two new physical barriers. • Impacts vessels attempting to do the loop. • Government agencies may have to duplicate some services if their jurisdictions extend beyond the barriers. • Passenger and government vessels may be affected by additional high water events.
Hybrid – Mid System Separation Cal-Sag Open	Medium	• Three physical barriers and 2 electric barriers may impact vessels attempting the loop. • Additional effects to vessels that must travel through electric barriers. • Some government agencies may have to duplicate services if their jurisdictions extend beyond the barriers. Passenger and government vessels may be affected by additional high water events. • Vessels under 20-feet will not be able to pass through the electronic barriers.
Hybrid – Mid System Separation CSSC Open	Medium	• One physical barrier and two electronic barriers. • Impacts vessels attempting to do the loop. • Additional effects to vessels that must travel through electric barriers. • Government agencies may have to duplicate services if their jurisdictions extend beyond the barriers. Passenger vessels and government vessels may be affected by additional high water events. • Vessels under 20-feet will not be able to pass through the electronic barriers.
*Estimated impacts are based on professional judgment and the relative number of non-cargo lock users who might be impacted. These impacts represent qualitative assessments of potential losses in national economic development (NED) estimates.		

D.12 FLOOD RISK MANAGEMENT

D.12.1 Baseline Condition

D.12.1.1 Focus

The Flood Risk Management (FRM) Team was tasked with assessing the flood risk impacts associated with the potential implementation of the various alternative plans considered in GLMRIS. The first step of this analysis was to complete a baseline economic assessment, which characterizes the flood risk in the Chicago Metro Area from both overland flooding and sewer backup flooding. The area of interest encompasses over 200 square miles of the Chicago Metro Area, including the Chicago River, the Chicago Sanitary and Shipping Canal, the Calumet-Saganashkee Canal, and part of the Calumet River. The area also includes sewer basins with outlets to the Chicago Area Waterways that could be impacted by a hydrologic separation alternative. This study analyzes physical damages to buildings and their contents, as well as other types of infrastructure such as rail yards, power equipment, etc.

D.12.1.2 Method

Data was collected for all structures in the area of interest that are susceptible to flooding. Structure values and elevations were compared to water surface elevations in order to estimate damages caused by sewer backup and overland flooding. Expected annual damage (EAD) was calculated for the base year (2017). EAD in the base year is the amount of damage that is expected to occur on an annual basis between the years 2017 and 2029. The year 2017 was chosen because it is the year the Thornton Reservoir and the McCook Phase I Reservoir are expected to begin operating to manage flood risk. The estimates of EAD contain a great deal of uncertainty, due to the myriad of unknowns in water surface elevations, values of infrastructure, elevations of homes and businesses, and susceptibility of infrastructure to flood damage. Therefore, EAD is presented as a distributed variable with confidence limits.

D.12.1.3 Key Findings

For the base year, the mean value of EAD is $254 million with a 75% chance that EAD is greater than $118 million, a 50% chance that it is greater than $178 million, and a 25% chance that it is greater than $324 million. The most likely value of EAD is $110 million.

Approximately 89.5% ($227 million) of the mean EAD is attributable to sewer backup flood, and 11.5% ($27 million) is attributable to overland flooding.

Approximately 43% ($110 million) of the total damage occurs to Residential structures, while 57% ($144 million) occurs to commercial, industrial, or public structures.

D.12.2 Future Without-Project Condition

D.12.2.1 Focus

The FRM Team then generated a FWOP condition assessment, which characterizes foreseeable changes in flood risk in the Chicago Metro Area, assuming no new Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins. Again, the area of interest encompasses the Chicago Metro Area, including the Chicago River, the Chicago Sanitary and Ship Canal (CSSC), the Calumet-Saganashkee Canal, and part of the Calumet River. The area also includes sewer basins with outlets to the Chicago Area Waterways that could be impacted by hydrologic separation measures (which are included in some of the GLMRIS alternative plans). This study analyzes physical damages to buildings and their contents, as well as other types of infrastructure such as rail yards, power equipment, etc.

D.12.2.2 Method

Expected annual damage (EAD) was calculated for the future year (2029). EAD in the future year is the amount of damage that is expected to occur on an annual basis between the years 2029 and 2067. The year 2029 was chosen because it is the year the McCook Phase II Reservoir is expected to begin operating to manage flood risk. The operation of this reservoir was determined to be the most significant factor in future flood risk conditions. The estimates of EAD contain a great deal of uncertainty, due to the myriad of unknowns in water surface elevations, values of infrastructure, elevations of homes and businesses, and susceptibility of infrastructure to flood damage. Therefore, EAD is presented as a distributed variable with confidence limits.

D.12.2.3 Key Findings

For the future year, the mean value of EAD is $215 million, with a 75% chance that EAD is greater than $102 million, a 50% chance that it is greater than $151 million, and a 25% chance that it is greater than $271 million. The most likely value of EAD is $91 million.

Approximately 90.3% ($194 million) of the mean EAD is attributable to sewer backup flood, and 9.7% ($21 million) is attributable to overland flooding.

Approximately 43% ($92 million) of the total damage occurs to residential structures, while 57% ($122 million) occurs to commercial, industrial, or public structures.

D.12.3 Future With-Project Condition

D.12.3.1 Focus

The FRM Team also developed a FWP condition assessment, which characterizes foreseeable flood risk impacts associated with the various alternative plans considered in GLMRIS. The area of interest is the same as the FWOP condition. This study analyzes physical damages to buildings and their contents, as well as other types of infrastructure such as rail yards, power equipment, etc.

D.12.3.2 Method

Expected annual damage (EAD) was calculated for the base year (2017), and the future year when stage two of the McCook Reservoir comes online (2029). While the two hydrologic separation alternatives considered in GLMRIS (Lakefront and Mid System) were analyzed, the FRM Team also identified the areas that would experience a change in flood risk based on the remaining alternatives (some of which include hydrologic separation measures as well). The change in flood risk in these areas were estimated, yielding a net change in equivalent expected annual damages (EEAD) associated with each alternative plan considered in GLMRIS.

D.12.3.3 Key Findings

The key findings for this assessment are demonstrated in Table D.5. Net changes in EEAD demonstrate changes in NED, but could also have effects on RED and OSE.

TABLE D.5 Flood Risk Management Impacts

GLMRIS Alternative Plan	Equivalent Expected Annual Damage – Net Change[1] (EEAD); ($1000s)	Notes
No New Federal Action	$0	This alternative yields the same level of flood risk as the without-project condition, and therefore has no net change in EEAD.
Non-Structural	$0	This alternative yields the same level of flood risk as the without-project condition, and therefore has no net change in EEAD.
Control Technology Without a Buffer Zone – Flow Bypass	$1,100	This alternative yields a net change in EEAD due to the locks at Stickney and Alsip, Illinois that cannot be opened during storm events.
Control Technology With a Buffer Zone	$570	This alternative has a similar level of flood risk in the study area as the No New Federal Action plan in the Chicago area, but an increased level of flood risk in the Indiana area.
Lakefront Hydrologic Separation	$65,900	This alternative yields a net change in EEAD due to physical barriers at Wilmette, Calumet City and Chicago, Illinois, and Hammond, Indiana.
Mid-System Hydrologic Separation	$1,100	This alternative yields a net change in EEAD due to physical barriers at Stickney and Alsip, Illinois.
Hybrid – Mid System Separation Cal-Sag Open	$28,000	This alternative yields a net change in EEAD due to physical barriers at Stickney Illinois, along the state line between Illinois and Indiana, and Hammond, Indiana.
Hybrid – Mid System Separation CSSC Open	-$26,400	This alternative yields a reduction in overall EEAD when compared with the without-project condition. For this alternative, a barrier would be located at Alsip, Illinois on the Cal-Sag Channel and both the T.J. Obrien Lock and Controlling Works on the Calumet River and the Chicago Controlling Works along the Chicago River would be opened to allow for flood water to continually be released into Lake Michigan during infrequent storm events. Allowing discharge to Lake Michigan allows for stage reductions during flood events. Further, the barrier at Alsip would reduce the amount of flow that currently passes westward on the Cal-Sag Channel during flood events. The barrier would limit flows to portions of the river that lie westward of the Alsip barrier, providing reductions in flood stages west of the barrier. In combination, the effects of allowing floodwaters to enter Lake Michigan during flood events coupled with stage reductions west of the barrier along the Cal-Sag channel result in an overall decrease in EEAD within the CAWS region as compared to the without-project condition.

[1] This column displays the equivalent expected annual damages associated with implementing each GLMRIS alternative plan. In the without-project conditions, damages are expected to occur to various structures. However, the implementation of a GLMRIS plan will either increase the total damages in the Chicago area (represented as positive values in this column) or decrease total damages in the Chicago area (negative value). Specifically, the values presented represent the net change between the without-project (EEAD of $232.2 million) and the with-project conditions. Positive values represent induced damages in the Chicago area; negative values represent a reduction in damages in the Chicago area. *Changes in EEAD represent the changes to the NED account.*

D.13 WATER QUALITY

D.13.1 Chicago Area Waterway System

D.13.1.2 Baseline Condition

D.13.1.2.1 Focus

The purpose of this assessment is to establish a baseline of water quality for users in the CAWS, as well as the costs associated with that water usage. A brief description of the locks and their locations that exist in the system and their water usage needs is also provided. Estimates of usage needs/discharges per day were compiled for the major water users/dischargers. The costs associated with water withdrawals and discharges were evaluated for the three waste water treatment plants (WWTPs) within the CAWS (North Side, Calumet, and Stickney). Water treatment costs were considered in light of meeting current water quality standards. The baseline economic assessment serves as an indicator of aspects of water quality that could change in the FWOP and FWP conditions.

D.13.1.2.2 Method

The primary sources of data for this report were the GLMRIS Environmental Team's databases of withdrawals and discharge permits, the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC), the 2012 budget of the MWRDGC and such planning documents as the Chicago Metropolitan Agency for Planning, *Water 2050, Northeastern Illinois Regional Water Supply Demand Plan.* These data sources provided information on the existing sources of supply of water to the CAWS, information on the number and kinds of water users that are in the Chicago Metropolitan area, and water treatment costs for the three waste water reclamation plants.

D.13.1.2.3 Key Findings

The main sources of water that enters the CAWS have been identified, as well as a description of the main water users of the CAWS and their current water needs/discharges. Major findings include:

- Lock system locations and water usage needs
- Estimate of CAWS water supply by source
- Estimate of Water usage needs/discharges per day by major user
- The three WWTPs (North Side, Calumet and Stickney) are the major contributors (60%) of water flow to the CAWS
- The location of the three waste water reclamation plants
- Estimate of existing operation and maintenance (O&M) costs (for year 2012) for the three WWTPs

Estimates of the annual O&M costs for the North Side, Calumet, and Stickney WWTPs are displayed in Table D.6.

Table D.6 Annual Operation and Maintenance Costs: North Side, Calumet and Stickney Water Treatment Plants

Waste Water Treatment Plant	Estimated Annual Operation and Maintenance Costs (2012 Dollars)
North Side	$27,096,713
Calumet	$36,435,174
Stickney	$87,547,800
Note: Estimates of operation and maintenance costs include the following activities: collection and treatment, solids processing, solids utilization, flood and pollution control, and general support.	

D.13.2 Lake Michigan

D.13.2.1 Baseline Condition

D.13.2.1.1 Focus

The *Baseline Economic Assessment of Water Quality – Lake Michigan Beaches* identifies the number of beaches that currently exist in Chicago's 28 miles of shoreline. This document provides the location and amenities offered at these beaches, as one travels geographically from north to south along the Chicago shoreline. An estimate of the value of beach usage was also identified.

D.13.2.1.2 Method

This evaluation used secondary sources to identify the location and number of public beaches in the Chicago area that are located on Lake Michigan. The primary source of the data was taken from the Chicago Park District web page. Beach descriptions were obtained from Wikipedia. Chicago neighborhood maps were obtained from Lucid Reality. Most aerial photos were from Bing maps. Information on individual beaches came from various internet web sites.

D.13.2.1.3 Key Findings

There are 77 communities in the Chicago area. This evaluation was restricted to the number of public beaches that were located in the 16 shoreline communities of the city of Chicago: Rogers Park, Edgewater, Uptown, Lakeview, Lincoln Park, Near North Side, Chicago Loop, Near South Side, Douglas, Oakland, Kenwood, Hyde Park, Woodlawn, South Shore, South Chicago, and East Side.

The keys findings of the existing condition evaluation include:

- *Number of Beaches-Beaches Affected* – There are 33 beaches, 28 of which could be impacted by changes in water quality (algae growth, turbidity, E. Coli), due to implementation of an ANS control measure.
- *Number Of Beach Visits* – There were over 20 million beach visits in 2004.
- *Value OF The Beach Season* - The total value of the 2004 beach season was placed at $800,000,000.
- *Value of The Beach Season Lost Due to Beach Closings* – It is estimated that the 2004 beach season lost $17 million of beach value due to beach closings (i.e., swimming bans due to poor lake quality).

D.13.3 Future Without-Project Condition

D.13.3.1 Chicago Area Waterway System

D.13.3.1.1 Focus

This FWOP condition assessment of water quality within the CAWS built on the findings of the CAWS baseline economic assessment of water quality. While, the baseline report identified existing water treatment costs (for year 2012) for the North Side, Calumet and Stickney WWTPs, the purpose of this evaluation is to identify the future water treatment costs for these WWTPs in the FWOP condition. Water treatment costs are expected change due to alterations in water quality standards that dischargers into the CAWS must meet.

The estimates of water treatment costs in the FWOP condition for these facilities have three key components: existing plant O&M costs as of 2012, O&M costs associated with plant improvements that will take place between 2012 and the first project year (2017), and known plant improvement plans that address discharge water disinfection.

The report also included an identification of the CAWS's major user groups such as commercial, industrial and public water users, and the level of their usage (withdrawal, discharge) over the project evaluation period. Withdrawal users include public and private groups. Discharge groups include WWTPs (North Side, Calumet, and Stickney WWTPs), commercial user/dischargers, and other dischargers.

Estimates of usage needs/ discharges per day were compiled for the main user groups for the FWOP condition. A brief description of usages that will exist in the CAWS in the future was provided. Usages by user group included commercial navigation, non-cargo navigation (water taxis, tour boats, charter boats) and recreation (private boaters, kayaks, rowing).

D.13.3.1.2 Method

Illinois EPA indicated that water quality standards for the CAWS are currently under review, and will change in the future. Limits on various chemical loads are under review, as well as the future need for water disinfection. The current indication is that these water quality standards for the CAWS will become more stringent, as higher water usage goals for the CAWS are pursued. There is also the possibility that the water quality standards for Lake Michigan will change in the FWOP condition. The timing of when these new water quality standards will be implemented will impact water usage costs over the FWOP condition's 50-year evaluation period.

This evaluation used secondary information sources that were available to identify water treatment costs for the three main WWTPs – to include North Side, Calumet, and Stickney. The primary sources of data for this report were the Environmental Team databases of withdrawals and discharge permits, the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC), MWRDGC 2012 budget, and the *Evaluation of Disinfection Technologies for the Calumet and North Side Water Reclamation Plants, Technical Memorandum 3, February 17,2012*, from the Disinfection Task Force to the Disinfection Task Force Advisory Committee.

D.13.3.1.3 Key Findings

Some of the key findings of the report include:

- General description of water usages that will exist under FWOP conditions in the CAWS
- Estimate of CAWS water supply by source
- Estimate of water usage needs/discharges per day by major user
- North Side, Calumet and Stickney WWTPs future O&M costs associated with water treatment
- Description of Without Project condition Water Discharge Standards for the CAWS
- How Future Water Quality Standards Impact CAWS Water Usage
- Estimate of new chlorination costs for the North Side and Calumet plants

Table D.7 Baseline and FWOP Condition Annual Operation and Maintenance Costs: North Side, Calumet and Stickney Water Treatment Plants

Waste Water Treatment Plant	Estimated Annual Operation and Maintenance Costs (2012 Dollars)
North Side	$29,161,713
Calumet	$39,989,174
Stickney	$156,698,687

D.13.4 Lake Michigan

D.13.4.1 Focus

The Lake Michigan FWOP condition water quality assessment identifies the number of beaches that would be extant under the FWOP condition in Chicago's 28 miles of shoreline, as well as future expected beach usage.

D.13.4.2 Method

This assessment builds on the baseline assessment, and estimates the number of existing and new beaches that will exist under FWOP conditions. The analysis assumes all current and new beaches will remain in existence over the project evaluation period, and that no further action is taken to prevent the transfer of ANS between the GL and Mississippi River Basins.

This evaluation used secondary sources to identify the location and number of public beaches in the Chicago area that are located on Lake Michigan. The primary source of the data was taken from the Chicago Park District Web page. Beach descriptions were obtained from Wikipedia. Chicago neighborhood maps came from Lucid Reality. Most aerial photos were from Bing maps. Information on individual beaches came from various internet web sites. Information on future beaches came from various new public beach initiatives.

D.13.4.3 Key Findings

Out of the 26 miles of Chicago Lakefront, about 2 miles on the south lakefront and 2 miles on the north lakefront remain undeveloped, unconnected and blocked from public use. The report identifies new beach initiatives for Chicago's Lake Michigan shoreline, such as: *The Last Four Miles: A Plan to Complete Chicago's Lakefront Parks* in 2009 by the Friends of the Parks.

D.13.4.4 Future With-Project Condition

The Water Quality Team did not complete an assessment of the impacts associated with the implementation of the alternative plans considered in GLMRIS due to several key pieces of information that were not available at the time of the WQ economics study. These key pieces of information which were not available for the CAWS water quality assessment include:

(1) Future With-Project water quality conditions. Water quality modeling results for Lake Michigan and the CAWS were not available at the time of the economics study. Water quality modeling performed for the CAWS and Lake Michigan, shown in Appendix F - Water Quality analyses, and the economics study were completed simultaneously.

(2) Water quality modeling performed for Lake Michigan, shown in Appendix F – Water Quality Analyses, simulated future water quality conditions near drinking water intake structures. The modeling did not simulate impacts to each of the Lake Michigan beaches; therefore, a number of future beach closure days could not be forecasted. The number of beach closure days would be expected to increase for GLMRIS Alternatives where there are uncontrolled discharges to Lake Michigan. The number of beach closure days may decrease for the Lakefront Separation Alternative, where FRM mitigation measures are designed to capture a greater proportion of backflows from the CAWS to Lake Michigan.

Net changes in water quality would yield changes to NED, EQ, RED and OSE.

D.14 WATER SUPPLY

D.14.1 Baseline Condition

D.14.1.1 Focus

The Water Supply Team was tasked with producing a baseline economic assessment of water use for water originating from Lake Michigan, diverted via cribs along the Illinois shoreline, and distributed to users in the Chicago Area. Specifically, the water supply baseline assessment is a summary of key documents pertaining to the Chicago area's water resources, demands, and future needs. This water supply economic assessment serves as a baseline of aspects of water supply that could change in the FWP conditions.

As communities and water users often rely on more than one source of water, and may rely more heavily on water diverted from Lake Michigan in the future, water use in Northeast Illinois as a whole is also examined. The assessment provides summary information from several interconnected reports examining the region's water resources, demands and future needs. Significant forethought, planning and cooperation concerning water supply and demand are already underway by a large group of vested stakeholders in Northeast Illinois. The Northeast Illinois Regional Water Supply Planning Group (RWSPG) was formed to consider future water supply needs of Northeast Illinois and to develop plans to guide future use. The main user sectors considered in the assessment include public users, industrial and commercial users, irrigation and agriculture, make-up power plants and flow-through power plants.

The assessment also summarizes the Supreme Court Decree which specifies several limitations on the diversion of Lake Michigan water by the State of Illinois. The main components of the Lake Michigan Diversion include domestic pumpage from Lake Michigan used for water supply and not returned to Lake Michigan, stormwater runoff from the diverted Lake Michigan watershed, and direct diversions through lakefront control structures. Direct diversion consists of lockage, leakage, navigational makeup flow and water quality dilution.

D.14.1.2 Method

The following reports were reviewed and summarized:

- Water 2050, Northeastern Illinois Regional Water Supply Demand Plan (2010)
- Regional Water Demand Scenarios for Northeastern Illinois:2005-2050 (2008)
- Opportunities and Challenges of Meeting Water Demand in Northeastern Illinois (2012)
- Lake Michigan Diversion Accounting Reports and Findings of the Sixth Technical Committee for Review of Diversion Flow Measurements and Accounting Procedures

The information presented in this assessment is not based on primary data collection.

D.14.1.3 Key Findings

Northeast Illinois water supplies are provided by Lake Michigan, inland surface waters of the Chicago Sanitary and Ship Canal, the Cal-Sag Channel, and the Chicago, Des Plaines, Fox, Illinois and Kankakee Rivers and groundwater sources (shallow and deep aquifer). Three future water demand scenarios forecasted to the year 2050 have been adopted by water resource planners: the Baseline (Current Trends), the Less Resource Intensive and the More Resource Intensive Scenarios. Population growth in Cook and Collar Counties is expected to be the main driver of increased water demand. The majority of the region's water comes from Lake Michigan, allocated to approximately 200 communities. In 2005, Lake Michigan provided about 69 percent of water used for all purposes except power generation, and about 85 percent of public water supply. The Lake Michigan Diversion is limited to 2.1 billion gallons per day. Water users are expected to rely more heavily on water taken from Lake Michigan in the future. Under the More Resource Intensive scenario, demand for water from Lake Michigan will exceed the daily diversion limit by year 2050.

Net changes in water supply would yield changes to NED, RED, and OSE.

D.14.1.4 Future Without-Project Condition

The Water Supply Team, which focused on the current demand for water within the Chicago area did not generate a FWOP condition assessment. In the FWOP condition, no new Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins. The baseline economic assessment was based on readily-available secondary data sources. A FWOP condition assessment would involve coordination with the major water providers in the area as well as an estimate of future water demand. This information was not available at the time of the study.

D.14.1.5 Future With-Project Condition

The Water Supply Team, which focused on the current demand for water within the Chicago area, did not generate a FWP condition assessment. In the FWP condition, new Federal action *is* taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins. The baseline economic assessment was based on readily-available secondary data sources. A FWP condition assessment would involve coordination with the major water providers in the area as well as an estimate of future water demand. This information was not available at the time of the study.

D.15 HYDROPOWER

D.15.1 Baseline Condition

D.15.1.1 Focus

The Hydropower Team was tasked with examining the current hydropower revenues that are associated with Lockport Powerhouse, and specifically, how those values would change in the FWOP and FWP conditions. To complete this task, the team first completed a baseline economic assessment which exhibits current revenues associated with hydropower generation and Lockport Powerhouse. This assessment also considers the level of contribution of Lockport in meeting the region's renewable portfolio standard. These values will set the baseline against which future conditions will be compared.

D.15.1.2 Method

Energy values are determined using historical monthly generation data supplied by the Metropolitan Water Reclamation District of Greater Chicago (MWRD) and the Pennsylvania New Jersey Maryland Interconnection LLC's (PJM's) historical Locational Marginal Price (LMP). These values were then indexed to 2012 dollars and seasonally averaged over the years 2009-2012. Data from ComEd and the Energy Information Agency (EIA) are utilized to calculate capacity using a Federal Energy and Regulation Commission (FERC) calculation.

D.15.1.3 Key Findings

Key findings from this assessment include:

- *Generation:* From 2007 through 2012 the Lockport Powerhouse has averaged 42.1 megawatt hours (MWh) of generation a year. This generation is moderately seasonally dispersed. Forty percent of the total generation occurs during the summer months of June through September, while only twenty-five percent of total generation occurs during the winter months of October through January. The 44,000 MWh average annual generation of Lockport represents about 16 percent of the average annual hydroelectric generation for the state of Illinois. There were approximately 5,000 gigawatt hours (GWh) of renewable generation in Illinois in 2010, therefore Lockport Powerhouse accounts for about 0.8 percent of total renewable generation.

- *Renewable Generating Resources Replacement Cost:* To replace the annual generation of 42.1 thousand MWh in satisfaction of the Illinois Renewable Portfolio Standard, it would require between 12 and 24 MW of new wind capacity. Reports from National Renewable Energy Lab (NREL) suggest installed capacity of wind generation at about $2.1 million. Therefore, an alternative renewable energy source would be estimated between $25 and $50 million.

- *Energy Value:* The energy value of the Lockport Powerhouse is based on the cost of the most likely generating replacement resource. Lockport Powerhouse contributes a small percentage to the overall load so value can be estimated using the PJM's LMP price. PJM's historical LMP prices are strongly correlated with natural gas prices. Since 2009, these prices have dropped significantly causing energy prices to drop as well. Assuming current trends in natural gas prices, year 2009 to 2012 historic prices indexed to 2012 dollars were averaged to develop monthly peak and off-peak prices. Peak values ranged from $56 per MWh for the month of July to $33 per

MWh for the month of November. Off peak prices showed less variability with a maximum rate of $33 per Mwh for the month of January and a minimum value of $22 per MWh for the month of November.

Historic generation records supplied by the MWRD show that 40 percent of generation occurs during peak time periods defined by PJM as weekdays between the hours of nine o'clock AM and ten o'clock PM. Multiplying the average monthly peak and off peak generating hours by the monthly peak and off-peak prices yielded a energy value of $1.3 million per year.

- *Dependable Capacity and Value:* The dependable capacity of a hydropower project is a measure of the amount of capacity that the project can reliably contribute towards meeting system peak power demands. The dependable capacity value of a hydropower project is a plant's dependable capacity multiplied by the capital cost of its most likely thermal replacement.

A screening curve analysis was performed on the historic hourly generation of Lockport Powerhouse for the years 2010–2012. This analysis showed that the Lockport power house capacity would be replaced by a thermal mix of 40 percent coal, 10 percent gas-fired combustion turbine, and 50 percent gas-fired combined cycle. This thermal mix results in a capacity value of $180 per kilowatt (Kw) per year. The historic hourly generation also showed that for the years 2010-2012, only 4000 Kw of capacity could be relied to be exceeded 85 percent of the time during the summer peak periods. Multiplying the 4000 Kw of dependable capacity by $134 per Kw yields a dependable capacity value of $536,000 per year.

D.15.2 Future Without-Project Condition

D.15.2.1 Focus

The Hydropower Team completed a FWOP condition economic assessment which establishes the future economic value of the Lockport Powerhouse. This assessment estimates how the energy value will change over the fifty year planning horizon, and estimates the value of the capacity of the Lockport Powerhouse in meeting the Renewable Portfolio Standards for the State of Illinois established in 2007.

D.15.2.2 Method

Lockport Powerhouse generation is assumed to be the same as the average annual generation value for the last ten years. The monthly distribution is also assumed to be consistent with historical generation. Energy values are estimated by indexing the current PJM's historical Locational Marginal Price (LMP) to EIA's long term generation forecast for the RFC West Region. Long term capacity value is assumed to be the capacity value of wind energy, the most likely renewable energy resource for the region. In all cases a fifty year period of record is assumed starting in 2012. All dollars are indexed to 2012 dollars.

D.15.2.3 Key Findings

- *Long Term Energy Value:* For this study, it is assumed that the annual average and monthly distribution generation will remain the same as the historical averages from the last ten years. Since Lockport Powerhouse contributes such a small percentage to the overall load, this value can be estimated using the PJM's LMP price. To predict the future energy values, the historical monthly LMP prices were indexed against the Energy Information Agency's long-term forecast for the RFC West Region to produce a monthly energy value for the fifty-year period of record. The federal discount rate of 4 percent is applied to the time series and then summed to create the present value for each month. The present value of the monthly energy prices is amortized to produce annualized monthly prices for peak and off-peak energy prices. The amortized annual energy value of the Lockport powerhouse is $1.4 million per year.

- *Long-Term Capacity Value:* In accordance with the Renewable Portfolio Standard for the State of Illinois, the long-term capacity value of the Lockport power house would be valued as the most likely renewable alternative. For the Illinois region this is wind power. To replace the annual generation of 42.1 GWh in satisfaction of the Illinois Renewable Portfolio Standard, it would require between 11 and 19 MW of new wind capacity. Reports from National Renewable Energy Lab indicate the cost of wind energy for a typical land-based US wind plan is $71/MWh. Therefore, alternative renewable energy source to replace Lockport's average annual generation of 42,100 MWh is estimated to be $3 million.

D.15.3 Future With-Project Condition

D.15.3.1 Focus

The Hydropower Team then completed a FWOP condition assessment, which evaluates the potential effects to hydropower generation at Lockport Powerhouse as a result of the various alternative plans considered in GLMRIS.

D.15.3.2 Method

Hydropower effects are addressed in terms of potential changes in generation and in the value of Lockport's energy and capacity. Potential changes in flow and water elevations at Lockport associated with the GLMRIS alternatives would drive hydropower generation impacts, which are calculated using the power equation. The energy value and capacity value associated with any anticipated change in hydropower generation would subsequently be estimated over the fifty-year planning horizon.

D.15.3.3 Key Findings

Results of the hydrology and hydraulics analysis indicate that changes to hydrologic conditions at Lockport Powerhouse would be negligible, resulting in no quantifiable impact to hydropower generation — and therefore no changes in national economic development (NED) estimates. Consequently, the FWP condition would be no different than the FWOP condition. Average annual hydropower generation of 42,100 MWh is expected to continue. The amortized annual energy value over the fifty-year period of analysis amounts to $1.6 million (2012 dollars). Dependable capacity of Lockport is be $536,000 (2012 dollars) annually (thermal replacement energy), and the renewable energy capacity value is estimated to be $3,000,000 (2012 dollars; assumes wind power replacement energy).

D.16 REGIONAL ECONOMICS

D.16.1 Baseline Condition

D.16.1.1 Focus

Aquatic nuisance species transfer between the GL and Mississippi River Basins could impact the fishing industries within these basins. Further, the implementation of various fisheries management plans within the basins could also impact the fishing activities within the basins, even if ANS control measures are implemented. The *Regional Economic Contribution Assessment* displays the significance of commercial, recreational, and charter fishing industries to the national economy. This is the level of regional economic activity at risk given ANS transfer or its prevention (i.e., the FWOP or FWP conditions).

Commercial cargo and passenger navigation are most at risk from the FWP conditions that include hydrologic separation implementation and/or new lock construction within the CAWS. The *Regional Economic Contribution Assessment* displays the significance of cargo and non-cargo navigation industries within the CAWS to the national economy. This is the level of regional economic activity at risk given the implementation of various ANS Controls (i.e., the FWP condition).

D.16.1.2 Method

To complete the regional economic contribution assessment, the Regional Economic Models, Inc. Policy Insight Plus (REMI PI^{+}) model was utilized. Counterfactual analyses were employed in order to estimate the value of: commercial, recreational, and charter fishing, as well as cargo and non-cargo navigation activities that take place within the GLMRIS Detailed Study Area. A counterfactual analysis involves extracting the value of the industry from the current economy, which allows the model to display the effects of an industry leaving a region. The resulting "impacts" display what the *current* value of the given activity is within each region. Three regions were utilized in the REMI PI+ model, to include: (1) the Chicago Combined Statistical Area (CSA), (2) the Great Lakes, Upper Mississippi River, and Ohio River Basins, and (3) the rest of the nation. This allowed for the analyst to present the contribution (by way of sales, value added, employment, and income) of these specific activities to each region.

D.16.1.3 Key Findings

The *Regional Economic Contribution Assessment* exhibits the contribution of various economic activities identified within the GLMRIS to the *existing* economy. The value of this assessment displays the regional economic activity that is at risk given ANS transfer or its prevention. Table D.8 and Table D.9 display the regional economic contribution of fishing activities within the GL Basin, and UMR and OHR Basins. This is the level of regional economic activity that is at risk in the FWOP and/or FWP condition – and establishes the threshold of regional economic development (RED) that could change in the future.

TABLE D.8 Economic Contributions of Fishing-Related Industries within the U.S. Waters of the Great Lakes Basin

Economic Activity within the Great Lakes Basin[1,2]	Sales Associated with Economic Activity (Nation-Wide)	Jobs Associated With Economic Activity (Nation-Wide)	Income[3] Associated With Economic Activity (Nation-Wide)
Commercial Fishing	$55,480,000	570	$13,860,000
Recreational Fishing	$14,253,000,000	111,693	$4,488,000,000
Charter Fishing	$105,000,000	828	$39,000,000

1 Fishing activities assessed for the Great Lakes Basin address the US waters of the Great Lakes (GL) and their tributaries below impassible barriers. The portions of tributaries that lie between the GL and the first dam are considered to be below impassible barriers. A key assumption is that aquatic nuisance species (ANS) could not pass the barriers via an aquatic pathway. The fisheries studies focused on waters that could be susceptible to ANS transfer.

2 All values presented in this table represent *national* sales, jobs, and income associated with the fishing-related industries within the GL Basin. The fishing activities in these basins generate sales, jobs, and income throughout the nation. This is because of indirect and induced effects. Indirect effects include the sales, employment and income of industries that support the fishing industries within the GL Basin, while induced effects include the spending throughout the nation due to the employment of individuals associated with fishing-related and supporting industries.

3 Income is the total earnings associated with the employment level supported by the given economic activity.

TABLE D.9 Economic Contributions of Fishing-Related Industries within the U.S. Waters of the Upper Mississippi River and Ohio River Basins

Economic Activity within the UMR and OHR Basins[1,2]	Sales Associated with Economic Activity (Nation-Wide)	Jobs Associated With Economic Activity (Nation-Wide)	Income[3] Associated With Economic Activity (Nation-Wide)
Commercial Fishing	$14,050,000	150	$3,480,000
Recreational Fishing	$5,783,000,000	49,200	$1,839,000,000
Charter Fishing[4]	NA	NA	NA

1 Fishing activities assessed for the Upper Mississippi River (UMR) and Ohio River (OHR) Basins address the U.S. waters of the UMR and OHR as well as their tributaries below impassible barriers. The portions of tributaries that lie between the UMR and the first dam, and the portions of tributaries that lie between the OHR and the first dam, are considered to be below impassible barriers. A key assumption is that aquatic nuisance species (ANS) could not pass the barriers via an aquatic pathway. The fisheries studies focused on waters that could be susceptible to ANS transfer.

2 All values presented in this table represent *national* sales, jobs, and income associated with the fishing-related industries within the UMR and OHR Basins. The fishing activities in these basins generate sales, jobs, and income throughout the nation. This is due to indirect and induced effects. Indirect effects include the sales, employment and income of industries that support the fishing industries within the UMR and OHR Basins, while induced effects include the spending throughout the nation due to the employment of individuals associated with fishing-related and supporting industries.

3 Income is the total earnings associated with the employment level supported by the given economic activity.

4 Note that the charter fishing industry within the UMR and OHR Basins is not included in this assessment since statistically reliable information was not available for this group.

Table D.10 displays the regional economic contribution of navigation industries within the CAWS. This is the level of regional economic activity that is at risk in the FWP condition.

TABLE D.10 Economic Contributions of Navigation-Related Industries within the Chicago Area Waterway System

Economic Activity within the Chicago Area Waterway System[1]	Sales Associated with Economic Activity (Nation-Wide)	Jobs Associated With Economic Activity (Nation-Wide)	Income[2] Associated With Economic Activity (Nation-Wide)
Commercial Cargo Navigation	$1,584,000,000	9,625	$485,000,000
Non-Cargo Navigation	$88,000,000	469	$22,000,000

1 Values presented in this table represent *national* sales, jobs, and income associated with the navigation-related industries within the Chicago Area Waterway System (CAWS). Even though the navigation-related industries examined in GLMRIS include those within the CAWS, they still generate sales, jobs, and income throughout the nation. This is because of indirect and induced effects. Indirect effects include the sales, employment and income of industries that support the navigation industries within the CAWS, while induced effects include the spending throughout the nation due to the employment of individuals associated with navigation-related and supporting industries.

2 Income is the total earnings associated with the employment level supported by the given economic activity.

D.16.1.4 Future Without-Project Condition

Fishing-Related Industries within the GL, UMR, and OHR Basins

- The *impacts* associated with the FWOP condition are not presented for fishing-related industries. Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since native and commercial fish species have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, this baseline economic assessment demonstrates the fishing industries within the GL, UMR, and OHR Basins that *could* be impacted if no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins (i.e., the FWOP condition).

Navigation-Related Industries within the CAWS

- ANS transfer is not anticipated to have a significant impact on navigation activities within the CAWS.

D.16.1.5 Future With-Project Condition

Fishing-Related Industries

- USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future resource availability regarding fishing activities in the case where Federal action is taken to prevent the transfer of ANS between the basins (i.e., the FWP condition). Since these management plans were not available, this assessment serves as a baseline of the commercial fishing industry within the Great Lakes, Upper Mississippi River, and Ohio River Basins that *could* be affected in the FWP condition.

Navigation-Related Industries

- Navigation activities within the CAWS could be impacted in the FWP condition — the case where new Federal action *is* taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins. The implementation of a GLMRIS project, in many of the alternatives, involves ANS control technologies that include aspects such as physical barriers in the CAWS and increased lockage times in the CAWS. Since the non-cargo vessel movements that were examined in GLMRIS take place within the CAWS, these specific movements could be impacted by implementation of a GLMRIS project. However, this report does not seek to quantify the impact of project implementation on these activities as the choices of business owners depend on their own, unique situation. Business owners may elect to move their businesses elsewhere, modify their existing structure, or shut down.

D.17 CONCLUSION

In support of GLMRIS, the Navigation and Economics PDT was formed. This team was tasked with qualitatively assessing and quantitatively deriving the value of economic activities that are at risk given the implementation (FWP condition) or lack of implementation (FWOP condition) of a GLMRIS project. The eight economic sub-teams addressed different economic and social factors that could change in the future, to include: fishing activities within the GL, UMR, and OHR Basins (at risk of change in the FWOP and FWP conditions), and; commercial and recreational navigation activities; flood risk; water quality; water supply; and hydropower generation within the CAWS (at risk of change in the FWP condition). A regional economic contribution assessment specifically focused on the fishing and navigation-related industries within the GLMRIS Detailed Study Area; and exhibit the regional economic activity (i.e., value added, output, jobs, and income) that could change in the future, given ANS transfer or its prevention. The analyses presented in this appendix include several economic values that serve to assist in fully describing the economic implications of each of the alternative plans considered in GLMRIS – to include both FWOP and FWP conditions.

ATTACHMENT 1

COMMERCIAL FISHING

Commercial Fisheries Baseline Economic Assessment - U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins

September 2013

U.S. Army Corps
of Engineers
Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

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PURPOSE OF COMMERCIAL FISHERIES BASELINE ECONOMIC ASSESSMENT:

In support of the Great Lakes and Mississippi River Interbasin Study (GLMRIS), the Fisheries Economics Team was formed in order to establish the current *economic* values associated with fisheries resources and associated industries within the Great Lakes, Mississippi River, and Ohio River Basins. This report establishes the current economic value of the commercial fisheries in the U.S. waters within the three basins based on the most recent annual harvest data available from state agencies (or equivalents) and inter-tribal agencies or organizations. This document is an assessment of the harvests (in pounds) and associated value of commercial fisheries in these basins; this includes both tribal and state-licensed commercial harvests.

Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since native and commercial fish species have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, this baseline economic assessment demonstrates the commercial fisheries and associated industry that *could* be affected if no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins (i.e., the future without-project condition).

Further, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future fishing harvests in the case where Federal action is taken to prevent the transfer of ANS between the basins (i.e., the future with-project condition). Since these management plans were not available, this assessment of commercial fisheries serves as a baseline of what harvests and associated values within the Great Lakes, Upper Mississippi River, and Ohio River Basins *could* be affected in the future with-project condition.

TERMINOLOGY: DEFINITIONS AND APPLICATIONS

Baseline Condition:

According to the U.S. Army Corps of Engineers' IWR 96-R-21, *Planning Manual*, the base condition- referred to as the baseline condition in this report- is the "conditions that exist at the time of the study." The Planning Manual states that the study may "rely on average conditions in recent years rather than precise data for the year of the study" if "the average reasonably represents the relevant study area conditions."

This report establishes the baseline condition by utilizing the average of the most recent five years of harvest data (harvest levels and prices) for commercial fisheries in the U.S. waters of the Great Lakes Basin, Upper Mississippi River Basin, and Ohio River Basin. The average was determined to be a more accurate representation of commercial fishing harvests due to annual harvest level fluctuations.

Without-Project Condition:

According to the U.S. Army Corps of Engineers' ER 1105-2-100, Planning Guidance Notebook, the without-project condition is "the most likely condition expected to exist in the future in the absence of a proposed water resources project. The future without-project condition constitutes the benchmark against which plans are evaluated. Forecasts of future without-project conditions shall consider all other actions, plans and ER 1105-2-100 programs that would be implemented in the future to address the problems and opportunities in the study area in the absence of a Corps project. Forecasts should extend from the base year (the year when the proposed project is expected to be operational) to the end of the period of analysis."

USACE was not able to obtain sufficient information to quantify the timing or magnitude of impacts of aquatic nuisance species (ANS) on commercial fish populations in the Great Lakes, Upper Mississippi River, and Ohio River Basins. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, this baseline economic assessment demonstrates the commercial fisheries and associated industry that *could* be impacted if no Federal action is taken to prevent the transfer of aquatic nuisance species between the Great Lakes and Mississippi River Basins.

With-Project Condition:

According to the U.S. Army Corps of Engineers' Planning Guidance Notebook, "the with-project condition is the most likely condition expected to exist in the future with the implementation of a particular water resources development project. Comparison of conditions with the project to conditions without the project will be performed to identify the beneficial and adverse effects of the proposed plans."

USACE was not able to obtain a complete set of fisheries management plans from management agencies. Therefore, forecasts regarding future harvest levels and associated values were not able to be generated. Consequently, this baseline economic assessment demonstrates the commercial fisheries and associated industry that *could* be affected by factors such as fisheries management plans even if Federal action *is* taken to prevent the transfer of aquatic nuisance species between the Great Lakes and Mississippi River Basins.

Harvest Value:

According to the National Oceanic and Atmospheric Association's (NOAA) National Marine Fisheries Services' (NMFS) report *Our Living Oceans; Report on the Status of U.S. Living Marine Resources, 1999,* the ex-vessel revenue is defined as "the quantity of fish landed by commercial fishermen multiplied by the average price received by them at the first point of sale… The estimate of economic value often takes…commercial catches and multiplies them by an average price to arrive at a baseline measure of economic worth among various user groups." This report establishes a baseline "harvest value" for all commercial fishing harvests in the Great Lakes, Upper Mississippi River, and Ohio River Basins by applying the following equation:

Harvest Level (Pounds) × Price (Dollars per Pound) = Harvest Value (Dollars)

Commercial Fishing:

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) Public Law 94-265, established by the U.S. Department of Commerce, National Oceanic and Atmospheric Association (NOAA) and National Marine Fisheries Service is the "primary law governing marine fisheries management in the United States federal waters." According to the MSA, "the term 'commercial fishing' means fishing in which the fish harvested, either in whole or in part, are intended to enter commerce or enter commerce through sale, barter or trade." Commercial harvests include both native and non-native fish.[1]

This definition is utilized to describe commercial fishing activities that take place in the U.S. waters of the Great Lakes, Upper Mississippi River and Ohio River Basins by both native and non-native commercial fishermen. Note that subsistence fishing is not included as part of the definition of "commercial fishing." This is a separate activity which will be addressed in a subsequent complementary report: *Subsistence Fishing in the Great Lakes, Upper Mississippi River, and Ohio River Basins.*

Subsistence Fishing:

In support of the Great Lakes and Mississippi River Interbasin Study, an assessment of subsistence activities in the Great Lakes, Upper Mississippi, and Ohio River Basins was generated. The report *Treaty Rights and Subsistence Fishing in the U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basin*, establishes a working definition of subsistence fishing which encompasses the following criteria:

[1] In this report, there will be an asterisk present when indicating a non-native species.

"1. A long-term consistent pattern of use, excluding interruptions beyond the control of the community or area;
2. A pattern of use recurring in specific seasons for many years;
3. A pattern of use consisting of methods and means of harvest which are characterized by efficiency and economy of effort and cost, conditioned by local characteristics;
4. The consistent harvest and use of fish or wildlife as related to past methods and means of taking; near, or reasonably accessible from, the community or area;
5. A means of handling, preparing, preserving, and storing fish or wildlife which has been traditionally used by past generations, including consideration of alteration of past practices due to recent technological advances, where appropriate;
6. A pattern of use which includes the handing down of knowledge of fishing and hunting skills, values, and lore from generation to generation;
7. A pattern of use in which the harvest is shared or distributed within a definable community of persons; and
8. A pattern of use which relates to reliance upon a wide diversity of fish and wildlife resources of the area and which provides substantial cultural, economic, social, and nutritional elements to the community or area."

This working definition is used to differentiate commercial fishing activities from subsistence fishing activities. This report solely generates a baseline assessment of commercial fishing activities. All documentation of subsistence fishing practices will be included in a subsequent report: *Treaty Rights and Subsistence Fishing in the U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basin.*

GLMRIS BACKGROUND INFORMATION:

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River basins by aquatic pathways. An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (FY13).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies,* Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

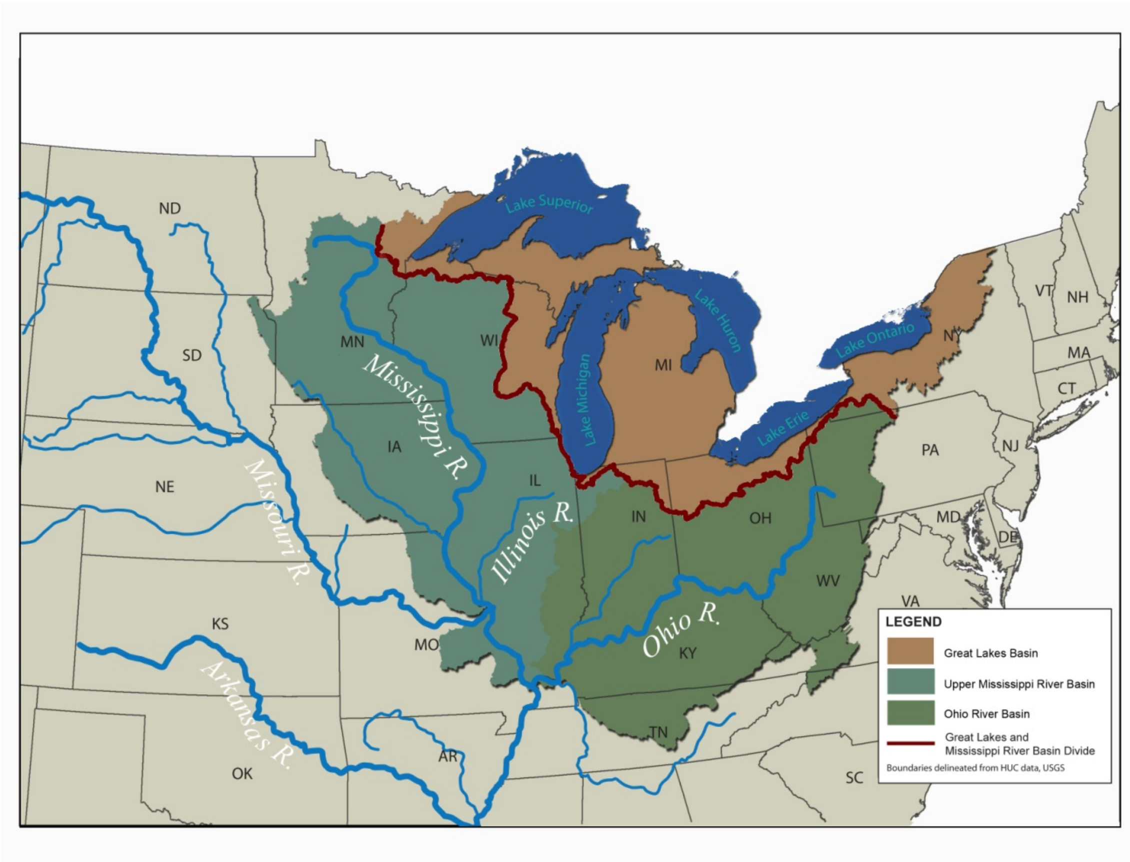
Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

GLMRIS STUDY AREA

The GLMRIS study area includes portions of the Great Lakes, Mississippi River, and Ohio River Basins that fall within the United States.

Figure 1: GLMRIS Study Area Map



Potential aquatic pathways between the Great Lakes, Mississippi River, and Ohio River Basins exist along the basins' shared boundary (illustrated in *Figure 1: GLMRIS Study Area Map*). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi and Ohio River Basins (green shaded areas) and the Great Lakes Basin (brown shaded area).

NAVIGATION AND ECONOMICS PRODUCT DELIVERY TEAM:

In support of the Great Lakes and Mississippi River Interbasin Study, the Navigation and Economics Product Delivery Team (PDT) was formed. The PDT was tasked with assessing the current value of *economic* activities within the GLRMIS detailed study area that *could* change with the implementation (FWP condition) or lack of implementation (FWOP condition) of a GLMRIS project. The PDT is comprised of several sub-teams, each of which focuses on a specific economic activity within the GLRMIS study area. These categories include:

Navigation Related Economic Categories

- Commercial Cargo
- Non-Cargo Related Navigation

Other Related Economic Categories

- Flood Risk Management
- Hydropower
- Commercial and Recreational Fishery[2]
- Water Quality
- Water Supply
- Regional Economics

Fisheries Economics Team:

The Fisheries Economics Team (Team) was formed in order to assess the current *economic* value of commercial, recreational, charter, and subsistence fishing activities, as well as pro-fishing tournaments within the Great Lakes Basin, Upper Mississippi River and Ohio River Basins. The results of these analyses serve to demonstrate the various economic activities could be impacted in the future.

USACE was not able to obtain sufficient information regarding the impacts of ANS on the various fisheries targeted by each of the fishing-related economic activities. Fisheries management techniques could also change the quality or quantity of available fisheries in the future. Therefore, the baseline assessments serve as indicators of what *could* be impacted in the FWOP condition.

Further, USACE was not able to obtain a complete set of fisheries management plans from management agencies to aid in the determination of future fisheries resources, and therefore, the

[2] The recreational fishery will be assessed via a survey of recreational anglers' current behavior. The charter fishing industry, subsistence fishing, and pro-fishing tournaments will also be assessed. The charter fishing industry will be assessed via a survey of charter captains' current behavior. A subsistence fishing assessment will be completed by contacting the tribes in the Great Lakes, Upper Mississippi River, and Ohio River Basins in order to determine their subsistence fishing harvests and the cultural significance of these harvests. Pro-fishing tournaments will be assessed via a literature review focusing on existing pro-fishing tournaments, what they entail, and where they are located.

Fisheries Economics Team did not forecast *future* economic values associated with fishing-related activities. Consequently, the baseline assessments serve as indicators of what could be affected in the FWP condition.

Commercial Fisheries Focus:

This *Commercial Fisheries Baseline Economic Assessment – U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins* report establishes the current economic value associated with commercial fisheries within the three basins. Specifically, this document highlights the long-term and short-term trends associated with the harvest levels (pounds) and associated harvest values within the Great Lakes, Upper Mississippi River, and Ohio River Basins. The most recent five-year average of harvest levels and values were utilized to assess the current value of the commercial fisheries. This report exhibits the value of commercial fisheries, within the three basins, that could be affected with the implementation (FWP condition) or lack of implementation (FWOP condition) of a GLMRIS project.

COMMERCIAL FISHERIES ASSESSMENT OVERVIEW:

This *Commercial Fisheries Baseline Economic Assessment – U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins* report establishes the current economic value associated with commercial fisheries within the three basins. The most recent five-year average of harvest levels and values were utilized to assess the current value of the commercial fisheries. This report exhibits the value of commercial fisheries, within the three basins, that could be affected with the implementation (FWP condition) or lack of implementation (FWOP condition) of a GLMRIS project.

Overview of Study Areas:

The Fisheries Economics Team established its study areas in the Great Lakes, Upper Mississippi River and Ohio River Basins in accordance with the overall GLMRIS study area. The GLMRIS Geographic Information System (GIS) Team was consulted to establish the specific study areas for the fisheries economics team. The process by which the GIS team established these focus areas is included in Appendix A of this report.

This baseline assessment of fisheries focuses on the major water bodies within the Great Lakes basin and the Upper Mississippi River and Ohio River Basins. The Great Lakes, Upper Mississippi River, Ohio River and their major tributaries are assessed but disjunct water bodies are not included since ANS cannot travel via aquatic pathways to these. The following describes the study areas within the two water basins in more detail:

Great Lakes Basin:

The Great Lakes basin study area includes: Lake Superior, Lake Michigan, Lake Ontario, Lake Huron and Lake Erie. Note that this study will only consider tribal and state-licensed commercial fishing activities that fall within U.S. boundaries of the Great Lakes. Canadian portions of the Great Lakes are outside of the scope of the study. See *Plate 1: Great Lakes Basin Map* for map of the Great Lakes Basin focus areas. The following table outlines the water bodies in the Great Lakes Basin that are included in this baseline assessment. For a complete list of all water bodies that were considered, see *Appendix A: Commercial Fisheries Assessment Methodology.*

Table 1: Great Lakes Basin Water Bodies Included in Baseline Economic Assessment

Water Body
Lake Michigan
Lake Erie
Lake Superior
Lake Ontario
Lake Erie & Tributaries[1]
1. Lake Erie is the only water body whose tributaries support commercial fishing activity. This was determined upon consultation with state's Departments of Natural Resources.

Upper Mississippi River and Ohio River Basins:

The Upper Mississippi River and Ohio River basins include the following rivers: the Upper Mississippi River, Ohio River and their tributaries. Tributaries of the Upper Mississippi River include the: Illinois, Kaskaskia, Rock, and Zumbro Rivers. See *Plate 2: Upper Mississippi River Stream Map* for a map of these streams. Tributaries of the Ohio River include the Wabash, Cumberland, Kentucky, and Salt Rivers. See *Plate 3: Ohio River Stream Map* for a map of these streams. Note that the rivers included in this analysis include only those that supported commercial fishing activities at some point during the analysis period.

Table 2: UMR and Ohio River Basin Water Bodies Included in Baseline Economic Assessment

Basin	Streams Included in Assessment
Upper Mississippi River	Upper Mississippi River Illinois River Kaskaskia River Rock River Zumbro River[1]
Ohio River	Ohio River Wabash River Cumberland River Kentucky River Salt River[2]

1. The Zumbro River will be assessed qualitatively since fish harvests on this river occurred infrequently during the analysis period.
2. The Salt River will be assessed qualitatively since fish harvests on this river occurred infrequently during the analysis period.

Overview of Methodology:

This baseline assessment of commercial fisheries establishes current baseline value of the commercial fisheries in the U.S. waters of the Great Lakes, Upper Mississippi River and Ohio River Basins based on recent harvest level and price data available from state agencies.

State agencies were requested to provide annual harvest levels and the associated dockside[3] values for the years between 1989 through 2009 in order to generate analyses of harvesting trends over time. Due to lags in data entry, the most recent year for which most state agencies were able to provide harvest data was 2009 in the Great Lakes Basin and 2005 in the Upper Mississippi River and Ohio River basins. Most states provided the harvest data for each species in the following format exemplified in Table 3.

[3] Prices indicate the price per pound which the commercial fishermen received for their harvests.

Table 3: Harvest Data Provided by State Agencies

Species	Year	Harvest Level (lbs)	Price ($/lb)
(species)	1989	x	y
(species)	1990	x	y
(species)	1991	x	y
…	…	…	…
(species)	2009	x	y

Prices were then converted to Fiscal Year (FY) 2013 values using the producer price index (PPI) for "other finfish."[4]

Equation 1: Price

$$\mathbf{Price_{2013} = (Price_{year\ x}) \times (PPI_{2013}/\ PPI_{year\ x})}$$

The FY13 prices were then multiplied by the harvest level (pounds) to yield the harvest value in FY13 dollars (as shown in Equation 2). This process was repeated for each species harvested by each state in each year between 1989 and 2009.

Equation 2: Harvest Value

$$\mathbf{Harvest\ (\$) = Harvest\ Level\ (lbs) \times Price\ (\$/lb)}$$

Annual harvest levels and values were then aggregated for each species in all bordering states of each water body. This is exemplified in Equation 3. This same equation was utilized to compute the annual harvest value of each species on each lake or river.

Equation 3: Single Species Harvest Level on a Lake or River

$$\mathbf{Annual\ Harvest\ Level\ for\ Bigmouth\ Buffalo\ on\ Lake\ Erie = Harvest\ Level_{MI} + Harvest\ Level_{OH}}$$

[4] "The Producer Price Index is a family of indexes that measures the average change over time in the selling prices received by domestic producers of goods and services. PPIs measure price change from the perspective of the seller. This contrasts with other measures, such as the Consumer Price Index (CPI), that measure price change from the purchaser's perspective. Sellers' and purchasers' prices may differ due to government subsidies, sales and excise taxes, and distribution costs" (Bureau of Labor Statistics). Producer price index (PPI) number "02230199" for "other finfish" was utilized for converting nominal dollars to FY13 dollars.

All species harvest levels were then aggregated for each water body. This is exemplified in Equation 4. The same equation was utilized to compute the annual harvest value of all species on each lake or river.

Equation 4: Harvest Level of All Species on a Single Lake or River

$$\textbf{Annual Harvest Level for All Species on Lake Erie} = \text{Harvest Level}_{\text{Species1}} + \text{Harvest Level}_{\text{Species 2}} + \ldots + \text{Harvest Level}_{\text{Species n}}$$

Harvest levels for all lakes or rivers were then aggregated at the basin level. This is exemplified in Equation 5. The same equation was utilized to compute the annual harvest value of all species on each lake or river.

Equation 5: Harvest Level of All Species In a Basin

$$\textbf{Annual Harvest Level for the Great Lakes Basin} = \text{Harvest Level}_{\text{Lake Michigan}} + \text{Harvest Level}_{\text{Lake Superior}} + \text{Harvest Level}_{\text{Species Huron}} + \text{Harvest Level}_{\text{Lake Erie \& Tributaries}} + \text{Harvest Level}_{\text{Lake Ontario}}$$

The average of the most recent five years of harvest level and harvest value data for each basin yielded the current value of the commercial fisheries in each basin. A thorough description of the data collection procedures and analysis methodology that was used to generate the baseline assessment is documented in Appendix A of this report.

Overview of Findings

Values for the commercial fisheries in the U.S. waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins are as follows:

Great Lakes Basin
The average harvest level from the most recent 5 years (2005 through 2009) for the U.S. waters of the Great Lakes Basin was determined to be approximately 20.24 million pounds with an associated harvest value of about $21.79 million in FY13 dollars. This forms the baseline harvest and value against which future conditions will be compared.

Upper Mississippi River Basin
The average harvest level from the most recent 5 years (2001 through 2005) for the Upper Mississippi River Basin was determined to be approximately 10.0 million pounds with an associated harvest value of about $3.84 million in FY13 dollars. This forms the baseline harvest and value against which future conditions will be compared.

Ohio River Basin
The average harvest level from the most recent 5 years (2001 through 2005) for the Ohio River Basin was determined to be approximately 1.38 million pounds with an associated harvest value of about $1.99 million in FY13 dollars. This forms the baseline harvest and value against which future conditions will be compared.

GREAT LAKES BASIN BASELINE ASSESSMENT

The fisheries that lie within U.S. waters of the Great Lakes Basin were assessed. The U.S. portion of the Great Lakes Basin fishery is valued at $21.79 million with a harvest level of 20.24 million pounds.

Baseline figures reflect the average of 2005 through 2009 harvest level and value data. Table 4 displays the contribution to the total Great Lakes Basin fishery harvest level and value by each of the Great Lakes. Note that Lake Michigan and Lake Erie support the greatest amount of commercial fishing (57.8 percent of the total pounds) and the greatest value (61.9 percent of the total).

Table 4: Great Lakes Baseline Harvest and Values

Lake	Harvest Level[1] (lbs)	Total Harvest Level (%)	Harvest Value[1] ($)	Total Harvest Value (%)
Lake Michigan	6,364,000	31.4	$8,629,000	39.6
Lake Erie	5,352,000	26.4	$4,850,000	22.3
Lake Huron	3,948,000	19.5	$4,404,000	20.2
Lake Superior	4,558,000	22.5	$3,880,000	17.8
Lake Ontario	21,000	0.1	$31,000	0.1
Total: All Lakes	**20,243,000**	**100.0**	**$21,793,000**	**100.0**
1. Harvest levels and values reflect a five-year average from 2005 through 2009. All values are rounded to the nearest thousand. Harvest values are in FY13 dollars.				

Lake Michigan's baseline harvest level is approximately 6.4 million pounds with an associated value of $8.6 million. The primary contributor to Lake Michigan's harvest levels and values is comprised of lake whitefish, which is harvested by state-licensed commercial fishermen in Michigan and Wisconsin, as well as tribal commercial fishermen (of the CORA member tribes[5]). Lake whitefish accounted for approximately 76 percent of Lake Michigan's baseline harvest level and 54 percent of the total Great Lakes Basin baseline harvest value.

Lake Erie's baseline harvest level is 5.4 million pounds with an associated value of $4.9 million. The harvest of species in the Temperate Bass and Perch families (such as white bass, white

[5] CORA is an acronym for the Chippewa Ottawa Resource Authority. Member tribes include the: Bay Mills Indian Community, Grand Traverse Band of Ottawa and Chippewa Indians in Michigan, Little River Band of Ottawa Indians, Little Traverse Bay Band of Odawa Indians, and Sault Ste. Marie Tribe of Chippewa Indians of Michigan. CORA reports commercial fishing harvests by tribal commercial fishermen to the state for fisheries management purposes.

perch, yellow perch, and walleye) account for the majority of the harvest level and value on Lake Erie. The baseline harvest level of these species accounted for approximately 2.7 million pounds. This represented 50 percent of the Lake's baseline harvest level.

Lake Huron, Lake Superior, and Lake Ontario accounted for a total of 41.9 percent of the Great Lakes' baseline harvest level and 42.1 percent of its value. The harvest of lake whitefish on Lake Huron and Lake Superior, and yellow perch on Lake Ontario are key contributors to these lakes' baseline values.

Table 5 displays the harvest level (in pounds) for the years 1989 through 2009 for each of the Great Lakes and the total for the Great Lakes Basin. Lake Erie's share of the commercial harvest has experienced a slight decrease over time in part due to fewer harvests of Carps and Herring. Lake Michigan's harvest levels have declined dramatically from the 1990s due to a decrease in harvest of lake whitefish. Lake Superior's increase in harvest levels can be attributed to the harvest of Smelts and Whitefishes. Lake Huron and Lake Ontario have also experienced slight declines in harvest levels and values over the 20-year period of analysis.

Table 5: Great Lakes Commercial Fishing Harvest Levels (Values Shown in Thousands)

Year	Lake Michigan		Lake Superior		Lake Huron		Lake Erie		Lake Ontario[1]		Total: All Lakes
	Lbs. Harvested	% of Total	Lbs. Harvested	% of Total	Lbs. Harvested	% of Total	Lbs. Harvested	% of Total	Lbs. Harvested	%of Total	
1989	7,129	41.8	1,476	8.7	3,001	17.6	5,443	31.9	N/A	N/A	**17,049**
1990	13,379	52.3	1,456	5.7	4,824	18.8	5,939	23.2	N/A	N/A	**25,598**
1991	15,938	57.9	1,058	3.8	4,854	17.6	5,533	20.1	141	0.5	**27,524**
1992	17,926	59.5	1,282	4.3	4,972	16.5	5,839	19.4	89	0.3	**30,108**
1993	15,530	59.0	1,112	4.2	4,835	18.4	4,773	18.1	67	0.3	**26,317**
1994	15,194	57.4	1,131	4.3	5,005	18.9	5,060	19.1	81	0.3	**26,471**
1995	14,336	55.7	962	3.7	5,519	21.4	4,884	19.0	60	0.2	**25,761**
1996	13,633	52.2	2,561	9.8	5,233	20.0	4,619	17.7	64	0.2	**26,110**
1997	12,695	48.5	2,488	9.5	5,614	21.5	5,306	20.3	53	0.2	**26,156**
1998	12,046	48.1	3,114	12.4	5,077	20.3	4,724	18.9	70	0.3	**25,031**
1999	10,845	48.6	3,059	13.7	4,593	20.6	3,789	17.0	48	0.2	**22,334**
2000	6,958	36.2	3,496	18.2	4,762	24.8	3,946	20.5	70	0.4	**19,232**
2001	6,722	32.9	4,233	20.7	5,657	27.7	3,746	18.4	47	0.2	**20,405**
2002	6,247	36.0	2,506	14.4	4,054	23.3	4,518	26.0	42	0.2	**17,367**
2003	6,009	34.6	3,260	18.8	4,097	23.6	3,991	23.0	12	0.1	**17,369**
2004	6,016	34.1	3,704	21.0	3,748	21.2	4,143	23.5	38	0.2	**17,649**
2005	6,922	35.3	3,754	19.1	4,019	20.5	4,912	25.0	7	0.0	**19,614**
2006	7,120	35.1	4,035	19.9	4,395	21.7	4,715	23.3	5	0.0	**20,270**
2007	5,919	29.0	4,449	21.8	4,181	20.5	5,810	28.5	35	0.2	**20,394**
2008	5,614	26.7	6,524	31.0	3,556	16.9	5,318	25.3	15	0.1	**21,027**
2009	6,246	31.4	4,027	20.2	3,591	18.0	6,006	30.2	41	0.2	**19,911**
5-Year Avg[2]	6,364	31.4	4,558	22.5	3,948	19.5	5,352	26.4	21	0.1	**20,243**

1.Note that Lake Ontario harvest data was not available until 1991.
2. The 5-year average is 2005 through 2009, the most recent years data available.

Table 6 displays the harvest values (in FY13 dollars) for the years 1991 through 2009 for each of the Great Lakes and the total for the Great Lakes basin.

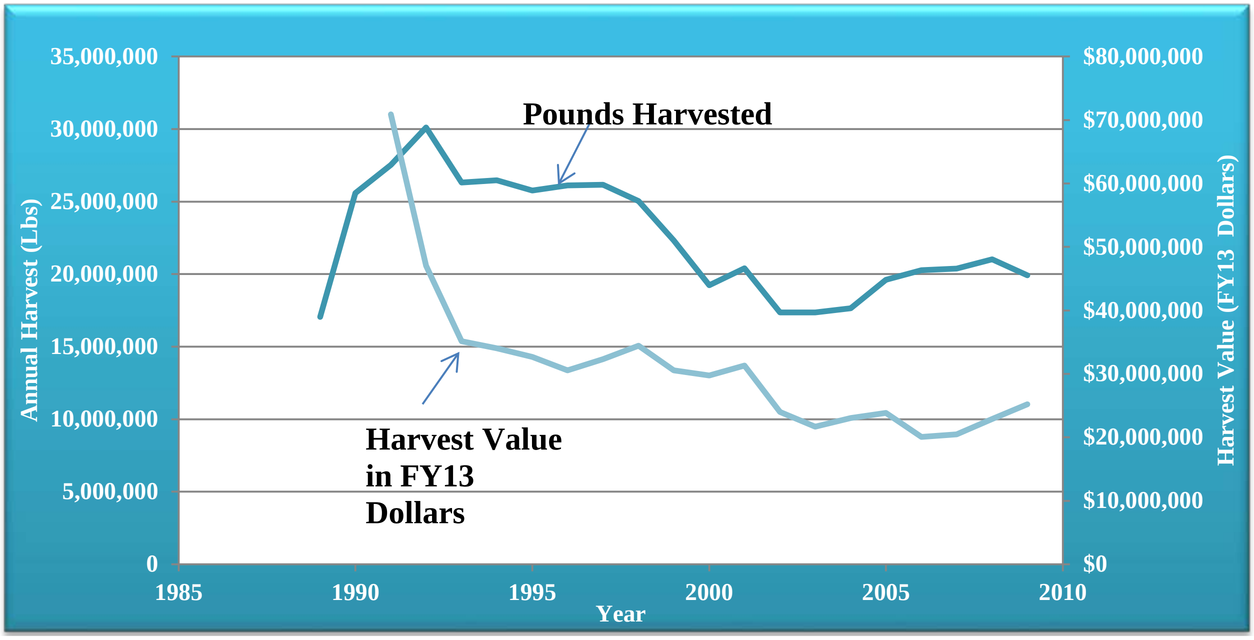
Table 6: Great Lakes Commercial Fishing Harvest Values (Values Shown in Thousands)

Year[1]	Lake Michigan		Lake Superior		Lake Huron		Lake Erie		Lake Ontario		Total: All Lakes (FY13 $)
	Harvest Value (FY13 $)	% of Total	Harvest Value (FY13 $)	% of Total	Harvest Value (FY13 $)	% of Total	Harvest Value (FY13 $)	% of Total	Harvest Value (FY13 $)	% of Total	
1991	44,287	64.1	2,252	3.3	12,447	18.0	9,601	13.9	513	0.0	**69,100**
1992	30,011	65.7	1,949	4.3	8,895	19.5	4,635	10.1	179	0.0	**45,669**
1993	23,040	67.6	1,287	3.8	6,715	19.7	2,962	8.7	98	0.0	**34,103**
1994	20,884	63.2	1,217	3.7	6,209	18.8	4,597	13.9	162	0.0	**33,069**
1995	19,200	60.4	1,094	3.4	7,599	23.9	3,742	11.8	174	0.0	**31,809**
1996	16,392	55.3	3,044	10.3	6,608	22.3	3,501	11.8	121	0.0	**29,665**
1997	16,487	52.4	3,267	10.4	6,800	21.6	4,707	15.0	180	0.0	**31,441**
1998	18,248	54.3	4,528	13.5	6,661	19.8	3,898	11.6	258	0.0	**33,593**
1999	16,044	54.2	3,947	13.3	5,968	20.2	3,523	11.9	107	0.4	**29,589**
2000	11,570	40.2	4,691	16.3	7,426	25.8	4,956	17.2	161	0.6	**28,805**
2001	11,126	36.7	6,235	20.6	8,355	27.6	4,477	14.8	107	0.4	**30,299**
2002	10,470	45.1	2,595	11.2	5,386	23.2	4,676	20.2	73	0.3	**23,200**
2003	8,366	39.9	3,209	15.3	5,226	24.9	4,144	19.8	20	0.1	**20,965**
2004	8,785	39.4	3,254	14.6	4,987	22.4	5,177	23.2	70	0.3	**22,273**
2005	9,604	41.6	3,050	13.2	4,827	20.9	5,603	24.3	12	0.1	**23,097**
2006	8,547	44.0	2,669	13.7	4,198	21.6	4,016	20.7	8	0.0	**19,438**
2007	7,258	36.7	2,905	14.7	4,001	20.2	5,584	28.2	56	0.3	**19,804**
2008	8,109	36.6	5,950	26.8	4,270	19.3	3,827	17.3	15	0.1	**22,171**
2009	9,624	39.4	4,778	19.6	4,722	19.3	5,221	21.4	64	0.3	**24,408**
5-Year Avg	8,629	39.6	3,871	17.8	4,404	20.2	4,850	22.3	31	0.1	**21,783**

1. Note that the Bureau of Labor Statistics did not start publishing producer price index (PPI) data for the "other finfish" category “02230199” until 1992. Since the PPI was needed in order to generate the harvest values for each of the Great Lakes, these values do not begin until 1991.

Figure 2 displays Great Lakes annual commercial fishing harvest data from the years 1989 through 2009.

Figure 2: Great Lakes Commercial Fishing Harvest Data



Harvest levels have dropped by almost 14 percent in recent years (2000-2009) compared to historic levels (1989-2009). Great Lakes fisheries harvest declines will be explored in more detail for each Great Lake.

Table 7: Summary Statistics for Great Lakes Basin

Annual Harvest Summary Data: 1989-2009	
Average Harvest (Pounds)	22,461,686
Maximum Harvest Level	30,107,349
Minimum Harvest Level	17,049,851
Annual Harvest value Summary Data: 1991-2009 (adjusted to FY13 dollars)	
Average Harvest value	30,042,672
Maximum Harvest value	68,587,368
Minimum Harvest value	19,437,812
Annual Harvest Summary Data: 1989-1999	
Average Harvest (Pounds)	25,314,243
Maximum Harvest Level	30,107,349
Minimum Harvest Level	17,049,851
Annual Harvest Summary Data: 2000-2009	
Average Harvest (Pounds)	19,323,872
Maximum Harvest Level	21,027,230
Minimum Harvest Level	17,365,947
Recent harvest levels (2000 - 2009) compared to historic (1989-2009)	-13.97%
BASELINE VALUE: GREAT LAKES BASIN	
5-Year Average Harvest Level (2005-2009)	20,243,297
5-Year Average Harvest Value (2005-2009)	$21,783,393

Lake Michigan Baseline Assessment

Harvest data for each of the Great Lakes will be explored in the order of commercial fishing harvest value contribution (from greatest to least).[6] Therefore, Lake Michigan is analyzed first.

Lake Michigan's baseline (5-year average from 2005-2009) harvest level is 6.4 million pounds with an associated value of $8.6 million. It contributes a total of 31.4 percent to the total fish harvest on the Great Lakes and 39.6 percent to the total harvest value of Great Lakes fisheries.[7] Tribal and state-licensed fishermen participating in commercial fishing activity on Lake Michigan during the analysis period (1989 through 2009) include those from: Illinois, Indiana, Michigan, and Wisconsin, as well as CORA member tribes. Lake Michigan experienced a decline in harvest levels since 1989. The maximum harvest level in the 1990s was 17.9 million pounds (1992) and accounted for about 59.5 percent of the total commercial harvest; the maximum harvest level since year 2000 was about 7.1 million pounds (2006) and accounted for approximately 35.1 percent of the Great Lakes commercial fishing harvests. See Table 8 for annual harvest levels and value over the 20-year analysis period.

Table 8: Lake Michigan's Total Commercial Fishing Harvests

Year	Harvest Level (lbs)	Harvest Value (FY13 $)
1989	7,129,484	N/A
1990[2]	13,379,156	N/A
1991	15,937,721	$44,287,367
1992	17,925,688	$30,010,708
1993	15,530,177	$23,040,410
1994	15,193,738	$20,884,373
1995	14,335,600	$19,200,476
1996	13,633,053	$16,391,516
1997	12,694,928	$16,486,647
1998	12,046,482	$18,247,552
1999	10,844,734	$16,043,840
2000	6,958,274	$11,569,845
2001	6,721,894	$11,125,951
2002	6,246,846	$10,469,710
2003	6,009,324	$8,365,607
2004	6,016,489	$8,784,949
2005	6,921,717	$9,604,177
2006	7,120,165	$8,547,293
2007	5,918,711	$7,258,408
2008	5,613,983	$8,108,945
2009	6,245,694	$9,623,951
5-Year Average	**6,364,054**	**$8,628,555**

1. The commercial fishing harvest value data does not begin until 1991. This is the first year that the Bureau of Labor Statistics began publishing producer price index (PPI) data for commercial fishing category "02230199."
2. CORA data begins in 1990.

[6] See *Table 4: Great Lakes Baseline Harvest and Values* for list of harvest levels by lake.
[7] Refer to *Great Lakes Baseline Harvest and Values* in the "Great Lakes" portion of the document.

Summary statistics for Lake Michigan in displayed in Table 9. Harvest levels are down by almost 37 percent in recent years (2000 through 2009) compared to the historical average (1989 through 2009). The baseline harvest level (about 6.4 million pounds) is a decline from the historical average harvest level of 10.1 million pounds.

Michigan and Wisconsin's state-licensed fishermen, as well as CORA member tribes harvest lake whitefish on Lake Michigan, and represent the majority of the commercial harvests during the analysis period (1989-2009). In 2009, the total harvest of lake whitefish by these states and tribes totaled approximately 5.5 million pounds, which is the vast majority (about 88 percent) of the total pounds of fish harvested on the Lake. Of this total harvest of lake whitefish, Michigan harvested 16 percent, Wisconsin 47 percent, and CORA member tribes 58 percent. The harvest of lake whitefish has declined in more recent years; the average harvest from 1989 through 1999 was about 6.6 million pounds while the average harvest during the 2000s was 4.6 million pounds. This also contributed to the decrease in harvest value for Lake Michigan. The baseline harvest value ($8.9 million) is significantly less than the average harvest value (1992 through 2009) of $16.2 million.

Table 9: Summary Statistics for Lake Michigan

Annual Harvest Summary Data: 1989-2009	
Average Harvest (pounds)	10,115,163
Maximum Harvest Level	17,924,127
Minimum Harvest Level	5,613,754
Annual Harvest Value Summary Data: 1991-2009 (adjusted to FY13 dollars)	
Average Harvest value:	$16,215,323
Maximum Harvest value	$45,779,492
Minimum Harvest value	$7,502,728
Annual Harvest Summary Data: 1989-1999	
Average Harvest (pounds)	13,513,429
Maximum Harvest Level	17,924,127
Minimum Harvest Level	7,129,484
Annual Harvest Summary Data: 2000-2009	
Average Harvest (pounds)	6,377,071
Maximum Harvest Level	7,120,165
Minimum Harvest Level	5,613,754
Recent harvest levels (2000 - 2009) compared to historic (1989-2009)	-36.96%
BASELINE VALUE: LAKE MICHIGAN	
5-Year Average Harvest Level (2005-2009)	**6,363,758**
5-Year Average Harvest Value (2005-2009)	**$8,919,103**

Figure 3 displays Lake Michigan's commercial fishing harvest data from the years 1989 through 2009. Note that the steep increase in harvests between 1989 and 1990 can be attributed to the contribution of CORA member tribes' commercial fishing harvest data. The decrease in harvests between 1990 and 2009 can be attributed to the reduced harvest of lake whitefish.

Figure 3: Lake Michigan Commercial Fishing Harvests

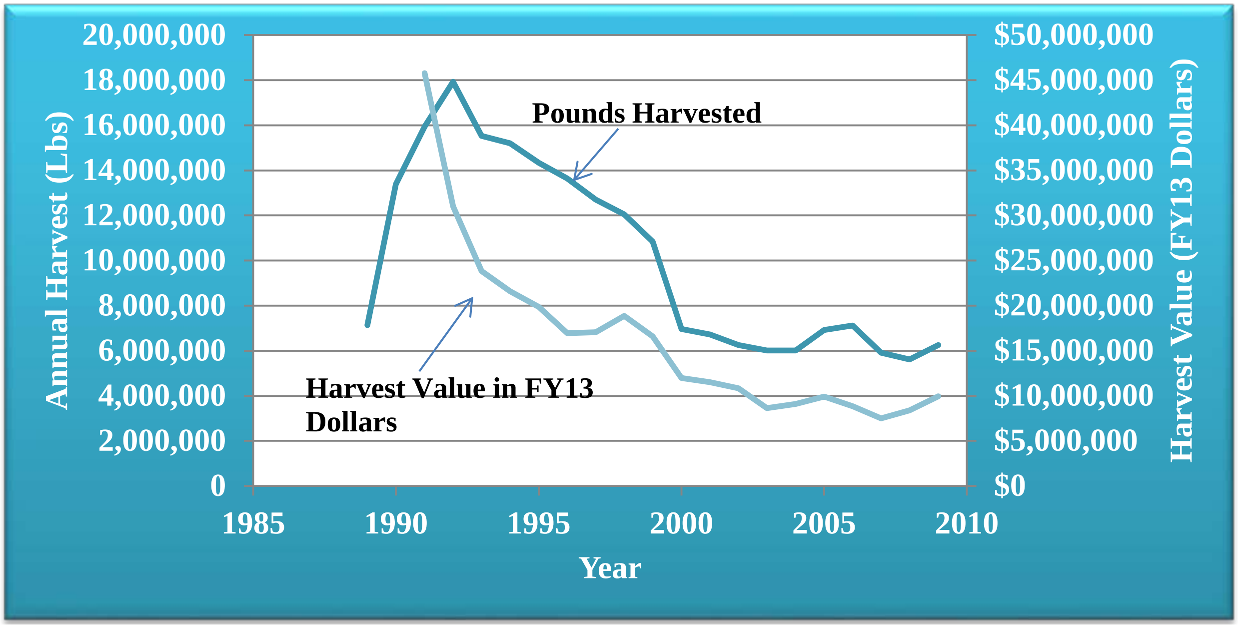


Table 10 displays the contribution of species to the total harvest level and value of commercial fishing on Lake Michigan. Note that almost all of the commercial fishing harvests are generated from the harvest of three families: whitefishes, smelt, and shads and herrings.

Lake whitefish (a species in the Whitefishes, Smelts, and Shads and Herrings family) alone account for approximately 6.0 million pounds of this total baseline harvest (6.4 million pounds) and approximately $8.5 million of the baseline harvest value for Lake Michigan ($8.9 million).

Table 10: Lake Michigan Baseline Harvest Data by Species

Family[1]	Harvested Species	Harvest Level[2] (lbs)	% of Total	Harvest Value[3] (FY13 $)	% of Total
Whitefishes, Smelts, and Shads & Herrings	chubs, lake whitefish, menominee, rainbow smelt, gizzard shad, alewife, cisco	5,984,226	94.0	8,527,796	95.6
Salmon, Trout, Chars, and Cods	coho salmon, chinook salmon, rainbow trout, lake char, burbot	298,622	4.7	226,988	2.5
Perches	yellow perch, walleye	76,677	1.2	163,858	1.8
Suckers	sucker	4,530	0.1	640	0.0
Drums	freshwater drum	0	0.0	0	0.0
Catfishes	channel catfish	0	0.0	0	0.0
Carp	common carp	0	0.0	0	0.0
	Total: All Species	**6,364,054**	**100.0**	**8,919,281**	**100.0**

1. Refer to Appendix A for description as to why the GLMRIS Natural Resources Team grouped some families together.
2. This is a five-year average (2005-2009) of the annual harvest levels.
3. This is a five-year average (2005-2009) of the annual harvest values displayed in FY13 dollars.

Lake Erie Baseline Assessment

Lake Erie's baseline (5-year average from 2005-2009) harvest level is 5.4 million pounds with an associated value of $4.8 million. It contributes a total of 26.4 percent to the total harvest of fish on the Great Lakes and 22.3 percent to the total harvest value of Great Lakes fisheries.[8] Harvests are attributed to four states: Michigan, Ohio, New York and Pennsylvania.[9] See Table 11 for annual harvest levels (in pounds) and values (in FY13 dollars) over the analysis period.

Table 11: Harvest Data for Lake Erie

Year	Harvest Level (lbs)	Harvest Value[1] (FY13 Dollars)
1989	5,443,095	N/A
1990	5,939,327	N/A
1991	5,532,511	$9,601,036
1992	5,838,627	$4,634,999
1993	4,772,962	$2,962,270
1994	5,059,831	$4,597,202
1995	4,883,971	$3,741,680
1996	4,618,735	$3,501,128
1997	5,305,893	$4,706,632
1998	4,724,498	$3,898,376
1999	3,788,982	$3,522,955
2000	3,945,936	$4,956,310
2001	3,745,802	$4,476,614
2002	4,517,853	$4,676,078
2003	3,991,044	$4,144,294
2004	4,142,656	$5,177,122
2005	4,912,167	$5,602,596
2006	4,714,614	$4,015,504
2007	5,809,849	$5,583,541
2008	5,318,201	$3,826,830
2009	6,006,281	$5,220,501
5-Year Average	**5,352,222**	**$4,849,795**

1. Note that the commercial fishing harvest value data does not begin until 1991. This is the first year that the Bureau of Labor Statistics began publishing producer price index (PPI) data for commercial fishing category "02230199." Harvest levels and values for Lake Erie reflect the Lake's harvest data as well as tributary harvest data. According to the Ohio DNR, the majority of commercial fishing on Lake Erie tributaries take place on those that lie between Lorain and Toledo, Ohio.

[8] Refer to Table 4 in the *Great Lakes Basin Baseline Assessment* portion of the document.
[9] Note that no tribal harvests were reported for Lake Erie.

Table 12 shows the Lake Erie fishery statistics. Lake Erie experienced little fluctuation in harvest levels and values over the 21-year analysis period.

Harvest levels are only down 4 percent in recent years compared to the historical average. The baseline harvest level (about 5.4 million pounds) is greater than the average harvest level of 4.9 million pounds. Further, the baseline harvest value ($4.8 million) is also a bit higher than the average harvest value of about $4.7 million.

The majority of the harvest on Lake Erie is attributed to the harvest of species in the Temperate Bass and Perch families. Their contribution to Lake Erie's baseline harvest level was approximately 2.7 million pounds. The total harvest of Temperate Bass and Perches increased by over 30 percent in recent years compared to the historical average (1989 through 2009).

The total harvest of white bass, white perch, yellow perch and walleye in 2009 was approximately 3.0 million pounds. Ohio harvested the majority of these pounds (2.8 million) in 2009, while Michigan harvested 131 thousand pounds, Pennsylvania (42 thousand) and New York (12 thousand).

Other families of species witnessed similar increases in harvest levels or have maintained constant harvest levels. For instance, the Catfish and Bullhead family (which includes species such as channel catfish and brown bullhead), accounted for roughly 11 percent of the baseline harvest level and experienced a 12 percent increase in harvest levels.

The increase in harvest levels experienced by the Temperate Bass, Perch, Catfish and Bullhead families are offset by the decrease in harvest levels of other species. The harvest of Carp and Herring is down by 48 percent in recent years (2000s) compared to the historical average. The harvest of common carp dropped from 1.3 million pounds in year 2000 to 556,000 pounds in 2004.

Other species, such as freshwater drum (which accounts for approximately 494,000 pounds of the baseline harvest level) experienced similar decreases in harvest levels over the analysis period. The harvest of freshwater drum decreased by 36 percent in the 2000s compared to the historical average.

Table 12: Summary Statistics for Lake Erie

Annual Harvest Summary Data: 1989-2009	
Average Harvest (Pounds)	4,905,373
Maximum Harvest Level	6,006,281
Minimum Harvest Level	3,745,802
Annual Harvest value Summary Data: 1991-2009 (adjusted to FY13 dollars)	
Average Harvest value	4,676,088
Maximum Harvest value	9,601,036
Minimum Harvest value	2,962,270
Annual Harvest Summary Data: 1989-1999	
Average Harvest (Pounds)	5,082,585
Maximum Harvest Level	5,939,327
Minimum Harvest Level	3,788,982
Annual Harvest Summary Data: 2000-2009	
Average Harvest (Pounds)	4,710,440
Maximum Harvest Level	6,006,281
Minimum Harvest Level	3,745,802
Recent harvest levels (2000 - 2009) compared to historic (1989-2009)	-3.97%
BASELINE VALUES: LAKE ERIE	
5-Year Average Harvest Level (2005-2009)	5,352,222
5-Year Average Harvest Value (2005-2009)	$4,849,795

Figure 4 displays Lake Erie's annual commercial fishing harvest data for the years 1989 through 2009.

Figure 4: Lake Erie Commercial Fishing Harvests

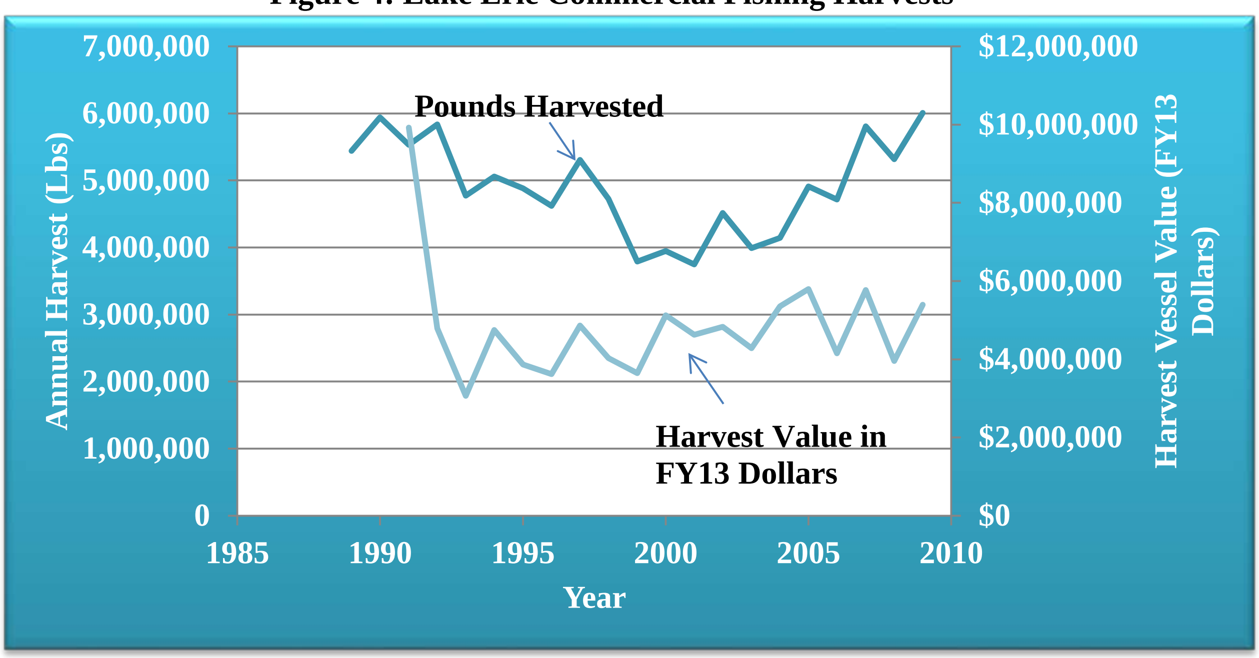


Table 13 exemplifies the contribution by species to the total harvest level and value of commercial fishing on Lake Erie.

Table 13: Lake Erie Baseline Harvest Data by Species

Family[1]	Harvested Species	Harvest Level[2]	% of Total	Harvest Value[3] ($)	% of Total
Temperate Bass & Perches	white bass, white perch, yellow perch, walleye	2,656,950	49.6	3,910,010	80.6
Suckers	bigmouth buffalo, quillback, suckers, redhorse	679,351	12.7	301,261	6.2
Shads & Whitefishes	lake whitefish, gizzard shad, chubs	273,878	5.1	139,969	2.9
Minnows & Carps	common carp, goldfish	660,619	12.3	193,225	4.0
Catfishes & Bullhead	channel catfish, bullhead	583,538	10.9	217,377	4.5
Drums	freshwater drum	493,805	9.2	87,302	1.8
Cods	burbot	4,082	0.1	651	0.0
Gars	gars	0	0.0	0	0.0
	Total: All Species	**5,352,222**	100.0	**4,849,795**	100.0

1. Refer to Appendix A of this report for a description as to why the Natural Resources Team grouped some families together.
2. This is a five-year average (2005-2009) of the annual harvest levels.
3. This is a five-year average (2005-2009) of the annual harvest values displayed in FY13 dollars.

Lake Huron Baseline Assessment

Lake Huron's baseline harvest level is 3.6 million pounds with an associated value of $4.7 million.[10] It contributes a total of 19.5 percent to the total harvest of fish on the Great Lakes and 20.2 percent to the total value of Great Lakes fisheries.[11]

Lake Huron experienced a decline in harvest levels since 1989. The maximum harvest level in the 1990s was 5.6 million pounds (1997) and accounted for about 21.5 percent of the total commercial fishing harvests on the Great Lakes; the maximum harvest level since year 2000 has been about 5.7 million pounds (2001) and accounted for 27.7 percent of the Great Lakes commercial fishing harvests. See Table 14 for annual harvest levels and values over the analysis period (1989 through 2009).

Table 14: Harvest Data for Lake Huron

Year	Harvest Level (lbs)	Harvest Value[1] (FY13 Dollars)
1989	3,001,332	N/A
1990[2]	4,823,925	N/A
1991	4,853,793	$12,446,810
1992	4,971,854	$8,894,825
1993	4,834,567	$6,715,019
1994	5,004,962	$6,209,040
1995	5,519,461	$7,599,286
1996	5,233,342	$6,608,149
1997	5,614,252	$6,799,909
1998	5,077,135	$6,661,050
1999	4,592,834	$5,967,912
2000	4,762,399	$7,425,538
2001	5,657,144	$8,354,820
2002	4,053,955	$5,386,191
2003	4,096,563	$5,225,543
2004	3,747,955	$4,987,481
2005	4,019,184	$4,827,267
2006	4,395,052	$4,198,444
2007	4,181,089	$4,000,927
2008	3,556,244	$4,270,150
2009	3,590,754	$4,721,544
5-Year Average	**3,948,465**	**$4,403,666**

1. Note that the commercial fishing harvest value data does not begin until 1991. This is the first year that the Bureau of Labor Statistics began publishing producer price index (PPI) data for commercial fishing category "02230199."
2. Note that CORA tribal commercial harvest data was not available until year 1990.

[10] Recall, the baseline figures represent the average values of commercial harvest levels and commercial harvest values over the five-year time period (2005-2009).
[11] Refer to *Table 4: Great Lakes Baseline Harvest and Values* in the "Great Lakes" portion of the document.

Table 15 is the summary statistics for Lake Huron. Harvest levels are down by approximately 8 percent in recent years compared to the historical average. The baseline harvest level (about 3.9 million pounds) is slightly less than the average harvest level of 4.6 million pounds. Further, the baseline harvest value (approximately $4.4 million) is also less than the average harvest value of $6.4 million.

CORA member tribes and Michigan state-licensed commercial fishermen harvest fish on Lake Huron. The primary harvested species is lake whitefish; in 2009, it accounted for 2.9 million pounds with an associated value of $4.3 million. CORA tribes' commercial fishermen harvested about 42 percent of the total lake whitefish from Lake Huron in 2009 while Michigan state-licensed commercial fishermen harvested about 58 percent of this total. This ratio fluctuates throughout the analysis period, sometimes with CORA tribes harvesting more and sometime the state-licensed commercial fishermen harvesting more of the total catch of lake whitefish. The total harvest of lake whitefish has been consistent over the analysis period (1989 through 2000).

The average harvest level in the 1990s was 4.9 million pounds while the average in the 2000s was 4.2 million pounds. Declines in harvest levels on Lake Huron can be attributed to the decrease in the harvest of species such as menominee, rainbow smelt, sucker, white perch, yellow perch, white bass, channel catfish, and common carp.

Table 15: Summary Statistics for Lake Huron

Annual Harvest Summary Data: 1989-2009	
Average Harvest	4,551,800
Maximum Harvest Level	5,657,144
Minimum Harvest Level	3,001,332
Annual Harvest value Summary Data: 1992-2009 (adjusted to FY13 dollars)	
Average Harvest value:	6,384,206
Maximum Harvest value	12,446,810
Minimum Harvest value	4,000,927
Annual Harvest Summary Data: 1989-1999	
Average Harvest	4,866,132
Maximum Harvest Level	5,614,252
Minimum Harvest Level	3,001,332
Annual Harvest Summary Data: 2000-2009	
Average Harvest	4,206,034
Maximum Harvest Level	5,657,144
Minimum Harvest Level	3,556,244
Recent harvest levels (2000 - 2009) compared to historic (1989-2009)	-7.60%
BASELINE VALUES: LAKE HURON	
5-Year Average Harvest Level (2005-2009)	3,948,465
5-Year Average Harvest Value (2005-2009)	$4,403,666

Figure 5 displays Lake Huron's commercial fishing harvest data for the years 1989 through 2009.

Figure 5: Lake Huron Commercial Fishing Harvests

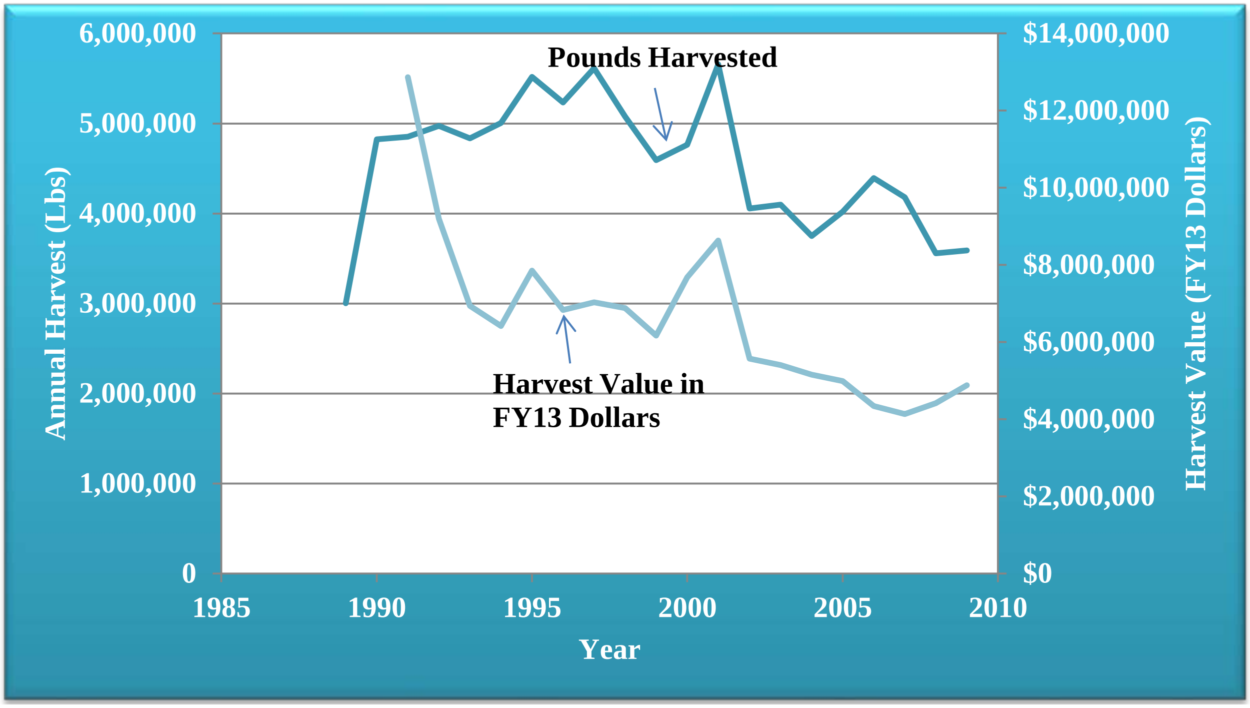


Table 16 exemplifies the contribution by species to the total harvest level and value of commercial fishing on Lake Huron.

Table 16: Lake Huron Baseline Harvest Data by Species

Family[1]	Harvested Species	Harvest Level[2]	% of Total	Harvest Value[3] (FY13 $)	% of Total
Whitefishes, Smelts, Shads, Herrings	chub, menominee, lake whitefish, smelt, gizzard shad, alewife, cisco	3,251,495	82.3	3,925,911	89.2
Cods, Chars, Salmon and Trouts	burbot, lake trout, coho salmon, chinook salmon, rainbow trout	343,844	8.7	319,315	7.3
Sunfishes, Temperate Bass, Perches	rock bass, crappie, white bass, white perch, yellow perch , walleye	64,959	1.6	81,024	1.8
Bullhead Catfishes	bullhead, channel catfish	135,951	3.4	48,028	1.1
Suckers	buffalo, quillback, sucker	65,542	1.7	16,341	0.4
Drums	freshwater drum	61,362	1.6	6,935	0.2
Carp	common carp	25,311	0.6	6,113	0.1
Gars, Bowfins	gar, bowfin	0	0.0	0	0.0
	Total: All Species	**3,948,465**	100.0	**4,403,666**	100.0

1. Refer to Appendix A of this report for description as to why the Natural Resources Team grouped some families together.
2. This is a five-year average (2005-2009) of the annual harvest levels.
3. This is a five-year average (2005-2009) of the annual harvest values displayed in FY13 dollars.

Lake Superior Baseline Assessment

Lake Superior's baseline harvest level is 4.6 million pounds with an associated value of $3.9 million.[12] It contributes a total of 22.5 percent to the total harvest of fish on the Great Lakes and 17.8 percent to the total value of Great Lakes fisheries.[13] Lake Superior experienced an increase in harvest levels since 1989. The maximum harvest level from 1989 through 1999 was approximately 3.1 million pounds (1998) and accounted for about 12.4 percent of the total commercial fishing harvests on the Great Lakes; the maximum harvest level since year 2000 was about 6.5 million pounds (2008) and accounted for 32.0 percent of the Great Lakes commercial fishing harvests. See *Table 17: Harvest Data for Lake Superior* for annual harvest levels (in pounds) and values (in FY13 dollars) over the analysis period.

Table 17: Harvest Data for Lake Superior

Year	Harvest Level (lbs)	Harvest Value[1] (FY13 Dollars)
1989	1,475,940	NA
1990	1,455,548	NA
1991	1,057,637	$2,252,155
1992	1,282,315	$1,949,129
1993	1,111,526	$1,286,745
1994	1,130,853	$1,216,528
1995	961,973	$1,093,647
1996[2]	2,561,445	$3,044,116
1997	2,488,206	$3,267,453
1998	3,114,177	$4,528,062
1999	3,058,686	$3,947,149
2000[3]	3,496,209	$4,691,415
2001	4,233,409	$6,234,665
2002	2,505,635	$2,594,913
2003	3,260,375	$3,208,907
2004	3,703,599	$3,253,516
2005	3,754,021	$3,050,073
2006	4,035,426	$2,668,877
2007	4,448,833	$2,905,082
2008	6,523,639	$5,950,053
2009	4,027,263	$4,778,431
5-Year Average	**4,557,836**	**$3,870,503**

1. Note that the commercial fishing harvest value data does not begin until 1991. This is the first year that the Bureau of Labor Statistics began publishing producer price index (PPI) data for commercial fishing category "02230199."
2. Great Lakes Indian Fish and Wildlife Commission (GLIFWC) data was not available until 1996.
3. Minnesota's harvest data begins in year 2000. Data prior to that point was unavailable.

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[12] Recall, the baseline figures represent the average values of commercial harvest levels and commercial harvest values over the five-year time period (2005-2009).
[13] Refer to *Table 4* in the "Great Lakes" portion of the document.

Table 18 shows the summary statistics for Lake Superior. Harvest levels are up about 41 percent in recent years compared to the historical average.

The baseline harvest level (about 4.6 million pounds) is greater than the historical average harvest level of 2.8 million pounds. Further, the baseline harvest value ($3.9 million) is greater the average harvest value of $3.3 million.

Harvest levels and values in the 1990s reflect the totals of two states' tribe and state-licensed commercial fishing harvests: Michigan and Wisconsin. However, the Great Lakes Indian Fish and Wildlife Commission data contribution does not begin until 1996; therefore, some increase in the harvest since then can be attributed to this data contribution.

The Great Lakes Indian Fish and Wildlife Commission (GLIFWC) represents the following tribes: Bay Mills Indian Community, Lac Vieux Desert Band of Lake Superior Chippewa Indians, Bad River Band of Lake Superior Chippewa Indians of Wisconsin, Red Cliff Band of Lake Superior Chippewa Indians of Wisconsin, Lac du Flambeau Band of Lake Superior Chippewa Indians of Wisconsin, Lac Courte Oreilles Band of Lake Superior Chippewa Indians of Wisconsin, St. Croix Chippewa Indians of Wisconsin, Mille Lacs Band of Ojibwe, and Fond du Lac Band of Lake Superior Chippewa Indians of Minnesota.[14]

Minnesota's data contribution begins in year 2000. Therefore, increases in harvest levels during the 2000s are partially attributed to Minnesota's data contribution.

The majority of the harvests on Lake Superior are comprised of lake whitefish. In 2009, the total harvest of this species was approximately 2.5 million pounds. This is about equal to the average harvest level of species in the 2000s.

[14] Note that the 1854 Treaty Authority member tribes (which border Lake Superior) did not provide harvest data for any year during the Great Lakes analysis period (1989 through 2009). These tribes include the Grand Portage Band of Lake Superior Chippewa Indians, and the Bois Forte Band of Lake Superior Chippewa Indians.

Table 18: Summary Statistics for Lake Superior

Annual Harvest Summary Data: 1989-2009	
Average Harvest (Pounds)	2,842,224
Maximum Harvest Level	6,523,639
Minimum Harvest Level	961,973
Annual Harvest Value Summary Data: 1991-2009 (adjusted to FY13 dollars)	
Average Harvest value (Pounds)	3,258,996
Maximum Harvest value	6,234,665
Minimum Harvest value	1,093,647
Annual Harvest Summary Data: 1989-1999	
Average Harvest	1,790,755
Maximum Harvest Level	3,114,177
Minimum Harvest Level	961,973
Annual Harvest Summary Data: 2000-2009	
Average Harvest (Pounds)	3,998,841
Maximum Harvest Level	6,523,639
Minimum Harvest Level	2,505,635
Recent harvest levels (2000 - 2009) compared to historic (1989-2009)	40.69%
BASELINE VALUES: LAKE SUPERIOR	
5-Year Average Harvest Level (2005-2009)	4,557,836
5-Year Average Harvest Value (2005-2009)	$3,870,503

Figure 6 displays Lake Superior's commercial fishing harvest data for the years 1989 through 2009. Increases in harvest levels in 1996 through 1999 can be partially attributed to the contribution of GLIFWC's data set. Increased harvest levels since 2000 are attributed to both GLIFWC's data set and state-licensed commercial fishing data provided by Minnesota (which wasn't available until year 2000). Therefore, increases in harvest levels and harvest values over the study period (1989 through 2009) are not necessarily indicative of increased harvest, but rather, an increase in reported harvests.

Figure 6: Lake Superior Commercial Fishing Harvests

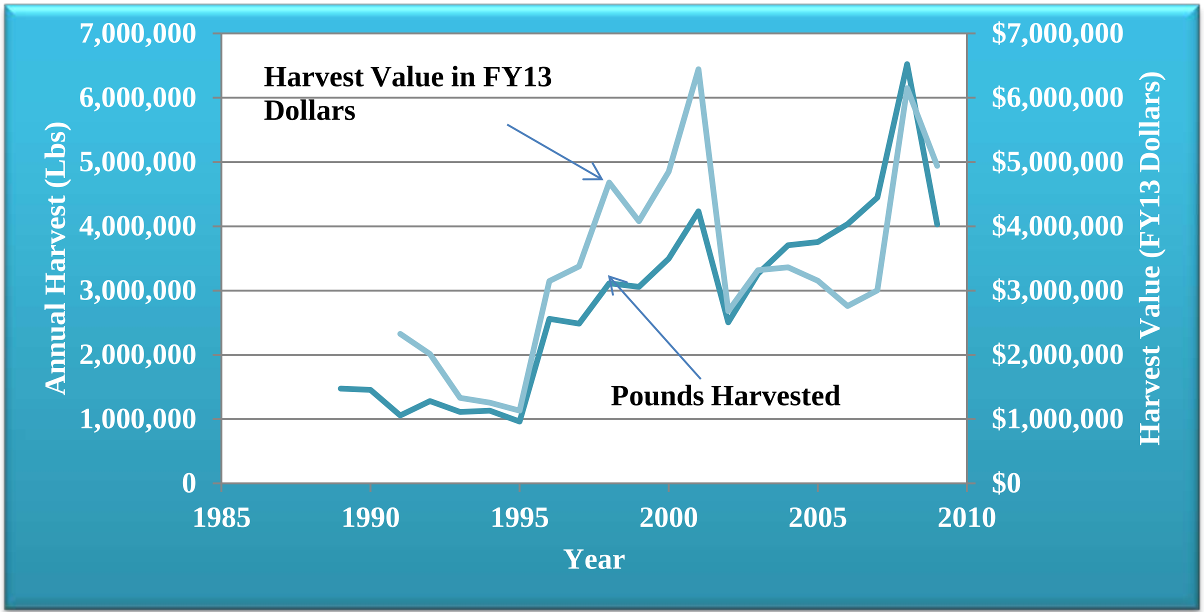


Table 19 exemplifies the contribution by species to the total harvest level and value of commercial fishing on Lake Superior.

Table 19: Lake Superior Baseline Harvest Data by Species

Family[1]	Harvested Species	Harvest Level[2] (lbs)	% of Total	Harvest Value [3] ($)	% of Total
Whitefishes, Smelts	lake herring, chubs, lake whitefish, cisco (flesh and roe), menominee, rainbow smelt, alewife	3,485,278	76.5	2,751,372	71.1
Whitefishes, Cods	lake char, burbot, splake, chinook salmon, coho salmon, European brown trout, rainbow trout	1,062,697	23.3	1,114,656	28.8
Perches, Cods	perch, walleye, northern pike	6,592	0.1	3,965	0.1
Suckers	sucker	3,269	0.1	510	0.0
Carp	common carp	0	0.0	0	0.0
	Total: All Species	**4,557,836**	100.0	**3,870,503**	100.0

1. Refer to Appendix A of this report for description of why the Natural Resources Team grouped families together.
2. This is a five-year average (2005-2009) of the annual harvest levels.
3. This is a five-year average (2005-2009) of the annual harvest value.

Lake Ontario Baseline Assessment

Lake Ontario's baseline (5-year average from 2005-2009) harvest level is 21 thousand pounds with an associated value of $31 thousand.[15] It contributes a total of 0.1 percent to the total harvest of fish on the Great Lakes and 0.1 percent to the total harvest value of Great Lakes fisheries.[16]

Lake Ontario experienced a decrease in harvest levels since 1991. The maximum harvest level in the 1990s was approximately 141 thousand pounds (1991) and accounted for 0.5 percent of the total commercial fishing harvests on the Great Lakes; the maximum harvest level since year 2000 has been about 70 thousand pounds (2000) and accounted for 0.4 percent of the Great Lakes commercial fishing harvests. See Table 20 for annual harvest levels (in pounds) and values (in FY13 dollars) over the analysis period.

Table 20: Lake Ontario Harvest Data

Year	Harvest Level1 (lbs)	Harvest Value[1] (FY13 Dollars)
1989	N/A	N/A
1990	N/A	N/A
1991	140,643	$512,729
1992	88,865	$179,039
1993	67,234	$98,459
1994	80,645	$161,864
1995	59,615	$174,287
1996	63,796	$120,582
1997	52,788	$179,960
1998	69,970	$258,197
1999	48,164	$106,758
2000	70,179	$161,461
2001	46,655	$106,754
2002	41,658	$72,825
2003	12,118	$20,323
2004	38,266	$70,061
2005	7,394	$12,404
2006	4,774	$7,694
2007	34,878	$55,660
2008	15,163	$15,083
2009	41,389	$63,530
5-Year Average	**20,720**	**$30,874**
1. Note that the commercial fishing harvest value data does not begin until 1991. This is the first year that commercial harvest data for Lake Ontario was available.		

[15] Recall, the baseline figures represent the average values of commercial harvest levels and commercial harvest values over the five-year time period (2005-2009).

[16] Refer to *Table 4: Great Lakes Baseline Harvest and Values* in the "Great Lakes" portion of the document.

Table 21 shows the summary statistics for Lake Ontario. Harvest levels and values decreased during the analysis period. Harvest levels are down by almost 40 percent in recent years compared to the historical average. The baseline harvest level (about 21,000 pounds) is less than half of the average harvest level of approximately 52,000 pounds. Further, the baseline harvest value ($31 thousand) is also less than a third of the average harvest value of $125 thousand.

Lake Ontario's harvest decreased (by almost 40%) in the 2000-2009 harvest levels, the 10-year average, compared to the 1991-2009 harvest levels. This can be attributed to the decrease in the harvest of numerous fisheries such as: white bass, rock bass, black crappie, sunfish and freshwater drum, which were harvested in the 1990s by New York's state-licensed commercial fishermen but were not harvested in the 2000s.

Note that all harvests on Lake Ontario are from state-licensed fishermen. No tribal commercial fishing harvests were reported during the analysis period (1991 through 2009).

Table 21: Summary Statistics for Lake Ontario

Annual Harvest Summary Data: 1991-2009	
Average Harvest (pounds)	51,800
Maximum Harvest Level	140,643
Minimum Harvest Level	4,774
Annual Harvest value Summary Data: 1991-2009 (adjusted to FY13 dollars)	
Average Harvest value	125,141
Maximum Harvest value	512,729
Minimum Harvest value	7,694
Annual Harvest Summary Data: 1991-1999	
Average Harvest (pounds)	74,636
Maximum Harvest Level	140,643
Minimum Harvest Level	48,164
Annual Harvest Summary Data: 2000-2009	
Average Harvest (pounds)	31,247
Maximum Harvest Level	70,179
Minimum Harvest Level	4,774
Recent harvest levels (2000 - 2009) compared to historic (1991-2009)	-39.68%
BASELINE VALUE: LAKE ONTARIO	
5-Year Average Harvest Level (2005-2009)	**20,720**
5-Year Average Harvest Value (2005-2009)	**$30,874**

Figure 7 displays Lake Ontario's commercial fishing harvest data for the years 1991 through 2009. Note that the number of state-licensed commercial fishermen decreased in year 2000. This is correlated with a decline in commercial fishing harvests and associated harvest values.

Figure 7: Lake Ontario Commercial Fishing Harvests

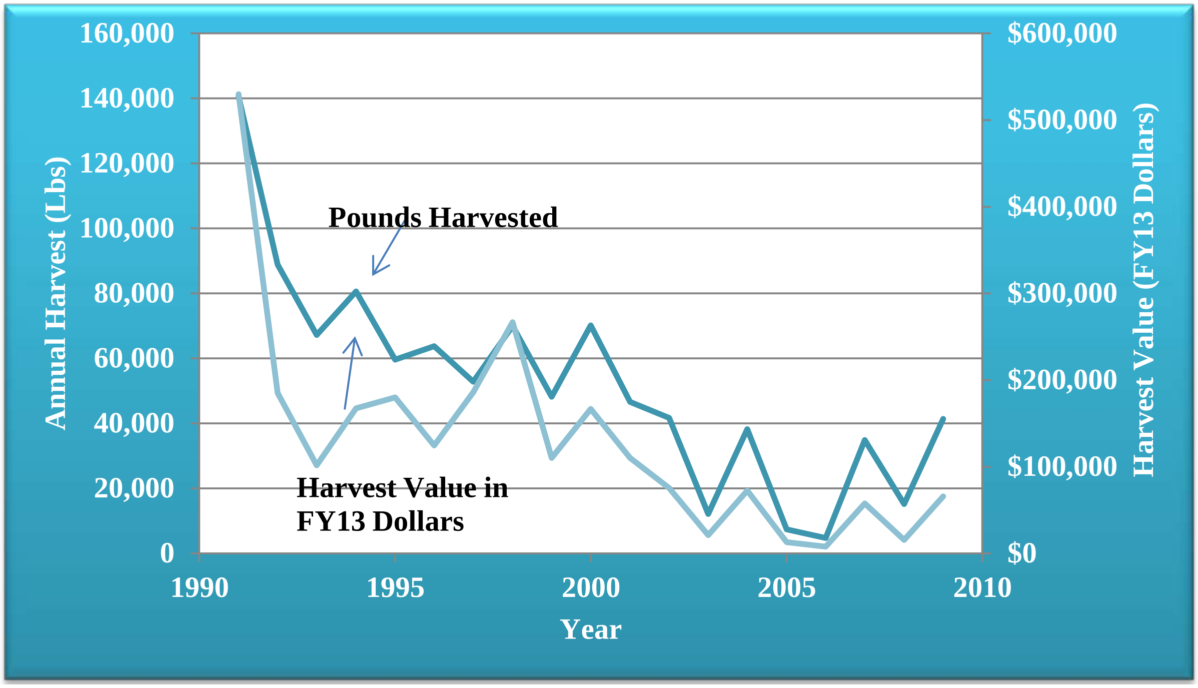


Table 22 exemplifies the contribution of species to the total harvest level and value of commercial fishing on Lake Ontario. Note that families Perches, Temperate Bass and Sunfishes are comprised of lake yellow perch, white perch, rock bass, black crappie and sunfish. Of these, yellow perch is the only species that was harvested between 2005 and 2009 (the period from which the baseline was derived). Therefore, yellow perch alone account for about 97 percent of Lake Ontario's total commercial fishing harvest and approximately 98 percent of its value.

Table 22: Lake Ontario Baseline Harvest Data by Species

Family[1]	Harvested Species	Harvest Level[2] (lbs)	% of Total	Harvest value[3] ($)	% of Total
Perches, Temperate Bass, Sunfishes	yellow perch, white perch, rock bass, black crappie, sunfish	20,151	97.3	30,333	98.2
Bullhead	brown bullhead	568	2.7	541	1.8
Drums	freshwater drum	0	0.0	0	0.0
	Total: All Species	**20,720**	**100.0**	**30,874**	100.0

1. Refer to Appendix A of this report for description as to why the GLMRIS Natural Resources Team grouped some families together.
2. This is a five-year average (2005-2009) of the annual harvest levels.
3. This is a five-year average (2005-2009) of the annual harvest values in FY13 dollars

UPPER MISSISSIPPI RIVER BASIN BASELINE ASSESSMENT

The analysis period for the Upper Mississippi River Basin includes years 1989 through 2005. These are the years for which the majority of states in the basin were able to provide commercial harvest data. The baseline harvest levels and values were derived from the average of the most recent five years of data available, years 2001 through 2005.

The Upper Mississippi River Basin fishery is valued at $3.8 million with a harvest level of almost 10.0 million pounds. Baseline figures reflect the average of 2001 through 2005 harvest level and harvest value data. Table 23 displays the total Upper Mississippi River Basin fishery harvest level and value.

This total is comprised of the following water bodies: Upper Mississippi River, Illinois River, Kaskaskia River, and the Rock River.[17] These are the only rivers in the Upper Mississippi River Basin for which states identified commercial fishing harvests during the analysis period (years 1989 through 2005).

Table 23: Upper Mississippi River Basin Baseline Harvest and Values

Basin	Water Bodies Included in Basin Total	Harvest Level[1] (lbs)	Harvest Value[1] ($)
Upper Mississippi River	Upper Mississippi River Illinois River Kaskaskia River Rock River Zumbro River[2]	9,999,000	3,840,000
1. Harvest levels and values reflect a five-year average from 2001 through 2005. All values are rounded to the nearest thousand. Harvest values are displayed in FY13 dollars. 2. The Zumbro River will be addressed in a qualitative manner due to the fact that harvests on these rivers only occurred in a few years during the analysis period.			

The primary contributor to the Upper Mississippi River Basin's harvest levels and values (in the Upper Mississippi, Illinois, Kaskaskia and Rock Rivers) is comprised of species such as: bigmouth, smallmouth and black buffalo (which contribute 27 percent to the total harvest in 2005), silver and bighead carp (21 percent), common carp (17 percent), and blue catfish, channel catfish and flathead catfish (15 percent).

The Zumbro River in Minnesota also supported commercial harvests during 1998 and 1999. The harvest of common carp, sucker, and quillback during these years totaled to approximately 49,000 pounds.

Table 24 displays the harvest level (pounds) and the associated harvest value for the years 1989 through 2005 for the Upper Mississippi River Basin.

[17] See *Plate 2: Upper Mississippi River Basin Map* for map of the rivers included in the Upper Mississippi River Basin baseline economic assessment.

Table 24: Upper Mississippi River Basin Harvest Levels and Values

Year	Harvest Level (lbs)	Harvest Value[1] (FY13 Dollars)
1989	11,190,479	N/A
1990[2]	16,070,981	N/A
1991	10,574,524	$7,533,689
1992	12,492,360	$5,712,031
1993	12,369,442	$4,458,959
1994	12,194,779	$3,980,212
1995	12,606,357	$4,509,721
1996	12,588,122	$3,982,560
1997	11,462,408	$4,240,694
1998	11,407,486	$4,162,345
1999[3]	11,132,226	$3,347,529
2000	9,097,356	$3,320,272
2001	10,077,421	$3,384,169
2002	10,450,292	$3,725,412
2003	9,914,227	$3,688,576
2004	9,499,023	$3,993,914
2005	10,051,589	$4,406,801
5-Year Average	**9,998,510**	**$3,839,774**

1. Note that the commercial fishing harvest value data does not begin until 1991. This is the first year that the Bureau of Labor Statistics began publishing producer price index (PPI) data for commercial fishing category "02230199."
2. Harvest levels for the Rock River in Illinois begin in 1990.
3. Harvest level and harvest value data for paddlefish and shovelnose sturgeon roe begin in year 1999.

The Upper Mississippi Basin has experienced a fluctuation in harvest levels over the analysis period. Harvest levels are down by 13 percent in recent years (2000 through 2005) compared to the historical average (1989 through 2005).

This can be attributed to the decrease in harvest levels of various species. For instance, harvest levels of common carp are down by 35 percent in recent years (2000 through 2005) compared to the historical average (1989 through 2005), while the harvest of buffalo (down 7 percent) and total harvests of catfishes and bullheads (down 9 percent) have also experienced declines in harvest levels.

Decreases in the harvest of some families of species are partially offset by increases in harvests of other species. For example, the harvest of shovelnose sturgeon and shovelnose sturgeon roe are up by 60 percent in recent years (2000 through 2005) compared to historic (1989 through 2005) levels. Further, the harvest of species such as silver and bighead carp (up 200 percent) and grass carp (up 78 percent) have experienced increases in harvest levels in recent years (up 156 percent) compared to historic levels.

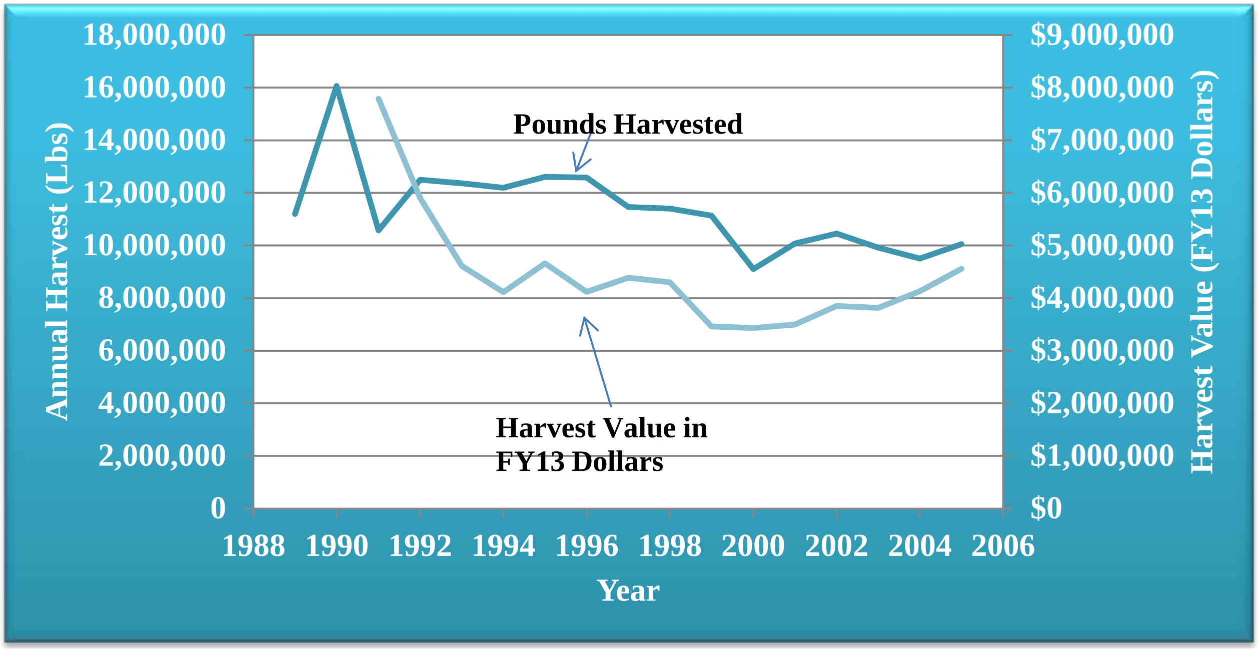
Table 25 exhibits summary statistics for total fish and roe harvests in the Upper Mississippi River Basin.

Table 25: Summary Statistics for the Upper Mississippi River Basin

Annual Harvest Summary Data: 1989-2005	
Average Harvest	11,363,475
Maximum Harvest Level	16,070,981
Minimum Harvest Level	9,097,356
Annual Harvest Value Summary Data: 1992-2005 (adjusted to FY13 dollars)	
Average Harvest value:	$4,296,459
Maximum Harvest value	$7,533,689
Minimum Harvest value	$3,320,272
Annual Harvest Summary Data: 1989-1999	
Average Harvest	12,189,924
Maximum Harvest Level	16,070,981
Minimum Harvest Level	10,574,524
Annual Harvest Summary Data: 2000-2005	
Average Harvest	9,848,318
Maximum Harvest Level	10,450,292
Minimum Harvest Level	9,097,356
Recent harvest levels (2000 - 2005) compared to historic (1989-2005)	-13.33%
BASELINE VALUES: UPPER MISSISSIPPI RIVER BASIN	
5-Year Average Harvest Level (2001-2005)	**9,998,510**
5-Year Average Harvest Value (2001-2005)	**$3,839,774**

Figure 8 displays the aggregated commercial fishing harvest levels and values for the years 1991 through 2009 for the following rivers: Upper Mississippi River, Illinois River, Kaskaskia River, and Rock River.

Figure 8: Upper Mississippi River Basin Commercial Fishing Harvest Data



Suckers represent the majority of the baseline commercial fishing harvest (35 percent) and baseline harvest value (29 percent) for the Upper Mississippi River Basin. This family includes species such as, buffalo, redhorse, carpsuckers, and other Sucker family species. These species are harvested in the following rivers: Upper Mississippi River (by Iowa, Wisconsin, Minnesota, Missouri and Illinois), the Illinois River (by Illinois), the Kaskaskia River (by Illinois) and the Rock River (by Illinois).

Bullhead and other Catfish species also make up a large majority of the commercial fishing harvest value in the Upper Mississippi River Basin. Channel catfish make up the majority of harvest in this family. The baseline harvest level for channel catfish was 1.2 million pounds with an associated value of $756 thousand. This species accounted for approximately 24 percent of the baseline harvest level in the Upper Mississippi River Basin.
Table 26: Upper Mississippi River Basin Baseline Harvest Data by Species exemplifies the contribution by species to the baseline harvest level and value of commercial fishing in the Upper Mississippi River Basin. Note that all harvests are from state-licensed fishermen. No tribal harvests were reported during the analysis period (1989 through 2005).

Table 26: Upper Mississippi River Basin Baseline Harvest Data by Species

Family[1]	Harvested Species	Harvest Level[2] (lbs)	% of Total	Harvest Value[3] ($)	% of Total
Suckers	bigmouth buffalo, smallmouth buffalo, black buffalo, sucker, redhorse, carpsucker	3,455,452	34.6	1,130,279	29.4
Bullhead Catfishes	bullhead, channel catfish, flathead catfish, blue catfish	1,730,585	17.3	1,068,714	27.8
Carps & Minnows	common carp, grass carp, minnows	2,128,550	21.3	277,972	7.2
Paddlefish, Mooneyes, Shads, Herrings & Carps	paddlefish, paddlefish roe, mooneye, goldeye, gizzard shad, skipjack herring, bighead carp, silver carp	1,146,414	11.5	521,095	13.6
Drums	freshwater drum	1,291,021	12.9	205,588	5.4
Sturgeons	shovelnose sturgeon, shovelnose sturgeon roe	130,448	1.3	618,085	16.1
Other	other	91,621	0.9	13,158	0.3
Gars & Bowfins	gars, bowfins	24,196	0.2	4,762	0.1
Freshwater Eels	American eel	223	0.0	122	0.0
	Total: All Species	**9,998,510**	**100.0**	**3,839,774**	100.0

1. Refer to Appendix B of this report for description as to why the Natural Resources Team grouped some families together.
2. This is a five-year average (2001-2005) of the annual harvest levels.
3. This is a five-year average (2001-2005) of the annual harvest values displayed in FY13 dollars.

OHIO RIVER BASIN BASELINE ASSESSMENT

The analysis period for the Ohio River Basin includes years 1999 through 2005. These are the years for which the majority of states in the basin were able to provide commercial harvest data. The baseline harvest levels and values were derived from the average of the most recent five years of data, years 2001 through 2005.

The Ohio River Basin fishery is valued at $2.0 million with a harvest level of 1.4 million pounds. Baseline figures reflect the average of 2001 through 2005 harvest level and harvest value data. Table 27 displays the total Ohio River Basin fishery harvest level and value.

This total is comprised of the following water bodies: Ohio River, Wabash River, Cumberland River and the Kentucky River.[18] These are the only rivers in the Ohio River Basin for which states identified commercial fishing harvests during the analysis period (years 1999 through 2005).

Table 27: Ohio River Basin Baseline Harvest and Harvest Value

Basin	Water Bodies Included in Basin Total	Harvest Level[1] (lbs)	Harvest Value[1] ($)
Ohio River	Ohio River Wabash River Cumberland River Kentucky River Salt River[2]	1,382,000	1,985,000
1. Harvest levels and values reflect a five-year average from 2001 through 2005. All values are rounded to the nearest thousand. Harvest values are displayed in FY13 dollars. 2. The Salt River will be assessed qualitatively since harvest levels were only available for two years during the analysis period.			

Table 27 exhibits the Ohio River Basin's baseline harvest level of approximately 1.4 million pounds with an associated value of $2.0 million. The primary contributors to the Ohio River Basin's harvest levels and harvest values are species such as: catfish (contribute 38 percent to the baseline harvest level; contribute 17 percent to the baseline harvest value) paddlefish roe (contribute 61 percent to the baseline harvest value), and others. Species in the Paddlefish, Mooneyes, Shads, and Carps family accounted for 41 percent of the Ohio River Basin's baseline harvest level and 72 percent of the baseline harvest value.

The Salt River yielded 205 pounds of commercial fish harvest in 1999 and 179 pounds in 2000. These levels can be attributed to the harvest of channel catfish, flathead catfish, buffalo, common

[18] See *Plate 3: Ohio River Basin Map* for rivers included in the Ohio River Basin baseline economic assessment.

carp and freshwater drum. Table 28 displays the harvest level and the associated harvest value for the years 1999 through 2005 for the Ohio River Basin.

Table 28: Ohio River Basin Harvest Levels and Values

Year	Harvest Level (lbs)	Harvest Value (FY13 Dollars)
1999	1,009,133	$786,191
2000	1,527,068	$1,753,598
2001	1,652,833	$1,780,231
2002	1,527,332	$1,771,161
2003	919,712	$1,348,427
2004	1,315,088	$1,888,034
2005	1,494,274	$3,138,161
5-Year Average	**1,381,848**	**$1,985,203**

The Ohio River Basin has experienced some fluctuation in harvest levels over the 7-year analysis period. Harvest levels are down by about 3 percent in recent years (2002 through 2005) compared to the historical average (1999 through 2005).

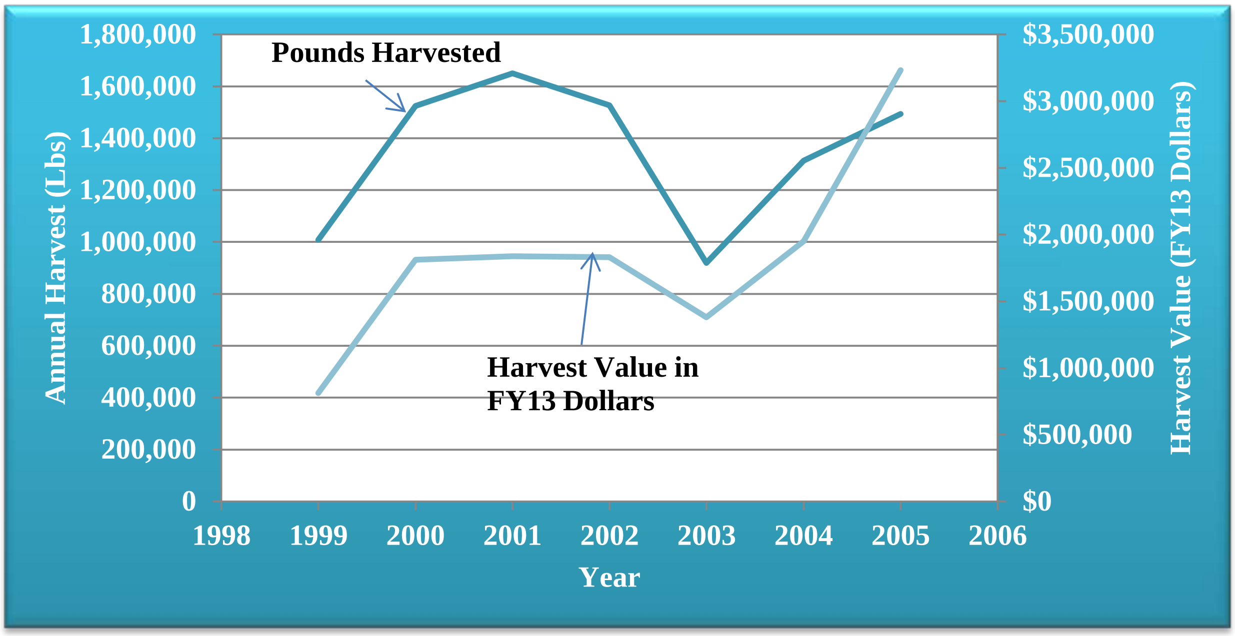
Table 29: Summary Statistics for the Ohio River Basin

Annual Harvest Summary Data: 1999-2005	
Average Harvest	1,349,349
Maximum Harvest Level	1,652,833
Minimum Harvest Level	919,712
Annual Harvest value Summary Data: 1999-2005 (adjusted to FY13 dollars)	
Average Harvest value:	$1,780,829
Maximum Harvest value	$3,138,161
Minimum Harvest value	$786,191
Annual Harvest Summary Data: 1999-2001	
Average Harvest	1,396,345
Maximum Harvest Level	1,652,833
Minimum Harvest Level	1,009,133
Annual Harvest Summary Data: 2002-2005	
Average Harvest	1,314,101
Maximum Harvest Level	1,527,332
Minimum Harvest Level	919,712
Recent harvest levels (1999 - 2001) compared to historic (1999-2005)	**-2.61%**
BASELINE VALUE: OHIO RIVER BASIN	
5-Year Average Harvest Level (2001-2005)	**1,381,848**
5-Year Average Harvest Value (2001-2005)	**$1,985,203**

Figure 9 displays Lake Ontario's commercial fishing harvest data for the years 1991 through 2009.

Note that the reduced harvest levels and values in 2003 can be partially attributed to the decrease in harvests of species in Kentucky's waters (in the Kentucky and Ohio Rivers). This was likely due to the fact that 2003 yielded the fewest number of fishing days due to lengthy periods of high water and high flow.

Figure 9: Ohio River Basin Commercial Fishing Harvest Data



Paddlefish and paddlefish roe accounted for the majority of the Ohio River Basin's commercial harvest value in 2005. The baseline harvest value was approximately $1.4 million, comprising 70 percent of the total baseline harvest value ($2.0 million) in the Ohio River Basin. Paddlefish and paddlefish roe were harvested on the Ohio River, Wabash River, Cumberland River and the Kentucky River.

Channel, flathead and blue catfish accounted for the majority of the remaining harvest levels and harvest values in 2005. The baseline harvest level of these three species was approximately 524 thousand pounds, with an associated harvest value of $343 thousand. These species were harvested from the Ohio River (by Illinois, Indiana and Kentucky), the Wabash River (by Illinois and Indiana), the Cumberland River (by Kentucky), and the Kentucky River (by Kentucky).

Note that all harvests are by state-licensed fishermen. There were no tribal harvests in the Ohio River Basin during the analysis period (1999-2005).

Table 30 exemplifies the contribution of species to the baseline harvest level and value of commercial fishing in the Ohio River Basin.

Table 30: Ohio River Basin Baseline Harvest Data by Species

Family[1]	Harvested Species	Harvest Level[2] (lbs)	% of Total	Harvest Value[3] ($)	% of Total
Paddlefish, Mooneyes, Shads, & Carps	paddlefish, paddlefish roe, mooneye, goldeye, gizzard shad, silver carp, bighead carp	569,538	41.2	1,422,332	71.6
Bullhead Catfishes	bullhead, channel catfish, flathead catfish, blue catfish	525,590	38.0	342,965	17.3
Suckers	buffalo, carpsuckers, suckers	211,299	15.3	65,390	3.3
Sturgeons	shovelnose sturgeon, shovelnose sturgeon roe	21,819	1.6	141,610	7.1
Other	Other	16,568	1.2	6,520	0.3
Minnows & Carps	minnows, common carp, grass carp	29,597	2.1	5,173	0.3
Drums	freshwater drum	5,007	0.4	755	0.0
Gars	gars	2,415	0.2	451	0.0
Freshwater Eels	American eel	14	0.0	9	0.0
	Total: All Species	**1,381,848**	100.0	**1,985,203**	100.0

1. Refer to Appendix B of this report for description as to why the GLMRIS Natural Resources Team grouped some families together.
2. This is a five-year average (2001-2005) of the annual harvest levels.
3. This is a five-year average (2001-2005) of the annual harvest values displayed in FY13 dollars.

CONCLUSION

The commercial fishing industry on the U.S. waters of the Great Lakes, Upper Mississippi River, and Ohio River basins are an economic engine for the region. While many fishery harvests have declined in the last twenty years, some have enjoyed increased harvests and values. Changes in harvests and values are driven by multiple factors, some biological, some concerning tastes and preferences of the consumer. This evaluation does not attempt to determine why the fisheries experienced changes in the past. Rather, this evaluation exhibits the current value of commercial fishing activities within the GLMRIS detailed study area.

USACE was not able to obtain sufficient information to quantify the timing or magnitude of impacts of ANS or the effects of implementation of fisheries management measures on targeted commercial fisheries. Consequently, this baseline economic assessment demonstrates the commercial fishing activities that *could* be impacted if Federal action is *or* is not taken to prevent the transfer of aquatic nuisance species between the Great Lakes and Mississippi River Basins (i.e., the FWP and FWOP conditions).

This evaluation summarizes the available commercial harvests and values for the U.S. waters of each of the Great Lakes, the Upper Mississippi River and its tributaries, and the Ohio River and its tributaries. The team worked closely with the reporting agencies and the Tribes to acquire the most current data set. Since there are yearly fluctuations in catch and value, the team determined that using the most recent five years of data would be an appropriate estimation of the current conditions of commercial fisheries. Findings from this evaluation include:

- The U.S. waters of the Great Lakes Basin yields an average of 20.3 million pounds of fish product for resale. The associated harvest value is $21.8 million (in FY13 dollars).
- The Upper Mississippi River basin yields an average of 10 million pounds of fish product for resale with an associated harvest value of $3.8 million (in FY13 dollars).
- The Ohio River basin yields an average of 1.4 million pounds of fish product for resale with an associated harvest value of $2.0 million (in FY13 dollars).

The baseline economic assessment of commercial fisheries is summarized further in Table 31.

Table 31: Summary Data

Basin	Baseline Harvest Level[1]	Baseline Harvest Value[2] ($)
Great Lakes[3]	20,243,000	21,793,000
Upper Mississippi River	9,999,000	3,840,000
Ohio River	1,382,000	1,985,000

1. This is a five-year average of the annual harvest levels (rounded to the nearest thousand). Harvest levels for the Great Lakes Basin are reflective of 2005 through 2009 harvest data; harvest levels for the Upper Mississippi River and Ohio River Basins are reflective of 2001 through 2005 harvest data.
2. This is a five-year average of the annual harvest values displayed in FY13 dollars (rounded to the nearest thousand). Harvest values for the Great Lakes Basin are reflective of 2005 through 2009 harvest data; values for the Upper Mississippi River and Ohio River Basins are reflective of 2001 through 2005 harvest data.
3. This baseline reflects harvest levels and values of the fisheries in the U.S. waters of the Great Lakes.

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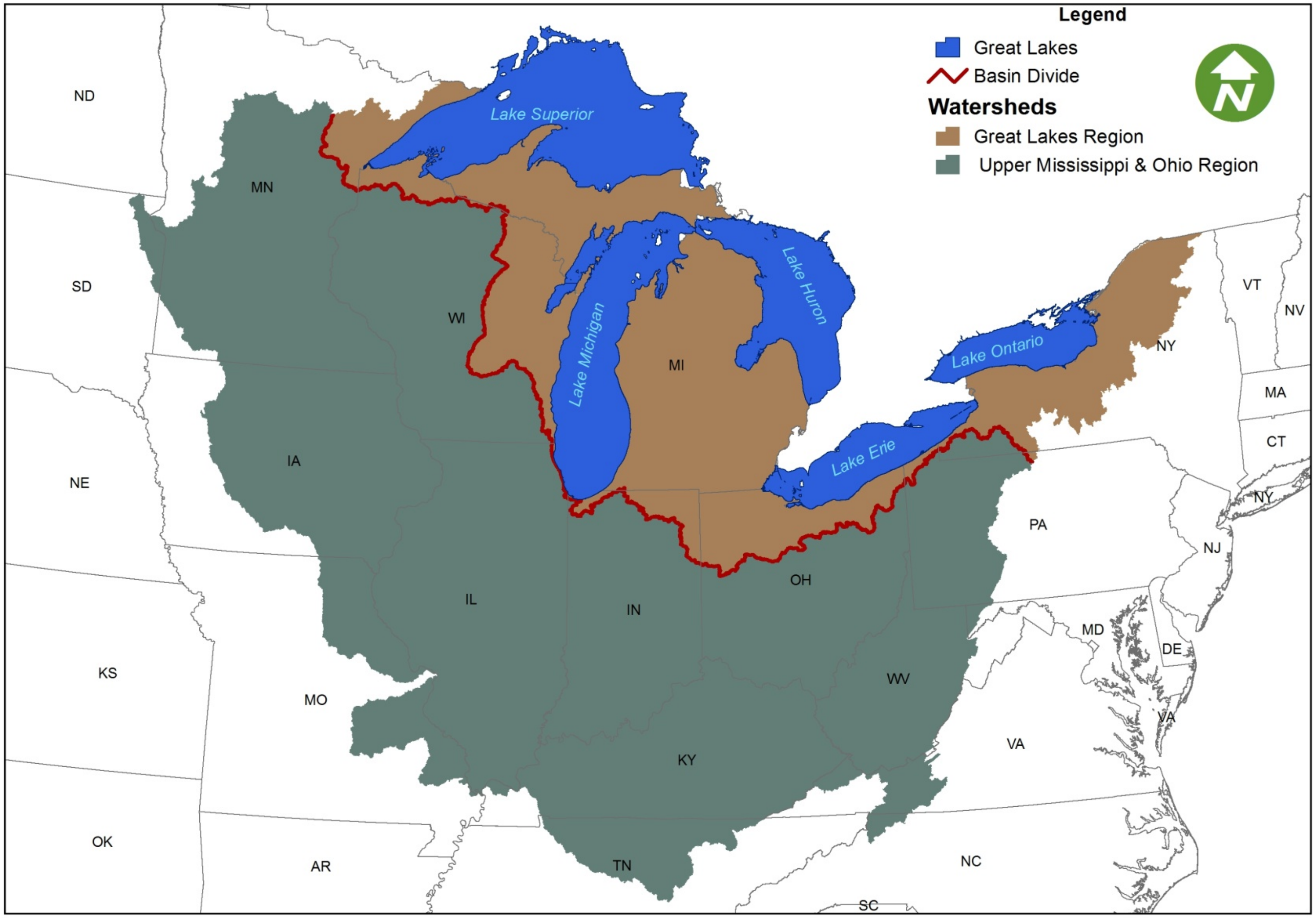
Plate 1: Great Lakes Basin

GLMRIS



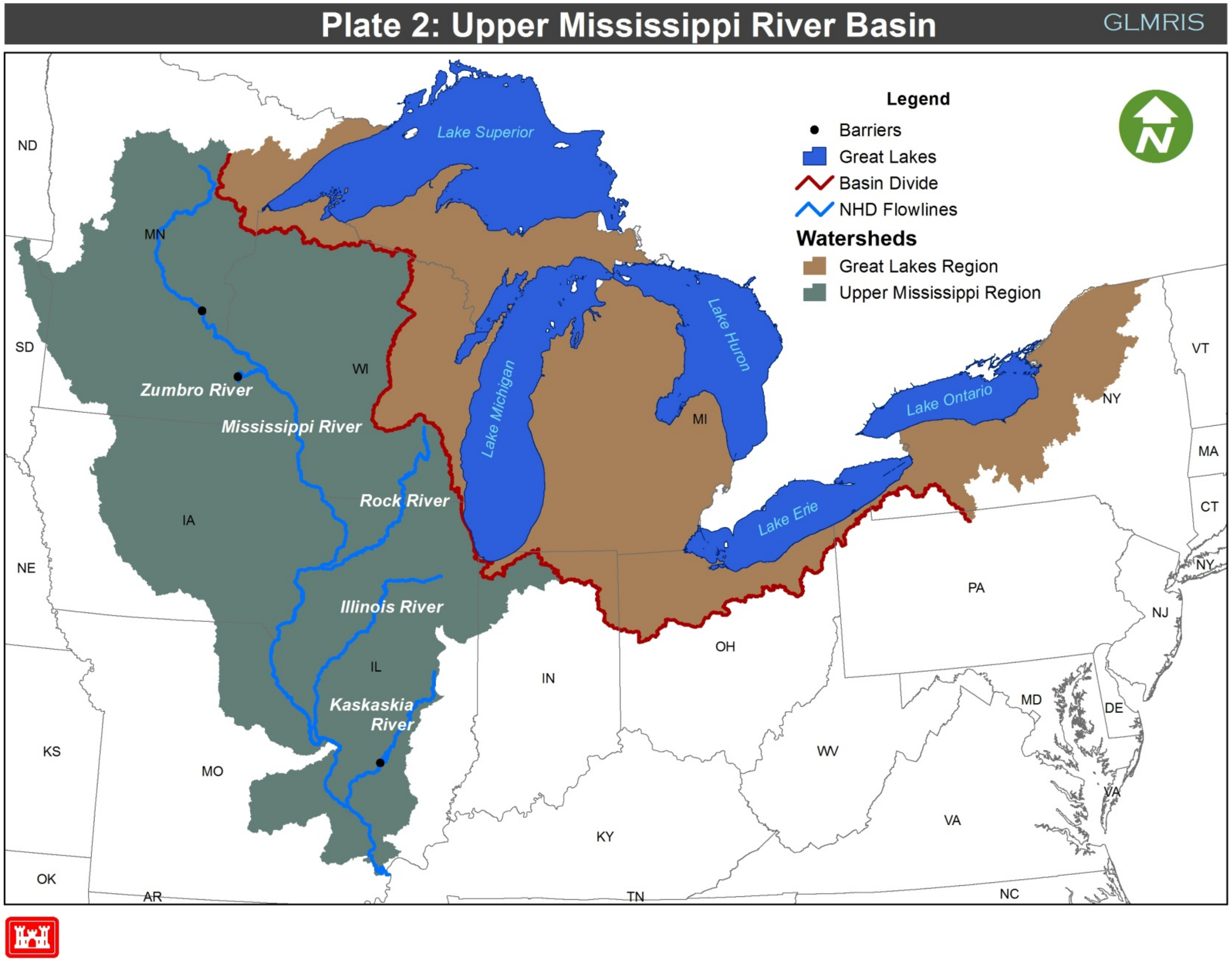


Plate 2: Upper Mississippi River Basin
GLMRIS
Legend
Barriers
Great Lakes
Basin Divide
NHD Flowlines
Watersheds
Great Lakes Region
Upper Mississippi Region
Lake Superior
Lake Michigan
Lake Huron
Lake Ontario
Lake Erie
Zumbro River
Mississippi River
Rock River
Illinois River
Kaskaskia River
ND
SD
NE
KS
OK
MN
IA
MO
AR
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IL
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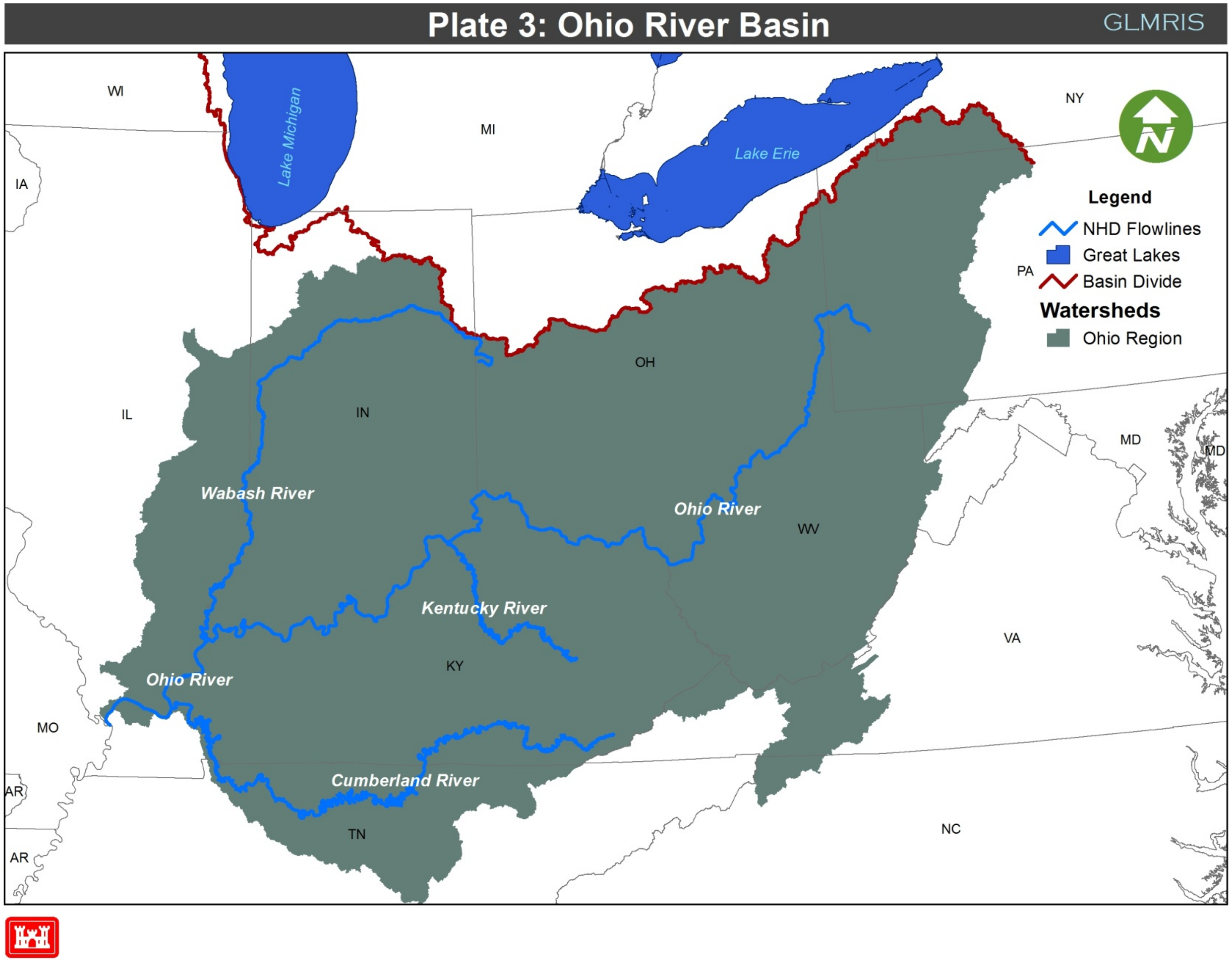

Plate 3: Ohio River Basin
GLMRIS
Legend
NHD Flowlines
Great Lakes
Basin Divide
Watersheds
Ohio Region
Lake Michigan
Lake Erie
WI
MI
NY
IA
PA
IL
IN
OH
MD
MD
WV
VA
KY
MO
AR
AR
TN
NC
Wabash River
Ohio River
Kentucky River
Ohio River
Cumberland River

Appendix A: Commercial Fisheries Baseline Economic Assessment Methodology

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INTRODUCTION

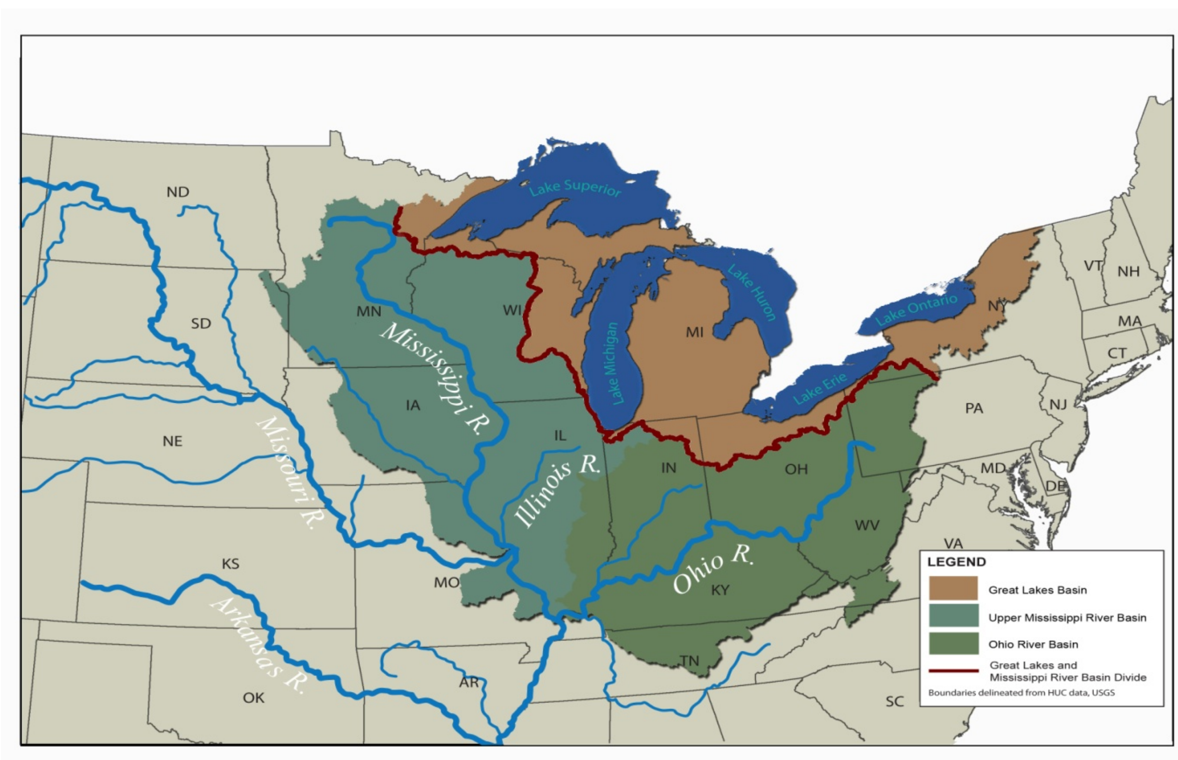
The following document outlines the methodology that was utilized to generate the baseline assessment of the commercial fisheries in the Great Lakes, Upper Mississippi River (UMR), and Ohio River Basins. The derivation of the focus areas, data collection procedures and data analysis methodologies are explained in this appendix to the *Commercial Fisheries Assessment- U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins*.

FOCUS AREAS

The Fisheries Economics Team identified the study area for the *Commercial Fisheries Assessment- U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins* in compliance with the overall Great Lakes and Mississippi River Interbasin Study (GLMRIS) study area. The GLMRIS study area includes portions of the Great Lakes, Mississippi River, and Ohio River basins that fall within the United States. Potential aquatic pathways between the Great Lakes and Mississippi River and Ohio River Basins exist along the basins' shared boundary. This shared boundary is the primary concentration of the study.

The Detailed Study Area is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The Detailed Study Area consists of the Upper Mississippi and Ohio River Basins (green) and the Great Lakes Basin (orange/brown). This study area is depicted in Figure 1.

FIGURE 1: GLMRIS STUDY AREA MAP



GREAT LAKES BASIN

The Fisheries Economics Team examined the fisheries within the Great Lakes Basin in the following water bodies: Lake Michigan, Lake Superior, Lake Huron, Lake Erie and Lake Ontario.[1] Great Lakes tributaries were also considered for the analysis. Disjunct water bodies within the Great Lakes Basin were not assessed due to the fact that Aquatic Nuisance Species (ANS) cannot transfer via aquatic pathways to separate water bodies.

The Fisheries Economics Team contacted agencies (such as Departments of Natural Resources) in order to determine whether the Great Lakes tributaries that fell within their state boundaries supported commercial fishing activity during the analysis period (years 1989 through 2009). If this criterion was met, then the tributary was included in this economic assessment.

The final Great Lakes Basin study area includes the following water bodies: Lake Michigan, Lake Erie (and its tributaries that lie between Lorain, Ohio and Toledo, Ohio), Lake Superior, Lake Huron, and Lake Ontario.[2]

UPPER MISSISSIPPI & OHIO RIVER BASINS

The Fisheries Economics Team examined the fisheries within the Upper Mississippi River Basin and the Ohio River Basin. In order to determine which streams to include in the baseline economic assessment, tribal commissions and state agencies (such as Departments of Natural Resources) were contacted in order to identify which streams supported commercial fishing activity at some point during the analysis period (years 1989 through 2009).[3]

In order to limit the fisheries analysis to the portions of these rivers that are at risk of being invaded by ANS via aquatic pathways, the GLMRIS Geographic Information System (GIS) Team located dams along the rivers. Working outward from Cairo, Illinois towards the rivers in the Upper Mississippi River Basin and Ohio River Basin, if an impassible dam was located, then the remaining portion of the river was excluded from the analysis.

For instance, since there were neither physical or technological barriers along the Illinois and Ohio Rivers that would prevent an ANS from transferring from the Great Lakes Basin into these rivers, the entire Illinois River and Ohio River were included in this analysis. However, the Coon Rapids Dam was located along the Upper Mississippi River in southern Minnesota and was determined to be a barrier to ANS transfer. Therefore, it is between Cairo, Illinois and the

[1] Note that the *Commercial Fisheries Baseline Economic Assessment- U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins* will focus only on the commercial fisheries in U.S. waters. Canadian portions of the Great Lakes and their tributaries will not be included in the analysis due to the fact that they are outside the scope of the GLMRIS study.
[2] According to the Michigan Department of Natural Resources, no commercial fishing activity takes place on Lake St. Clair so it has been omitted from this analysis.
[3] Disjunct water bodies within the UMR and Ohio River Basins were not assessed due to the fact that Aquatic Nuisance Species (ANS) have limited ability to transfer via aquatic pathways to separate water bodies.

aforementioned dam in Coon Rapids, Minnesota that will be the focus of the UMR. This dam identification process was applied to all rivers in both basins.

The final Upper Mississippi River Basin study area includes the following rivers: the Upper Mississippi River, Illinois River, Kaskaskia River, Rock River, and Zumbro River. The final Ohio River Basin study area includes the: Ohio River, Wabash River, Cumberland River, Kentucky River, and Salt River.

DATA COLLECTION

The following discussion focuses on the data collection procedures that were employed in order to obtain harvest level and dockside value[4] data for the fisheries in the Great Lakes, Upper Mississippi River, and Ohio River Basins.

AGENCY ASSISTANCE FOR THE GREAT LAKES BASIN

The *Commercial Fisheries Assessment - U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins* seeks to identify the current value of the fisheries in the Great Lakes, Upper Mississippi River, and Ohio River Basins.

In order to accomplish this task, the Fisheries Economics Team collaborated with fisheries specialists at state and inter-tribal agencies such as Departments of Natural Resources and the Great Lakes Indian Fish and Wildlife Commission, to obtain data regarding states' commercial fishing harvests and their associated values.

These agencies each collect commercial fishing harvest data from commercial fishermen on a monthly basis[5] for fisheries management purposes.[6] Note that all harvest levels and associated dockside values utilized to generate the *Commercial Fisheries Assessment - U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins* reflect those that are reported by the fishermen to state or inter-tribal agencies.[7] Irregularities or outliers in the data sets were

[4] Dockside values indicate the price per pound which the commercial fishermen received for their harvests.

[5] Note that some states collect commercial fishing harvest data (harvest level and ex-vessel price data) on a daily basis (such as Ohio's trap net fishermen harvesting from Lake Erie) while the Michigan Department of Natural Resources requires that state-licensed commercial fishermen report their harvests on an annual basis. However, the remaining state agencies require reporting on a monthly basis.

[6] Tribal commercial fishermen report their harvests to the tribes, which then report them to the inter-tribal agencies, who then provide the data to the state's Department of Natural Resources for fisheries management purposes.

[7] The use of this data has certain implications, the first being that the data that was utilized for the formation of the *Commercial Fisheries Assessment - U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins* is secondary data. Therefore, USACE did not have the ability to ensure that all data was reported in a consistent manner. It is assumed that there may be

responded to by: (1) contacting the state or inter-tribal agency to ascertain whether the irregularity in the data could be attributed to an event (ex: fewer fishing days due to flooding in a given year) or whether the irregularity in the data set resulted from an error in data entry (which resulted in an alteration of the data), or (2) finding that there was no identifiable reasoning as to why harvest data presented an outlier, in which case the data was left unaltered. These steps to ensure an accurate secondary data set are presented in Table 1.

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some misrepresentation of actual harvests, as well as some errors regarding data entry. USACE attempted to account for irregularities in the data by contacting state and inter-tribal agencies to make determinations as to why values in certain years appeared to be outliers. In some cases, harvest data fluctuations were attributed to data entry errors (which resulted in amendments to the data sets), while others were attributed to actual changes in the harvest due to fewer numbers of fishing days in a given year (which yielded no changes to the data sets). Other data irregularities that were not explained by these aforementioned reasons remained unaltered in order to preserve the integrity of the data.

TABLE 1: DATA LIMITATIONS

Category	Basin[1]	Limitation	Resolution
Data Collection	GL, UMR, OHR	Harvest data reflects the reporting completed by commercial fishermen.	The purpose of the commercial fisheries baseline economic assessment is to establish the current value of the commercial fisheries is based upon “the most recent annual harvest data available from state agencies (or equivalents) and inter-tribal agencies or organizations.” The report does not claim to have collected primary data.
Data Entry	GL, UMR, OHR	Since commercial fishermen report their harvest data to the state or tribe (which then reports it to their inter-tribal agency which reports it to the state), there are assumed to be at least some data entry errors.	For years during which there seem to be anomalies or outliers in the data, state/inter-tribal agencies were contacted in order to determine whether the oddity was a data entry error or whether a specific event caused a change in harvest levels or associated dockside values. Changes that were or were not explained are identified in the report.
Data Availability	GL	The most recent annual harvest data (harvest levels and associated dockside values) were not available for all states for the most recent years (2010 and 2011) due to lags in data entry.	Harvest data (harvest levels per species and associated dockside values) were requested for all years between 1989 and 2009 in order to provide the analyst with approximately 20 years of harvest data to analyze trends in harvest levels and values.
	UMR, OHR	The most recent annual harvest data (harvest levels and associated dockside values) were not available for all states for the most recent years (2006 through 2011) due to lags in data entry.	Harvest data (harvest levels per species and associated prices) were requested for all years between 1989 and 2005 in order to provide the analyst with approximately 16 years of harvest data to analyze trends in harvest levels and dockside values. Note that the most recent harvest data for most states harvesting fish and roe on the Ohio River Basin was 1999.

Category	Basin[1]	Limitation	Resolution
Tribal Data Availability	GL	Several tribes bordering the Great Lakes participate in commercial fishing activities. Data provided by the states did not identify whether harvests, as reported to USACE, were solely state-licensed commercial fishing harvests or whether they included tribal harvests.	State agencies were contacted in order to distinguish whether commercial fishing harvest data, as reported by the state DNRs, included or excluded tribal commercial fishing harvests in order to avoid double-counting. It was found that all states keep separate records of tribal commercial fishing harvests.
	GL	The following tribes engage in commercial fishing activities, but did not provide harvest data for any year during the GL analysis period (1989 through 2009): 1854 Treaty Authority member tribes (Grand Portage Band of Lake Superior Chippewa Indians, Bois Forte Band of Lake Superior Chippewa Indians).	This report does not include any data from the 1854 Treaty Authority member tribes. These tribes border Lake Superior. This is noted in the Lake Superior portion of this report.
Missing Harvest Prices	GL, UMR, OHR	For certain years, dockside value data was not available for specific species.	In order to allow for a quantitative analysis of all reported harvests, one of four methods was applied to generate proxies for missing dockside values.

Category	Basin[1]	Limitation	Resolution
Missing Harvest Levels	GL, UMR, OHR	For a few states, one year during the analysis period was reported to have a harvest level of zero despite harvest levels in previous and subsequent years.	State and inter-tribal agencies were contacted in order to obtain this missing data. If there was a reason that a harvest did not occur in this year, the harvest level remained a zero and the irregularity in the data was noted in the text. In the case where it was found that there was no identifiable reasoning as to why harvest data presented an outlier, the data was left unaltered and the irregularity was noted in the text.
1. GL refers to the Great Lakes Basin. UMR refers to the Upper Mississippi River Basin. OHR refers to the Ohio River Basin.			

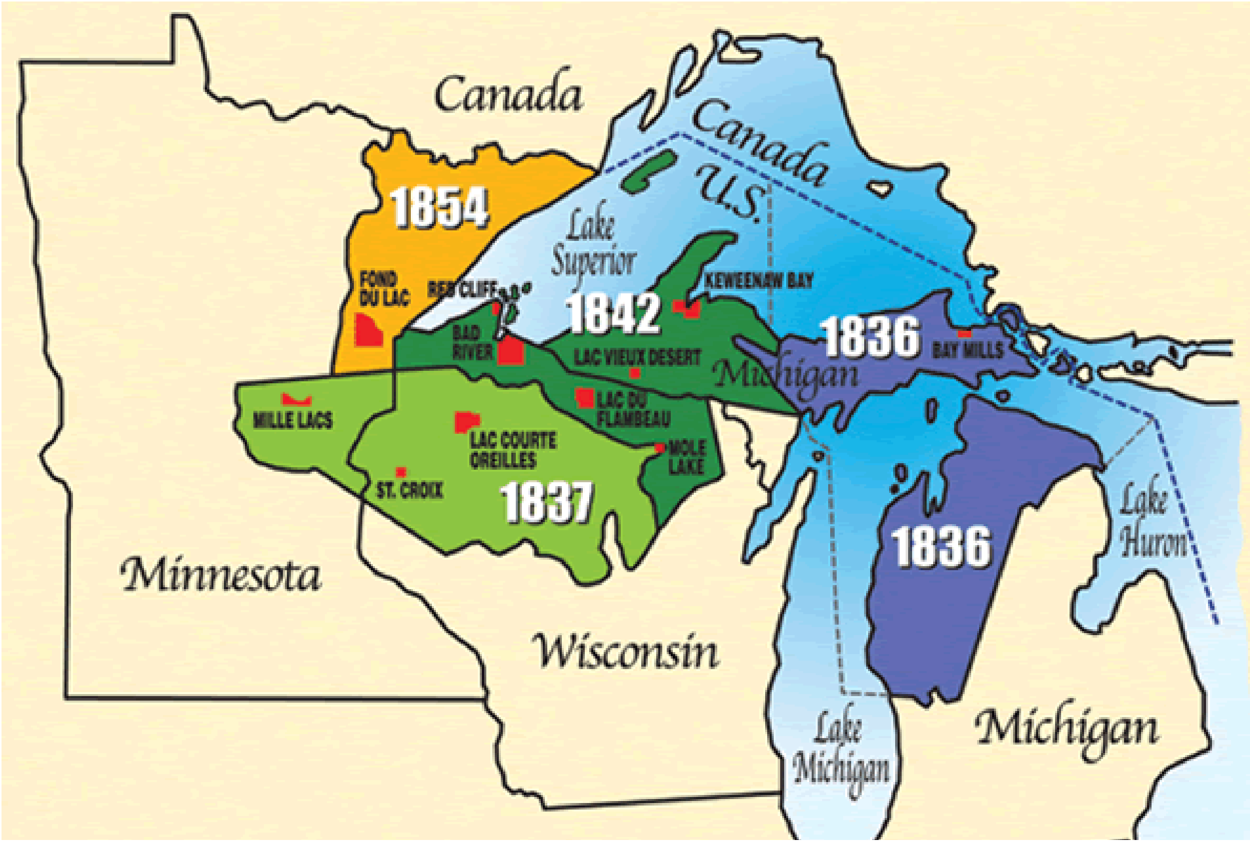
All states bordering the following water bodies in the Great Lakes Basin were contacted: Lake Michigan, Lake Superior, Lake Huron, Lake Erie, and Lake Ontario. Further, inter-tribal agencies which are comprised of tribes that engage in fishing on the Great Lakes were contacted. These agencies include[8] the:

- Great Lakes Indian Fish and Wildlife Commission (GLIFWC), which is comprised of the following tribes that fish on Lake Superior:
  - Bay Mills Indian Community
  - Keweenaw Bay Indian Community
  - Lac Vieux Desert Band of Lake Superior Chippewa Indians
  - Bad River Band of Lake Superior Chippewa Indians of Wisconsin
  - Red Cliff Band of Lake Superior Chippewa Indians of Wisconsin
  - Lac du Flambeau Band of Lake Superior Chippewa Indians of Wisconsin
  - Lac Courte Oreilles Band of Lake Superior Chippewa Indians of Wisconsin
  - Sokaogon Chippewa Community of Wisconsin
  - St. Croix Chippewa Indians of Wisconsin
  - Mille Lacs Band of Ojibwe
  - Fond du Lac Band of Lake Superior Chippewa Indians of Minnesota

Figure 2exemplifies the locations of the GLIFWC member tribes.

[8] Note that in addition to the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) and the Chippewa Ottawa Resource Authority (CORA), the 1854 Treaty Authority was also contacted. However, this inter-tribal organization did not contribute commercial fishing harvest data to this study effort.

FIGURE 2: GLIFWC MEMBER TRIBES



- Chippewa Ottawa Resource Authority (CORA), which represents the following tribes that reside in Michigan and fish on Lake Michigan, Lake Superior, and Lake Huron:
  - Bay Mills Indian Community[9]
  - Grand Traverse Band of Ottawa Indians
  - Little River Band of Ottawa Indians
  - Little Traverse Bay Band of Odawa Indians
  - Sault Ste. Marie Tribe of Chippewa Indians of Michigan

[9] Note that the Bay Mills Indian Community is included as part of GLIFWC and CORA. GLIFWC reports on all harvests on Lake Superior, therefore CORA data for Lake Superior was not utilized since it was already encompassed in the GLIFWC data set. Note that the GLIFWC and CORA data did not distinguish harvests by each tribe, but rather, a total annual harvest for each species. Therefore, the assumption that all member tribes commercially harvest fish on the Great Lakes should not be made.

The following tables exhibit the agencies that were contacted in order to obtain commercial fishing harvest data.

TABLE 2: LAKE SUPERIOR AGENCY ASSISTANCE

Bordering States	Contributing Agencies
Minnesota	Minnesota Department of Natural Resources/ Great Lakes Indian Fish and Wildlife Commission (GLIFWC)
Wisconsin	Wisconsin Department of Natural Resources/ Great Lakes Indian Fish and Wildlife Commission (GLIFWC)
Michigan	Michigan Department of Natural Resources/ Great Lakes Indian Fish and Wildlife Commission (GLIFWC)

TABLE 3: LAKE MICHIGAN AGENCY ASSISTANCE

Bordering States	Contributing Agencies
Wisconsin	Wisconsin Department of Natural Resources
Illinois	Illinois Department of Natural Resources
Indiana	Indiana Department of Natural Resources
Michigan	Michigan Department of Natural Resources/ Chippewa Ottawa Resource Authority (CORA)

TABLE 4: LAKE HURON AGENCY ASSISTANCE

Bordering States	Contributing Agencies
Michigan	Michigan Department of Natural Resources/ Chippewa Ottawa Resource Authority (CORA)

TABLE 5: LAKE ERIE AGENCY ASSISTANCE

Bordering States	Contributing Agencies
Michigan	Michigan Department of Natural Resources
Ohio[1]	Ohio Department of Natural Resources
Pennsylvania	Pennsylvania Fish and Boat Commission
New York	New York State Department of Environmental Conservation
1. Ohio was the only state to report commercial fishing activity on Lake Erie's tributaries (between Lorain and Toledo, Ohio).	

TABLE 6: LAKE ONTARIO AGENCY ASSISTANCE

Bordering States	Contributing Agencies
New York	New York State Department of Environmental Conservation

TABLE 7: LAKE ST. CLAIR AGENCY ASSISTANCE

Bordering States	Contributing Agencies
Michigan	Michigan Department of Natural Resources[1]
1. According to the Michigan Department of Natural Resources, there is no commercial fishing activity on Lake St. Clair. Therefore, it is excluded from the commercial fisheries analysis.	

DATA CONTRIBUTION FOR THE GREAT LAKES BASIN

Each agency was requested to provide commercial harvest data for the period, 1989-2009. This data set of 21 years was determined by the Fisheries Economics Team and Natural Resources Team to be an appropriate duration over which the harvest data could be summarized and analyzed. Table 8 exemplifies the states/ inter-tribal agencies that were found to have commercial fishing activity at some point during the analysis period. Table 9 displays the years for which the harvest data was provided.

TABLE 8: GREAT LAKES COMMERCIAL FISHING ACTIVITY

State	Lake Superior	Lake Michigan	Lake Huron	Lake Erie	Lake Ontario
Minnesota	×				
Wisconsin	×	×			
Illinois					
Indiana					
Michigan	×	×	×	×	
Ohio				×	
Pennsylvania				×	
New York				×	×
GLIFWC	×				
CORA	×	×	×		
Note: There is no commercial fishing activity on Lake St. Clair according to the Michigan Department of Natural Resources.					

TABLE 9: DATA PROVIDED FOR THE GREAT LAKES

Great Lake	State/Agency	Data Provided[1]
Lake Superior	Minnesota	2000-2009
	Wisconsin	1989-2009
	Michigan	1989-2009
	GLIFWC	1996-2009
Lake Michigan	Wisconsin	1989-2009
	Illinois	1989-2009
	Michigan	1989-2009
	Indiana	1989-2009
	CORA	1990-2009
Lake Huron	Michigan	1989-2009
	CORA	1990-2009
Lake Erie	Michigan	1989-2009
	Ohio	1989-2009
	Pennsylvania	1989-2009
	New York	1999-2009
Lake Ontario	New York	1999-2009
1. Note that some states provided data in excess of the requested 20-year period. This is not reflected in the table. This table is included to provide the reader with an understanding of what data was available for the given time period.		

Agency Assistance For The UMR and Ohio River Basins:

State agencies were contacted in order to obtain commercial fishing harvest data for the water bodies in the Upper Mississippi River and Ohio River Basins. The following tables display which agencies were contacted in order to provide commercial fishing harvest data on the Upper Mississippi River, Illinois River, Kaskaskia River, Rock River, Zumbro River, Ohio River, Wabash River, Cumberland River, Kentucky River, and Salt River.

TABLE 10: UMR AGENCY ASSISTANCE

Bordering States	Contributing Agencies
Minnesota	Upper Mississippi River Conservation Committee
Iowa	Upper Mississippi River Conservation Committee
Missouri	Upper Mississippi River Conservation Committee
Wisconsin	Upper Mississippi River Conservation Committee
Illinois	Illinois Department of Natural Resources, Upper Mississippi Conservation Committee

TABLE 11: UMR TRIBUTARY AGENCY ASSISTANCE

River	Bordering State	Contributing Agency
Illinois	Illinois	Illinois Department of Natural Resources
Kaskaskia	Illinois	Illinois Department of Natural Resources
Rock	Illinois	Illinois Department of Natural Resources
Zumbro	Minnesota	Minnesota Department of Natural Resources

TABLE 12: OHIO RIVER AGENCY ASSISTANCE

Bordering States	Contributing Agencies
Illinois	Illinois Department of Natural Resources
Indiana	Indiana Department of Natural Resources
Kentucky	Kentucky Department of Fish and Wildlife
Ohio	Ohio Department of Natural Resources
West Virginia	Ohio Department of Natural Resources
Pennsylvania	Ohio Department of Natural Resources

TABLE 13: OHIO RIVER TRIBUTARY AGENCY ASSISTANCE

River	Bordering State	Contributing Agencies
Wabash	Illinois	Illinois Department of Natural Resources
	Indiana	Indiana Department of Natural Resources
Cumberland	Kentucky	Kentucky Department of Fish and Wildlife
Kentucky	Kentucky	Kentucky Department of Fish and Wildlife
Salt	Kentucky	Kentucky Department of Fish and Wildlife

DATA CONTRIBUTIONS FOR THE UMR & OHIO RIVER BASIN

Each agency for states bordering the rivers in the UMR and Ohio River Basins was requested to provide commercial fishing harvest data for the period 1989-2009. Table 14 exemplifies the Upper Mississippi River Basin states that were found to have commercial fishing activity at some point during this period. Table 15 exhibits the years for which the harvest data was provided.

TABLE 14: STATES WITH COMMERCIAL FISHING IN THE UMR BASIN

State	UMR	Illinois River	Kaskaskia River	Rock River	Zumbro River
Minnesota	×				×
Iowa	×				
Missouri	×				
Wisconsin	×				
Illinois	×	×	×	×	

TABLE 15: DATA PROVIDED FOR THE UMR BASIN

River	Bordering State	Data Provided[1]
Upper Mississippi River	Minnesota	1989-2005
	Iowa	1989-2005
	Missouri	1989-2005
	Illinois	1989-2005
	Wisconsin	1989-2005
Illinois River	Illinois	1989-2005
Kaskaskia River	Illinois	1989-2005
Rock River	Illinois	1989-2005
Zumbro River	Minnesota	1998-1999
Ohio River	Illinois	1989-2005
	Indiana	1999-2005
	Kentucky	1999-2005
	Ohio	N/A[2]
	West Virginia	N/A
	Pennsylvania	N/A

1. Note that some states provided data in excess of the requested 20-year period. This is not reflected in the table. This table is included to provide the reader with an understanding of what data was available for the given time period.
2. “N/A” indicates that these states do not commercially harvest fish on the given water body.

Note that year 2005 is the most recent year for which all states were able to provide harvest data. Therefore, the analysis period of the Upper Mississippi River Basin is 1989 through 2005.

Table 16 exemplifies the Ohio River Basin states that were found to have commercial fishing activity at some point during this period. Table 17 exhibits the years for which the harvest data was provided.

TABLE 16: STATES WITH COMMERCIAL FISHING IN THE OHIO RIVER BASIN

State	Ohio River	Wabash River	Cumberland River	Kentucky River	Salt River
Illinois	×	×			
Indiana	×	×			
Kentucky	×		×	×	×
Ohio					
Pennsylvania					
West Virginia					

TABLE 17: DATA PROVIDED FOR THE OHIO RIVER BASIN

River	Bordering State	Data Provided[1]
Ohio River	Illinois	1995-2005
	Indiana	2006-2005
	Kentucky	1999-2005
Wabash River	Illinois	1989-2005
Cumberland River	Kentucky	1999-2005
Kentucky River	Kentucky	1999-2005
Salt River	Kentucky	1999-2001
1. Note that some states provided data in excess of the requested 20-year period. This is not reflected in the table. This table is included to provide the reader with an understanding of what data was available for the given time period.		

Note that years 1999 through 2005 are the years that almost all were able to provide harvest data. Therefore, the analysis period for the Ohio River Basin is 1999 through 2005.

DATA ANALYSIS

The following discussion outlines the processes for generating harvest levels and values for commercially harvested species on each water body in the Great Lakes, Upper Mississippi River, and Ohio River Basins.

DATA ORGANIZATION

Each of the aforementioned state agencies in the Great Lakes, UMR, and Ohio River Basins was requested to provide commercial fishing harvest data for the years between 1989 and 2009.[10] The

[10] Recall, this is not the analysis period for all basins. The analysis period for each basin is reflective of the available commercial harvest data from state agencies. The analysis period for

following data was requested of each state for each water body over the given time period: year, species, pounds harvested, and dockside values.[11] The data, if not already done so, was organized in the following format. For example, Figure 3 exhibits the organizational structure of a given harvested species (Lake Whitefish) by the state of Michigan from Lake Michigan.

FIGURE 3: INITIAL ORGANIZATION OF COMMERCIAL HARVEST DATA

Year	Species Name	Total Catch (lbs)	Dockside Value ($/lb)
• 1989	• lake whitefish	• 2,023,896 lbs	• $0.97
• 1990	• lake whitefish	• 2,326,067 lbs	• $1.08
• ...	• lake whitefish	• ...	• ...
• 2009	• lake whitefish	• 855,780 lbs	• $1.28

This same process was repeated for each species harvested by each state on each water body.[12] Therefore, a complete set of historical data was generated for all harvested species in the Great Lakes, Upper Mississippi River, and Ohio River Basins.

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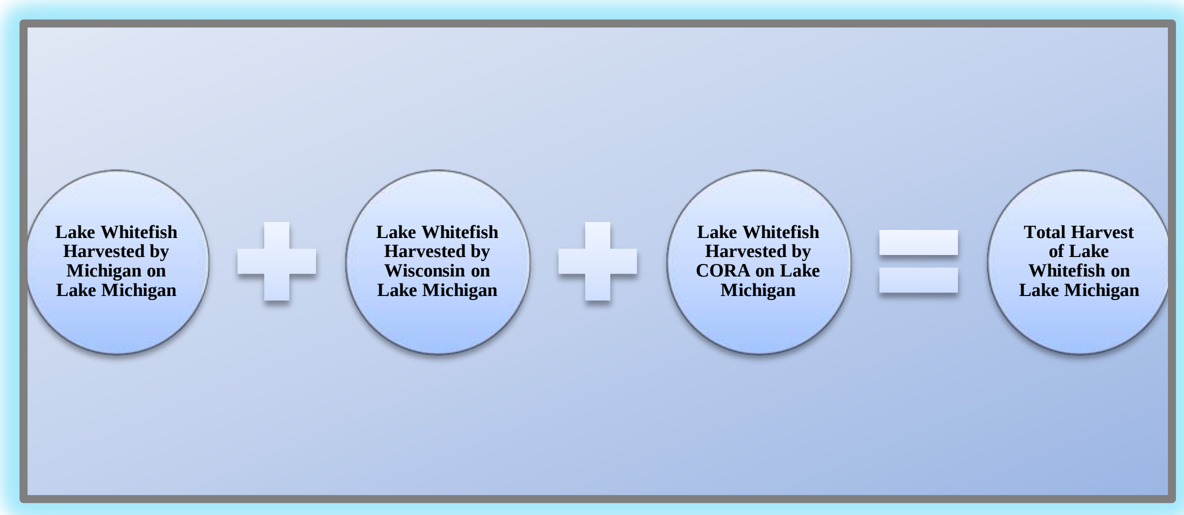
the Great Lakes Basin is 1989 through 2009; the analysis period for the UMR Basin is 1989 through 2005; the analysis period for the Ohio River Basin is 1999 through 2005.

[11] This is the price per pound of the species. For the purposes of this analysis, all harvest prices are presented as price per pound. These values were reported by the state in nominal values. At a later point in the analysis process, these nominal values were converted to current (FY13) dollar values.

[12] This methodology was applied to all water bodies in the Great Lakes, UMR, and Ohio River Basins.

Figure 4 demonstrates how each data set for each state contributed to the analysis of the individual species harvested on each water body.

FIGURE 4: DATA COLLECTION CONCEPT



CONVERTING NOMINAL DOLLARS TO REAL DOLLARS

The total harvest value of a given species in a given year is derived by the following equation:

EQUATION 1: HARVEST VALUE

$$\textbf{Harvest Value (\$) = Total Catch (lbs)} \times \textbf{Dockside Value (\$/lb)}$$

In order for the dockside value to be input into this equation, it must be converted into a common year's value. This allows for harvest values from Year_1 to be directly compared to $\text{Year}_2,\ldots,\text{Year}_n$. The Producer Price Index (PPI) was utilized to accomplish this task. The PPI "is a family of indexes that measures the average change over time in the selling prices received by domestic producers of goods and services. PPIs measure price change from the perspective of the seller…PPIs are used to adjust other economic times series for price changes and to translate those series into inflation-free dollars" (Bureau, 2011). State agencies provided harvest price data in nominal dollars. The process for converting nominal dockside values to current dollars[13] is exemplified in Equation 2.

[13] "The PPI is a family of indexes that measures the average change over time in the selling prices received by domestic producers of goods and services. PPIs measure price change from the perspective of the seller. This contrasts with other measures, such as the Consumer Price Index (CPI), that measure price change from the purchaser's perspective. Sellers' and purchasers' prices may differ due to government subsidies, sales and excise taxes, and distribution costs" (Bureau, 2011). Producer price index (PPI) number "02230199" for "other finfish" was utilized

EQUATION 2: DOCKSIDE VALUE

$\textbf{Dockside Value}_{FY13} = (\textbf{Dockside Value}_{year\ x}) \times (\textbf{PPI}_{FY13} / \textbf{PPI}_{year\ x})$

For example, when converting the dockside value of lake whitefish harvested by Michigan from Lake Michigan from 2002 into FY13 dollars (demonstrate in Table 18), the aforementioned equation was applied.

TABLE 18: EXAMPLE OF DERIVATION OF CURRENT DOCKSIDE VALUE

Equation	$\textbf{Dockside Value}_{FY13Dollars} = (\textbf{Dockside Value}_{2002}) \times (\textbf{PPI}_{FY13} / \textbf{PPI}_{2002})$
Input Values	$\text{Dockside Value}_{FY13\ Dollars} = (\$0.89) \times (314.6/220.40)$
Final Value	$\text{Dockside Value}_{FY13\ Dollars} = \$1.27$
1. Note that the PPI values were generated by the Bureau of Labor Statistics for the category “other finfish.”	

Upon converting the nominal dollars to FY13 dollars, the analyst was then able to apply the dockside value formula. Table 19 exemplifies the complete process of calculating the harvest values for the years 2005 to 2009 for the commercial harvest of Lake Whitefish by the State of Michigan on Lake Michigan. This procedure was applied to each harvested species in each water body[14] by each bordering state.

for converting nominal dollars to October 2012 (FY13) dollars. Note that this PPI was utilized instead of the average PPI for all goods and services in order to ascertain a change in price that more accurately reflects that of fish. The National Oceanic and Atmospheric Association was contacted in order to determine the specific water bodies that the fish in PPI category “other finfish” was comprised of. It was found that this PPI reflects changes in prices of saltwater fish rather than freshwater fish. However, this PPI was utilized due to the fact that it is assumed that it more accurately reflects the changes in prices of freshwater fish than does the average PPI (for all goods and services). During the analysis process, year FY13 was the most recent year for which the Bureau of Labor Statistics published an annual PPI for the “other finfish” category.

[14] “Each water body” refers to each analyzed water body in the Great Lakes, UMR, and Ohio River Basins.

TABLE 19: LAKE WHITEFISH DOCKSIDE VALUE DERIVATION

Year	Total Catch (lbs) (a)	Dockside Value ($/lb) (b)	PPI: Current Year (c)	PPI: FY13 (d)	Dockside Value (FY13 $) e = b × (d/c)	Total Harvest Value (FY13 $) f = a × e
2005	823,696	$0.58	253.3	314.60	$0.72	$593,360
2006	1,263,025	$0.56	297.8	314.60	$0.59	$747,195
2007	1,044,310	$0.55	328.0	314.60	$0.53	$550,905
2008	953,686	$0.54	322.0	314.60	$0.53	$503,155
2009	855,780	$1.28	278.6	314.60	$1.45	$1,236,943
1. Year 1992 was the first year for which the BLS generated a Producer Price Index for the “other finfish” category, PPI series ID "WPU02230199."						

MISSING HARVEST LEVELS:

Some states reported annual harvest levels with zeroes for one or more of the years during the analysis period. In order to preserve the integrity of the report’s purpose, which is to establish the current economic value of the commercial fisheries in the U.S. waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins based on the most recent annual harvest data *available* from state agencies (or equivalents), these zeroes were assumed to be an accurate representation of the total harvest for each state (or inter-tribal agency) in the given year.

However, for some data sets, zeroes appeared in a year with relatively high harvest levels in previous and subsequent years. In this case, the appropriate agency was contacted in order to ensure that the zero was an accurate representation of the harvest. If the zero was accurate, the data was not altered. However, if the data was found to be a data entry error, the zero was replaced with the appropriate value.

MISSING DOCKSIDE VALUES:

Several states were able to provide harvest level data for the full analysis period. However, some dockside values were unavailable for various years, especially during the late 1980s and 1990s. In order to capture the total harvest value during these years, four techniques were employed to generate surrogates for these missing dockside values. Table 20 exemplifies when each of the methods was utilized. These methods were selected in order to reflect the assumption that dockside values (dollars per pound) are similar across states harvesting in the same basin.

TABLE 20: CHOOSING A METHOD TO GENERATE DOCKSIDE VALUE PROXIES

State's data set identifies a specific species harvested on a given water body	State's data set identifies an dockside value for the specific species on a given water body in a given year	Another state bordering the same water body, harvesting the same species in the same year has an dockside value available	Other states bordering the other water bodies in the same basin and harvest the same species have dockside value data available for the given year	Same state has a dockside value available for the given species on the given water body in a subsequent year	Method Employed
Yes	No	Yes	→	→	**Method 1**
Yes	No	No	Yes	→	**Method 2**
Yes	No	No	No	Yes	**Method 3**
No/Yes	No	No	No	No	**Method 4**

The following discussion will pertain to the four methods that were employed in order to generate dockside values for harvested species without associated dockside values readily available by the states. A proxy for the dockside value was only used when the harvest data for a given year was missing the associated dockside value.

METHOD 1

Method 1 was utilized when:

- State's data set identified a specific species harvested on a given water body
- State's data set did not identify a dockside value for the specific species on a given water body in a given year
- Another state, bordering the same water body, harvesting the same species in the same year has a dockside value available

The first effort to generate a value to be used as a proxy for the missing dockside value involved producing the average dockside value of other states that also harvested the given species in the given year on the given water body. This allows for prices to reflect fluctuations in the market over time. Table 21 demonstrates an example of where this procedure was applied.

TABLE 21: MISSING DOCKSIDE VALUE: CASE 1

Water Body	Bordering States/ Tribes	Species	Year	Harvest Level Data Provided (Y/N)	Dockside Value Provided (Y/N)
Lake Superior	Minnesota	Lake Trout	2000	Y	Y
Lake Superior	Wisconsin	Lake Trout	2000	Y	**N**
Lake Superior	Michigan	Lake Trout	2000	Y	Y
Lake Superior	GLIFWC/CORA	Lake Trout	2000	Y	N

As is shown in Table 21, Michigan and Minnesota were able to provide complete harvest data for year 2000. Wisconsin was able to provide harvest level data but not dockside value data. In this case, the average nominal dockside value of Michigan and Minnesota's harvest of Lake Trout in year 2000 on Lake Superior was used as a proxy for the dockside value of Lake Trout harvested by Wisconsin. This analysis process is shown in Table 22. This process was repeated for GLIFWC and CORA dockside values for lake trout.

TABLE 22: EVALUATION METHOD FOR MISSING DOCKSIDE VALUE- CASE 1

Current Year	Total Catch (lbs) (a)	Nominal Dockside Value (b)	PPI: Year of harvest (c)	PPI: FY13 (d)	Dockside Value (FY13 $) e = b × (d/c)	Total Harvest (FY13 $) f = a × e
2000	15,549	=average (MI, MN) =$1.12	218.2	314.6	$1.61	$25,109

METHOD 2

Method 2 was utilized when:

- State's data set identified a specific species harvested on a given water body
- State's data set did not identify a dockside value for the specific species on a given water body in a given year
- Another state, bordering the same water body, harvesting the same species in the same year doesn't have dockside value available
- Other states bordering other water bodies in the same basin and harvest the given species have dockside value data available for the given year

In the case where there was no state on the same waterbody from which to borrow a nominal dockside value to use as a proxy for the missing dockside value, a second method was employed. This involved using the average dockside value of all other states in the basin which harvested the given species. An example of where this method was utilized is Kentucky's harvest of suckers on the Ohio River. The Kentucky Department of Natural Resources was unable to provide dockside values so the average value of suckers in the basin was utilized as a surrogate for this missing dockside value.

TABLE 23: MISSING DOCKSIDE VALUES- CASE 3

Water Body	Bordering	Species	Year	Dockside Value Provided (Y/N)

	State			
Ohio River	Kentucky	Suckers	2004	**N**
Illinois River	Illinois	Suckers	2004	Y
UMR	Illinois	Suckers	2004	Y
UMR	Iowa	Suckers	2004	Y
UMR	Minnesota	Suckers	2004	Y
UMR	Missouri	Suckers	2004	Y
UMR	Wisconsin	Suckers	2004	Y

Therefore, the surrogate ex-vessel value is an average of all other states' ex-vessel values for suckers in the basin in year 2004. This is exemplified in the following table.

TABLE 24: EVALUATION METHOD FOR MISSING DOCKSIDE VALUE- CASE 3

Current Year	Total Catch (lbs) (a)	Nominal Dockside Value (b)	PPI: Current Year (c)	PPI: FY13 (d)	Dockside Value (FY13 $) e = b × (d/c)	Total Harvest Value (FY13 $) f = a × e
2004	1,170	=average ($IL_{IL\ River}$, IL_{UMR}, IA_{UMR}, MN_{UMR}, MO_{UMR}, WI_{UMR}) =$0.15	207.6	314.6	$0.23	$272

METHOD 3

Method 3 was utilized when:

- State's data set identified a specific species harvested on a given water body
- State's data set did not identify a dockside value for the specific species on a given water body in a given year
- Another state, bordering the same water body, harvesting the same species in the same year doesn't have dockside value available
- Other states bordering the other water bodies in the same basin and harvest the given species do not have dockside value data available for the given year
- The same state has an dockside value available for the given species on the given water body in a subsequent year

In the case where there was no state from which to borrow a nominal dockside value to use as a proxy for the missing dockside value, then a third method for generating a dockside value was utilized. This method involved utilizing a subsequent year's value and price-adjusting the value to the missing year.

For instance, this was the case for Iowa's harvest of shovelnose sturgeon roe. Ex-vessel value data was available for recent years but not earlier years. Table 25 demonstrates an example of where this procedure was applied.

TABLE 25: MISSING DOCKSIDE VALUE: CASE 2

Water Body	Bordering State	Species	Year	Ex-Vessel Value Provided (Y/N)
Upper Mississippi River	Iowa	Shovelnose Sturgeon Roe	2000	**N**
Upper Mississippi River	Iowa	Shovelnose Sturgeon Roe	2001	Y

In this case, the year 2001 nominal value was adjusted to year 2000 price levels, and then re-adjusted to FY13 price levels. This is exemplified in the table below.

TABLE 26: EVALUATION METHOD FOR MISSING EX-VESSEL VALUE- CASE 2

Current Year	Dockside Value (2001$) (a)	PPI: 2001 (b)	PPI: 2000 (c)	Dockside Value (2000$) $d = a \times (c/b)$	PPI: FY13 (e)	Harvest Value (FY13$) $f = d \times (e/c)$
2000	= year 2001 value =$25.00	236.6	218.2	=$23.06	314.6	=$33.25

METHOD 4

Method 4 was utilized when:

- State's data set did or did not identify a specific species harvested on a given water body
- State's data set did not identify an dockside value for the group of species on a given water body in a given year
- Another state, bordering the same water body, harvesting the same group of species in the same year doesn't have dockside value available
- Other states bordering the other water bodies in the same basin do not have ex-vessel value data available for the given year
- The same state does not have a dockside value available for the given group of species on the given water body in a subsequent year

In this case, the average dockside value of all other species harvested by the state in that given year was used as a proxy for the missing dockside value of the "other species" category. Since the list of "other species" did not include roe in any of the data sets, the dockside value of roe was excluded from this average.[15]

This was the case for Kentucky's harvest of "other" species on the Ohio River. The derivation of Kentucky's harvest value for "other" species in the year 2004 is exemplified in the table below.

TABLE 27: EVALUATION METHOD FOR MISSING DOCKSIDE VALUE- CASE 4

Current Year	Total Catch (lbs) (a)	Nominal Dockside Value (b)	PPI: Year of harvest (c)	PPI: FY13 (d)	Dockside Value (FY13 $) e = b × (d/c)	Total Harvest Value (FY13 $) f = a × e
2004	83	=average (all other species harvested by KY on the Ohio River) =$0.28	207.6	314.6	$0.43	$35

The following tables exhibit the number of times that methods 1 through 4 were employed for each state bordering each water body in each basin for the baseline period (2005-2009 for the Great Lakes Basin; 2001-2005 for the Upper Mississippi River and Ohio River Basins).

[15] Roe have significantly higher ex-vessel values that fish; therefore the analyst excluded this from the average ex-vessel value calculation. This preserved the integrity of the approximated value.

TABLE 28: DOCKSIDE VALUE APPROXIMATTIONS- GL BASIN

Basin	State	Water Body	Years Analyzed	# of Years Analyzed	# of Species Analyzed	# of Ex-Vessel Values Calculated	Method 1	Method 2	Method 3	Method 4
GL	IL	Lake Mich.	2005-2009	5	2	10	0	0	0	0
GL	IN	Lake Mich.	2005-2009	5	5	25	0	0	0	0
GL	MI	Lake Erie	2005-2009	5	14	70	0	0	0	0
GL	MI	Lake Huron	2005-2009	5	22	110	0	0	0	0
GL	MI	Lake Mich.	2005-2009	5	11	55	0	0	0	0
GL	MI	Lake Sup.	2005-2009	5	10	50	0	0	0	0
GL	MN	Lake Sup.	2005-2009	5	10	50	0	0	0	0
GL	NY	Lake Erie	2005-2009	5	1	5	0	0	0	0
GL	NY	Lake Ont.	2005-2009	5	6	30	0	6	0	0
GL	OH	Lake Erie	2005-2009	5	10	50	0	34	0	0
GL	PA	Lake Erie	2005-2009	5	13	65	40	0	0	15
GL	WI	Lake Sup.	2005-2009	5	6	30	0	0	0	0
GL	WI	Lake Mich.	2005-2009	5	5	25	0	1	0	0
					Total	**575**	**40**	**41**	**0**	**15**
						Percent of Total	**7%**	**7%**	**0%**	**3%**
									Percent Estimated	**17%**

TABLE 29: DOCKSIDE VALUE APPROXIMATIONS- UMR BASIN

Basin	State	Water Body	Years Analyzed	# of Years Analyzed	# of Species Analyzed	# of Ex-Vessel Values Calculated	Method 1	Method 2	Method 3	Method 4
UMR	IL	Illinois River	2001-2005	5	2	19	95	0	0	0
UMR	IL	Kaskaskia River	2001-2005	5	5	18	90	0	0	0
UMR	IL	Rock River	2001-2005	5	14	10	50	0	0	0
UMR	IL	UMR	2001-2005	5	22	19	95	0	0	0
UMR	IL	Illinois River (Roe[1])	2001-2005	5	11	1	5	0	0	0
UMR	IL	UMR (Roe[1])	2001-2005	5	10	2	10	4	0	0
UMR	IA	UMR	2001-2005	5	10	14	70	3	0	0
UMR	MN	UMR	2001-2005	5	1	17	85	5	0	0
UMR	MO	UMR	2001-2005	5	6	18	90	2	0	0
UMR	WI	UMR	2001-2005	5	10	18	90	14	0	0
					Total	**680**	**28**	**0**	**0**	**0**
						Percent of Total	**4%**	**0%**	**0%**	**0%**
									Percent Estimated	**4%**

1. Illinois' roe harvests were included in separate data sets.

TABLE 30: DOCKSIDE VALUE APPROXIMATION: OHIO RIVER BASIN

Basin	State	Water Body	Years Analyzed	# of Years Analyzed	# of Species Analyzed	# of Ex-Vessel Values Calculated	Method 1	Method 2	Method 3	Method 4
Ohio River	IL	Ohio River	2001-2005	5	17	85	0	0	0	0
Ohio River	IL	Wabash River	2001-2005	5	19	95	0	0	0	0
Ohio River	IL	Ohio River (Roe[1])	2001-2005	5	2	10	0	0	2	0
Ohio River	IL	Wabash River (Roe[1])	2001-2005	5	1	5	0	0	2	0
Ohio River	IN	Wabash River	2001-2005	5	9	45	35	0	0	5
Ohio River	IN	Ohio River	2001-2005	5	7	35	28	0	0	5
Ohio River	KY	Cumberland River	2001-2005	5	13	65	53	0	2	6
Ohio River	KY	Kentucky River	2001-2005	5	12	60	0	55	0	5
Ohio River	KY	Ohio River	2001-2005	5	16	80	71	0	4	5
					Total	**480**	**187**	**55**	**10**	**26**
						Percent of Total	**39%**	**11%**	**2%**	**5%**
									Percent Estimated	**58%**

1. Illinois' roe harvests were included in separate data sets.

CATEGORIZING SPECIES IN EACH WATER BODY:

Recall that this *Commercial Fisheries Economic Baseline Assessment* is intended to serve as part one of a three-part process.

The first is to establish the current value of the commercial fisheries in the Great Lakes and Upper Mississippi River basins. This is accomplished via the *Commercial Fisheries Baseline Economic Assessment*.

The second part is to ascertain how the value of the fisheries would change in the event of aquatic nuisance species (ANS) transfer between the basins. In order for the baseline assessment to prepare the framework for the without-project condition, the GLMRIS Natural Resources Team (NRT) was consulted to determine a method of aggregating the data.

It was determined that the harvest data for the species in each water body should be categorized by Family and ecological similarities. Habitat utilization, feeding regimes, and other life history characteristics were used to group species together using letter categories. By categorizing species in this manner, the potential effects of aquatic nuisance species can be easily identified based on ecological overlap. For example, the introduction of an invasive filter feeder could have significant impacts on any of the commercial fish species that are also filter feeders. The groupings are explained in the following:

A- This group consists of members from the families gars (Lepisosteidae) and bowfins (Amiidae). These groups of fish are found in back water habitat and primarily feed on other fish.

B- Paddlefish (*Polyodon spatula*), mooneyes (*Hiodon* spp.), shads and herrings (Clupeidae), and two species from the minnows and carps family (bighead carp and silver carp) are grouped together. These fish are filter feeding species that inhabit the upper portions of the water column.

C- Minnows and Carps (Cyprinidae) make up this category. These fish are omnivores that consume everything from macrophytes to insects as they scavenge a diverse array of habitats.

D- These fish are primarily benthic feeders where they forage on macroinvertebrates. Most species of suckers (Catostomidae) are categorized in this group.

E- Two species of sucker (river redhorse *Moxostoma carinatum* and greater redhorse *Moxostoma valenciennesi*) as well as the only freshwatermember of the drum family (Sciaenidae: *Aplodinotus grunniens*) are grouped together because they primarily feed on mollusks.

F- This group consists of the catfishes. Catfish (Ictaluridae) are predatory; however they tend to be more general in their consumption of food. They will eat everything from macroinvertebrates to fish.

G- One species of smelt (Osmeridae: *Osmerus mordax*) and the whitefishes (Salmonidae: Coregoninae) are classified here. This group of fish spends much of their time in deeper waters and filter feed zooplankton and possum shrimp *Mysis relicta*. The rainbow smelt does make migrations and deviate to feeding on fish at larger sizes, but primarily spend much of their time in deep water feeding on plankton.

H- One members of the true cod family, burbot (Gadidae: *Lota lota*) and the salmons, trouts and chars Salmonidae: Salmoninae are predators of the Great Lakes. Their early life stages are dependent on possum shrimp as well.

I- Temperate bass (Moronidae), sunfishes (Centrarchidae), and perches (Percidae) are different groups of fish that share similar traits and therefore are combined for the purpose of this study.

These families are often found in riverine systems and the littoral zone of lakes in which they feed on a variety of organisms at different stages of their life. As juveniles, all three groups prey on zooplankton and as adults feed on insects and fish.

J- This group consists of the sturgeon family (Acipenseridae). These fish are benthic fish that consume everything from mollusks to fish.

K- Freshwater eels are represented by one species, the American eel (*Anguilla rostrata*), which is catadromous, meaning they migrate from freshwater to saltwater to spawn. Their diet includes fish, insects, frogs, and they scavenge for decaying organisms.

Table 31 categorizes all harvestable species on the Great Lakes, was provided by the Natural Resources Team.

TABLE 31: HARVESTABLE SPECIES IN THE GREAT LAKES BASIN

Family	Species	Common Name	Native/ Non-Native	Categorization Letter
Bowfin	*Amia calva*	bowfin	Native	A
Shads & Herrings	*Alosa psuedoharengus*	alewife	Non-Native	B
	Dorosoma cepedianum	gizzard shad	Native	B
Minnows & Carps	*Cyprinus carpio*	common carp	Non-Native	C
	Carassius auratus	goldfish	Non-Native	C
Suckers	*Ictiobus niger*	black buffalo	Native	D
	Ictiobus cyprinellus	bigmouth buffalo	Native	D
	Ictiobus bubalus	smallmouth buffalo	Native	D
	Moxostoma carinatum	river redhorse	Native	E
	Moxostoma valenciennesi	greater redhorse	Native	E
	Moxostoma duquesnei	black redhorse	Native	D
	Moxostoma erythrurum	golden redhorse	Native	D
	Moxostoma macrolepidotum	shorthead redhorse	Native	D
	Moxostoma anisurum	silver redhorse	Native	D
	Carpiodes cyprinus	quillback	Native	D
Bullhead Catfishes	*Ictalurus punctatus*	channel catfish	Native	F
	Ameiurus melas	black bullhead	Native	F
	Ameiurus natalis	yellow bullhead	Native	F
	Ameiurus nebulosus	brown bullhead	Native	F
Smelts	*Osmerus mordax*	rainbow smelt	Non-Native	G
Whitefishes[1]	*Coregonus alpenae*	longjaw cisco	Native	G
	Coregonus artedi	lake herring	Native	G
	Coregonus clupeaformis	lake whitefish	Native	G
	Coregonus hoyi	bloater	Native	G
	Coregonus johannae	deepwater cisco	Native	G
	Coregonus kiyi	kiyi	Native	G
	Coregonus nigripinnis	blackfin cisco	Native	G
	Coregonus reighardi	shortnose cisco	Native	G
	Coregonus zenithicus	shortjaw cisco	Native	G
	Prosopium cylandraceum	menominee	Native	G
Salmons, Trouts & Chars	*Salvelinus namaycush*	lake char[2]	Native	H
	Salvelinus namaycush x fontinalis	splake[3]	Native	H
	Oncorhynchus tshawytscha	Chinook salmon	Non-Native	H
	Oncorhynchus kisutch	coho salmon	Non-Native	H
	Oncorhynchus mykiss	rainbow trout	Non-Native	H
	Salmo trutta	European brown trout	Non-Native	H
True Cods	*Lota lota*	burbot	Native	H
Temperate Bass	*Morone chrysops*	white bass	Native	I
	Morone americana	white perch	Non-Native	I
Sunfishes	*Ambloplites rupestris*	rock bass	Native	I
	Pomoxis nigromaculatus	black crappie	Native	I
	Pomoxis annularis	white crappie	Native	I
Perches	*Sander vitreus*	walleye	Native	I
	Perca flavescens	yellow perch	Native	I
Drums	*Aplodinotus grunniens*	freshwater drum[4]	Native	D

1. Chub, chubs, herring, whitefish, ciscos are all one species or another of the whitefish family.
2. Lean lake trout, fat lake trout and siscowet are all morphs of lake char.
3. Hybrid between lake char and brook char.
4. Also called sheepshead.

This same methodology was applied when aggregating the states' harvest data for the water bodies within the Upper Mississippi River basin. All harvestable fish are listed in Table 32.

Table 32: Harvestable Fish Species in the UMR and Ohio River Basins

Family	Species	Common Name	Native/ Non-Native	Categorization Letter
Sturgeons	*Scaphirhynchus platorynchus*	shovelnose sturgeon	Native	J
Paddlefish	*Polyodon spatula*	paddlefish	Native	B
Gars	*Lepisosteus osseus*	longnose gar	Native	A
	Lepisosteus platostomus	shortnose gar	Native	A
	Lepisosteus oculatus	spotted gar	Native	A
Bowfins	*Amia calva*	bowfin	Native	A
Mooneyes	*Hiodon tergisus*	mooneye	Native	B
	Hiodon alosoides	goldeye	Native	B
Freshwater Eels	*Anguilla rostrata*	American eel	Native	K
Shads & Herrings	*Alosa chrysochloris*	skipjack herring	Native	B
	Dorosoma cepedianum	gizzard shad	Native	B
Minnows & Carps	*Cyprinus carpio*	common carp	Non-native	C
	Ctenopharyngodon idella	grass carp	Non-native	C
	Hypophthalmichthys nobilis	bighead carp	Non-native	B
	Hypophthalmichthys molitrix	silver carp	Non-native	B
Suckers	*Ictiobus niger*	black buffalo	Native	D
	Ictiobus cyprinellus	bigmouth buffalo	Native	D
	Ictiobus bubalus	smallmouth buffalo	Native	D
	Moxostoma carinatum	river redhorse	Native	E
	Moxostoma valenciennesi	greater redhorse	Native	E
	Moxostoma duquesnei	black redhorse	Native	D
	Moxostoma erythrurum	golden redhorse	Native	D
	Moxostoma macrolepidotum	shorthead redhorse	Native	D
	Moxostoma anisurum	silver redhorse	Native	D
	Carpiodes cyprinus	quillback	Native	D
	Carpiodes carpio	river carpsucker	Native	D
	Carpiodes velifer	highfin carpsucker	Native	D
Bullhead Catfishes	*Ictalurus punctatus*	channel catfish	Native	F
	Ictalurus furcatus	blue catfish	Native	F
	Ameiurus melas	black bullhead	Native	F
	Ameiurus natalis	yellow bullhead	Native	F
	Ameiurus nebulosus	brown bullhead	Native	F
	Pylodictis olivaris	flathead catfish	Native	F
Drums	*Aplodinotus grunniens*	freshwater drum	Native	E

AGGREGATING HARVEST DATA

These groupings were used to aggregate the commercial harvest data provided by each state for each water body. For example, four states (Michigan, New York, Ohio, and Pennsylvania) were found to have engaged in commercial fishing activities on Lake Erie between the years of 1989 and 2009.

Each state harvested one or multiple species during 1989 through 2009 timeframe. All harvests were categorized into families, as displayed in the following tables.

TABLE 33: LAKE ERIE HARVEST DATA BY FISHERY FAMILY

State	Suckers				Minnows & Carps		Bullhead & Catfishes	
	bigmouth buffalo	quillback	sucker	redhorse	common carp	goldfish	channel catfish	bullhead
MI	×	×	×		×	×	×	×
NY								
OH	×	×	×		×	×	×	×
PA			×	×			×	×

State	Shads, Herrings & Whitefishes		Temperate Bass & Perches				Drums	Cods
	gizzard shad	lake whitefish	white bass	white perch	yellow perch	walleye	freshwater drum	burbot
MI	×	×	×	×			×	
NY					×			
OH	×	×	×	×	×		×	×
PA		×	×	×	×	×	×	×

Each species' annual harvest levels and harvest values (for all years between 1989 and 2009) were then aggregated individually. For instance, two states (Michigan and Ohio) harvested bigmouth buffalo at some point during the 21-year period. The following tables display the harvest data for these two states for the most recent five years worth of data.

TABLE 34: MICHIGAN'S HARVEST OF BIGMOUTH BUFFALO ON LAKE ERIE

Species	Year[1]	Harvest Level (lbs)	Dockside Value ($/lb)	Harvest value ($)
bigmouth buffalo	2005	96,621	$0.72	$70,047
bigmouth buffalo	2006	85,269	$0.52	$44,528
bigmouth buffalo	2007	215,282	$0.22	$47,613
bigmouth buffalo	2008	142,726	$0.10	$14,007
bigmouth buffalo	2009	130,301	$0.06	$7,510
1. This analysis process was applied to all years between 1989 through 2009 for the Great Lakes Basin, all years between 1989 and 2005 for the Upper Mississippi River Basin, and 1999 through 2005 for the Ohio River Basin.				

TABLE 35: OHIO'S HARVEST OF BIGMOUTH BUFFALO ON LAKE ERIE

Species	Year[1]	Harvest Level (lbs)	Dockside Value ($/lb)	Harvest Value[2] ($)
bigmouth buffalo	2005	230,426	$0.72	$167,051
bigmouth buffalo	2006	263,396	$0.70	$183,545
bigmouth buffalo	2007	268,884	$0.41	$110,166
bigmouth buffalo	2008	226,574	$0.43	$97,262
bigmouth buffalo	2009	371,632	$0.57	$211,129
1. This analysis process was applied to all years between 1989 through 2009 for the Great Lakes Basin, all years between 1989 and 2005 for the Upper Mississippi River Basin, and 1999 through 2005 for the Ohio River Basin. 2. Harvest values are in FY13 dollars.				

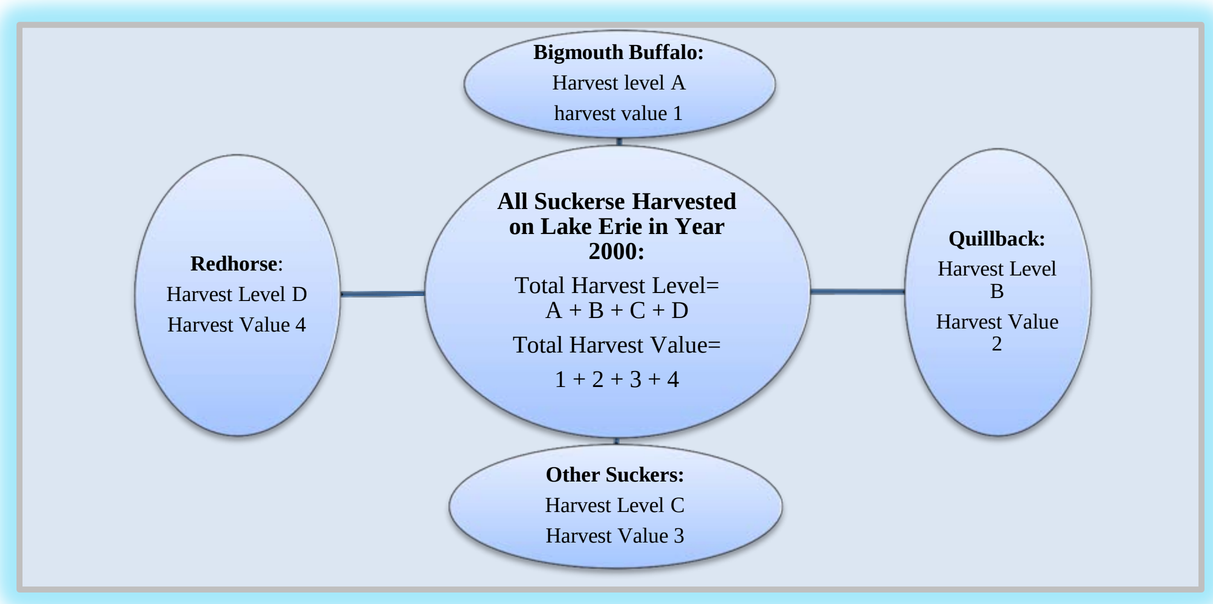
These annual harvest levels and values were aggregated in order to yield the total annual harvest levels and values for bigmouth buffalo between the years of 1989 and 2009. The output is exemplified in the table below.

TABLE 36: LAKE ERIE COMBINED HARVEST

Species	Year[1]	Harvest Level (lbs)	Harvest Value ($)
bigmouth buffalo	2005	327,047	$237,098
bigmouth buffalo	2006	348,665	$228,073
bigmouth buffalo	2007	484,166	$157,779
bigmouth buffalo	2008	369,300	$111,269
bigmouth buffalo	2009	501,933	$218,639
1. This analysis process was applied to all years between 1989 through 2009 for the Great Lakes Basin, all years between 1989 and 2005 for the Upper Mississippi River Basin, and 1999 through 2005 for the Ohio River Basin.			

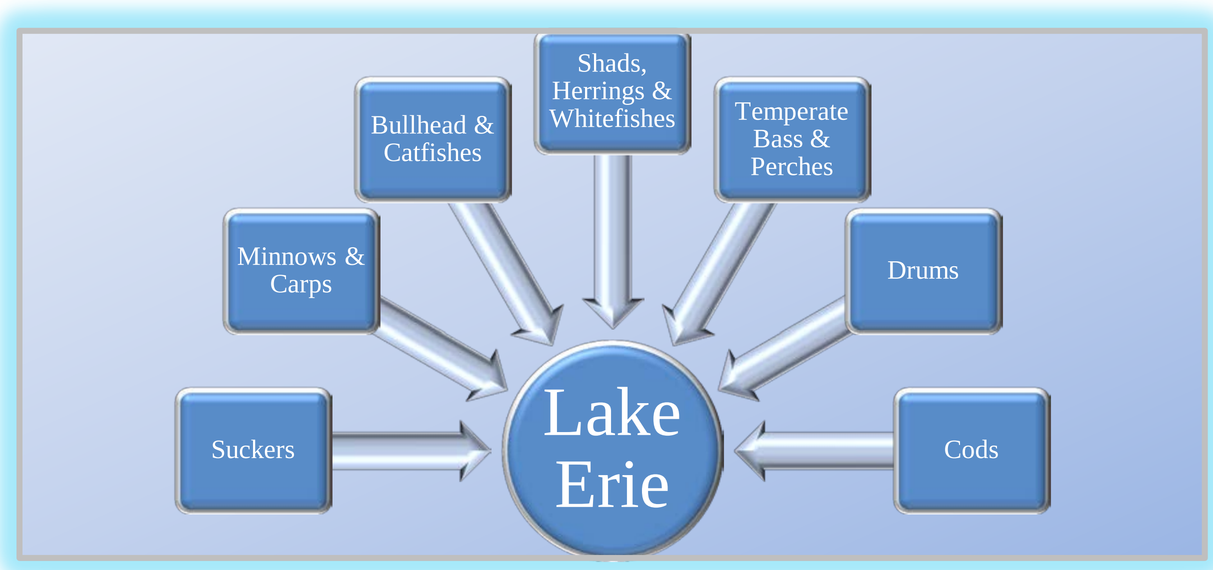
This process was repeated for all species in the "suckers" family. The harvest levels and values for species in a given family were then aggregated. Figure 5 demonstrates how the data was aggregated. This was repeated for each year during the analysis period.

FIGURE 5: EXAMPLE OF AGGREGATION OF SPECIES



In order to determine the baseline value for each water body, the annual harvest levels and values for each family were aggregated. This yielded the total harvest level of all species for all years during the 21-year period. The following figure displays how the final data set for Lake Erie was aggregated.

FIGURE 6: FINAL AGGREGATION OF ALL SPECIES FOR LAKE ERIE



This aggregation of data by species, family and lake was repeated for the Great Lakes, Upper Mississippi River, Illinois River, and Ohio River.

Baseline Values

In order to determine the baseline value of the each of the water bodies in the Great Lakes and Upper Mississippi River basins, the average harvest level and value were derived using the most recent five years of harvest data. Note that the averages of harvest levels and values for each water body were derived in order to present a more complete picture of recent trends in commercial fishing. Annual fluctuation in harvest levels and associated harvest values are apparent in the data. In order to ensure that the baselines best reflect typical harvest levels, an average of the most recent five years of data was generated to serve as baselines (current values) of the commercial fisheries in the Great Lakes, Upper Mississippi River, and Ohio River Basins.

Lake or River Baseline Values

For instance, the baseline harvest level for Lake Erie (and each of the other water bodies in the Great Lakes and Upper Mississippi River basins[16]) was computed by taking the average of the most recent five years of harvest level data. A five-year average was chosen in order to more closely approximate current conditions and to account for any annual fluctuations. This equation is shown below.

EQUATION 3: BASELINE HARVEST LEVEL

$$\textbf{Lake Erie Baseline Harvest Level} = \left(\sum_{Y=2005}^{2009} \text{Harvest Level}_Y \right) / 5$$

The baseline harvest value for Lake Erie was computed by taking the average of the most recent five years of harvest value data.[17] This equation is shown below.

EQUATION 4: BASELINE HARVEST VALUE

$$\textbf{Lake Erie Baseline Harvest Value} = \left(\sum_{Y=2005}^{2009} \text{Harvest Value}_Y \right) / 5$$

Basin Baseline Values

In order to generate the baseline value of the entire Great Lakes basin, the annual harvest level and value data for each water body were aggregated for each year during the analysis period. The

[16] The water bodies analyzed in the Great Lakes basin include: Lake Erie, Lake Michigan, Lake Superior, Lake Huron and Lake Ontario. The water bodies analyzed in the Upper Mississippi River basin include: the Upper Mississippi River, the Illinois River and the Ohio River.

[17] These values were normalized to FY13 values.

aggregation of the harvest data for each Great Lake yielded the total harvest levels and values of the commercial fisheries in the Great Lakes basin. This is exemplified in Figure 7.

FIGURE 7: AGGREGATION OF DATA FOR THE GREAT LAKES BASIN

The following table exemplifies the final data set for the Great Lakes Basin.

TABLE 37: GREAT LAKES BASIN COMBINED HARVEST

Year	Harvest Level (lbs)	Harvest Value[1] ($)
1989	17,049,851	N/A
1990	25,597,956	N/A
1991	27,522,305	$68,587,368
1992	30,107,349	$45,489,662
1993	26,316,466	$34,004,444
1994	26,470,029	$32,907,144
1995	25,760,620	$31,635,089
1996	26,110,371	$29,544,909
1997	26,156,067	$31,260,640
1998	25,032,261	$33,335,039
1999	22,333,401	$29,588,614
2000	19,232,997	$28,804,569
2001	20,404,904	$30,298,803
2002	17,365,947	$23,199,717
2003	17,369,424	$20,964,673
2004	17,648,965	$22,273,129
2005	19,614,483	$23,096,517
2006	20,270,031	$19,437,812
2007	20,393,361	$19,803,619
2008	21,027,230	$22,171,061
2009	19,911,382	$24,407,957

1. Note that the Bureau of Labor Statistics did not start publishing producer price index (PPI) data for the "other finfish" category “02230199” until 1992. Since the PPI was needed in order to generate the harvest values for each of the Great Lakes, these values do not begin until 1991. All harvest values are in FY13 dollars.

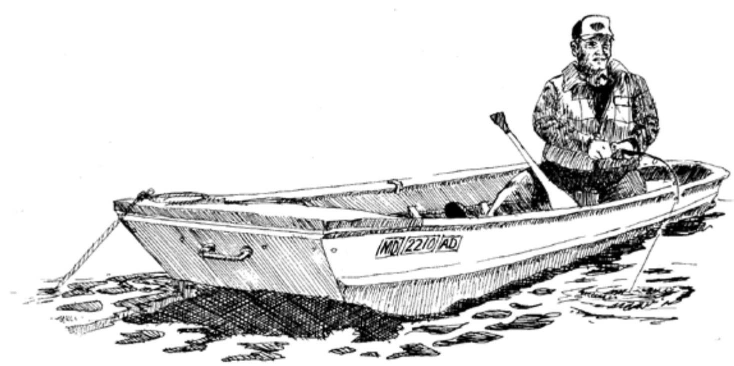
Equation 3 and Equation 4 were utilized to generate the baseline harvest levels and values for the Great Lakes basin. Note that these equations utilize the most recent five years of harvest data (highlighted in orange in Table 37).

Similarly, the aggregation of the harvest data from each river in the Upper Mississippi and Ohio River Basins yielded the total harvest levels and harvest values of the commercial fisheries in the Upper Mississippi River basin.

ATTACHMENT 2

RECREATIONAL FISHING

Potential Effects of Aquatic Nuisance Species on the Behavior of Recreational Anglers, Boaters, and Beachgoers



January 2013

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Executive Summary

This report summarizes the findings from a series of focus groups conducted as part of the United States Army Corps of Engineers/Cornell University “Recreation Impacts of Aquatic Nuisance Species to the Great Lakes and Mississippi River Basins” cooperative agreement. The overall purpose was to describe how and why aquatic nuisance species in the Upper Mississippi River, Ohio River, and Great Lakes basins may affect recreational behaviors of angler, boaters, and beachgoers. Understanding the ways that recreationists may respond to the presence of aquatic nuisance species and the particular effects of these species that may lead to this response is necessary for understanding the impacts of aquatic nuisance species on recreationists. This work will be used as a foundation for later research on the economic impacts of aquatic nuisance species on recreationists.

Eight focus groups were conducted with anglers, three with recreational boaters, and three with recreational beachgoers. A focus group is a type of collective interview in which a researcher brings together a group of people to discuss their views on a particular topic. The researcher acts as a facilitator who introduces several open-ended questions, but who also helps each participant to build off responses given by the other participants. Focus groups allow for thoughts, ideas, and viewpoints to emerge that may not be detected in a one-on-one exchange, but that develop and surface in open dialogue. Such methods are intended to provide greater depth of understanding than can commonly be achieved in a large sample quantitative survey.

A number of factors, including, but not limited to aquatic nuisance species, influenced the recreational behavior of anglers, boaters, and beachgoers. In each user group, the factors cited most often by focus group participants as affecting fishing, boating, and beachgoing behavior were related to the potential effects of aquatic nuisance species. Anglers expressed concerns about catch rate and fish size—and fishing quality more generally—based on impacts from aquatic nuisance species. Secondary effects of aquatic nuisance species—such as the inconvenience or expense of shifting fishing location--were also described. Other influences on behavior were identified that did not link to aquatic nuisance species (e.g., weather, access to fishing sites, social relationships). Boater and beachgoer behavior were tied to aquatic nuisance species-related issues such as water clarity, health and safety, and visual beauty.

Most of the potential impacts of aquatic nuisance species on recreation seemed to be negative, such as limiting the number of locations in which recreation is desirable, causing some forms of recreation to become more difficult, less fun, or less safe, and perhaps leading some people to forsake certain activities altogether. Nevertheless, a few impacts from aquatic nuisance species could be positive. For example, the increased water clarity provided by zebra mussels appealed to many focus group participants.

Even though the focus group participants seemed to be affected primarily negatively by aquatic nuisance species, they frequently showed a willingness to adapt rather than becoming frustrated to the point that they would cease participation entirely. Substituting different locations or forms of preferred recreational activities (e.g., types of fishing, uses of beaches,

etc.) for current ones was a frequently cited approach to dealing with aquatic nuisance species. Recreationists repeatedly asserted that they would adapt and continue to recreate, even if it left them with a diminished experience.

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I. Study Background

GLMRIS Background Information

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River basins by aquatic pathways.

An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (FY13).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: (a) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and (b) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users; and
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries.

GLMRIS Navigation and Economics Product Delivery Team

In support of GLMRIS, the Navigation and Economics Product Delivery Team (PDT) was formed. The PDT was tasked with assessing the current value of *economic* activities within the GLMRIS detailed study area that *could* change with the implementation (Future With Project (FWP) condition) or lack of implementation (Future Without Project (FWOP) condition) of a GLMRIS project. The PDT is comprised of several sub-teams, each of which focuses on a specific economic activity within the GLMRIS study area.

Fisheries Economics Team

The Navigation and Economics PDT's Fisheries Economics Team focused on fishing activities within the U.S. waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins (i.e., the GLMRIS detailed study area) that *could* change in the FWOP and/or FWP condition.

Five baseline economic assessments, which quantitatively or qualitatively describe the current economic activities dependent on fisheries, were developed. The reports focus on the following categories: commercial, recreational, charter, and subsistence fishing, as well as professional fishing tournaments. Each baseline assessment focuses exclusively on the specified fishing activity within the GLMRIS detailed study area – to include the U.S. waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins. It is imperative to note that collectively, these values do *not* represent a comprehensive value of these three basins. Each basin has further economic (e.g., non-use values) and environmental values that are not captured in this economic appendix. Rather, the fishing-related economic activities assessed by the Fisheries Economics Team serve as indicators of key aspects of the economy that *could* change in the future, with or without the implementation of a GLMRIS project.

Report Purpose

In support of GLMRIS, Cornell University (CU) was tasked, in part, with estimating how recreational activities – that take place within the Great Lakes Basin (GL), and Upper Mississippi River and Ohio River Basins (UMORB) – would be impacted by the transfer of ANS between these basins. Specifically, this document describes the findings of fourteen focus groups that were conducted in order to establish the potential effects of ANS transfer between the GL and UMORB on the behavior of recreational anglers, boaters, and beachgoers within these basins.

The overall purpose of this report is to describe how interactions with aquatic nuisance species in the UMORB and GL basin will likely affect recreational behaviors related to interaction with aquatic environments in these basins. The portions of the study area that were of particular interest were the Great Lakes, the Upper Mississippi and Ohio Rivers, and those lakes, ponds, rivers, and streams that are not separated from these water bodies by any barriers impassable to fish (dams, waterfalls, etc.). It is these waters that USACE considers susceptible to the effects of possible ANS transfer between the Great Lakes basin and the UMORB (in either direction).

Aquatic nuisance species may have a range of effects on aquatic systems, and some of these effects may influence whether and how anglers, boaters, and beachgoers choose to recreate. Behaviors with economic implications are of particular interest. Eight focus groups were conducted with anglers, three with recreational boaters, and three with recreational beachgoers providing qualitative data that allow for a better understanding of the major influences (for example, the desires, experiences, and constraints) that shape behavior of all three recreational groups. An understanding of the factors that shape recreational behavior allows assessment of whether and how (further) introduction of aquatic nuisance species could affect recreational communities. The results reported reveal some patterns in how behaviors may change as a result of aquatic nuisance species (for example, location, frequency, or type of recreation).

II. Theoretical Background

Data collection and analysis were guided by a well-established theory of characteristics that lead to behavior change called the Theory of Planned Behavior (Ajzen, 1991, 2002; Ajzen et al., 2011). This theory asserts that three major sets of factors will predict an individual's intentions to behave in a certain way (e.g., to engage in a particular type of recreation): (a) attitudes (e.g., perceptions about what is good or bad, desirable or undesirable, useful, meaningful, etc.); (b) perceived norms (i.e., one's beliefs about which actions other people, who are important to the individual, think the individual should take); and (c) perceived control (i.e., one's ability to actually engage in an activity, due to personal as well as external factors). The focus groups were used to collect data about which factors influence the recreational behaviors of anglers, boaters, and beachgoers with a particular focus on those factors that could be influenced by the spread of (additional) aquatic nuisance species into the area.

The primary way that aquatic nuisance species might affect user behavior was through changes in resource quality – characteristics of the resource that are important to recreational users (size of fish populations, water quality, presence of weeds, etc.). The US Army Corps of Engineers provided preliminary assessments of the types of effects that aquatic nuisance species might have on resource quality. During the focus groups, these potential occurrences were discussed with representatives of user groups to gauge how they would likely respond.

III. Methods

Focus groups were conducted in fourteen locations throughout the study area (Figure 1 and Table 1). A focus group is a type of collective interview in which a researcher brings together a group of people, interested in and informed about a particular topic, to discuss their views on that topic. The researcher acts as a facilitator who introduces several open-ended questions, but who also helps each participant to build off responses given by the other participants. The researcher only asks questions and does not provide information or correct inaccurate statements because participants are less likely to share their perspectives freely if they expect their responses to be critiqued. Focus groups are designed to provide in depth information from people about topics for which their possible responses might not be able to be predicted in advance. A focus group approach was adopted for this research because the literature available did not clearly indicate the different types of influences that would likely lead to behavior change for the different user groups of interest in this study. Focus groups allow for thoughts, ideas, and viewpoints to emerge that may not be detected in a one-on-one exchange, but that develop and surface in open dialogue; they also allow participants to offer impressions of whether or not the group generally has consensus on an issue or perspective. They are not intended to provide statistically valid representations of a particular place or group in the same way provided by a random sample quantitative survey instrument.

Participants for the fourteen focus groups were identified through a variety of methods. At some locations, researchers had previously worked with individuals (staff members of state fish and wildlife agencies, Sea Grants, local parks, etc.) who worked with recreational users in that

Figure 1. Map of study area showing locations of focus groups.

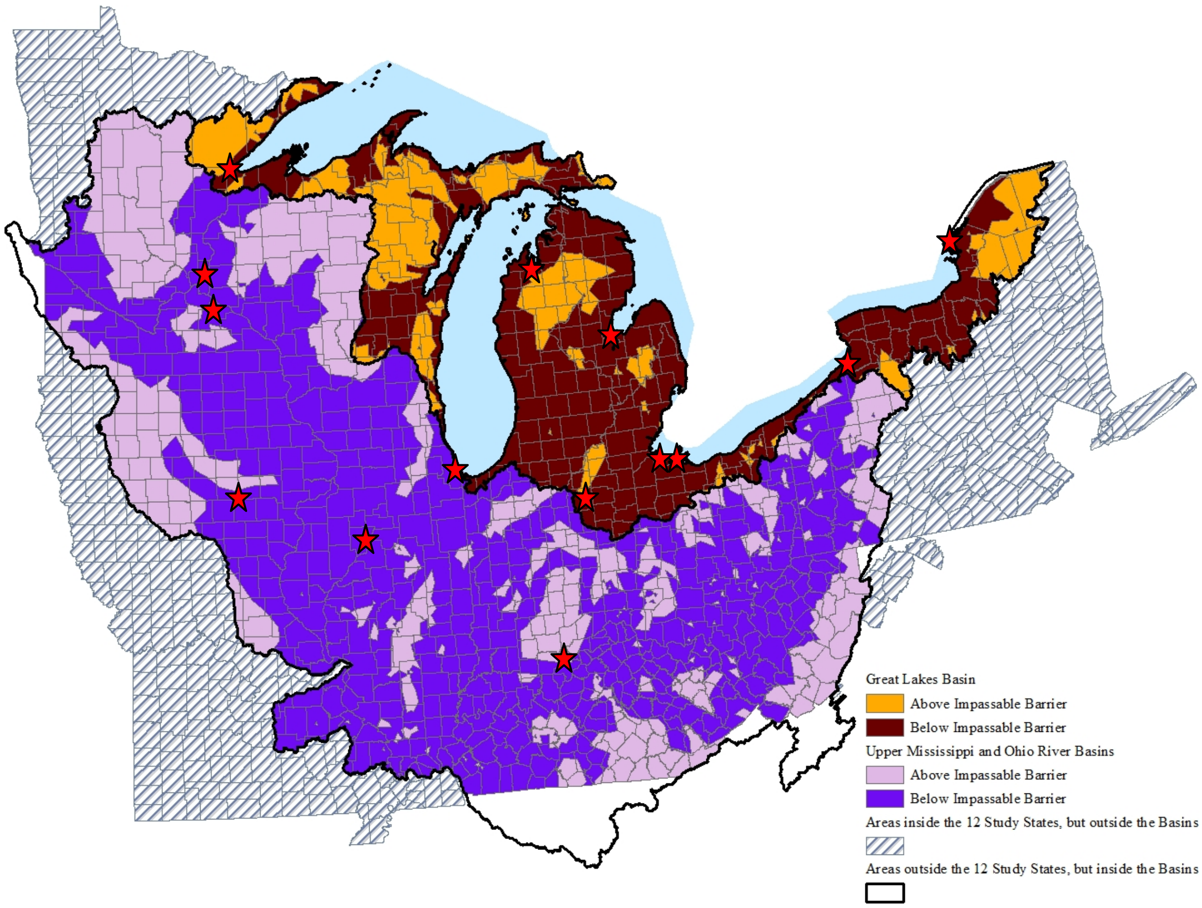

Table 1. Focus Group Characteristics

Location	Date	Recreational group interviewed	Number of participants	Duration of discussion
Oswego, NY	Nov. 7, 2011	Anglers	8	1h 45m
Peoria, IL	Nov. 15, 2011	Anglers	6	1h 32m
Eagan, MN	Nov. 16, 2011	Anglers	11	1h 54m
Duluth, MN	Nov. 17, 2011	Anglers	21	1h 58m
Port Clinton, OH	Dec. 5, 2011	Anglers	8	2h 08m
Bay City, MI	Dec. 13, 2011	Anglers	8	2h 14m
Fort Wayne, IN	Dec. 14, 2011	Anglers	15	1h 59m
Louisville, KY	Dec. 15, 2011	Anglers	15	2h 00m
Traverse City, MI	Apr. 10, 2012	Beachgoers	11	1h 27m
Chicago, IL	Apr. 11, 2012	Beachgoers	9	1h 33m
Minneapolis, MN	May 9, 2012	Beachgoers	13	1h 43m
Alexandria Bay, NY	May 2, 2012	Boaters	11	1h 32m
Put-in-Bay, OH	May 6, 2012	Boaters	9	1h 26m
Pella, IA	May 10, 2012	Boaters	14	1h 14m

area. In these locations, recruitment started with "snowball sampling" (i.e., contacting individuals who have knowledge of recreational users in a location and asking for recommendations of people to participate, then contacting those individuals, asking them to participate and asking for additional suggestions). In addition to snowball sampling, and particularly in locations where the researchers had no contacts, recruitment occurred by way of announcements in local newspapers and announcements via e-mail list-serves of organizations supportive of the research being conducted. The focus groups lasted between 1 hour 14 minutes and 2 hours 14 minutes, with an average duration of 1 hour 45 minutes; they contained between 6 and 21 participants with an average attendance of slightly over 11 individuals. The size of the interviews was established to allow for a variety of perspectives to emerge on how aquatic nuisance species, and other factors, could influence the recreational behaviors of interest. Random sample statistics are irrelevant to data analysis of focus groups and, therefore, did not influence sample selection.

The majority of the focus groups were conducted with anglers because the data from this group were not only being used to understand how aquatic nuisance species would most likely affect recreational behaviors, but also to design a follow up survey to anglers about the effects of nuisance species on fishing behavior. All of the focus groups contributed to an understanding of how major recreational groups could be affected by the (further) introduction of aquatic nuisance species, and allowed for identification of similarities and differences between the potential impacts on each of the three recreational groups. The findings related to each recreational group are discussed in the Results section below; the report concludes with a discussion of the similarities and differences between recreational groups.

The focus groups were conducted either by a single facilitator or by a team of two facilitators, with one person leading the questioning and the other helping with follow up questions. The same facilitator led all the angler groups, with an additional facilitator present at three of the groups. Another facilitator conducted all the beachgoer and boater interviews. All four faciliators were trained in advance and participated in practice interviews.

The facilitators approached each interview with a list of major questions and follow up questions (see Appendices A, B, C), vetted through the pilot interview process and by the US Army Corps of Engineers. In all three sets of interviews, the questioning started by asking participants why, where, and how often they engaged in the relevant form of recreation (i.e., fishing, boating, or beachgoing). Next, they were asked whether their recreational behaviors had changed in the past, and then to explain what factors led them to change, or would conceivably lead them to change their behaviors. The participants were asked for any factors that affect their recreational behavior, not just those directly or indirectly linked to aquatic nuisance species. This was for the practical reason that it might be very difficult for someone to identify all the ways in which aquatic nuisance species affect him/her indirectly. More importantly, understanding the extent to which factors not related to aquatic nuisance species affect recreational behaviors can help reveal the relative importance of aquatic nuisance species in shaping behavior.

Finally, the participants were asked to comment on the extent to which certain specific factors (related to aquatic nuisance species) would cause them to change their recreation behaviors. Additional follow up questions, as appropriate, explored further statements made by participants during the interviews. The faciliators audio recorded each interview; trained transcriptionists were employed to transcribe verbatim each of the fourteen interviews.

Coding

After transcription, three researchers (the two primary facilitators for the focus groups and a third individual who did not participate in the groups) were trained to code the transcripts. Coding is a process by which the transcripts are examined for words or phrases that indicate certain concepts of interest. In this study, the words and phrases of interest were those identifying factors that might influence recreational behavior. For example, an important code/factor in the angler focus groups was fish size. Anytime a focus group participant made a comment about fish size in some way influencing his or her fishing behavior, the coders marked the phrase that contained this reference as "fish size." A single phrase could have multiple codes associated with it.

In collaboration with other researchers who were involved in the overall study, the three coders generated a list of factors they believed to be important influences on fishing, boating, and beachgoing behavior. The factors were derived based on a review of the literature and an initial examination of the transcripts. The coders then created a list of definitions for each factor. The factors were grouped into four general categories, based primarily on the ideas contained in the Theory of Planned Behavior (Ajzen, 1991, 2002): (a) attitudes/perceptions of recreation that affected behavior; (b) external constraints on participation in recreation (i.e., factors arising from sources not directly associated with the individual); (c) internal constraints on recreation (i.e., factors arising from characteristics of the individual); and (d) perceptions about actions that friends or family think are right or appropriate.

Reliability Assessment

To ensure reliability (consistency across the different coders) the three coders first jointly coded one angler transcript. Two coders independently coded the first third of each of the remaining seven angler transcripts. The codes for each factor were then compared for agreement and reliability. Agreement was measured as the percentage of all instances in which the two coders agreed upon the application of a given factor to a particular section of text. For example, if coder A coded 8 instances of factor Y and coder B coded 9 instances of factor Y, with 7 of those instances overlapping, the overall agreement would be 70% (7 cases of agreement + the one case that coder A identified, but B did not, + the two cases that coder B identified that A did not). Five of the remaining seven angler transcripts obtained excellent reliability scores, having over 70% agreement on all 26 factors. One of the transcripts exhibited low agreement (<70%) on a single factor, and a second transcript exhibited low agreement on five factors. The coders reviewed and came to agreement on the correct factor in each instance of disagreement. After conducting the reliability analysis, a single coder coded the last 2/3 of each transcript (all three coders participated in this process, but there was no duplication of coding across transcripts). Having established strong reliability among coders during the coding of the angler interviews, a single coder independently coded each of the boater and beachgoer transcripts. The data were analyzed by generating frequency statistics for the number of times each factor was cited in each group of interviews.

IV. Results

This section is separated into three sub-sections, each describing the major findings from the particular recreational group. Two main questions guide the data collection and analysis in each set of focus groups:

1. How might (further) introduction of aquatic nuisance species affect recreational (i.e., fishing, boating, or beachgoing) behavior?
2. How might other influences affect those same recreational behaviors?

Anglers

Two main forms of data are presented. First, this section summarizes the total number of instances in which each factor influencing fishing behavior was discussed (defined as a single statement by one individual, set apart by statements from other people) throughout the eight angler focus groups. Of the 26 factors identified in the angler transcripts during the coding process, the top ten most cited are listed in this report (see Table 2). (Some factors that influence angler behavior would most likely not be affected by aquatic nuisance species; factors followed by a † are factors that could likely be connected to effects of aquatic nuisance species.) The second form of data presented here are quotes from the focus groups that capture the meaning of the factors discussed. While each factor highlighted may have been mentioned many times during the focus groups, certain quotes captured the essence of these influences on fishing behavior. It is common practice in focus group research to also provide the quotes as "raw data".

Effects of Aquatic Nuisance Species on Fishing Behavior

Before discussing the most frequently cited factors that influenced fishing behavior for the focus group participants, and these factors' potential connections to aquatic nuisance species, a brief overview is offered of the ways in which the participants explicitly described how aquatic nuisance species might influence their fishing behavior. On 64 occasions, a focus group participant identified a link between his or her fishing behavior and the presence of aquatic nuisance species. Anglers mentioned many different types of aquatic nuisance species that have affected their fishing in the past and expressed concerns about the potential advent of Asian carp in their area. An interesting pattern observed in most focus group participants, when they spoke of aquatic nuisance species, was that they mentioned their efforts to adapt. A participant from Bay City highlighted this mode of expression:

> When the exotics came in and changed everything, then we had to learn to fish all over again; we learned that maybe you could get some steelhead at the top and, and then the lake trout at the bottom and so now we fish for whatever we can get and we're doing different things.

Table 2. Most Cited Influences on Fishing Behavior

Influence (factor)	Number of times cited in angler interviews
Catch rate†	111
Fish size†	56
Equipment, boats, fishing gear available	54
Cost / gas usage†	50
Weather	47
Seasonality of fishing	46
Access	45
Social interaction	44
Fishing "quality"†	43
Fishing for itself	38

† These factors are those the researchers identified as potentially most closely linked with the effects of aquatic nuisance species.

A participant from Louisville, Kentucky, touched on the difficulty of adapting:

> The river is impacted with all these invasive species and we all try to adapt, but sometimes it's difficult … We spent a whole springtime sitting trying to catch a fish and getting your line cut because of the zebra mussels. You've got to go to different line and you change your fishing techniques to adapt to that and so you kind of grin and bear it and, and hope for the best.

Participants also commented on how they might deal with Asian carp, should the fish appear locally. A person from Eagan expressed his perspective on how Asian carp would affect his fishing behavior; "Yeah it's a lot of politics and that's the bad news but personally, I will never stop fishing. I will find a way to fish." The following discussion of factors affecting fishing behavior and quotes illustrating them reveal that aquatic nuisance species have the potential to affect anglers in very real ways, and may lead to reduction in overall fishing, changes in locations in which people fish, and overall enthusiasm for fishing. Nonetheless, an overarching sentiment pervaded the focus groups that even if fishing became worse, committed anglers would find a way to cope.

This report now examines the individual factors most commonly cited in the focus groups as affecting fishing behaviors. The arrival of new aquatic nuisance species might influence fishing behavior by affecting some of these factors, while they would not likely affect others. First described are influences potentially tied to the effects of aquatic nuisance species.

Factors Closely Related to Potential Effects of Aquatic Nuisance Species

Catch rate refers to comments about the number of fish caught during a fishing outing. A large number of interviewees spoke of the importance of being able to catch many fish. Some of these anglers spoke of their own interest in catching fish while others, notably charter boat captains, mentioned that their customers expect to catch many fish. While not every comment about the importance of high catch rates was related directly to concerns about aquatic nuisance species, the potential ability of aquatic nuisance species to cause decline in fish populations of other species has led to identification of catch rate as closely related to potential effects of aquatic nuisance species.

A man from Port Clinton, Ohio, speaking of himself and his friends, stated, "We fished the shoreline a couple times last year probably but it's, it's not even worth it to us. You know if we don't catch ten, fifteen fish in two hours, it's not worth it to us." A charter boat captain from Bay City, Michigan, gave a response indicative of other captains:

> There's a difference between the way [he] fishes and I fish, because I have to produce numbers for clients. He can go and he can fish all day or not fish if the fishing isn't good that particular day. He can do pretty much what he wants because he does not have to put fish in the boat.

Few anglers were willing to definitively state how many fish represented a "good catch" for a particular period of time; many indicated that it would vary based on the species, conditions, etc., but they did seem to have a general idea of what was acceptable and what was not. An angler from Eagan, Minnesota, expanded upon the importance of catching a good number of fish; "It's no fun if you aren't catching anything and you're not catching anything of size."

Fish size sometimes paired closely with catch rate, but was also often discussed separately or in conjunction with the theme of fishing simply for reasons of "fun." Larger fish generally seemed to make the focus groups' participants' fishing experiences more exciting and rewarding. A man from Port Clinton offered, "If I go perch fishing I pretty much strictly fish in Canada because the perch are a lot bigger up there." Another interviewee in that same focus group added, "The bigger the fish the more fun it is to catch." These were indicative of many of the comments related to fish size. When an interviewee from Peoria, Illinois, was asked what he would do if fish size decreased in his fishing area, he responded, "Just find a body of water that has bigger size and more of what we want, whether that means driving farther or changing your methods." Again, he pointed to a willingness to adapt to changes in fishing conditions. To the extent that aquatic nuisance species lead to reductions in the size of species that are popular among anglers, they may also lead to shifts in the locations where anglers fish most regularly.

Fishing quality, the ninth most cited influence on fishing behavior, is mostly a combination of aspects of the first and second most cited influences, catch rate and fish size. The statements the researchers classified as relating to fishing quality, however, were broader and did not make specific reference to quantity or dimensions of the fish. For example, an angler from Oswego mentioned, "I'm with [him], I go where the fishing is good. I live on Otisco Lake so I literally fish every day if I feel like it." Because this factor combines aspects of catch rate and fish size, as well as potentially other factors related to the desirability of fishing in a given location, it is perhaps even more susceptible to the effects of aquatic nuisance species. Anglers mentioned that they may reduce the number of days they fish or find new locations if the fishing is not "good."

Less clearly connected to aquatic nuisance species, but still relevant to the effects of these species on fishing behavior, were discussions related to ***cost***, and particularly the price of gasoline. If aquatic nuisance species displace people because they lead to less desirable fishing conditions, as is suggested above, they may further reduce the willingness to fish if the only remaining desirable fishing areas start becoming farther and farther afield. While some of the focus group participants made it clear that cost of fishing is less of an obstacle for them (e.g., the quote above from a man who stated he would just drive to wherever the fishing is good), for many respondents, the need to drive father to reach a desirable fishing location seemed to affect their behaviors. An angler from Duluth, Minnesota, provided an example of a decision based on financial concerns:

> We didn't go to Lake Michigan this year because there's three of us boats that usually go together, and we will come up with our diesel pickups. We went over the records of what we spent last year in gas and fuel. This year it wasn't unattainable, but why throw away that money to go down there? We just, we stay and fish around here.

A focus group participant from Peoria discussed the interplay between expenses and catch rate, indicating that he and his friends sometimes make a trade off between the two:

> We try to keep fairly close around Peoria just because there's good lakes further away but everybody complains about the gas and everything, so for the most part we try to stay within an hour or so of Peoria, but there's a few lakes they're okay with driving farther if you catch a lot of fish.

Other Influences on Fishing Behavior Not Linked to Aquatic Nuisance Species

There were several other factors that the focus group participants cited as influencing fishing behavior that would likely not be affected by the arrival of new aquatic nuisance species. These factors are nevertheless important to understand because to the extent that anglers make decisions about fishing based on these factors, their behaviors will not change with the introduction of aquatic nuisance species.

The ***equipment, boats, and/or fishing gear*** available to anglers was a major influence on fishing behavior. Lack of availability of specific gear was cited as a limitation to fishing in certain areas or for specific species. An angler from Port Clinton explained a characteristic constraint the researchers often heard related to the specifications of his boat:

> Things that will affect me the most are going to be wave heights. My boat's 17' and out on Lake Erie that's not that big; that's fairly small, so I get turned back a lot. A lot of

> days I can't fish, or I have to fish some place where I really don't have confidence that I'm going to do well, but it's more sheltered.

A participant from Fort Wayne, Indiana, detailed the constraints attached to lacking a piece of equipment entirely; "Usually I fish from shore because I don't have access to a boat, and I do also fish ice fishing so that does allow me more access." While only tangentially related to presence of aquatic nuisance species, one could conceive of instances in which presence of such species lead to reductions in desirable fishing areas, further limiting the places in which an angler wishes to fish. The combined constraints of only having particular gear or equipment available and only having certain desirable fishing areas available could produce fewer feasible fishing locations.

Related in some ways to the influence of equipment and accessories, but also with many independent consequences of its own, were the effects of ***weather*** on fishing behavior. When speaking about the frequency with which and the locations in which he fishes, an angler from Bay City stated, "It depends on conditions…the weather was horrible this year on Lake Huron, we had days and days we couldn't get out, so you're focusing in other areas." An interviewee from Duluth expressed another common sentiment, noting that he simply will not fish in some conditions, "I fish every weekend that I can. But if there's an east wind, you know, I'll stay home."

While the focus group participants explained that Nature's hand could affect fishing in temporary and haphazard ways through weather, Nature also affects behaviors in a more predictable and less transient way through the ***seasonality of fishing***. Some interviewees described how their fishing is constrained by the number of days they can physically be on the water, but other anglers, who specialize more particularly in one or two species, mentioned additional constraints. Speaking of the seasonality of certain locations, an angler from Port Clinton asserted:

> I don't fish that [area] often. You've got to do that in the spring; by late summer it gets hit every day by guys like me out there catching them, and the fishing progressively gets worse. It sounds like East Harbor is nice in the fall.

A participant from Eagan spoke of variation in species:

> I'm sort of an opportunistic fisherman and I like to fish when that particular specie is active, actively biting. I'll change species from month to month depending on what the water temperature is and whether it's in the stream or whether it's in a lake.

While aquatic nuisance species obviously have no effect on the occurrence of spring, summer, and autumn, they may limit the ranges during which particular species are readily available and, thus, frustrate anglers who are used to fishing for certain species during specific months of the year. This could lead to reduction in fishing effort or a change in fishing location. Nevertheless, the second quote above provides another example of an angler's willingness to adapt.

Some influences on fishing behavior functioned as constraints, limiting fishing in certain circumstances, but also as factors promoting fishing in others. ***Access***, for oneself and/or one's equipment to bodies of water, was one such influence. An angler from Bay City explained how ease of access could make fishing more inviting, "We have an 18' boat that we take out right there in town. We're lucky, the harbor is right there and just a few blocks from our house." An interviewee from Peoria described how lack of access could make fishing difficult and limit frequency of and locations for fishing, "Right now you can't even get in there with a boat even because it's so dry. It's like certain areas of Lake Story are so bone dry that there ain't no water there."

Social interaction seemed to affect fishing behavior differently from many of the other influences. Rather than primarily shaping the frequency with which one fished, social interaction seemed mainly to affect the anglers' approach to fishing. Some people spoke of fishing with their families, and how they might try for species they would not otherwise fish for when with their wives, children, or grandchildren. Others seemed to treat fishing as a more laid-back endeavor when fishing with friends. A man from Port Clinton stated, "It's probably 3 years maybe; I've been doing this every Wednesday, that's how we hang out." An interviewee from Oswego, New York, explained how spending time with friends influences the location in which he fishes:

> I have friends that come out of Marion Manor and I generally fish with them when I go down there, and if I don't fish with them, they give me where to go and what to do and when to do it, so I fish that a lot on the east end.

While no interviewee articulated it explicitly, aquatic nuisance species could affect fishing behaviors through the influence of social interactions by making certain fishing locations less desirable (due to catch rate, size, etc.). Most of the participants in the focus groups were dedicated anglers, but many also mentioned that the family members that they fish with are rather casual anglers. Therefore, while a dedicated angler may be able to adapt, to grin and bear it, if fishing quality declines, this may not be true of the people with whom these dedicated anglers occasionally fish.

Fishing for itself is the name given to a factor that categorizes a series of comments that were almost in direct opposition to the statements about the importance of catch rate or fish size. This attitude expressed a vision of fishing as something beyond the fish themselves. An interviewee from Bay City explained:

> I'm just a fisherman. I am going to fish somewhere, sometime, so many days out of every year. Whether I catch fish or not is irrelevant. … I'd like to. I have every intention of doing so, but nobody lives or dies if I don't.

An angler from Fort Wayne expressed a similar sentiment that catching fish is not necessary for a positive fishing experience:

> To me it's not so much going out and catching fish; it's just to get away from when I was working. It was just to get out, just to relax just to you know to go out. I mean catching fish to me was, is a plus obviously, but I've had some really wonderful times not catching anything.

While many anglers who cared deeply about catch rate and fish size indicated willingness to adapt to changing conditions, potentially caused by aquatic nuisance species, the anglers who cited "fishing for itself" showed a willingness to adapt in a different sense. They may not need to find a new location or a different method of fishing if their real purpose in "fishing" is more about broadly enjoying nature, being with friends, or taking in the quiet and solitude of a favorite fishing spot. Nonetheless, the factors catch rate, fish size, and fishing "quality" (considered together) were cited over five times as often as fishing for itself was cited.

Responding to Change

Some influences showed real potential to limit or displace fishing activity, but above all there was an overarching sense of the ability to adapt or to substitute a new location, mode of fishing, species, or activity for one's current approach to fishing.

Many participants identified ability to adapt as a characteristic of true anglers. An interviewee from Port Clinton described how shifting fishing location or size of fish is one way to adapt if fishing quality changes:

> We'd find somewhere else. … I've gone before to a couple different reservoirs and haven't caught anything two, three times, but I'll even change to smaller fish if I have to; the goal is to not get skunked when we go fishing.

An angler from Eagan expressed that no matter how bad the fishing conditions, he will find a way to continue his activity; "Personally I will never stop fishing for anything. I'll catch fish. God forbid something happens where everything gets wiped out by the invasive species, I'll still go fishing. I am a fisherman." Many of the anglers who attended the focus groups were long-time, very committed anglers. The extent to which other anglers, who are newer or less committed, would exhibit equal willingness to adapt and substitute is an open question, but it is unlikely that less devoted anglers would exhibit a similar fervor.

Boaters

Boaters are another major recreational group potentially affected by presence of aquatic nuisance species. There is some overlap between anglers and recreational boaters - many anglers fish from boats and many recreational boaters also fish to some extent. Boaters, nonetheless, pursue a wider range of activities on the water, from boating in order to find desirable places to swim, to water-skiing, tubing, relaxing on a Sunday afternoon, and engaging in non-motorized activities such as sailing, kayaking, and canoeing. The range of ways in which aquatic nuisance species could affect boaters is, thus, quite diverse. Asian carp that jump at the sound of an engine certainly have the potential to affect activities involving motor boats, particularly those activities that involve towing someone (often children) behind a boat. Less obvious are the effects of zebra mussels, which could reduce boating by covering sandy beaches that boaters frequent with sharp broken shells. Thick mats of milfoil or other nuisance non-native aquatic weeds can also lead to an aesthetically (visually and olfactorily) unpleasant experience that could reduce or displace boating.

Based on the idea that different types of boaters will experience aquatic nuisance species-related impacts differently, the focus groups included a wide range of boaters. Motor boaters were the most common participants, followed by kayakers and sailors, but the groups also included people who jet ski, water ski, use boats for tubing, use boats to take them to remote areas for swimming, work as charter fishing boat captains, and people who snorkel or dive from boats.

Of the 38 factors identified as influencing boater behavior, this report lists the top seven most cited (see Table 3; these are the factors that were cited at least ten times across the three focus groups; factors followed by a † are factors that could likely be connected to effects of aquatic nuisance species). As in the section on fishing behavior, the report presents both the number of times each factor was mentioned and quotes to illustrate each factor.

Effects of Aquatic Nuisance Species on Boater Behavior

Before discussing particular influences on boating behavior, and their potential connections to aquatic nuisance species, a brief overview is offered of the ways in which the focus group participants explicitly described how aquatic nuisance species influenced or might influence their boating behavior. On 55 occasions, a focus group participant linked boating behavior directly to the presence of Asian carp, on 51 occasions boating behavior was linked to aquatic weeds or algae (although not all references were to invasive/exotic weeds), and on 18 occasions participants connected boating behavior and the presence of zebra mussels. Effects of other aquatic nuisance species on boating behavior, such as round gobies, were cited only sporadically.

Asian carp were the most discussed aquatic nuisance species. The potential effects of Asian carp on boating behavior fit into many categories. Some people were concerned about their own safety and/or that of their families; others, particularly those from the tourist towns of Alexandria Bay, NY, and Put-in-Bay, OH, were worried about potential effects on tourists' desire to come to an area where aquatic nuisance species were prevalent.

A motor boater from Alexandria Bay explained how safety concerns associated with Asian carp would lead to behavior change; "We have grandchildren. I can tell you right now, that'd be the end of their going with us." Similarly, a motor boater from Pella stated, "As [our children] start having grandkids, we'll be back out there pulling and tubing. And we would not do that on a lake where the invasive fish would be jumping. We wouldn't. We would go somewhere else." Many people spoke of how certain activities, or doing certain activities with particular people, would end in the presence of the carp. A kayaker from Pella spoke of his own personal safety when he asserted, "When I saw that Asian carp jumping, I wouldn't kayak like I did today." This

Table 3: Most Cited Influences on Boating Behavior

Influence (factor)	Number of times cited in boater interviews
Effects on fish †	22
Water clarity †	18
Tourist culture †	15
Health / safety †	14
Weather	12
Visual beauty †	10
Cost / gas usage †	10

† These factors are those that the researchers identified as potentially most closely linked with the effects of aquatic nuisance species.

man earlier spoke of someone being forced to quit a kayaking race due to being hit in the head by a jumping carp.

A boater from Put-in-Bay expanded upon the theme that some types of boaters may react differently to the carp than others:

> I think that if they were jumping into the boat, I bet these guys who come here to party would get real close, so they could throw them out or club 'em to death. But I think it would bother the families in small boats. I think if a fish that big jumped into a boat that had a six year old girl sitting in it, she wouldn't want to come back in the boat again.

Another Put-in-Bay boater reflected on how this sort of change could affect the town in which he lives:

> I think the biggest effect it would have here would be on tourism for fishing. You wouldn't see those groups of a hundred boats out there, especially the charter boats.

Whether it was because of fears about safety for oneself or someone else, or simply a desire not to be annoyed by fish that are literally in one's face, several of the participants seemed ready to stop at least some forms of boating due to the presence of Asian carp. The financial implications of this are clear, especially for the tourist towns whose lifeblood depends on a culture of boating.

Participants in the focus groups were asked to share how any type of aquatic nuisance species, not just Asian carp, might affect their boating behaviors. Aquatic weeds and algae, mentioned 51 times by the focus group participants, were a close second to Asian carp in the number of times cited. Some people spoke of aquatic weeds as a nasty, disgusting thing to which they did not want to expose themselves or their families, while others were concerned about the weeds' effects on the local water-based economy. A third common concern with aquatic weeds was their propensity to clog motors or to block passage, making boating impossible. An interviewee from Alexandria Bay clearly articulated a prevalent concern of several participants:

> When my boys were young, they used to sail the mini sailfish. Nobody could use it now. You put a rudder in that thing and you're going nowhere. The wind may come and you're just going over, because it clogs. They were always out there water-skiing. Now it's zoom, stop, back up, get rid of the weeds, go again … You just can't. It's all weeds.

While some of the interviewees quoted here were referring to experience with native aquatic vegetation, and others referenced struggles with invasive weeds, all of the quotes help reveal how future aquatic nuisance vegetation could affect boating behavior. A boater from Put-in-Bay highlighted conversations he had with several local boaters when he made the following statement about why aquatic weeds are particularly bothersome to boaters:

> It's the stuff that they can see on the lake that people are concerned about. We don't see the zebra mussels, or round gobies. Hey, they're in the lake. Did anyone ever call [the Chamber of Commerce] and say, "I'm not coming to Put-in-Bay because of round gobies?" But certainly, the algae, the stuff that you can see.

This interviewee once again highlights the potential effects of certain aquatic invasive/exotic species (as well as native aquatic weeds and algae) on tourism, pointing to relevant economic implications.

Zebra mussels were not cited as affecting boating behavior nearly as often as were Asian carp, but they were still the second most cited aquatic nuisance species of concern (because the aquatic weeds/algae factor included native species as well). Most concerns about zebra mussels were expressed by boaters who enjoyed swimming or spending time on beaches as part of their boating experience. For example, a motor boater from Alexandria Bay noted, "I used to like to go swimming with my bare feet. That doesn't happen anymore, because when you come out, there's blood on the rocks, in the sand. It's all zebra mussels."

Much of the discussion in the focus groups, however, did not refer specifically to aquatic nuisance species, but rather to factors influencing decisions about boating – some of which could be affected by aquatic nuisance species. The discussion below lists and explains the individual factors most commonly cited in the focus groups as affecting boating behaviors. The influences potentially tied to the effects of aquatic nuisance species are described first.

Factors closely related to potential effects of aquatic nuisance species

Even though the three focus groups discussed in this section were with boaters, many of the participants also fished, and others were particularly concerned about effects of aquatic nuisance species on the ecosystem or and the local water-based tourism economy. For these reasons, ***effects on fish*** was the most commonly cited factor. An interviewee from Alexandria Bay succinctly summarized a common concern, "We've had a multi-million dollar fishery in Lake

Ontario and the St. Lawrence River. … If we let Asian carp into the Great Lakes, it will be, probably be, the demise of our fishery as we know it today." Fewer people would engage in boating in the Alexandria Bay area if the fish were affected because that is a major reason for boating locally.

Water clarity related predominantly to feelings that the water that was not clear was simply not pleasant enough to recreate in. A boater from Pella offered such a sentiment; "I usually avoid going on the water when the water's scummy or doesn't smell good." Many focus group participants related problems with water clarity to presence of aquatic weeds, although not many of them differentiated between native and non-native weeds. The only positive effect of aquatic nuisance species that was discussed frequently in the boater focus groups was the ability of zebra mussels to improve water clarity. In this sense, the economic effects of zebra mussels seem more ambiguous than the effects of a species such as Asian carp. It is difficult to weigh the increase in boating from water clarity against the decrease from jagged shells on beaches; different people are bothered by each influence on boating behavior. Also, the mere presence of weeds or the zebra mussels rarely prevented boating altogether; the problem needed to reach some threshold to threaten to reduce activity.

Because two of the three towns in which the boating focus groups were located have economies heavily dependent on tourism, it seemed natural that presence of a ***tourist culture*** affected the ways in which aquatic nuisance species could influence boating behavior. The participants in the focus groups were permanent residents of the towns where the groups were conducted, but these residents were able to offer informed opinions about tourist behaviors from years of interaction with those who frequent their town. Tourists are a mobile population that may like a certain location, but if conditions change only slightly in an unfavorable direction, the tourists are able to find a new place to recreate. Changes in resource quality, thus, will likely affect tourists differently from local residents who boat. The focus group participants widely agreed that tourist culture affects boating behavior by making the boating population more mobile, more willing to switch location, than resident boaters are. A boater from Alexandria Bay, concerned about declining tourism in his town, suggested:

> We're really tourism-based here and we draw from all around the country…You see a lot of boats coming up Route 81, the main corridor. Those people may go elsewhere. So if we have major changes, whether they're coming here to go water skiing, they're coming here with their jet skis, or they're getting hit with Asian carp or whatever that's coming into the Great Lakes, they may take their boating someplace else…It'll affect the economy big time.

Multiple quotes have already been presentedrelated to ***health / safety***, in addition to the other influences with which they were associated. This factor covered concerns about personal and family well being, and the viewing of potential dangers as either a constraint that prevents boating or makes it undesirable. A motor boater from Alexandria Bay emphasized the importance of safety in relation to potential introduction of Asian carp:

> We'd have to design a whole new boat. We'd have to have a cage around it. You'd have to have a football helmet on and armored plating on to ride your jet ski. I don't think I want to get hit by a 30 pound carp going 40 miles an hour. It'd probably break your neck. It would probably decapitate you.

Visual beauty was cited when interviewees discussed how the aesthetics of a place can lead them to recreate in one location versus another. An example comes from the previous quote of the Put-in-Bay boater that estimated how visual problems can drive tourists away most quickly. Kayakers from Pella mentioned that they drive over an hour several days a week to kayak on a lake with stunning palisades. If flying fish (Asian carp), jagged shells on beaches (zebra mussels), or unpleasant weeds thickly covering the water damage the aesthetics of a location, several boaters indicated their willingness to stop recreating of find somewhere else to boat.

Cost / gas usage is basically the same influence as it was in the angler interviews. Interviewees mentioned reducing or (on rarer occasions) stopping boating if the price of gas or other traveling expenses became too high. Again, it has the potential to reduce boating or to displace boating so that economic benefits associated with this form of recreation accrue to different towns, villages, and regions.

Other Influences on Boating Behavior Not Linked to Aquatic Nuisance Species

As with the angler interviews, and for many of the same reasons, ***weather***, was an often-cited influence on boating behavior. A Pella boater explained how weather affects the location of his boating, and his means of access:

> Lake Red Rock is big enough that if you're going to boat in a power boat, you boat basically on the side of the lake where the wind is coming from. In the summertime, typically the wind's coming from the southwest, so we have a tendency to use the ramps or boat across because the swells can get a pretty good size.

Responding to Change

Despite some boaters flat out stating that they would quit boating altogether or cease certain types of boating activities in the presence of Asian carp or aquatic weeds / algae, many discussed their willingness to adapt or substitute a new activity or location for their current ones. A frequent recreational boater and charter boat captain from Alexandria Bay stated:

> The communities along the river and the lakes, they've always adjusted, they've always adapted. And we will continue to. There's no part of my brain that thinks we'll fold up our tents and go away if the Asian carp comes. We'll find a way to adapt to it. It'll be miserable and it's gonna be an expensive thing, but…the only thing that we've had control of is how we respond to it, and how we adapt to it.

A boater from Pella similarly explained how Asian carp may also be something to which local residents could adapt, in the way that others have already adapted:

> Some of my friends live in Quincy, Illinois, right there on the Mississippi, they just hear all the time that their friend is out boating and all of a sudden they get hit by a fish, because there's a ton of them down there. So it's just a nuisance for them, just normal.

While many boaters exhibited a willingness to adapt or to substitute different activities or locations for currently used ones (this capacity was mentioned 38 times in the boater interviews), the focus groups revealed that this willingness might vary based on the type of activity in which boaters engage. On sixteen occasions across the three focus groups, boaters stated that the influence of the aforementioned factors on their behavior would depend upon the type of boating activity in which they were engaged. One boater at Pella described how the effects of Asian carp on sailors and kayakers versus motor boaters may be different; "My guess for the paddlers and the sailors is it would probably not be that big an issue." After this statement, many other kayakers and sailors chimed in, only half jokingly, expressing that Asian carp may be a good thing if these fish limited the number of motor boats on the lake. A motor boater from Pella underscored the potential effects of Asian carp on family outings; "For family activities, if you're skiing, knee boarding, or tubing, most of that is with families. If it's not safe, you're not going to do it. They'd have to stop." A boater from Put-in-Bay, however, questioned the extent to which one could escape the effects of Asian carp; "I wonder what the option's going to be if you've got those big fish jumping into your boat. That's not location specific."

Beachgoers

These three focus groups included a range of beachgoers. A majority of participants used beaches for swimming, but many also cited using the beaches as entry points for boating (particularly kayaks and small sailboats), as places to bring their children (who would often be swimming), as locations to hike, to relax, to play volleyball, and to walk one's dog. Aquatic nuisance species were cited as potentially affecting each user group, but for different reasons. Some of these differences are highlighted in the paragraphs that follow. Of the 35 factors identified for the beachgoer transcripts, this report lists and explains each factor that was cited at least ten times across the three focus groups (see Table 4).

Effects of Aquatic Nuisance Species on Beachgoer Behavior

Asian carp, which were cited 45 times as affecting beachgoing behavior, influenced behavior by causing many interviewees to express that they would avoid beaches and the water if carp were present, because they viewed the carp as scary, unsafe, or generally repulsive. One woman from Chicago, Illinois, simply stated, "It would definitely affect - Asian carp in Lake Michigan - I would never go in the water." Another person at that same interview explained how Asian carp could drive one away from beaches, or a town, even if the primary use of the water is not for swimming:

> When we're playing volleyball, we do use the water. We're not really swimming, but we always go in to clean off and to cool down. I think that depending on the level and the number of carp swimming around, I would cease to do that, and that would probably slow me down from wanting to go to the beach. And to be honest, a long term effect would probably be me not wanting to stay in Chicago. I stay here only because of the summers. There's really nothing else holding me back from moving to Denver, California, or somewhere else.

While most of the reactions to Asian carp were not so intense, many focus group participants noted that the carp would make them reconsider beach activities on some level. A man from Traverse City, Michigan, explained how Asian carp might affect beach use, even if they have little actual effect on the types of activities in which beachgoers engage; "I think it would be a negative impact on the beaches too, at least initially, just because of the unknown."

Zebra mussels, the second most cited aquatic nuisance specie affecting beachgoing behavior, with 29 citations, played a unique role in revealing how aquatic nuisance species affect beachgoing behavior. For the vast majority of the participants at the three focus groups, zebra mussels were the only aquatic nuisance species with which they had substantial direct experience. Many beachgoers had dealt with the issue of zebra mussels for over a decade. The most common concern about zebra mussels related to cutting one's feet when walking on a beach or in shallow water. Yet, a large majority of the participants expressed their readiness to adapt to the new beach conditions. For example, a beachgoer from Traverse City cited a similar concern to the previously quoted boater from Put-in-Bay, the thought that visual effects are more important than things such as zebra mussels:

> I think what will keep me from going to beaches is anything that is unsightly that detracts from the whole experience. I can walk on those types of shells - zebra mussels with shoes, but weeds are unsightly; it's just not a good experience.

As in the boater focus groups, both native and exotic aquatic weeds and algae were cited as affecting beachgoing behaviors (24 citations). Interviewees mentioned how weeds limited the areas where they could physically boat. A sailor from Minneapolis recalled, "It does inhibit the areas you can sail on [Lake] Calhoun. There's a big shallow area that you can't use; you can't sail through in the summertime." Another Minneapolis participant detailed the more common reaction to aquatic weeds and algae, that they simply make spending time on/in the water unpleasant:

> I mentioned we were down in southern Minnesota kayaking on this lake, and it was scummy and nasty and we won't go back there. So I don't know how much scum there has to be there before you do not go back. Well, when we were there it was scummy enough not to return.

Table 4: Most Cited Influences on Beachgoing Behavior

Influence (factor)	Number of times cited in beachgoer interviews
Water clarity †	34
Health / safety †	22
Visual beauty †	22
Seasonality of use	21
Yuck factor †	17
Distance from home	16
Access	14
Fear / unknown †	12
Pollution	12

† These factors are those that the researchers identified as potentially most closely linked with the effects of aquatic nuisance species.

Factors Closely Related to Potential Effects of Aquatic Nuisance Species

Water clarity, which was an influence on fishing and boating behavior, played a heightened role in the beachgoer interviews. Sometimes water clarity was an influence thatencouraged the focus group participants to use a body of water, due to being very clear, or dissuaded them from using it, due to murky waters or high levels of sediment. Low water clarity made some interviewees feel unclean, it caused others to feel unsafe, either for themselves or for their children. A man from Chicago explained, "The visibility of the water – we were talking about that today. That's a big thing. Like, I'm swimming and it's really muddy, and kind of scary, there might be something down there. I won't be able to see the Asian carp."

Concerns about ***health and safety*** were, as in the boating interviews, once again a frequently cited influence on behavior. The reasons for health and safety being a concern were similar – interviewees stated that they would not want to expose themselves, and particularly their children, to harm potentially caused by aquatic nuisance species. A beachgoer from Traverse City clearly expressed this sentiment; "If there's a potential for my kids to be hurt or me to get hurt by big fish, by swimming out on my favorite beach, there's going to be one less beachgoer."

The aesthetics or ***visual beauty*** of the beaches and water was again an often-cited factor that made people want to use the beaches, or led them to choose one location over another. A woman from Chicago shared this outlook:

> I see that water everyday, and when I get frustrated with work, I turn around and that's what I look at. I want to keep seeing that. … When tourists come to town and you take

> your friends up to the 96 Lounge in the John Hancock Building, it's to look at the water. It's what you can see from all the buildings around Chicago. It's our mountains.

While the factor termed ***"yuck factor"*** did surface in the boater interviews, it was not mentioned frequently enough to rise into the top cited influences on behavior. In the beachgoer focus groups, participants repeatedly mentioned that they had avoided areas, or, in the future, would avoid areas for recreating, because the locations are gross, nasty, unpleasant, scummy, etc. People referred to both visual and olfactory offenses. A beachgoer who also kayaks in Minneapolis stated why she no longer kayaks in certain areas, "There'd be like floating algae in the water so thick that trying to kayak through it was just nasty." A woman from Traverse City expressed her frustration with dealing with what she considered to be unpleasant fish:

> My answer to your question about what would stop me from going is if I'm out at West Bay and the Asian carp are jumping, I'm done. There are certain things that I just can't - as much as I love to swim, I just can't.

In the discussion above of the influences of Asian carp and water clarity on beachgoing behavior, it is evident that some people were willing to discontinue beachgoing activities, to engage less frequently, or to switch to new locations because they found the fish to be scary or were uncertain of how the fish may affect them. ***Fear*** and the ***unknown*** drove them away. A Traverse City beachgoer put this matter quite plainly; "I'm more of an alarmist, and I'm more fearful of the Asian carp. … Asian carp scare the daylights out of me."

Other Influences on Beachgoer Behavior Not Linked to Aquatic Nuisance Species

Seasonality of use is a factor that refers to both temperature and weather constraints that prevent people from engaging in certain forms of beach recreation at particular times of year, but also to attitudes about when particular forms of recreation are most enjoyable. After describing how she swims only seasonally, a beachgoer from Minneapolis described how she can use the beaches for other activities twelve months each year; "Walking, I'm probably out on the Mississippi River three to four days a week. Already been down there early spring. Dog's been in the water. I do that year round."

Distance from home was another factor that appeared in the angler and boater focus groups, but that did not rise to the top of the list of most cited factors. The closer to home a beach is, the more likely one is to use it. This seems intuitive, but several interviewees shared the more nuanced assertion that they may be willing to travel farther for certain activities, but not for others. People who could carry their boats from their homes to the water mentioned that if this were not the case, their amount of boating may decrease considerably. A kayaker from Minneapolis offered, "One is proximity. We live by [Lake] Calhoun. [Because] the three lakes of Cedar, Calhoun, and Harriet are connected, we run those lakes and Minnehaha Creek and kayak because we can just walk our kayaks down there." A beachgoer from Traverse City explained that dog walking on the beach is not an activity for which one will generally get into a car and drive:

> I agree 100%. I have a dog I walk probably about 5 times a week on the beach, and I use what's closest to me. It makes a difference what's in your neighborhood. If you can walk it, it's that much greater.

While distance from home is classified as a factor not closely linked with aquatic nuisance species, some interviewees did make the assertion that they would likely go to the beach less, particularly for certain activities (such as dog walking) if beaches by their home became undesirable due to aquatic nuisance species.

A top influence on fishing behavior, ***access***, reemerged in the beachgoer focus groups as important, and was manifest in similar ways. A beachgoer from Minneapolis, for example, explained how the infrastructure locally promotes beach usage:

> Minneapolis has a wealth of walking trails around the lakes or around the rivers. They have boat ramps - when I say Minneapolis I just mean the metropolitan area - they have much greater infrastructure here than almost any other place I've ever been as far as the amount of different things you can do on the water.

Pollution influenced beachgoing behavior for reasons of health / safety as well as connection to the yuck factor. People expressed that they would find a new location or stop swimming altogether if pollution got bad enough. Particularly in Chicago, pollution referred to anthropogenic introductions into the water such as trash and sewage. In Traverse City, dead fish and birds washing up on the shores was a form of pollution that drove beachgoers away.

Responding to Change

The focus group participants' proclivity to adapt their behavior or substitute other locations for recreation, in light of potential threats to current practices, was cited 46 times across the three focus groups. Many interviewees did cite various factors that would lead them to stop certain types of beach recreation altogether, but as in the boating and fishing interviews, a perspective of resilience seemed to be more prominent. A beach volleyball player from Chicago explained how she would likely respond to Asian carp:

> If I have a job here, and I can't leave tomorrow, and all of a sudden Asian carp came in, I'm probably still gonna play beach volleyball. It's gonna suck, and I'm gonna hate it, and I might even be looking for other jobs, but you're gonna get used to it.

The idea that people may be able to deal with the effects of aquatic nuisance species, but that it would lead to a diminished experience, was prevalent in all three interviews. A beachgoer from Minneapolis offered a similar sentiment with respect to swimming and kayaking from local beaches, if aquatic nuisance species were to arrive; "You do it at the same time just as much, but bitch about it."

While the previous two quotes speak to anticipated reactions, several interviewees also spoke of how they have already adapted to other aquatic nuisance species, such as zebra mussels:

> My family has a portable basket of shoes. Of every different size for every single town. We addressed that idea probably ten years ago downstate, and this basket just goes with us. It's not a pretty sight, but it's just - we've adapted because of the zebra mussels. So we would never exclude a beach because of the zebra mussels, we'd just adapt accordingly.

It is important to note that most of the focus group participants perceived there to be a number of locational substitutes for where to recreate. No beachgoer indicated so strong an attachment to a single beach that he/she was unwilling to also use other beaches. Having multiple locations available increased the participants' willingness to adapt by using different beaches. A Traverse City beachgoer explained, "We have the luxury of going to another beach, or going inland to a lake. What is Chicago going to do? They just got one main strip there in terms of beach." Despite this concern for Chicago, several of the Chicago participants expressed the belief that they have access to a diversity of locations. One interviewee, however, questioned whether the average beachgoer in Chicago may share this perception. Speaking to the other interviewees, he explicated:

> So you're able to make your decision based on knowledge of how [ecology] works. But, I don't know one beach from another or what types of beaches are better for what types of bacteria or weeds. So my natural reaction is to say, "It's not the beach that's bad, it's Lake Michigan that's bad." Because, it's all the same lake.

Beachgoers like this man would have lower substitutability than the other interviewees; they would be more likely to avoid beachgoing altogether, should a problem or threat emerge.

V. Conclusion

Effects of Aquatic Nuisance Species on Fishing, Boating, and Beachgoing

Aquatic nuisance species have potential to influence many of the factors cited as affecting angler, boater, and beachgoer behavior. For example, catch rate and fish size were vastly important factors affecting angler behavior (and, to a slightly lesser extent, boater behavior) that could be influenced by the effects of aquatic nuisance species. Likewise, water clarity, personal and family health and safety, and visual beauty, were central factors affecting boater and beachgoer behavior that could be affected by aquatic nuisance species. For each recreation group, there also were additional important factors affecting behavior that are unrelated to aquatic nuisance species. Weather, seasonality of recreation, and access were key factors affecting behavior across all three user groups that have little to no connection to the effects of aquatic nuisance species. In each user group (i.e., anglers, boaters, and beachgoers) the factors that were cited most often by focus group participants as affecting fishing, boating, and beachgoing behavior were related to the potential effects of aquatic nuisance species.

Because aquatic nuisance species could affect many different factors that influence recreational behavior for each user group, and because some of those factors top the list as the most often referenced factors affecting behavior, introduction of aquatic nuisance species into new areas could be expected to have noticeable impacts on anglers, boaters, and beachgoers. Most of these impacts would be negative, such as limiting the number of locations in which recreation is desirable, causing some forms of recreation to become more difficult, less fun, or less safe, and perhaps leading some people to forsake certain activities altogether. Nevertheless, a few impacts from aquatic nuisance species could be positive. For example, the increased water clarity provided by zebra mussels appealed to many of the focus group participants. This, combined with the fact that many people had learned to adapt to the jagged shells left on beaches from zebra mussels, could mean that some aquatic nuisance species may not be much of a nuisance; perhaps, rather, they can benefit certain anglers, boaters, and beachgoers.

Responding to the Effects of Aquatic Nuisance species

Even though the focus group participants seemed to be affected primarily negatively by aquatic nuisance species, people's behavior changes that accompanied the effects of nuisance species frequently showed resilience and willingness to adapt rather than a level of concern or frustration that would lead to disengagement from an activity. Substituting different locations or activities for current ones was a frequently cited approach to dealing with aquatic nuisance species. Several of the quotes from the results section indicate that if anglers, boaters, and beachgoers needed to, they would drive father, spend more, or work more diligently to access places to recreate. Others mentioned that they would deal with these species simply by continuing what they do today, but being less happy about it. The mindset that one can and must adapt was particularly manifest in the beachgoer and boater focus groups, but it was also prominent in the angler focus groups. Recreationists repeatedly asserted that they would adapt and continue to recreate, even if it left them with a diminished experience. However, if the locations in which recreation occurs start to shift, local economic effects could be much more pronounced.[1]

[1] When discussing the potential impact of aquatic nuisance species on recreationist behavior, it must be noted that the focus group participants in this study were mostly dedicated anglers, boaters, and beachgoers. These participants may not be (and, actually, are likely not) representative of anglers, boaters, and beachgoers in general in the areas where the research was conducted. The people who participated in the focus groups volunteered. The participants who attended were commonly more avidly attached to their form of recreation than others who also recreate in similar ways. In some instances, this difference could make the impact of aquatic nuisance species less severe for less avid recreationists. Reduction in catch rate or elimination of a favorite beach or boating area may not pose as large of an inconvenience. On the other hand, people who are not so passionately enthusiastic about their form of recreation may be more willing to stop altogether, rather than to adapt and substitute when an aquatic nuisance species changes their attitudes about recreating or constrains recreation possibilities.

Participants were more likely to adapt to some factors than others. For example, while water clarity and health/safety both played a prominent role in the boating and beachgoing interviews, lack of water clarity generally made people less likely to use, or more apprehensive about using, a water source for their preferred recreation. The health/safety influence, however, generally caused people to state flat out that they would not recreate in a certain way or place anymore. Therefore, while water clarity was mentioned more frequently in the last two sets of interviews, the health/safety influence may actually have a more lasting and detrimental effect on limiting recreation. When examining the effects of an influence, it is, therefore, important to consider not only the number of people who consider it to be a problem, but also whether it will cause those people simply to pursue their activity on the next lake, or to stop an activity entirely.

The “yuck factor” was another influence that seemed to have a powerful capacity to drive people away from recreation entirely. Whether it was bad aquatic weeds or nasty Asian carp, people indicated that these influences could cause them to quit recreating completely. Of course, the effects of Asian carp were a hypothetical for nearly all of the focus group participants. Therefore, it would be interesting to see whether and how attitudes might change over time. It is possible that certain aquatic nuisance species may make people want to discontinue their behavior, and may actually lead to a temporary break in that behavior, until they observe, either through mass communication, interpersonal conversation, or their own experience, that the effects are not as bad as they anticipated. Even very strong attitudes may change over time if people come to believe that the effects of an aquatic nuisance species are different than they anticipated. Such a change seems more likely than the change in an attitude itself. For example, if Asian carp were to decimate native fish populations, anglers that care greatly about high catch rates could continue fishing if they changed their attitudes to simply want less fish, or different types of fish. This type of attitude change might be more difficult or take longer time than learning more about the effects of a nuisance species.

Synthesis

In conclusion, aquatic nuisance species seem to have the capacity to affect fishing, boating, and beachgoing behavior in a wide range of ways, directly and indirectly. Some of the effects of aquatic nuisance species, and Asian carp in particular, can be expected to cause some individuals to cease certain forms of recreation. Children specifically may be engaging in less fishing, boating, and beachgoing if their guardians know that Asian carp are present. Many interviewees, nonetheless, demonstrated a strong resiliency and willingness to adapt to whatever new conditions arise. Very few interviewees disagreed, however, that the presence of Asian carp and other nuisance species would lead to a diminished recreational experience. Those who were not overly concerned about the presence of the giant fish generally responded with the half-hearted comment that even if it affected others badly, their form of recreation would be less affected. The vast majority of the focus group participants identified themselves as people who care not only about recreating, but about the greater ecosystem in which they live. The interviewees were not concerned simply about their own diminished experience, but also about the diminished beauty and diversity of the natural world.

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Appendix A: Interview Guide for Angler Focus Groups

Recreational Impacts of Aquatic Nuisance Species to the Great Lakes and Mississippi River Basins

Focus Group Interview Guide

1. Introductory Script

Statement of Purpose

Cornell University is conducting this study in cooperation with the United States Army Corps of Engineers to evaluate the effects of aquatic nuisance species on recreation in the Great Lakes and Upper Mississippi River Basins. The purpose of the focus group is to help us understand how recreational anglers make their choices about fishing – where they fish, what types of species they fish for, and how their fishing might change if the types of species that are available changed. Your ideas will help us to determine how anglers would be affected if aquatic nuisance species affected the types of fish that anglers could catch.

We will ask a series of questions for discussion, with no right or wrong answers. For most of these questions, we'd like you to answer in an open discussion. We may follow up with additional questions in response to particular points individuals raise. All perspectives are important. There are no right or wrong answers. We may check in with different individuals occasionally to find out if they agree or disagree with points that have been made.

Participation in this focus group is voluntary. You do not have to participate if you don't want to. You may also refuse to answer specific questions. There is no penalty to you if you decide that you do not want to complete the focus group.

Your identity will remain completely confidential. No one but the researchers in this study will be able to associate your responses with your name. We will not report results in a way that would allow other people to determine who made particular comments to us. We may use direct quotations from some people in reports or publications, but we will delete any information that could be used to identify specific people before we do. The session will be audio-recorded and the recording will be transcribed.

2. Focus Group Questions

Opening Statement

Let's start by going around the table and have everyone introduce themselves.

Introductory Questions

First, I would like to ask you about your fishing preferences, addressing where you fish, how you fish, the species you pursue, and how often you fish.

1. Where do you go fishing? Where do you prefer to fish? Great Lakes? Inland lakes? Rivers and streams? Other locations?
2. What particular species do you fish for?
3. How do you go fishing? From a private boat? A charter boat? Shore? Pier? Other places?
4. How often do you usually go fishing?

Transition Questions

At this point, I would like to ask you about the reasons why you choose to go to particular fishing sites regularly over others.

1. What are your reasons for going to the site you most regularly fish? What about your favorite fishing sites?

    a. The particular species that are available? The number of fish you catch? The size of the fish? The condition of the fish? To find edible fish? Good water quality? Natural beauty? Peace and quiet? b. What kinds of features are important for you to have at your fishing sites? How important is it for you to have access to a boat ramp? To a bridge, pier, or beach?

    c. How convenient is it for you to get to the locations you prefer? How far away are these locations? How long does it take you to get there? How much does it cost you? Do you have to pay any access fees? Other costs? How much does cost matter?

d. How important is it to you to go fishing with particular people? Who do you prefer to fish with?

e. How long have you been going to the locations that you fish the most?

We have talked about the reasons why you choose to go to particular fishing sites regularly. I would like to understand a bit more about the importance of these reasons.

2. What is/are the most important factor(s) of all in choosing that specific location? What is/are the least important factor(s)?

We've been talking up until now about the reasons you choose particular fishing sites. But there also might be times when you are thinking about going fishing somewhere but decide NOT to fish at a particular spot or for a particular species. Maybe you choose a different spot or maybe you decide not to go fishing at all. We'd like to understand some of the reasons why you choose NOT to go fishing at some sites or for some species. (spot.)

3. When you decide not to fish at a specific location, what is the most important reason for not fishing there?
4. When you decide not to fish for specific species, what is the most important reason for not fishing for those species?
5. When you decide not to fish from shore, private boat, charter, or pier, what is the most important reason for not fishing from there?

Key Questions

1. Over the past 10 years, how has the type of fishing you do changed? Locations you fish? Species you fish for, how often you fish, or where you fish from? If you have made changes, can you tell us a bit about the reasons you've changed the type of fishing you do?

One of the things we're interested in is whether anglers might do things differently if there were changes in the species they fished for.

2. How would your fishing change if you only caught your preferred fish species about half as often as you do now at your favorite fishing sites (i.e., in your favorite spot it took you

twice as long to catch the same number of fish)? No change? Stop fishing? Or fish less frequently? (Or more frequently?) Fish for different species at the same location? Change where you fish from: shore to boat or vice versa? Fish at other locations for the same species?

3. How much would your catch rate have to decline to get you to stop fishing at that location altogether?
4. What would you do if the fish you caught were on average a lot smaller than those you usually catch now at your favorite fishing sites? No change? Stop fishing? Or fish less frequently? (Or more frequently?) Fish for different species at the same location? Change where you fish from: shore to boat or vice versa? Fish at other locations for the same species?
5. How small would the average fish have to get for you to stop fishing at that location altogether?

Ending Questions

One of the things we wanted to learn from you is how the way you fish might change if the species you like to fish for weren't as common or were smaller. We've talked about a lot of different things you might do.

1. Is there anything we haven't talked about that you think is important for us to know?

If you're interested in receiving a copy of the report we prepare based on this study, provide me with your address or email address. (*Provide them with my business cards.*)

THANK YOU!

Appendix B: Interview Guide for Boater Focus Groups

Recreational Impacts of Aquatic Invasive Species to the Great Lakes, Upper Mississippi River, and Ohio River Basins

Focus Group Interview Guide - Boaters

1. **Introductory Script**

Statement of Purpose

Cornell University is conducting this study in cooperation with the United States Army Corps of Engineers to evaluate the effects of aquatic invasive species on recreation in the Great Lakes, Upper Mississippi, and Ohio River Basins. The purpose of the focus group is to help us understand how recreational boaters make choices about where they boat, what types of experiences they seek, and how their recreation options and behaviors might change if conditions changed in the lakes and rivers they use. Your ideas will help us to determine how recreational boaters would be affected if aquatic invasive species were to influence the conditions in lakes and rivers where you boat.

We will ask a series of questions for discussion, with no right or wrong answers. For most of these questions, we would like you to answer in an open discussion. We may follow up with additional questions in response to particular points individuals raise. All perspectives are important. We may check in with participants occasionally to find out if they agree or disagree with points that have been made.

Participation in this focus group is voluntary. You do not have to participate if you do not want to. You may also refuse to answer specific questions. There is no penalty to you if you decide that you do not want to complete the focus group.

Your identity will remain completely confidential. No one but the researchers in this study will be able to associate your responses with your name. We will not report results in a way that would allow other people to determine who made particular comments to us. We may use direct quotations from some people in reports or publications, but we will delete any information that could be used to identify specific people before we do. The session will be audio-recorded and the recording will be transcribed.

2. **Focus Group Questions**

Opening Statement

Let us begin by going around the table and introducing ourselves.

Introductory Questions

First, I would like to ask you about your boating preferences, addressing where you boat, how often you go boating, any other activities you may engage in while boating, and what kind of boat you use.

1. How often do you boat?
2. Where do you go boating? Great Lakes? Inland lakes? Rivers? Other locations?
3. What else do you do when you boat (e.g., swim, water ski, fish, etc.)?
4. What type of boat do you use? (Tell me about your boat(s).) Kayaks, canoes, small sailboats, cruising yachts (motor or sailing), fishing boats with motors, speed boats? Do you own, borrow, or rent the boat?

Transition Questions

At this point, I would like to ask you about the reasons why you choose to go to particular recreation sites regularly over others.

1. Do you boat in many different places, or do you tend to go to a single place or a few places fairly often?
2. What are your reasons for going to the site where you most regularly boat? What makes your favorite site special and/or unique?

    a. The types of activities you can engage in there? The number of other people using the site? The size or shape of the body of water? The water quality? Presence of desired facilities? Natural beauty? Peace and quiet?

    b. What kinds of features are important for you to have at your boating sites? How important is it for you to have access to a boat ramp, marina, moorings, a yacht club, beach, waterfront restaurants, or other amenities?

c. How convenient is it for you to get to the locations you prefer? How far away are these locations? How long does it take you to get there? How much does the amount of time it takes to get there matter to your decision?

d. How much does it cost you to arrive at and boat at the location(s) you prefer? Do you have to pay any access fees? Other costs? How much does cost matter?

e. How important is it to you to go boating with particular people? With whom do you usually boat?

f. How long have you been going to the locations where you boat the most?

We have discussed the reasons why you choose to go to particular boating sites regularly. I would like to understand a bit more about the importance of these reasons.

3. What is/are the most important factor(s) of all in choosing that specific location?

Key Questions

1. Over the past 10 years, how has the type of boating you engage in changed? Locations you boat? Type of boats you use? If you have made changes, please tell us about the reasons you have changed.

One of the things we are interested in is whether recreational boaters might do things differently if there were changes in conditions of the lakes and rivers they use.

2. How would your boating change if:
    a. You had to deal with thick mats or beds of aquatic plants/weeds in areas you like to boat?
    b. If water clarity increased or decreased?
    c. If jumping fish (carp) were present that could hit you or your boat while boating?
    d. If jagged shells lined the water's bottom?
    e. If areas you like to swim had higher levels of parasites that could affect humans?
    f. If more bacteria that could make you sick were present in the water?

No change? Stop boating? Go boating less frequently? Pursue different activities at the same location? Change the type of boat you use? Go boating someplace else?

3. At what point would these effects cause you to stop boating at that location altogether?
4. How would your boating change if access points or bodies of water that you use for boating were closed?

    Stop boating? Recreate less frequently? Engage in the same activities at another location? Other?

5. How would your boating change if there were increased regulations for preventing movement of aquatic invasive species?
    g. What if you had to clean your boat each time after hauling it?
    h. What if the boat had to be inspected before/after using it?
    i. What if you were not allowed to transport your boat between certain bodies of water?
6. Can you think of any other factors that may cause you to stop boating, or cause you to go boating noticeably less frequently?

Ending Questions

Our primary interest is to learn from you how you might change your boating preferences if the condition of the lakes and rivers you use were to change due to presence of aquatic invasive species. We have talked about several different things you might do.

1. Is there anything we have not talked about that you think is important for us to know?

If you are interested in receiving a copy of the report we prepare based on this study, provide me with your address or email address. (*Provide them with business cards.*)

THANK YOU!

Appendix C: Interview Guide for Beachgoer Focus Groups

Recreational Impacts of Aquatic Invasive Species to the Great Lakes, Upper Mississippi River, and Ohio River Basins

Focus Group Interview Guide – Swimmers and Beach Users

1. Introductory Script

Statement of Purpose

Cornell University is conducting this study in cooperation with the United States Army Corps of Engineers to evaluate the effects of aquatic invasive species on recreation in the Great Lakes, Upper Mississippi, and Ohio River Basins. The purpose of the focus group is to help us understand how recreational swimmers and beach users make choices about where they swim and enjoy beaches, what types of experiences they seek, and how their recreation options and behaviors might change if conditions changed in the lakes and rivers they use. Your ideas will help us to determine how recreational swimmers would be affected if aquatic invasive species were to influence the conditions in lakes and rivers where you swim.

We will ask a series of questions for discussion, with no right or wrong answers. For most of these questions, we would like you to answer in an open discussion. We may follow up with additional questions in response to particular points individuals raise. All perspectives are important. We may check in with participants occasionally to find out if they agree or disagree with points that have been made.

Participation in this focus group is voluntary. You do not have to participate if you do not want to. You may also refuse to answer specific questions. There is no penalty to you if you decide that you do not want to complete the focus group.

Your identity will remain completely confidential. No one but the researchers in this study will be able to associate your responses with your name. We will not report results in a way that would allow other people to determine who made particular comments to us. We may use direct quotations from some people in reports or publications, but we will delete any information that could be used to identify specific people before we do. The session will be audio-recorded and the recording will be transcribed.

2. Focus Group Questions

Opening Statement

Let us begin by going around the table and introducing ourselves.

Introductory Questions

First, I would like to ask you about your preferences related to beaches and swimming, addressing where you swim, what additional activities you pursue when swimming (e.g., sunbathing, playing beach sports, boating), and how often you pursue each activity.

1. How often do you go to beaches or go swimming?
2. Where do you go swimming? Great Lakes? Inland lakes? Rivers and streams? Other locations?
3. What else do you do when you swim (e.g., sunbathe, play beach sports, use watercraft, etc.)?
4. How often to pursue these other activities when swimming or at beaches?

Transition Questions

At this point, I would like to ask you about the reasons why you choose to go to some swimming sites or beaches regularly over others.

1. Do you swim in many different places, or do you tend to go to a few places fairly often?
2. What are your reasons for going to the site where you most regularly swim? What makes your favorite site special and/or unique?

    a. The types of activities you can engage in there? The number of other people using the site? The size or shape of the body of water? The condition/quality of the water? Presence of desired facilities? Natural beauty? Peace and quiet?

    b. What kinds of features are important for you to have at your swimming sites? How important is it for you to have access to sandy beaches, lifeguards, sports fixtures (e.g., a beach volleyball court), diving platforms, nearby restaurants or concessions, or other amenities?

c. How convenient is it for you to get to the locations you prefer? How far away are these locations? How long does it take you to get there? How much does the amount of time it takes to get there matter to your decision?

d. How much does it cost you to arrive at and swim at the location(s) you prefer? Do you have to pay any access fees? Other costs? How much does cost matter?

e. How important is it to you to go swimming with particular people? With whom do you usually swim?

f. How long have you been going to the locations that you swim the most?

We have discussed the reasons why you choose to go to particular swimming sites regularly. I would like to understand a bit more about the importance of these reasons.

3. What is/are the most important factor(s) of all in choosing that specific location?

Key Questions

1. Over the past 10 years, how has your use of swimming sites or beaches changed? Locations you visit? Type of waterfronts you frequent? If you have made changes, please tell us about the reasons you have changed.

One of the things we are interested in is whether people who go to beaches or swimming sites might do things differently if there were changes in conditions of the lakes and rivers they use.

2. How would your use of these sites change if:
    j. You had to deal with thick mats or beds of aquatic plants/weeds?
    k. If water clarity increased or decreased?
    l. If jumping fish (carp) were present near your beaches and swimming sites?
    m. If jagged shells lined the water's bottom?
    n. If beaches and swimming sites had higher levels of parasites that could affect humans?
    o. If more bacteria that could make you sick were present in the water?

No change? Stop going to these sites? Go to the beaches and swimming sites less frequently? Pursue different activities at the same location? Engage in the same activities at another location?

3. At what point would these effects cause you to stop using that location altogether?
4. How would your use of swimming sites and beaches change if access points, beaches, or bodies of water that you use for swimming were closed?

   Stop swimming or using beaches? Swim or use beaches less frequently? Engage in the same activities at another location? Other?

5. Can you think of any other factors that may cause you to stop swimming or using beaches, or cause you to swim or use beaches noticeably less frequently?

Ending Questions

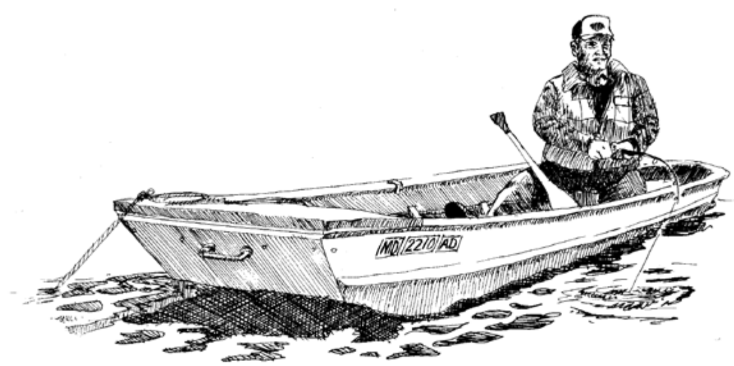
Our primary interest is to learn from you how you might change your use of swimming sites and beaches if the condition of the lakes and rivers you use were to change due to presence of aquatic invasive species. We have talked about several different things you might do.

1. Is there anything we have not talked about that you think is important for us to know?

If you are interested in receiving a copy of the report we prepare based on this study, provide me with your address or email address. (*Provide them with business cards.*)

THANK YOU!

Net Benefits of Recreational Fishing, Beachgoing, and Boating in the Great Lakes, Upper Mississippi River, and Ohio River Basins: A Review of the Literature



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HDRU Series No 12-2

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Executive Summary

This report reviews the recreational valuation literature on fishing, beachgoing, and boating in the Great Lakes, Upper Mississippi River, and Ohio River Basins. Its purpose is to determine whether the existing literature is sufficient to: (a) estimate the current net value of these activities in the study region; and (b) estimate how these values might change with the introduction of aquatic nuisance species (ANS).

Estimating the net value of a recreational activity requires: (a) an estimate of the average net value per day; and (b) an estimate of the total number of days taken to engage in that activity. In surveying the relevant literature, Cornell Univeristy (CU) adopted the following premises:

- No single study is sufficient to estimate a comprehensive net value of recreational fishing, beachgoing or boating in either the Great Lakes Basin or the Upper Mississippi and Ohio River Basins. Although a number of studies have estimated the net value per day for these activities, they have been limited in their geographic coverage. Because recreational values can be expected to vary in different parts of our study region, none of these existing individual studies can be used as an estimate of the average net value per day estimate for the entirety of either or both basins.
- However, if a sufficient number of studies is conducted within a region, even if each of those studies is limited in its geographic focus, these studies can, *considered as a set*, help determine the range of net values per day that might be expected for the region. This range of net values per day can be multiplied by the number of days users take part in the activity to approximate the total annual recreation net value.

The following conclusions were drawn with regard to estimating a baseline net value of recreational activities in the three basins:

- Too few studies of the net value of beachgoing and boating have been conducted within the study region to establish the range of net values per day of these activities. **Therefore, based on the existing literature, it is not possible to estimate the total annual net value of either beachgoing or boating in either the Great Lakes Basin or the Upper Mississippi and Ohio River Basins.**
- For the Great Lakes, however, a sufficient number of studies have been conducted to establish that the net value per day of recreational fishing likely falls between $20 and $75 ($2012). When the endpoints of this range are multiplied by the USFWS estimate of about 18 million angler days in the Great Lakes in 2006, it results in **an estimate of the aggregate annual net value of recreational fishing in the Great Lakes of $360 million to $1.35 billion ($2012)**.

- It is important to note that this range is an estimate of *net value*, which is distinct from other economic measures that may have been reported such as *expenditures* and *economic impacts*. Cornell reports net values in this report because, according to economic theory and Federal regulation, net value is considered the appropriate measure for assessing the benefits of public policy alternatives.

Estimating the change in net value of an activity in response to ANS requires estimates of how: (a) resource quality would change in response to ANS (e.g., the change in the numbers of fish that anglers would catch); (b) the average net value per day would change as resource quality changed; and (c) the total number of trips to engage in that activity would change. With regard to estimating how the net values of recreational activities would change if ANS were introduced:

- Insufficient evidence exists in the literature to address any of these questions and, consequently, **it is not possible based on the existing literature to estimate how the total annual net value of recreational fishing, beachgoing, or boating would change if ANS were introduced in to the Great Lakes and/or the Upper Mississippi and Ohio River Basins**

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I. Study Background

GLMRIS Background Information

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River basins by aquatic pathways.

An ANS is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (FY13).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: (a) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and (b) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential ANS;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users; and
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries.

GLMRIS Navigation and Economics Product Delivery Team

In support of GLMRIS, the Navigation and Economics Product Delivery Team (PDT) was formed. The PDT was tasked with assessing the current value of *economic* activities within the GLMRIS detailed study area that *could* change with the implementation (Future With Project (FWP) condition) or lack of implementation (Future Without Project (FWOP) condition) of a GLMRIS project. The PDT is comprised of several sub-teams, each of which focuses on a specific economic activity within the GLMRIS study area.

Fisheries Economics Team

The Navigation and Economics PDT's Fisheries Economics Team focused on fishing activities within the U.S. waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins (i.e., the GLMRIS detailed study area) that *could* change in the FWOP and/or FWP condition.

Five baseline economic assessments, which quantitatively or qualitatively describe the current economic activities dependent on fisheries, were developed. The reports focus on the following categories: commercial, recreational, charter, and subsistence fishing, as well as professional fishing tournaments. Each baseline assessment focuses exclusively on the specified fishing activity within the GLMRIS detailed study area – to include the U.S. waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins. It is imperative to note that collectively, these values do *not* represent a comprehensive value of these three basins. Each basin has further economic (e.g., non-use values) and environmental values that are not captured in this economic appendix. Rather, the fishing-related economic activities assessed by the Fisheries Economics Team serve as indicators of key aspects of the economy that could change in the future, with or without the implementation of a GLMRIS project.

Report Purpose

In support of GLMRIS, Cornell University (CU) was tasked, in part, with estimating the current net value of recreational activities that take place within the Great Lakes Basin (GL), and Upper Mississippi River and Ohio River Basins (UMORB) that could be affected by ANS transfer between these basins. Cornell University completed this review of existing literature to aid in the determination of which previously published studies of recreational fishing, beachgoing, and boating are potentially relevant to GLMRIS.

II. Introduction and Report Summary

Objectives of this Report

There are two specific objectives of this review:

> Objective 1: To assess whether the existing body of recreational valuation studies can be used to estimate the current net value of recreational fishing, beachgoing and boating for the Great Lakes and Upper Mississippi and Ohio River Basins, and
>
> Objective 2: To assess whether these studies can be used to provide estimates of how recreational values might change with the introduction of ANS.

The first objective focuses on establishing a baseline value of the recreational activities in the GLMRIS study area. The second objective is directed toward assessing how much this baseline value is likely to be affected by ANS. The values estimated in Objective 1 provide a conceptual upper bound for potential losses under Objective 2.

The region on which CU will focus in this report includes the watersheds within the following Great Lakes and Upper Mississippi and Ohio River Basins states: Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Kentucky, Michigan, Ohio, West Virginia, Pennsylvania and New York. It should be noted that most of the available literature for these activities in this region has been conducted in the Great Lakes "coastal" states. Consistent with USACE procedures and guidelines (USACE 1983), all dollar values reported in this review will be updated to FY $2012 using the consumer price index (CPI Value=226.889, USACE 2012), unless otherwise noted.

The following process was used to identify studies to be included in this review. First, CU examined existing recreational valuation databases (e.g., Loomis and Richardson, 2008; EVRI, 2002) and databases and literature reviews of valuation estimates for specific recreational activities (e.g., Boyle et al., 1998/1999; NOEP, 2012). These studies were supplemented with others identified in original web and journal searches for recreational valuation studies conducted within the study area. CU generally has not included estimates for studies for which the sample data used in the study were collected prior to 1985, due to concerns about the "shelf life" of recreational values and the substantial evolution of valuation methods since the mid 1980s.

As a preview of our findings, CU concludes that, with respect to establishing a baseline value for recreational fishing:

- There are several studies that estimate the value per day for recreational fishing in the Great Lakes. These estimates generally range from $20 to $75 per day ($2012 dollars).

Combining these estimates with an estimate of the total participation in recreational fishing generates an estimated aggregate value from recreational fishing in the Great Lakes of $360 million to $1.35 billion per year.

- There are fewer estimates of value per fishing day available for the Upper Mississippi and Ohio River Basins, and there are no available estimates of total fishing participation specific to these study basins, so it is not possible to generate a reliable range of estimates of aggregate value of recreational fishing for the entire study area.

The existing literature on the value of recreational activities in the Great Lakes and Upper Mississippi and Ohio River Basins is not sufficient for generating defensible estimates of the baseline value of beachgoing and boating in these basins.

- In the case of boating, there is information on the rate of participation (number of boating days) in the Great Lakes, but there are too few estimates of the recreational value per boating day to generate a reliable overall estimate of the aggregate value of this recreational resource.
- In the case of beachgoing, there are too few estimates of recreational value per beach day to generate reliable estimates for the aggregate value of this recreational resource, and there are no comprehensive estimates of total beachgoing participation (number of days) for either the Great Lakes or the Upper Mississippi and Ohio River Basins.

With respect to Objective 2, CU concludes that the existing literature is not sufficient to generate reliable estimates of the impact that ANS might have on the recreational values enjoyed by anglers, beachgoers, or boaters in the study area. The remainder of this report provides our evidence and logic for these claims.

Overview of Conceptual Foundations: Net Value

This report focuses on economic measures of the value of recreational fishing, boating and beachgoing in the Great Lakes, Upper Mississippi and Ohio River Basins, and on how those values might change due to inter-basin transfer of ANS. Consistent with USACE procedures and guidelines (USACE, 1983, 2000, 2012), the net (economic) value is defined as the amount that those recreational resources contribute to the Federal planning objective of national economic development (NED).

> "The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment**,** pursuant to national environmental statutes, applicable

> executive orders, and other Federal planning requirements… Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the Nation. Contributions to NED include increases in the net value of those goods and services that are marketed, and also of those that may not be marketed." (USACE, 1983, p. iv).

Because many different measures of the economic value of recreational activities have been reported in various outlets, it is important to distinguish the NED concept of net value from other, related measures that are often reported, such as "expenditures" and "economic impacts." The net value of a resource is the difference between the amount an individual would be willing to pay to access the resource and the amount that they actually have to pay for gasoline, lodging, entry fees, and food at the recreation site and other trip-related costs. For reference CU provides a brief discussion of the alternative measures of economic activity in the Appendix. The interested reader is also referred to Scodari (2009) and Aiken (2009) for further discussion.

Measures of net value are typically expressed as value per unit, such as net value per day of a recreational activity. The aggregate annual net value generated by a recreational resource is the average net value per day (or per trip) multiplied by the total number of days (trips) taken to engage in that activity. This is the appropriate measure of the annual net value generated by a recreational resource from a NED perspective for the purposes of Objective 1 of this review.

The issue of interest in Objective 2 is how the baseline net value might change as a consequence of inter-basin transfer of ANS. Here, a change in the quality of the recreational resource will typically affect both the net value per trip for that activity and the total number of trips taken to engage in that activity. For example, if fishing quality in a region were to decline as a consequence of an ANS, recreationists may continue their recreational activities at the site(s) they currently use, but get less satisfaction (and less net value) from each trip; they may choose to recreate at other sites that provide less net value than they previously enjoyed; they may choose to fish fewer times per year; or they may cease fishing altogether. The change in aggregate annual net value from the fishery would account for both the change in net value per trip and the change in total number of trips.

Overview of Conceptual Foundations: Methods of Valuing Recreation

Because most outdoor recreation activities are publicly provided, rather than being purchased from a private supplier, it is usually not possible to estimate either total value or net value directly from observed market data (USACE 2012). USACE recognizes alternative "non-market valuation" procedures "for estimating use and willingness to pay by means of travel behavior, user surveys, and other quantifiable measures" (USACE 2000, p. E-183). Three non-market valuation methods – the travel cost method, the contingent valuation method, and unit day values – are specified in USACE procedures and guidelines for estimating the net values of recreational activities and estimating how those net values change in response to water-related projects. To this CU adds two other methods widely used in contemporary project analyses, benefit transfers and meta analysis. CU briefly describes each of these methods below.

The *travel cost method* uses actual visitation data on the number of trips taken to a recreation site to estimate the net value of the resource and how that net value changes as the quality of the resource changes. The travel cost method works by comparing the number of trips taken to a site by people who live close to the site to the number of trips taken by people who live farther from the site. "The basic premise of the travel cost method is that per capita use of a recreation site will decrease as out-of-pocket and time costs of traveling to the site increase, other variables being constant" (USACE 2000, p. E-184). The total value per trip, net value per trip, and number of trips taken can be calculated for recreationists living different distances from the site and for sites with different resource quality.

Contingent valuation relies on survey questions about hypothetical behavior to estimate the net value of a resource or the net value of a change in resource quality: "The contingent valuation method estimates NED benefits by directly asking individual households their willingness to pay for changes in recreation opportunities at a given site." (USACE 2000, p. E-185). Depending on how the survey questions are structured, contingent valuation can be used to measure the total amount the recreationist is willing to pay for access to a site (total value), the amount the recreationist is willing to pay over and above the actual cost of visiting the site (net value), or the amount the recreationist would be willing to pay if a change occurred to the quality of the site (change in net value). The aggregate net value of the resource or of a change in the quality of the resource can be estimated by summing the individual net values for all users in the study area.

Often times, original estimates that use the travel cost method or contingent valuation are not available for a specific project. In such instances, a third approach identified by the USACE is the *unit day value* method.

> "The unit day value method relies on expert or informed opinion and judgment to estimate the average willingness to pay of recreational users. By applying a carefully thought-out and adjusted unit day value to estimated use, an approximation is obtained that may be used as an estimate of project recreation benefits" (USACE 2000, p. E-185).

The principles for using unit day values in the USACE planning process are grounded in the economic and environmental principles and guidelines stated in USACE 1983 and 2000. Ranges for these values are annually updated in USACE memoranda (e.g. USACE 2012) to account for changes in economic conditions by multiplying the 1982 unit day value by Consumer Price Index (CPI) factors published by the Bureau of Labor Statistics. Unit day values are selected from the updated ranges using a system that assigns points based on five criteria: activities, facilities, relative scarcity, ease of access and aesthetic factors.

The USACE provides a range of unit day values to use as a proxy for the net value of different types of recreation. USACE procedures and guidelines state that unit day values should not be used when evidence suggests that the value of a recreational activity lies outside the range of published unit day values. Accordingly, in each of the following reviews for recreational fishing, beachgoing and boating, CU assesses whether estimates of net value per recreational day fall within the published range of unit day values for that activity.

The unit day value method represents the simplest type of a benefits transfer valuation approach. Broadly defined, "Benefits transfer refers to the process of using valuation results for one or more sites derived in original demand studies (the study sites) to calculate benefits estimates at another site (the project site)" (Scodari, 2009 p. 49). The unit day value method uses administratively-determined unit-day values for general and specialized recreation activities developed using expert judgment. In this report, two additional benefits transfer methods are used. The first, which CU refers to as *average benefits transfer* in the remainder of this report, calculates the average of estimates from a number of previous studies of like resources within the region being studied and uses these averages to predict that value of the current site being studied. CU will also draw from *meta analysis* research, wherein a statistical model is developed that accounts for differences among published estimates between regions and/or activities or due to differences in methodology.

Thus far, CU has presented each of the valuation methods separately, which is not always the case in the studies reviewed. For example, Rosenberger and Loomis (2000, 2001) provide both benefits transfer and meta analysis estimates for Great Lakes and Northeast recreational fishing. Breffle et al. (1999) uses both the travel cost method and a variation of contingent valuation in a study of Great Bay recreational fishing.

Summary of Results for Recreational Fishing, Beachgoing and Boating

In the following subsections CU summarizes the findings of our literature review organized around the two objectives identified in the introduction and, where appropriate, provide net value estimates drawn from the literature. Chapters II to IV of this study provide details on the individual studies reviewed. To facilitate comparisons across studies, all dollar values reported in this review are updated to FY $2012 using the consumer price index (CPI value=226.889, USACE 2012), unless otherwise noted.

Recreational Fishing

<u>Estimating the Net Value of Fishing:</u> Chapter II reviews available studies that estimate the net value of recreational fishing in the Great Lakes, Upper Mississippi and Ohio River Basins. Table II.a provides a summary of estimates of net value per day of fishing from selected studies reviewed in Chapter II, organized by the valuation method used. Studies included in the table are those that provide sufficiently reliable estimates of the net value of fishing applicable to the study area.

No single study in Table II.a covers the entirety of the study region in terms of geography or species targeted. This lack of a comprehensive, region-wide study is important because evidence provided in a number of studies suggests that fishing values will vary across recreational sites and types of fishing. Therefore, fishing values estimated in one part of our study region may not apply very well to other parts of our study region. For this reason, CU concludes that *no existing individual study* can be used to provide a representative net value per day estimate for the entirety of either or both basins.

Nevertheless, when *considered as a set,* CU believes that the studies included in Table II.a can be used to help determine the range of net values per fishing day that might be expected for the Great Lakes portion of the study area. While the range of net values provided by the various studies is broad, there is some convergence across studies. Because these studies were conducted in a variety of settings within the Great Lakes region, this range of net values likely encompasses the average net value within that region. An examination the values in Table II.a reveals that the number of observations above $75 are few and spread out. Dropping the top three value estimates (Boyle et al. 1999, Salmon; Boyle et al. 1999, Bass; and Aiken 2009, Walleye (WI)), which CU characterizes as outliers, suggests that average net value estimates will likely lie in the range from $20 to $75 ($2012).

The estimates of net value in Table II.a can be used to evaluate whether it is appropriate to use USACE's published unit day values to estimate the net value of recreational fishing in the study region. Because the relevant unit day values tend to be lower than the estimates from

Table II.a. Estimated Willingness to Pay Values per Person per Fishing Day

Valuation Method	Estimated Net Value/ Day ($2012)[a]	Fish Category	Location	Reference
Average Benefits Transfer	45	Cold water fish	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	48	Warm water fish	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	44	Anadromous runs	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	23	Mixed species	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	56	Species not specified,	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer/Meta Analysis	45-54	General	Great Lakes and the Northeast	Rosenberger and Loomis (2001)
Meta Analysis	90[b]	Bass	Great Lakes	Boyle et al. (1999)
Meta Analysis	109[b]	Salmon	Great Lakes	Boyle et al. (1999)
Travel Cost Method	41	Trout	Michigan Great Lakes	Lupi et al. (1998)
Travel Cost Method	51	Salmon	Michigan Great lakes	Lupi et al. (1998)
Travel Cost Method	42	Salmon and/or Trout	Wisconsin Water, Southern Lake Michigan	Phaneuf et al. (1998)
Travel Cost Method	42-55	Anadromous Runs	Lake Erie Tributaries	Kelch et al. (2006)
Contingent Valuation	54	Yellow Perch	Green Bay	Bishop et al. (1990)
Contingent Valuation	25	General	New York Great Lakes	Connelly and Brown (1991)
Contingent Valuation	28	General	New York Inland Waters	Connelly and Brown (1991)
Contingent Valuation	41	Salmon and Trout	Wisconsin Water, Great Lakes	Lyke (1993)
Contingent Valuation	22	General	New York Great Lakes	Connelly et al. (1997)

(continued on next page)

Table II.a. Estimated Willingness to Pay Values per Person per Fishing Day (continued)

Valuation Method	Estimated Net Value/ Day ($2012)[a]	Fish Category	Location	Reference
Contingent Valuation	22	General	New York Inland Waters	Connelly et al. (1997)
Contingent Valuation	50 (IA), 50 (IL), 68 (MO), 69 (IN), 71 (WV)	Bass	Selected States in Great Lakes and UMORB[c]	Aiken (2009)
Contingent Valuation	48 (PA), 53 (NY)	Trout,	Selected States in Great Lakes and UMORB[c]	Aiken (2009); Harris (2010);
Contingent Valuation	49 (MI) 68 (MN), 74 (OH), 91 (WI)[b]	Walleye	Selected States in Great Lakes and UMORB[c]	Aiken (2009)

a. Rounded to the nearest dollar.

b. As discussed in the text, these three observations are regarded as outliers.

c. UMORB denotes the Upper Mississippi and Ohio River Basins.

these studies, CU concludes that unit day values should not be used to estimate the net value of fishing in the Great lakes and the Upper Mississippi and Ohio River Basins.

As noted above, identifying the value of a fishing day is only one element needed to estimate the aggregate net value of recreational fishing. A measure of how much fishing occurs, such as angler days per year, is also needed. The US Fish and Wildlife Service provides periodic estimates of Great Lakes fishing effort as part of its National Survey of Fishing Hunting and Wildlife Associated Recreation (e.g. USFWS, 2008). This report does not break out participation data for the either the Great Lakes Basin or the Upper Mississippi and Ohio River Basins. However, it does report fishing participation for the Great Lakes, a resource that has received substantial popular attention due to concern about ANS in recent years and for which aggregate expenditure and economic impact values have been reported by private and government entities (American Sportfishing Association, 2008; Great Lakes Commission, 2012).

While they are somewhat dated, CU uses participation data from the 2006 National Recreation Survey (USFWS 2008), as this is the most recent basin-wide survey of recreational fishing that has been reported[1]. These estimates have been used elsewhere for calculating

[1] A more recent survey was completed in March 2012, but the summary reports are not expected until November 2012. (http://wsfrprograms.fws.gov/Subpages/NationalSurvey/2011_Survey.htm)

the impact of recreational fishing for the Great Lakes (USFWS, 2008; American Sportfishing Association, 2008). For comparative purposes it is helpful to use the same baseline for aggregating values.

Multiplying the USFWS estimate of about 18 million angler days in the Great Lakes in 2006 by the range of a net values ($20 to $75 in $2012 dollars) identified above, results in a total annual recreation net value estimate ranging from $360 million to $1.35 billion.[2]

Estimating Changes in the Net Value of Fishing in Response to ANS: While several studies have been conducted within the study region that attempt to estimate the impact that changes in fishing quality would have on recreational values from fishing, CU concludes that individually and collectively these studies do not provide a good basis for calculating economic losses associated with potential declines in catch rates, a measure of fishing quality that can potentially be linked to ANS. Our review of available studies shows that changes in net values that occur due to changes in catch rate depend on current catch rates at a site, the availability of alternative fishing sites, and other factors. Therefore, transferring estimates of economic losses associated with a decline in fishing quality based on a study at one site to other sites within the study area is not recommended.

Beachgoing

Estimating the Net Value of Beachgoing: There has been relatively very little research that measures the recreational use value of a beach day (Freeman 1995; Song et al. 2010). Estimates of net beach recreation values are highly variable across non-market valuation methods, over time, and across states and water bodies (Atiyah, 2009).

Few recreation valuation studies have been conducted for Great Lakes beaches, and CU was unable to identify any inland water recreation studies that provided values for beachgoing as a standalone activity. The estimated net economic values per person per beach recreation day are reported in Table II.b from the three studies conducted in the Great Lakes. A fourth study, reported in Murray et al. (2001) and Yeh et al. (2006) and discussed in Chapter III, is

[2] It is useful to contrast this range of net value estimates with available estimates of expenditures and economic impact from fishing in the Great Lakes. The USFWS (2008) reports that Great Lakes recreational angling-related expenditures in 2006 totaled $1.7 billion ($2012), of which trip-related expenditures were $1.2 billion ($2012). Using these data, a study conducted for the American Sportfishing Association estimates the economic importance of Great Lakes fishing to be approximately $7 billion in 2006 (American Sportfishing Association, 2008), which translates to about $8 billion in $2012. For reference CU provides a brief discussion of the alternative measures of economic activity in the Appendix. The interested reader is also referred to Scodari (2009) and Aitken (2009) for further discussion.

Table II.b. Estimated Net Values per Person per Beach Recreation Day

Valuation Method	Estimated Net Value/Day ($2012)	Location	Study
TCM	$33 -35	Two Lake Erie (Ohio) Beaches	Sohngen et al. (1998)
TCM	$48	Chicago Beaches	Shaikh (2006a,b)
TCM	$46-$62	Michigan State GL Beaches	Song et al. (2010)

a. Rounded to the nearest dollar.

not included in this table because these papers did not provide estimated net values for recreation beach days.

Each of the individual studies listed in Table II.b has too narrow a geographic focus to serve as the basis for providing comprehensive net value estimates for the entire study region. While there is a convergence in estimated net benefits across the three studies conducted in the Great Lakes, in the range of $33 to $62 ($2012) per beach recreation day, CU maintains that three studies are not enough to reliably establish range of net values per day for beachgoing.

The estimates of net value from the studies reported in Table II.b can be used to evaluate whether USACE's published unit day values should be used for estimating the net value of beachgoing in the study region. Because the estimates of the net value per day in Table II.b are well above the range of relevant unit day values published by USACE, USACE unit day values should not be used to estimate the net value of beachgoing in the study region.

Even if a reliable range of estimates of value per beachgoing day were available, there is no estimate of how much beach visitation occurs within the GLMRIS study area. This prevents us from calculating the aggregate net value of the resource, but this number is likely to be large: in Michigan alone there are almost 600 Great Lakes public beaches that have been identified by health departments and state agencies, along with substantial private access (Song et al. 2010). Further, beachgoers tend to use beaches multiple times a season. Shaikh (2006a,b) reports that the average beachgoer in Chicago went to the beach 14 times a season. Lake Erie beach visitors (Murray et al. 2001) indicated that they planned to visit 15 times that season.

As a result of the above data limitations, CU concludes that the existing body of literature on beach valuation is inadequate for providing estimates of the net value of beachgoing in the Great Lakes and Upper Mississippi and Ohio River Basins.

Estimating Changes in the Net Value of Beachgoing in Response to ANS: The existing literature is also inadequate for projecting estimates of loss in net values of beach recreation associated with ANS. Two studies have estimated water quality impacts on beach recreation within the Great Lakes region (Song et al. 2010 and Murray et al. (2001)/Yeh et al. (2006)) and CU has not located any studies in the Upper Mississippi and Ohio River Basins. Further, these two studies focus on E. Coli contamination and corresponding beach advisories (related to sewage overflows), which seem unlikely to correspond to the effects of ANS. Overall, CU therefore concludes that the existing body of literature on beach valuation is not sufficient for providing estimates of changes in net economic value associated with the quality of beach recreation.

Recreational Boating

Estimating the Net Value of Recreational Boating: Little valuation research on recreational boating has been conducted in the Great Lakes and the Upper Mississippi and Ohio River Basins. The recreational values data base maintained by Rosenberger, Loomis and colleagues over the years contains two publications for Great Lakes or Northeast states from 1985 to 2011, with respect to motor boating and two more studies in the category of floating/rafting/canoeing. These few studies are not enough to reliably estimate the aggregate value of recreational boating in the region.

In a contingent valuation study of recreational boating on Lake Ontario and the St. Lawrence River in 2002, Connelly et al. (2005, 2007) report that average net value per boating recreational day to be almost $87 ($2012). If one assumed that "the estimated value was distributed equally among people on the boat, a "rough estimate" of net value per person per day would be about $29. Comparison of values across subsets of the data indicates that net value varies systematically with boat size, and whether or not a marina, yacht club, or pier is used. A separate travel cost study of canoeing in the Boundary Water Canoe Area in Minnesota, a very different kind of system with very different types of use, provides a per person per day net value estimate of $12 ($2012) (Hellerstein, 1991).

Three other studies are reviewed in Chapter IV, but are not included here because they provide inadequate information for assessing the reliability of the estimated values.

Estimates of the net value of recreational boating could be based on USACE unit day values. While CU was able to conclude that USACE unit day values likely underestimate actual net recreational values for fishing and beachgoing, insufficient studies are available to allow us to determine whether this is the case for estimating the net value of recreational boating.

While there is a shortage of studies on the net value per day of recreational boating, a recent USACE study of the Great Lakes Basin (USACE 2008) does provide estimates of annual recreational boating effort. This study estimates that about 17 million boat days occurred on the Great Lakes and connecting waters in 2003, a level of participation similar to that for recreational fishing. However, despite having data on participation, the data on net recreational boating values is too sparse (a single study conducted in New York) to estimate the net value of the entire Great Lakes. Nor is any similar activity data available for the Upper Mississippi and Ohio River Basins.

In summary, CU concludes that the existing literature does not provide a large enough body of research to identify reliable estimates of net economic value for a day of recreational boating in the study area.

Estimating Changes in the Net Value of Recreational Boating in Response to ANS: With the exception of Connelly et al. (2007), the existing body of research does not address change in net economic value associated with resource quality. The quality variation in the Connelly et al. study is in water levels, a factor of recreational boating quality that is not likely to be associated with ANS.

Outline of the Remainder of the Report

The remainder of the report is organized into four chapters, an appendix, and a glossary of acronyms used in this report. Chapters III through V synthesize the relevant economic valuation literature on recreational fishing, beachgoing, and boating, respectively. Each chapter begins with an overview, provides a description of each study that is potentially relevant to recreational valuation in the GLMRIS study area, and concludes with a short synthesis. Chapter VI provides additional technical and econometric details about the studies reviewed in Chapters III through V for readers who are interested in additional information. The appendix provides a discussion intended to clarify the difference between the net economic value approach adopted here and other measures of economic contribution, such as expenditures and economic impact analyses.

III. Economic Valuation Studies of Recreational Fishing in the Great Lakes and Upper Mississippi and Ohio River Basins

Over the years a large body of non-market valuation research on recreational fishing has developed, with several major studies conducted in the GLMRIS study area. This attention has been driven by the importance and widespread nature of this recreational activity as well as the fact that catch rate statistics were a readily available measure of the quality of the resource. This later feature fostered the development of new methods of valuation techniques that accounted for quality changes, particularly in the travel cost method.

Several authors have collected and summarized fisheries valuation research for the purposes of conducting benefit transfers and meta-analyses. Sorg and Loomis (1984) covered the literature on outdoor recreation from the mid-1960's to 1982, identifying 93 benefit estimates in all. Walsh et al. (1992) summarized estimates of net value from 70 study sites from recreational value research in the United States from 1968-1988. This data set was updated and combined with other literature reviews in a series of reports by Loomis and co-authors, including Rosenberger and Loomis (2000, 2001), Kaval and Loomis (2003), and Loomis (2005). Loomis and Richardson (2008) updated these studies, cross-checking with a separate Sport Fishing Data Base (Boyle et al., 1999). Rosenberger and Loomis (2000, 2001) demonstrate that although there is substantial variation in estimates of net values across studies, these estimates vary systematically and in expected/explainable ways.

CU now turns to a discussion of the various studies that are potentially relevant to the GLMRIS study, and assess the relevance of individual studies and the collected body of research to estimating net values for recreational fishing in the study area and how these net values might be affected by quality changes, such as those that might be caused by ANS. The reports are ordered by method (Average Benefits Transfer (BT), Meta Analysis (MA), Travel Cost Method (TCM), Contingent Valuation (CV), and methods that use a combination of techniques).

As noted in the introduction, CU limits our literature review to studies that use data collected in 1985 or after. Limiting the data collection to this time period is motivated by concerns about the "shelf life" of non-market valuation estimates.[3] Our particular choice of cut off in

[3] Researchers in non-market valuation have not identified, or to our knowledge specifically discussed and debated, the "shelf life" for non-market values. In other words it has not been documented whether WTP estimates provided in research from decades ago are relevant as measures of value for current policy purposes even after they are adjusted by consumer price (CPI) indices. This is of particular concern for recreational activities such as recreational fishing in the Great Lakes in which the level of activity, and hence underlying demand, has changed substantially over generations and over time. For example, the 2006 National Survey of Fishing, Hunting, and Wildlife-Related Recreation reports that from 1996 to 2006 Great Lakes recreational fishing declined by 30% (USFWS, 2008, p. 18). While some research is ongoing on generational effects on recreational

1985 is somewhat arbitrary, but is also informed by the fact that Talhelm et al.'s (1979, 1988) well-known reports on the Great Lakes fishery cover research up to 1985. Further, in the mid-1980s the statistical approaches used in travel cost analyses underwent fundamental change.

Moreover, CU only includes studies in our review that endeavor to provide values over a geographical region, rather than a single inland lake (e.g. Eiswerth et al. 2008) or river stretch (e.g. Collins et al. 2005) or narrowly defined subset of fishermen (e.g. Provencher and Bishop, 1997). An exception to these inclusion criteria is Kelch et al. (2006), as their research provides unique insights into Ohio/Lake Erie Steelhead Salmon. Finally, our review of the data does not include valuation studies measuring the effects of toxic contamination (e.g. Montgomery and Needleman, 1997) or changes in water quality without accounting for changes in catch rate (e.g. Parsons and Kealy, 1992; Feather et al. 1995).

Each review will be structured following the outline in Box 1.

values (e.g. Englin 2012), the appropriateness of transferring values over extended time periods remains an open empirical issue. Economic methods for valuing recreational activities such as angling have evolved substantially over time. In the decades since the Talhelm report, "single site" recreation valuation studies of the type employed in the work prior to the Talhelm report, have largely been replaced by "Multisite" choice methods that use statistical approaches that better account for substitutability across fishing activities and sites and the incorporation of fishing quality into the econometric modeling. In turn this more complete accounting is able to accommodate the effects of a change in quality in one part of the fishery: if the quality of angling in one part of a fishery is affected by, say, pollution or ANS, anglers may decrease their effort in that site/fishing mode combination and offset their reduced fishing by increasing effort at other fishing and or other fishing modes.

Box 1: The Structure of Each Review

<u>Identifying Name of Study (date)</u>

Location:

Data Type, Date:

Project Sponsor:

Publications (Date, Type):

Stated Purpose of Research Effort:

Data Collection/Sampling Information:

Reported Values:

Assessment of Study and Relevance to GLMRIS:

Notes *r.r. = response rates*
n = number of complete responses
WTP = willingness to pay
ABT = average benefits transfer
MA = meta analysis
TCM = travel cost method
CV = contingent valuation
Unless otherwise indicated, all reported values are adjusted to $2012 using the CPI.

<u>Loomis and Richardson (ABT 2007)</u>:

Location: Northeast recreation area, including the Great Lakes

Data Type, Date: Average benefits transfer, using original estimates from 1967 to 2005.

Project Sponsor: National Council of Science and the Environment

Publications: Loomis and Richardson (2008, Report)
Loomis (2011, personal communication)

Stated Purpose of Research Effort: Within the limits of the then available literature, this study sought to provide up-to-date benefit transfer values and estimated meta-analyses equations. Values for fisheries and other recreation use values were reported in tabular form by region.

Data Collection/Sampling Information: This report is the most recent iteration of a cumulative effort to assimilate recreational values studies that includes Sorg and Loomis (1984), Walsh et al. (1992); Rosenberger and Loomis (2000, 2001), Kaval and Loomis (2003) and Loomis (2005). The fishing values were updated and cross-checked with a separate Sport Fishing Data Base (Boyle et al., 1999, see the review Boyle et al. (MA 1999) below.).

Reported values: The following average values were reported for different fishing categories for fresh and saltwater fishing in the Great Lakes and the Northeast (Loomis, 2011, Personal communication), where N represents the number of estimated values used.

Species	Cold Water	Warm Water	Anadromous	Mixed	Not Specified
Average	45	48	44	22	56
N	58	119	33	30	112

Assessment of Study and Relevance to GLMRIS: The above values include observations for salt water fishing and for other fishing activities in the Northeast Recreation Area outside the GLMRIS region. However, because the values include the Great Lakes region and non-Great Lakes states within the Upper Mississippi Basin (e.g., Iowa and Missouri) and Upper Ohio River Basin (e.g., West Virginia), these values are relevant to the GLMRIS study with respect to providing an estimate of the current net value of the fishery. These data are not appropriate for changes in fishing quality however.

<u>Rosenberger and Loomis (ABT/MA 2001)</u>:

Location: Northeast recreation area, including the Great Lakes

Data Type, Date: Average benefits transfer and meta analysis, using original estimates from 1967 to 1998.

Project Sponsor: United States Forest Service (USFS)

Publications: Rosenberger and Loomis (2001, Report)
Rosenberger and Loomis (2000, Journal Article)

Stated Purpose of Research Effort: Within the limits of the then available literature and data, this study sought to provide up-to-date benefit transfer values and estimated meta-analyses equations. Values for fisheries and other recreation use values were reported in tabular form by region.

Data Collection/Sampling Information: This report is an interim iteration of the cumulative efforts of assimilating recreational values studies discussed in the main text.. This string of research includes Sorg and Loomis (1984), Walsh et al. (1992), Kaval and Loomis (2003), Loomis (2005) and Loomis and Richardson (2007).

Reported values: The net benefits per recreational fishing day in the Great Lakes and the Northeast, based on the averaging the values estimates from 43 studies is $45 ($2012). The corresponding value from the meta analysis is $73. These data include both fresh and saltwater studies.

Assessment of Study and Relevance to GLMRIS: The above values include observations for salt water fishing and for other fishing activities in the Northeast Recreation Area outside the GLMRIS region. However, because the values include the Great Lakes region and non-Great Lakes states within the Upper Mississippi Basin (e.g. Iowa and Missouri) and Upper Ohio River Basin (e.g. West Virginia), these values are relevant to the GLMRIS study with respect to providing an estimate of the current net value of the fishery. These data are not appropriate for changes in fishing quality however.

Boyle et al. (MA 1999)

Location: National, including the study region

Data Type, Date: Meta analysis, using original estimates from 1982 to 2005.

Project sponsor: U.S. Fish and Wildlife Service (USFWS)

Publications: Boyle et al. (1998, Report)
Boyle et al. (1999, Report)

Stated Purpose of Research Effort: This study involved developing a database of recreational valuation studies (Boyle et al., 1998) and a meta analysis of the values in the data base (Boyle et al. 1999) as part of an effort by the USFWS to improve the efficacy of, and consistency in, their analyses involving the economic valuation of sports fishing opportunities. Specifically, the meta analysis of these data was intended to: 1) provide a means to systematically explore the variation in sport fishing value estimates across studies; 2) provide formal models for use in developing welfare estimates for sport fishing opportunities in cases where original estimates are not available; and 3) identify where the are representation gaps in the economic valuation for various sportfishing opportunities.

Data Collection/Sampling Information: A review of the literature identified citation information on over 250 sport fishing studies, but active collection efforts were limited to 150 studies due to resource limitations. After winnowing this data using various criteria, the data base resulted in detailed study information for 70 studies that provided a total of 1002 per-day and per-trip welfare estimates. A statistical, meta analysis was conducted on these data (see technical information in Chapter VI), indicating that estimated net values varied significantly with the type of fish caught, the type of waterbody and method used to collect data.

Reported Values: The net benefits per day, based on the simple average of 461 value estimates for recreational fishing across the county, is $62 ($2012). The corresponding value from the meta analysis is $73. Two sample scenarios were estimated for Great Lakes fisheries: Great Lakes Bass ($90) and Great Lakes Salmon ($109).

Assessment of Study and Relevance to GLMRIS: The estimated values are relevant to GLMRIS, although some caution is merited in adopting these values because the estimated values have relatively large standard deviations and thus lack statistical precision (see technical details in Chapter VI).

Lyke (TCM 1993):

Location: Wisconsin Waters of Lake Superior and Lake Michigan and inland fisheries.

Data Type, Date: Multisite TCM; Primary data collection, 1990. (1989 fishing season)

Project sponsor: University of Wisconsin Sea Grant Institute.

Publications: Lyke (1993, Dissertation)

Stated Purpose of Research Effort: The purpose of this study was to investigate whether the net value of fishing quality to anglers, as represented by catch rates per unit of effort, could be measured using the TCM, and whether TCM and CV estimates are similar for the same quality change. For a discussion of the comparability across the two methods, refer to the Lyke (1993) entry in the CV subsection below.

Data Collection/Sampling Information: A stratified sample based on geographic location and the estimated number of Great Lakes anglers within a county was drawn from 1988 fishing licenses purchased in Wisconsin. Screening postcards were used to identify people who fished for trout or salmon in the Wisconsin Great Lakes and/or inland waters in 1989 (r.r. = 70%). Based on the postcard information, two separate mail survey questionnaires were distributed to respondents who: 1) Indicated that they fished on the Wisconsin Great Lakes in 1989 (Wisconsin Great Lakes Sport Fishing Survey (WGL), r.r. = 90%, n = 274); or 2) Indicated that they did not fish on the Wisconsin Great Lakes in 1989 (Wisconsin Sport Fishing (WSF) Survey, r.r. 85%, n = 239).

The questionnaires were mailed in February 1990, using a recall approach to elicit travel cost information from 1989[4]. In the WGL questionnaire, 29 separate Lake Michigan and Lake Superior areas were identified, and anglers were allowed to supplement this list. More detailed information (e.g. catch rates for particular species, seasonal variation in fishing effort, average distance and time traveled, and method of fishing) was requested about the two areas with the most frequent visits. A similar approach was used for the (WSF) survey,

[4] Ideally travel cost data could be collected immediately after every trip or through the use of a regularly collected travel log. However, such an approach is simply beyond the capacity of most survey efforts. The question thus arises as to the consequences of relying on lengthy recall periods. The USFWS suggests that there is systematic recall bias: the USFWS's "Research found that the amount of activity and expenditures reported in 12-month recall surveys was overestimated in comparison with that reported using shorter recall periods." (2008, p. vii). This finding of upward recall bias is consistent with past research conducted by Cornell (Connelly and Brown 1995, Connelly et al. 2000). However, more recent research by Connelly and Brown (2011) that more carefully controls for potential methodological effects in comparisons across more and less frequent contacts provides evidence that the recall effects may occur in the other direction, and that even if there are significant effects they are not substantial (<10%). As such, the issue of recall bias effects remains unsettled. Nevertheless, calls for shorter recall periods should not be abandoned. Other factors being constant, shorter recall periods will be preferred to longer recall periods.

with the difference being that the respondent self-identified the specific bodies of water fished.

Reported Values: The results from a number of TCM net value estimates are provided in this dissertation for various scenarios. Of most relevance to GLMRIS are the mean net-benefit per trip values for All Wisconsin Great Lakes ($35.38 per trip ($2012), p. 172), Wisconsin parts of Lake Michigan ($34.33 per trip ($2012), p. 140), Wisconsin parts of Lake Superior ($1.04 per trip, p. 140) and Inland Wisconsin ($260.32 per trip ($2012), p. 140). Because the net values for Great Lakes fishing were elicited for each *trip*, and trips "may mean stopping for an hour on the way to work, or it may mean fishing for several days hundreds of miles from home" (p. 141) it is not clear how the values translate into per day values. In comparing these values to other results in the literature, the author notes that the estimated values are "compatible or a little low relative to the cold water fishing literature" but that the "per day values for Inland fishing are much higher than other values" (p. 139) in the literature.

Assessment of Study and Relevance to GLMRIS: The sampling effort was rigorous and resulted in a high response rate. The data has been used for further modeling development by Phaneuf et al. (TCM 1997 - see review below). However, there are some aspects of the methodology that are not described sufficiently to judge their reliability (see Chapter VI), and the dissertation lacks sufficient detail explaining how values were derived, which complicates assessment of the quality of the analysis.

Due to the concerns about and lack of documentation regarding modeling issues CU concludes that the values from this study are not appropriate for use in the GLMRIS project.

<u>Jones and Sung (TCM 1993):</u>

Location: Michigan inland fisheries and waters of the Great Lakes.

Data Type, Date: Multisite TCM; Primary data collection, 1983-1984.

Project sponsor: Michigan Department of Natural Resources (MDNR), U.S. Environmental Protection Agency (USEPA)

Publications: Jones and Sung (1993, Report)
Jones and Lupi (2000, Journal Article)

Stated Purpose of Research Effort: This research had two major objectives. The first was to address several methodological issues associated with travel cost models. The second was to allow the state to use the model to improve fisheries management and to perform Natural Resource Damage Assessment for injuries to Michigan State fisheries.

Data were taken from a mail survey of 1% of the anglers licensed to fish in Michigan during the 1983 and 1984 license years (r.r.= 59%; n = 10,948). Questionnaires were sent out at various times over the period from November 1983 to September 1984, resulting in recall periods from less than a month to almost 14 months. While the survey data used in this study was collected prior to our general cutoff data of 1985, CU includes this study in our review because its method of categorizing anglers by fishing activity is utilized in later research and because of the statistical methods used.

The questionnaire requested detailed information on the angler's most recent fishing trip, including species sought, location, trip length, trip expenditures etc., as well as demographic background including fishing experience and preference information. Importantly, while details were provided about the most recent trip, the data collection effort had "severe data limitations at the total participation level. We do not know the total number of season trips" (Jones and Sung, p. 4). Catch rates for Great Lakes warm and cold water fish and for anadromous runs were obtained from MDNR creel studies. It was determined that creel data could not be used for inland fishing: instead proxies for fishing quality, such as total lake acreage per county for each of cold water and warm water lakes, and miles of cold water and warm water rivers and streams broken down by quality level (top quality, second quality, other), were used. The MDNR classifies top quality streams as those that have good self-sustaining stocks of warm/cold game fish. Secondary quality streams contain populations of warm/cold game fish, but these populations are appreciably limited by factors such as pollution, competition, or inadequate natural production.

Reported values: Standard values such as net value per day of fishing were not reported for these data, in part because of the data limitation on total fishing days. The model was used to demonstrate how changes in recreation days might be affected by eliminating PCB contamination on the Kalamazoo River. However, the estimated improvement values are not germane to GLMRIS.

Assessment of Study and Relevance to GLMRIS: The overall contribution of the study to estimating fishing recreation values in the GLMRIS area is limited by the lack of data on total trips taken during the season, which prevents consideration of how quality affects the frequency of trips and shifts in trip locations across a season. As such, this work is not relevant to the objective of estimating net values of recreational fishing in the study area and does not provide adequate information for estimating how changes in quality will affect net values of the recreational fishing resource.

MSU (TCM 1996)

Location: The Great Lakes and Inland Waters of the State of Michigan

Data Type, Date: Multisite TCM; Primary data collection 1994-1995.

Project sponsor: Michigan Department of Natural Resources (MDNR)

Publications: Hoehn et al. (1996, Report)
Various conference papers/staff reports: e.g. Chen et al. (1999), Lupi and Hoehn (1997), Lupi et al. (1998)
Lupi et al. (2003, Journal Article)

Stated Purpose of Research Effort: This study was funded to provide an economic model of recreational fishing which could help the MDNR protect and manage Michigan's fishery resources. The results of the study were to be consistent with Natural Resource Damage Assessment guidelines, allowing for defensible estimates of environmental injuries under Federal and State environmental laws. As such, the economic model had to be capable of measuring the economic value of changes in natural resource quality at a number of sites.

The MSU study implemented a repeated travel cost visitation model that involved multiple contacts during the 1994 fishing season. Random digit dialing was used to identify Michigan Residents who were potential anglers for the 1994 season, where potential meant that they fished in the previous year or stated an intention to fish in the upcoming season. Of the respondents who were identified as potential anglers, 78% agreed to participate. Of those who agreed to participate, 80% completed the entire CATI panel survey that followed anglers during the course of the 1994-95 fishing year. To balance respondent burden with the need for accuracy frequent anglers were called more than infrequent anglers, with panel frequencies ranging from three to eight interviews over the fishing season. Each interview basically consisted of asking whether the respondent had fished or not since the previous interview, and if they fished, respondents were asked the location, duration, and species targeted for each trip. To enhance accuracy, fishing logs were provided. In this manner MSU was able to get detailed cost and quality data for each trip. This approach to collecting data avoids possible recall biases and other issues associated with aggregating estimated trips and costs across an entire season.

Reported values: In various reports the authors demonstrated how days fishing and consequent changes in total WTP would be affected by specified changes in the fishery. For example, they provided simulations for lake closures in specific counties (due perhaps to a contamination incident) and increases in lake trout on the St. Mary's River (an outcome of increases in lamprey treatments). As a result, this effort only provided limited information regarding net-benefits per day of recreational fishing. The authors reported user day values for trout and salmon of about $41 and $51, respectively ($2012, Lupi et al. 1998).

Assessment of Study and Relevance to GLMRIS: Because of the high quality data collection methods and the application of state of the art statistical methods, this study can be regarded as an exemplar for Great Lakes travel cost fisheries research. The MSU model provides a snapshot of how anglers responded to travel costs and site quality for Michigan fisheries circa 1994-95, but it remains an open question of whether its estimated values are applicable beyond Michigan state waters. The model could be used to simulate the catch rate impacts associated with hypothetical ANS, and indeed has been used so for evaluating the benefits of Sea Lamprey control (Lupi et al. 2003).

Phaneuf et al. (TCM 1997)

Location: Wisconsin waters of Lake Superior and Lake Michigan.

Data Type, Date: Multisite TCM; Secondary data from Lyke (1993) (1989 fishing season)

Project sponsor: US EPA, USDA Western Regional Project W-133.

Publications: Phaneuf (1997, Dissertation)
Phaneuf et al. (1998, 2000, Journal Articles)
Herriges et al. (1999, Book Chapter)

Stated Purpose of Research Effort: The broad aspects of this data collection effort are described in the TCM entry for Lyke (TCM 1993). Phaneuf and co-authors used the Lyke (1993) Wisconsin Great Lakes Fishing Survey to develop a new modeling approach for recreational modeling.

Reported Values: Phaneuf et al. (1998) reported seasonal values from a variety of statistical models that effectively close the Southern portion of Lake Michigan (this could be attributed to an environmental disaster). Converting these seasonal values to average per trip net value using information provided in Lyke (TCM 1993) provides an estimate of about $53/trip. CU converted this value to a rough per-day value estimate of $42 by dividing the per-trip value by 1.25. This indirect adjustment factor (1.25=25/20) was derived from the 1991 National Survey of Fishing, Hunting and Wildlife-Associated Recreation (USFWS 1993) by dividing the estimated 25 million annual Great Lakes fishing days by the estimated of 20 million annual Great Lakes trips fishing trips.

Assessment of Study and Relevance to GLMRIS: The new approach to modeling recreation is a contribution. However, such a modeling approach is appropriate only for limited numbers of site choices, and is not extendable to settings with more choices. The use of only the GL data set from the Lyke (TCM 1993) study preempts concerns about substitutes mentioned in that review.

Phaneuf et al.'s values could be aggregated to estimate net values. Yet expanding a localized study to the entire geographical area of GLMRIS would not be appropriate because of the widely varying opportunities and conditions in the Great Lakes and UMORB.

Upneja et al. (TCM 2001)

Location: Inland and Great Lakes waters of Pennsylvania

Data Type, Date: Single site TCM; Primary data collection 1995-1996

Project sponsor: Center for Rural Pennsylvania

Publications: Upneja et al. (2001, Journal Article)

Stated Purpose of Research Effort: The objective of this study was to determine the economic benefits of sportfishing activities in the commonwealth of Pennsylvania.

Data Collection/Sampling Information: Drawing every 70th name from the list of licensed Pennsylvania anglers in 1994, a mail survey was administered in stages between June 1995 and May 1996. Anglers were asked to report trip expenditures of their most recent fishing trip, the species targeted, the total number of fishing trips taken and other recreational information. The response rate was 6.5% (n=987).

Reported values: Estimated mean net value per person per day is $435.

Assessment of Study and Relevance to GLMRIS: The 6.5% response rate and technical issues discussed in Chapter VI preclude this study for use in basin-wide estimates of net value under the GLMRIS study.

<u>Besedin et al. (TCM 2004)</u>

Location: Michigan Great Lakes (Michigan, Huron, Erie, Superior)

Data Type, Date: Multisite TCM; Secondary data 2001

Project sponsor: US EPA

Publications: Besedin et al. (2004, Presentation)
US EPA (2004, Report)

Stated Purpose of Research Effort: Building from an analysis of Michigan State Great Lake waters, this study evaluates recreational fishing losses in the Great Lakes hydrological region caused by "impingement and entrainment" of fish by power plant cooling water intake structures (CWIS). It was completed as part of the Environmental Protection Agency's (EPA's) regulatory impact analysis for regulations of power plant CWIS under section 316(b) of the Clean Water Act.

Data Collection/Sampling Information: A sample of 10,000 anglers was taken from a subset of the Michigan Department of Natural Resources (MDNR) Measurement of Sportfishing Harvest in Lakes Michigan, Huron, Erie, and Superior study, conducted in 2001, which surveyed boat, shore and ice anglers at fishing sites in Michigan State's Great Lakes waters. No socio-economic data was collected. Catch rate data were estimated from ten years of MDNR creel data. After excluding non-Michigan residents and anglers who traveled more than 120 miles one way to the fishing site, single-day TCM data were available for 9,758 GL and tributaries anglers.

Reported values: Per-Trip net values are reported for simulated scenarios of reductions in **"**impingement and entrainment" of fish by cooling water intake structures. These values cannot be used to estimate the current net value of fishing or how that value might change in response to ANS because they are specific to this source of environmental impact. Net values for an additional fish caught on a trip were also reported.

Assessment of Study and Relevance to GLMRIS: The limited discussion of data collection provided in the conference presentation and the US EPA report make it difficult to assess the quality of the data and, hence, the overall study. From the econometric modeling perspective (see technical report for this study in Chapter VI) there is some concern that modes of fishing (e.g. warm water fishing) could not be/were not separated in the statistical analyses creating potential biased in the estimates.

The reported WTP values are not appropriate for developing an estimate of the net benefits of the total recreational fishing resource as they report only changes in net benefits associated with the regulation being considered. A subset of the WTP estimates reported in this study, i.e. WTP for an additional fish per trip, are relevant to estimating net economic value of the GLMRIS fishing resources only to the extent that values per fish could be used as a measure of quality change within the Great Lakes.

Murdock (TCM 2006)

Location: Michigan Great Lakes

Data Type, Date: Multisite TCM; Secondary data 1998.

Project sponsor: The data collection was funded by the Fox River Group

Publications: Murdock (2002, Dissertation)
Murdock (2006, Journal Article)

Stated Purpose of Research Effort: The contribution of this study is primarily methodological in that it focuses on developing a way to address unobserved quality characteristics of recreation sites in statistical models.

Data Collection/Sampling Information: The model was applied to data collected as part of an Natural Resource Damage Assessment plan potentially resulting from releases of hazardous substances to the Lower Fox River and the Bay of Green Bay (see Desvousges et al. 2000 and MacNair and Desvousges 2007). A random digit dialing telephone survey recruited Wisconsin anglers willing to complete a fishing diary each month for June through September 1998. Of the recruited anglers 81% returned at least one of their monthly diaries and 64% completed all four months. This paper uses data on the 512 anglers who completed all four months of the survey and reported taking a single day fishing trip. The fish trip log collected information on fishing location, distance travelled, trip and location characteristics, and number of fish caught of each species, size and the number of fish eaten. As with the Breffle et al. (1999) study reported below, contingent valuation-like data were also collected, but are not reported here because it pertains mostly to fish consumption advisories.

Fish catch measures were obtained by combining information from the Wisconsin Department of Natural Resources (WDNR) and the data collected in the survey. As a result catch rates vary across sites but not anglers. 737 fishing sites were visited by anglers and organized into roughly seven by five mile quadrangles.

Reported values: No estimates of WTP per day are provided. Illustrative policy values for a 10% increase in walleye and musky catch are reported in miles rather than dollars.

Assessment of overall study quality and contributions: The net values are provided in miles travelled/water quality tradeoffs rather than dollars and are hence not relevant to the GLMRIS project.

Kelch et al. (TCM 2006)

Location: Lake Erie Tributaries

Data Type, Date: Single site TCM; Primary data collection 2003

Project sponsor: Ohio Sea Grant College

Publications: Kelch et al. (2006, Journal Article)

Stated Purpose of Research Effort: The objective of this research was to provide net value estimates to policy makers interested in assessing the effectiveness of steelhead salmon stocking programs and providing access and opportunities for fishing operations. Fishing for anadromous fish represents a high quality fishing experience, and interest in steelhead fishing in Lake Erie tributaries has risen in recent years.

Data Collection/Sampling Information: Between October 2002 and April 2003 Ohio Sea Grant staff contacted over 500 steelhead anglers on the streambanks of eight Lake Erie tributaries and asked them to participate in a mail survey about steelhead fishing. Of the over 500 anglers contacted, 487 agreed to provide their names and addresses, and 375 responded to the mailed survey with usable information (r.r. =77%). Of this 93% were on single day trips, and only these data were used in the analyses.

Reported values: Estimated net-benefits per single-day fishing ranged from $42 to $55 ($2012).

Assessment of overall study quality and contributions: This is a straightforward, solid study. If it can be assumed that there is little substitution between anadromous run fishing and other fishing activities and that substitution options to other tributaries are low, then this provides a useful contribution to Great Lakes fishery valuation research.

Relevance to GLMRIS: Subject to the caveats above regarding substitution alternatives and concerns that conditions differ in other parts of the Great Lakes, the net values could be used to contribute to estimates of the current net value of anadromous fishing in the Great Lakes. Yet expanding these localized estimates to the entirety of anadromous fishing effort in the Great Lakes may not be appropriate because of varying conditions at other sites.

<u>Milliman (CV 1986):</u>

Location: Green Bay, Wisconsin.

Data Type, Date: CV; Primary data collection 1986

Project sponsor: University of Wisconsin – Madison, Wisconsin Sea Grant, National Sea Grant.

Publications: Bishop et al. (1990, Journal Article)
Milliman et al. (1992, Journal Article)

Stated Purpose of Research Effort: In 1983, the Wisconsin Department of Natural Resources (WDNR) initiated a regulatory program for yellow perch in Green Bay with the intent of rehabilitating this fishery. Amongst other efforts, this study sought to estimate WTP values for the current fishery and WTP values for the projected improvements to the fishery.

Data Collection/Sampling Information: The basis for estimating the value per angler trip was a CV survey of perch anglers conducted in 1986. WDNR creel census clerks and university-employed clerks intercepted perch anglers at all the significant fishing sites along the Wisconsin shores of Green Bay. Anglers were asked whether they would be willing to complete a mail questionnaire from the university regarding perch fishing. A sample of 600 anglers was drawn at random from those who agreed to participate in the study. The survey was mailed during the fall of 1986 (r.r. = 91%).

In the mail survey respondents were asked about the fishing trip during which they were initially intercepted. Expenditure and other travel cost information were collected along with information about the number of fish caught and the average size of these fish. To estimate net benefits, respondents were asked if they would have still taken the trip if their total expenses had increased by a specified number of dollars, wherein the dollar value varied across respondents. Respondents answered yes or no to this question.

Reported values: Estimated average net-benefits per trip under existing conditions was about $54 ($2012). Other values are reported for hypothetical improvements in catch and fish length, but are not replicated here.

Assessment of Study and Relevance to GLMRIS: This is a straightforward application of the dichotomous choice CV method. This provides a localized net value for a fishing day under the conditions that existing in Green Bay in 1986 and is thus relevant to the GLMRIS study. Yet expanding a localized study to the entire geographical area of GLMRIS would not be appropriate because of the widely varying opportunities and conditions in the Great Lakes and UMORB.

<u>Connelly and Brown (CV 1990)</u>

Location: Inland and Great Lakes waters of New York

Data Type, Date: CV; Primary data collection 1989 (for 1988 fishing season)

Project sponsor: New York Department of Environmental Conservation (NYDEC)

Publications: Connelly et al. (1990, Report)
Connelly and Brown (1991, Journal Article)

Stated Purpose of Research Effort: This research was conducted to provide baseline data on the recreational value of the freshwater fisheries in New York State and to show how comparisons of value can be made over time. The authors note that these valuation estimates were needed to help justify fisheries management expenses and as a data base for evaluating future policy alternatives.

Data Collection/Sampling Information: A systematic sample of resident and nonresident New York fishing license holders was selected for the license year over the period from October 1987 through September 1988. The licenses were sorted and the sample was stratified by county of purchase. A questionnaire was mailed in January 1989, in which respondents were ask to list for calendar year 1988 the number of days fished, species sought and travel cost by location (r.r. =62.4%; n=10,314, of which about ½ were asked CV questions).

After eliciting information about the entire fishing season, respondents were asked to recall a specific fishing trip from amongst those they had previously identified. Respondents were then asked how many days they spent on the trip and the cost for their share of the expenses. Next, a series of questions was asked to get respondents to think in more detail about how much they would be willing to pay for that trip if their share of expenses had increased. Finally, respondents were asked 'What is the maximum amount that you would have been willing to pay before you would have decided not to go?'

Reported values: This research provides a number of values for various fresh water resources in New York. Considered in total, these suggest that there is variation in recreation values across locations within a state. Despite this, the overall variation between GL and inland waters is not that large. Net value for GL was about $25 ($2012). For inland lakes the value is $28 ($2012).

Assessment of Study and Relevance to GLMRIS: The large sample in this study provides broad coverage across the entire state, and was stratified in ways that would allow aggregation across sites. The demonstration of variation of values across sites within a state demonstrates the concerns raised in various parts of this review about potential biases associated with aggregation of data in which values are not matched with effort.

The estimates from this study provide a regional net value for a fishing day under the conditions that would be relevant to the GLMRIS study. Yet expanding a single state study to the entire geographical area of GLMRIS would not be appropriate because of the widely varying opportunities and conditions in the Great Lakes and UMORB.

Lyke (CV 1993)

Location: Wisconsin Waters of Lake Superior and Lake Michigan and inland fisheries.

Data Type, Date: CV; Primary data collection, 1990. (1989 fishing season)

Project sponsor: University of Wisconsin Sea Grant Institute.

Publications: Lyke (1993, Dissertation)

Stated Purpose of Research Effort: The purpose of this study was to investigate whether valuation of environmental quality, as represented by catch rates per unit of effort, could be measured using the TCM, and whether TCM and CV estimates converge for the same quality change. The TCM model and overall data collection effort was discussed in the Lyke (TCM 1993) entry above. Here CU concentrates on the CV estimates.

Data Collection/Sampling Information: After individually estimating personal expenditures for Great Lakes fishing, respondents were asked to suppose that fishing conditions remained the same in the upcoming year, but that annual costs would rise by a specified amount that varied across anglers. Respondents indicated whether or not they would still choose to fish in the Wisconsin Great Lake.

Reported values: Annual mean net values were estimated and the information in the dissertation allows these values to be converted into net value per trip. The average CV net value per Great Lakes trip was estimated to be about $51 ($2012). This is larger than the corresponding estimate from the TC model of about $35 ($2012) although this interpretation is made with some qualifications because of concerns about interpreting the TCM values estimated in Lyke (TCM 1993). CU converted Lyke's estimated CV value to a rough per-day value estimate of $41 by dividing the per-trip value by 1.25. This indirect adjustment factor (1.25=25/20) was derived from the 1991 National Survey of Fishing, Hunting and Wildlife-Associated Recreation (USFWS 1993) by dividing the estimated 25 million annual Great Lakes fishing days by the estimated of 20 million annual Great Lakes trips fishing trips.

Assessment of Study and Relevance to GLMRIS: Much of the data and estimation issues raised in the Lyke (TCM 1993) review do not carry over to the CV analysis, as the latter uses only the CV responses to the Wisconsin Great Lakes Sport Fishing Survey. A limitation of the data is that it measures per trip net value rather than per day net value, making it difficult to compare with other surveys. The CV data is found to provide higher values than the TCM.

This study provides a regional net value for a marginal fishing trip under the conditions that existing in Wisconsin Great Lake Waters in 1988. It is relevant to the GLMRIS objective of estimating net value of the fishery resource. Yet expanding a localized study to the entire geographical area of GLMRIS would not be appropriate because of the widely varying opportunities and conditions in the Great Lakes and UMORB.

<u>Connelly et al. (CV 1997)</u>

Location: Inland and Great Lakes Waters of New York

Data Type, Date: CV; Primary data 1996-1997

Project sponsor: New York Department of Environmental Conservation (NYDEC)

Publications: Connelly et al. (1997, Report)

Stated Purpose of Research Effort: A systematic sample of resident and nonresident New York fishing license holders was selected for the license year over the period from October 1995 through September 1996. The licenses were sorted and the sample was stratified by county of purchase. A questionnaire was mailed in January 1997, in which respondents were ask to list for calendar year 1996 the number of days fished, species sought and travel cost by location (r.r. =62.4%; n=8,760, of which about ½ were asked CV questions). While this mail survey asked respondents to recall activities across the entire year, a separate phone survey was conducted each quarter in 1996. The completion rate for the entire year was 30%. Although the response rates varied greatly across methods, the average annual fishing days (17.6-17.7 days in 1996) were nearly identical.

After eliciting information about the entire fishing season, respondents were asked to recall a specific fishing trip from amongst the trips they had listed in the seasonal section. Respondents were then asked how many days they spent on the trip and the cost for their share of the expenses. Next, a series of questions was asked to get respondents to think in more detail about how much they would be willing to pay for that trip if their share of expenses had increased. Finally, respondents were asked 'What is the maximum amount that you would have been willing to pay before you would have decided not to go?' These questions were designed to parallel those in Connelly and Brown (1990) and allow comparison of values across time.

Reported values: This research provides a number of values for various fresh water resources in New York. Net value for GL was about $22 ($2012). For inland lakes the value is $22 ($2012).

Assessment of Study and Relevance to GLMRIS: This large sample provides broad coverage across the entire state, and was stratified in ways that would allow aggregation across sites. In conjunction with Connelly and Brown (CV 1991) this research is unique in the sense that it allows comparison of estimates obtained using the same methods for fishing seasons eight years apart. Site-by-site comparisons across the two survey years indicated that values either remained the same or declined over time, which would be consistent with a fall in recreational fishing effort on the GL that commenced in the early 1990s. In combination with a decline in fishing effort, the total estimates for the net-benefits of New York GL fishing fell from $133 million dollars in 1988 ($2012) to $91 million dollars in 1996 ($2012).

The estimated values provide a regional net value for a fishing day under the conditions that existing in New York in 1988 and are relevant as such to the GLMRIS project. Yet expanding a single state study to the entire geographical area of GLMRIS would not be appropriate because of the widely varying opportunities and conditions in the Great Lakes and UMORB.

<u>National Survey of Fishing, Hunting and Wildlife Associated Recreation – NFHWAR (CV 2006)</u>

Location: All 50 states and the District of Columbia

Data Type, Date: CV, Primary Data 2006

Project sponsor: U.S. Department of Interior, Fish and Wildlife Service (USFWS), and U.S. Department of Commerce, U.S. Census Bureau.

Publications: USFWS (2008, Report)
Aiken (2009, Report)
Harris (2010, Report)

Stated Purpose of Research Effort: In an effort to provide information about the importance of wildlife-based recreation in the U.S., the current form of National Survey of Fishing, Hunting, and Wildlife-Associated Recreation has been conducted every five years since 1991 with only minor changes during that period.

Data Collection/Sampling Information: A multistage probability sample of "sportspersons" was drawn from Census Bureau files, generating 22,000 complete interviews (r.r. = 77%). Interviews were conducted by telephone and in person. While the survey is motivated, in part, by requests from State agencies to provide state-level information, small sample sizes in some Great Lakes and individual states were "too small to report data accurately" and in other cases consisted of only 10-29 observations.

The survey elicits information about type and frequency of fishing, species targeted, fishing and boat expenditures and demographic characteristics, From the perspective of this review, the above information is augmented by CV questions that differentiated between within-state and out-of-state residents. After asking respondents to think about their share of expenses for a typical trout (or bass or walleye) trip during 2006, respondents were asked to provide an open ended CV indicting the additional cost that would have prevented him/her from taking even one such trip.

Reported values: Harris (2010) and Aiken (2009) provide estimates of net value per day of bass, trout and walleye fishing for selected states. The values reported exclude the Great Lakes. Average $2012 net value per day for in-state residents for Bass Fishing are $50 (Iowa), $68 (Missouri), $50 (Illinois), $69 (Indiana), and $71 (West Virginia). For trout fishing, WTP/day is $48 (Pennsylvania) and $53 (New York). Walleye fishing net value per day is $68 (Minnesota), $91 (Wisconsin), $48 (Michigan) and $74 (Ohio).

Assessment of Study and Relevance to GLMRIS: This periodic survey is important because it provides a series of snapshots of fishing effort. As such it is a source that is used for aggregating fishing effort across states and regions. A limit of this data is that coverage is thin in some settings, and the CV data are spotty and not linked to the quality of the resource.

With respect to providing net values his study could be of use to GLMRIS to fill in gaps for some species in some states where other non-market valuation studies have not been conducted.

Breffle et al. (Combined Methods 1999)

Location: Wisconsin Waters of Lake Superior and Lake Michigan and inland fisheries.

Data Type, Date: Combined travel cost method and choice experiments (a variation on contingent valuation), Primary Data Collection, 1999. (1998 fishing season)

Project sponsor: University of Wisconsin Sea Grant Institute.

Publications: Breffle et al. (1999, Report)
Morey and Breffle (2006, Journal Article)

Stated Purpose of Research Effort: The USACE documents (2000, 2012) treat TCM and CV methods as mutually exclusive. However, beginning in the 1990s, non-market valuation researchers began combining these two methods (Whitehead et al. 2008). The following study uses an approach that combines the travel cost method with choice experiments (a variation on contingent valuation).

The objective of this research was to assess compensable values of losses of recreational fishing opportunities as a result of releases of polychlorinated biphenyls (PCBs) into the waters of Green Bay. This report was prepared as part of the Lower Fox River/Green Bay Natural Resource Damage Assessment. This study offers a counterpart to the MacNair and Desvousges study referenced in the review of Murdcoch (TCM 2003) above.

Data Collection/Sampling Information: A three-step procedure was used to collect data from a random sample of individuals in the target population of anglers who purchased licenses in counties near Green Bay and who were active in fishing the Wisconsin waters of Green Bay. First, a random sample of anglers was drawn from county lists of 1997 resident and non-resident license holders. Second, using the license holder list, a telephone survey was conducted to identify and recruit Green Bay anglers for a follow-up mail survey. The telephone survey (r.r. = 69.4%), conducted from November 1998 to January 1999, collected data on the per day costs per angler and the number of fishing days under then current, 1998, conditions at Green Bay, along with attitudinal data. The cost and visitation data served as the primary inputs for the revealed preference model. Third, a mail survey with the stated preference questions was conducted with the current Green Bay anglers (r.r. = 78.9%, n=647). Respondents who agreed to participate in the mail survey were mailed a survey booklet within one week after they completed the telephone survey.

Reported values: The reported values in the study primarily pertain to the values estimated for different levels of water pollution in Green Bay. As such the values are generally not applicable to the GLMRIS project. For example, Breffle et al. (1999) report the following WTP values ($2012) for a 10% increase in catch rates for a range of species in Green Bay holding the contamination level constant: Yellow Perch ($1.03), Trout/Salmon ($1.07), Walleye ($0.56), Smallmouth Bass ($0.90), All Species at Once ($3.56). For these estimates the fish consumption advisory (FCA) level was kept constant at 4, which corresponds to the least restrictive of the actual FCAs in in Green Bay in 1998 (do not eat more than once a week for perch, and once a month for trout/salmon, bass and walleye).

Assessment of Study and Relevance to GLMRIS: The study is useful in that it provides an example of how combined valuation methods could be used for fishing quality changes at one site while considering possibilities of substituting in and out of the fishery. This could lead to defensible estimates of compensatory damages without the additional cost of "collecting legally defensible data on all the sites [which] can cost hundreds of thousands of dollars." (Morey and Breffle, 2006, p. 151)

The values reported here are not appropriate for GLMRIS because they only focus on improvements in quality. As shown in the Jones and Sung and MSU technical summaries in Chapter VI, values for losses and gains in quality are not symmetric.

Synthesis of Recreational Fishing Net Values

Estimating the Net Value of Fishing: This chapter reviews available studies that estimate the net value of recreational fishing in the Great Lakes, Upper Mississippi and Ohio River Basins. Table III.a provides a summary of estimates of net value per day of fishing from selected studies reviewed in this chapter, organized by the valuation method used. Studies included in the table are those that provide sufficiently rigorous estimates of the net value of fishing applicable to the study area.

The estimates of net value in Table III.a can be used to evaluate whether it is appropriate to use USACE's published unit day values (UDVs) to estimate the net value of recreational fishing in the study region. The USACE procedures and guidelines state that the UDV approach is not appropriate "If evidence indicates a value outside the published range" (USACE 2012). For "most warm water fishing" the relevant UDV would be "General Recreation" with an associated $2012 range of $3.72 to $11.17 (USACE 2012, p. 1). For "unique experiences such as inland and marine fishing for salmon and steel head" the UDV would be classified as "Specialized Recreation", with corresponding UDVs of $15.13 to $44.21 (USACE 2012, UDV attachment, p. 1). Because the estimates of the net value per day of fishing in Table III.a tend to lie above the range of UDVs published by USACE – particularly for warmwater fishing – USACE UDVs should not be used to estimate the net value of fishing in the Great Lakes and Upper Mississippi and Ohio River Basins. Instead, estimates should be used from studies conducted specific to the region for the specific activities (coldwater and warmwater fishing).

No single study in Table III.a covers the entirety of the study region in terms of geography or species targeted. This lack of coverage is important because evidence provided in a number of studies suggests that fishing values will vary across recreational sites and types of fishing. Therefore, fishing values estimated in one part of our study region may not apply very well to other parts of our study region. For this reason, CU concludes that *no existing individual study* can be used to provide an average net value per day estimate for the entirety of either or both basins.

Nevertheless, when *considered as a set,* CU believes that the studies included in Table III.a can be used to help determine the range of net values per fishing day that might be expected for the study area. While the range of net values provided by the various studies is broad, there is some convergence across studies. Because these studies were conducted in a variety of settings within the Great Lakes region, this range of net values likely encompasses the average net value within the region. An examination the values in Table III.a reveals that the number of observations above $75 are few and dispersed. Dropping the top three value estimates (Boyle et al. 1999, Salmon; Boyle et al., 1999 Bass, and Aiken, 2009 Walleye), which

Table III.a. Estimated Willingness to Pay Values per Person per Fishing Day

Valuation Method	Estimated Net Value/ Day ($2012)[a]	Fish Category	Location	Reference
Average Benefits Transfer	45	Cold water fish	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	48	Warm water fish	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	44	Anadromous runs	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	23	Mixed species	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer	56	Species not specified,	Great Lakes and the Northeast	Loomis and Richardson (2008)
Average Benefits Transfer/Meta Analysis	45-54	General	Great Lakes and the Northeast	Rosenberger and Loomis (2001)
Meta Analysis	90[b]	Bass	Great Lakes	Boyle et al. (1999)
Meta Analysis	109[b]	Salmon	Great Lakes	Boyle et al. (1999)
Travel Cost Method	41	Trout	Michigan Great Lakes	Lupi et al. (1998)
Travel Cost Method	51	Salmon	Michigan Great lakes	Lupi et al. (1998)
Travel Cost Method	42	Salmon and/or Trout	Wisconsin Water, Southern Lake Michigan	Phaneuf et al. (1998)
Travel Cost Method	42-55	Anadromous Runs	Lake Erie Tributaries	Kelch et al. (2006)
Contingent Valuation	54	Yellow Perch	Green Bay	Bishop et al. (1990)
Contingent Valuation	25	General	New York Great Lakes	Connelly and Brown (1991)
Contingent Valuation	28	General	New York Inland Waters	Connelly and Brown (1991)
Contingent Valuation	41	Salmon and Trout	Wisconsin Water, Great Lakes	Lyke (1993)
Contingent Valuation	22	General	New York Great Lakes	Connelly et al. (1997a)

(continued on next page)

Table III.a. Estimated Willingness to Pay Values per Person per Fishing Day (continued)

Valuation Method	Estimated Net Value/ Day ($2012)[a]	Fish Category	Location	Reference
Contingent Valuation	22	General	New York Inland Waters	Connelly et al. (1997a)
Contingent Valuation	50 (IA), 50 (IL), 68 (MO), 69 (IN), 71 (WV)	Bass	Selected States in Great Lakes and UMORB[c]	Aiken (2009)
Contingent Valuation	48 (PA), 53 (NY)	Trout,	Selected States in Great Lakes and UMORB[c]	Aiken (2009); Harris (2010);
Contingent Valuation	49 (MI) 68 (MN), 74 (OH), 91 (WI)[b]	Walleye	Selected States in Great Lakes and UMORB[c]	Aiken (2009)

d. Rounded to the nearest dollar.

e. As discussed in the text, these three observations are regarded as outliers.

f. UMORB denotes the Upper Mississippi and Ohio River Basins.

CU characterizes as outliers, suggests that average net value estimates will likely lie in the range from $20 to $75 ($2012).

As noted above, identifying a range of the value of a fishing day is only one of the components needed to estimate value of recreational fishing in the region. A measure of how much fishing occurs, such as angler days per year, is also needed. The US Fish and Wildlife Service provides periodic estimates of Great Lakes fishing effort as part of its National Survey of Fishing Hunting and Wildlife Associated Recreation (e.g. USFWS, 2006). This report does not break out participation data for the either the Great Lakes Basin or the Upper Mississippi and Ohio River Basins. However, it does report fishing participation for the Great Lakes, a resource that has received substantial popular attention due to concern about ANS in recent years and for which aggregate expenditure and economic impact values have been reported by the government and private entities (Great Lakes Commission, 2012; American Sportfishing Association, 2008).

While they are somewhat dated, CU uses participation data from the 2006 National Recreation Survey (USFWS 2008), as this is the most recent survey reported[5]. Although the USACE has expressed its own concerns about using the USFWS (2008) report for generating a

[5] A more recent survey was completed in March 2012, but the summary reports are not expected until November 2012. (http://wsfrprograms.fws.gov/Subpages/NationalSurvey/2011_Survey.htm)

value of recreation for GLMRIS (USACE 2012), the USFWS estimates of Great Lakes angler days remain the best currently available. Moreover, these estimates have been used elsewhere for calculating recreational value for the Great Lakes (e.g., American Sportfishing Association, 2008). For comparative purposes it is helpful to use the same baseline for aggregating values.

Multiplying the USFWS estimate of about 18 million angler days in the Great Lakes in 2006 by the range of a net values ($20 to $70 in $2012 dollars) identified above, results in a total annual recreation net value estimate ranging from $360 million to $1.35 billion.

<u>Estimating Changes in the Net Value of Fishing in Response to ANS:</u> While several studies have been conducted within the study region that attempt to estimate the impact that changes in fishing quality would have on recreational values from fishing, CU concludes that individually and collectively these studies do not provide a good basis for calculating economic losses associated with potential declines in catch rates, a measure of fishing quality that can potentially be linked to ANS. Our review of available studies shows that changes in net values that occur due to changes in catch rate depend on current catch rates at a site, the availability of alternative fishing sites, and other factors. Therefore, transferring estimates of economic losses associated with a decline in fishing quality based on a study at one site to other sites within the study area is not recommended.

An analysis by Johnston et al. (2006) points to another possible approach to estimating damages, multiply WTP per fish by the reduction in fish catch. Motivated by policy analyses that call for welfare estimates denominated in per fish units (e.g. US EPA 2004), they conduct a meta analysis of the marginal value of catching an additional fish. The meta regression results demonstrate that reported values vary systematically with methodological variations across studies, angler attributes, and resource and context attributes. After statistically accounting for these variations across studies, “These results suggest that WTP per fish is closely related to the type of species targeted. Moreover, model results appear to be consistent with common intuition regarding the highest verses lowest value recreational fish” (Johnston et al. 2006, p. 23). Despite this positive result, a closer examination of the data suggests that WTP per fish varies widely for a species across studies. For example, Johnston estimates marginal WTP for walleye to be $5.10 ($2012) in the Breffle et al. (Combined Methods1999) study and $27.95 ($2012) based on Murdoch’s analysis.

On the basis of this wide variability in value per fish across studies, CU would not recommend using a WTP per fish approach based on the existing literature to address quality changes in the GLMRIS study area.

IV. Economic Valuation Studies of Beachgoing in the Great Lakes and Upper Mississippi and Ohio River Basins

Relative to its popularity as a recreational activity[6], researchers have expressed surprise that there has been comparatively very little research on measuring the recreational use value of a beach day (Freeman 1995; Song et al. 2010). A substantial literature has built up on the valuation of water quality improvements and decrements, typically motivated by levels of water impairment under the Clean Water Act. For example, Iowa State University has undertaken a substantial statewide water quality valuation effort (http://www.card.iastate.edu/environment/). However, WTP for water quality improvements encompasses a range of activities in addition to beachgoing and these studies do not isolate benefit measures for individual activities. Other research (e.g. , Rabinovici et al. 2004), focuses on health impacts associated with water contamination, which would only be relevant to the current project to the extent that invasive species foster water quality contamination problems related to health outcomes. A broader focus on water quality improvements also includes non-use use values over and beyond values associated with swimming or other water recreation (e.g., Carson and Mitchell 1993). Moreover, many of the studies that have focused on beach recreation have been directed toward valuing specific beach projects such as erosion control (e.g. Croke et al. 1987) or beach renourishment (e.g. Van Houtven and Poulos 2009). In all, this broader set of studies on water quality is neitheramenable to isolating the value of a beach recreation day nor estimating how such values would be affected by ANS, and hence not of direct relevance to the GLMRIS project.

With respect to non-market valuation research, a meta analysis by Atiyah (2010) identifies 35 studies from 1975 to 2005 that estimate use value estimates for beach visit days under existing conditions. However, the geographical coverage of beach studies has been far from comprehensive.

> "The beaches of Florida and California have been examined more often than the rest of the coastal states combined, leading with 10 and 8 studies respectively. On the East Coast, most studies have been conducted in Massachusetts and New Jersey, but many coastal states and the Great Lakes have few or no studies on beach use. This is likely because Florida and California are considered major beach destinations and thus have dominated the research agenda." (Atiyah 2010, pp. 56-57).

One Great Lakes study was included in Atiyah's review (Sohngen et al. 1999). CU has located four additional studies (two of which were produced after the 2005 end-date for Atiyah's data set). All of these studies used the travel cost method (TCM).

[6] Leeworthy et al. (2005) estimate that over 900 million days of marine beach recreation (excluding the Great Lakes) were taken the United States in 2005. This averages to over 4 days per person per year.

Based on the 35 published and gray literature studies included in Atiyah's (2010) meta analysis, it is evident that that beach recreation values are highly variable across non-market valuation methods, over time and across states. Loomis (2005) identifies 22 net-benefit/person/day estimates for "going to the beach" in the Northeast, with a mean value of $51 ($2012). This information suggests that that application of the USACE unit day values (UDV) of $3.72 - $11.17 for general recreation (e.g. picnicking and swimming) is not appropriate for application to the GLMRIS project.

Atiyah's (2010) meta analysis further demonstrates that estimated recreational beach day values varied significantly by whether the study used CV (lower value estimates) or TCM (higher), whether average values per trip (higher) or marginal values (lower) per trip were collected, where the beach was located (California had lower values) and by authorship and year. While annual and total values of beaches are higher the, perhaps surprising, lower recreational day values for California beaches is explained by the higher frequency of visits and the availability of substitute activities. Within the beachgoing valuation studies conducted in the Great Lakes region reviewed on the following pages, estimated values have systematically varied with difficulty of access, the Great Lake on which the beach is located, proximity to large populations, beach length, presence of zebra mussel shells, and contamination advisories (Murray et al. 2001; Yeh et al. 2006; Song et al. 2010).

CU now turns to individual assessments of the Great Lakes beach recreational values studies. CU begins with a review of the Loomis (2005) benefits transfer report and Atiyah's (2010) meta analysis thesis (MA). CU then examines four travel cost studies that have been conducted in the region.

<u>Loomis (ABT, 2005)</u>

Location: Northeast area, corresponding to Forest Service Region R9 (Northern United States Eat of the Rocky Mountains)

Data Type, Date of Data Collection: Average benefits transfer; Secondary Data.

Project sponsor: US Forest Service, Pacific Northwest Research Station

Publications: Loomis (2005, Report)

Summary: This report served two functions. First, it provided information from a literature review of economic studies conducted from 1967 to 2003 in the United States. Second, it develops basic guidelines on performing benefits transfers in the context of recreational use valuation.

Data Collection/Sampling Information: This study is an iteration of a long series of data collection activities covering recreational valuation studies from mid-1960s to 1982 (Sorg and Loomis 1984), 1968 to 1988 (Walsh et al. 1992), 1968 to 1993 (MacNair 1993) and 1993 to 1998 (Loomis et al. 1999). Rosenberger and Loomis (2001) then merged many of these reports and improved coding procedures. The present report added new studies up through 2003, resulting in a data set with 1,239 estimates of net values for 30 outdoor recreation activities.

There are 22 estimated values from an unspecified number of studies conducted in an area that roughly follows the Northeast census region (the northeastern states extending eastward from Minnesota/Iowa/Missouri)

Reported Values: The estimated net value per day of “going to the beach” is $51 ($2004) with a range from $5 to $141.

Assessment of Study and Relevance to GLMRIS: This study is useful in that it demonstrates the range of beach recreation values across a number of studies. With the exception of Sohngen et al. (1999), which CU reviews below, all studies reported in the northeast region were conducted at saltwater sites. Beyond background information on beach recreation values, this report does not bring any information relevant to the GLMRIS project.

Atiyah (ABT 2009)

Location: United States, Secondary Data from 35 studies

Data Type, Date of Data Collection: Average benefits transfer; secondary data.

Project sponsor: Not Specified aside from University Affiliation, University of California Los Angeles

Publications: Atiyah (2009, Dissertation)

Summary: The study reviewed is one of three papers/chapters in a doctoral dissertation. The overall objective was is to explore the degree to which beach recreation values currently available in the literature can be useful in guiding beach management policy, especially when original research is not possible. A literature review was conducted to identify estimates of net values. A statistical analysis of these values was undertaken to identify what effect that factors (geography, value type and methodology, authorship and year of study) have on value estimates.

Data Collection/Sampling Information: Studies were identified primarily by drawing from the National Ocean Economic Program (NOEP) data base for non-market values (see http://www.oceaneconomics.org/nonmarket/valEstim.asp) . Thirty five studies providing 98 value estimates were identified, primarily from the coastal regions with a concentration of studies from California and Florida. One Great Lakes study was included in Atiyah's review (Sohngen et al. 1999).

Reported Values: The range in values of this study was from $0.08 ($2012) to $140. No average was provided.

Assessment of Study and Relevance to GLMRIS: This study is useful in that it demonstrates the range of beach recreation values across a number of studies, providing evidence that they vary systematically due to a number of factors including methodology (travel cost method estimates are higher than contingent valuation estimates), beach location and author and year published. With the exception of Sohngen et al. (1999) which CU reviews below, all studies used were saltwater sites. Hence, this report does not bring any additional information specific to the GLMRIS project.

Sohngen et al. (TCM 1998)

Location: Two Lake Erie Beaches, Maumee Bay and Headlands State Park

Data Type, Date of Data Collection: Single site TCM; Primary data collection 1997.

Project sponsors: Lake Erie Protection Fund, the Ohio Sea Grant College Program, National Sea Grant College Program, State of Ohio, the Greater Toledo Convention and Visitors Bureau, and the Lake County Visitor Bureau.

Publications: Sohngen et al. (1998, Report)
Values are also reported in Parsons (2003, Book Chapter)

Summary: The objective of this study was to provide the first estimate of the recreational value of freshwater beaches to provide better information to policy makers, beach managers and local officials.

Data Collection/Sampling Information: In the summer of 1997, questionnaires were distributed using a random assignment to beach users at two beaches (Maumee Bay and Headlands) at opposite ends of Ohio's Lake Erie coast. The two beaches also vary dramatically in terms of amenities on the beach. Individuals who agreed to complete the questionnaire but did not send a prompt response were sent a follow-up questionnaire. Response rates across the two sites were 52% (n=394) and 62% (n=376).

Information was collected on the frequency of visits, expenditures, demographic characteristics and attitudes. Average number of single day beach trips per season ranged from 6.0-7.9 at these sites, with an average mileage traveled of 26-35 miles. Multiple day trips averaged 3.7-3.9 a season at these, with the average distance traveled being 86-175 miles. Response patterns suggest that water quality has a relatively small effect on decisions to go to a beach, but that "individuals appear to be concerned about the water quality at the particular beach they are visiting."

Reported values: Parsons (2003) summarizes the range in day trip values (in $2012) being between $20 and $47 for Maumee Bay with a midpoint of $33. For Headlands the range was $16-$55 with a midpoint of $35.

Assessment of Study and Relevance to GLMRIS: This represents a novel first application to Great Lakes beach recreation that directly reports a value per beach day. Subject to technical concerns about the role of substitute beach sites, this paper provides a localized value estimate for a beach day that could be used as input in to the GLMRIS project. Yet, it is questionable if such localized beach estimates are appropriate as estimates for the entire GLMRIS region.

<u>Sohngen et al. (TCM 2001/2006)</u>

Location: 15 Lake Erie Beaches

Data Type, Date of Data Collection: Multisite TCM; Primary data collection 1998.

Project sponsors: National Oceanographic and Atmospheric Administration, Ohio State University Sea Grant College Program.

Publications: Murray et al. (2001, Journal Article)
Yeh et al. (2006, Journal Article)

Summary: Reflecting concerns about deteriorating water quality at Great Lakes beaches, resulting in beach closure advisories, and increased efforts to provide information about beach advisories, this study, sought to estimate the benefits of reduced closure days and the role of information in choice decisions.

Data Collection/Sampling Information: Respondents were intercepted at 15 different Lake Erie beaches during randomly selected sampling periods in summer 1998 (r.r. =56%, n=1587). The questionnaire asked individuals to log the type of trip (single or multiple day) on which they were intercepted, how they were spending their time on that trip, and the number of single or multiple-day trips they had taken and planned to take to each to the 15 Lake Erie Beaches and beaches outside of that set throughout the entire year. The average visitor took 15 beach trips to these targeted beaches a season and three other beach trips. Home zip code and information on income were gathered for the travel cost analysis. Other demographic and attitudinal variables were collected along with information centered on how respondents learned about and reacted to beach advisories. Information on water quality (average E. Coli measurements per season), number of advisories per seasons and grain size, slope of beach, number of zebra mussel shells and facilities were gathered from other sources.

Reported values: Reported values focus on the value of reduced beach closure advisories, and hence localized pollution levels. Murray et al. (2001) estimate that removing an advisory on each beach that experiences them could improve seasonal welfare by up to nearly $39 per season ($2012).

Assessment of Study and Relevance to GLMRIS: This study provides useful information about pollution costs and how recreationists' choices are affected pollution advisories. It also demonstrates the variety of quality variables that might need to be considered in assessing the net value of beach recreation on the Great Lakes coast.

This study does not provide information useful for estimating aggregate net values for beach recreation in the Great Lakes. It is only related to assessing the impact of water quality changes if ANS can be linked to beach closure and related advisories.

Shaikh (TCM 2006):

Location: Chicago Beaches

Data Type, Date of Data Collection: Single site TCM; Primary data collection 2004.

Project sponsor: Joyce Foundation, University of Chicago.

Publications: Shaikh (2006a, Mimeo)
Shaikh (2006b, Presentation).

Summary: The objectives of the project were to assess the economic value of a day at the beach and the total seasonal value of Chicago Beaches along with the economic impact of swimming bans.

Data Collection/Sampling Information: A total of 1573 in-person, on-site surveys were conducted on nine different Chicago beaches in the summer of 2004. The proportions of surveys conducted on each beach were based on attendance by beach. Between 85% and 90% of individuals approached agreed to do the survey.

The information collected in the survey included: trip distance, mode of transport, time traveled and other travel expenses, activities and time on the beach and demographic characteristics. Perceptions of beach quality and the existence of swim bans were also elicited.

Reported Values: The estimated value of a day at the beach was $48 ($2012) and the average visitor went to the beach 14 times in a season.

Assessment of Study and Relevance to GLMRIS: This study is unique in the Great Lakes in that it provides information about urban beachgoing and could be of use to other similar settings across the Great Lakes.

Song et al. (TCM 2010)

Location: Great Lakes Beaches on all Michigan State Great Lakes

Data Type, Date of Data Collection: Multisite TCM; Primary data collection 2007 (recall data for 2006).

Project sponsors: Not identified.

Publications: Song et al. (2010, Conference Presentation)

Summary: This study sought to provide recreation use values for Great Lakes beaches in Michigan, including the entirety of nearly 600 separate beaches across the four Great Lakes in the state.

Data Collection/Sampling Information: Using a web-based survey drawing from a representative web-based survey panel in 2006, the survey instrument identified respondents who indicated that they had visited a Great Lakes beach in the previous year. Beach visitors (n=2566) were ask to provide the beach name and other identifying information for the beach they had visited the most during the last three years, with over 66% providing enough information to precisely locate the beach visited. Household zip code and demographic information also were available. Data available about the beaches included length of beach and number of days of beach advisories and closures in 2006. The total number of beach days per season was not collected.

Reported Values: The estimated net value of a day at the beach in $2012 ranged from $46 (Lake Superior) to $62 (Lake Erie) with an estimate for all sites being $52. The estimated loss associated with closing a particular site on a day the individual had chosen to go to the beach ranges from $-0.11 (Superior) to $-1.01 (Erie), with a central estimate of $-0.37. If instead all the sites on an entire lake were closed on the day an individual decided to go to the beach, then the estimated average losses would be $-83 (Michigan), $-3 (Superior), $-15 (Huron) and $-15 (Erie). The differences in values across lakes are explainable. Lake Michigan sites are numerous and popular. Lake Superior has low visitation rates.

Assessment of Study and Relevance to GLMRIS: This study demonstrates that the net value of current beach use and changes in use are affected by whether substitute beach sites are available. Therefore, it is necessary to account for the pattern of impacts on beaches that ANS might have in simulating economic losses. (That is, economic losses will differ if affected beaches are clumped in one region vs. randomly distributed.) The authors note “In general, the estimated economic loss per person per trip of closing an individual site is not large. This appears to reflect the presence of many substitutes of the loss/closure of one beach site.”

While it may be true that the economic losses of closing an individual site are not large, it is less true for the loss of all beaches in a region or even all Great Lakes beaches.

This study provides value estimates consistent with day use and is relevant to the GLMRIS project as such. While this study provides estimates for beach recreation for four Great Lakes coastlines in Michigan, these values may not be extendable to other states.

Synthesis of Beachgoing Net Values

Evidence from recreation beach valuation studies conducted across the United States from 1975 to 2005 (Atiyah, 2009) suggest that the range of possible values of beach recreation days will exceed the USACE unit day values (UDV) for general recreation. Such a finding is consistent with a recent USACE report that notes that unit day values "used by the Corps… are significantly lower (in real terms) than unit values for comparable recreation activities estimated in contemporary recreation demand studies" (Scodari, 2009, p. 50) Given this result, USACE procedures and guidelines recommend that site or regional TCM or CV values be used.
Table IV.a summarizes the average WTP per day of beach recreation reported in the TCM studies reviewed above earlier in this section that were deemed appropriate for use in the GLMRIS project.

Table IV.a. Estimated WTP Values per Person per Beach Recreation Day

Valuation Method	Estimated Net Value/Day[a] ($2012)	Location	Study
TCM	$33 -$35	Two Lake Erie (Ohio) Beaches	Sohngen et al. (1998)
TCM	$48	Chicago Beaches	Shiakh (2006)
TCM	$46-$62	Michigan State GL Beaches	Song et al. (2010)

a. Rounded to the nearest dollar.

While there is some convergence in estimated values across the three studies, CU maintains that it is premature to draw conclusions regarding the average or a range of per person/per day net values. By itself, this precludes being able to estimate an aggregate net value for beach recreation in the GL Basin, let alone the UMORB.

An equally fundamental problem is that there is no estimate of aggregate beach visitation in either basin. There are a number of piecemeal publications that provide estimates for particular beaches or stretches of coastline. However, the only published attempt that CU is aware of that tries to provide a contemporary estimate of beach users and beach days across the Great Lakes is Austin et al. (2007). They proceed by transferring ratios of beach swimmers to total population (0.43) and swimming days per population (4.4) per person from a study of coastal population in marine (saltwater) coastal states with similar swimming season lengths as in the Great Lakes (see Leeworthy and Wiley 2001; Leeworthy et al. 2005 provide national projections for marine (saltwater) beaches for 2010). These states include Connecticut, Delaware, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Oregon, Rhode Island, Virginia, and Washington. On this basis Austin et al. estimate that there are about 8 million swimmers and 84 million Great Lakes swimming days per year. Taking the ratio of swimming days per swimmer provides an estimate of 10 swimming days per swimmer.

CU is cautious with respect to this projection. First, to our knowledge there is no evidence that coastal beach visitation to population patterns parallel those in the GL Basin. Further, based on the survey data provided by Shaikh (TCM 2006), Murray et al. (2001), and Yeh et al. 2006), the measured, as opposed to projected, visitation rates by beachgoers is 14 to 18 visits per season rather than 10. Austin et al. (2007) similarly raised questions about the accuracy of their own projections by comparing their estimates with those of other estimates for particular localities. They note “For example, Chicago’s beaches receive about 27 million visitors a year according to one source, and we estimate 27 million swimming days for all of Illinois” (p. 35). On the basis of these types of comparison they conclude that their estimate is likely to be conservative. In all, CU finds reason to discount the Austin et al. projection for use in policy evaluation.

The existing literature is also inadequate to begin to project estimates of economic loss associated with ANS. Only two studies have estimated quality impacts on beach recreation within the GL region, and CU has not located any studies in the UMORB. Further the two quality studies focus on E. Coli contamination and corresponding beach advisories, which may or may not correspond to the effects of ANS.

The Song et al. (TCM 2006) results point to the issue of substitution effects across beaches as a dominant concern in any efforts to simulate the economic effect of ANS. The key point is that the *distribution* of beaches impacted by ANS will fundamentally affect the level of damages. One cannot simply say, for example, that ANS will impact 20% of the beaches on Michigan’s Lake Michigan coast. The level of damages will be fundamentally related to how that 20% is distributed, whether for example the beaches are clumped in a contiguous manner or randomly distributed across the entire coast.

In all, CU concludes that the existing body of literature on beach valuation is inadequate for providing aggregate estimates of total recreational use value and changes in value associated with the quality of beach recreation.

V. Economic Valuation Studies of Boating in the Great Lakes and Upper Mississippi River Basins

In his 1995 review of the water recreation literature, Freeman said, ”There is virtually no literature on the value of access to marine waters for boating activities other than fishing” (p. 393). This lack of information is seen in other sources as well. The data base maintained by Rosenberger, Loomis and colleagues over the years contains only two Great Lakes states studies in the Northeast from 1985 to 2011 with respect to motor boating, and three more studies in the category of floating/rafting/canoeing, which is not enough to provide data for a benefits transfer analysis (see Loomis and Richardson, 2008 or http://recvaluation.forestry.oregonstate.edu/)[7].
Recreational boating may fall in either the general ($3.72-$11.17) or specialized ($15.13-$42.21) UDV category. The USACE 2012 UDV document suggests that boating should be included in the General Category. However, white water boating, especially in back-country or hard-to-access areas characterized by “low density use”, might be categorized as Specialized Recreation.

Following the format used in the recreational fish and beachgoing reviews in Chapters 2 and 3, CU now provides a review of six studies that give estimates of net value for recreational boating in the study region. Net value for recreational boating varies with the type of boating activity, so CU includes that in the data type section of each review. The study reviews are organized by method as follows: meta analysis (MA), travel cost method (TCM) and contingent valuation (CV). Within each method, the studies are ordered chronologically. CU does not report separate values for benefits transfer because the limited number of studies that are relevant to the GLMRIS are evaluated individually here.

[7] (One of the studies reported in the Loomis and Richardson data set focuses on willingness to pay for reductions in phosphorus run off (Matthews et al., 2002), but it did not separate out willingness to pay values associated with recreational boating, so it is not reviewed here.)

Rosenberger and Loomis (MA 2000)

Location: Northeast area, corresponding to Forest Service Region R9 (Northern United States East of the Rocky Mountains)

Data Type, Date of Data Collection: Meta analysis; Secondary data.

Project sponsor: US Forest Service, Rocky Mountain Research Station

Publications: Rosenberger and Loomis (2001, Report)
Rosenberger and Loomis (2000, Journal Article)

Summary: This study served two functions. First, it provided information from a literature review of economic studies spanning 1967 to 1998 in the United States and Canada. Second, it developed guidelines for performing benefits transfers in the context of recreational use valuation.

Data Collection/Sampling Information: This study was the most recent iteration of a long series of data collection covering recreational valuation studies from mid-1960s to 1982 (Sorg and Loomis 1984), 1968 to 1988 (Walsh et al. 1992), 1968 to 1993 (MacNair 1993) and 1998 to 1998 (Loomis et al. 1999). This study merged many of these reports and improved coding procedures. The resulting data set included 760 travel costs and contingent valuation net value estimates from 163 separate research efforts covering 21 recreational activities.

Reported Values: The estimated net value per motorized boating trip was about $43 and for float boating was about $62 ($2012).

Assessment of Study and Relevance to GLMRIS: The data provides comprehensive coverage of recreational values across a number of recreational activities. For technical reasons (see Chapter VI) CU does not recommend using the net value estimates above for either motorboating or float boating under the GLMRIS project. Further, this study does not estimate how net value might change in response to changes in resource quality.

Hellerstein (TCM 1991)

Location: Boundary Waters Canoe Area, Minnesota

Data Type, Date of Data Collection: Canoeing; Single site TCM; Secondary data (from 1980)

Project sponsor: US Forest Service, Rocky Mountain Forest and Range Experiment Station

Publications: Hellerstein (1991, Journal Article)

Summary: The objective of this paper was to evaluate how different statistical models affect net value estimates.

Data Collection/Sampling Information: Data were taken from 27,433 overnight permits issued for the Boundary Waters Canoe Area in 1980, comprising a complete census of overnight visitors. The date of the study falls before 1985, the cutoff date identified for studies to be uses in this review. However, it was included in this analysis because the modeling techniques are consistent with methods used currently. In addition, the application to canoeing is unique within the study area.

While the data provided information about the distance travelled to the site and the length of stay, individual characteristics were not observed and thus could not be incorporated into the modeling framework (see technical notes in Chapter VI).

Reported Values: The estimated net value per trip ranged from $9 ($2012) to $17.

Assessment of Study and Relevance to GLMRIS: This study provides information about an activity that is not present elsewhere in our literature review.

This study is potentially relevant to GLMRIS for estimating the total value of canoeing in remote areas, although some caution is warranted because of the age of the data. This study does not estimate how net value changes as resource quality changes.

__**Bowker et al. (TCM 1997)**__

Location: Gauley River, West Virginia

Data Type, Date of Data Collection: Whitewater rafting; Single site TCM; Primary data collection in 1993.

Project sponsor: Not identified.

Publications: Bowker et al. (1997, Working Paper)

Summary: The objective of this research was to develop and statistically test whether individual single site travel cost demand models for whitewater rafting trips could be transferred from one study area to another. In addition to the Gauley River, which lies in West Virginia in the GLMRIS target area, TCMs were developed for four other sites out of the target area.

Data Collection/Sampling Information: A random sample of names was drawn from outfitter records of those people who used outfitter services on that river in 1993. Questionnaires were mailed asking for information on trips, expenditures and various socioeconomic variables. Response rates for the five study areas ranged from 28% to 46%, but no specific response rate for the Gauley River study area was provided. Because this data is drawn from outfitter records, the estimated values are only relevant to guided rating trips.

Reported Values: The estimated net value per trip ranged from $365 ($2012) to $502 for a guided rafting trip.

Assessment of Study and Relevance to GLMRIS: The limited discussion of data collection provided makes it difficult to assess the quality of these data. The focus of the paper was on benefits transfers, and the information was limited on the attributes of the actual study. The relatively high estimated net value per trip is intriguing, as the direction at least is consistent with the idea that whitewater rafting is a unique experience that should be differentiated from other types of boating.

This study is not is not relevant to GLMRIS, because not enough information is available to assess the overall quality of the reported net values.

Bhat et al. (TCM 1998)

Location: Northeast and Great Lakes Ecological Region

Data Type, Date of Data Collection: Motor boating and water skiing, TCM, Secondary data collected in 1985-1987.

Project sponsors: U.S. Forest Service (USFS)

Publications: Bhat et al. (1998, Journal Article)

Summary: The purpose of this research was the Renewable Resource Planning Act requirement that the USFS develop general estimates of the economic value of a variety of outdoor recreation activities in the United States. Net value for motor boating was estimated along with similar values for several other recreation activities. The specific purpose of the paper was to provide a methodology for estimating recreation values in the U.S. using what the authors refer to as an "ecoregional" approach. The ecoregional approach divides landscapes into various size ecosystem units that represent geographical groups or associations of similarly functioning ecosystems. The Northeast and Great Lakes Ecoregion corresponds somewhat with the GLMRIS study area. It includes parts of Minnesota, Missouri, Wisconsin, Illinois, Indiana, Ohio, Michigan, Kentucky, Tennessee, West Virginia, Pennsylvania and New York .

Data Collection/Sampling Information: Data for this study was obtained from the Public Area Recreation Visitor Study (PARVS) and the "CUSTOMER" survey. PARVS and CUSTOMER were ongoing multi-agency data collection efforts that conducted on-site interviews at over 350 sites across the continental United States from 1985 to 1992. Sites included National Parks, Forests and Rivers, USACE and Tennessee Valley Authority Reservoirs and numerous state recreation areas. Data were collected on the respondents' personal and household characteristics, the main activity of the trip during which they were being interviewed, trip expenditures, distance and time of travel. Individuals completed a 12 month profile of the total number of recreational trips taken, list of sites visited and activities taken, and length of each trip.

Reported Values: The undated estimated net value per day was reported to be $9.85. Assuming a reference date of $1992, this translates to about $16 ($2012).

Assessment of Study and Relevance to GLMRIS: This approach differs from the other TCM studies reviewed in this document which focus on the values for an individual site/activity and the reason that individuals choose one site over the other. This study instead lumps all sites into one unified model, which along with other technical issues discussed in Chapter VI creates likely biases. For this reason this study is not relevant to the GLMRIS project.

<u>Shafer et al. (TCM 2000)</u>

Location: Pennsylvania water bodies

Data Type, Date of Data Collection: Motor boating, single site TCM; Primary data collection 1994.

Project sponsor: Not identified.

Publications: Shafer et al. (2000, Journal Article)

Summary: The objective of this study was to estimate the economic value of seven major motor boating sites in Pennsylvania, three of which lie in the Great Lakes or Upper Mississippi and Ohio River Basins (Three Rivers Area, Lake Erie/Presque Isle Bay, Kinzua Reservoir).

Data Collection/Sampling Information: A systematic sample of every 20th registered boat owner in Pennsylvania with a boat in the range of the 16 feet or longer was sent a mail questionnaire in 1994 (r.r. = 27.9%, n=2731). Boat owners were asked to provide travel cost information for their most recent trip including location, expenditure and length of stay. In addition, boaters were asked to report the total number of boating trips taken to the site each year. About 76% of the total boat trips reported were taken to seven major sites and 36% of the reported trips involved fishing.

Reported Values: The estimated net value per trip (in $2012) was $104 (Three Rivers), $178 (Lake Erie/Presque Isle), and $144 (Kinzua Reservoir).

Assessment of Study and Relevance to GLMRIS: The modeling in this study was at a minimal level and the presentation was incomplete (see technical details in Chapter VI). Given these shortcomings, the main contribution of this study is to point out the possibility of double counting between fishing and boating in creating an aggregate value, as 36% of the boat trips taken involved fishing.

This study is not is not relevant to GLMRIS, in part because not enough information is available to assess the overall quality of the reported net values.

Connelly et al. (CV 2005)

Location: Lake Ontario and the St. Lawrence River

Data Type, Date of Data Collection: Motor boating; CV; Primary data collection in 2002.

Project sponsors: International Joint Commission.

Publications: Connelly et al. (2005, Project Report)
Connelly et al. (2007, Journal Article)

Summary: The objectives of this study were to show how the net value of recreational boating can be assessed and how net value for recreational boating can be linked to water levels. Water levels affect the ability to launch boats from docks, marinas, boat ramps etc. The review here focuses only on the net value estimates for the conditions taken on a typical trip and does not include the Canadian portion of the study.

Data Collection/Sampling Information: A stratified sample (accounting for boat length and geographical region) was drawn from registered boaters who indicated on their license application that their county of principal use was one of the eight counties bordering the study site. A telephone screening was used to identify those who had boated on Lake Ontario or the St. Lawrence River in 2002. A mail survey was sent to those telephone respondents who agreed to participate (r.r. =70%, n=2388).

Boaters' WTP was measured through the mail questionnaire by asking about the length of a typical trip, expenditures made on such a trip, and then an open-ended CV question regarding the maximum amount that the boating group would have been willing to pay for a typical trip before they would they have decided not to go.

Reported Values: The mean net value per day per boat was $87 ($2012). If one assumed that "the estimated value was distributed equally among people on the boat, a rough estimate would be" almost $29 ($87/3). Comparison of values across access methods suggest that the net value per day is higher for boaters who make use of a marina, yacht club or private pier. There is also some spatial variation, with Eastern Lake Ontario and the St. Lawrence River having an average estimated net value per day that is 13% higher than that of Western Lake Ontario. Finally, reported WTP values per boating day ($2012) vary across boat lengths: $79 (<16 feet), $87 (16 feet – 25 feet), $127 (26 feet – 39 feet), $102 (40 feet or more).

Assessment of Study and Relevance to GLMRIS: This is a very straightforward study with close attention paid to sampling design. The results are important in that they demonstrate that net value varies by location and boat size category.

The results of this study could serve as inputs to the GLMRIS study for estimating the net value of boating. However, CU would not recommend extending a single state study to estimating net values for the entire Great Lakes and UMORB. Although changes in net value associated with changes in water level were estimated, this does not pertain to ANS. Therefore, this study is not relevant to the GLMRIS project for estimating changes in value due to ANS.

Synthesis of Recreational Boating Net Values

In contrast to recreational fishing and beachgoing, CU does not provide a summary table of net values of boating. Only the Hellerstein (TCM 1991) and the Connelly et al. (CV 2005) studies provided net values per recreational day that could be used to calculate aggregate net value. These average net values are $12 (canoeing) and $29 respectively in $2012.

The timing of the Connelly et al. (2005, 2007) study is fairly close to the John Glenn Great Lakes Basin (USACE 2008) recreational boating study that gathered activity patterns for recreational boaters in 2003-2004. This study estimates that about 17 million boat days occurred on the Great Lakes and connecting waters in 2003 and provides breakdowns by state, whether a boat is in a marina or not, and boat length. However, CU would not recommend multiplying this estimate of days by the value from only one study in one state to get an estimate of aggregate net value because conditions vary too widely across the study area.

Beyond net value estimates, the values reported in these various studies suggest that there is substantial variation in net values across different boating activities and locations. This suggests that future research intended to provide information about the total net recreational boating value in the GLMRIS, should estimate values for each boating activity as well as values for different boating classifications within a specific activity. To achieve a total net value for boating each of these values would have to be matched with an estimate of total effort for that activity.

The existing body of research does not address changes in values that might be linked to ANS.

VI. Technical and Econometric Details of Studies Reviewed

This chapter provides additional information about technical details for many of the recreational valuation studies reviewed in Chapters II-IV. The order of presentation follows the ordering in those chapters

Recreational Fishing Studies: Chapter II

Loomis and Richardson (ABT 2007): Technical Econometric Details.

There are no technical features that merit attention for this report.

Rosenberger and Loomis (ABT/MA 2001): Technical Econometric Details.

There are no technical features for the average benefits transfer portion of the study that merit attention for this report.

The meta analysis includes 701 net value estimates from 131 studies of 21 recreation activities from 1967 to 1998. An ordinary least squares model of a linear form was used to estimate the meta regression. Focusing only on the results relevant to this review, the meta regressions finds that the valuation method, region, and water body were significant explanatory factors. The coefficient on fishing, however, was not significantly different from general recreation.

A separate meta regression was not run for fisheries data by itself and net value estimates are derived from the broader model.

Boyle et al. (MA 1999): Technical Econometric Details.

The data used were not the complete population of studies available at the time. Because of resource constraints, data collection was truncated at 150 of the 250 or so studies identified in the literature.

An ordinary least squares model of a linear form was estimated. Coefficients that were significant in the full sample model included the type of fish, the water body, valuation technique and method used to elicit values (e.g. a mail survey).

Of relevance to this review are the two hypothetical policy scenarios, assuming a travel cost method, for Great Lakes Salmon and Great Lakes Bass Fishing. The respective estimated total day values in $1996 were $62.06 ($48.50) and $75.10 ($48.61) with the standard deviation of the estimates provided in the parentheses. As such, the estimated values are relatively imprecise with coefficients of variation of 1.28 to 1.55. Hence, utilization of these net value estimates should be conducted with caution.

Lyke (TCM 1993): Technical, Econometric Details.

The TCM data were estimated using various random utility modeling specifications. It was found that a two-level nested logit model was estimable and performed best amongst alternatives considered. The two nesting levels were mode (charter fishing, fishing from a private boat, stream fishing or another kind of fishing) and destination (defined as a fishing area in relation to a location). Estimated coefficients on trip cost and time were negative. Coefficients for catch rates were positive.

There are several technical concerns with this study. The data collected from the Wisconsin Great Lakes (WGL) and Wisconsin Sportfishing (WSF) surveys are distinct in the sense that no site-specific data is collected on inland fisheries activities in the WGL. Within the inland questionnaire, the locational data is collected for only two of the most visited sites, raising questions about the completeness of the site choice set and subsequent biases. Further, it is not clear how alternative sites were identified and included into the analyses. These limitations on spatial resolution hamper consideration of substitution effects between Great Lakes and Inland Waters, and uncertainty about how site alternatives were handled raises concerns about the overall econometric analyses. Variation in catch rates is significant in the model, but is based on self-reported catch data which has been argued against in the literature because of endogeneity. Finally, there is a lack of clarity in the dissertation explaining how values were derived, which complicates external assessment of the quality of the analysis.

Jones and Sung (TCM 1993): Technical, Econometric Details.

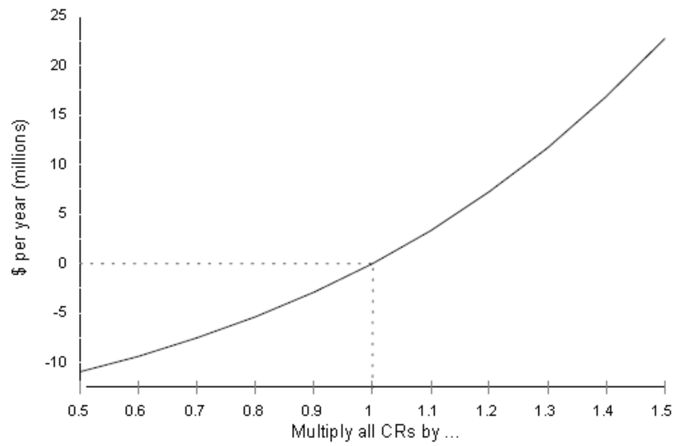
The authors developed a random utility model (RUM) of demand for recreational fishing, covering all water bodies and all species types throughout all 83 counties in the state. A nested multinomial logit RUM was used for the site choice model. Three levels of choices were modeled for each choice occasion: type of trip (single day or multiple day), fish product line (type of fish pursued), and destination site. A major innovation in this study was the use of "product lines", drawn from an earlier factor analysis study of the 1983-84 fishing season that identified distinct fishing experiences across license holders (Kikutchi 1986). The resulting product lines incorporate distinctions among type of water body (Great Lake, tributaries, and inland rivers/streams) and type of fish species (warm water and cold water). The inclusive values of the nested RUM model lie within the expected utility theoretic range, indicating that the product line groupings represent an improvement over models without such groupings. Within the product lines, the coefficient on the trip cost was negative, and quality measures tended to be positive. While a participation model was estimated, its acceptability is hampered by the lack of trip frequency data and is not discussed here.

Jones and Lupi (2000) find that a 10% decrease in catch rates creates a decline in aggregate fisheries use-value that is 7% to 14% lower than the increase in aggregate fisheries use value associated with a 10% increase in catch rates. For a 50% change in catch rate, the value associated with a decrease is 34% to 45% lower that the corresponding value for an increase. In conjunction with the MSU (TCM 1996) study discussed below, this provides evidence that there is an asymmetry between gains and losses in catch rates.

MSU (TCM 1996): Technical, Econometric Details.

The basic structure of the nested multinomial logit model followed that of Jones and Sung (1993). Three levels of nested decisions were modeled: trip length (single day versus multiple day), product line (Great Lakes (GL) cold water fishing, GL warm water fishing, Inland lakes (IL) warm water fishing, IL cold water fishing, Rivers and Streams (RS) cold water fishing, RS warm water fishing, and Anadromous Runs), and destination site choice within each one of these trip length/product line decision branches. A difference from the Jones and Sung (1993) model is that the panel data allowed MSU to model 63 choice occasions across the season in which the probability of taking a trip and, if a trip is taken, the series of nested probabilities leading to the destination choices were estimated. Thus, the total number of trips taken during the season can be modeled. Site quality for the GL warm water, GL cold water and the anadromous product lines are calculated using Michigan Department of Natural Resources creel data for each county and vary by month. IL stream and river miles were aggregated and categorized as described in the Jones and Sung (1993) above. The quality measures were generally statistically significant and positively correlated with the probability of being chosen. The coefficient on trip costs was negative, and varied between single day and multiple day trips. The inclusive values for each nest were consistent with utility theory, and support the nesting structure over a non-nested model.

The MSU analyses allow for the possibility of estimating changes in catch rates across a broad range of percentage changes. The figure below demonstrates and important result from this study, that because of entry and exit, willingness to pay for a change in catch rates (CR) is non-linear (source: Source: Lupi and Hoehn, 1997, Figure 4)



The reason for this asymmetry in a recreational fishery travel cost model is discussed by Lupi and Hoehn (1997):

> "it is clear that the estimated gains from increasing catch rates exceed the estimated losses for an equivalent decrease in catch rates. The reason for this is due to the role of site and activity substitution embodied in the recreational demand model. When the quality of the Great Lakes trout and salmon fisheries decreases (increases), anglers substitute out of (into) this fishery. Thus, for decreases in quality, anglers who are taking trips to fish for Great Lakes trout and salmon experience losses, but the magnitude of these losses is limited by the utility they could receive from switching to their next best alternative. Their next best alternative could be fishing for a different species, fishing at a different site, or fishing less. Because the values being measured are use-values, once an angler switches sites, they do not experience any further losses if quality at a site they are no longer visiting continues to decrease. Conversely, when the quality of a site increases, anglers who are currently using the site experience benefits. In addition, some anglers are induced to switch to the site where quality increases, and these additional users also benefit from the increase in quality. Thus, site substitution in travel cost models plays a dual role, mitigating losses and accentuating gains relative to models that ignore such substitution possibilities." (p. 13)

Phaneuf et al. (TCM 1997): Technical, Econometric Details.

The authors develop a utility-theoretic Kuhn-Tucker modeling approach for recreational modeling in which many site choices have zero observations. As noted above, the Great Lakes portion the Lyke (TCM, 1993) study provides for adequate information about substitute Great Lake activities but not information about inland product lines. The extension of Kuhn-Tucker modeling to recreation is a contribution. However, such a modeling approach is appropriate only for limited numbers of site choices, and is not extendable to more extensive choice settings. The use of only the Great Lakes data set from the Lyke study preempts concerns about substitutes mentioned in that review.

The coefficients of trip price and catch rate are negative and positive, respectively.

Upneja et al. (TCM 2001)

An ordinary least squares regression strategy was used for the identified trip and the total number of trips taken in the previous 12 months. While the coefficient on trip cost was negative, the significance levels of the coefficient are not provided. There is no correspondence between the trip cost and the total number of trips taken. Substitute sites are not accounted for in the model, leading to possible omitted variable bias in the estimates.

Besedin et al. (TCM 2004): Technical, Econometric Details.

A random utility, site choice model was estimated using a multinomial logit model. Choice sets included up to 74 randomly selected sites per angler within 120 miles from the angler's home zip code. Since socioeconomic data was not collected, median household income by zip code from the 2000 census was used as an income variable. The authors attempted to estimate a nested logit model with separate nests for warm water and cold water species. However, in contrast to the Jones and Sung (TCM, 1993) and the MSU (TCM 1996) studies, nested models are reported not to fit as well, with the authors suggesting that the poorer fit was due to overlap between warm water and cold water fishing sites. In addition, data was not available on the number of trips by mode, so that welfare estimates were based only on the total number of trips. The coefficients in the resulting model have the expected signs: notably the coefficient on travel cost is negative and coefficients on catch rates are positive.

The modeling does not account for a trip participation model for the Great Lakes, "because the required data were not available" (US EPA 2004, G4-9). Due to entry and exit into the fishery with changes in catch rates, a net economic benefits are expected to be a convex function of catch rates. This issue is discussed further in the MSU 1996 Technical Details in this chapter.

Murdoch (TCM 2006): Technical, Econometric Details.

This research argues that the use of quality in travel costs models captures many other site characteristics. Hence, the estimates of the coefficients for site are likely biased. An alternative two-stage method of analysis is developed that simply uses binary variables for each county and then regresses the county specific coefficients on quality varaibles.

Because of econometric complications which results in an incorrect coefficient on travel cost, illustrative policy values for a 10% increase in walleye and musky catch are reported in miles rather than dollars. The proposed modeling approach provided WTP estimates for changes in quality that are notably larger, up to a factor of four, than when estimated with traditional modeling approaches.

Kelch et al. (TCM 2006)

Although individuals were contacted at different streams, the model was estimated like a single site count model. Site specific dummy variables were used to account for potential unobserved characteristics across sites. Corrected and uncorrected negative binomial count models were estimated. The coefficient on travel cost was negative and significant. Quality data were not collected and hence were not included in the model.

Milliman (CV 1986):

Respondents answered a dichotomous choice question which was modeled using a logit random utility model. The probability of a yes response declined significantly with the dollar value, but was not significantly related to catch rate or average size.

Connelly and Brown (CV 1990)

A linear demand function was mentioned but not reported. WTP values were derived from the demand estimate.

Lyke (CV 1993)

Simple logit random utility models were estimated for the dichotomous choice responses with only the cost value as a covariate. The coefficient on costs was negative.

Connelly et al. (CV 1997)

A linear demand function was mentioned but not reported. WTP values were derived from the demand estimate.

National Survey of Fishing, Hunting and Wildlife Associated Recreation – NFHWAR (CV 2006)

There are no technical features that merit attention for this report.

Breffle et al. (RP/SP 1999)

The authors estimated what they refer to a as a minimal RUM that they identified as being appropriate for estimating compensatory values in Natural Resource Damage Assessment for unique settings in which the quality varies only at one site. This model used a complete data set in the sense that all alternative fishing sites, and the alternative of not fishing, were included in the choice set. However, details about the individual fishing sites were not utilized. Instead fishing at all other sites was combined with all the nonfishing alternatives. The authors recognized that such a model will not suffice if one wants to value changes at multiple fishing sites or how much demand at another site will drop when one site is improved. This model combined travel costs and choice experiment data to value improvements relative to the current level of contamination.

Estimated coefficients on catch rates and indicators characterizing the level of fishing advisories were significant and corresponded to directional expectations.

Beachgoing Studies: Chapter III

Loomis (ABT, 2005)

There are no technical features that merit attention for this report.

Atiyah (ABT, 2009)

A multiple regression meta-analysis was conducted using each value per recreation day estimate (converted to $2007) as a function of methodology (TCM vs. CVM), type of value (averaged or marginal value), state (CA, FL or other), author (dummy variables to explore effect of prolific authors) and year of the study. Travel cost estimates were significantly higher than contingent valuation estimates. Average values (from integrating under a demand curve) were found to be higher than marginal values, California had lower values (attributed to more frequent visits) and certain authors had higher values and estimated values were found to grow across years. Simple OLS regression methods were used without clustering observations by study (R^2= 0.98).

Sohngen et al. (TCM 1999)

Single site models were estimated, including both continuous (linear and log linear) and discrete (Poisson and Negative Binomial). Costs to one (Maumee) or two (Headlands) substitute sites were included. The coefficient on travel cost was always negative. The coefficient on the price of the substitute sites was generally positive, indicating that visitation rates rise with costs of going elsewhere, but the significance levels were mixed. While, substitute sites were accounted for in the estimation, reducing concerns about biases in the coefficients, the exploration of substitute sites in the modeling was rather limited.

Sohngen et al. (TCM 2001/2006)

Using only the single day data, WTP per day trip and total beach trips was estimated using a nested RUM site choice model linked to a Poisson count model. The coefficient on travel costs is negative. Visitation significantly increased with water quality, desirable sand composition and beach facilities, and declined with the number of zebra mussel shells observed on the beach and the slope of the beach.

Yeh et al. (2006) used data from the same survey exercise, but added an additional trip length nest (single-day or multiple-day) in a manner that accounts for multiple objectives of longer trips. Single and multiple day trips had significantly different coefficients on the travel cost parameter. Inclusive values for trip length were consistent with utility maximization and lend support to nesting by trip length.

Shaikh (TCM 2006):

A count data (corrected negative binomial) model was estimated for number of beach trips taken per season. Regression statistics were not reported. Price elasticity was negative, as was the elasticity with respect to the number of swim mans at that beach.

The single-site method of this study is appropriate to the extent that this study models all Chicago Beaches as one beach and no beaches outside this area are viewed as substitutes. The lack of substitutes would not broadly hold across the entirety of the Great Lakes and UMORB, and hence the day values reported in this study are not extendable to the Great Lakes as a whole. Opportunities for benefits transfers would primarily be to similar urban settings.

Song et al. (TCM 2010)

A two-level nested RUM was estimated with the first nest being the GL water body and the second nest being beach sites geographically proximate and sharing the same characteristics (143 groups). The coefficients on travel cost and closure days were negative and significant, while the beach length coefficient was positive and significant. The number of closure advisory days separate from actual closures was not significant. Inclusive variables were consistent with utility theory and improved the model.

With respect to valuing changes in quality, this study shows that impacts of ANS will depend fundamentally on the spatial porousness of their impact, i.e. whether effects are concentrated or are periodic along a coastline.

It should be noted that Frank Lupi and colleagues at Michigan State University are in the process of implementing a statewide follow up to Song et al. (2010) study that will not only account for multisite decision choices but will also explore the decision to participate in beach recreation and the total number of beach visits across the season of those that participate in beach recreation.

Boating Studies: Chapter V

<u>Rosenberger and Loomis (MA 1998): Technical, Econometric Details.</u>

Net value per person per day per activity was estimated as a linear function of binary methodological, site and activity variables. The model had an adjusted R^2 of 27%.

For motorboating there was only one observation in the northeast, and the coefficient on the binary variable for Motorized Boating was not significant. For float boating there were four observations from three studies, and the coefficient on float boating was significant and positive. Due to the small sample size and the age of the data used, CU does not recommend the estimated values for inclusion in the GLMRIS program. CU discusses one of these studies (Hellerstein, 1991) in Chapter IV.

<u>Hellerstein (TCM 1991): Technical, Econometric Details.</u>

Data for this model was aggregated into the 1,396 counties within 1000 miles of the Boundary Waters Canoe Area. Income, population, employment, poverty, education, and age distribution were taken from county statistics. The author argues that the adding up properties of the Poisson and the negative binomial models used in this analysis facilitate the use and interpretation of these aggregated data in count data models. About half of the counties had zero visits.

Poisson and negative binomial models were estimated and a semilog ordinary least squares model with zero trip observations dropped was used for comparative purposes. CU focuses our attention on the Poisson and negative binomial models for which the aggregate numbers of visits from the country served as the dependent variable. In addition to social demographic variable listed above, the travel cost to Algonquin Provincial Park, as substitute site in southern Ontario was included in the estimated models.

The hypothesis of equality between expected visits and variance of expected visits was rejected, suggesting the use of the negative binomial model. The own price coefficient in the model is negative and significant and the sign on the coefficient of the substitute price is positive as theoretically expected.

Bowker et al. (TCM 1997): Technical, Econometric Details.

Truncated Poisson and negative binomial count data models were estimated for the travel cost data (n=180). The estimated coefficient on travel cost was negative, and the number of visits was positively correlated with income and previous experience. Substitute sites were apparently accounted for (but were not significant in the model), but that variable is not adequately defined in the paper.

The authors incorporate site characteristics in the model, showing that price response and consumer surplus are likely affected by site characteristics.

The estimated net value per trip were $256 ($1993) to $352 ($1993) for a guided rafting trip using a truncated Poisson model. The net values varied based on whether reported or imputed costs were used and whether the wage rate was set to 25% or 50% of the wage

Out of sample transfer models were not successful: 60% of these transfers "were resounding failures based on statistical test of congruence" (Bowker et al., p. 11). In-sample models had an 80% success rate. The authors conclude that benefits transfer is problematic if extended to beyond the range of available data.

Bhat et al. (TCM 1998): Technical, Econometric Details.

This study differs from the other TCM studies reviewed in this document in the sense that the other research has sought site specific values in which recreationists travel varying distances to a single site or set of sites. Here the perspective is "population specific" in which the research studies and models trips made by a population or community to all sites.

Separate truncated Poisson count data models were estimated for several recreational activities. Models included trip cost, distance and time costs to the nearest substitute site for the same activity, annual household income, and a binary variable to differentiate between local and non-local participants.

For motorboating and water skiing in the Northeast and Great Lakes ecoregion (sample size not available) the coefficient on travel costs was negative, the coefficient on distance to the nearest substitute from the individual's origin of activity was positive and significant, and the nonlocal effect was positive and significant. The authors indicate that this later value suggests a difference in consumption behaviors of local and nonlocal visitors, i.e. ceteris paribus this indicates that nonlocal visitors have a higher visitation rate. CU has not seen this variable in other travel cost analyses and are concerned about possible biases it might introduce in the estimated net value measure.

Shafer et al. (2000): Technical, Econometric Details.

Simple ordinary least squares models were estimated for each site. While the coefficient on logged trip cost was negative, the significance levels of the coefficient are not provided. Substitute sites are not accounted for in the model, leading to possible omitted variable bias in the estimates. Differences in boat lengths are not accounted for in the net value estimate.

Connelly et al. (2005): Technical, Econometric Details.

Average net value was estimated by averaging the open-ended CV responses, broken out into various groupings.

Appendix: On Net Economic Value, Expenditures and Economic Impact Analysis

The purpose of this appendix is to provide an non-technical discussion of net value vis-à-vis expenditrues and net economic impact. The interested reader is also referred to Scodari (2009) and Aitken (2009) for additional discussions using supply and demand graphs.

When an individual takes a trip away from home to engage in a recreational activity such as a day spent fishing, boating, or going to the beach, the *total value* to the recreationist of the trip is defined as the largest amount of money he or she would be willing to pay to go on that trip to do that activity. The amount the individual actually spends to take that trip is called the recreationist's *expenditures* for the trip. Expenditures would include money spent on such things as gasoline, lodging, entry fees, and food at the recreation site.

An individual will only go on a recreational trip if the benefit they get from doing so (their total value) is larger than the cost to them of the trip (the expenditures). The *net value* from the trip is defined as the recreationist's total value for the trip minus the expenditures for the trip. Net value is also commonly referred to as the *consumer surplus* that the individual gets from engaging in the activity – it is the surplus value they receive from the activity over and above what they actually have to pay for the activity. If a recreational opportunity were somehow lost, recreationists would lose this net value.

One point of clarification is necessary. Our definition of net value of the resource includes only the value that recreationists place on participating in the activity - the so-called "use value" from the activity, or the "all-or-nothing value" of taking the trip (Talhelm , 1988). Many people who do not use water resources recreationally still may care about the quality of those resources. This review will not address these so-called "nonuse values."

CU defined expenditures as the amount that recreationists actually spend on products and services for each trip. Studies will often report expenditures made by recreationists in a region as an indication of the importance of recreational resources to local or regional communities. Studies will also commonly use information on recreational expenditures to help calculate the regional *economic impact* from the activity. When visitors from outside a region spend money in that region while on a recreational visit, some of those new expenditures induce local businesses and households to spend more money themselves. For example, when a visiting recreationist purchases food at a local restaurant, that local restaurant may purchase some of its food from the local grocery store. Similarly, the server at the restaurant will spend some of his or her tip money inside the region. There is therefore a multiplier effect, where the regional economic impact from recreational expenditures is larger than the initial expenditure.

Information on the magnitude of recreational expenditures and their resulting regional economic impact is often of great interest to local officials and business owners. However, expenditures and economic impacts do not represent benefits from a NED perspective. There are two reasons why. First, recreation expenditures do not take into account the cost of providing the goods and services that recreationists purchase. For example, if a fisherman or boater spends $40 for gasoline for his boat, the marina will have to purchase that gasoline from a wholesale supplier, and that gasoline is no longer available for someone else to use for another purpose. Second, when recreationists spend money in a region where they go to recreate, that is money they can no longer spend in other regions or on other activities. Recreation expenditures and economic impacts represent transfers of income from recreationists to local businesses, from one activity to another, and from one region to another, rather than an added value to the economy. This point was emphasized in a recent background document on issues surrounding the Chicago Area Waterway System: the Congressional Research Service noted that economic impact measures "cannot be used to estimate changes in social welfare, to assess trade-offs among public policy alternatives, or to conduct benefit-cost analysis" (Buck et al., 2010, p. 7)

Glossary of Acronyms

ABT – Average Benefits Transfer

ANS – Aquatic Nuisance Species.

CATI – Computer Assisted Telephone Interviewing

CPI – Consumer Price Index

CR – Catch Rates

CU – Cornell University

CV – Contingent Valuation

GLMRIS – Great Lakes and Mississippi River Interbasin Study

MA – Meta Analysis

NED – National Economic Development

r.r. – Response Rate

TCM – Travel Cost Method

UMORB – Upper Mississippi and Ohio River Basins

USACE – U.S. Army Corps of Engineers

USFWS – U.S. Fish and Wildlife Service

WTP – Willingness to Pay

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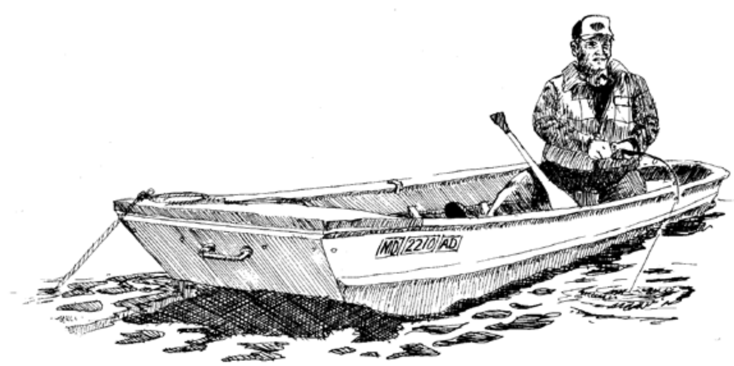
Net Benefits of Recreational Fishing in the Great Lakes, Upper Mississippi River, and Ohio River Basins



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Executive Summary

This report provides estimates of the net value to anglers of recreational fishing in the Great Lakes and Upper Mississippi and Ohio River basins within the following 12 states: Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Kentucky, Michigan, Ohio, West Virginia, Pennsylvania and New York. Within these three basins, particular attention is given to those lakes, ponds, rivers, and streams that are located downstream from all barriers impassable to fish (dams, waterfalls, etc.). It is these waters that the United States Army Corps of Engineers (USACE) considers susceptible to the effects of possible aquatic nuisance species (ANS) transfer between the Great Lakes basin and the Upper Mississippi and Ohio River basins (in either direction).

Cornell University (CU) developed an economic model to estimate net baseline recreational fishing values using the travel cost valuation method. The development of these net benefit estimates took place in three stages: (a) a series of focus groups with recreational anglers; (b) surveys of recreational anglers; and (c) the development and estimation of an economic model of angler behavior. The surveys were also used to develop estimates of trip expenditures.

Based on fishing license sales data provided by the states, it was estimated that 6.6 million anglers lived and fished in the 12-state study area in 2011. These anglers spent an estimated 62.9 million days fishing in those portions of the Great Lakes basin below barriers impassable to fish. They spent 57.6 million days fishing in those portions of the Upper Mississippi and Ohio River basins that are below barriers impassable to fish.

The average net value per angler day, estimated from CU's recreational fishing model, was $19.52. The aggregate net value of recreational fishing in those portions of the Great Lakes basin below barriers impassable to fish is estimated to be $1.228 billion for calendar year 2011. The corresponding aggregate net value of recreational fishing in those portions of the Upper Mississippi and Ohio River basins below barriers impassable to fish is estimated to be $1.124 billion.

Although CU was originally tasked with estimating the impacts of ANS on the net value of recreational fishing, USACE was not able to obtain sufficient information to quantify the timing or magnitude of impacts of ANS on sportfish populations in the Great Lakes, Upper Mississippi River, and Ohio River Basins. Consequently, this report serves as an indicator of the net value of recreational fishing that *could* be impacted in the future without-project (FWOP) condition – the case where no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins.

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This study was funded by the U.S. Army Corps of Engineers under a cooperative agreement with Cornell University (W912HZ-11-2-0030) as part of the Great Lakes and Mississippi River Interbasin Study. In addition, numerous individuals contributed to this study. Dena Abou-el-Seoud and Lorraine Cordova of the U.S. Army Corps of Engineers provided us with valuable support and guidance. Haoying Wang contributed to the programming of the economic models. Karlene Smith assisted with the implementation of the mail survey and coded the data from the questionnaires that were returned. Cornell's Survey Research Institute implemented the web surveys. Representatives of the state fish and wildlife agencies in Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Kentucky, Michigan, Pennsylvania and New York assisted us in obtaining a sample of anglers for our surveys. Sea Grant and state fish and wildlife agency staff members helped us recruit participants for our focus groups.

Critical input on econometric modeling and survey design were provided by Frank Lupi (Michigan State University) and John Whitehead (Appalachian State University). Interaction between the study group and these external reviewers was facilitated by funding through USDA Regional Project W-2133, which also provided support for computer software used to generate travel cost estimates in this research. Cornell University and Pennsylvania State University are also acknowledged for their support of this research effort.

The authors of this report are particularly indebted to the numerous recreational anglers throughout the 12-state study area who participated in our focus groups and surveys.

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Study Background

GLMRIS Background Information

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River basins by aquatic pathways.

An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (FY13).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: (a) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and (b) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users; and
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries.

GLMRIS Navigation and Economics Product Delivery Team

In support of GLMRIS, the Navigation and Economics Product Delivery Team (PDT) was formed. The PDT was tasked with assessing the current value of *economic* activities within the GLMRIS detailed study area that *could* change with the implementation (Future With Project (FWP) condition) or lack of implementation (Future Without Project (FWOP) condition) of a GLMRIS project. The PDT is comprised of several sub-teams, each of which focuses on a specific economic activity within the GLMRIS study area.

Fisheries Economics Team

The Navigation and Economics PDT's Fisheries Economics Team focused on fishing activities within the U.S. waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins (i.e., the GLMRIS detailed study area) that *could* change in the FWOP and/or FWP condition.

Five baseline economic assessments, which quantitatively or qualitatively describe the current economic activities dependent on fisheries, were developed. The reports focus on the following categories: commercial, recreational, charter, and subsistence fishing, as well as professional fishing tournaments. Each baseline assessment focuses exclusively on the specified fishing activity within the GLMRIS detailed study area – to include the U.S. waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins. It is imperative to note that collectively, these values do *not* represent a comprehensive value of these three basins. Each basin has further economic (e.g., non-use values) and environmental values that are not captured in this economic appendix. Rather, the fishing-related economic activities assessed by the Fisheries Economics Team serve as indicators of key aspects of the economy that *could* change in the future, with or without the implementation of a GLMRIS project.

Report Purpose

After conducting a review of the available literature on the value of recreational fishing, Cornell University (CU) concluded that, based on available literature, it is possible to generate a range of estimates of the value of recreational fishing in the Great Lakes, but that the available literature is not sufficient to estimate the value of recreational fishing in the Upper Mississippi or Ohio River Basins. The purpose of this report is to generate new estimates of the economic value of recreational fishing in the entire GLMRIS study area that could be affected by implementation of a GLMRIS project.

In the FWOP condition, no *new* Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins. The impacts associated with the FWOP condition are not presented in this report. Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin if they were to transfer and become established. Since targeted fish species have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, the baseline economic assessment presented in this report demonstrates the net value of recreational fishing within the Great Lakes, Upper Mississippi River, and Ohio River Basins that could be affected in the FWOP condition.

In the FWP condition, *new* Federal action is taken to prevent the transfer of ANS between the basins. Even absent interbasin transfer of ANS, the FWP condition will differ from the current condition as a consequence of future fishery management decisions. However, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future resource availability regarding fishing activities in the FWP condition. Since these management plans were not available, the baseline assessment presented in this report is the current net value of recreational fishing within the Great Lakes, Upper Mississippi River, and Ohio River Basins that *could* be affected in the FWP condition.

Introduction

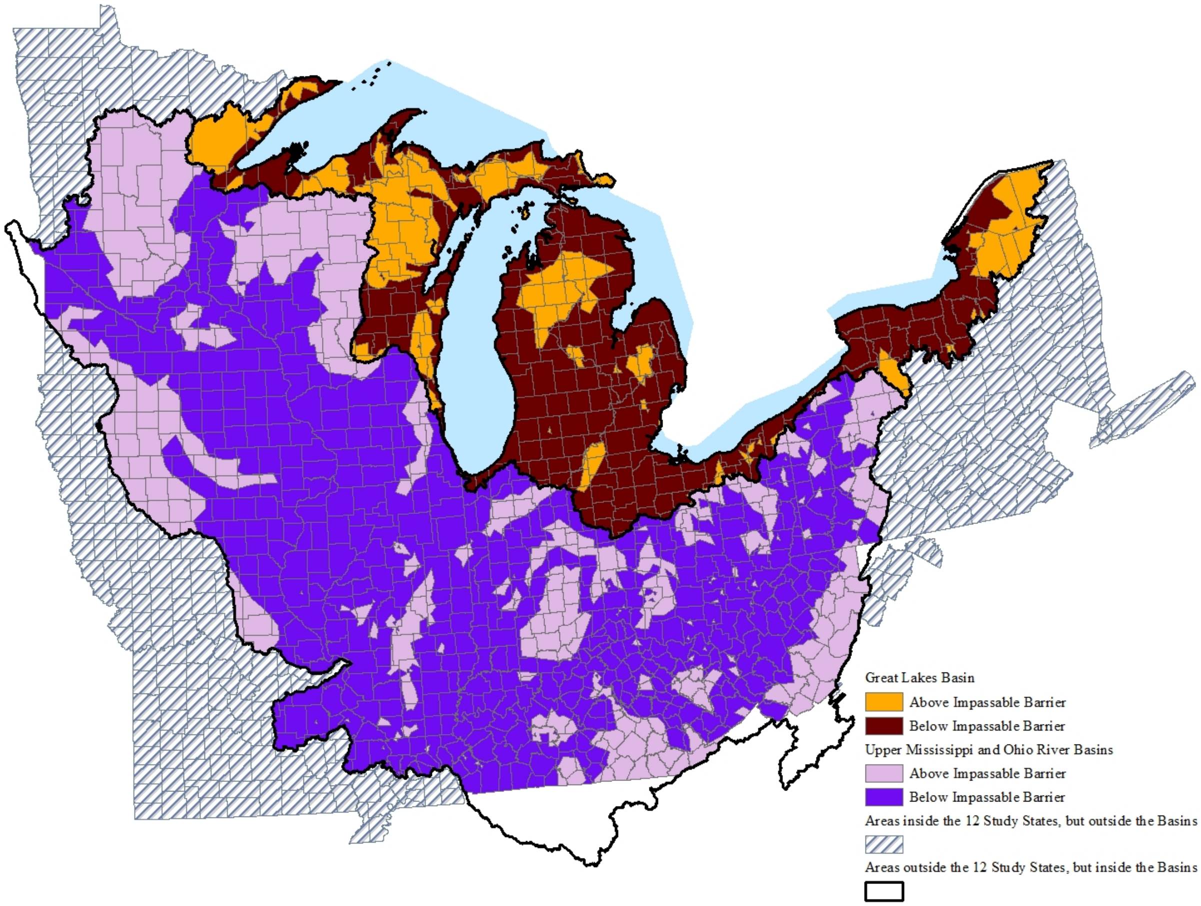
Objectives of this Report

As part of the USACE/ CU "Recreation Impacts of Aquatic Nuisance Species to the Great Lakes and Mississippi River Basins" cooperative agreement (W912HZ-11-2-0030), this report provides an estimate of the net value to anglers of recreational fishing in the Great Lakes and Upper Mississippi and Ohio River basins. The region on which this report focuses includes the watersheds of the Great Lakes and Upper Mississippi and Ohio River Basins within the following states: Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Kentucky, Michigan, Ohio, West Virginia, Pennsylvania and New York (Figure 1). Consistent with USACE procedures and guidelines (USACE 1983), all dollar values reported in this document are updated to FY $2012 using the consumer price index (CPI Value=226.889, USACE 2012), unless otherwise noted[1].

This report is one product of a study designed to assess the possible effects if ANS transfer occurs between the Great Lakes basin and the Upper Mississippi and Ohio River basins (UMORB). The portions of the 12-state study area that were of particular interest, therefore, were the Great Lakes, the Upper Mississippi and Ohio Rivers, and those lakes, ponds, rivers, and streams that are not separated from these water bodies by any barriers impassable to fish (dams, waterfalls, etc.). It is these waters that USACE considers susceptible to the effects of possible ANS transfer between the Great Lakes basin and the Upper Mississippi and Ohio River basins (in either direction). Based on discussions with USACE and with biologists conducting research on invasive aquatic species in the Great Lakes basin and the UMORB, CU hypothesized that ANS transfer would affect the net value of recreational fishing by potentially decreasing the quality of the sport fishery resource. In particular, ANS transfer could lead to decreases in sportfish populations, which would lead to decreases in fishing success, as measured by catch rates. These decreases in catch rates could affect the net recreational value anglers derive from fishing in the study area in two ways. First, anglers could receive less value from each fishing trip they take. Second, anglers could choose to change where and how often they go fishing. CU's recreational fishing model is designed to be flexible enough to estimate projections of both types of impacts.

[1] The survey data was collected for Calendar Year 2011, which extends from January 1, 2011 to December 31, 2011. With exception of expenditure data for the most recent trip, the timing of fishing trips throughout CY 2011 is unknown. The U.S. government's Fiscal Year (FY) 2012 begins on October 1, 2011 and ends on September 30, 2012 and the Consumer Price Index (CPI) basis used by the USACE for FY 2012 is September 2011 (USACE 2012). Because the FY 2012 basis for the USACE lies in CY 2011, the values reported in this study can be regarded as either CY 2011 or FY 2012 values, the latter being appropriate for USACE reporting (US ACE 2012).

Figure 1. Map of study area.



This report focuses on the estimates of baseline fishing values generated using the travel cost method for fishing trips taken during 2011. Estimates of angler expenditures that can be used by USACE for regional economic impact analyses are also presented in this report.

Although Cornell University was originally tasked – in accordance with the United States Army Corps of Engineers (USACE)/Cornell University (CU) "Recreation Impacts of Aquatic Nuisance Species to the Great Lakes and Mississippi River Basins" cooperative agreement (W912HZ-11-2-0030) – to estimate the impacts of ANS on the net value of recreational fishing, USACE was not able to obtain sufficient information to quantify the timing or magnitude of impacts of ANS on sportfish populations in the Great Lakes, Upper Mississippi River, and Ohio River Basins. This lack of information prohibited CU from utilizing the full extent of their recreational fishing survey and subsequently developed logic model that would aid in the determination of the impacts of ANS on the net value of recreational fishing within these basins.

If USACE is able to quantify the timing and magnitude of ANS impacts on recreational fisheries in the future, the recreational fishing survey and logic model could be utilized to quantify the impact of ANS on the net value of recreational fishing.

Consequently, this report serves as an indicator of the net value of recreational fishing that could be impacted in the future without-project (FWOP) condition – the case where no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins. However, it is important to note that this information does not preclude the possibility of changes in this net value of recreational fishing in the future with-project (FWP) condition, as other factors, aside from ANS transfer, could impact the behaviors of recreational anglers.

Overview of Conceptual Foundations: Net Value

This report generates an economic measure of the value of recreational fishing in the Great Lakes, Upper Mississippi and Ohio River Basins. Consistent with USACE procedures and guidelines (USACE, 1983, 2000, 2012), net (economic) value of a recreational resource is defined as the amount the recreational resource contributes to the Federal planning objective of national economic development (NED).

> "The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements… Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the Nation. Contributions to NED include increases in the net value of those goods and services

> that are marketed, and also of those that may not be marketed." (USACE, 1983, p. iv).

Because a variety of measures of the economic value of recreational activities have been reported in various outlets, it is important to distinguish the NED concept of net value from other measures that are often reported, such as "expenditures" and "economic impacts." The net value of a recreational resource is the difference between the amount an individual would be willing to pay to access the resource and the amount that they actually have to pay for gasoline, lodging, entry fees, and food at the recreation site and other trip-related costs. CU provides a brief discussion of alternative measures such as expenditures and economic activity in the Appendix. The interested reader is also referred to Scodari (2009) and Aitken (2009) for further discussion.

Measures of net value are often expressed as value per unit, such as net value per day of a recreational activity. The aggregate annual net value generated by a recreational resource could then be estimated by multiplying the average net value per day (or per trip) by the estimated total number of days (trips) that anglers engaged in that activity. This is the appropriate measure of the annual net value generated by a recreational resource from a NED perspective and thus forms the basis for this study.

Overview of Conceptual Foundations: Methods of Valuing Recreation

Because most outdoor recreation activities are publicly provided, rather than being purchased from a private supplier, it is usually not possible to estimate either total value or net value directly from observed market data (USACE 2012). USACE recognizes alternative "non-market valuation" procedures "for estimating use and willingness to pay by means of travel behavior, user surveys, and other quantifiable measures" (USACE 2000, p. E-183). The travel cost method and the contingent valuation method are two of these non-market valuation methods. USACE procedures and guidelines specify that these methods may be used for estimating the net values of recreational activities and estimating how those net values change in response to water-related projects.

The *travel cost method* uses actual visitation data on the number of trips taken to different recreation sites to estimate the net value of the resource and how that net value changes as the quality of the resource changes. The travel cost method works by comparing the number of trips taken to a site by people who live close to the site to the number of trips taken by people who live farther from the site. "The basic premise of the travel cost method is that per capita use of a recreation site will decrease as out-of-pocket and time costs of traveling to the site increase, other variables being constant" (USACE 2000, p. E-184). The total value per trip, net value per trip, and number of trips taken can be calculated for recreationists living different distances from a site and for sites with different resource quality. The travel cost method is known as a *revealed preference* method because it is based on the current, actual behavior of recreationists.

Contingent valuation relies on survey questions about hypothetical behavior to estimate the net value of a resource or the net value of a change in resource quality: “The contingent valuation method estimates NED benefits by directly asking individual households their willingness to pay for changes in recreation opportunities at a given site.” (USACE 2000, p. E-185). Depending on how the survey questions are structured, contingent valuation can be used to measure the total amount the recreationist is willing to pay for access to a site (total value), the amount the recreationist is willing to pay over and above the actual cost of visiting the site (net value), or the amount the recreationist would be willing to pay if a change occurred to the quality of the site (change in net value). The aggregate net value of the resource or of a change in the quality of the resource can be estimated by summing the individual net values for all users in the study area. The *contingent behavior* method is related to the contingent valuation method; in the contingent behavior method, recreationists are asked how their recreational choices (e.g., number of fishing trips taken) would change with an improvement or decrement in resource quality. Both the contingent valuation and contingent behavior methods are known as *stated preference* methods.

In this study, a combination of travel cost and contingent behavior approaches are used. The travel cost method and the contingent behavior method each have advantages and disadvantages. The advantages of the travel cost method are that it can provide an estimate of the baseline net value of the recreational resource (and subsequent changes in that value), it is based on actual behavior, it can model the entire causal chain linking resource quality to recreational value, and it is based on straightforward measures of actual behavior. The limitations of the travel cost method are that it requires extensive data on recreational activities and sophisticated economic modeling techniques, and it cannot be used to model situations that do not now exist (e.g. previously unexperienced changes in the composition of species.)

Stated preference methods, such as contingent behavior, can address some of the limitations of the travel cost method. Because recreationists are asked how their choices would change with changes in resource quality, these methods are very flexible and can be used to assess economic effects of scenarios that do not currently exist. This approach is also relatively less time consuming and less data intensive than using the travel cost model. One of the key limitations of stated preference models is that they are based on hypothetical questions about what an individual would do in a different, perhaps previously unexperienced, situation.

Models combining revealed and stated preference elements take advantage of the strengths, and avoid some of the limitations, of each of the two approaches (Whitehead et al., 2008).

Development of these models involves collecting data on actual trip behavior and adding hypothetical questions about behavior if resource quality were to change. This approach takes advantage of data on actual recreationist behavior but can introduce hypothetical situations and therefore model response to a wider variety of scenarios. The limitations of this approach are that data from questions about hypothetical and actual behavior may not be directly comparable, extensive data are needed, and considerable pre-survey work is required to develop sound survey methods.

Given CU's interest in: (a) developing estimates of changes in economic value that are based on reliable measurements of actual behavior; and (b) modeling recreationist responses to hypothetical future ecological scenarios that do not currently exist, CU adopted a combined revealed and stated preference model for this study.

Recreational Value of the Great Lakes and Upper Mississippi and Ohio River Basin Fishery: Literature Review

Poe et al. (2012) reviewed available studies that estimate the net value of recreational fishing in the Great Lakes, Upper Mississippi and Ohio River Basins. Table 1 provides a summary of estimates of net value per day of fishing from these studies. The studies reviewed were those that provided sufficiently reliable estimates of the net value of fishing applicable to the study area.

No single study in Table 1 covers the entirety of the study region in terms of geography or species targeted. This lack of a comprehensive, region-wide study is important because evidence provided in a number of studies suggests that fishing values will vary across recreational sites and types of fishing. Therefore, fishing values estimated in one part of the study region may not apply very well to other parts of the study region. For this reason, Poe et al. (2012) concluded that *no existing individual study* can be used to provide a representative estimate of net value per day or per trip for the entirety of either or both basins.

Nevertheless, Poe et al. (2012) argued that, when *considered as a set,* the studies included in Table 1 could be used to help determine the range of net values per fishing day that might be expected for the Great Lakes portion of the study area. While the range of net values provided by the various studies is broad, there is some convergence across studies. Because these studies were conducted in a variety of settings within the Great Lakes region, this range of net values likely encompasses the average net value within that region. An examination of the values in Table 1 reveals that the observations above $75 are few and spread out across a wide range of fishing types and/or locations. Dropping the top three value estimates (Boyle et al. 1999, Salmon; Boyle et al. 1999, Bass; and Aiken 2009, Walleye (WI)), which Poe et al. (2012) characterized as outliers, suggests that average net value estimates will likely lie in the range

Table 1. Estimated willingness to pay values per person per fishing day.

Estimated Net Value/ Day ($2012)[a]	Fish Category	Location	Reference
45	Cold water fish	Great Lakes and the Northeast	Loomis and Richardson (2008)
48	Warm water fish	Great Lakes and the Northeast	Loomis and Richardson (2008)
44	Anadromous runs	Great Lakes and the Northeast	Loomis and Richardson (2008)
23	Mixed species	Great Lakes and the Northeast	Loomis and Richardson (2008)
56	Species not specified,	Great Lakes and the Northeast	Loomis and Richardson (2008)
45-54	General	Great Lakes and the Northeast	Rosenberger and Loomis (2001)
90[b]	Bass	Great Lakes	Boyle et al. (1999)
109[b]	Salmon	Great Lakes	Boyle et al. (1999)
41	Trout	Michigan Great Lakes	Lupi and Hoehn (1997)
51	Salmon	Michigan Great lakes	Lupi and Hoehn (1997)
42	Salmon and/or Trout	Wisconsin Water, Southern Lake Michigan	Phaneuf et al. (1998)
42-55	Anadromous Runs	Lake Erie Tributaries	Kelch et al. (2006)
54	Yellow Perch	Green Bay	Bishop et al. (1990)
25	General	New York Great Lakes	Connelly and Brown (1991)
28	General	New York Inland Waters	Connelly and Brown (1991)
41	Salmon and Trout	Wisconsin Water, Great Lakes	Lyke (1993)
22	General	New York Great Lakes	Connelly et al. (1997)

(continued on next page)

Table 1. Estimated willingness to pay values per person per fishing day (continued).

Estimated Net Value/ Day ($2012)[a]	Fish Category	Location	Reference
22	General	New York Inland Waters	Connelly et al. (1997)
50 (IA), 50 (IL), 68 (MO), 69 (IN), 71 (WV)	Bass	Selected States in Great Lakes and UMORB[c]	Aiken (2009)
48 (PA), 53 (NY)	Trout,	Selected States in Great Lakes and UMORB[c]	Aiken (2009); Harris (2010);
49 (MI) 68 (MN), 74 (OH), 91 (WI)[b]	Walleye	Selected States in Great Lakes and UMORB[c]	Aiken (2009)

a. Rounded to the nearest dollar.

b. As discussed in Poe et al. (2012), these three observations are regarded as outliers.

c. UMORB denotes the Upper Mississippi and Ohio River Basins.

from $20 to $75 ($2012) for Great Lakes fishing. An insufficient number of studies were available to develop similar net value estimates for the UMORB.

As noted above, identifying the value of a fishing day is only one element needed to estimate the aggregate net value of recreational fishing. A measure of how much fishing occurs, such as angler days per year, is also needed. The US Fish and Wildlife Service provides periodic estimates of fishing effort as part of its National Survey of Fishing Hunting and Wildlife Associated Recreation (e.g. USFWS, 2002, 2008). The National Survey does not provide separate data for participation in the Great Lakes Basin (i.e., all the water bodies in the Great Lakes watershed, including but not limited to the Great Lakes) or the Upper Mississippi and Ohio River Basins. However, it does report fishing participation for the Great Lakes themselves, a resource that has received substantial popular attention due to concern about aquatic nuisance species in recent years and for which aggregate expenditure and economic impact values have been reported by private and government entities (Austin et al., 2007; Great Lakes Commission, 2012).

While they are somewhat dated, Poe et al. (2012) used participation data from the 2006 National Recreation Survey (USFWS 2008), as this is the most recent survey of recreational fishing providing data on fishing in the Great Lakes that had been reported at the time the Poe et al. (2012) report was written[2]. These estimates have been used elsewhere for calculating the impact of recreational fishing for the Great Lakes (USFWS, 2008; Austin et al., 2007). For comparative purposes it is helpful to use the same baseline for aggregating values.

Multiplying the USFWS estimate of about 18 million angler days in the Great Lakes in 2006 by the range of net values ($20 to $75 in $2012 dollars) identified above, Poe et al. (2012) concluded that the total annual recreation net value lies between $360 million and $1.35 billion. This range can serve as a point of comparison for the estimate reported in this study's results. Subsequent to the writing of the Poe et al. (2012) report, the USFWS released a preliminary report for the 2011 National Recreation Survey (USFWS 2012a) for angler days in 2011, which reported that an estimated Great Lakes angler days to be 19.7 million in 2011. Multiplying this level of effort by the endpoints on the range of net values ($20 to $75 in $2012) reported in Poe et al. (2012) provides an estimated range of total annual recreation net value for Great Lakes fishing of between $393 million and $1.475 billion.

Study Area

The study area on which this report focuses includes the watersheds of the Great Lakes and Upper Mississippi and Ohio River Basins within the following states: Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Kentucky, Michigan, Ohio, West Virginia, Pennsylvania and New York (Figure 1). These states will collectively be referred to as the "12-state study area" throughout this report.

Methods

The development of a net benefit estimate associated with current recreational fishing in the Great Lakes and the Upper Mississippi and Ohio River Basins took place in three stages: (a) a series of focus groups with recreational anglers conducted in November and December 2011; (b) three surveys of recreational anglers conducted between January and August 2012; and (c) the development and estimation of an economic model of angler behavior based on the survey data, which was completed in the fall of 2012. Two of the surveys were also used to develop estimates of trip expenditures.

[2] A more recent survey was completed in March 2012, but only preliminary documents (USFWS, 2012a,b) were available at that this report was written.

Focus Groups

Focus groups with recreational anglers were conducted to inform the development of the subsequent survey of anglers (Evensen et al. 2012). A focus group is a type of group interview in which a researcher brings together a small number of people, with particular characteristics (e.g., age, gender, race, participation in certain activities), to discuss a topic relevant to that group. The researcher acts as a facilitator who introduces open-ended questions to which the group responds. Focus groups are used to solicit in-depth information from people about topics for which their possible responses might not be able to be predicted in advance.

Focus groups were used in this study to determine: the range of ways in which angler behavior might change if a decline in fishing quality was precipitated by ANS transfer; how anglers characterize different types of fishing; and how changes in sportfish populations could best be communicated to anglers. Eight focus groups, with eight to 21 participants in each group, were conducted in various locations in the study region in November and December 2011 (Table 2). Participants were identified through a variety of methods. When the researchers had contacts in a locality selected for a focus group, recruitment started with "snowball sampling" (i.e., contacting individuals who had knowledge of recreational anglers in the location and asking for recommendations of people to participate, then contacting those individuals, asking them to participate and asking for additional suggestions). In addition to snowball sampling, and particularly in locations where the researchers had no contacts, recruitment occurred by way of announcements in local newspapers and announcements via e-mail listservs of organizations supportive of the research being conducted.

The focus groups were conducted either by a single facilitator or by a team of two facilitators, with one person leading the questioning and the other helping with followup questions and data recording. The same facilitator led all the groups, with an additional facilitator present at three of the groups. The primary question topics[3] included patterns of fishing behavior, changes in fishing behavior and reasons for those changes, factors that could influence fishing behavior in the future, and how fishing behavior might change in response to a decline in the number and size of fish caught (the primary ways in which ANS were expected to influence anglers). The facilitators audio recorded each group; recordings were later transcribed.

The recordings and transcripts were reviewed to identify the range of ways anglers said they might respond to a decrease in fishing quality (e.g., change effort levels, stop fishing altogether,

[3] Please refer to the Appendix for details regarding the questions posed to the focus groups.

Table 2. Focus group characteristics.

Location	Date	Number of participants	Duration of discussion
Oswego, NY	Nov. 7, 2011	8	1h 45m
Peoria, IL	Nov. 15, 2011	6	1h 32m
Eagan, MN	Nov. 16, 2011	11	1h 54m
Duluth, MN	Nov. 17, 2011	21	1h 58m
Port Clinton, OH	Dec. 5, 2011	8	2h 08m
Bay City, MI	Dec. 13, 2011	8	2h 14m
Fort Wayne, IN	Dec. 14, 2011	15	1h 59m
Louisville, KY	Dec. 15, 2011	15	2h 00m

fish in different locations, fish for different species) and how to describe or characterize types of fishing experiences across a range of fishing types in ways that were meaningful to anglers[4].

Survey

CU conducted a survey of recreational anglers in a 12-state region containing the Great Lakes and Upper Mississippi and Ohio River basins: New York, Pennsylvania, Ohio, Indiana, Michigan, Illinois, Wisconsin, Minnesota, Iowa, Missouri, Kentucky, and West Virginia. The study population was defined as those living and fishing in the 12-state region. The primary purpose of the survey was to gather data from anglers that could be used to develop economic models that could estimate the net value of recreational fishing under current and hypothetical future conditions. The survey was conducted in three stages: (1) a screening survey conducted over the telephone; (2) a main survey conducted by mail or online; and (3) a followup survey conducted online. The design of the survey instruments was informed by the research team's past experience with a number of similar surveys. Although some limited pretesting of the main survey instruments was conducted, an extensive pretest was not possible to conduct because of the need to complete the project within a 14-month timeline.

Screening Survey

A sample of anglers was recruited in each state through a screening survey. In all states except Ohio and West Virginia, the sample was recruited from individuals identified through randomly selected fishing license records from the previous license year. License types included resident and non-resident licenses, both annual and short-term[5]. Among non-resident licenses, only those with addresses within the 12-state region were used to define the sample. CU drew an initial sample of 28,200 licenses in these 10 states. Lexis-Nexis searches identified telephone numbers for as many individuals as possible based on their names and addresses. Individuals with known telephone numbers were sent a pre-notice letter that described the study and requested their participation in it about one week before they were contacted by telephone. Individuals were then contacted by telephone to screen them for participation in the subsequent angler survey. The screening process consisted of a short series of questions designed to determine if respondents fished in 2011 and intended to fish in 2012[6]. A total of 7,201 individuals met these criteria, agreed to participate in the subsequent survey, and either provided their e-mail address or confirmed their mailing address. Individuals recruited in this

[4] See Evensen et al. (2012) for focus group results.
[5] The sample did not include one-day licenses because a very low response rate was anticipated from this group, and their fishing would have made up only a very small proportion of the total number of fishing days.
[6] Please refer to the Appendix for the questions used in the screening survey

way were also asked several questions about how much and what type of fishing they did in 2011. This information was used to target survey versions to individual respondents, and for assessing non-response bias after the subsequent survey.

Ohio and West Virginia would not release their fishing license data. Instead, a sample of anglers from each state was recruited through random digit dialing. Random digit dialing is a process that begins by identifying the set of telephone area codes and exchanges for a given state or region. Telephone numbers within the state are generated by pairing these area codes and exchanges with 4 random digits. Samples of 13,934 phone numbers (for Ohio) and 3,000 phone numbers (for West Virginia) were provided by the Marketing Systems Group. Respondents were contacted by phone and screened for eligibility (adults living in Ohio or West Virginia who fished in the study region during 2011). Eligible respondents were asked to provide an e-mail address or a postal address to use for the subsequent survey. A total of 5,780 households was reached through these numbers, and 558 of these households were determined to be eligible for participation in the survey. The same screening questions were used with these anglers as were used with the anglers living in the other 10 states. A total of 491 individuals agreed to participate in the angler survey.

Anglers who agreed to participate in the survey were classified into one of three groups according to the types of fishing that they did based on their answers to the screening survey questions:

- **Great Lakes Anglers:** Anglers who fished the Great Lakes or Great Lakes tributaries.
- **Coldwater Anglers:** Anglers who did not fish the Great Lakes or Great Lakes tributaries, but who did fish elsewhere for trout or salmon (in either the Great Lakes basin or UMORB).
- **Warmwater Anglers:** Anglers who did not belong to one of the previous two groups (in either the Great Lakes basin or UMORB).

These groups were used to assign variations of the survey instrument during the subsequent web survey.

The screening process through which a total of 7,692 anglers was recruited to participate in the survey, took place from January 9-March 6, 2012.

Web and Mail Survey Implementation

Data were collected through both a web-based survey and a mail survey, which were conducted from March 21-May 26, 2012. The sample was divided into two groups: those with e-mail access who were willing to participate in the survey via the internet (n = 4,562) and those without e-mail access or who preferred to participate via mail (n = 3,112)[7].

Participants who agreed to participate in the web-based survey were sent a thank you e-mail to verify their e-mail address and remind them about the survey approximately one week before the survey began. At the outset of survey, an e-mail with a link to the web survey was sent to each angler in the sample. Non-respondents were sent up to four reminder e-mails[8] encouraging them to participate in the survey.

Mail survey participants were sent a cover letter with a copy of the survey instrument. Non-respondents were sent up to three reminder letters spaced seven to 10 days apart. The second reminder letter included a second copy of the survey instrument for those who may have misplaced it.

Web and Mail Survey Instruments

The web and mail survey instruments covered similar content except that: (a) some questions were formatted differently in the two instruments; and (b) some questions from the web survey were not included in the mail survey because of space constraints.

The topics covered in the surveys[9]can be divided into four primary areas: background information, expenditure data, travel cost data, and contingent behavior responses. The background information included:

- Number of years fished
- Factors influencing choice of fishing locations
- Types of fishing engaged in during 2011 (e.g., Great Lakes, inland lakes and ponds, etc.)
- Importance of fishing relative to other activities
- Boat ownership
- Socio-demographic information (e.g., age, gender, income)

To estimate mean angler expenditures per trip, respondents were asked information about their most recent fishing trip, including:

- Month and year
- Number of days fished (if an overnight trip)

[7] Some individuals who had been agreed to participate were found to live outside the 12-state study area, and so were not included in either sample.
[8] Standard protocol in *mail* surveys is to send up to three reminder letters, but because the cost of sending additional reminders in *web* surveys is negligible (no costs for materials or postage), a fourth reminder was sent.
[9] Please see the Appendix for the survey instruments.

- Primary type of fishing
- Location (county-level)
- Number of people in household on trip
- Expenditures (categorized)
- Mode of transportation

To develop the travel cost portion of the model, data were collected on all fishing trips taken in 2011 so that travel costs could be determined. These data included:

- Zip code of primary home and any secondary home (which provided a point of origin for fishing trips)
- Fishing locations
  - Locations of day trips taken within the study area. In the web survey, these locations were designated at the county level for the state in which respondents fished the most and at the state level for other locations. In the mail survey, these locations were designated at the county level for the respondents' state of residence and not specified for other trips within the study area. That is, in the mail survey, respondents reported total days fished outside their home state, but within the 12-state study area.
  - Locations of overnight trips taken within the 12-state study area. In the web survey, these locations were designated by the nearest city, village, or town (which were subsequently coded to the county level). In the mail survey, these locations were designated at the county level for the respondents' state of residence and not specified for other trips within the study area.
  - The number of trips taken to each location. For overnight trips, web survey respondents also provided the total number of days spent fishing on all trips to each location.
  - Primary types of fishing on the fishing trips to each location. Based on a literature review and the data collected during the focus groups, seven types of fishing were designated: Great Lakes for trout and salmon (GLCold); Great Lakes for warmwater species (GLWarm); inland lakes and ponds for trout and salmon (ILCold); inland lakes and ponds for warmwater species (ILWarm); salmon or steelhead on spawning runs (Anadromous); rivers and streams for trout and salmon, but not on spawning runs (RSCold), and rivers and streams for warmwater species (RSWarm).

We also included a series of contingent behavior questions to explore how angler behavior would change if fishing quality was reduced. To develop the contingent behavior portion of the model, respondents were asked hypothetical questions about how the number of fishing trips they took would change if fishing quality declined. Data collected through these questions included:

- Number of day and overnight trips taken in a normal year for each of the seven types of fishing. (Respondents were encouraged to use the number of trips they had reported for 2011 as a "normal year" if they thought 2011 was typical.)
- The respondents' estimates of the number of day and overnight fishing trips they would take for each of the seven types of fishing in a normal year if the number of fish they could catch decreased by 0%, 30%, or 50%. Specific percentage decreases varied by fishing type. The range of percentage decreases was chosen based on discussions with USACE ecologists, to cover the range of possible impacts of ANS on sport fish populations in the study area.

In these questions, CU presented each respondent with a hypothetical scenario specifying changes to the number of fish they could catch in each of the seven fishing types. Thirty different hypothetical scenarios were developed. In each scenario, respondents were told that the number of fish they could catch for each of the seven types of fishing would decline by 0%, 30%, or 50% (Table 3). Each respondent was randomly assigned one scenario from among a subset of the 30 scenarios that were most likely to influence types of fishing in which they engaged (based on how they had been classified in the screening survey).

- Great Lakes Anglers in the web survey were randomly assigned to one of scenarios 1-8, or 11-20.
- Coldwater Anglers in the web survey were randomly assigned to one of scenarios 1-2 or 4-20.
- Warmwater Anglers in the web survey were randomly assigned to one of scenarios 2-20.
- Participants in the web survey who did not answer the screening survey questions about the type of fishing they did were randomly assigned to one of scenarios 2 or 4-30.
- Mail survey respondents were randomly assigned to one of scenarios 21-30.

Assigning the scenarios in this way assured that most respondents received a scenario that included a catch rate decrease for at least one type of fishing in which the respondent engaged.

Followup Survey

A short followup survey of 2,281 web survey respondents was implemented between June 27 and August 7, 2012, to collect additional expenditure data so that the expenditure data more

Table 3. Percentage decline in number of fish caught per day in hypothetical scenarios presented to survey respondents.

	Type of Fishing						
Scenario	Great Lakes for Trout and Salmon	Great Lakes for Warmwater Species	Inland Lakes and Ponds for Trout and Salmon	Inland Lakes and Ponds for Warmwater Species	Salmon or Steelhead on Spawning Runs	Rivers and Streams for Trout and Salmon but not Including Spawning Runs	Rivers and Streams for Warmwater Species
1	30	50	0	0	50	50	0
2	50	0	30	50	50	0	0
3	30	0	0	50	50	0	30
4	30	0	50	0	30	0	30
5	0	30	30	50	0	50	0
6	50	30	50	0	50	0	0
7	0	0	50	0	30	50	50
8	0	50	0	50	0	50	30
9	0	0	50	30	0	50	30
10	0	0	50	50	0	30	50
11	30	0	30	0	30	50	0
12	0	50	30	0	0	30	30
13	50	0	0	0	50	50	50
14	50	30	0	0	30	0	30
15	0	30	0	30	50	50	0
16	50	50	0	30	30	0	0
17	30	30	50	0	0	30	0
18	0	30	0	0	30	30	30
19	0	50	50	30	50	0	0
20	30	0	0	50	50	30	0
21	50	0	0	30	30	30	0
22	0	50	0	0	50	30	50
23	0	0	30	30	30	30	0
24	0	30	0	50	30	0	50
25	0	0	30	30	50	0	50
26	30	30	0	30	0	0	50
27	0	30	30	0	50	0	30
28	0	50	50	50	30	0	0
29	30	0	50	30	0	0	30
30	30	50	30	0	0	0	50

fully represented the range of types of fishing trips that take place over the course of an entire fishing season. At the outset of the survey, an e-mail with a link to the web survey was sent to each angler in the sample. Non-respondents were sent up to four reminder e-mails encouraging them to participate in the survey. Through this survey, expenditure data were collected about the most recent fish trip respondents took subsequent to their completion of the previous survey. The type of expenditure information collected was identical to that collected in the previous survey.

Analysis

Non-response Analysis

Respondents (individuals who completed both the screening survey and the subsequent web/mail survey) were compared to non-respondents (individuals who completed only the screening survey) to determine if non-response bias existed. The two groups were compared according to whether they fished in 2011, the types of fishing in which they participated, and the number of days they fished in 2011. These comparisons allowed determination of whether respondents to the web/mail survey (whose responses were used to generate CU's estimates of the economic value of recreational fishing) were more avid than other anglers, fished more days, or participated in different types of fishing.

Data Weighting

Weighting the data was necessary because of the different methods used for sample selection in different states. The need for random digit dialing sampling in Ohio and West Virginia resulted in fewer potential respondents to the survey from those states, compared with other states in the study area where license records were available. CU used the 2011 list of paid license holders by state from the US Fish and Wildlife Service National Fishing License Report to estimate the proportion of licenses (resident and non-resident) sold in each state. It was assumed that the sample from Ohio and West Virginia was representative of resident and non-resident license holders in those states. Before calculating the proportion from each state, the number of licenses sold in each state was decreased by the proportion of non-resident licenses purchased by people living outside the study area, as the study population was defined as those who lived and fished in the study area states (anglers who lived outside the study area were deleted when the sample was drawn). For Ohio and West Virginia, where it was unknown how many licenses were sold to those living outside the study area, CU used the mean proportion of surrounding states. Weight factors were calculated based on the proportion of licenses sold in each state and applied to number of respondents to the mail and web survey (n=3,539). The same procedures were used for the followup web survey that estimated expenditures. New weight factors were calculated and applied to respondents of the web followup who indicated they had fished subsequent to the implementation of the main survey.

Estimating Per Day Expenditures from Main Survey and Followup Survey

In the main survey, anglers were asked about their household's expenditures on their most recent trip to the study area where the primary purpose was fishing; these trips could have been in 2011 or early in 2012. Information from respondents who reported a trip outside the study area or indicated no fishing took place on the trip was deleted from the analysis. The expenditures reported were divided by the number of days fished on the trip to get expenditures per day per household. The non-zero data were examined for values considered out of range. The top 1% of non-zero values were considered out of range. For example, spending $300 or more per day at bait and tackle shops, or $625 or more per day at hotels or campgrounds was considered out of range. These outliers, along with non-numeric responses (e.g., a lot, some), were replaced with the mean value of the valid values for the analysis. Expenditures by category were summed to get total expenditures. Expenditure estimates were weighted by state of license purchase as discussed above. They were not adjusted to FY $2012 because they already cover the FY $2012 time span.

In the followup survey, anglers were first asked if they had fished in the study area since completing the web survey. Only those who had taken a trip were asked about their most recent trip expenditures. The expenditures reported were divided by the number of days fished on the trip to get expenditures per day per household. The non-zero data were examined for values considered out of range. The results were very similar to the results of the main survey, so the cut-off values from the main survey were used in the followup survey as well. These outliers were replaced with the mean value of the valid values from the followup survey for the analysis. Expenditures by category were added to get total expenditures. Expenditure estimates were weighted by state of license purchase as discussed above.

Angler Characteristics

The mail and web surveys included questions about background characteristics of anglers, which allowed us to describe anglers in the study region. These background characteristics included state of residence and socio-demographic characteristics (e.g., age, gender, income, marital status, presence of children at home). Questions were also asked that related to fishing avidity, including motivations for fishing, self-assessments on the importance of the fishing to the respondent, number of years fished, and whether a fishing boat was owned. The results of these background variables are presented in the Results section.

Estimating the Number of Anglers and Total Days Fished in 2011

The total number of anglers living and fishing in the 12-state study area in 2011 was calculated by state of residence. The number of resident fishing licenses sold in each state was obtained from state databases. This number was increased by the proportion in the sample that lived in each state but fished only in other states in the study area, and therefore would not be counted in the number of resident licenses sold. For example, four people in the sample lived in Iowa but fished only in states other than Iowa, so they are not part of the population of Iowa resident fishing license buyers. Therefore, the number of resident fishing license buyers was increased by the proportion these four anglers represent of all Iowa residents in the sample. Further, based on survey responses, only 87.5% of 2011 fishing license buyers actually fished in 2011. To reflect this participation rate, the number of license buyers was reduced by this proportion in all states to get an estimate, based on license sales, of the number of anglers who lived and fished in the 12-state study area in 2011.

Total days fished in 2011 were calculated by multiplying the mean number of days fished per angler by state of residence times the number of anglers who lived and fished in the 12-state study area in 2011. Days fished within the 12-state study area were apportioned into 5 regions: (1) Great Lakes basin below barriers impassable to fish, (2) Great Lakes basin above barriers impassable to fish, (3) UMORB below barriers impassable to fish, (4) UMORB above barriers impassable to fish, and (5) areas within the 12-state study area but outside of either basin. The days of fishing that took place in each of these 5 regions was estimated by calculating the proportion of the water bodies in each county in each of the five regions and multiplying that proportion by the days fished in that county. For days reported by state (the county fished was not known) the same method of apportioning days by region was used.

Economic Modeling

The objective of the economic modeling was to provide estimates of net economic value per angler per fishing day based on the web and mail survey data[10]. The net value per angler day is the form of value most frequently reported in the recreational valuation literature and is used here to allow comparison to previous research. As discussed in the introductory section of the present report, previous fisheries research conducted in the Great Lakes suggests that a range of $20 to $75 would encompass the likely net value per day of fishing in the Great Lakes. When combined with participation estimates, these individual, trip-level estimates can, with appropriate caveats, be aggregated up to net value per angler season and total value of the fishery at basin or state level to provide approximate net economic values at regional levels.

[10] We have utilized the term "net value" throughout this report and in the preceding literature review (Poe et al. 2012). Net economic value is often referred to as "consumer surplus" in the recreational valuation literature.

The econometric model used in this analysis is referred to as a “Repeated Site Choice” model. This model accounts for three choices that the angler must make each time he or she has the opportunity to take a fishing trip. As depicted in Figure 2, these choices can be represented by a decision tree consisting of three decision levels.

The Repeated Site Choice modeling structure begins by assuming that a recreational angler has a number of “Choice Occasions” throughout a fishing season. For the purposes of this study, we defined the fishing season to be calendar year 2011. Within this season each angler has 365 choice opportunities, or days.

For each choice occasion, the angler must first decide whether to go fishing or to do something else, such as go to work, participate in another recreational activity etc. This is depicted as the participation level in Figure 2.

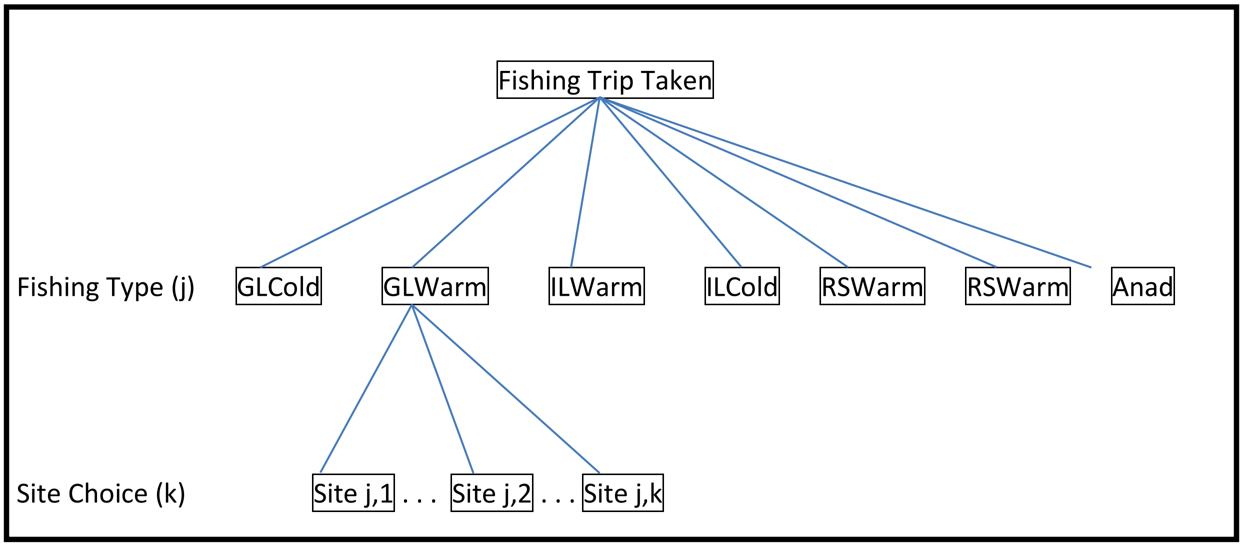
If the angler chooses to go fishing, then a second decision must be made – which fishing type to engage in on that trip. Consistent with previous recreational fishing studies of the Great Lakes and Inland Fishing in the State of Michigan by Kikuchi (1986), Jones and Sung (1993) and Hoehn et al. (1998), our modeling framework divides fishing types within the study region into seven categories: Great Lakes for trout and salmon (GLCold), Great Lakes for warmwater species (GLwarm), inland lakes and ponds for trout and salmon (ILCold), inland lakes and ponds for warmwater species (ILWarm), rivers and streams for trout and salmon but not on spawning runs (RSCold), and rivers and streams for warmwater species (RSWarm), and salmon or steelhead on spawning runs (Anadromous). These Fishing Type characterizations were used in the focus groups, and found to be salient to participants.

Having chosen a fishing type, the third decision the angler makes is where to go fishing. There will often be several alternative fishing sites available to each angler that offer the type of fishing he or she has chosen for that trip. With respect to this “Site Choice” from available sites, the fundamental premise of travel cost modeling is that the probability of choosing a particular site is positively related to the fishing quality at the site and inversely related to the travel costs to the site, all other factors held constant.

It is assumed that the angler proceeds through this series of participation, fishing type, and site choice decisions each day of the year, which is the reason this model is named “Repeated Site-Choice” model.

Anglers need not actually make the three decisions in sequence; they can be made simultaneously. The nesting structure presented in Figure 2, in which fishing sites are grouped by, or nested under, a fishing type, captures the idea that trips of the same fishing type are more similar to each other than they are to trips of a different fishing type. In other words, a day spent fishing for trout in streams in county A is more like a day spent fishing for trout in

Figure 2. Nested site choice model using Great Lakes for warmwater species example.



Notes: The acronyms used in this table are defined in the corresponding text. Although not depicted in the Figure, each Fishing Type nest has K sites available, where K can vary by Fishing Type.

streams in county B than it is like a day spent fishing for bass in a lake in County A. This assumption can be tested statistically.

Given the geographical extent of the study area, CU decided to define fishing sites at the county level (i.e., each fishing "site" considered in the modeling was a composite of all the sites within a given county), with 1042 counties in the 12-state study region[11]. Of these 1042 counties, 82 with shoreline on the Great Lakes were identified as Great Lakes coastal counties. All Great Lakes coastal counties were assumed to support fishing for both coldwater and warmwater species.

Based on expert opinion and survey responses, 99 counties were identified that contain rivers or streams that support fishing for anadromous salmon and/or steelhead on spawning runs.

Counties that support sportfishing for coldwater species (trout and salmon) in inland streams, rivers, lakes or ponds were identified by combining 1) those counties identified by state fish and wildlife agencies as supporting coldwater fishing and 2) those counties identified by survey respondents as inland salmon and trout fishing destinations. We do not differentiate in this study between naturally reproducing coldwater fisheries and those that exist only through stocking of catchable fish. On this basis, 671 of the 1042 counties in the 12-state study area, were designated as counties that support fishing for coldwater species in both rivers and streams and in lakes and ponds.

All counties were deemed to support inland warmwater fishing in both rivers and streams and in lakes and ponds.

Travel Cost Data: The travel cost to each fishing site was calculated for each angler using the geographical coordinates of the primary zip code for the respondent as the departure location and the centroid(s) of the destination county (counties) as the destination location. For respondents that indicated they owned two homes, travel costs were calculated from both the home zip code and the second home zip code. The PC*Miler™ software package was used to

[11] The decision to organize destinations at the country level was motivated by the large number of potential sites, the difficulty of identifying every possible fishing site across the entire region, and the difficulty for survey respondents of identifying their trip destinations at finer than a county level. By way of comparison, Murdoch (2005) identifies 569 sites visited by anglers in a study of the Green Bay area fisheries in Wisconsin. In a NY survey, Connelly et al. (2007) reported on the 80 most frequently fished waters from a list of over 5,000 waters in NY. In addition, information gathered in the process of conducting the focus groups suggested that anglers would have a difficult time identifying which waters were above or below impassable barriers. Hence, the unit of measurement of destinations was the county level and not further distinguished by reference to impassable barriers.

calculate the round trip miles, time traveled, and toll costs from each zip code to the centroid of each of the 1042 possible destination counties.

The travel cost per mile ($0.29) used in our analyses accounts for the operating costs of driving, including fuel costs, tire wear, and maintenance, and the depreciation associated with driving extra mileage. Estimated per-mile costs for maintenance, depreciation and tire wear were taken from the American Automobile Agency (AAA, 2011). Average fuel costs were taken from US Energy Information Administration data (USEIA, 2012) and average fuel efficiency for cars and light trucks were provided in the Bureau of Transportation Statistics (USBTS 2012). Data collected from the expenditure sections of the survey indicated that anglers used cars on about 23% of fishing trips and light-duty trucks on 77% of fishing trips. These proportions allowed the estimation of an average fleet value for per-mile travel costs. For reference, the per-mile travel costs used in this study are similar to recreational travel cost studies reported in the GLMRIS study region since 2000 and reviewed in Poe et al. (2012): $0.32 (Murray et al., 2001), $0.30 (Yeh et al., 2006), $0.35 (Kelch et al., 2006) and $0.38 (Song et al., 2010)[12].

The cost attributed to the anglers' travel time was estimated by first imputing a wage rate per minute (calculated as reported annual income per year/2000 working hours per year/60 minutes per hour), multiplying this by the estimated round trip time of travel, and then adjusting this value to account for the economic concept that the opportunity cost of travel time is only a portion of the imputed wage cost. The estimated round trip minutes traveled from the anglers home zip code to the destination county and back were provided by PC*Miler™ software. For the respondents who did not provide an income value, the state level average household income reported by survey respondents was used as a proxy. The resulting values per minute were divided by three (multiplied by 0.33) to reflect the opportunity cost of travel time. These opportunity cost adjustments and annual hours worked assumptions correspond to standards in travel cost modeling (Parsons, 2003), and fall within the range of recreational travel cost studies reported in the GLMRIS study region since 2000 and reviewed in Poe et al. (2012): 0.35, 2000 hours (Murray and Sohngen, 2001); 0.30, 2040 hours (Yeh et al., 2006); 0.30, 2000 hours (Kelch et al., 2006); and 0.33, 2000 hours (Song et al., 2010).

The third component of travel costs, toll costs, were estimated using the PC*Miler™ software and multiplied by two to estimate round trip toll costs.

[12] The cost-per-mile values are the values reported in the original studies. They are not updated to 2012 following standard USACE procedures that use Consumer Price Indices (USACE 1982), because the costs are very specific and not necessarily reflective of changes in the broader CPI. These values are reported here simply to provide comparative references for the pre-mile travel costs used in the present study, and are not used in any of the analyses reported herein.

The three components of travel cost - mileage cost, opportunity cost of time, and toll costs – were summed for each origin zip code/destination county pairing in the data set. When both a primary and secondary zip code were indicated, the lowest travel cost from the two origin zip codes was used for each possible destination county.

Site Choice Set: While there are 1042 potential destination counties in the data set, it is evident that many of these destinations far exceed the distances that would reasonably be travelled in a day trip from the angler's indicated zip code of origin. To eliminate trips that likely were undertaken for a primary purpose other than fishing, CU limited the set of possible destinations available to an angler to those counties that lay within 150 minutes (2.5 hours) of the zip code of origin for all fishing types except trips taken for Anadromous fishing. For Anadromous fishing, because of the relative rarity of this type of fishing, the time cutoff was higher, 180 minutes (3 hours). These cutoffs were chosen so that the data would capture at least 95% of the trips indicated by survey respondents, but still minimize the effect of outlier observations. Past travel cost fisheries studies conducted in the study region have used similar approaches to limiting the site choice set, frequently using a mileage cut off instead of the time limits we imposed: e.g. 150 miles (Hoehn et al., 1996) and 120 miles (US EPA, 2004). If anglers listed a second origin zip code, the set of feasible destinations was broadened to include all of the counties that lie within the designated time threshold from either the primary or the secondary zip code origin.

Feasible counties for each Fishing Type were further limited to those counties that support the indicated Fishing Type. For example, it is not possible to go Great Lakes fishing in Missouri, but there are counties in Missouri with coldwater fishing opportunities. It is assumed that all counties in the 12-state study area included warm water fishing opportunities. The resulting set of counties provides what we refer to as the "Site Choice Set" for each angler.

Destination County/Counties: In the web and mail surveys, respondents indicated the destination county(ies) to which they took each fishing day trip in a Fishing Type category, and the frequency of visits they took to each site in 2011. These destination counties represent the site choices that the angler made from the Site Choice Set. If the angler indicated a destination county outside of the Site Choice Set (i.e. a destination county that does not support the fishing type chosen), then this trip was not included in the Site Choice Model.

The degree of specificity with which anglers reported their fishing trip destinations varied across the survey mode and whether the fishing trip occurred within or outside of the home state. Three variations of destination county identification were accounted for in this analysis.

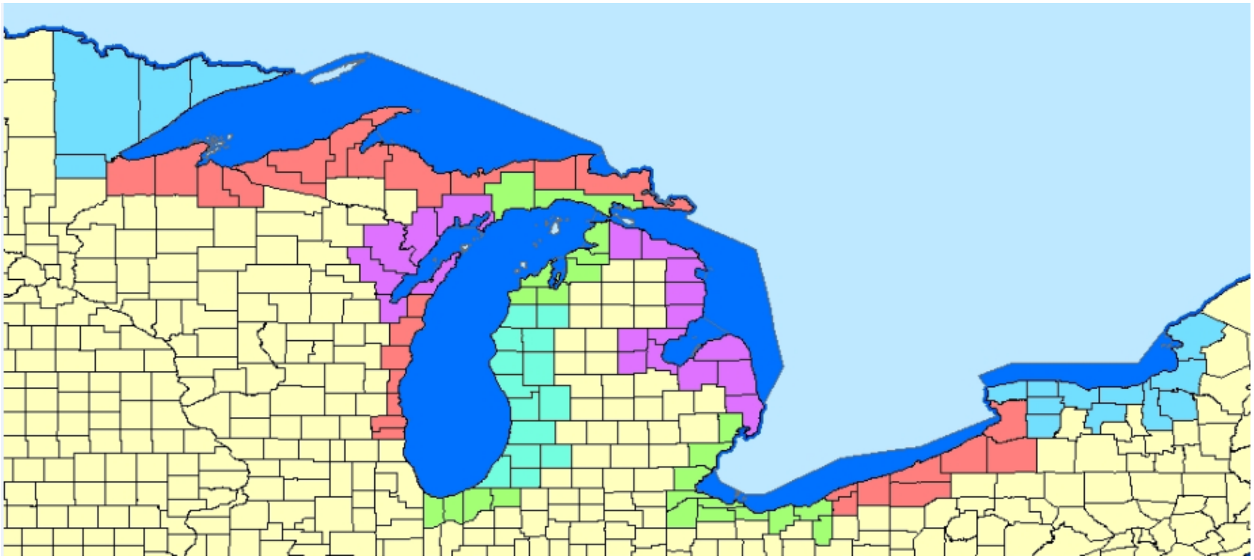
(1) If a fishing trip was taken within the angler's "home state" (for mail survey respondents) or the state in which they fished "the most" (for web survey respondents), then the specific destination county was indicated.
(2) In the web survey, for trips taken to states other than the state they fished in the most, respondents indicated which state was visited, and how often, for each fishing type. In these cases all counties in the destination state that were within the time cutoff from the angler's origin zip code and that supported the fishing type indicated were coded as possible destination counties.
(3) In the mail survey, anglers who traveled to fishing destinations outside their home state indicated the number of day-trips fished in "All other States in the Study Area" for each fishing type. In these cases, all the counties that were outside of the home state that were within the time cutoff from the anglers origin zip code and that supported the fishing type indicated were designated as possible destination counties.

On this basis, for each trip taken by an angler, the "Site Chosen" may include one or several destination counties. This variation is accounted for in the Site Choice Model.

Site Choice Characteristics: As noted above, the probability that an angler will chose a particular site is predicted to be positively related to the quality of the site and inversely related to the travel time and distance to the destination site. Recreational fishing models have often characterized site quality using expected catch rates (i.e. catch per unit of effort) obtained from creel surveys. In this study, CU did not adopt such an approach for two reasons. First, consistent catch rate estimates are not available at all sites in all the states in the study, and the methods used to estimate and report catch rates are not uniform across states. Second, as shown recently by Murdoch (2006), catch rates provide only one aspect of the overall quality of a site, and could lead to biased estimates of the effect of catch rates on the probability of site choice if other aspects for fishing quality are not included in the model. Other aspects of fishing quality at a site may be quite diverse and in many instances unobservable or difficult to measure, such as the beauty of a site, accessibility, location relative to other amenities, congestion, and other factors.

Lacking a complete characterization of site quality, Murdoch (2006) proposed that separate constants for each site, in our case county, be estimated. These county-specific constants would capture all the actual or perceived variations in site quality across sites. This approach was adapted for the Great Lakes and Anadromous fishing types. Because the total number of Great Lakes and Anadromous fishing trips in the survey data was not large enough to estimate reliable county-specific constants for each county, these counties were grouped into 11 contiguous shoreline segments. These segments are indicated in Figure 3 for the Anadromous

Figure 3. Anadromous run (AR) counties.



Segments, from east to west: AR1 – Northern Lake Superior/Minnesota; AR2 – Southern Lake Superior; AR3 – Green Bay; AR4 – Southern Lake Michigan/Wisconsin; AR5 – Southern Lake Michigan/Indiana; AR6 – Eastern Lake Michigan; AR7 – Northern Lake Michigan; AR8 – Lake Huron; AR9 – Lake St. Clair, Western Lake Erie; AR10 – Eastern Lake Erie; AR11 – Lake Ontario. Note that the Illinois Department of Natural Resources indicates that there are no streams in Illinois that support anadromous runs.

fishing type. The 11 Great Lakes fishing type segments correspond to those presented in Figure 3, but exclude the 17 counties that support anadromous runs but do not have Great Lakes shoreline. For the Anadromous fishing type, 11 segment-specific constants were estimated. Two segment-specific constants were estimated for each of the Great Lakes segments, one capturing site quality for GLCold fishing and the other capturing site quality for GLWarm fishing.

The four inland waters fishing types – ILWarm, ILCold, RSWarm and RSCold - were widely dispersed across the study region. Because sampling intensity varied from state to state, many inland counties received no fishing visits in our sample. This made it impossible to estimate county-specific constants for each fishing type. Inland counties were therefore grouped by state, and state-specific constants were estimated for each fishing type.

To improve our ability to model variation in fishing availability and quality among inland and anadromous counties, continuous habitat quality measures were also included in the model for these fishing types. In adopting this approach it is important to note that such an approach is not expected to provide unbiased estimates of the responsiveness of fishing site choice to the changes in specific measures of habitat quality used. Nevertheless, including habitat quality measures in the model allows CU to establish baseline utility levels for each inland and anadromous county that better match perceived quality from the anglers' perspectives.

The following continuous habitat measures were used to model baseline utility for each county for each fishing type. These were included in the model in addition to the state-specific and group-specific constants estimate for each fishing type

- For fishing types ILWarm, ILCold, RSWarm, RSCold, and Anadromous:
    - Habitat Condition Index: An index developed by the National Fish Habitat Partnership that measures the intensity of human disturbance of the landscape that can affect aquatic habitats. Low index values indicate high risk of habitat degradation, while high index values indicate low risk of habitat degradation (downloaded from ecosystems.usgs.gov/fishhabitat/).
- For fishing types ILWarm and ILCold:
    - Total area (in square miles) of all inland lakes and ponds
- For fishing types GLWarm and GL Cold
    - Great Lakes shoreline (in miles)
- For fishing types RSWarm, RSCold and Anadromous:
    - Total length (in miles) of all smaller streams (stream order 3 and 4)
    - Total length (in miles) of all larger streams and rivers (stream order 5 and higher)

Lake area and stream miles were calculated using ArcMAP from the USGS National Hydrography Dataset.

Results

Focus Group Results

Detailed results from the focus groups are reported in a separate report (Evensen et al 2012), but several results particularly pertinent to the development of our survey methods are summarized here. The focus groups were used to explore how anglers make decisions about fishing and to learn the potential range of behavioral responses that could occur in reaction to changes in sportfish catch rates. Participants' responses helped CU better understand the language used by anglers when discussing decisions of where to fish and what species to target, which informed the wording used in the surveys.

Focus group participants expressed a range of potential responses to changes in sportfish catch rates. Some participants said that they would not change their behavior if catch rates were to fall. Several, however, said that they would see a decline in catch rates as a challenge to their abilities, and that they might fish even more. Others said that they would fish less often, or would change where they fish or what species they target.

Most focus group participants easily understood the distinction between warmwater and coldwater target species, and stated that they were able to state which category of fish species they primarily targeted on an individual fishing trip. Further, focus group participants understood the distinction between Great Lakes waters and tributaries to those waters.

Of particular importance to development of the survey, focus group participants were not able to identify which waters were located upstream from barriers impassable to fish and which waters were located downstream from barriers impassable to fish. For this reason, the survey did not ask anglers to report whether their fishing trips were to waters upstream or downstream from impassable barriers.

Response Rates and Non-respondent Analysis

Screening Survey with Licensed Anglers

From the sample of 28,200 anglers selected from license records, Lexis-Nexis[13] searches identified phone numbers for 22,043 anglers based on their names and addresses. Some of

[13] Lexis-Nexis is a fee-based service that allows users to look up telephone numbers based on name and address information.

these anglers (n=365) were never contacted by phone because the response rate from their state was higher than other states, and resources were devoted to states with lower response rates. Of those contacted by phone (n=21,678), 29% of the phone numbers were determined to be out-of-service or incorrect. Of those with a working phone, 7,201 were contacted, interviewed, deemed eligible for the primary web and mail survey (the person fished in the study region during 2011 or planned to fish there in 2012), and agreed to participate in the web or mail survey by providing either their e-mail address or confirming their postal address. This represents 47% of those with a working phone. Only 4% of those with a working phone refused to either be interviewed or participate in the web or mail survey. Table 4 shows the results of the screening process by state of license purchase. Because CU wanted to maintain the same proportions by state in the web and mail survey as existed in the initial sample, more effort was devoted to certain states to increase response rates with the goal of having similar percentages agreeing to the web and mail survey in each state.

Screening Survey with Ohio and West Virginia Residents

Because CU was not able to obtain license records for Ohio and West Virginia, a random-digit dial (RDD) sampling strategy was used in these two states to identify and recruit eligible anglers. Samples of 13,934 phone numbers (targeting Ohio) and 3,000 phone numbers (targeting West Virginia) were purchased. Of these, 22% in Ohio and 13% in West Virginia were subsequently identified as non-working numbers. From the sample of those with a working phone number, 37% of those contacted in Ohio and 33% in West Virginia were not eligible for the web or mail survey because no one in the household fished in the study region. Few people refused to be interviewed or participate in the web or mail survey (Table 5). In Ohio 382 people agreed to complete the web or mail survey, and in West Virginia 109 people agreed.

Web and Mail Survey Response

Out of the 7,692 anglers who provided contact information for the web and mail survey, 18 were determined to live outside the study area and were not contacted, 4,562 provided working e-mail addresses, and 3,112 provided mailing addresses (Table 6). Of those contacted by e-mail to participate in the web survey, 50% completed the survey (n=2,281). Of those contacted by mail, 60 were undeliverable and 1,258 responded. The adjusted response rate (accounting for undeliverables) for the mail survey was 41%. Overall, the response rate across the two surveys was 46%.

Non- respondent Analysis

Of the 7,674 anglers contacted, 3,539 responded to either the web or mail survey. The non-respondent comparison analysis (as described above) revealed that respondents were slightly

Table 4. Response rates for screening interviews with licensed anglers.

			Of those with a working phone:			
State of license purchase	Initial sample	% with bad phone number	% ineligible for follow-up	% refused screening or follow-up	% agreeing to follow-up	# agreeing to follow-up
IA	1,119	34.8	6.0	2.6	44.4	324
IL	1,995	21.1	17.5	5.3	39.2	616
IN	1,852	29.7	5.3	2.2	35.1	457
KY	1,596	33.5	9.8	4.8	47.9	508
MI	3,071	33.2	9.3	5.0	52.6	1079
MN	3,030	27.1	11.3	5.4	49.0	1081
MO	1,790	38.9	6.4	5.6	43.4	475
NY	1,917	27.5	9.7	2.8	51.4	714
PA	1,870	18.7	4.0	2.4	50.1	771
WI	3,438	28.3	6.5	4.5	47.7	1176
Total	21,678	29.0	8.8	4.2	46.8	7,201

Table 5. Response rates for screening interviews with Ohio and West Virginia residents.

			Of those with a working phone:			
State of license purchase	Initial sample	% with bad phone number	% ineligible for follow-up	% refused screening or follow-up	% agreeing to follow-up	# agreeing to follow-up
OH	13,934	22.1	37.5	2.5	3.5	382
WV	3,000	12.9	32.7	2.1	4.2	109

Table 6. Web and mail survey response rates.

Survey mode	Initial sample	Undeliverables	Respondents	Response rate
Web	4,562	-	2,281	50%
Mail	3,112	60	1,258	41%
Total	7,674	60	3,539	46%

more likely to be active in fishing than non-respondents based on their answers to questions on the screening survey (Table 7). The difference in the percent indicating they fished in 2011 was statistically significant, but the practical difference (93% vs. 91%) is negligible. Corresponding differences were found for some of the more specific fishing participation variables such as fishing the Great Lakes, fishing other lakes and ponds, or fishing for trout and salmon. For those who fished in 2011, there was not a statistically significant difference in the average number of days fished between respondents (25.2 days) and non-respondents (24.0 days) based on their answers to questions in the screening survey. Accordingly, CU concluded that the data collected through our surveys adequately characterized the population of recreational anglers in the 12-state study area, and no adjustments to the data were made to account for non-response bias prior to economic modeling.

Followup Web Survey Response

Out of the 2,281 anglers who responded to the main web survey and were subsequently asked to participate in the followup web survey, 1,499 responded, yielding a response rate of 66% (Table 8). Of the 1,499 who responded, 30% (n=448) indicated they had not fished since filling out the main web survey and thus, were not asked to provide any further information. Analysis of trip expenditures was done using the remaining 1,051 respondents.

Socio-Demographic Characteristics

State of Residence

The data show the relatively unequal distribution of respondents by state of residence within the 12-state study area (Table 9). Particularly strongly represented are the lake states of Minnesota (13.7% of all respondents), Wisconsin (13.6%), and Michigan (10.9%). Only 2.7% of respondents were from West Virginia, and 3.3% were from Illinois. Based on fishing license sales data provided by the states, it was estimated that 6.6 million anglers lived and fished in the 12-state study area in 2011. Minnesota, followed by Michigan and Wisconsin had the largest populations of anglers who fished in the study area. (The total number of anglers who live in a state in the study area would be larger because some people only fish in states outside the study area, and so were not included in the sample. This is more likely true in states on the edge of the study area with good fishing opportunities outside the study area).

A number of angler characteristics (age, gender, income, marital status) were assessed because these characteristics may be related to fishing behavior. Anglers were disproportionately male (82.2%). Further, a strong majority of anglers (79%) is married—only 9% has never been married (Table 10). Over half (58%) of the married respondents' spouses/partners also fish.

Table 7. Fishing participation characteristics (from the screening interview) of those who responded to the web/mail survey compared with those who did not respond.

	Respondents	Non-respondents
	Percent	
Fished in 2011		
Yes	92.7	90.9
No	7.3	9.1
	(x^2 = 8.87, df = 1, p = 0.001)	
Fished Great Lakes in 2011		
Yes	20.4	17.3
No	79.6	82.7
	(x^2 = 11.35, df = 1, p = 0.001)	
Fished Great Lakes tributaries for trout or salmon in 2011		
Yes	15.0	11.7
No	85.0	88.3
	(x^2 = 16.60, df = 1, p < 0.001)	
Fished other lakes or ponds in 2011		
Yes	86.1	84.1
No	13.9	15.9
	(x^2 = 5.62, df = 1, p = 0.018)	
Fished large rivers in 2011		
Yes	38.7	39.4
No	61.3	60.6
	NS	
Fished other rivers or streams in 2011		
Yes	41.6	41.4
No	58.4	58.6
	NS	
Fished for salmon or trout in 2011		
Yes	38.6	34.3
No	61.4	65.7
	(x^2 = 13.67, df = 1, p < 0.001)	
Fished for other kinds of fish in 2011		
Yes	94.9	93.8
No	5.1	6.2
	NS	
Plan to fish in 2012		
Yes	99.2	98.2
No	0.8	1.8
	(x^2 = 14.19, df = 1, p < 0.001)	
	Mean	
# days fished in 2011	25.2	24.0
	NS	

NS = not significant

Table 8. Followup web survey response rate.

	Number	Percent
Respondents	1,499	66%
Fished since last survey?	448	30%
Initial Sample	2,281	

Table 9. Proportion of survey respondents by state of residence, and the estimated number of anglers derived from license sale information provided by the states by state of residence.

State of Residence	Percent of respondents	Estimated total # of anglers living and fishing in 12-state study area in 2011[1]
IA	5.3	269,003
IL	3.3	605,649
IN	7.0	332,061
KY	5.9	404,389
MI	10.9	805,792
MN	13.7	1,024,003
MO	10.5	545,902
NY	9.1	589,557
OH	8.1	520,789
PA	9.9	635,577
WI	13.6	728,604
WV	2.7	162,568
Total	100.0	6,623,893

[1]Based on fishing license sales (see Methods section for more details).

Table 10. Respondent marital status.

Marital Status	Percent
Never Married	8.7
Married	79.6
Unmarried Partner	2.8
Divorced	6.7
Widowed	2.2

Based on responses to the measure of age ("what year were you born"), anglers in the study region averaged 54 years old, with a roughly symmetric distribution around this mean (Figure 4).

Some 60% of anglers were employed full-time or self-employed, which may influence the amount of time they have available for fishing. The remaining anglers were retired (29%) or employed part-time or unemployed. With respect to income, only 18% of anglers had household incomes (in 2011) of less than $35,000 per year; 25% had household incomes of $100,000 or more. The modal single household income category (23.5%) is $50,000-$74,999 (Table 11). About 10% of respondents did not answer this question.

Fishing Behavior and Commitment

Number of Years Fished

On average, and consistent with the relatively high median age of our sample, anglers have extensive experience fishing: anglers have fished an average of 40 years (mean=39.9, median=40), and 75% had fished at least 30 years (Figure 5).

Fishing Motivations

Respondents were asked to describe the importance of several types of motivations for fishing, including those that emphasized achievement (expect to catch fish, expect to catch a lot of fish, big fish, and the right species of fish) and those that were less tied to catching fish (close to home, scenic, near family and friends). Each of these was measured on a five point scale ranging from 1=not at all important to 5=extremely important (Table 12).

Being able to fish for desired fish species (mean =3.57) was rated most important, followed by catching at least some fish (3.28). With regard to evaluating the potential impacts of ANS, there are anglers who care about catching fish (big fish, lots of them, and the species they want) and those who are interested in beauty, social relationships, convenience. Presumably the former group of anglers (those who care about catching fish) is more likely than the latter group to fish less if ANS transfer led to a decline in fishing quality – or alternatively to switch to other fishing locations or types of fishing with better opportunities for catching fish.

These results suggest that the type of fish sought is important, justifying the nesting approach used in the econometric model. Further, although fish catch rates appear to be important in site choice, other "quality" factors appear to be important in the site choice. This latter result

Figure 4. Angler age.

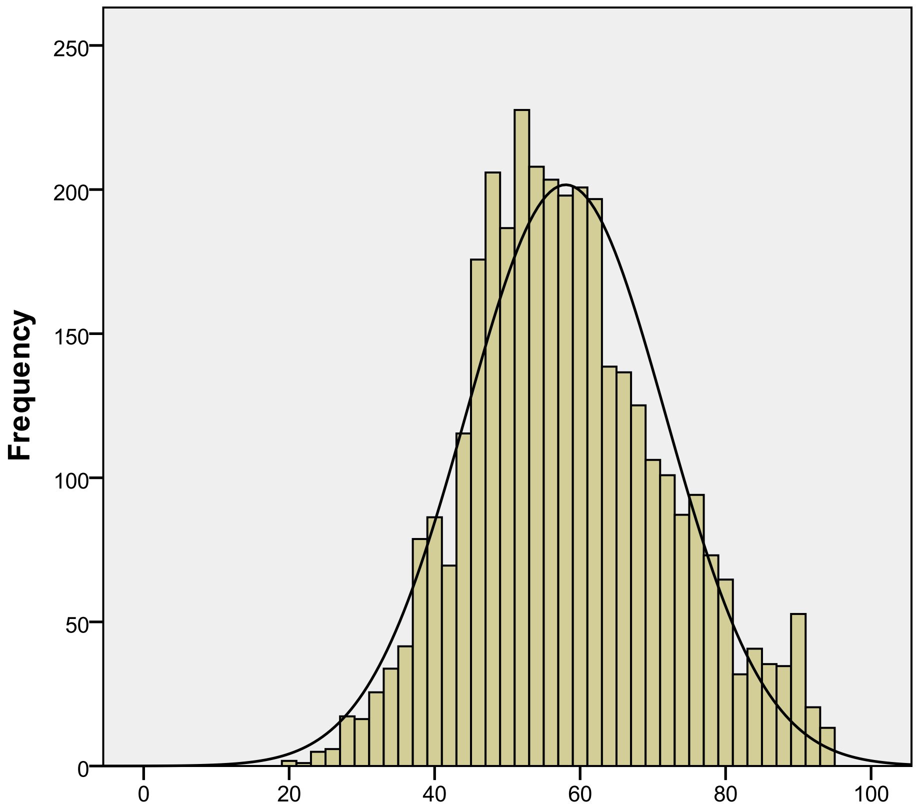


Figure 5. Number of years fished.

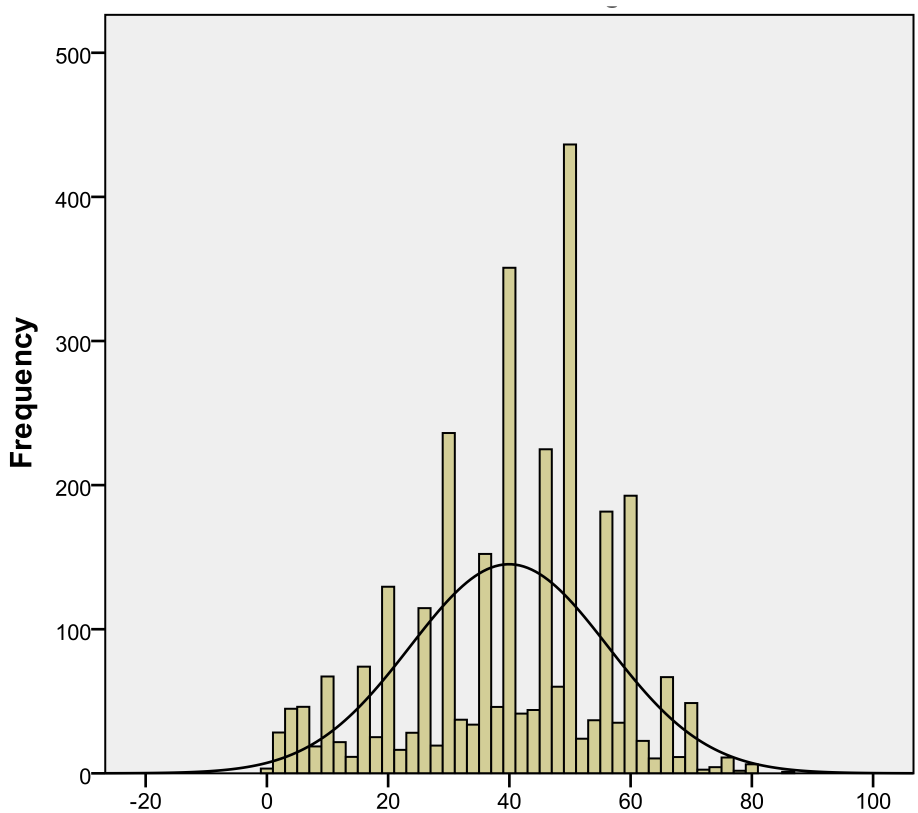


Table 11. Respondent income.

Income	Percent
Less than $15,000	4.2
$15,000 to 24,999	6.4
$25,000 to 34,999	7.9
$35,000 to 49,999	14.3
$50,000 to 74,999	23.5
$75,000 to 99,999	18.3
$100,000 to 149,999	17.2
$150,000 to 199,999	4.7
$200,000 or more	3.6

Table 12. Importance of fishing motivations.

	Fishing Motivation						
	Fishing location close to home/camp	Expect to catch some fish at location	Expect to catch a lot of fish at location	Fishing location has scenic beauty	Fishing location near family/friends	Fishing location contains fish species I like	Fishing location known for big fish
Mean	2.88	3.28	2.26	3.07	2.23	3.57	2.41
Median	3.00	3.00	2.00	3.00	2.00	4.00	2.00
SD	1.13	1.00	1.00	1.04	1.24	1.06	1.06

supports using state- and segment-specific constants in the Site-Choice Model as described above.

Fishing Commitment

It also might be expected that more committed anglers are more likely than less committed anglers to continue fishing even if they could catch fewer fish. Therefore, several measures of fishing commitment were examined. To begin with, respondents offered a self-assessment of their fishing commitment (Table 13). The distribution of responses was approximately normal, with only 25% in one of the two extreme values ("I would easily find something as enjoyable as fishing" and "I would miss fishing more than all other interests"). The anglers who "would miss fishing more than all other interests" would likely fish even if quality declined, and a decline in fish stocks, therefore, would not be expected to lead to an equal decline in recreational fishing.

Other measures of commitment are related to the opportunities anglers have to fish: whether they own a boat and whether they live within walking distance of fishing sites. Only 13% of respondents do not have a boat they use for fishing. Almost three times as many (35%, the most common response category) have both a motorized and non motorized boat (Table 14). Sixty-four percent, however, do not live within walking distance of any fresh water fishing.

Detailed Fishing Behavior Variables

Respondents reported the number of day trips and overnight trips they took for each of the seven fishing types. The total number of day trips, total number of overnight trips, and the total number of days spent on overnight trips were summed across all fishing types. Respondents reported an overall average of 28.0 days of fishing on day trips in the past year (Table 15). A strong majority of this fishing was on inland waters rather than the Great Lakes. Half of all day trips (14.1 days) were warmwater fishing on inland lakes. The second most common fishing type for day trips was warmwater river fishing (5.9 days). Thus, warmwater inland fishing (lakes and rivers combined) accounted for over 70% of all day trips. Inland coldwater fishing (lakes and rivers) accounted for 4.1 days of fishing, and Great Lakes fishing (coldwater, warmwater, and anadromous runs) accounted for 3.8 days of fishing (on day trips). About half of Great Lakes fishing day trips (1.9 days) were for warmwater species rather than coldwater.

Respondents reported an overall average of 3.28 overnight trips (Table 16); this figure is based only on the data from only the web survey, as inspection of the responses to this question from the mail survey revealed evidence that a high proportion of mail survey respondents misinterpreted the question and reported the number of days fished on overnight trips instead

Table 13. Fishing Commitment

Feelings about Fishing	Percent
Easily find something as enjoyable as fishing	12.4
Would miss fishing, but not as much as other things	34.4
Would miss fishing more than most other interests	39.2
Would miss fishing more than all other interests	13.9

Table 14. Boat ownership

Boat Owned?	Percent
No	13.1
Non-motorized	27.2
Motorized	25.0
Both non-motorized and motorized	34.7

Table 15. Number of day trips, by type of fishing.

	Great Lakes for trout and salmon	Great Lakes for warmwater species	Inland lakes and ponds for trout and salmon	Inland lakes and ponds for warmwater species	Inland rivers and streams for trout and salmon	Inland rivers and streams for warmwater species	Salmon or steelhead on spawning runs	Total
Mean	1.27	1.85	1.35	14.11	2.88	5.93	0.63	28.02
Median	0.00	0.00	0.00	6.00	0.00	0.00	0.00	15.00
SD	1.11	8.08	7.39	22.99	10.23	14.81	3.64	38.05

Table 16. Number of overnight trips, by type of fishing.

	Great Lakes for trout and salmon	Great Lakes for warmwater species	Inland lakes and ponds for trout and salmon	Inland lakes and ponds for warmwater species	Inland rivers and streams for trout and salmon	Inland rivers and streams for warmwater species	Salmon or steelhead on spawning runs	Total
Mean	0.23	0.24	0.14	1.80	0.33	0.45	0.09	3.28
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SD	1.85	1.53	1.28	5.57	2.12	2.32	0.79	7.79

of the number of overnight trips[14]. The patterns within fishing type generally reflect those seen for day trips: over half of all overnight trips (1.80) were to inland lakes. The second most common fishing type was warmwater river fishing (0.45 overnight trips). Great Lakes fishing combined across warmwater, coldwater, and anadromous categories, accounted for 0.56 overnight trips per respondent.

With respect to the total number of days fished on overnight trips (Table 17), only the data from web respondents is included in the analysis for the reasons described above. Web respondents took multiple overnight fishing trips each year and fished an average of 5.89 days over the course of the year on these trips. The average number of days fished on each individual overnight trip was slightly less than 2.

Using CU's estimates of the number of anglers living and fishing in the study area in 2011 the estimates of the average days fished by fishing type were expanded to total days fished by type of fishing reflecting the relative importance of each fishing type (Table 18). It was estimated that 224 million days were spent fishing in the 12-state study area in 2011. The majority of those days were spent on inland lakes and ponds for warmwater species. Great Lakes fishing accounted for 32.8 million days (GL Warm, GL Cold and Anadromous). Preliminary estimates from the National Survey conducted in 2011 suggest far fewer days (19.7 million) spent fishing Great Lakes waters (USFWS 2012a). The discrepancy is likely due to the generally fewer days fished on average reported by National Survey respondents and the generally wide confidence intervals associated with National Survey data at the state and regional levels. In 2006 the 95% confidence interval around this estimate was 4.4 million days (USFWS 2008). Confidence interval data are not yet available for the 2011 USFWS National Survey.

Table 19 shows the average days fished by state of residence used to calculate the overall number of days fished in the study area by those living in the 12-state study area. These data are used in the calculations of net economic value later in the report. The data by state are informative because they can be compared with preliminary data from the 2011 National Survey (USFWS 2012b). Note: The National Survey data are for state residents fishing anywhere in the United States; CU's estimates are for fishing only in the 12-state study area. Estimates of days fished vary widely with some instances where the National Survey estimates

[14] Because of space constraints in the mail survey, different questions were used to collect data on overnight trips in the web and mail surveys. In the web survey, respondents were asked about the number of overnight trips and the total number of days spent fishing on those overnight trips for each fishing location. In the mail survey, respondents were asked only about the number of overnight trips to each location. The number of overnight trips reported by mail survey respondents was much higher than the number reported by the web survey respondents. In fact, the number of overnight trips reported by mail survey respondents was similar to the number of days spent fishing on overnight trips reported by web survey respondents, suggesting that mail respondents may have misinterpreted the question and reported days spent fishing on overnight trips rather than number of overnight trips.

Table 17. Number of days on overnight trips, by type of fishing.

	Great Lakes for trout and salmon	Great Lakes for warmwater species	Inland lakes and ponds for trout and salmon	Inland lakes and ponds for warmwater species	Inland rivers and streams for trout and salmon	Inland rivers and streams for warmwater species	Salmon or steelhead on spawning runs	Total
Mean	0.30	0.45	0.22	3.45	0.53	0.73	0.21	5.89
Median	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SD	2.54	2.52	1.77	9.04	2.84	3.58	1.94	12.11

Table 18. Estimated total number of days fished (on day trips and overnight trips) in 12-state study area in 2011 by type of fishing.

Type of fishing	Estimated total # of days on day trips	Estimated total # of days on overnight trips	Estimated total # of days fished in 12-state study area in 2011
Great Lakes for trout and salmon	9,039,490	1,901,318	10,940,808
Great Lakes for warmwater species	12,743,542	3,219,357	15,962,899
Inland lakes and ponds for trout and salmon	8,767,420	1,296,506	10,063,926
Inland lakes and ponds for warmwater species	92,782,895	24,138,904	116,921,798
Inland rivers and streams for trout and salmon	18,622,692	3,735,740	22,358,432
Inland rivers and streams for warmwater species	37,500,326	4,814,892	42,315,218
Salmon or steelhead on spawning runs	4,490,943	1,379,880	5,870,822
TOTAL	183,947,308	40,486,597	224,433,905

Table 19. Mean number of day trips and days spent on overnight trips by anglers, total days spent by anglers living and fishing in the 12-state study area, and comparison with preliminary estimates from the National Survey by state of residence.

State of residence	Mean days on day trips	Mean days on overnight trips	Total days	National Survey preliminary estimate of # of days fished in U.S. in 2011[2]
IA	31.5	7.4	10,464,209	6,909,000
IL	26.9	12.8	24,044,272	15,614,000
IN	34.0	7.5	13,780,540	21,542,000
KY	23.7	3.0	10,797,190	10,245,000
MI	29.3	5.5	28,041,564	26,744,000
MN	20.1	7.1	27,852,874	24,903,000
MO	24.0	7.9	17,414,270	14,448,000
NY	28.8	3.4	18,983,720	29,112,000
OH	29.6	2.0	16,456,921	19,116,000
PA	34.9	4.9	25,295,954	9,926,000
WI	27.9	5.6	24,408,221	15,320,000
WV	37.3	5.5	6,957,910	4,767,000
Total			224,497,646	198,646,000

[2]Source: 2011 National Survey of Fishing, Hunting, and Wildlife-associated Recreation: State Overview – September 2012.

are much larger (e.g., NY) and some instances where they are smaller (e.g., PA) or similar (e.g., KY) to CU's estimates. The discrepancies are likely due to the small sample sizes at the state level in the National Survey data, and to a lesser extent in CU's data. Using New York as an example and confidence interval data from the 2006 National Survey (2011 is not yet published) the New York estimate from the National Survey has a confidence interval of ± 10.9 million days. CU's estimate has a confidence interval of ± 3.3 million days. The confidence intervals around the two estimates overlap. The overall study area estimates are quite close, varying by about 13%.

Based on CU's method of apportioning days fished within a county to one of the two basins in the study area (using the proportion of the water bodies in each county that fell into each basin), CU estimated that 74 million days were spent fishing in the Great Lakes basin – 42% of the fishing effort in the two basins combined (Table 20). This Great Lakes basin is larger than the Great Lakes themselves because it includes all of the inland lakes, ponds, rivers, and streams draining into the Great Lakes (Figure 1). Similarly the UMORB accounts for 58% or 102 million days of fishing effort in the two basins combined. These numbers are used later in the report to estimate net economic value by basin.

Angler Expenditures

Twice during the course of this study, anglers were asked to report their trip expenditures for their most recent trip taken for the primary purpose of fishing. The reason for gathering this data was to provide information on expenditures that could be used in a regional economic impact analysis by USACE. The first time expenditure data were collected was during the main data collection effort that occurred in March-May and the second time occurred in July-August. In both surveys, anglers were asked about their most recent trip in an effort to reduce recall bias. The results are intended to be representative of fishing trips taken during the time periods when the surveys were conducted, but they do not necessarily represent all types of trips taken over the course of a fishing season.

Trip Expenditure Estimates from the Main Survey

Anglers reported their trip expenditures for their most recent trip. For some anglers, this was just prior to their filling out the survey (March-May, 2012) to as far back as January 2011. The majority of trips reported took place in June through October 2011. Almost all anglers (94%) traveled by car to the fishing site for this trip. Expenditures were reported by anglers for their household's share of the trip. The average number of household members participating in the trip was 1.4.

Table 20. Estimates of days fished by basin.

Study Area Basins	Proportion of days	Total days
Great Lakes basin		
Below impassable barriers	0.359	62,900,000
Above impassable barriers	0.061	10,668,000
UMORB		
Below impassable barriers	0.328	57,575,000
Above impassable barriers	0.252	44,154,000
Total		175,297,000

Anglers estimated that their per-day expenditures in the county where they fished were approximately $98, with another $26 spent in counties outside the county where they fished. The expenditure category with the highest mean expenditures in the county where they fished was gas stations (Table 21). Lodging, food, and fishing supplies accounted for most of the remaining expenditures. Gas stations and bait and tackle shops accounted for most of the spending outside the county where the fishing took place.

Expenditures varied based on the type of fishing (Tables 22 and 23). Average costs were highest for fishing trips to the Great Lakes (including Anadromous) and for trips targeting coldwater species. Anglers spent almost twice as much per day on Great Lakes fishing as compared to inland waters. (Note: Many more anglers reported on trips to inland waters than Great Lakes waters, reflected in the means in Table 21.) Expenditures at gas stations were generally the highest category on average across all types of fishing, but for Great Lakes fishing expenditures for fishing charters or guides was higher.

Expenditures by state fished may be the most useful information for regional economic impact analysis and are therefore included in Tables 24 and 25. These data were not weighted, so the variability in sample sizes should be taken into consideration in any impact analysis work. Information for West Virginia was not reported because of low numbers of respondents from this state.

Expenditures varied by state fished, with New York and Ohio having the highest average per day expenditures in the county fished and Iowa and Indiana having the lowest (Table 24). The expenditure category with the highest mean expenditures in the county where they fished was gas stations in all states except Minnesota, where lodging expenditures were higher.

Trip Expenditure Estimates from the Followup Survey

Anglers reported their trip expenditures for their most recent trip since filling out the main survey, which could range from March to July. The majority of trips reported took place in June 2012. Most anglers (81%) traveled by car to the fishing site for this trip. Expenditures were reported by anglers for their household's share of the trip. The average number of household members participating in the trip was 1.5.

Anglers estimated that their per-day expenditures in the county where they fished were approximately $96. An additional $27 was spent per day in counties outside the county where they fished. These averages varied little from the data collected in the main survey of $98 and $26 per day, respectively. The expenditure category with the highest mean expenditures in the county where they fished was gas stations (Table 26). Lodging, food, and fishing supplies

Table 21. Mean expenditures per day per household for the most recent fishing trip (May 2012 or earlier) by expenditure category in county where fishing took place and in other counties.

Expenditure Category	Spent in county where fished	Spent in other counties
	Mean expenditures per day per household	
Bait and tackle shops	$13.47	$5.43
Restaurants or bars	14.52	2.47
Grocery or convenience type stores	11.26	3.61
Lodging (hotels, motels, B&Bs, campgrounds)	17.25	1.69
Gas stations (fuel, sundries)	23.12	10.28
Marinas or yacht clubs (rental or launching fees, fuel, supplies)	6.66	0.80
Fishing charters or guides	6.56	0.63
Other	3.19	0.94
TOTAL	96.02	25.85

Table 22. Mean expenditures per day per household for the most recent fishing trip (May 2012 or earlier) by expenditure category in county where fishing took place, by type of water and species fished for.

	Money spent in county for fishing:			
	Great Lakes waters (including anadromous runs) (n = 330)	Inland waters (n = 2,445)	Coldwater species (n = 477)	Warm water species (n = 2,293)
Expenditure category	Mean expenditures per day per household			
Bait and tackle	$17.32	$12.85	$14.52	$13.26
Restaurants or bars	23.33	13.31	17.42	13.96
Grocery stores	13.34	10.93	10.57	11.38
Lodging	24.66	16.32	20.21	16.79
Gas stations	31.16	21.97	24.75	22.78
Marinas or yacht clubs	21.07	4.74	7.38	6.57
Fishing charters or guides	34.68	2.77	16.22	4.64
Other	3.58	3.17	2.36	3.40
TOTAL	169.16	86.07	113.45	92.79

Table 23. Mean expenditures per day per household for the most recent fishing trip (May 2012 or earlier) by expenditure category in other counties, by type of water and species fished for.

	Money spent in other counties for fishing:			
	Great Lakes waters (including anadromous runs) (n = 330)	Inland waters (n = 2,445	Coldwater species (n = 477)	Warm water species (n = 2,293)
Expenditure category	Mean expenditures per day per household			
Bait and tackle	$4.62	$5.42	$7.21	$4.95
Restaurants or bars	3.13	2.33	2.66	2.38
Grocery stores	3.24	3.61	3.91	3.51
Lodging	1.80	1.58	1.09	1.72
Gas stations	11.06	10.13	11.01	10.09
Marinas or yacht clubs	3.66	0.42	2.41	0.47
Fishing charters or guides	2.38	0.36	0.10	0.71
Other	3.82	0.56	1.23	0.88
TOTAL	33.70	24.41	29.63	24.72

Table 24. Mean expenditures per day per household for the most recent fishing trip (May 2012 or earlier) by expenditure category in county where fishing took place, by state where fishing trip took place.

	Money spent in county for fishing in:										
	IL (n = 94)	IN (n = 162)	IA (n = 131)	KY (n = 159)	MI (n = 448)	MN (n = 428)	MO (n = 209)	NY (n = 259)	OH (n = 101)	PA (n = 291)	WI (n = 519)
Expenditure category	Mean expenditures per day per household										
Bait and tackle	$10.36	$14.10	$12.64	$13.29	$12.92	$12.49	$9.71	$17.63	$17.28	$14.34	$13.41
Restaurants or bars	10.56	10.83	6.38	8.73	15.14	16.08	12.53	19.04	18.41	13.37	16.92
Grocery stores	8.33	7.73	7.77	12.52	12.68	13.88	10.14	14.36	10.35	7.90	10.22
Lodging	17.71	10.05	6.87	15.66	12.45	30.60	20.25	20.90	14.95	7.69	15.87
Gas stations	17.90	17.34	16.37	21.87	25.56	26.14	25.83	28.35	24.59	17.96	21.96
Marinas or yacht clubs	4.12	1.09	0.27	7.30	6.68	3.89	8.63	13.96	17.42	4.77	3.64
Fishing charters or guides	1.33	0.12	0.00	5.88	14.45	5.66	1.19	8.24	22.28	1.36	4.03
Other	1.99	0.73	1.06	4.16	6.08	5.94	3.02	2.15	0.15	1.03	3.43
TOTAL	72.30	61.99	51.37	89.41	105.96	114.69	91.31	124.64	125.43	68.41	89.49

*West Virginia was not included in this table due to sample size < 30.

Table 25. Mean expenditures per day per household for the most recent fishing trip (May 2012 or earlier) by expenditure category in other counties, by state where fishing trip took place.

Expenditure category	Money spent in other counties for fishing in:										
	IL (n = 94)	IN (n = 162)	IA (n = 131)	KY (n = 159)	MI (n = 448)	MN (n = 428)	MO (n = 209)	NY (n = 259)	OH (n = 101)	PA (n = 291)	WI (n = 519)
	Mean expenditures per day per household										
Bait and tackle	$9.69	$6.39	$3.34	$5.79	$4.49	$3.72	$8.35	$4.89	$6.13	$7.78	$2.86
Restaurants or bars	3.16	2.75	1.08	1.64	2.10	4.04	2.12	1.94	4.04	1.86	2.15
Grocery stores	2.52	4.14	2.93	3.02	3.66	6.58	3.98	2.91	2.47	2.57	2.57
Lodging	0.67	2.16	1.13	1.23	2.18	1.98	1.76	0.30	4.55	1.33	1.02
Gas stations	15.61	12.94	4.20	10.91	10.47	13.27	13.10	9.47	8.68	6.69	9.02
Marinas or yacht clubs	2.62	0.41	0.00	0.25	0.65	0.52	0.86	3.91	0.63	0.04	0.08
Fishing charters or guides	0.00	0.00	0.05	0.19	0.41	0.58	0.00	1.35	4.70	0.15	0.38
Other	1.24	0.06	0.10	0.17	0.52	0.89	2.11	2.02	0.37	0.84	0.55
TOTAL	35.11	28.85	12.83	23.20	24.48	31.59	32.29	26.79	31.58	21.26	18.64

*West Virginia was not included in this table due to sample size < 30.

Table 26. Mean expenditures per day per household for the most recent fishing trip (March – July 2012) by expenditure category in county where fishing took place and in other counties.

Expenditure Category	Spent in county where fished	Spent in other counties
	Mean expenditures per day per household	
Bait and tackle shops	$13.05	$5.01
Restaurants or bars	14.21	2.41
Grocery or convenience type stores	12.83	3.82
Lodging (hotels, motels, B&Bs, campgrounds)	16.50	2.44
Gas stations (fuel, sundries)	22.43	10.73
Marinas or yacht clubs (rental or launching fees, fuel, supplies)	5.68	0.69
Fishing charters or guides	7.46	1.09
Other	3.58	0.64
TOTAL	95.76	26.83

accounted for most of the remaining expenditures. Gas stations and bait and tackle shops accounted for most of the spending outside the county where the fishing took place.

Expenditures varied based on the type of fishing in the county fished (Table 27). Average costs were highest for fishing trips to the Great Lakes (including Anadromous). Anglers spent twice as much per day on Great Lakes fishing as compared to inland waters. This is the same finding as was seen in the main survey. Expenditures based on species sought (coldwater versus warmwater) did not appear to differ during this time period. Expenditures at gas stations were generally the highest category on average across all types of fishing, but for Great Lakes fishing expenditures for fishing charters or guides was higher. Expenditures varied little by type of fishing outside the county fished (Table 28).

Expenditures by state fished may be the most useful information for regional economic impact analysis and are included in Tables 29 and 30. These data were not weighted, so the variability in sample sizes and the small sample sizes in some states should be taken into consideration in any subsequent impact analysis work. Information for West Virginia was not reported because of low numbers of respondents from this state.

Expenditures varied by state fished, with Ohio (keeping in mind the small sample size from this state) having the highest average per day expenditures in the county fished and Iowa and Indiana having the lowest (Table 29). The expenditure categories with the highest mean expenditures in the county where they fished were gas stations and lodging.

Economic Modeling Results

Maximum likelihood, random utility modeling methods were used to estimate the Repeated Site-Choice model based on reported day trips taken in 2011[15]. Only general results from this modeling exercise are reported here, in part because the model involves over 100 estimated coefficients. Moreover, several of the estimated coefficients are specific to the statistical structure of the model, for which the discussion is relegated to the Technical Appendix.

Overall the estimated site-choice model is consistent with underlying economic theory. Specifically, two coefficients, called scale parameters, had estimated values that lay within the ranges necessary for the model to be consistent with economic theory. The scale parameter for the site choice was 0.1194 while the scale parameter for the fishing type choice was 0.1329. Both estimated values fall in the range from zero to 1, and the scale parameter for the higher-

[15] Estimation of a similar model for overnight trips failed to converge. When aggregating values, the net value estimate per day from the day trip model is used to value fishing days on overnight trips. This could introduce a downward bias, if a day spent fishing on an overnight trip generates higher net value than a day trip.

Table 27. Mean expenditures per day per household for the most recent fishing trip (March – July 2012) by expenditure category in county where fishing took place, by type of water and species fished for.

	Money spent in county for fishing:			
	Great Lakes waters (including anadromous runs) (n = 137)	Inland waters (n = 884)	Coldwater species (n = 126)	Warm water species (n = 896)
Expenditure category	Mean expenditures per day per household			
Bait and tackle	$18.35	$12.12	$12.14	$13.07
Restaurants or bars	23.06	12.70	13.71	14.15
Grocery stores	15.87	12.18	9.96	13.06
Lodging	19.27	16.22	13.81	17.03
Gas stations	32.91	20.67	25.93	21.81
Marinas or yacht clubs	16.18	4.11	7.04	5.55
Fishing charters or guides	38.86	2.54	11.92	6.78
Other	1.66	3.92	0.86	4.00
TOTAL	166.18	84.46	95.37	95.46

Table 28. Mean expenditures per day per household for the most recent fishing trip (March – July 2012) by expenditure category in other counties, by type of water and species fished for.

	Money spent in other counties for fishing:			
	Great Lakes waters (including anadromous runs) (n = 137)	Inland waters (n = 884)	Coldwater species (n = 126)	Warm water species (n = 896)
Expenditure category	Mean expenditures per day per household			
Bait and tackle	$4.73	$5.09	$8.00	$4.63
Restaurants or bars	2.21	2.46	3.40	2.29
Grocery stores	4.93	3.69	3.67	3.88
Lodging	3.95	2.22	0.40	2.74
Gas stations	11.99	10.60	14.05	10.32
Marinas or yacht clubs	1.43	0.59	0.00	0.80
Fishing charters or guides	0.00	1.26	0.00	1.25
Other	0.12	0.72	0.24	0.70
TOTAL	29.36	26.64	29.75	26.62

Table 29. Mean expenditures per day per household for the most recent fishing trip (March – July 2012) by expenditure category in county where fishing took place, by state where fishing trip took place.

	Money spent in county for fishing in:										
	IL (n = 50)	IN (n = 57)	IA (n = 42)	KY (n = 44)	MI (n = 140)	MN (n = 155)	MO (n = 69)	NY (n = 95)	OH (n = 39)	PA (n = 130)	WI (n = 195)
Expenditure category	Mean expenditures per day per household										
Bait and tackle	$4.46	$9.33	$6.72	$10.70	$13.37	$12.51	$12.13	$18.64	$17.95	$15.86	$11.16
Restaurants or bars	5.86	7.20	9.79	12.36	10.73	15.91	14.04	16.00	20.82	17.84	15.05
Grocery stores	3.88	7.07	7.93	11.91	12.97	14.32	15.65	12.01	13.32	13.02	12.71
Lodging	17.77	8.14	5.54	16.70	14.56	31.57	30.24	8.06	25.07	13.42	15.07
Gas stations	12.32	15.38	11.08	19.10	22.37	24.50	31.52	23.50	24.97	26.55	22.60
Marinas or yacht clubs	7.83	10.26	0.00	1.40	5.68	7.92	5.11	10.59	8.31	2.29	2.37
Fishing charters or guides	9.00	0.00	0.00	9.05	0.82	9.35	1.27	5.26	42.33	0.57	3.14
Other	5.60	0.94	3.20	.54	4.26	1.80	1.23	2.37	2.54	4.38	0.95
TOTAL	66.71	58.32	44.25	81.78	84.77	117.90	111.18	96.44	155.32	93.94	83.06

*West Virginia was not included in this table due to sample size < 30.

Table 30. Mean expenditures per day per household for the most recent fishing trip (March – July 2012) by expenditure category in other counties, by state where fishing trip took place.

	Money spent in other counties for fishing in:										
	IL (n = 50)	IN (n = 57)	IA (n = 42)	KY (n = 44)	MI (n = 140)	MN (n = 155)	MO (n = 69)	NY (n = 95)	OH (n = 39)	PA (n = 130)	WI (n = 195)
Expenditure category	Mean expenditures per day per household										
Bait and tackle	$5.73	$4.53	$4.97	$8.64	$5.36	$3.34	$4.61	$6.75	$2.56	$6.13	$4.57
Restaurants or bars	1.08	2.60	3.45	3.78	1.48	2.45	4.01	0.56	1.73	2.93	2.97
Grocery stores	2.63	4.58	2.46	9.05	3.59	4.96	5.12	3.10	1.15	3.02	3.97
Lodging	0.75	1.76	0.00	15.06	0.39	2.45	0.72	0.40	3.59	0.77	2.23
Gas stations	15.22	6.86	8.17	14.69	12.62	10.87	10.02	10.12	10.00	8.80	14.42
Marinas or yacht clubs	0.00	0.88	0.00	2.27	2.07	0.20	0.75	0.53	0.00	0.33	0.41
Fishing charters or guides	0.00	0.00	0.00	10.22	0.00	0.00	0.00	0.00	0.00	0.00	2.56
Other	1.00	0.68	3.57	0.11	0.13	0.51	2.24	0.00	0.00	0.60	0.31
TOTAL	26.41	21.90	22.63	63.83	25.64	24.79	27.47	21.47	19.04	21.89	31.45

*West Virginia was not included in this table due to sample size < 30.

level choice is larger than the scale parameter for the lower-level choice, which indicates that the estimated model is consistent with utility theory (Train, 2003). From a practical perspective, this result shows that anglers view fishing trips of the same fishing type as being more similar than fishing trips of different fishing types.

Taken together, the segment-specific constants for the Great Lakes trout and salmon and the Great Lakes warmwater fishing types are significant compared to a model in which such constants are not included. Similarly, the inclusion of the segment-specific constants for the Anadromous fishing type and the state-specific constants for the four inland fishing types significantly contribute to the statistical model. Estimated coefficients for continuous variables associated with fishing habitat and accessibility were of the expected sign and generally significant. Specifically, anglers were more attracted to counties with higher values of the habitat condition index for all five non-Great Lakes fishing types. For the ILWarm and ILCold fishing types, counties with more lake area were more attractive. For the RSWarm fishing type, anglers were attracted to counties with more miles of both smaller and larger streams, though larger streams had a bigger effect than smaller streams, indicating that warmwater stream and river anglers were particularly attracted by larger streams and rivers. For the RSCold fishing type, anglers were more attracted to counties with more miles of both smaller and larger streams, but it was smaller streams that had a larger effect, indicating that coldwater stream anglers were more attracted by smaller streams. These findings are consistent with general differences between warm and coldwater stream fishing, where typically the best coldwater fishing is in smaller headwater streams. For Anadromous fishing, anglers were attracted to counties with more large streams and rivers, but were not attracted to counties with more small streams and rivers, possibly indicating that anglers were more attracted to counties that lie farther down in the drainages, closer to the Great Lakes. For the GLWarm and GLCold fishing types, anglers were attracted to counties that had more shoreline miles.

A number of angler characteristics were included as explanatory variables in the participation level of the model. Most notably, anglers who were employed full time, who had higher income, or who were older tended to fish less often.

Within the repeated site choice framework the coefficient on travel costs is expected to take a negative value, as the probability of fishing at a site is expected to decline with travel cost to the site. That is, all other factors held constant, anglers prefer to visit sites closer to home (with lower travel costs). The estimated coefficient in the CU model is -0.00681, with a 95 percent confidence interval from -0.00617 to -0.00745.

These estimated coefficients can be used to calculate the net value of a fishing day. Over an entire season, each angler is expected to take a certain number of trips of each fishing type. This will vary between anglers. If fishing quality for one fishing type declines to the point where an angler no longer wishes to participate in that fishing type, then the trips that would have been taken to engage in that fishing type are displaced. Some of these trips are still taken, but for different fishing types. For others of these displaced trips, the angler chooses to engage in a nonfishing activity instead. The loss in net economic value, per displaced trip, is measured by the ratio of the scale parameter for the fishing type choice divided by the absolute value of the parameter on travel cost. Applying this method results in an estimated net value (consumer surplus) of $19.52 per fishing day, with a 95% confidence interval from $19.01 to $20.06.[16]

Net Value

As discussed in the introductory section of this report, previous fisheries research conducted in the Great Lakes suggests that a range of $20 to $75 would encompass the likely net value per day of fishing in the Great Lakes. The average net value per angler day generated by CU's model was $19.52 (95% CI: $10.01-$20.06) which is at the lower end of this predicted range, presumably because it is based not only on Great Lakes fishing but fishing in inland waters in the Great Lakes basin and the UMORB, which are less highly valued.

CU notes that the Repeated Site Choice modeling framework used here is best suited for valuing marginal (small) changes in access to fishing sites or changes in the quality at a single site or group of sites. That same point would also apply to most values reported in the literature. With this caveat, CU obtained estimates of aggregate seasonal values for each basin by multiplying the estimated value from the site choice model by the estimated number of angler days provided in other sections of this report.

The total aggregate net value of fishing in the Great Lakes basin and the UMORB was $3.422 billion (Table 31). If the analysis is restricted to those portions of both basins that are below barriers impassable to fish (the portions that USACE considers susceptible to the effects of ANS transfer), the net value of fishing is $2.352 billion. Of this, $1.228 billion is in the Great Lakes basin and $1.124 billion is in the UMORB.

[16] This net value is strictly valid only for changes in fishing quality that result in small changes in fishing behavior. For declines in fishing quality that cause large changes in fishing behavior (for example, if multiple types of fishing were to decline simultaneously, thus offering fewer substitutes) the loss in net value per displaced trip will be larger (Haab and McConnell, 2002). This caveat applies also to many of the net value estimates from the literature reviewed by Poe et al (2012). The baseline estimates of net value for fishing in the Great Lakes, Upper Mississippi and Ohio River basins presented in this report should therefore be viewed as lower-bound estimates.

Table 31. Estimates of days fished and the associated net economic value, by basin.

Study Area Basins	Total days	Net economic value (in billions of dollars)
Great Lakes basin		
Below impassable barriers	62,900,000	1.228
Above impassable barriers	10,668,000	0.208
UMORB		
Below impassable barriers	57,575,000	1.124
Above impassable barriers	44,154,000	0.862
Total	175,297,000	3.422

Summary and Conclusions

This project sought to estimate the net value to anglers of recreational fishing in the Great Lakes and Upper Mississippi and Ohio River basins. Using focus groups and mail and web-based surveys of recreational anglers throughout the 12-state region, the team used travel cost techniques to establish baseline recreational fishing values and develop an economic model of angler behavior.

To summarize, results indicate that 6.6 million anglers lived and fished in the 12-state study area in 2011 and that this population spent 175 million days fishing in the Great Lakes basin and the UMORB. Anglers spent 74 million days fishing in the Great Lakes basin, which included fishing in Great Lakes waters, but also included fishing in the inland lakes, ponds, rivers, and streams that flow into the Great Lakes. Even more fishing (102 million days) took place in the Upper Mississippi and Ohio River basin.

The economic model revealed an average net value per angler day of $19.52. Fishing within the those portions of the Upper Mississippi and Ohio River basin that are below barriers impassable to fish (the portions that USACE considers susceptible to the effects of ANS transfer) accounted for an aggregate net value of $1.124 billion. Fishing within those portions of the Great Lakes basin that are below barriers impassable to fish accounted for an aggregate net value of $1.228 billion.

The net value approach employed in this study measures a fundamentally different concept than other economic measures such as expenditures or economic impact. Hence, the figures reported herein are not directly comparable with those derived using other methodologies. The net value approach is appropriate for benefit-cost analyses under the national economic development objectives indicated in USACE project evaluation guidelines.

Although CU was originally tasked with estimating the impacts of ANS on the net value of recreational fishing, USACE was not able to obtain sufficient information to quantify the timing or magnitude of impacts of ANS on sportfish populations in the Great Lakes, Upper Mississippi River, and Ohio River Basins. Consequently, this report serves as an indicator of the net value of recreational fishing that could be impacted in the future without-project (FWOP) condition – the case where no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins.

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Appendix: On Net Economic Value, Expenditures and Economic Impact Analysis

The purpose of this appendix is to provide a non-technical discussion of net value as a measure of the contribution of recreational fishing to NED, and contrast that to two other measures that are often reported, expenditures and net economic impact. The interested reader is also referred to Scodari (2009), Aitken (2009) and Poe et al. (2013) for additional discussions using supply and demand graphs.

When an individual takes a trip away from home to engage in a recreational activity such as a day spent fishing, boating, or going to the beach, the *total value* to the recreationist of the trip is defined as the largest amount of money he or she would be willing to pay to go on that trip to do that activity. The amount the individual actually spends to take that trip is called the recreationist's *expenditures* for the trip. Expenditures would include money spent on such things as gasoline, lodging, entry fees, and food at the recreation site.

An individual will only go on a recreational trip if the benefit they get from doing so (their total value) is larger than the cost to them of the trip (the expenditures). The *net value* from the trip is defined as the recreationist's total value for the trip minus the expenditures for the trip. Net value is also commonly referred to as the *consumer surplus* that the individual gets from engaging in the activity – it is the surplus value they receive from the activity over and above what they actually have to pay for the activity. If a recreational opportunity were somehow lost, recreationists would lose this net value. They would, however, not incur any expenditures and would have that money to spend on other activities.

One point of clarification is necessary. CU's definition of net value of the resource includes only the value that recreationists place on participating in the activity - the so-called "use value" from the activity, or the "all-or-nothing value" of taking the trip (Talhelm , 1988). Many people who do not use water resources recreationally still may care about the quality of those resources. This review will not address these so-called "nonuse values."

CU defined expenditures as the amount that recreationists actually spend on products and services for each trip. Studies will often report expenditures made by recreationists in a region as an indication of the importance of recreational resources to local or regional communities. Studies will also commonly use information on recreational expenditures to help calculate the regional *economic impact* from the activity. When visitors from outside a region spend money in that region while on a recreational visit, some of those new expenditures induce local businesses and households to spend more money themselves. For example, when a visiting recreationist purchases food at a local restaurant, that local restaurant may purchase some of its food from the local grocery store. Similarly, the server at the restaurant will spend some of his or her tip money inside the region. There is therefore a multiplier effect, where the regional economic impact from recreational expenditures is larger than the initial expenditure.

Information on the magnitude of recreational expenditures and their resulting regional economic impact is often of great interest to local officials and business owners. However, expenditures and economic impacts do not represent benefits from a NED perspective as discussed in the text. There are two reasons why. First, recreation expenditures do not take into account the cost of providing the goods and services that recreationists purchase. For example, if a fisherman or boater spends $40 for gasoline for his boat, the marina will have to purchase that gasoline from a wholesale supplier, and that gasoline is no longer available for someone else to use for another purpose. Second, when recreationists spend money in a region where they go to recreate, that is money they can no longer spend in other regions or on other activities. Recreation expenditures and economic impacts represent transfers of income from recreationists to local businesses, from one activity to another, and from one region to another, rather than an added value to the economy. This point was emphasized in a recent background document on issues surrounding the Chicago Area Waterway System: the Congressional Research Service noted that economic impact measures “cannot be used to estimate changes in social welfare, to assess trade-offs among public policy alternatives, or to conduct benefit-cost analysis” (Buck et al., 2010, p. 7)

Appendix: Focus Group Guide

Recreational Impacts of Aquatic Nuisance Species to the Great Lakes and Mississippi River Basins

Focus Group Interview Guide

1. Introductory Script

Statement of Purpose

Cornell University is conducting this study in cooperation with the United States Army Corps of Engineers to evaluate the effects of aquatic nuisance species on recreation in the Great Lakes and Upper Mississippi River Basins. The purpose of the focus group is to help us understand how recreational anglers make their choices about fishing – where they fish, what types of species they fish for, and how their fishing might change if the types of species that are available changed. Your ideas will help us to determine how anglers would be affected if aquatic nuisance species affected the types of fish that anglers could catch.

We will ask a series of questions for discussion, with no right or wrong answers. For most of these questions, we'd like you to answer in an open discussion. We may follow up with additional questions in response to particular points individuals raise. All perspectives are important. There are no right or wrong answers. We may check in with different individuals occasionally to find out if they agree or disagree with points that have been made.

Participation in this focus group is voluntary. You do not have to participate if you don't want to. You may also refuse to answer specific questions. There is no penalty to you if you decide that you do not want to complete the focus group.

Your identity will remain completely confidential. No one but the researchers in this study will be able to associate your responses with your name. We will not report results in a way that would allow other people to determine who made particular comments to us. We may use direct quotations from some people in reports or publications, but we will delete any information that could be used to identify specific people before we do. The session will be audio-recorded and the recording will be transcribed.

2. Focus Group Questions

Opening Statement

Let's start by going around the table and have everyone introduce themselves.

Introductory Questions

First, I would like to ask you about your fishing preferences, addressing where you fish, how you fish, the species you pursue, and how often you fish.

1. Where do you go fishing? Where do you prefer to fish? Great Lakes? Inland lakes? Rivers and streams? Other locations?
2. What particular species do you fish for?
3. How do you go fishing? From a private boat? A charter boat? Shore? Pier? Other places?
4. How often do you usually go fishing?

Transition Questions

At this point, I would like to ask you about the reasons why you choose to go to particular fishing sites regularly over others.

1. What are your reasons for going to the site you most regularly fish? What about your favorite fishing sites?

   a. The particular species that are available? The number of fish you catch? The size of the fish? The condition of the fish? To find edible fish? Good water quality? Natural beauty? Peace and quiet? b. What kinds of features are important for you to have at your fishing sites? How important is it for you to have access to a boat ramp? To a bridge, pier, or beach?

   c. How convenient is it for you to get to the locations you prefer? How far away are these locations? How long does it take you to get there? How much does it cost you? Do you have to pay any access fees? Other costs? How much does cost matter?

   d. How important is it to you to go fishing with particular people? Who do you prefer to fish with?

   e. How long have you been going to the locations that you fish the most?

We have talked about the reasons why you choose to go to particular fishing sites regularly. I would like to understand a bit more about the importance of these reasons.

2. What is/are the most important factor(s) of all in choosing that specific location? What is/are the least important factor(s)?

We've been talking up until now about the reasons you choose particular fishing sites. But there also might be times when you are thinking about going fishing somewhere but decide NOT to fish at a particular spot or for a particular species. Maybe you choose a different spot or maybe you decide not to go fishing at all. We'd like to understand some of the reasons why you choose NOT to go fishing at some sites or for some species. (spot.)

3. When you decide not to fish at a specific location, what is the most important reason for not fishing there?
4. When you decide not to fish for specific species, what is the most important reason for not fishing for those species?
5. When you decide not to fish from shore, private boat, charter, or pier, what is the most important reason for not fishing from there?

Key Questions

1. Over the past 10 years, how has the type of fishing you do changed? Locations you fish? Species you fish for, how often you fish, or where you fish from? If you have made changes, can you tell us a bit about the reasons you've changed the type of fishing you do?

One of the things we're interested in is whether anglers might do things differently if there were changes in the species they fished for.

2. How would your fishing change if you only caught your preferred fish species about half as often as you do now at your favorite fishing sites (i.e., in your favorite spot it took you twice as long to catch the same number of fish)? No change? Stop fishing? Or fish less frequently? (Or more frequently?) Fish for different species at the same location? Change where you fish from: shore to boat or vice versa? Fish at other locations for the same species?
3. How much would your catch rate have to decline to get you to stop fishing at that location altogether?

4. What would you do if the fish you caught were on average a lot smaller than those you usually catch now at your favorite fishing sites? No change? Stop fishing? Or fish less frequently? (Or more frequently?) Fish for different species at the same location? Change where you fish from: shore to boat or vice versa? Fish at other locations for the same species?
5. How small would the average fish have to get for you to stop fishing at that location altogether?

Ending Questions

One of the things we wanted to learn from you is how the way you fish might change if the species you like to fish for weren't as common or were smaller. We've talked about a lot of different things you might do.

1. Is there anything we haven't talked about that you think is important for us to know?

If you're interested in receiving a copy of the report we prepare based on this study, provide me with your address or e-mail address. (*Provide them with my business cards.*)

THANK YOU!

Appendix: Survey Recruitment Script

Recreational Impacts of Aquatic Nuisance Species to

the Great Lakes and Mississippi River Basins

OMB control number 0710-0001

Telephone Survey Instrument

Introduction Version 1: Licensed anglers for whom we have names, addresses, and telephone numbers

Good (morning/afternoon/evening).

May I speak with _____________? (If not available, ask for best time to reach this person. END INTERVIEW.)

My name is ________, and I work for Cornell University in Ithaca, NY. We are conducting a survey of people who bought fishing licenses in _________ *(State)* last year to find out a little bit about how much they fished, what species they fished for, and whether they plan to fish next year. This study is funded by the U.S. Army Corps of Engineers and will help us understand how fishermen and women might be affected if invasive species cause fish populations to go down in the future.

May I ask you a few questions about your recent fishing experience? This will only take a few minutes of your time.

Thank you. Before we begin, there are a few points I need to cover:

I want to assure you that all the information you give will be kept completely confidential and that none of it will be released in any way that would permit identification of you. Your participation in this study is, of course, voluntary, and you may choose not to participate at any time. If there is any question you would prefer not to answer, just tell me and we will go on to the next question.

Introduction Version 2: Licensed anglers from Illinois for whom we have addresses and telephone numbers, but not names

Good (morning/afternoon/evening). My name is ________, and I work for Cornell University in Ithaca, NY. We are conducting a survey of people who bought fishing licenses in Illinois last year to find out a little bit about how much they fished, what species they fished for, and whether they plan to fish next year. We are contacting your household because we believe someone at your address bought a fishing license last year.

1. Did anyone in your household age 18 or older go fishing in Illinois last year?

   _____ Yes

   _____ No (END INTERVIEW)

   1a. How many people over age 18 in your household went fishing in Illinois last year?

   _____ (*Number of people who fished*). (If one person, ask to speak with that person, skip question #2, and continue below. If that person is not available, ask for name and convenient time to call back. If more than one person, ask #2.)

2. Of those people, who had a birthday most recently?

   _____ (*First name of person).* If not individual on phone, ask to speak with them. If not available, ask for best time to reach this person and end interview.

Once you have fishing interviewee, continue here:

Thank you ________ *(Name)* for taking time to speak with me today. We are conducting a survey of people who bought fishing licenses in Illinois last year to find out a little bit about how much they fished, what species they fished for, and whether they plan to fish next year. This study is funded by the U.S. Army Corps of Engineers and will help us understand how fishermen and women might be affected if invasive species cause fish populations to go down in the future.

May I ask you a few questions about your recent fishing experience? This will only take a few minutes of your time.

Thank you. Before we begin, there are a few points I need to cover:

I want to assure you that all the information you give will be kept completely confidential and that none of it will be released in any way that would permit identification of you. Your participation in this study is, of course, voluntary, and you may choose not to participate at any time. If there is any question you would prefer not to answer, just tell me and we will go on to the next question.

Introduction Version 3: Individuals identified through random digit dialing in West Virginia and Ohio

Good (morning/afternoon/evening). My name is ________, and I work for Cornell University in Ithaca, NY. We are conducting a survey of people who went fishing last year in Ohio or West Virginia.

1. Do you currently live in Ohio or West Virginia?

    _____ Ohio

    _____ West Virginia

    _____ Neither (END INTERVIEW)

2. Did anyone in your household age 18 or older go fishing in <Ohio,West Virginia> last year?

    _____ Yes

    _____ No (END INTERVIEW)

    (If they offer that someone fished in NY, PA, OH, IN, MI, IL, WI, MN, IA, MO, KY, or WV last year; continue with interview.)

    2a. How many people over age 18 (in your household) went fishing (in <Ohio,West Virginia> last year)?

    _____ *(Number of people who fished)*. (If one person, ask to speak with that person, skip question #3, and continue below. If that person is not available, ask for name and convenient time to call back. If more than one person, ask #3.)

3. Of those people, who had a birthday most recently?

    _____ *(First name of person).* If not individual on phone, ask to speak with them. If not available, ask for best time to reach this person and end interview.

Once you have fishing interviewee, continue here:

Thank you ________ *(Name)* for taking time today. We are conducting a survey of people who went fishing last year in <Ohio,West Virginia> to find out a little bit about how much they fished, what species they fished for, and whether they plan to fish next year. This study is funded by the U.S. Army Corps of Engineers and will help us understand how fishermen and women might be affected if invasive species cause fish populations to go down in the future.

May I ask you a few questions about your recent fishing experience? This will only take a few minutes of your time.

Thank you. Before we begin, there are a few points I need to cover:

I want to assure you that all the information you give will be kept completely confidential and that none of it will be released in any way that would permit identification of you. Your participation in this study is, of course, voluntary, and you may choose not to participate at any time. If there is any question you would prefer not to answer, just tell me and we will go on to the next question.

Main Survey Questions used with ALL individuals

1. Did you go fishing at all during 2011?

    _____No (Skip to Question 5)

    _____Yes (Continue with Question 2)

2. About how many days did you fish during 2011?

    _____ *(Number of days)*

3. Did you go fishing in…

    a) The Great Lakes (Lake Michigan, Lake Superior, Lake Huron, Lake Erie, and Lake Ontario)

        _____No

        _____Yes

    b) Any tributaries flowing into the Great Lakes for trout or salmon?

        _____No

        _____Yes

    c) Other lakes or ponds (not the Great Lakes)?

        _____No

        _____Yes

    d) Large rivers?

        _____No

        _____Yes

    e) Other rivers or streams?

        _____No

        _____Yes

4. During 2011, did you fish for…

   a) Salmon or trout?

      _____No

      _____Yes

   b) Other kinds of fish?

      _____No

      _____Yes

5. Do you plan to fish in 2012?

   _____No

   If the individual says no: That's all the questions I have for you. Thank you for taking the time to speak with me today. END INTERVIEW.

   _____Yes (Skip to 5b.)

   _____Not sure (Continue with 5a)

   5a. Do you think it's *likely* that you'll fish next year or not?

      _____No (END INTERVIEW)

      _____Yes (GO TO Question 5b)

   5b. Do you think it's likely that you'll fish in the state where you live?

      _____No

      _____Yes (Skip to Closing)

5c. Which states do you think it's likely that you'll fish in? *(Record if ANY of the following states are mentioned: NY, PA, OH, IN, MI, IL, WI, MN, IA, MO, KY, or WV)*

If the individual says no to 5b and doesn't mention any of the states in 5c: That's all the questions I have for you. Thank you for taking the time to speak with me today. END INTERVIEW.

Closing Statement and Questions

We'll be contacting you again in March to ask you more about your fishing experiences because it will help us to figure out how you and other fishermen and women might be affected if invasive species cause fish populations to go down. We'd prefer to survey you by e-mail because it doesn't cost as much and saves us all money. Would you please provide me with your e-mail address?

_____E-mail

E-mail address: _________

_____Mail

May I confirm your mailing address so we can send you our survey? Is it? _________
(Information comes from state fishing license records.)

_____Refuse to participate in survey

That's all the questions I have for you. Thank you for taking the time to speak with me today. END INTERVIEW.

Appendix: Web Survey Instrument

A Survey of Anglers in the Great Lakes and
Upper Mississippi and Ohio River Basins

Research conducted by the
Human Dimensions Research Unit
Department of Natural Resources
Cornell University

Earlier this year, we contacted you and asked about your fishing experiences in 2011 and your plans for 2012. You provided your e-mail address so we could contact you again to ask some more detailed questions about your fishing experiences in 2011 and how your fishing experiences might change if the quality of fishing changes. We are conducting this study for the U.S. Army Corps of Engineers who are looking at the effects of aquatic nuisance species in the Great Lakes and Upper Mississippi and Ohio River Basins.

Whether you fish a lot or only a little, your participation in this survey is important. The information you provide will be used to help decision makers assess alternative plans that may affect recreational fishing.

Your participation in this survey is voluntary, but we sincerely hope you will take just a few minutes to answer our questions. Your identity will be kept confidential and the information you give us will never be associated with your name.

THANK YOU FOR YOUR HELP!

<u>U.S Army Corps of Engineers Agency Disclosure Notice OMB Number 0710-0001</u>
The public report burden for this data collection effort is estimated at 20 minutes per individual, including the time for reviewing instructions, searching existing data sources, gathering and maintaining data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this data collection, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Executive Services Directorate, Information Management Division, 1155 Defense Pentagon, Washington DC, 20301-1155 and the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503, Attn: Desk Officer for US Army Corps of Engineers. Respondents should be aware that notwithstanding any other provision of law, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

1. About how many years have you fished?

_______ years

2. How important is each of the following factors in choosing **where** you fish? *(Check one number for each item.)*

Factor	Not Important	Somewhat Important	Important	Very Important	Extremely Important
Close to home or camp	1	2	3	4	5
You can expect to catch at least some fish	1	2	3	4	5
You can expect to catch a lot of fish	1	2	3	4	5
Scenic beauty of the area	1	2	3	4	5
You have friends/family nearby	1	2	3	4	5
The water contains the kind of fish you want to catch	1	2	3	4	5
The water is known for big fish	1	2	3	4	5

The next set of questions asks about where you fished in 2011, how many fishing trips you took, and the type of fishing you did. To help you identify the places where you fished we provide you with a series of maps.

For the purpose of this survey, a **FRESHWATER FISHING TRIP** is any time you leave your home for the **PRIMARY PURPOSE** of going fishing on lakes, rivers, streams or ponds, and could mean **going just down the street to fish for an hour**, or could mean **spending several days hundreds of miles from home.** A freshwater fishing trip could include fishing from a boat, from shore, or ice fishing.

3. Please look at the map of the states in our study area below (the shaded states). Did you take any **freshwater fishing trips** to fish in any of **the shaded states** in **2011**? *(Check one.)*

    □ Yes
    □ No *(Skip to Question 19)*

[MAP SHOULD APPEAR ON SCREEN FOR ANY SETS OF QUESTIONS THAT REFER TO SHADED AREA ON MAP.]

For the remainder of this survey, we are interested in knowing about the freshwater fishing trips you took to fish in the shaded states on the map.

4. What is your home zip code?

____

4a. Do you have a second home or cabin from which you fish or leave to go fishing at other sites?

□ Yes
□ No *(Skip to Question 5)*

4b. What is the zip code of that residence?

____

5. Did you take any fishing trips to fish in the **Great Lakes** (Erie, Huron, Michigan, Ontario, and Superior) in 2011 in one of the shaded states on the map? This includes fishing from a boat or from shore, but does **not** include fishing in tributaries (rivers and streams flowing into the Great Lakes).

□ Yes
□ No

6. Did you take any fishing trips to fish in **inland lakes and ponds** in 2011, either from a boat of from shore, in one of the shaded states on the map? An inland lake or pond is any lake, pond or reservoir that is not a Great Lake.

□ Yes
□ No

7. Did you take any fishing trips in one of the shaded states on the map to fish for **salmon or steelhead on spawning runs** in 2011?

□ Yes
□ No

8. Did you take any fishing trips to fish in **rivers or streams** in 2011 in one of the shaded states on the map, that were **not** for salmon or steelhead on spawning runs?

□ Yes
□ No

9. On the fishing trips you took in 2011, did you try to catch particular types of fish? (*Check all that apply.*)

- □ On one or more of my fishing trips, I primarily tried to catch salmon or trout
- □ On one or more of my fishing trips, I primarily tried to catch warmwater species, such as walleye, perch, bass, muskie, catfish, panfish, etc.

The next set of questions asks about your **DAY trips** to fish in 2011 – how many day trips you took and where you went. A day trip is a fishing trip where you leave home for the **PRIMARY PURPOSE** of going fishing, and **return home on the same day or later that night**.

Later on, we'll ask you about your overnight trips.

10. Now please think about the times you took **DAY trips** to fish in 2011. Did you take any day trips to fish in one of the shaded states on the map in 2011?

- □ Yes
- □ No *(Skip to Question 16)*

11. Please use the checklist to indicate all of the states where you took a day trip in **2011**. If you fished from a boat, please indicate the state where you launched. *(Check all that apply.)*

- □ Illinois
- □ Indiana
- □ Iowa
- □ Kentucky
- □ Michigan
- □ Minnesota
- □ Missouri
- □ New York
- □ Ohio
- □ Pennsylvania
- □ West Virginia
- □ Wisconsin

(If checked only one, skip to Question 13)
(If checked more than one, continue with Question 12)

12. In which state did you take the most day trips in 2011? *(Check **one**.)*

- □ Illinois
- □ Indiana
- □ Iowa
- □ Kentucky
- □ Michigan
- □ Minnesota
- □ Missouri
- □ New York
- □ Ohio
- □ Pennsylvania
- □ West Virginia
- □ Wisconsin

13. Below is a map of <<Primary State Name>>, showing the county boundaries. Please click on every county in which you took **DAY trips** in 2011 (up to a total of 8 counties where you fished the most). If you fished in more than one county on a particular fishing trip, please click on the county in which you fished the most. If you fished from a boat, please click on the county where you launched.

Google map of state selected with county boundaries presented.

When you are done, click on the button below

Done

(Show map with <<COUNTY1>> highlighted)

[REPEAT QUESTION 14 FOR EACH COUNTY SELECTED IN QUESTION 13.]

14. You said that you took day trips to fish in <<COUNTY1>>. <<COUNTY1>> is highlighted on the map. How many **DAY trips** did you take to do each of the following types of fishing from **<<COUNTY1>>** in **2011**?
    - Please tell us both about your fishing for **trout and salmon** and your fishing for **warmwater species**, such as walleye, perch, bass, muskie, catfish, panfish, etc.
    - If you did more than one type of fishing on a trip, list the trip next to the one type of fishing that was most important to you on that trip.

Type of fishing (inside the shaded area on the map)	# of **DAY** trips I took to do this type of fishing in this county in 2011
Great Lakes for trout and salmon	_________
Great Lakes for warmwater species	_________
Inland lakes and ponds for trout and salmon	_________
Inland lakes and ponds for warmwater species	_________
Salmon or steelhead on spawning runs	_________
Rivers and streams for trout and salmon, but not including spawning runs	_________
Rivers and streams for warmwater species	_________
Total freshwater fishing DAY trips (sum of all seven categories) in this county	<<SUM>>

[If only 1 state selected in Question 11, skip to Question 16. Otherwise, repeat Question 15 for each state selected in Question 11 EXCEPT FOR the state selected in Question 12. A map of the state should appear each time this question is repeated.]

15. You said that you also took day trips to fish in <<STATE2>>. How many **DAY trips** did you take to do each of the following types of fishing anywhere in **<<STATE2>>** in **2011**?

Type of fishing (inside the shaded area on the map)	# of **DAY** trips I took to do this type of fishing in this county in 2011
Great Lakes for trout and salmon	_________
Great Lakes for warmwater species	_________
Inland lakes and ponds for trout and salmon	_________
Inland lakes and ponds for warmwater species	_________
Salmon or steelhead on spawning runs	_________
Rivers and streams for trout and salmon, but not including spawning runs	_________
Rivers and streams for warmwater species	_________
Total freshwater fishing DAY trips (sum of all seven categories) in this county	<<SUM>>

The previous set of questions asked you about your day trips. In this next section, we'd like to learn about all of the **OVERNIGHT trips** you took to fish in 2011 – how many overnight trips you took and where you went. An overnight fishing trip is a trip where you leave home for the **PRIMARY PURPOSE** of going fishing and you **stay away from home at least one night**, for example in a hotel, a cabin, a tent, or an RV.

16. Did you take any **OVERNIGHT trips** to go fishing in one of the shaded states on the map in **2011**?

□ Yes
□ No *(Skip to Question 19)*

In the next series of questions, we'll ask about each of the locations where you took **OVERNIGHT** trips to fish in 2011 to any of the shaded states on the map.

17. For each overnight trip you took (up to a maximum of 8 trips), please list the state and the city, village, or town closest to where you fished on that trip.
- If you took more than one trip to the same location, you only have to list that location once.
- If you fished in several locations on a particular fishing trip, please list the location where you did most of your fishing.
- If you were fishing from a boat, please list the location where you launched your boat on that trip.

Trip Location 1

State: ______________________________

City, village, or town: __________________

Trip Location 2

State: ______________________________

City, village, or town: __________________

Trip Location 3

State: ______________________________

City, village, or town: __________________

Trip Location 4

State: ______________________________

City, village, or town: __________________

Trip Location 5

State: ______________________________

City, village, or town: __________________

Trip Location 6

State: ______________________________

City, village, or town: __________________

Trip Location 7

State: ______________________________

City, village, or town: __________________

Trip Location 8

State: ______________________________

City, village, or town: __________________

When you are done, click on the button below

Done

[REPEAT QUESTION 18 FOR EACH LOCATION ENTERED IN QUESTION 17.]

18. You said that you took at least one overnight trip to fish in the following location:

State: ______________________________

City, village, or town: __________________

How many **OVERNIGHT trips** did you take to this location to do each of the following types of fishing in 2011?

- If you did more than one type of fishing on a trip, list the trip next to the one type of fishing that was most important to you on that trip.
- We also ask that you tell us the **total number of days** that you fished on these overnight trips. So, for example, if you took two overnight trips, and you fished two days on the first trip, and three days on the second trip, then you fished a total of five days on overnight trips.

Type of fishing (inside the shaded area on the map)	# of **OVERNIGHT** trips I took to this location to do this type of fishing in 2011	Total # of days I fished on these trips
Great Lakes for trout and salmon	_________	_________
Great Lakes for warmwater species	_________	_________
Inland lakes and ponds for trout and salmon	_________	_________
Inland lakes and ponds for warmwater species	_________	_________
Salmon or steelhead on spawning runs	_________	_________
Rivers and streams for trout and salmon, but not including spawning runs	_________	_________
Rivers and streams for warmwater species	_________	_________
Total freshwater fishing DAY trips (sum of all seven categories) in this county	<<SUM>>	<<SUM>>

19. The table below lists all the freshwater fishing **DAY trips** and all the freshwater fishing **OVERNIGHT trips** you took in the 12 shaded states on the map in **2011**. But last year may not have been a normal year for you fishing.

Please tell us about how many **DAY** and **OVERNIGHT** freshwater fishing trips you take in a **normal or average year**.

- If you think 2011 was a normal or average year, you can just use the numbers from 2011.
- If you don't think 2011 was a normal or average year, make your best guess as to how many trips you would take in a normal or average year – you don't have to be exact.

[<<N1d>> through <<N7d>> in the table below are populated as follows:
<<N1d>> is the sum of all the answers entered into the first row of the table in Question 14 and the first row of the table in Question 15 for all the times questions 14 and 15 were answered.
<<N2d>> is the sum of all the answers entered into the second row of the table in Question 14 and the first row of the table in Question 15 for all the times questions 14 and 15 were answered.
<<N3d>> is the sum of all the answers entered into the third row of the table in Question 14 and the first row of the table in Question 15 for all the times questions 14 and 15 were answered.
<<N4d>> is the sum of all the answers entered into the fourth row of the table in Question 14 and the first row of the table in Question 15 for all the times questions 14 and 15 were answered.
<<N5d>> is the sum of all the answers entered into the fifth row of the table in Question 14 and the first row of the table in Question 15 for all the times questions 14 and 15 were answered.
<<N6d>> is the sum of all the answers entered into the sixth row of the table in Question 14 and the first row of the table in Question 15 for all the times questions 14 and 15 were answered.
<<N7d>> is the sum of all the answers entered into the seventh row of the table in Question 14 and the first row of the table in Question 15 for all the times questions 14 and 15 were answered.
<<NTotald>> is the sum of <<N1d>> through <<N7d>>.]
[<<N1o>> through <<N7o>> in the table below are populated as follows:
<<N1o>> is the sum of all the answers entered into the middle column of the first row of the table in Question 18 for all the times Question 18 was answered.
<<N2o>> is the sum of all the answers entered into the middle column of the second row of the table in Question 18 for all the times Question 18 was answered.
<<N3o>> is the sum of all the answers entered into the middle column of the third row of the table in Question 18 for all the times Question 18 was answered.
<<N4o>> is the sum of all the answers entered into the middle column of the fourth row of the table in Question 18 for all the times Question 18 was answered.
<<N5o>> is the sum of all the answers entered into the middle column of the fifth row of the table in Question 18 for all the times Question 18 was answered.
<<N6o>> is the sum of all the answers entered into the middle column of the sixth row of the table in Question 18 for all the times Question 18 was answered.
<<N7o>> is the sum of all the answers entered into the middle column of the seventh row of the table in Question 18 for all the times Question 18 was answered.
<<NTotalo>> is the sum of <<N1o>> through <<N7o>>.]

Type of fishing (inside the shaded area on the map)	# of **DAY** trips I took in 2011 to do this type of fishing	# of **DAY** trips I take in a **NORMAL** year to do this type of fishing	# of **OVERNIGHT** trips I took in 2011 to do this type of fishing	# of **OVERNIGHT** trips I take in a **NORMAL** year to do this type of fishing
Great Lakes for trout and salmon	<<N1d>>	__________	<<N1o>>	__________
Great Lakes for warmwater species	<<N2d>>	__________	<<N2o>>	__________
Inland lakes and ponds for trout and salmon	<<N3d>>	__________	<<N3o>>	__________
Inland lakes and ponds for warmwater species	<<N4d>>	__________	<<N4o>>	__________
Salmon or steelhead on spawning runs	<<N5d>>	__________	<<N5o>>	__________
Rivers and streams for trout and salmon, but not including spawning runs	<<N6d>>	__________	<<N6o>>	__________
Rivers and streams for warmwater species	<<N7d>>	__________	<<N7o>>	__________
Total freshwater fishing trips (sum of all seven categories)	<<NTotald>>	<<NTotalAd>>	<<NTotalo>>	<<NTotalAo>>

[The numbers entered in the middle column of the first 7 rows will be designated as <<N1ad>> through <<N7ad>>. <<NTotalAd>> is the calculated sum of <<N1ad>> through <<N7ad>>.]
[The numbers entered in the righthand column of the first 7 rows will be designated as <<N1ao>> through <<N7ao>>. <<NTotalAo>> is the calculated sum of <<N1ao>> through <<N7ao>>. If <<NTotalAd>> and <<NTotalAo>> are BOTH “0”, skip to Question 22.]

In the next questions we ask you about how the number of fishing trips that you take in a normal year might change if the quality of fishing for different types of fishing changes.

20. Suppose that the quality of fishing changed for the type of fishing that you like to do the most. Suppose that the number of fish you caught per day decreased by 40% in the entire shaded area on the map. How would you change the number of DAY fishing trips you would take, compared to what you do in a NORMAL year? (Please select all that apply.)

- □ I would still take the same number of day fishing trips for this type of fishing
- □ I would take fewer day fishing trips for this type of fishing
- □ I would take more day fishing trips for other types of fishing
- □ I would take the same total number of day fishing trips for all types of fishing
- □ I would take fewer total fishing trips for all types of fishing in the shaded states on the map
- □ I would take more fishing trips outside the shaded area on the map
- □ I would stop fishing entirely

21. Now we want you to suppose **that number of fish you caught decreased** for *several types* of fishing. We are going to show you one or two tables describing possible ways that the number of fish you caught might decrease.

[If <<NTotalAd>> is "0", skip to Question 21b.]

21a. The table below shows you one way that the number of fish you caught might decrease. It also shows the number of **DAY** trips you take in a normal year. (The **OVERNIGHT** trips, if you take them in a normal year, will appear in a later table.)

If the number of fish you caught decreased as shown, how many **DAY** fishing trips (inside the shaded area on the map) would you take for each type of fishing?

If you're not sure, make your best guess as to how many trips you would take. (Please enter a number in each space on the right hand side)

[NOTE: The % changes in this table will vary between 0-50% for different respondents.]

Type of fishing (inside the shaded area on the map)	# of **DAY trips** I take in a **NORMAL** year to do this type of fishing	% Change in # fish caught per day fishing	# of **DAY trips** I would take to do this type of fishing
Great Lakes for trout and salmon	<<N1ad>>	No Change	_________
Great Lakes for warmwater species	<<N2ad>>	**20% less than normal**	_________
Inland lakes and ponds for trout and salmon	<<N3ad>>	No Change	_________
Inland lakes and ponds for warmwater species	<<N4ad>>	No Change	_________
Salmon or steelhead on spawning runs	<<N5ad>>	**20% less than normal**	_________
Rivers and streams for trout and salmon, but not including spawning runs	<<N6ad>>	No Change	_________
Rivers and streams for warmwater species	<<N7ad>>	**30% less than normal**	_________
Total freshwater fishing DAY trips (sum of all seven categories) in this county	<<NTotalAd>>		_________

[If <<NTotalAo>> is “0”, skip to Question 22.]

21b. This new table shows the number of **OVERNIGHT** trips you take in a normal year.
If the number of fish you caught decreased as shown, how many **OVERNIGHT** fishing trips (inside the shaded area on the map) would you take for each type of fishing?
If you’re not sure, make your best guess as to how many trips you would take. (Please enter a number in each space on the right hand side)
[NOTE: The % changes in this table will vary between 0-80% for different respondents.]

Type of fishing (inside the shaded area on the map)	# of **OVERNIGHT trips** I take in a **NORMAL** year to do this type of fishing	% Change in # fish caught per day fishing	# of **OVERNIGHT trips** I would take to do this type of fishing
Great Lakes for trout and salmon	<<N1Ao>>	No Change	__________
Great Lakes for warmwater species	<<N2Ao>>	**20% less than normal**	__________
Inland lakes and ponds for trout and salmon	<<N3Ao>>	No Change	__________
Inland lakes and ponds for warmwater species	<<N4Ao>>	No Change	__________
Salmon or steelhead on spawning runs	<<N5Ao>>	**20% less than normal**	__________
Rivers and streams for trout and salmon, but not including spawning runs	<<N6Ao>>	No Change	__________
Rivers and streams for warmwater species	<<N7Ao>>	**30% less than normal**	__________
Total freshwater fishing DAY trips (sum of all seven categories) in this county	<<NTotalAo>>		__________

Now we'd like to find out more about what kinds of expenses you have when you go fishing. We'd like you to think back to the **most recent freshwater fishing trip** you took in **2011 or 2012** inside the shaded area on the map. Remember that when we say FRESHWATER **FISHING TRIP**, we mean any time you leave home for the **PRIMARY PURPOSE** of going fishing on lakes, rivers, streams or ponds, and could mean **going just down the street to fish for an hour**, or could mean **spending several days hundreds of miles from home.**

22. During what year did you take **your most recent freshwater fishing trip** in the **shaded area on the map**? (*Check one.*)

□ 2011
□ 2012

□ I did not take a trip in the shaded area on the map in either 2011 or 2012 *(Skip to Question 29)*

22a. During what month of that year did you take that trip? (*Check one.*)

□ January
□ February
□ March
□ April
□ May
□ June
□ July
□ August
□ September
□ October
□ November
□ December

23. How many nights were you away from home on this trip? *(If you were just out for the day or part of the day, please enter "0" nights.)*

_______ night(s) *(If "0" nights, skip to Question 23 b)*

23a. On how many different days during this trip did you fish?

_______ days

23b. How many people in your household (besides yourself) went with you in the same car and fished on this trip? *(If you fished by yourself, enter "0.")*

_______ people

24. Please check the **primary type of fishing** you did on that trip. (*Check one.*)

- □ Great Lakes for trout or salmon
- □ Great Lakes for warmwater species
- □ Inland lakes and ponds for trout or salmon
- □ Inland lakes and ponds for warmwater species
- □ Salmon or steelhead on spawning runs
- □ Rivers and streams for trout or salmon, but not including spawning runs
- □ Rivers and streams for warmwater species

25. In what state did you spend the most time fishing on that trip? (*Check one.*)

- □ Illinois
- □ Indiana
- □ Iowa
- □ Kentucky
- □ Michigan
- □ Minnesota
- □ Missouri
- □ New York
- □ Ohio
- □ Pennsylvania
- □ West Virginia
- □ Wisconsin

26. Please click on one of the counties on the map to show the approximate location of where you spent the most time fishing on the trip. If you fished from a boat, please click on the county where you launched.

[Map of state checked in Question 25 will appear.]

27. For this trip, **approximately** what was your household's share of the expenses for the trip: (1) that you paid in the county where you fished; and (2) that you paid in areas outside the county where you fished?

	Money spent in county where you fished	Money spent in areas outside of county where you fished
Bait and tackle shops	$____________	$____________
Restaurants or bars	$____________	$____________
Grocery or convenience type stores	$____________	$____________
Hotels, motels, B&Bs, campgrounds	$____________	$____________
Gas stations (fuel, sundries)	$____________	$____________
Marinas or yacht clubs (rental or launching fee, fuel, supplies)	$____________	$____________
Fishing charters or guides	$____________	$____________
Other	$____________	$____________

28. How did you get to the location where you fished on this trip? *(Check one.)*

- □ Walked or bicycled
- □ Motorcycle
- □ Compact or economy car
- □ Mid or full-size car
- □ Pickup truck or SUV
- □ RV
- □ Airplane
- □ Other

For the final questions, we'd like to ask a little bit more about you and your fishing.

29. Which statement below best describes your feelings about fishing? *(Check one.)*

- □ If I could not go fishing, I would easily find something else to do that would be equally enjoyable
- □ If I could not go fishing, I would miss it, but not as much as a lot of other things I enjoy
- □ If I could not go fishing, I would miss it more than most of the other interests I now have
- □ If I could not go fishing, I would miss it more than all the other interests I now have

30. Do you own a boat that you use for fishing?

- □ No *(Skip to Question 31)*
- □ Yes, non-motorized *(Skip to Question 31)*
- □ Yes, motorized

30a. What is your boat's length?

_______ feet

31. Is there a place that you go freshwater fishing within walking distance of your home?

- □ Yes
- □ No

32. What is your gender?

- □ Female
- □ Male

33. What is your marital status?

- □ Never married *(Skip to Question 34)*
- □ Married
- □ Unmarried partner
- □ Divorced *(Skip to Question 34)*
- □ Widowed *(Skip to Question 34)*

33a. Does your spouse or partner fish?

- □ Yes
- □ No

34. How many children 18 or under live in your home?

_______ children

35. What is your employment status? *(Please check one.)*

- □ Employed, full-time
- □ Employed, part-time
- □ Self-employed
- □ Unemployed or not in labor force
- □ Retired
- □ Student
- □ Non-wage employment (e.g.., stay at home parent)

36. In what year were you born? ________

37. What was your household income (before taxes) in 2011? *(Please check one.)*

- □ Less than $15,000
- □ $15,000 to $24,999
- □ $25,000 to $34,999
- □ $35,000 to $49,999
- □ $50,000 to $74,999
- □ $75,000 to $99,999
- □ $100,000 to $149,999
- □ $150,000 to $199,999
- □ $200,000 and more

Appendix: Mail Survey Instrument

A Survey of Anglers in the Great Lakes and Upper Mississippi and Ohio River Basins

Cornell University
Human Dimensions Research Unit

OMB 0710-0001

A Survey of Anglers in the Great Lakes and Upper Mississippi and Ohio River Basins

Research conducted by the
Human Dimensions Research Unit
Department of Natural Resources
Cornell University

Earlier this year, we contacted you and asked about your fishing experiences in 2011 and your plans for 2012. You provided your mailing address so we could contact you again to ask some more detailed questions about your fishing experiences in 2011 and how your fishing experiences might change if the quality of fishing changes. We are conducting this study for the U.S. Army Corps of Engineers who are looking at the effects of aquatic nuisance species in the Great Lakes and Upper Mississippi and Ohio River Basins.

Whether you fish a lot or only a little, your participation in this survey is important. The information you provide will be used to help decision makers assess alternative plans that may affect recreational fishing.

Please complete this questionnaire at your earliest convenience, seal it with the white re-sealable label provided, and drop it in any mailbox; return postage has been provided. Your participation in this survey is voluntary, but we sincerely hope you will take just a few minutes to answer our questions. Your identity will be kept confidential and the information you give us will never be associated with your name.

THANK YOU FOR YOUR HELP!

1. **About how many years have you fished?**

   _____ years

2. **How important is each of the factors below in choosing <u>where</u> you fish?** *(Check one box for each statement.)*

Factors	Not at all important	Somewhat Important	Important	Very Important	Extremely Important
Close to home or camp	☐	☐	☐	☐	☐
You can expect to catch at least some fish	☐	☐	☐	☐	☐
You can expect to catch a lot of fish	☐	☐	☐	☐	☐
Scenic beauty of the area	☐	☐	☐	☐	☐
You have friends/family nearby	☐	☐	☐	☐	☐
The water contains the kind of fish you want to catch	☐	☐	☐	☐	☐
The water is known for big fish	☐	☐	☐	☐	☐

3. **Do you have a second home or cabin from which you fish or leave to go fishing at other sites?**

   ☐ No

   ☐ Yes → What is the zip code of that residence? _______

In this survey when we say a **FRESHWATER FISHING TRIP** we mean any time you leave your home for the **PRIMARY PURPOSE** of going fishing on lakes, rivers, streams or ponds, and could mean **going just down the street to fish for an hour**, or could mean **spending several days hundreds of miles from home.** A freshwater fishing trip could include fishing from a boat, from shore, or ice fishing.

4. **During what year and month did you take your most recent freshwater fishing trip (even just for part of a day) to a state shaded on the front cover?** *(Check one year and write in the month.)*

- ☐ 2011 Month: ________
- ☐ 2012 Month: ________
- ☐ I did not take a trip in 2011 or so far in 2012 to a state in the study area *(Skip to Question 13.)*

5. **How many nights were you away from home on this trip?** *(If you were just out for the day or part of the day, please write in 0 nights.)*

_______ night(s)

5a. On how many different days during this trip did you fish?

______ days

5b. How many people in your household (besides yourself) went with you in the same car and fished on this trip? *(If you fished by yourself, enter "0.")*

______ people

6. **Was this trip to fish:** *(Check only one.)*

- ☐ in the Great Lakes (Erie, Huron, Michigan, Ontario, and Superior). *This includes fishing from a boat or from shore, but does **not** include fishing in tributaries (rivers and streams flowing into the Great Lakes).*
- ☐ in inland lakes or ponds, either from a boat or from shore? *An inland lake or pond is any lake, pond or reservoir that is not a Great Lake.*
- ☐ for salmon or steelhead on spawning runs?
- ☐ in rivers or streams but not for salmon or steelhead on spawning runs?

7. **On this trip, did you fish primarily for:** *(Check one.)*

- ☐ Trout or salmon
- ☐ Warmwater species, such as walleye, perch, bass, muskie, catfish, panfish, etc.

8. **Please tell us the state and county where you spent the most time fishing on this trip. If you don't know the name of the county, please write in the nearest city, village or town. If you were fishing from a boat, please list the county where you launched your boat.**

State: ______________

County (or nearest city, village, or town): ________________________

9. **For this trip, approximately what was your <u>household's share</u> of the expenses for the trip: (1) that you paid in the county where you fished; and (2) that you paid in areas outside the county where you fished?**

	Money spent in county where you fished	Money spent in areas outside of county where you fished
Bait and tackle shops	$__________	$___________
Restaurants or bars	$__________	$___________
Grocery or convenience type stores	$__________	$___________
Hotels, motels, B&Bs, campgrounds	$__________	$___________
Gas stations (fuel, sundries)	$__________	$___________
Marinas or yacht clubs (rental or launching fee, fuel, supplies)	$__________	$___________
Fishing charters or guides	$__________	$___________
Other	$__________	$___________

10. **How did you get to the location where you fished on this trip?** *(Check one.)*

- ▢ Walked or bicycled
- ▢ Motorcycle
- ▢ Compact or economy car
- ▢ Mid or full-size car
- ▢ Pickup truck or SUV
- ▢ RV
- ▢ Airplane
- ▢ Other

11. Did you take any day or overnight trips <u>in 2011</u> to any of the states in the study area (states are shaded on the front cover) for the PRIMARY PURPOSE of freshwater fishing? Please include the trip you just told us about if it was in 2011.

☐ No (SKIP TO Question 13) ☐ Yes (Continue below)

12. **In the table below, please write in all the counties you fished in 2011 for the state on the map included with this questionnaire (up to a total of 8 counties where you fished the most). If you're not sure of the county, make your best guess. If you fished in more than one county on a particular fishing trip, please indicate the county that you PRIMARILY fished in. If you fished from a boat, please list the county where you launched.**

For each county, please write in how many day trips you took and how many overnight trips you took <u>for each of the 7 types of fishing listed</u>. If you did more than one type of fishing on a trip, list the trip next to the one type of fishing that was most important to you on that trip.

On the last line, please write in all the fishing trips you took in 2011 that were outside the state on the map, but inside the study area (shaded area on front cover).

Where did you fish in 2011?	Great Lakes for trout or salmon		Great Lakes for warmwater species		Inland lakes and ponds for trout and salmon		Inland lakes and ponds for warmwater species		Salmon or steelhead on spawning runs		Rivers and streams for trout and salmon, but not including spawning runs		Rivers and streams for warmwater species	
County (on enclosed map)	# of day trips	# of overnight trips	# of day trips	# of overnight trips	# of day trips	# of overnight trips	# of day trips	# of overnight trips	# of day trips	# of overnight trips	# of day trips	# of overnight trips	# of day trips	# of overnight trips
Number of Trips to All Other States in Study Area →														

13. We've been asking you about your fishing in 2011, but 2011 may not have been a normal fishing year for you. How many DAY and OVERNIGHT fishing trips do you take in a NORMAL or average year to states in our study area (shaded on the front cover map)? If you think 2011 was a normal year, you can just add the numbers in Question 12. Put each fishing trip in the category where it fits best.

Type of fishing (inside the shaded area on the map)	# of **DAY** trips I take in a normal year to do this type of fishing	# of **OVERNIGHT** trips I take in a normal year to do this type of fishing
Great Lakes for trout and salmon		
Great Lakes for warmwater species		
Inland lakes and ponds for trout and salmon		
Inland lakes and ponds for warmwater species		
Salmon or steelhead on spawning runs		
Rivers and streams for trout and salmon, but not including spawning runs		
Rivers and streams for warmwater species		

We've asked you about how much you fish in a normal year. Now we'd like to know how the number of fishing trips that you take in a normal year might change <u>if the number of fish you caught decreased</u>.

14. **<u>If the number of fish you caught decreased</u> for some types of fishing, how many DAY fishing trips (inside the shaded area on the map) would you take for each type of fishing?** If you're not sure, make your best guess as to how many trips you would take. *(The table on the next page will ask about overnight trips.)*

Type of fishing (inside the shaded area on the map)	% DECREASE in # of fish caught per day fishing	# of DAY trips I would take to do this type of fishing
Great Lakes for trout and salmon	**30% less than normal**	
Great Lakes for warmwater species	**50% less than normal**	
Inland lakes and ponds for trout and salmon	**30% less than normal**	
Inland lakes and ponds for warmwater species	No change	
Salmon or steelhead on spawning runs	No change	
Rivers and streams for trout and salmon, but not including spawning runs	No change	
Rivers and streams for warmwater species	**50% less than normal**	

15. <u>If the number of fish you caught decreased</u> for some types of fishing, how many OVERNIGHT fishing trips (inside the shaded area on the map) would you take for each type of fishing?

Type of fishing (inside the shaded area on the map)	% DECREASE in # of fish caught per day fishing	# of OVERNIGHT trips I would take to do this type of fishing
Great Lakes for trout and salmon	**30% less than normal**	
Great Lakes for warmwater species	**50% less than normal**	
Inland lakes and ponds for trout and salmon	**30% less than normal**	
Inland lakes and ponds for warmwater species	No change	
Salmon and steelhead on spawning runs	No change	
Rivers and streams for trout and salmon, but not including spawning runs	No change	
Rivers and streams for warmwater species	**50% less than normal**	

For the final questions, we'd like to ask a little bit more about you and your fishing.

16. Do you own a boat that you use for fishing? *(Check all that apply.)*

☐ No

☐ Yes, non-motorized

☐ Yes, motorized (How long is it? _______ ft.)

17. Is there a place that you go freshwater fishing within walking distance of your home?

☐ No

☐ Yes

18. What is your gender?

☐ Male

☐ Female

19. How many children 18 or under live in your home?

_______ children

20. What is your marital status?

- ☐ Never married
- ☐ Married (Does your spouse fish? ☐ No ☐ Yes)
- ☐ Unmarried partner (Does your partner fish? No Yes)
- ☐ Divorced
- ☐ Widowed

21. What is your employment status? *(Please check one.)*

- ☐ Employed, full-time
- ☐ Employed, part-time
- ☐ Self-employed
- ☐ Unemployed or not in labor force
- ☐ Retired
- ☐ Student
- ☐ Non-wage employment (e.g., stay at home parent)

22. In what year were you born? 19________

23. What was your household income (before taxes) in 2011? *(Please check one.)*

☐ Less than $15,000	☐ $75,000 to $99,999
☐ $15,000 to $24,999	☐ $100,000 to $149,999
☐ $25,000 to $34,999	☐ $150,000 to $199,999
☐ $35,000 to $49,999	☐ $200,000 or more
☐ $50,000 to $74,999	

Please use the space below for any comments you wish to make.

Thank you for your time and effort!

To return this questionnaire, simply seal it with the white removable seal, and drop it in the mail (return postage has been paid).

Appendix: Followup Survey Instrument

A Followup Survey of Anglers in the Great Lakes and

Upper Mississippi and Ohio River Basins

Research conducted by the

Human Dimensions Research Unit

Department of Natural Resources

Cornell University

Earlier this year, we sent you a survey and asked about your fishing experiences in 2011, your plans for 2012, and how your fishing experiences might change if the quality of fishing changes. In this much shorter, followup survey, we want to ask you just a few questions about your most recent fishing experiences. The questions should take about 5 minutes to answer.

We are conducting this study for the U.S. Army Corps of Engineers who are looking at the effects of aquatic nuisance species in the Great Lakes and Upper Mississippi and Ohio River Basins. Whether you fish a lot or only a little, your participation in this survey is important. The information you provide will be used to help decision makers assess alternative plans that may affect recreational fishing.

Your participation in this survey is voluntary, but we sincerely hope you will take just a few minutes to answer our questions. Your identity will be kept confidential and the information you give us will never be associated with your name.

THANK YOU FOR YOUR HELP!

U.S Army Corps of Engineers Agency Disclosure Notice OMB Number 0710-0001

The public report burden for this data collection effort is estimated at 5 minutes per individual, including the time for reviewing instructions, searching existing data sources, gathering and maintaining data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this data collection, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Executive Services Directorate, Information Management Division, 1155 Defense Pentagon, Washington DC, 20301-1155 and the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503, Attn: Desk Officer for US Army Corps of Engineers. Respondents should be aware that notwithstanding any other provision of law, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

We are going to be asking you just a few questions about **FRESHWATER FISHING TRIPS** that you have taken **THIS YEAR (2012)**.

For the purpose of this survey, a **FRESHWATER FISHING TRIP** is any time you leave your home for the **PRIMARY PURPOSE** of going fishing on lakes, rivers, streams or ponds, and could mean **going just down the street to fish for an hour**, or could mean **spending several days hundreds of miles from home.** A freshwater fishing trip could include fishing from a boat, from shore, or ice fishing.

1. Please look at the map of the states in our study area below (the shaded states). Have you taken any **freshwater fishing trips** to fish in any of the shaded states since you completed our earlier survey back in March, April, or May? *(Check one.)*

   □ Yes
   □ No *(Skip to "thank you" at end of survey.)*
   □ Don't Know

We'd like to find out a little bit of information about your **most recent freshwater fishing trip** inside the shaded area on the map.

2. During what month of 2012 did you take **your most recent fishing trip** in the **shaded area on the map**? (*Check one.*)

- □ March
- □ April
- □ May
- □ June
- □ July

3. Was this trip **a day trip** (you returned home on the same day or later that night) or **an overnight trip** (you stayed away from home at least one night)? (*Check one.*)

- □ Day Trip *(Skip to Question 5)*
- □ Overnight Trip

4. How many nights were you away from home on this trip? *(Enter "0" if it was a day trip)*

_______ night(s) [IF "0," SKIP TO QUESTION 5.}

4a. On how many different days during this trip did you fish?

_______ days

5. How many people in your household (besides yourself) went with you and fished on this trip? *(If you fished by yourself, enter "0.")*

_______ people besides yourself

6. In what state did you spend the most time fishing on that trip? (*Check one.*)

□ Illinois	□ Missouri
□ Indiana	□ New York
□ Iowa	□ Ohio
□ Pennsylvania	□ Kentucky
□ Michigan	□ West Virginia
□ Minnesota	□ Wisconsin

7. Please click on one of the counties on the map to show the approximate location where you spent the most time fishing on the trip. If you fished from a boat, please click on the county where you launched.

[Map of state checked in Question 6 will appear.]

8. For this trip, **approximately** what was your household's share of the expenses for the trip that you: (1) paid in the county where you fished; and (2) paid in areas outside the county where you fished?

	Money spent in county where you fished	Money spent in areas outside of county where you fished
Bait and tackle shops	$_____________	$_____________
Restaurants or bars	$_____________	$_____________
Grocery or convenience type stores	$_____________	$_____________
Hotels, motels, B&Bs, campgrounds	$_____________	$_____________
Gas stations (fuel, sundries)	$_____________	$_____________
Marinas or yacht clubs (rental or launching fee, fuel, supplies)	$_____________	$_____________
Fishing charters or guides	$_____________	$_____________
Other	$_____________	$_____________

[IF "OTHER" IS CHECKED, A BOX TO ENTER EXPLANATION APPEARS.]

9. How did you get to the location where you fished on this trip? *(Check all that apply.)*

- □ Walked or bicycled
- □ Motorcycle
- □ Compact or economy car
- □ Mid or full-size car
- □ Pickup truck or SUV
- □ RV
- □ Airplane
- □ Other

  [IF "OTHER" IS CHECKED, A BOX TO ENTER EXPLANATION APPEARS.]

10. Please check the **primary type of fishing** you did on that trip. (*Check one.*)

- “Great Lakes” includes Lakes Superior, Huron, Michigan, Erie, or Ontario.
- “Warmwater species” are species like walleye, perch, bass, muskie, catfish, and panfish.

  - □ Great Lakes for trout or salmon
  - □ Great Lakes for warmwater species
  - □ Inland lakes and ponds for trout or salmon
  - □ Inland lakes and ponds for warmwater species.
  - □ Salmon or steelhead on spawning runs
  - □ Rivers and streams for trout or salmon, but not including spawning runs
  - □ Rivers and streams for warmwater species

11. You said that the primary type of fishing you did on this trip was:

<<ANSWER FROM QUESTION 10>>

Imagine that before you went on this trip, you knew that the number of fish you would catch per day when doing this type of fishing was <<30%/50%>> lower than it would usually be in the entire shaded area on the map. The quality of other types of fishing would be the same as usual. What would you have done?

[THE NUMBER 30 OR 50 IS RANDOMLY INSERTED IN THE QUESTION.]

- □ Gone on the trip anyway and stayed about the same amount of time as I did
- □ Gone on the trip and stayed longer to try to catch more fish
- □ Gone on the trip, but not stayed as long
- □ Done another type of fishing at the same location
- □ Done another type of fishing at a different location
- □ Done the same type of fishing at a different location
- □ Done another activity away from home, not fishing
- □ Stayed at home

Those are all the questions we have. THANK YOU for participating in this survey!

Technical Appendix: Model Specification and Estimation

The Great Lakes/Upper Mississippi Recreational Angling Model (GLMRAM) is a repeated nested logit random utility model (RUM) that models the recreational angler behavior in the Great Lakes, Upper Mississippi and Ohio River basins. The model explains and predicts the following recreational behaviors:

- how often a recreational angler goes fishing
- what type of fishing they do
- where they do fish
- how those behaviors would change if catch rates were to decrease

Details on data collection are provided in the body of the report. This technical appendix describes the mathematical structure of the model and its estimation.

Definition of a Fishing Trip

A fishing trip is a trip taken away from home for the primary purpose of recreational angling. The trip begins when the angler leaves home and ends when he/she returns home again. The trip could be only for an hour or two or could last for several days. Trips where the angler leaves home and returns on the same day are defined as day trips. Trips where the angler is away from home overnight are defined as overnight trips.

For a given angler, a fishing trip is completely described by three factors:

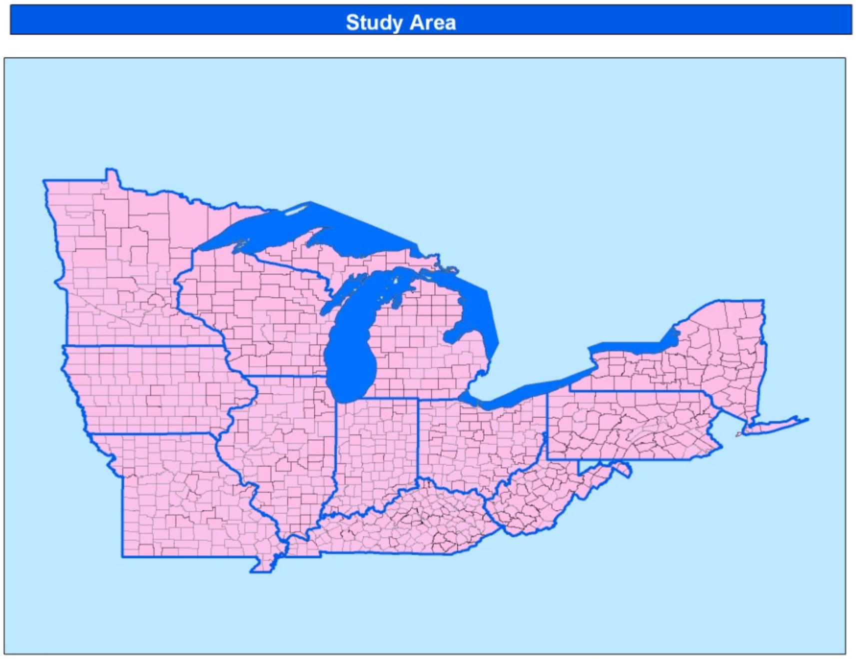
- whether the trip is a day trip or an overnight trip
- the trip origin and destination county
- the type of fishing done on the trip

Definition of Origin and Destination for a Trip

The study area is shown in the Figure TA-1. It includes almost all of the U.S. portions of the Great Lakes, the Upper Mississippi River, and the Ohio River basins. The study area includes 1024 counties.

Each county is treated as a unique fishing destination. Each time an angler goes fishing, he or she must choose one destination (county) for that trip. For trips where the angler fished from a boat, the destination county is defined as the county where the boat was launched. For trips where an angler fished in more than one county, the angler was asked to report the county he or she primarily fished in during that trip. Fishing trips taken to destinations outside of the study area are not included in the dataset or the model.

Figure TA-1. Study area.



The procedure for calculating round trip travel costs to each destination is described in detail in the report. For each trip, the trip origin is the zip code of either the angler's primary residence or their secondary residence if they have one. If a respondent has two homes, travel cost is measured from both the primary home zip code and the secondary home zip code, and the lesser of the two calculated travel costs is used. The Site Choice Set for each trip (set of destination counties that the angler can consider) includes all counties that support the indicated fishing type and that the angler can reach within a specified cutoff driving time.

Fishing Type

We identify seven different types of freshwater fishing that occur within the study area. These are

1. GLCold – fishing in the Great Lakes for coldwater species (trout and salmon)
2. GLWarm – fishing in the Great Lakes for warmwater species
3. ILCold – fishing in inland lakes and ponds for coldwater species (trout)
4. ILWarm – fishing in inland lakes and ponds for warmwater species
5. RSCold – fishing in rivers and streams for coldwater species (trout - excluding anadromous runs)
6. RSWarm – fishing in rivers and streams for warmwater species

7. Anad – fishing in rivers that drain into the Great Lakes for salmon and trout that are swimming upstream to spawn (anadromous runs)

Not every type of fishing can be done in every county in the study area. GLCold and GLWarm can only be done from counties that border the Great Lakes. ILCold and RSCold can only be done in counties that have coldwater fish present, either naturally or stocked. Anad can only be done in counties that have rivers with anadromous runs. Counties were designated as supporting coldwater fishing if either a survey respondent reported taking a trip to that county to fish for RSCold or ILCold or the county was identified by its state fish management agency as supporting wild or stocked coldwater fishing. Similarly, counties were designated as supporting anadramous fishing if they included river stretches hydrologically connected to the Great Lakes and either a survey respondent reported engaging in anadramous fishing in the county or a state fish management agency identified the county as supporting anadramous fish runs.

Each fishing trip is assigned to one fishing type. For fishing trips where more than one type of fishing occurs, the respondent was asked to report the fishing type he or she primarily engaged in during that trip.

Data Collected

More detail on how the data was collected and summary statistics are provided in the body of the report.

Three different types of data were collected. First, anglers were asked to describe every fishing trip they took within the study region during 2011. Second, if the angler felt that 2011 was not a normal year with regards to their fishing activity, the angler was asked how many trips of each fishing type they take in a normal year. Third, anglers were asked how many fishing trips they would take if recreational quality, as measured by catch rate, were to decrease.

Data on 2011 Trips

Data on fishing trips taken in 2011 was collected from two surveys, one conducted by mail and the other conducted through the web. These two surveys collected slightly different information about trips.

In both surveys, complete information was collected for all trips taken within the respondent's home state. This information included

- the destination county
- the fishing type
- whether the trip was a day trip or an overnight trip

For trips taken outside the respondent's home state, the following information was collected for each trip

- Web Survey
    - destination state is known (but not county)
    - the fishing type
    - whether the trip was a day trip or an overnight trip
- Mail Survey
    - only know that destination is outside of home state (specific destination state or county is not known)
    - fishing type
    - whether the trip was a day trip or an overnight trip

Normal Year Trip Frequency Data

Anglers may have felt that 2011 was not a normal year for them, perhaps due to illness or injury or some other unusual situation. After reporting their 2011 fishing trip data, each respondent was asked how many times they go fishing in a "normal year." In question 19 of the web survey and Question 13 of the mail survey, respondents reported the total number of day trips and the total number of over overnight trips taken for each fishing type in a normal year.. No destination information was collected for this data.

Contingent Behavior Trip Frequency Data

Respondents were then asked to imagine that fishing quality, as measured by catch rates, were to decline. Each respondent was presented with a specific catch rate decline scenario. As depicted in questions … and … of the web survey and questions 14 and 15 of the mail survey, each catch rate decline scenario included seven catch rate declines – one for each fishing type. The catch rate declines differed across fishing types, but were the same for all counties within each fishing type. All catch rate declines were described as a percentage of the catch rate for that fishing type in 2011. Respondents were asked how many times in a year they would go fishing for each fishing type in a year if catch rates were to decline according to the presented scenario. Different respondents got different combinations of catch rate declines. Respondents were not asked where they would go fishing, only how many total day and overnight trips they would take for each fishing type.

Trip Decision Model

The recreation model developed here is for day trips. Day trips account for 89% of all trips taken in the study region and 83% of all fishing days. An overnight trip model was not specified or estimated for two reasons. First, because there is less data on overnight trips with which to identify spatially distinct quality parameters in the model, a model estimated based on overnight trips will be less reliable statistically. Second, angler behavior regarding overnight trips likely follows a different, more complex, decision process than for day trips. When calculating the net value generated by fishing in the study region, the value associated with overnight trips was calculated by multiplying the net value per fishing day estimated from the day trip model by the estimated total number of fishing days that occurred on overnight trips. The assumption is that the net value per fishing day is the same for day trips and for overnight trips.

For day trips, anglers are assumed to make their trip decisions (whether to go fishing, what type of fishing to do, where to go fishing) based on the utility they receive from engaging in each fishing type in each county. A repeated nested logit random utility model (NLRUM) is assumed (Morey et al. 1993). In the model, each angler has N opportunities to go fishing (choice occasions). On each choice occasion, the angler makes a series of decisions. First, they decide whether or not to take a trip (participation decision). If they decide to take a trip, they then decide what type of fishing to do (fishing type decision). Once they have decided what type of fishing to do, they decide where to go fishing (destination decision). The destination decision is constrained by the fishing type decision – the angler can only go to destinations that offer that type of fishing. The decision tree for each fishing opportunity is shown in Figure TA-2.

The Utility Function

An angler is assumed to obtain utility of 0 if they choose to stay home and do something other than going fishing. The utility that individual i obtains from engaging in fishing type k in county j consists to two components, a deterministic component, U_{ij}^k, and a random component, ε_{ij}^k

$$V_{ij}^k = U_{ij}^k + \varepsilon_{ij}^k$$

The deterministic component is assumed to take the following form

$$U_{ij}^k = \gamma_k Q_{jk} + \beta TC_{ij} + \varphi^k ln\left(CR_j^k\right) + \mu X_i + \delta_k Z_i + \omega_k S_i$$

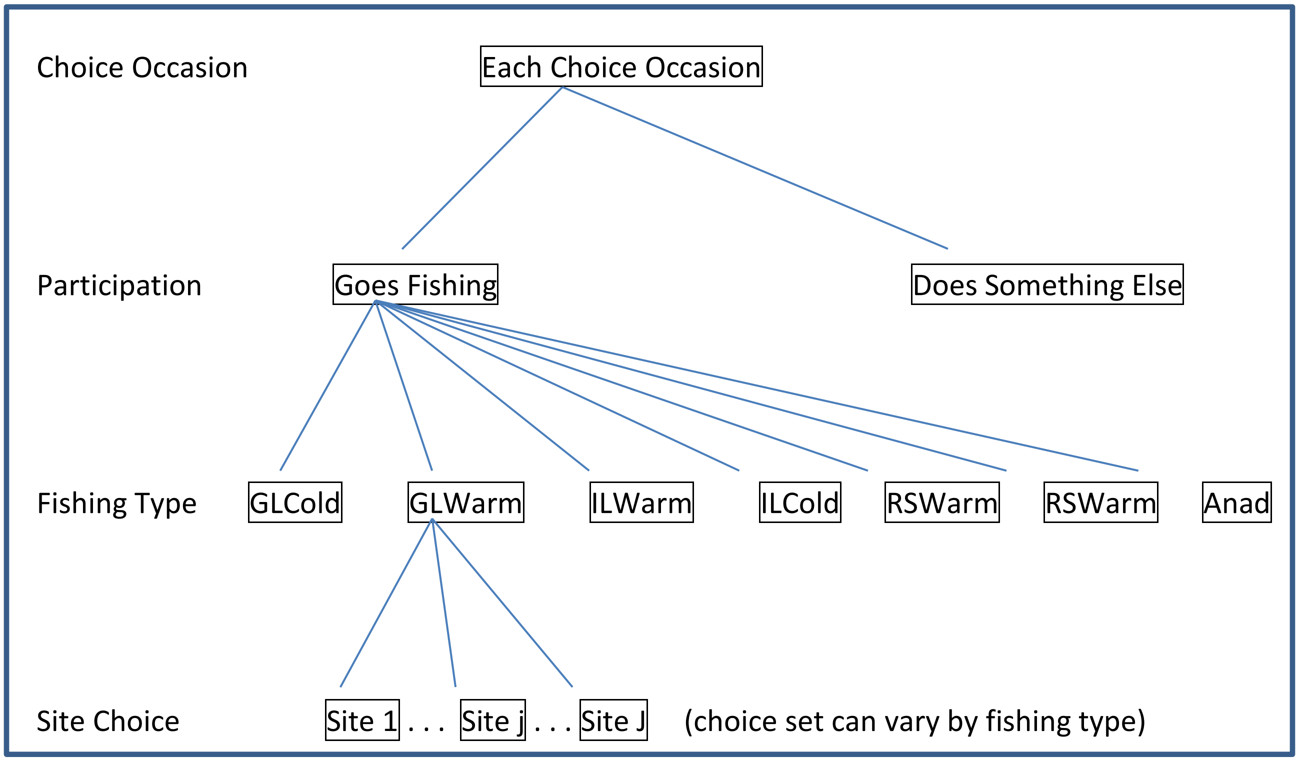
where

i = index for individual

j = index for county; j = 1,2,…,1042

k = index for fishing type; k=1,2,…,7

Figure TA-2. Nested logit decision tree.



TC_{ij} = Round trip travel costs from centroid of i's home zip code to centroid of jth county. If a respondent has two homes, travel cost to the jth county is measured from both the primary home zip code and the secondary home zip code, and the lesser of the two calculated travel costs is used.

β = Marginal utility of income.

CR_j^k = Catch rate for fishing type k in county j, expressed as percent of 2011 catch rate.

φ^k = parameter to capture influence of catch rate reduction on fishing type choice.

Q_{jk} = Vector of site characteristics relevant to fishing type k.

γ_k = Vector of marginal utilities of site characteristics for fishing type k.

X_i = Vector of characteristics of the individual that affect the participation decision.

μ = Vector of parameters for participation decision (marginal impact of each element of X_i on utility from going fishing)

Z_i^k= Vector of characteristics of the individual that affect fishing type choice.

δ_k = Vector of fishing type choice parameters for fishing type k (marginal impact of each element of Z_i^k on utility from engaging in fishing type k)

S_i = Dummy variable for whether a trip is based on observed behavior in 2011 or stated behavior (=1 if normal year or contingent behavior; =0 if actual trip taken in 2011)

ω_k = parameter to capture influence of hypothetical bias on fishing type choice.

ε_{ij}^k = random error term in utility for individual i of engaging in fishing type k in county j

Influence of Catch Rate on Utility and Behavior

A unique aspect of the model as it is applied here is how catch rate is included in the utility function. The catch rate measure, CR_j^k is defined as a percentage of the baseline (2011) catch rate. For all observed trips taken in 2011 and all "normal year" trips, CR_j^k=1, so that ln(CR_j^k)=0. For contingent behavior trips, CR_j^k<1 for fishing types whose catch rate declines in the hypothetical scenario, so that ln(CR_j^k)<0. As CR_j^k declines toward 0, ln(CR_j^k) declines to -∞ in the limit. The functional form therefore imposes the restriction that no trips will be taken to a destination that has catch rate of 0.

For CR_j^k values between 0 and 1, the shape of the utility function depends on the value of φ^k. Figure TA-3 shows how a catch rate reduction at one site can affect the probability of visiting that site. In this constructed example, the site has a probability of being chosen of 0.01 if CR_j^k=1. As CR_j^k declines, the probability of the site being chosen declines, but at a rate that depends on the value of φ^k. Three different curves are shown for different values of φ^k. If φ^k is small (blue curve), then the probability of choosing the site declines slowly with small decreases in catch rate. If φ^k is large (green curve) then the probability of choosing the site declines rapidly with small decreases in catch rate. An intermediate value of φ^k gives a roughly linear relationship between catch rate and probability of choosing the site. The functional form chosen is therefore very flexible with regards to the impact of catch rate reductions on behavior with the restriction that the probability of choosing a site/fishing type combination goes to zero as the catch rate for that fishing type for that site goes to 0.

The flexibility of the model means that it should be used with caution when projecting impacts of catch rate reductions outside the range of the data. In the catch rate reduction scenarios presented to survey respondents, catch rates for each fishing type were reduced by between 0% and 50%.Complete loss of a fishing type will logically lead to no fishing for that fishing type. However, we have no information on the specific shape of the lines in Figure TA-3 for catch rate reductions larger than 50% but less than complete loss.

Conditional Site Choice Probability

Complete information on destination choice is not available for all trips. In some cases, we only know which state or states were visited. Let g=1,2,…,G_i^k be an index, where each value of g represents an observed trip destination for angler i. If the observed trip destination is within the angler's home state, then g will represent a unique county. If the observed trip destination is outside the angler's home state, then g will represent a set of counties. For example, if the angler indicates that the trip was to a particular state other than the home state, then g represents all counties within that state that lie in the site choice set, i.e. those counties that offer that type of fishing and that are within the travel time cutoff for the angler.

The conditional probability of individual i taking a trip to destination set g, conditional on going fishing for fishing type k, is given by

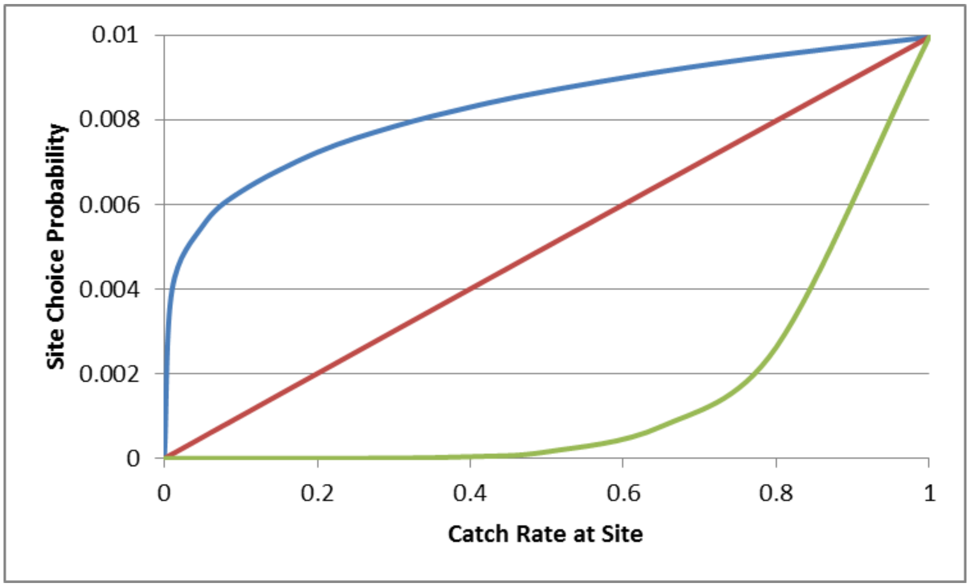
$$\Pr(g|k,p) = \frac{\sum_{j \in C_{ig}^k} \left\{ exp\left(U_{ij}^k / \lambda_k \right) \right\}}{\sum_{j \in C_i^k} \left\{ exp\left(U_{ij}^k / \lambda_k \right) \right\}}$$

where

p,np = indicator for participation (=p if angler goes fishing on that occasion; np if angler does not go fishing on that occasion)

C_i^k = individual i's full choice set for fishing type k. Includes all counties within the cutoff travel time from i's zip code that offer fishing type k.

Figure TA-3. Influence of catch rate on site choice probability.



C_{ig}^k = set of counties included in destination set g for fishing type k for individual i. C_{ig}^k is always a subset of C_i^k. If the visited county is known (i.e. in home state), C_{ig}^k will include that county only; if the visited county is not known, but visited state or states is known, C_{ig}^k will include all relevant counties in that state or states. For "normal year" trips and contingent behavior trips, no information about destination is known, and C_{ig}^k includes all of the same counties as C_i^k.

λ_k = Scale parameter for the site choice decision for fishing type k

Note that because Z_i, X_i and H_i do not vary among sites, they will cancel out in the formula and will not affect the site choice probabilities.

For each individual i, the inclusive value for fishing type k is given by

$$IV_i^k = ln\left[\sum_{j \in C_i^k} \left\{exp\left(U_{ij}^k / \lambda_k\right)\right\}\right]$$

The expected utility from taking a trip of fishing type k is given by

$$EU_i^k = \lambda_k IV_i^k$$

Fishing Type Choice Probability

The probability of choosing fishing type k, conditional of going fishing, depends on the expected utility from fishing type k as compared to the expected utility of the other fishing types, as follows

$$\Pr(k|p)\frac{exp\left[{EU_i^k}/{\sigma}\right]}{\sum_{h\in 1\ldots 7}\left\{exp\left[{EU_i^h}/{\sigma}\right]\right\}}$$

where σ is the scale parameter for fishing type decision. The inclusive value for going fishing is given by

$$IV_i^p = ln\left[\sum_{h\in 1\ldots 7}\left\{exp\left[{EU_i^h}/{\sigma}\right]\right\}\right]$$

The expected utility from going fishing is given by

$$EU_i^p = \sigma IV_i^p$$

Probability of Going Fishing (participation)

The probability that individual i goes fishing on a given choice occasion depends on the expected utility from going fishing

$$Pr(p)\frac{exp\left({EU_i^p}/{\rho}\right)}{1+exp\left({EU_i^p}/{\rho}\right)}$$

where ρ is the scale parameter for the participation decision. Traditionally, ρ is normalized to equal 1. The inclusive value per choice occasion is given by

$$IV_i^{co} = \ln\left(1+exp\left({EU_i^p}/{\rho}\right)\right)$$

The expected utility per choice occasion is given by

$$EU_i^{co} = \rho IV_i^{co}$$

Welfare Measures

With knowledge of the model parameters, it is possible to calculate welfare impacts of changes in access, site quality, or catch rate. The change in net economic value over an entire season from a change in conditions is given by the compensating variation (CV):

$$CV_i = N * \frac{EU_i^{co}(0) - EU_i^{co}(1)}{-\beta}$$

where $EU_i^{co}(0)$ is the expected utility per choice occasion under the baseline (2011) catch rate and access conditions and $EU_i^{co}(1)$ is the expected utility per choice occasion under the new conditions.

For some changes in conditions that prevent anglers from taking trips that they otherwise would have taken, it is possible to calculate a user day value (for day trips). Examples would include closure of a site that prevents all trips to that site, or a decrease in catch rate for a specific fishing type that induces anglers to take fewer trips of that fishing type. For changes in conditions that displace angler trips, a user day value is defined as the compensating variation for the change in conditions divided by the expected number of fishing days that would be displaced by the change in conditions.

Consider first a change in access or catch rate that discourages or prevents anglers from visiting a specific site or set of sites for a specific type of fishing. Anglers will take fewer trips to the affected site or sites, but will substitute and fish some of the displaced trips at other, unaffected sites. If the number of displaced fishing days (the decrease in fishing days at the affected site or sites) is small, then the compensating variation per displaced fishing day for fishing type k is given by $-\lambda_k/\beta$. This user day value is appropriate for use when valuing changes that affect one site or a small group of sites. It accounts for substitution away from the affected site or sites to other, unaffected sites.

Alternatively, a change in conditions could discourage or prevent anglers from fishing for a specific fishing type at all sites. Anglers will fish less often for that fishing type, but will substitute and fish some of the displaced days for other, unaffected fishing types. If the number of displaced fishing days is small, then the compensating variation per displaced fishing trip is given by $-\sigma/\beta$. This user day value is appropriate for use when valuing changes that affect one fishing type across the entire study region. It accounts for substitution away from the affected fishing type to other fishing types. This is the user day value used for calculating the baseline value of fishing in the GLMRIS study area.

Finally, a change in conditions could prevent an angler from doing any type of fishing at any site (complete closure of all recreational fishing). For an angler with a very low probability of going fishing, the user day value associated with complete loss of all fishing is given by –ρ/β. This is an extreme situation that is well outside the range of our observed data. Any estimate of this user day value will be very unreliable.

In all three cases, the formula for user day value is strictly valid only for changes that displace a small number of trips.

Construction of the Likelihood Function

On a given choice occasion, the probability of observing a particular trip of fishing type k to destination set g is given by

$$\Pr(g,k,p) = Pr(p) * \Pr(k|p) * \Pr(g|k,p)$$

The probability of the angler not taking a trip is given by

$$Pr(np) = 1 - Pr(p)$$

The likelihood function for an entire season's trip behavior is given by

$$lnL = \sum_i \left\{ \sum_k \sum_g \left(F_{ig}^k \ln[\Pr(g,k,p)]\right) + \left(N - \sum_k \sum_g F_{ig}^k\right) \ln(1 - \Pr(p)) \right\}$$

where

N = number of choice occasions per year (set at 365)

F_{ig}^k = Number of times during the season angler i took a trip to destination g to do fishing type k

Note that each angler can show up in the likelihood function up to three times: once for their 2011 trip data, once for their normal year trips, and once for their contingent behavior trips.

Estimation

An important objective of this research is to estimate a reliable model of recreational behavior under current (2011) conditions. For this reason, the model parameters were estimated in two steps. First, the model was estimated using only 2011 trip data (actual trips taken). For the first stage regression, the participation scale parameter, ρ, is normalized to 1. Because H_i=0 and CR_j^k=1 for all 2011 trips, the parameters φ^k and ω_k cannot be identified during the first step regression. This was done so that all parameters other than φ^k and ω_k would be estimated based on observed 2011 trip behavior only, and would not be based on stated behaviors associated with normal year or contingent behavior trips.

Previous research has shown that anglers tend to report future trip participation at higher rates than is observed in actual trip behavior. This could be due to optimism on the anglers' part, where they report the amount of angling they plan to do, but fail to take into account events that could prevent them from fulfilling those plans, such as sickness or other unanticipated events (Englin and Cameron 1996; Hensher et al 1998). We account for the tendency to overstate trip frequency by estimating a parameter for each fishing type, ω_k, that captures differences in trip frequency between hypothetical trip behavior and actual trips taken. A second observed issue is that survey respondents may report choices that imply random error terms that have higher variance than that implied by actual choice behavior. It has been speculated that recreationists facing actual trip choices have more of an incentive to evaluate their own utility, reducing the variance in the error terms.

In the second step, the estimated parameters from the first step regression were held fixed, and φ^k and ω_k were estimated using the "normal year" and contingent behavior data. This approach is admittedly inefficient, and there is the concern that estimated standard errors will be biased, particularly in the second-stage regression. To account for potential differences in error variance between hypothetical and actual trip choices, we estimate in the second stage regression new values for σ and ρ, so that the scale parameters for the hypothetical trip behavior are allowed to differ from the scale parameters for the actual 2011 trip behavior. Because we do not have information on site choice in the hypothetical data, it is not possible to estimate new values of the site choice scale parameters for hypothetical data.

Results

Details on construction of site quality measures, Q_{jk}, are discussed in the body of the report. The following county-specific quality measures were included in the first stage regression:

For GLCold and GLWarm:

- Fishing-type specific constant
- Constants for each of 10 county groups
- Shoreline Miles

For Anadromous:

- Fishing-type specific constant
- Constants for each of 10 county groups
- Aquatic Habitat Quality Index
- Miles of streams in the county (stream order 3-4)
- Miles of rivers in the county (stream order 5-7)

For ILCold, ILWarm: - Fishing-type specific constant

- Constants for each state (Omitted state is Michigan)
- Aquatic Habitat Quality Index
- Lake area in county (square miles)

For RSCold, RSWarm

- Fishing-type specific constant
- Constants for each state (Omitted state is Michigan)
- Aquatic Habitat Quality Index
- Miles of streams in the county (stream order 3-4)
- Miles of rivers in the county (stream order 5-7)

An estimation where the seven site-choice scale parameters were unrestricted resulted in some site-choice scale parameters larger than the estimated fishing-type scale parameter, which would be inconsistent with a random utility model. Hence, a common value of $\lambda_k = \lambda$ for all k fishing types is estimated.

All angler characteristics were included in the X_i vector, and none were included in the Z_i vector. That is, angler characteristics were assumed to affect participation frequency, not fishing type choice. This was done to reduce the number of parameters estimated.

The first stage estimation was done using day trips for the 2011 season. The results are presented in Table TA-1.

Economic theory predicts that the coefficient on travel cost will be negative, and that the scale parameters will satisfy the inequalities $\lambda<\sigma<\rho$. These conditions are satisfied for the first stage results, indicating that our observed trip data is consistent with expected utility theory.

Coefficients for continuous site quality measures are of the expected signs and almost all are statistically significant. Counties with more shoreline miles are more likely to be visited for GLCold and GLWarm trips. Counties with more lake area are more likely to be visited for ILWarm and ILCold trips. Counties with more stream miles are more likely to be visited for RSCold and RSWarm trips. Counties with more river miles are more likely to be visited for RSWarm and Anad trips. More river miles did not have a significant impact on visitation for RSCold trips, suggesting that RSCold anglers are targeting smaller streams. Stream miles had a negative impact on Anad trips, suggesting that Anadromous anglers are targeting counties located lower in the watersheds. Finally, higher values of the Aquatic Habitat Quality Score were associated with more trips for all five inland fishing types.

Higher income anglers fish less frequently, as do anglers with full time employment. The relationship between age and fishing frequency has an inverted U shape, with a peak between 30 and 40 years of age.

The second stage estimation included normal year and contingent behavior responses. As demonstrated in Table TA-2, the second stage regression results show that anglers, on average, project more trips in a normal year than they took in 2011 (i.e. ω_k>0). This was true for all fishing types. For all fishing types, decreased catch rate would lead to decreased fishing participation (i.e. φ^k>0). The fishing type that was most sensitive to decreases in catch rate was GLCold, while the fishing type that was least sensitive was Anadromous.

Based on the estimation results, The user day values for changes that affect trips to a given site is $17.53, while the user day value for changes that affect all trips of a single fishing type is $19.52.

The scale parameter for fishing type choice, σ, estimated from the hypothetical trips data was larger than that estimated from the data on 2011 trips. This would suggest that anglers project a higher rate of substitution between fishing types than they actually exhibit. The participation scale parameter, ρ, estimated from the hypothetical data was close 1, the normalized value imposed for the 2011 data.

Table TA-1. First stage model estimation results using 2011 trip data.

Variable	Estimate	T-Stat	Description
Site Quality Measures - GLCold			
GLCold	-2.4437	-64.846	Fishing-type-specific constant
GLCold Grp 1	0.1694	6.554	County group constant - County group 1
GLCold Grp 2	0.0253	1.615	County group constant - County group 2
GLCold Grp 3	0.0284	1.591	County group constant - County group 3
GLCold Grp 4	-0.1832	-9.239	County group constant - County group 4
GLCold Grp 5	-0.0718	-6.723	County group constant - County group 5
GLCold Grp 6	-0.0227	-1.866	County group constant - County group 6
GLCold Grp 7	-0.1717	-7.422	County group constant - County group 7
GLCold Grp 8	-0.3052	-11.790	County group constant - County group 8
GLCold Grp 9	0.0803	5.451	County group constant - County group 9
GLCold Grp 10	0.0252	1.672	County group constant - County group 10
GLCold x shoremi	1.0161	6.283	Shoreline Miles
Site Quality Measures - GLWarm			
GLWarm	-2.5664	-66.826	Fishing-type-specific constant
GLWarm Grp 1	0.0748	1.774	County group constant - County group 1
GLWarm Grp 2	0.0163	0.958	County group constant - County group 2
GLWarm Grp 3	0.0094	0.433	County group constant - County group 3
GLWarm Grp 4	0.0616	3.810	County group constant - County group 4
GLWarm Grp 5	-0.0759	-5.140	County group constant - County group 5
GLWarm Grp 6	-0.0568	-2.802	County group constant - County group 6
GLWarm Grp 7	0.2002	11.786	County group constant - County group 7
GLWarm Grp 8	0.2224	12.660	County group constant - County group 8
GLWarm Grp 9	0.2897	16.205	County group constant - County group 9
GLWarm Grp 10	0.2097	12.280	County group constant - County group 10
GLWarm x Shoremi	1.7606	9.664	Shoreline Miles
Site Quality Measures - Anadromous			
Anad	-2.8913	-60.093	Fishing-type-specific constant
Anad Grp 1	0.1141	1.429	County group constant - County group 1
Anad Grp 2	0.0479	1.673	County group constant - County group 2
Anad Grp 3	0.2052	8.258	County group constant - County group 3
Anad Grp 4	-0.0791	-1.979	County group constant - County group 4
Anad Grp 5	0.1701	9.459	County group constant - County group 5
Anad Grp 6	0.1436	7.572	County group constant - County group 6
Anad Grp 7	0.0988	3.758	County group constant - County group 7
Anad Grp 8	0.0762	3.203	County group constant - County group 8

Anad Grp 9	0.3283	15.518	County group constant - County group 9
Anad Grp 10	0.2796	14.230	County group constant - County group 10
Anad x habscore	0.0783	7.036	Aquatic habitat quality score
Anad x strms34	-0.1154	-2.306	Miles of streams (stream order 3-4)
Anad x strms57	0.8282	4.508	Miles of rivers (stream order 5-7)
<u>Site Quality Measures - ILCold</u>			
ILCold	-2.9236	-62.803	Fishing-type-specific constant
IN x ILCold	-0.1076	-5.796	State-specific constant - Indiana
IL x ILCold	-0.0571	-3.433	State-specific constant - Illinois
IA x ILCold	-0.0049	-0.256	State-specific constant - Iowa
KY x ILCold	-0.1238	-6.756	State-specific constant - Kentucky
MN x ILCold	-0.4124	-11.972	State-specific constant - Minnesota
MO x ILCold	0.0720	5.555	State-specific constant - Missouri
NY x ILCold	0.1708	11.155	State-specific constant - New York
OH x ILCold	0.0494	3.365	State-specific constant - Ohio
PA x ILCold	0.1764	12.211	State-specific constant - Pennsyvlania
WV x ILCold	0.0143	0.919	State-specific constant - West Virginia
WI x ILCold	-0.1820	-11.289	State-specific constant - Wisconsin
ILCold x habscore	0.0813	8.845	Aquatic habitat quality score
ILCold x lake area	0.6468	17.646	Lake Area
<u>Site Quality Measures - ILWarm</u>			
ILWarm	-2.5059	-68.662	Fishing-type-specific constant
IN x ILWarm	-0.1130	-12.469	State-specific constant - Indiana
IL x ILWarm	-0.0638	-8.242	State-specific constant - Illinois
IA x ILWarm	-0.0700	-7.617	State-specific constant - Iowa
KY x ILWarm	-0.0788	-10.072	State-specific constant - Kentucky
MN x ILWarm	-0.0925	-10.432	State-specific constant - Minnesota
MO x ILWarm	-0.1106	-12.564	State-specific constant - Missouri
NY x ILWarm	-0.0053	-0.616	State-specific constant - New York
OH x ILWarm	-0.0068	-1.123	State-specific constant - Ohio
PA x ILWarm	-0.0408	-2.849	State-specific constant - Pennsyvlania
WV x ILWarm	-0.1995	-17.562	State-specific constant - West Virginia
WI x ILWarm	-0.0413	-6.412	State-specific constant - Wisconsin
ILWarm x habscore	0.0615	5.988	Aquatic habitat quality score
ILWarm x lake area	0.4487	23.984	Lake Area
<u>Site Quality Measures - RSCold</u>			
RSCold	-2.8376	-64.875	Fishing-type-specific constant
IN x RSCold	-0.5658	-9.976	State-specific constant - Indiana
IL x RSCold	-0.1357	-9.765	State-specific constant - Illinois
IA x RSCold	-0.0613	-4.463	State-specific constant - Iowa

KY x RSCold	-0.2388	-12.202	State-specific constant - Kentucky
MN x RSCold	-0.2296	-12.161	State-specific constant - Minnesota
MO x RSCold	-0.1800	-12.151	State-specific constant - Missouri
NY x RSCold	0.1033	8.639	State-specific constant - New York
OH x RSCold	-0.1266	-8.986	State-specific constant - Ohio
PA x RSCold	0.1859	14.678	State-specific constant - Pennsyvlania
WV x RSCold	0.0880	6.814	State-specific constant - West Virginia
WI x RSCold	-0.1612	-9.882	State-specific constant - Wisconsin
RSCold x habscore	0.0865	11.554	Aquatic habitat quality score
RSCold x strms34	0.2902	14.639	Miles of streams (stream order 3-4)
RSCold x strms57	0.0934	1.475	Miles of rivers (stream order 5-7)
<u>Site Quality Measures - RSWarm</u>			
RSWarm	-2.6913	-68.495	Fishing-type-specific constant
IN x RSWarm	-0.0965	-9.155	State-specific constant - Indiana
IL x RSWarm	0.0109	1.013	State-specific constant - Illinois
IA x RSWarm	0.1035	10.845	State-specific constant - Iowa
KY x RSWarm	-0.0061	-0.527	State-specific constant - Kentucky
MN x RSWarm	-0.0833	-6.513	State-specific constant - Minnesota
MO x RSWarm	-0.0907	-8.882	State-specific constant - Missouri
NY x RSWarm	0.0705	6.636	State-specific constant - New York
OH x RSWarm	0.0299	2.678	State-specific constant - Ohio
PA x RSWarm	0.0874	6.273	State-specific constant - Pennsyvlania
WV x RSWarm	0.0054	0.542	State-specific constant - West Virginia
WI x RSWarm	0.0110	1.276	State-specific constant - Wisconsin
RSWarm x habscore	0.0474	11.209	Aquatic habitat quality score
RSWarm x strms34	0.2821	16.993	Miles of streams (stream order 3-4)
RSWarm x strms57	0.6276	17.864	Miles of rivers (stream order 5-7)
<u>Travel Cost</u>			
β	-0.0068	-20.765	Round Trip Travel Cost
<u>Angler Characteristics that affect participation decision</u>			
μ - ln(income)	-0.0724	-6.345	natural log of income/10000
μ - FT Employed	-0.1926	-20.283	=1 if full time employed
μ - Age	1.8729	11.361	Age/100
μ - Age squared	-2.8688	-16.806	(Age/100)^2
<u>Scale Parameters – 2011 Trip Data</u>			
σ – 2011 data	0.1329	21.777	Scale parameter for fishing type decision
λ – 2011 data	0.1194	16.324	Scale parameter for site choice decision

Table TA-2: Second stage estimation using stated trip (normal year and contingent behavior) data**.**

Variable	Estimate	T-Stat	Description
Catch Rate Index Coefficient			
ϕ – GLCold	0.2186	9.351	Catch Rate Index Coefficient for GLCold
ϕ - GLWarm	0.1735	8.332	Catch Rate Index Coefficient for GLWarm
ϕ – ILCold	0.1523	13.417	Catch Rate Index Coefficient for ILCold
ϕ – ILWarm	0.1546	27.919	Catch Rate Index Coefficient for ILWarm
ϕ – RSCold	0.1745	15.660	Catch Rate Index Coefficient for RSCold
ϕ – RSWarm	0.1849	13.304	Catch Rate Index Coefficient for RSWarm
ϕ – Anad	0.0938	6.638	Catch Rate Index Coefficient for Anad
Stated Trips Data Constants			
ω - GLCold	0.7567	41.103	Stated trip data constant for GLCold
ω - GLWarm	0.8463	55.267	Stated trip data constant for GLWarm
ω - ILCold	0.8130	67.306	Stated trip data constant for ILCold
ω - ILWarm	1.3751	660.833	Stated trip data constant for ILWarm
ω - RSCold	1.0362	175.576	Stated trip data constant for RSCold
ω - RSWarm	1.1851	102.724	Stated trip data constant for RSWarm
ω - Anad	0.6528	65.011	Stated trip data constant for Anad
Scale Parameters – Stated Trips Data			
σ – Stated data	0.3786	431.501	Scale parameter for fishing type choice
ρ – Stated data	0.9148	148.519	Scale parameter for participation choice

ATTACHMENT 3

CHARTER FISHING

Great Lakes Charter Fishing Industry- Baseline Economic Assessment

September 2013

U.S. Army Corps of Engineers

Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

The Great Lakes Charter Fishing Industry in 2011

Final Report

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May 2013

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ABSTRACT:

In support of the Great Lakes and Mississippi River Interbasin Study (GLMRIS), the Ohio State University Sea Grant Extension Office led a survey of charter captains in the Great Lakes Basin in order to establish the current economic value of the charter fishing industry in the U.S. waters of the Great Lakes Basin.

Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since targeted charter fishing species have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, this baseline economic assessment demonstrates the charter fishing industry that *could* be affected if no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins (i.e., the future without-project condition).

Further, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future resource availability and regulations regarding charter fishing activities in the case where Federal action is taken to prevent the transfer of ANS between the basins (i.e., the future with-project condition). Since these management plans were not available, this assessment serves as a baseline of the charter fishing industry within the Great Lakes Basin that *could* be affected in the future with-project condition.

As part of the Great Lakes survey of the charter fishing industry, a total of 1,148 Great Lakes charter fishing captains were surveyed in 2012 about their 2011 fishing season, with about a 30 percent response rate. The survey aided in the identification of detailed business expenditures, the number of trips taken per charter captain, and the targeted species. In 2011, there were an estimated 1,904 active licensed charter captains in the Great Lakes. Of these, approximately 1,700 captains operated as an independent small business, while another estimated 200 were non-boat owning captains. Together they generated between $34.4 million and $37.8 million in annual sales and salary, in 2011 dollars. Due to the low number of respondents to the Mississippi River Basin (MRB) river guide survey, statistically reliable information is not presented for this group.

GLMRIS BACKGROUND INFORMATION

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River basins by aquatic pathways. An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (FY13). As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

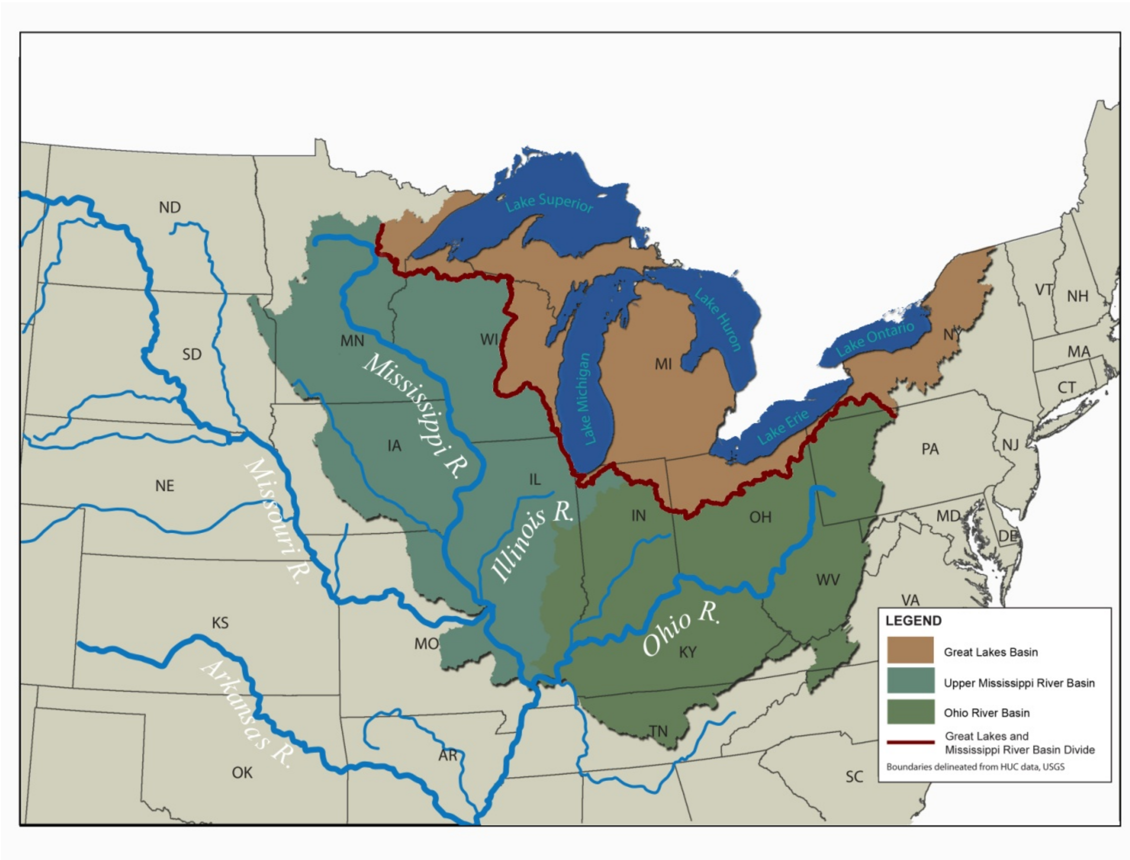
Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

GLMRIS STUDY AREA

The GLMRIS study area includes portions of the Great Lakes, Mississippi River, and Ohio River Basins that fall within the United States.

Figure 1: GLMRIS Study Area Map



Potential aquatic pathways between the Great Lakes, Mississippi River, and Ohio River Basins exist along the basins' shared boundary (illustrated in *Figure 1: GLMRIS Study Area Map*). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi and Ohio River Basins (green shaded areas) and the Great Lakes Basin (brown shaded area).

NAVIGATION AND ECONOMICS PRODUCT DELIVERY TEAM

In support of the Great Lakes and Mississippi River Interbasin Study, the Navigation and Economics Product Delivery Team (PDT) was formed. The PDT was tasked with assessing the current value of *economic* activities within the GLRMIS detailed study area that *could* change with the implementation (FWP condition) or lack of implementation (FWOP condition) of a GLMRIS project. The PDT is comprised of several sub-teams, each of which focuses on a specific economic activity within the GLRMIS study area. These categories include:

Navigation Related Economic Categories

- Commercial Cargo
- Non-Cargo Related Navigation

Other Related Economic Categories

- Flood Risk Management
- Hydropower
- Commercial and Recreational Fishery[1]
- Water Quality
- Water Supply
- Regional Economics

Fisheries Economics Team:

The Fisheries Economics Team (Team) was formed in order to assess the current *economic* value of commercial, recreational, charter, and subsistence fishing activities, as well as pro-fishing tournaments within the Great Lakes Basin, Upper Mississippi River and Ohio River Basins. The results of these analyses serve to demonstrate the various economic activities could be impacted in the future.

Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since native and commercial fish species have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Consequently, this baseline economic assessment demonstrates the charter fishing industry that *could* be affected if no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins (i.e., the future without-project condition).

Further, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future resource availability and regulations in the case where Federal action is taken to prevent the transfer of ANS between the basins (i.e., the future with-project condition). Since these management plans

[1] Charter and subsistence fishing, as well as pro-fishing tournaments are also addressed.

were not available, this assessment serves as a baseline of the charter fishing industry within the Great Lakes, Upper Mississippi River, and Ohio River Basins *could* be affected in the future with-project condition.

Charter Fishing Focus:

This *Great Lakes Charter Fishing Industry – Baseline Economic Assessment* report establishes the current economic value associated with commercial fisheries within the three basins. Specifically, this report exhibits the value of the charter fishing industry (valued via charter fishing annual sales and salary), within the Great Lakes Basin, that could be affected with the implementation (FWP condition) or lack of implementation (FWOP condition) of a GLMRIS project.

INTRODUCTION

The development and status of the Great Lakes charter fishing industry has been well documented previously by Dawson et al. (1995) and Kuehn, Pistis and Lichtkoppler (2005). This paper presents the results of the most recent Great Lakes wide survey of the charter fishing industry. In the summer of 2012 the Great Lakes Sea Grant Network (GLSGN), led by Ohio Sea Grant, conducted a comprehensive survey of the charter fishing industry in each of the Great Lakes states. The survey was an effort to update the status, characteristics and economics of the charter fishing industry in the Great Lakes and is modeled after a similar survey effort conducted in 1994 and 2002. The data reported here are adjusted for inflation to 2011 dollars. The results of a limited response (12 response out of 44 guides surveyed) to an exploratory survey of MRB river guides are presented in Appendix I.

The Great Lakes charter industry originated in the 1970's with the stocking of non-native salmonids in Lakes Superior, Michigan, Huron and Ontario and the rehabilitation of the natural reproducing walleye and yellow perch stocks in Lake Erie (Dawson, Lichtkoppler and Pistis 1989). Additionally fishery management policies designed to favor sport fishing over commercial fishing were implemented (Kuehn, Lichtkoppler and Pistis 2005). The number of active charter captains grew explosively in the 1980's, peaked in the early 1990's, declined by over 27 percent in the mid-1990's, declined another 12 percent by 2002 (Dawson, Lichtkoppler and Pistis 1989; Kuehn, Lichtkoppler and Pistis 2005) and declined another 1.4 percent by 2011. The percentage of captains planning to quit the charter business has inched up from 16 percent in 1994 to 21 percent in 2011. The percent of captains planning no major changes in their charter business also increased from a low of 22 percent in 2006 to 25 percent in 2011. Based on the responses to the 2011 survey, in the face of the current slow growth economy, the impacts of aquatic invasive species on the Great Lakes ecosystem, and the threat of additional invasions of non-native invasive species, a continued modest decline in the number of Great Lakes charter captains would not be surprising. Table 1 presents a brief history of the charter fishing industry in the Great Lakes.

Table 1: History of Charter Fishing Industry in the Great Lakes

	1970s*	1980s*	1994*	2002*	2011
Number of Active Charter Captains	599	3,304	2,205	1,932	1,904
Percent Change (+/-)	N/A	+406.5%	-27.3%	-12.4%	-1.4%
Estimated Total Revenue[1] ($Million)	N/A	N/A	$38.77	$43.57	$37.87
Percent Change (+/-)	N/A	N/A	N/A	+12.4%	-13.1%
Estimated Number of Charter Trips per Captain Annually	N/A	N/A	44.2	53.4	45.4
Percent of Captains Indicating that they Plan to Quit the Charter Business	N/A	N/A	16%	18%	21%
Percent of Captains Indicating No Changes Planned	N/A	N/A	23%	22%	25%

1. Adjusted for inflation to 2011 dollars (U.S. Department of Labor 2013).
*Note that all data is from Kuehn, Lichtkoppler and Pistis 2005, and Dawson et al. 1995.

One theory concerning the trends in the Great Lakes charter industry is that the industry appears to reflect angler participation in the Great Lake fishery in general (Kuehn, Lichtkoppler and Pistis 2005). Angler participation may be related to a number of factors that may have positive or negative impacts on the industry including the weather, changes in fish populations, fish consumption advisories, positive or negative perceptions of the Great Lakes, extent of harmful algal blooms, a poor economy, impacts of non-native invasive species, an ageing angler population, lack of recruitment of young anglers into recreational fishing, and more. For example, in 2011 the Great Lakes experienced an unusually rainy summer that some Captains say may have caused more charter cancelations than in a year with a more typical weather pattern. Additionally, in unsettled economic times the affordability of a charter trip will likely decline as households focus on their personal finances rather than recreation. Finally, fish stocks that are stressed and depressed by non-native species (sea lamprey, zebra and quagga mussels, et al.) may not be as attractive to the angling public. The timing and magnitude of the impacts from aquatic nuisance species on the charter fishing industry are difficult to quantify due to the complexities listed above.

METHODS

In coordination with the United States Army Corps of Engineers (USACE) and the GLSGN, two standard surveys were developed and approved by the USACE and the Office of Management and Budget, which included: (1) the Great Lakes Charter Captains Survey 2011 and (2) the Mississippi River Basin Fishing Guide Survey 2011. Both surveys were exempted from review by the Institutional Review Board (IRB) of the Office of Responsible Research Practices at The Ohio State University. Once all necessary approvals and exemptions were obtained, the study commenced.

Lists of Great Lakes charter captains were obtained by GLSGN colleagues from all eight Great Lakes states and were provided to Ohio Sea Grant (OHSG), with the exception of Michigan. The lists of captains were obtained from state agencies, charter associations and from publicly available listings and advertisements for charter services. A total of 1,984 Great Lakes charter captains were identified. From past experience we knew that a small percentage of these captains would no longer be in business and validation of the lists would be accomplished by seeing how many undeliverable returns we would receive. Only the captains' names and addresses were on the lists we received. This information was entered into an Access™ file to produce the mailing labels. From these lists, a stratified (by state) random sample of 900 captains was drawn and OHSG mailed out 900 surveys to all states but Michigan. Michigan Sea Grant (MISG) drew a sample of 300 Michigan-based captains and mailed these captains the survey[2].

We initially planned to have MISG mail and code the Michigan captains' surveys for several reasons, the major one being that MISG was planning to add survey items that would be specific to Michigan captains. But for various coordination, timing, and logistic reasons adding more items to the survey was not possible thus having the surveys returned to MISG became a moot point. Additionally, in the past it has taken some time to get permission to use the MI DNR's list of licensed captains and we expected that MISG could get clearance to do the mailing more quickly than OHSG. Because of the unavoidable delays in receiving the funding this was not possible. All surveys, including those mailed by MISG, were returned to OHSG for database development and analysis. The data was entered into an Excel™ database. Once the data was verified the database was imported into SPSS™ software for analysis.

We utilized a relatively large sample of 1,200 of the 1,984 identified captains because from past experience we knew some of the captains that were identified would no longer be in business and we needed a large sample to get a sufficient number of responses for analysis. We did not survey all of the captains due to cost, time and labor constraints imposed by the short deadline to produce a report. Using a modified Dillman (1978, 2000) mail survey technique OHSG and MISG initiated the survey in May 2012. The survey was planned to go out prior to the start of the 2012 charter season, but logistic issues between USACE and NOAA-Sea Grant resulted in a delay. This could have had an effect on response rate.

[2] Note that all charter fishing captain surveys were administered in the summer 2012. Despite attempts to distribute the surveys prior to the 2012 charter fishing season, due to logistics issues regarding the Economy Act agreement between USACE and NOAA-Sea Grant, the survey did not take place until after the 2012 charter fishing season began.

In order to maximize the response rate, OHSG and MISG made up to four contacts by mail. OHSG mailed out the initial contact to 900 captains on May 9, 2012 with follow up contacts to non-respondents on May 30, June 13 and a final contact on June 27, 2012. MISG mailed out surveys to their sample of 300 captains on May 16, with follow up mailings to non-respondents sent on May 30, July 6 and July 27. A severe funding issue was responsible for the one month gap between the May and July mailings by MISG. The contact letters are found in Appendix III and were essentially the same excepting for the dates for the OHSG and the MISG mailings.

The initial mailing contained the first contact letter, a copy of the survey instrument, a pre-addressed and pre-stamped return envelope and a slip of paper where the respondent could provide their name and address and ask for a copy of the results of the survey. The second and final mailings consisted of only the second and fourth reminder letters respectively. The third mailing contained the third contact letter, a copy of the survey instrument, a pre-addressed and pre-stamped return envelope and a slip of paper where the respondent could provide their name and address and ask for a copy of the results of the survey.

RESULTS

Of the 1,984 identified charter captains 80 were identified as out of business in 2011 giving us an estimated 1,904 active licensed charter captains in the Great Lakes in 2011. OHSG and MISG mailed a combined total of 1,200 Great Lakes surveys to charter captains in the Great Lakes study area. Of this total, 52 (4.3 percent) were either returned as undeliverable, did not charter in 2011, or refused to respond. Therefore, a total of 1,148 Great Lakes charter fishing captains received surveys in the summer of 2012 and constituted our sample population.

In our current study, of the responding captains who indicated a home state, 35 percent were based in Ohio, 28 percent were based in Michigan, 16 percent were from Wisconsin, 5 percent were from New York, 5 percent were from Illinois, 4 percent were from Pennsylvania, 4 percent were from Indiana, and 3 percent were from Minnesota. The timing of the MISG mailings did not appear to adversely impact the response rate of MI charter captains as MI captains had the highest response rate of any state. No state appeared to dominate the responses disproportionately when compared to the size of its charter fleet. This is demonstrated in Table 2.

Table 2: Percent of Active Captains by State

State	# of Active Captains	% of Active Captains	# of All Captains Surveyed	% of All Captains Surveyed	Percent of Captains Responding
New York	89	5%	93[a]	8%	4.8%
Pennsylvania	45	2%	44	4%	4.2%
Ohio	726	38%	401	33%	34.8%
Michigan	515	27%	300	25%	28.3%
Indiana	46	2%	45	4%	3.9%
Illinois	106	6%	85	7%	4.8%
Wisconsin	343	18%	200	17%	16.1%
Minnesota	35	2%	32	3%	3.3%
TOTAL	**1,904**	**100%**	**1,200**	**100%**	**100%**

[a] From a list of a total of 113 New York captains we surveyed 93 and found that a significant number were no longer active thus the number surveyed was larger than the number of active captains offering charter services in 2011.

Dillman (2000) identifies sampling error, coverage error, measurement error and non-response error as sources of errors that would reduce the value of a survey. Linder, Murphy and Briers (2001) explain that sampling error always exists when a random sample is drawn and cannot be eliminated unless a census is taken. Our large sample size (1,200) relative to the total charter captain population (1,904) helps to reduce sampling error. We avoid coverage error by including all known licensed legal Great Lakes charter captains in our potential survey population. We reduce measurement error by utilizing many of the same survey items from previous Great Lakes charter surveys that have provided information in the past.

Social science research has recognized that failure to address non-response error is an issue (Linder, Murphy and Briers, 2001) particularly when response rates are less than 85 percent

(Linder and Wingenbach 2002) and that comparing early and late respondents was an acceptable method of addressing non-response error (Linder and Wingenbach 2002, Linder, Murphy and Briers 2001, Miller and Smith 1983). Two other procedures for addressing non-response errors: 1) days to respond as a regression variable, or; 2) comparing respondents to non-respondents were also recommended by Linder and Wingenbach (2002). We did not collect the data necessary to utilize the days to respond method. The comparison of respondents to non-respondents method was deemed too labor and time intensive to implement in the abbreviated time available to us to generate our findings for the USACE. Comparing early and late respondents is consistent with how non-response errors have been addressed in our previous charter industry surveys and that is the technique we again used in this study.

For the Great Lakes charter survey we defined our late respondents as those returns that came in after the third contact by mail. This would allow a sufficient number of late responses for a statistical analysis according to Linder and Wingenbach (2002). We compared the responses from captains operating their own charter business who provided economic data to the responses of early respondents (n=211) and late respondents (n=93), using a one-way ANOVA. There were no significant differences ($p \leq 0.05$) for the five demographic variables tested including boat size, model year, years of captain's experience and numbers of trips chartered in 2011. There were no significant differences ($p \leq 0.05$) for the 28 economic variables tested. We then compared the responses of early respondents (n= 231) to late respondents (n=111) of all responding captains to 22 attitudinal variables. A significant difference between the respondent groups was found for just two of 22 attitudinal variables. The importance of obtaining new clients was significantly higher for early respondents than for the late respondents ($F=5.28$, $df=331$, $p \leq 0.05$). The perceived impact of aquatic nuisance species on their business for early respondents was also significantly higher than for the late respondents ($F=5.77$, $df=307$, $p \leq 0.05$). By random chance one would expect to see significant differences at the $p \leq 0.05$ level for one out of 20 variables.

One might expect that a higher response rate would yield significantly different results if we were able to compare one year's results to another. In 2010 we surveyed the Ohio Lake Erie charter industry and achieved a response rate of almost 48.9 percent (234 out of 479) (Lucente et al. 2012). Thus we may compare the results for just the 116 Ohio respondents in the 2011 survey to the results of the 234 Ohio charter captains in the 2010 survey. Of 23 demographic and economic variables that could be tested only the cost of drug testing was significantly different ($F=5.255$, $df=224$, $p \leq 0.05$) between the two surveys. Significant differences between early and late responders in 2011 were found in only two out of the 55 variables were able to test. Only one significantly different variable out of 23 tested variables comparing the 2011 and 2010 charter survey data for Ohio charter captains were found. The researchers conclude that the results reported in this paper are credible and are generally representative of the Great Lakes charter fishing industry in 2011.

Business

Business organization and boat ownership patterns are presented in Table 3. Over 89 percent of the responding captains own their boat and operate as a small business and more than 77 percent operate their firm as a sole proprietorship. The typical Great Lakes charter fishing captain in

2011 has been licensed for 12.8 (SD, ±10.5) years. About 11 percent of captains responding did not operate their own charter firm but rather were hired out as employees on a temporary or seasonal basis. Most businesses (about 85 percent) operated only one boat, which was typically 8.96 meters (29.4 feet) long, over 20.8 years old, and 72% of the boats were powered by an inboard motor.

Table 3: Charter Operation and Business Organization of Great Lakes Six-Pack (Six Passengers Or Less) Charter Boat Fishing Businesses

Business Organization	# of Respondents	% of Respondents
Charter Firms		
Owned a Boat	291	86.4%
Leaded/Rented Boat	3	0.9%
Other Arrangement (LCC)	6	1.8%
Work for Hire Captains		
Freelance hire per trip	32	9.5%
Salaried Employee	5	1.5%
Total	**337**	**100.0%**
Charter Firm Ownership		
Sole proprietorship	215	77.1%
Partnership	7	2.5%
Corporation	47	16.8%
Other (LLC)	10	3.6%
Total	**279**	**100.0%**

The average replacement cost for a charter vessel was $101,184 (SD, ±128,025), and $15,408 (SD, ±14,200) for onboard business-related equipment. About 48 percent of the respondents used a tow vehicle for towing their boat or other charter-related business. The average replacement cost of the tow vehicle was $32,056 (SD, ±15,016), and $4,475 (SD, ±3,035) for the tow trailer. The tow vehicle was used for boat towing almost 17 percent of the time and for other charter business 27 percent of the time.

Captains

Most of the 304 responding captains operating a small business were “Six-Pack” operators, licensed by the US Coast Guard to carry no more than six passengers. Notably, very few captains (11.1 percent) relied on the charter business as their primary source of income (Table 4). Only 14.2 percent of responding captains chartered in a state or water body other than where their home port was located. Of those captains only 13.5 percent of their charters were run away from their home port.

Table 4: Reasons Why People Are Great Lakes Charter Fishing Captains

Reason	# of Respondents	% of Respondents
Help people enjoy fishing	267	78.1%
Like the work	201	58.8%
Secondary source of income	157	45.9%
Other	53	15.5%
Primary income source	38	11.1%
*Respondents were asked to check all items that applied and multiple choices were allowed. *Number of respondents = 342.		

Trips and Revenues

Responding captains operating their own business averaged 25.4 full-day and 20.0 half-day paid charter trips for the year. Most of these were for salmon or trout, followed by walleye, yellow perch, smallmouth bass and other fish species (Table 5). Using the response data, the total population of 1,696 active charter firms were estimated to have made 76,981 charter trips, of which 43,044 (55.9 percent) were full-day trips and 33,937 (44.1 percent) were half-day trips (Table 6). A full day trip is defined as seven hours long from dock to dock or a limit catch of the target species.

Table 5: Average Trips, Charge, Revenues

Fish Species	Trip Length	Average Number of Trips per Business[a]	Average Charge per Trip[b] (N= Number of Respondents)	Revenues Earned per Business[c]
Trout or Salmon	Full Day	9.6	$566 (102)	$5,452
	Half Day	16.3	$448 (116)	$7,315
Walleye	Full Day	11.1	$484 (91)	$5,386
	Half Day	2.5	$365 (34)	$893
Yellow Perch	Full Day	3.2	$419 (83)	$1,332
	Half Day	0.9	$377 (18)	$331
Smallmouth Bass	Full Day	1.0	$500 (22)	$480
	Half Day	0.2	$331 (6)	$73
Other Fish Species	Full Day	0.5	$404 (7)	$190
	Half Day	0.1	$405 (2)	$49
Subtotal	**Full Day**	**25.4**		**$12,841**
	Half Day	**20.0**		**$8,661**
	Totals	**45.4**		**$21,502**

*Great Lakes six-passenger charter firm by species sought and trip length.
[a] Rounded to the nearest tenth (N=275)
[b] Rounded to the nearest dollar
[c] Revenues are estimated by multiplying the average number of trips times the average charge per trip.

Table 6: Number of Trips and Revenues in GL Charter Fishing Industry 2011

Fish Species	Trip Length	Estimated # of Trips	Average Charge per Trip[a]	Revenues Earned[b]	Percent of Total Revenues
Trout or Salmon	Full Day	16,349	$566	$9,246,916	34.0%
	Half Day	27,713	$448	$12,406,672	34.0%
Walleye	Full Day	18,876	$484	$9,134,140	25.0%
	Half Day	4,155	$365	$1,514,820	4.2%
Yellow Perch	Full Day	5,393	$424	$2,259,784	6.2%
	Half Day	1,492	$377	$562,172	1.5%
Smallmouth Bass	Full Day	1,628	$500	$814,454	2.2%
	Half Day	373	$331	$123,439	0.3%
Other Fish Species	Full Day	797	$404	$322,368	0.9%
	Half Day	204	$405	$82,426	0.2%
Subtotal	**Full Day**	**43,044**			
	Half Day	**33,937**			
	Totals	**76,981**		**$36,467,091**	**100%**

[a] Rounded to the nearest dollar
[b] The numbers of trips are extrapolations of respondent trip rates applied to the estimated population of 1,696 active Great Lakes charter firms (excluding party and head boats). Revenues are calculated from the number of trips multiplied by the average charge per trip.

August was the busiest month, with an average of 12.4 (SD, ±11.5) trips per captain. This was followed by July at 12.0 (SD, ± 9.4) and June 9.6 (SD, ±7.3). Captains averaged 7.7 (SD, ±7.2) trips in May, 6.3 (±6.4) trips in April, about 6.1 (SD, ±5.8) trips in September, 4.4 (SD, ±4.7) trips in October and just 4.2 (SD, ±3.2) trips in March.

Charter fees varied according to target species, length of the charter, and services offered. The most popular trip was the half-day trout or salmon charter; its cost averaged $448 (SD, ±$95) per boat (range $150 to $800) with an average of 4.4 (SD, ±1.2) clients. The reported total revenue for the 58 captains operating their own business firms providing their gross sales figures was $19,478 (SD, ±20,776). This is $2,024 less than the $21,502 estimated revenue found in Table 6 but well within one standard deviation from the reported mean.

Total calculated revenues for the Great Lakes charter firms is almost $36.5 million (Table 6). The estimated 1,904 active Great Lakes charter captains in 2011 brought in an estimated $34,440,560 to $37,874,960 in gross income in 2011 (1,696 firms x reported sales of $19,478 per firm or calculated sales of $21,503 per firm + 208 captains for hire x $6,759 in average gross earnings).

Costs and Returns

The 11 percent of responding non-business owning captains who ran a charter boat owned by someone else reported average gross earnings of $6,759 (SD, ±13,507). For boat owning captains operating their own business firm, the largest annual operating expenses were boat fuel, boat dockage, and equipment repair (Table 7).

Table 7: Average Annual Operating Costs

	All Firms		Firms with Boat Loan		Firms with Depreciation		Firms without Boat Loan or Depreciation	
Item	**Expense**	**N**	**Expense**	**N**	**Expense**	**N**	**Expense**	**N**
Boat Fuel	$4,183	236	$4,136	67	$4,867	50	$4,028	134
Boat Dockage	$1,757	242	$1,783	71	$1,565	49	$1,762	137
Equipment repair	$1,413	243	$1,402	72	$1,772	48	$1,230	138
Boat Maintenance and Repair	$1,231	248	$1,350	71	$1,537	49	$1,181	143
Miscellaneous	$818	225	$862	66	$1,161	47	$697	126
Advertising	$1,120	236	$1,060	69	$1,406	48	$1,070	133
Insurance	$906	250	$919	72	$978	50	$887	143
Boat storage fees	$970	237	$982	71	$984	50	$957	131
Office and Communications	$684	228	$690	69	$773	49	$639	125
Labor (hired)	$1,186	212	$1,204	67	$843	46	$1,250	113
Boat Repair not Covered by Insurance	$477	212	$415	68	$519	44	$459	113
License fees	$295	231	$297	70	$366	49	$263	127
Drug Testing/Professional Dues	$124	231	$121	67	$163	46	$112	132
Boat launch fees	$51	218	$52	69	$45	46	$50	118
Total Operating Costs[a]	**$14,819**	**216**	**$15,723**	**61**	**$16,160**	**40**	**$13,930**	**128**
Standard Deviation	±$13,468		±$13,244		±$8,892		±$14,222	

[*] Average annual operating costs for all reporting boat-owning captains, for captains reporting boat loans, for captains reporting depreciation and for captains not reporting a boat loan or depreciation. Responses includes only 6 pack charter firms that own, lease or have other boat arrangements. N= number of respondents.
[a] Estimated by taking the mean of the sum of the individual operating costs (where all individual operating costs were given) and the estimated total operating costs (where all operating costs were not given and an estimate of the total operating costs were given). If both were provided we used the sum of the individual operating costs for the estimate of the total cost.

The average cash requirement to operate the charter firm is the operating expenses plus the boat loan payments. Over 65% of the 211 reporting captains did not have a boat loan. Of the 72 responding captains that had a boat loan the annual average payment was $5,064 (±3,406). The average total cash needed to operate the charter firm is $16,547 for all firms (Table 8). This means that the typical charter firm that owned and operated a single vessel would have to generate sales of $ 16,547 just to meet the cash needs of the firm.

Table 8: Average Revenue

Income/Expenses	All Businesses	Businesses	Businesses	Businesses not

			reporting boat loan		reporting depreciation		reporting boat loan or depreciation	
	Amount	N	Amount	N	Amount	N	Amount	N
Average revenue	$19,478	258	$19,872	68	$20,958	48	$19,142	157
Standard Deviation (SD)	±$20,776		±$20,506		±$14,203		±$22,212	
Cash flow needs								
Average operating costs	$14,819	216	$15,723	61	$16,160	40	$13,930	128
Boat-loan payments	$1,728	211	$5,064	72	$1,970	45	$0	109
Cash needed [a]	$16,547		$20,787		$18,130		$13,930	
Net cash flow [b]	**$2,931**		**(-$915)**		**$2,828**		**$5,212**	

* Average revenue, cash flow needs and net cash flow to the firm for Great Lakes charter boat businesses in 2011 estimated by all businesses, businesses reporting boat loan payments, businesses reporting depreciation, and businesses not reporting boat loan payments and/or depreciation. Negative numbers are indicated in parentheses. N is the number of actual respondents. Responses include only 6 pack charter firms that own, lease, or have other boat arrangement.

[a] Sum of Average operating costs and average boat loan payments

[b] Average revenue minus the cash needed to operate the business

Using the reported revenues, the resulting net cash flow is positive for all businesses, businesses reporting depreciation and for businesses with no boat loan and no depreciation (Table 8). Only the firms reporting a boat loan had a negative cash flow. Those firms with a positive annual cash flow could pay the day-to-day bills to operate the charter business. Those with a negative cash flow would need resources outside the charter firm to meet the cash needs of the firm.

Economic costs include all the costs of operating the charter firm, plus the capital costs (Table 9). Boat loan costs are a cash requirement if a loan exists, but are not part of the economic costs. Capital costs include depreciation of the boat, and the opportunity cost of owning a boat instead of investing in stocks, bonds, or some other enterprise. In addition, owner labor and management receive revenues in excess of operating and capital costs.

Table 9: Economic Cost Components

Income/Expenses	**All Businesses**	**Businesses reporting boat loan**	**Businesses reporting depreciation**	**Businesses not reporting boat loan or depreciation**

	Amount	N	Amount	N	Amount	N	Amount	N
Average revenue	$19,478	258	$19,872	68	$20,958	48	$19,142	157
Economic Cost								
Average operating costs	$14,819	216	$15,723	61	$16,160	40	$13,930	128
Capital Costs								
Opportunity Costs [a]	$5,958	265	$6,172	64	$6,521	48	$5,769	166
Depreciation	$3,684	91	$6572	20	$6,723	50	NA	NA
Total Capital Costs	$9,642		$12,743		$13,244		$5,769	
Total economic cost [b]	**$24,461**		**$28,466**		**$29,404**		**$19,699**	
Net return to operator [c]	**(-$4,983)**		**($-8,594)**		**($-8,446)**		**($-$557)**	

* Economic cost components, total economic cost and net return to the operator for Great Lakes charter boat businesses in 2011 estimated by all businesses, businesses reporting boat loan payments, businesses reporting depreciation, and businesses not reporting boat loan payments and/or depreciation. Negative numbers are indicated in parentheses. N is the number of actual respondents. Responses include only 6 pack charter firms that own, lease or have other boat arrangement.

[a] Opportunity costs are estimated at 5% of the average estimated replacement cost of the boat and on board equipment.

[b] Total economic cost equals average operating costs plus total capital costs (opportunity cost plus depreciation)

[c] Net return is equal to the average revenue minus the total economic cost

Responding captains report average depreciation of $3,684 (±6,191). Interest costs are estimated at five percent of the value of the capital equipment. A total of 265 captains provided estimates for both the replacement cost of their primary charter boat and all of the onboard equipment. Estimated replacement cost of the boat and equipment is $119,161 (±136,504); five percent of this is $5,958 (±6,825). Therefore, capital costs are $9,642. The total economic cost of operating a typical Great Lakes charter firm is $24,461. Any revenue in excess of $24,461 is the return to owner labor and management.

On average, a charter business would have had to generate sales of over $24,461 to provide a positive return to the operating captains' time and labor, and charter firms operated at a negative net return of $4,983 for the owners' time and labor (Table 9). Charter fishing is an enterprise that may help to subsidize the costs of owning and operating a Great Lakes seaworthy boat. Table 9 shows that on average none the four groupings of charter business firms actually makes money for the firm owner. Thus they are subsidizing the firm with their own funds or in-kind labor and/or management. On average, there is no net return to the firm for the owner. However, every charter firm is a unique business enterprise and some firms will make money. As reported earlier just over 11 percent of the captains rely on their charter work for their primary income.

Plans for the Future

We asked respondents a series of items about their plans for the coming five years and the results are presented in Table 10. In 2002 and 2011, the majority of charter captains (55 percent and 57 percent respectively) stated that they plan to increase their number of trips, and approximately 19 percent in 2002 and almost 17 percent in 2011 plan to buy a new (larger) boat. While these results indicate a potential expansion of the charter industry, it is important to note that over 4 out of 10 of respondents (41 percent in 2002) and almost half (48 percent) in 2011 plan to raise prices of charter services, while roughly one-fifth (21 percent) plan to leave the charter business compared to 18 percent in 2002. Over all, the 2011 results are not much different from the responses we received in our 2002 Great Lakes charter industry survey (see Table 10).

The captains in 2011 saying that they plan to quit the business have been in business 7.6 years longer than the 2011 captains who did not indicate that they plan to quit in the next five years. The home states of those captains planning to quit chartering in the 2011 survey are roughly represented in the same proportion as the percentage of overall respondents with Ohio, Michigan and Wisconsin ranking 1, 2, and 3 respectively in both the total number of respondents and in the number of respondents planning to quit the charter business.

Table 10: 5-Year Plans

Activity	Percent of Respondents Selecting a Change Planned for their Charter Activities in the Next 5 Years	
	2002	2011
Number of Respondents	868	342
Increase number of annual trips	58.5%	56.7%
Increase prices of charter services	41.0%	48.2%
No major changes	21.8%	24.9%
Quit the charter business	17.7%	21.1%
Buy/operate a newer boat	19.2%	16.7%
Buy/operate a bigger boat	14.1%	14.0%
Branch out into other fishing related businesses	9.6%	12.3%
Decrease number of annual trips	6.5%	11.1%
Hire additional first mate(s)	7.7%	11.1%
Expand into multi-activity and/or non-fishing charters	8.5%	10.8%
Hire additional charter captain(s)	5.8%	9.9%
Buy/operate an additional boat	4.8%	8.5%
Other	7.8%	7.0%
Buy your own charter boat	2.2%	3.2%
Decrease prices	0.7%	0.6%
*Five-year plans of Great Lakes charter captains (number of respondents =342). Respondents were asked to select all the plans that applied to them. N= 342.		

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APPENDIX I: MISSISSIPPI RIVER BASIN (MRB) GUIDES SURVEY

We believe the MRB fishing guide business to be a small cottage type industry that is not well organized or on a scale comparable to that of the Great Lakes charter industry. The GLSGN had a difficult time locating MRB fishing guides to survey. OHSG could not identify any Ohio based MRB fishing guides. All Ohio professional fishing guides must have a state license. Phone calls to Ohio Department of Natural Resources game protectors located in three counties bordering on the Ohio River resulted in no identifiable river fishing guides. When asked, one Ohio bait shop owner located near the Ohio River could not identify any Ohio River fishing guides.

Professional fishing guides in Illinois that use a boat must obtain a Passenger Boat License. IL-IN Sea Grant submitted a Freedom of Information Act (FOIA) request to obtain a listing of the passenger boat licensees from the Illinois Department of Natural Resources, in the hopes that at least a partial list of Mississippi River guides could be generated from this information. The FOIA request resulted in IL-IN Sea Grant receiving the Illinois passenger boat list. However, not one captain on the list identified themself as a Mississippi River charter captain. One known Illinois-based Mississippi River guide was contacted directly via email by IL-IN Sea Grant for contact information, but no mailing information was provided.

A list of 63 MRB fishing guides was developed by WISG colleagues and 50 guides with identifiable mailing addresses were mailed the (MRB) fishing guide survey. Three of the surveys were returned as undeliverable. Three surveys were returned with the respondents indicating that they did not offer fishing guide services in 2011. Thus we have a sample size of 44. To date only 12 MRB surveys have been returned with useful data providing a response rate of about 27%.

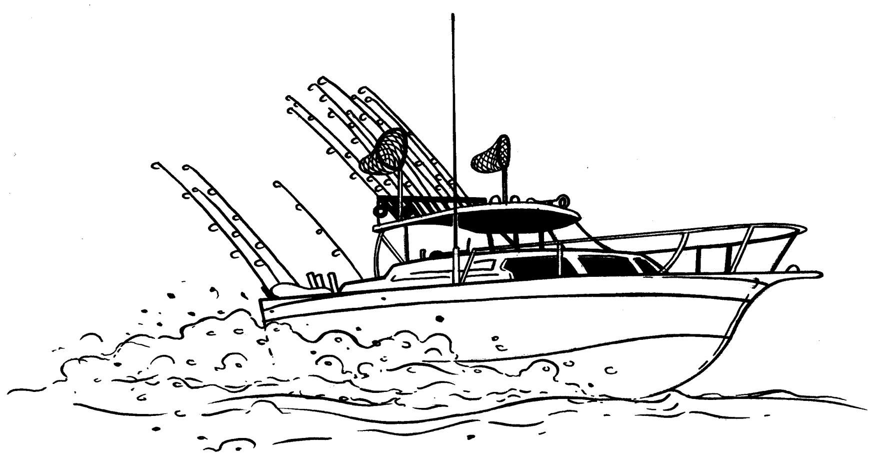
Because of the small sample size and low number of returns a statistically valid summary of the responses is not possible and we are thus unable to provide reliable information on the MRB river guide businesses. That said, none of twelve MRB Survey respondents use the CAWS and nine of eleven respondents support the separation of the Mississippi River / Great Lakes basins. Eight of twelve MRB survey respondents selected zero ($0) as the amount they would be willing to pay annually for basin separation.

APPENDIX II: GREAT LAKES CHARTER INDUSTRY SURVEY INSTRUMENT

Great Lakes Sea Grant Network
in cooperation with the
U.S. Army Corps of Engineers

Great Lakes Charter

Captains Survey2011



Please return your completed survey to:

Great Lakes Charter Captains Survey

Ohio State University

Ohio Sea Grant

99 East Erie Street

Painesville, Ohio 44077

U.S Army Corps of Engineers Agency Disclosure Notice
OMB Number 0710-0001

The public report burden for this data collection effort is estimated at 20 minutes per survey, including the time for reviewing instructions, searching existing data sources, gathering and maintaining data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this data collection, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Executive Services Directorate, Information Management Division, 1155 Defense Pentagon, Washington DC, 20301-1155 and the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503, Attn: Desk Officer for US Army Corps of Engineers. Respondents should be aware that notwithstanding any other provision of law, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

PLEASE DO NOT RETURN YOUR SURVEY RESPONSE TO THE ABOVE ADDRESS.

Statement of Purpose: The United States Army Corps of Engineers (USACE), in consultation with other agencies, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). USACE will evaluate a range of options and technologies designed to prevent the spread of aquatic nuisance species (ANS) between the Great Lakes (GL) and Upper Mississippi River (UMR) basins. GLMRIS will analyze the potential effects of each alternative plan on the current uses of the aquatic pathways. The goal of the study is to identify potential solutions to reduce the risk of the transfer of invasive species. The charter fishing industry has changed over the years. The Great Lakes Sea Grant Network is coordinating with USACE for a Great Lakes wide charter captain survey to better assist decision-makers in this GLMRIS evaluation.

Participation in this survey is completely voluntary and all information you provide will be kept strictly confidential. **Your responses will remain strictly confidential and will in no way be associated with you or your business.** Your responses to the following questions will be aggregated with other responses to help us determine the impacts from alternatives that address the spread of aquatic nuisance species Responses and comments provided will be shared with the project delivery team. The information collected will be managed in accordance with AR 25-400-2 records retention requirements.

If you have any questions about the Great Lakes Mississippi River Interbasin Study, please contact the Project Manager, David Wethington at (312) 846-5522. For questions about the Charter Captains survey, please contact the Project Lead Economist, Dena Abou-el-Seoud, at (312) 846-5584 or Frank Lichtkoppler, Extension Specialist for the Ohio Sea Grant College Program at (440) 350-2267

Great Lakes Charter Captains Survey 2011

Please answer all questions completely.

(1) What type of charter boat did you operate in 2011? *(Please circle one response.)*

A. Six passengers or less (six pack)

B. More than six passengers (party boat)

(2) How did you work or operate in 2011? *(Please circle your response.)*

A. I owned my own boat (or boats) and operated my own charter business. **(GO TO Question 4.)**
B. I leased or rented a boat and operated my own charter business or guide service.
C. I worked full time during fishing season as a salaried employee.
D. I worked for one or more boat owners receiving a fee for each trip run or day worked.
E. Other, please explain

____

(3) If you were a non-boat owning, work for hire charter captain, what were your wages or salary (total fees paid to you) for your Great Lakes charter captain services in 2011? *(Please fill in amount.)*

$______________

(4) My homeport is located: *(Please circle best choice).*

(4a) on (or nearest to) the following water body:	(4b) in the state of: *(circle choice).*
A. Lake Superior	A. Minnesota
B. Lake Michigan	B. Wisconsin
C. Lake Huron	C. Michigan
D. Lake St. Clair	D. Illinois
E. Lake Erie	E. Indiana
F. Lake Ontario	F. Missouri
G. Mississippi River	G. Iowa
H. Ohio River	H. Ohio
I. . Other ________________	I. Kentucky
	J. Pennsylvania
	K. New York
	L. West Virginia
	M. Other ________________

(5) In 2011, did you charter in any states or on any water body other than where your homeport is located? *(Please circle your response.)*

A. YES
B. NO **If NO, GO TO Question 6**

5a. If yes, what percentage of your charters were conducted in other states and /or on other water bodies? *(Please fill in Water body, state and percent.)*

Other State Water body: ____________

Other State__________________

Percent: of charters__________%

Other State Water body: ____________

Other State__________________

Percent: of charters __________%

(6) How many charter boats do you own, rent, or operate as part of your business? *(Please fill in the number of boat(s).)*

_______BOAT(S)

(7) Please write in the length and model year of your primary charter boat.

A.________ FEET

B. ________ MODEL YEAR

C. ________ DRAFT (including propeller)

(8) How is your primary charter vessel powered? *(Please circle your response.)*

A. INBOARD

B. OUTBOARD

C. INBOARD / OUTDRIVE

D. OTHER, PLEASE LIST____________________

<u>If you were a non-boat owning, work for hire charter captain, please skip to Question 14.</u>

(9) Indicate the type of charter business for your primary charter vessel. (*Please circle your response.)*

A. SOLE PROPRIETOR

B. PARTNERSHIP

C. CORPORATION

D. OTHER, PLEASE LIST________________________

(10) What were your gross sales (total charter fees paid to you) for your primary charter vessel in 2011? *(Please fill in total fees collected in 2011.)*

$__________

(11) Please itemize below your approximate annual charter business costs for 2011. Do your best to estimate these costs. If you have only a general idea of the total costs, fill in Question 11a.

A. Boat fuel (include oil cost if outboard) $__________

B. Boat dockage (slip fees) $__________

C. Boat storage fees (winterizing, haul out, boat cleaning, etc.) $__________

D. Boat launch fees $__________

E. Boat maintenance, repair for normal servicing, i.e., oil changes, tune-ups, registrations, etc. $__________

F. Equipment repair and replacement for fixing or replacing lost, worn or old equipment (i.e. tackle, electronics, etc.) $__________

G. Boat repair for accidental damages or breakdowns not covered by insurance $__________

H. Annual charter boat insurance premiums $__________

I. Annual boat loan payments $__________

J. Depreciation $__________
(Number of years depreciated: _____ years)

K. Publicity/advertising (for ads, business cards, fliers, sport shows, signs etc.) $__________

L. Office and business expenses (communications, secretary, phone, fax, tax advisor, postage, accounting, stationary, computers, etc.) $__________

M. Labor costs for payment of captain(s), mates, etc. (include fully burdened costs which include taxes, insurance, and other benefits) $__________

N. License fees (resident, non-resident, FCC radio license, six-pack license, Coast Guard fees, etc.) $__________

O. Drug testing/Professional Assoc. dues $__________

P. Miscellaneous (for all other incidental expenses, e.g., ice, photos, food and beverages, bait/tackle for customers, etc.) $__________

(11a) If you do not have information on the above costs, please estimate your total charter business costs for 2011. $__________

(12) In dollars, what is your best estimate of the current replacement cost (that is the cost of comparable new equipment) of your:

A. Primary charter vessel $__________

B. All business-related onboard equipment $__________

C. The tow trailer (if any) $__________

D. The tow vehicle (if any) $__________

(13) What proportion of time (given in percent) is your tow vehicle actually used for:

A. Boat towing __________%

B. Other charter business __________%

C. Non-business / personal use __________%

These percentages should equal 100%

(14) Please indicate the species or group of species you target, the number of trips made in 2011, and the rate structure by filling in the appropriate blanks for your charter business in the table below:

FULL DAY TRIP - 7 HOURS OR LIMIT

	Fish species	**Fish species**	**Fish species**	**Fish species**	**Fish species**
	Trout or Salmon	Walleye	Yellow Perch	Small mouth Bass	Fill in Species
Please fill in number of trips made for each species in 2011					
Please fill in per person charge **OR:**	**$**	**$**	**$**	**$**	**$**
Please fill in boat trip charge.	**$**	**$**	**$**	**$**	**$**
Average Number of clients per trip.					

HALF DAY TRIP - LESS THAN 7 HOURS

	Fish species	**Fish species**	**Fish species**	**Fish species**	**Fish species**
	Trout or Salmon	Walleye	Yellow Perch	Small mouth Bass	Fill in Species
Please fill in number of trips made for each species in 2011					
Please fill in per person charge **OR:**	**$**	**$**	**$**	**$**	**$**
Please fill in boat trip charge.	**$**	**$**	**$**	**$**	**$**
Average Number of clients per trip.					

(15) In 2011, please indicate the charter boat trips by month for your primary vessel? *(Total charter boat trips should equal the number you indicated in question 14.)*

March	**April**	**May**	**June**	**July**	**August**	**September**	**October**

(16) What year did you first begin offering charter-fishing services in the Great Lakes, Upper Mississippi, or Ohio River basins under Coast Guard and/or DNR/DEC licensing? *(Please fill in the year.)*

YEAR __________

(17) What problems concern you the most about the charter fishing industry? *Please rate each of the issues below with 1 being the least important and 5 being most important to you.*

	Least Important				Most Important
A. Illegal fishing practices	1	2	3	4	5
B. Habitat loss	1	2	3	4	5
C. The economy	1	2	3	4	5
D. Interstate licensing	1	2	3	4	5
E. Fish consumption advisories	1	2	3	4	5
F. Overcrowding of the fishery	1	2	3	4	5
G. Low sport fish populations	1	2	3	4	5
H. Sport fish catch limits	1	2	3	4	5
I. Aquatic nuisance species (ANS)	1	2	3	4	5
J. Fisheries management	1	2	3	4	5
K. Decrease in the forage					

	fish population	1	2	3	4	5
L.	Harmful algal blooms	1	2	3	4	5
M.	Poor weather	1	2	3	4	5
N.	Cost of fuel	1	2	3	4	5
O.	Obtaining new clients	1	2	3	4	5
P.	Other Please list					
	________________	1	2	3	4	5

The Corps of Engineers is considering basin separation as a means of combating the transfer of aquatic nuisance species (ANS) between the Great Lakes and the river system connections. Basin separation would reduce the risk of ANS transfer but would not eliminate all transfer pathways. Basin separation could include closure of one or more of the locks in the Chicago Area Waterway System (CAWS). The following questions concern your opinion of these basin separation alternatives.

(18) Do you use the Chicago Area Locks in a typical year? (Please circle response.)

A. YES **B. NO**

If a physical barrier were erected on the Chicago Area Waterway System, there would be **both positive and negative effects**.

A) During high flow or flood conditions, storm water and/or treated sewage which currently flow toward the Mississippi River **could** remain lakeward of the barrier, potentially causing odors and deterioration of Lake Michigan water quality if water treatment is not improved.

B) Traffic between Lake Michigan and the Mississippi and Ohio River basins **could** be reduced or eliminated.

C) Risk of transfer of ANS between Lake Michigan and the Mississippi and Ohio River basins **could** be reduced.

(19) Please choose a response that best describes how you feel about a basin separation measure that would reduce the risk of transfer of Aquatic Nuisance Species (ANS) but have the possibility of adverse impacts. *(Please check your response.)*

_____ I support a basin separation. **_____ I am opposed to basin separation.**

[19a] If it was necessary to impose a fee to support your response, what is the most you would be willing to pay **annually** to ensure that your choice is implemented and maintained? (**Please *select one value from the list below that represents the maximum amount you would be willing and able to pay annually to keep the waterways open or closed***.)

A. _____$2,500 to $4,999
B. _____$1,000 to $2,499
C. _____$750 to $999
D. _____$500 to $749
E. _____$250 to $499
F. _____$100 to $249
G. _____$50 to $99
H. _____$1 to $49
I. _____$0

[19b] Please choose the response that best describes your reason for the previous answer (*Please select **only one** response*):

A. _____ That's what it is worth to me.

B. _____ It's worth more to me, but it's all I can afford to pay
C. _____I didn't want to place a dollar value.
D. _____ I object to paying.
E. _____ Not enough information is provided.
F. _____ Other reason:
____

(20) Please estimate the percentage of your charter patrons that come from 50 miles or further from your homeport? _________%

(21) Why are you a professional charter fishing captain? *(Circle all that apply.)*

A. Primary source of income
B. Secondary source of income
C. Like the work
D. Opportunity to help people enjoy fishing
E. Other, please list reason:____

(22) Do you think ANS will impact your business within the next five years?

YES _______ GO TO Question 22a

NO _______ GO TO Question 23

(22a) What percentage decline or increase in revenue do you think the ANS may have on your business in the next five years?

Fill in **the decline in revenue** if any

Percentage **DECLINE** ___________%

Fill in **the increase in revenue** if any

Percentage **INCREASE**___________%

(23) Do you have plans to change your charter boat business operations over the next 5 years? ***Please check all that apply to your charter activities.***

A. Buy your own charter boat ________

B. Buy/operate a bigger boat ________

C. Buy/operate a newer boat ________

D. Buy/operate an additional boat ________

E. Hire additional charter captain(s) ________

F. Hire additional first mate(s) ________

G. Increase the number of charter trips made per year ________

H. Decrease the number of charter trips made per year ________

I. Branch out into other fishing related businesses ________

J. Quit the charter business ________

K. Expand into multi activity and/or non-fishing charters ________

L. No major changes planned in my charter business ________

M. Increase prices of charter services ________

N. Decrease prices of charter services ________

O. Other, please list ________________ ________

Aquatic nuisance species (ANS) are nonindigenous (not native to an area) species that threaten the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters.

Below is a list of species of concern that are in the Mississippi River Basin and could impact the Great Lakes.

FISH

skipjack herring (Alosa chrysochloris)
northern snakehead (Channa argus)
silver carp (Hypophthalmichthys molitrix) an Asian carp
bighead carp (Hypophthalmichthys nobilis) an Asian carp
black carp (Mylopharyngodon piceus) an Asian carrp
inland silverside (Menidia beryllina)

CRUSTACEAN
scud (Apocorophium lacustre)

PLANTS
dotted duckweed (Landoltia [Spirodela] punctate)
marsh dewflower (Murdannia keisak)
Cuban bulrush (Oxycaryum cubense)

(24) Please provide additional comments on the impact of Aquatic Nuisance Species on your charter fishing business in the space below……

____

____

____

Thank you for completing the survey.

Sea Grant Great Lakes Network

THE OHIO STATE UNIVERSITY EXTENSION

All answers will be kept strictly confidential and will not be associated with you or your business individually.

Please return the completed survey in the enclosed envelope to:

Ohio Sea Grant 99 East Erie Street Painesville, Ohio 44077

APPENDIX III: CONTACT LETTERS

First Contact Letter

May 9, 2012

Dear Great Lakes Charter Captain:

At the request of the US Army Corps of Engineers the Great Lakes Sea Grant Network led by the Ohio Sea Grant Program is coordinating this Great Lakes wide Charter Captains survey in order to better assist the Great Lakes charter fishing industry and to provide information for the Great Lakes and Mississippi River Interbasin Study (GLMRIS). The purpose of GLMRIS is to identify potential solutions to reduce the risk of the transfer of invasive species such as the Asian carps. This research will document the status of the Great Lakes charter fishing industry in 2011. This is the fifth Great Lakes wide charter industry survey since the mid 1970's. Our last Great Lakes wide survey of the charter industry was in 2002.

You have been randomly selected to participate in the 2011 Great Lakes Charter Captains Survey. Your participation in this research will help to provide an accurate and credible assessment of the Great Lakes Charter Industry's development. In order for the results to truly represent your industry, it is important that you complete and return the enclosed questionnaire. We estimate that it will take you 20 minutes to complete this survey. The survey is strictly voluntary and there are no consequences for not participating.

Your responses will remain strictly confidential and will in no way be associated with you or your business. All responses will be grouped together and reported as a group. There are no identification marks on the questionnaire. The return envelope has an identification number on it for mailing purposes only. This is so that we may check your name off the mailing list when your questionnaire is returned.

The results of this research will be made available to the US Army Corps of Engineers, Great Lakes Charter Associations, charter captains, key decision makers, researchers and interested citizens. You may receive a summary of results by checking "Copy of Results Requested" on the enclosed slip of paper and printing your name and address on the paper. Please do not put this information on the questionnaire.

I would be most happy to answer any questions you may have concerning this survey. Please call or e-mail me at 440/ 350-2267 or lichtkoppler.1@osu.edu respectively.

For questions about your rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact Ms. Sandra Meadows in the Office of Responsible Research Practices at 1-800-678-6251.

Thank you for your assistance.

Sincerely,

Frank Lichtkoppler	Joe Lucente	Tory Gabriel
Professor OSU Extension and	Asst. Professor	Educator
Extension Specialist, Sea Grant	OSU Extension, Sea Grant	OSU Extension, Sea Grant

Second Contact Letter (To Non-Respondents If Needed)

May 30, 2012

Dear Great Lakes Charter Captain:

Recently, a questionnaire seeking your input concerning the Great Lakes charter fishing industry was mailed to you. Your name was randomly drawn from a 2011 list of licensed Great Lakes charter captains.

If you have already completed and returned the questionnaire please accept our sincere thanks. If not, please complete it today. We estimate that it will take you 20 minutes to complete the survey. The survey is strictly voluntary and there are no consequences for not participating.

As only a small, but representative, number of Great Lakes charter captains received the survey it is extremely important for you to complete the questionnaire. All responses will be kept strictly and completely confidential and will not be associated with you or your business individually. All data is grouped together and reported as a group.

Your assistance in this research is needed to accurately document the Great Lakes charter captain's contribution to the Great Lakes fishing industry. This information will be used to help inform the US Army's Great Lakes and Mississippi River Interbasin study whose purpose is to identify potential solutions to reduce the risk of the transfer of invasive species such as the Asian carps.

If you have any questions or have misplaced your questionnaire please call me at 440/ 350-2267 or e-mail me at Lichtkoppler.1@osu.edu.

For questions about your rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact Ms. Sandra Meadows in The Ohio State University Office of Responsible Research Practices at 1-800-678-6251.

Sincerely,

Frank Lichtkoppler	Joe Lucente	Tory Gabriel
Professor OSU Extension and	Asst. Professor	Educator
Extension Specialist, Sea Grant	OSU Extension, Sea Grant	OSU Extension, Sea Grant

Third Contact Letter (To Non-Respondents If Needed)

June 13, 2012

Dear Great Lakes Charter Captain:

About a month ago, we wrote to you seeking responses to our 2011 Great Lakes charter captain's survey. As of today we have not received your completed questionnaire.

In order for the results to be accurate and representative of the industry it is essential that each captain in the sample return their completed questionnaire. Only a percentage of captains have the opportunity to respond. We estimate that it will take you 20 minutes to complete this survey. The survey is strictly voluntary and there are no consequences for not participating.

In the event that your questionnaire has been misplaced, a replacement is enclosed. Please fill it out and return it today.

Your assistance in this research is needed to accurately document the Great Lakes charter captain's contribution to the Great Lakes fishing industry. This information will be used to help inform the US Army's Great Lakes and Mississippi River Interbasin Study (GLMRIS) whose purpose is to identify potential solutions to reduce the risk of the transfer of invasive species such as the Asian carps.

Your responses will be completely confidential. All responses will be grouped and only reported as a group.

Your cooperation is greatly appreciated. If you have already sent in your completed questionnaire please disregard this notice.

For questions about your rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact Ms. Sandra Meadows in the Office of Responsible Research Practices at 1-800-678-6251.

Sincerely,

Frank Lichtkoppler	Joe Lucente	Tory Gabriel
Professor OSU Extension and	Asst. Professor	Educator
Extension Specialist, Sea Grant	OSU Extension, Sea Grant	OSU Extension, Sea Grant

Fourth and Final Contact Letter (To Non-Respondents If Needed)

June 27, 2012

Dear Great Lakes Charter Captain:

This is our last effort to encourage you to be a part of the 2011 Great Lakes Charter Captains Survey. Your completed questionnaire will help us to present an accurate and complete picture of the Great Lakes charter industry.

Please excuse us if you have already sent in your completed survey. If you need a copy of the survey please e-mail me at Lichtkoppler.1@osu.edu or me at 440 / 350-2267. **The survey is strictly voluntary and there are no consequences for not participating.**

At the request of the US Army Corps of Engineers the Great Lakes Sea Grant Network led by the Ohio Sea Grant Program is coordinating this Great Lakes wide Charter Captains survey. This work will inform the US Army Corps of Engineers Great Lakes and Mississippi River Interbasin Study (GLMRIS). The purpose of GLMRIS is to identify potential solutions to reduce the risk of the transfer of invasive species such as the Asian carps. It is important that the Great Lakes charter industry have a voice in the GLMRIS.

All responses are completely confidential and will be reported only as a group. For a copy of the results for your state please print your name and address on a separate sheet of paper. Please do not put your name on the questionnaire.

We estimate that it will take you 20 minutes to complete this survey. For questions about your rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact Ms. Sandra Meadows in the Office of Responsible Research Practices at 1-800-678-6251.
Sincerely,

Frank Lichtkoppler	Joe Lucente	Tory Gabriel
Professor OSU Extension and	Asst. Professor	Educator
Extension Specialist, Sea Grant	OSU Extension, Sea Grant	OSU Extension, Sea Grant

ATTACHMENT 4

SUBSISTENCE FISHING

Treaty Rights and Subsistence Fishing in the U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins

August 2013

U.S. Army Corps of Engineers

Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

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TREATY RIGHTS AND SUBSISTENCE FISHING IN THE U.S. WATERS OF THE GREAT LAKES, UPPER MISSISSIPPI RIVER, AND OHIO RIVER BASINS

Prepared by

Angela Kappen and Bruce Verhaaren

Environmental Science Division, and

Timothy Allison

Decision and Information Sciences Division

Argonne National Laboratory

for

The GLMRIS Fisheries and Economics Team

U.S. Army Corps of Engineers

Chicago District

June 2012

Prepared by Angela Kappen and Bruce Verhaaren, Environmental Science Division, and Timothy Allison, Division and Information Sciences Division, Argonne National Laboratory, Argonne, Ill. Work supported under Military Interdepartmental Purchase Request W81G6602391126 from the U.S Department of Defense, Department of the Army, Corps of Engineers Chicago district, through U.S. Department of Energy contract DE-AC02-06CH11357.

About Argonne National Laboratory

Argonne is a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC, under contract DE-AC02-06CH11357. The laboratory's main facility is outside Chicago at 9700 South Cass Avenue, Argonne, Illinois 60439. For information about Argonne, see www.anl.gov.

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ACKNOWLEDGEMENTS

We are grateful that throughout our research, we were afforded the chance to work with knowledgeable professionals. We would like to thank all the representatives of the Native American tribes who took the time to sit with us and talk about their valuable resources:

- Vice-Chairman Marvin DeFoe, Subsistence Fisherman Charles Newago, Treaty Natural Resources Administrator Chad Abel, Fisheries Specialist Bryan Bainbridge, and Tribal Historic Preservation Officer Larry Balber of the Red Cliff Band of Lake Superior Chippewa Indians of Wisconsin;

- Water Resource Specialist Naomi Tillison, Fisheries Specialist Tim Wilson, Fishery Technician Ed Leoso, Subsistence Fisherman Michael Plucinski, and Tribal Historic Preservation Officer Edith Leoso of the Bad River Band of Lake Superior Chippewa Tribe;

- Director of Biology and Environment Seth Moore, Fish and Wildlife Biologist E.J. Isaac, and Chairman Norman Deschampe of the Grand Portage Band of Lake Superior Chippewa Indians;

- Natural Resources Director Thomas Howes and Tribal Historic Preservation Officer Leroy DeFoe of the Fond du Lac Band of Lake Superior Chippewa Indians; and

- Cecil Pavlat, Tribal Historic Preservation Officer for the Sault Ste. Marie Tribe of Chippewa Indians of Michigan.

We would like to thank the intertribal organizations for helping us to understand their roles in administering the different treaties and allowing us to interview them. We thank the Director of the Administration for Native Americans Program, H. James St. Arnold; Inland Fisheries Specialist, Joe D. Rose, Jr.; and Great Lakes Fisheries Specialist, Bill Mattes, of the Great Lakes Fish and Wildlife Commission. We also thank Executive Director, Sonny Myers, and Director of the Resource Management Division, Andy Edwards, at the 1854 Treaty Authority.

In addition, we would also like to thank the government agencies who were willing to share their information with us and guide us to the right places to gather our information. Special thanks go to the Michigan Department of Natural Resources, Fisheries Division, and to David Caroffino and Dennis Knapp at the Wildlife Division. We thank Fisheries Biologist, Scott Hanson, and Lake Superior Fisheries Team Supervisor, Peter Stevens, at the Wisconsin Department of Natural Resources as well.

Finally, we would like to thank Elizabeth Hocking, of Argonne National Laboratory, for her research on treaties and other legal issues and Hal Greenwood, also of Argonne, for creating the maps included in this report.

NOTATION

ANS	aquatic nuisance species
BMIC	Bay Mills Indian Community
CORA	Chippewa Ottawa Resource Authority
FWOP	future without-project
FWP	future with-project
GIS	geographic information system
GLIFWC	Great Lakes Indian Fish and Wildlife Commission
GLMRIS	Great Lakes Mississippi River Interbasin Study
KBIC	Keweenaw Bay Indian Community
LRBOI	Little River Band of Ottawa Indians
NYSDEC	New York State Department of Environmental Conservation
SNI	Seneca Nation of Indians
UMR	Upper Mississippi River
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

GLMRIS BACKGROUND INFORMATION:

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River basins by aquatic pathways

An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (FY13). As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies,* Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

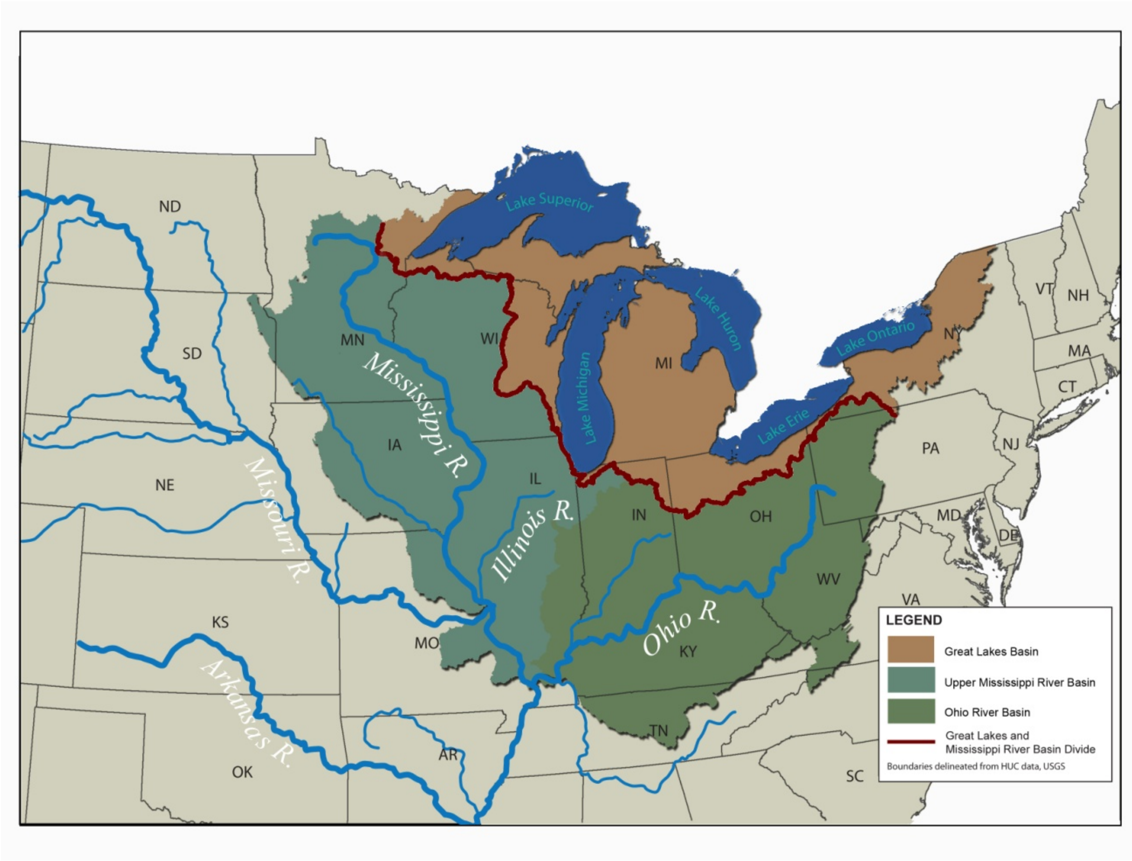
Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

GLMRIS STUDY AREA

The GLMRIS study area includes portions of the Great Lakes, Mississippi River, and Ohio River Basins that fall within the United States.

Figure 1: GLMRIS Study Area Map



Potential aquatic pathways between the Great Lakes, Mississippi River, and Ohio River Basins exist along the basins' shared boundary (illustrated in *Figure 1: GLMRIS Study Area Map*). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi and Ohio River Basins (green shaded areas) and the Great Lakes Basin (brown shaded area).

NAVIGATION AND ECONOMICS PRODUCT DELIVERY TEAM:

In support of the Great Lakes and Mississippi River Interbasin Study, the Navigation and Economics Product Delivery Team (PDT) was formed. The PDT was tasked with assessing the current value of *economic* activities within the GLRMIS detailed study area that *could* change with the implementation (FWP condition) or lack of implementation (FWOP condition) of a GLMRIS project. The PDT is comprised of several sub-teams, each of which focuses on a specific economic activity within the GLRMIS study area. These categories include:

Navigation Related Economic Categories

- Commercial Cargo
- Non-Cargo Related Navigation

Other Related Economic Categories

- Flood Risk Management
- Hydropower
- Commercial and Recreational Fishery[1]
- Water Quality
- Water Supply
- Regional Economics

Fisheries Economics Team

The Fisheries Economics Team (Team) was formed in order to assess the current *economic* value of commercial, recreational, charter, and subsistence fishing activities, as well as pro-fishing tournaments within the Great Lakes Basin, Upper Mississippi River and Ohio River Basins. The results of these analyses serve to demonstrate the various economic activities could be impacted in the future.

Subsistence Fishing Focus

This document highlights the current subsistence fishing activities (and associated cultural significance) that take place within the Great Lakes, Upper Mississippi River and Ohio River Basins.

Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since native and commercial fish species have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality

[1] The commercial and recreational fishing sub-team also assessed charter, subsistence fishing, as well as pro-fishing tournaments within the Great Lakes, Upper Mississippi River, and Ohio River Basins.

or quantity of available fisheries in the future without-project (FWOP) condition. Consequently, this baseline economic assessment demonstrates subsistence fishing activities that *could* be affected if no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins (i.e., the FWOP condition).

Further, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future fishing harvests in the case where Federal action is taken to prevent the transfer of ANS between the basins – the future with-project (FWP) condition. Since these management plans were not available, this assessment of subsistence fishing activities serves as a baseline of what harvests and associated values within the Great Lakes, Upper Mississippi River, and Ohio River Basins *could* be affected in the FWP condition.

SUMMARY

The U.S. Army Corps of Engineers (USACE), in consultation with other state and federal agencies and Native American tribes, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS) pursuant to the Section 3061(d) of the Water Resources Development Act of 2007. GLMRIS will explore options and technologies, collectively known as aquatic nuisance species (ANS) controls that could be applied to prevent ANS transfer between the Great Lakes, Mississippi River, and Ohio River Basins through aquatic pathways. As defined in the *Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990,* 16 U.S.C. § 4702(1), ANS are nonindigenous species that threaten the diversity or abundance of native species; or the ecological stability of infested waters; or commercial, agricultural, aquacultural, or recreational activities that depend on such waters. In support of GLMRIS, the USACE GLMRIS Fisheries Economics Team is conducting baseline studies of fisheries in the Great Lakes, Mississippi River, and Ohio River Basins. This study focuses on a unique sector of the fisheries — the subsistence fishery undertaken by Native American tribes under treaty rights.

Currently, 37 federally recognized tribes reside within the U.S. portion of the Great Lakes Basin, Upper Mississippi River Basin, and Ohio River Basin. These tribes, most of which are located next to or near the Great Lakes, are descendants of a larger indigenous population that was reduced and displaced by the arrival of Euro-American populations from the east. In the face of continued immigration, many tribes in the study area were forced to move west. Others sought to remain in their native lands and, through a series of treaties, ceded most of their traditional lands, retaining only small reserves.

Fishing, hunting, and gathering were important elements of their traditional lifeways, providing most or all of their subsistence. In some, but not all treaties, tribes reserved the right to hunt, fish, and gather on the lands they ceded, since they perceived that this right was essential to their survival and their ways of life. In spite of military, legal, and health challenges, 16 federally recognized tribes retain hunting, fishing, and gathering rights under the treaties. All of these tribes continue subsistence harvesting in the Great Lakes, Upper Mississippi River, and Ohio River Basins to greater or lesser extents. Among the other federally recognized tribes in the study area, those with reservations that provide access to major waterways and clean water still practice subsistence fishing. Many of the tribes that do not have access to rivers and streams on their reservation fish under the applicable state regulations on public land or are buying lakes for subsistence fishing purposes. In addition, the tribes that live close to contaminated waters have programs in place to help clean these waters in order to provide their members fishing opportunities. The introduction of ANS is another component that could threaten their traditional ways of life. This study assesses the economic and cultural importance of subsistence harvesting for tribal communities in the Great Lakes, Upper Mississippi River, and Ohio River Basins.

Four separate treaties reserve subsistence hunting, gathering, and fishing rights for tribes in ceded territories in Michigan, Wisconsin, and Minnesota. Both the Ojibwe (Chippewa) and Ottawa bands retain these rights under the treaties, and both are also engaged in these subsistence activities. Although these communities and harvests associated with these activities are small, the activities do play a large role in the tribes' cultural identities. Typically, only a small number of

tribal members are fully engaged in subsistence harvesting, but their harvest is shared with many throughout the community. They share their harvest with family, friends, and those in the community unable to fish. Typically, some of the people in the tribes are unable to purchase fish and would go without fish if they were not able to share in the subsistence harvest. Thus, subsistence harvesting is a core value for these bands, and the right to fish and hunt for subsistence is cherished by all, even those who are not presently engaged in the practice. It is part of the tribes' cultural identity and an indication of their status as sovereign entities.

Because of the importance of subsistence fishing, the tribes are concerned about the prospect of ANS damaging their fish harvest. The Algonquian tribes traditionally have seen themselves as having been placed along the Great Lakes and the Mississippi River by their Creator and given the responsibility of stewardship over their environment. The Iroquoian and Sioux tribes have also used the resources within the study area because they believe that those are the resources they have been given by their Creator to sustain themselves.

The valuation of subsistence harvests used a production cost model, which assumes that the value of subsistence fish harvests is equal to the cost of equipment, travel, and labor expended on subsistence activities. The annual value of subsistence activities to an individual household was estimated to be between approximately $15,000 and $16,500. Limitations associated with the production cost model meant that the amount of subsistence value that can be ascribed to social and cultural values, as distinct from food production, could not be determined.

INTRODUCTION

The U.S. Army Corps of Engineers (USACE), in consultation with other state and federal agencies and Native American tribes, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS) pursuant to the Section 3061(d) of the Water Resources Development Act of 2007. GLMRIS will explore options and technologies, collectively known as aquatic nuisance species (ANS) controls, that could be applied to prevent ANS transfer between the Great Lakes, Upper Mississippi River, and Ohio River Basins (see Figure 1.1) through aquatic pathways. As defined in the *Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990,* 16 U.S.C. § 4702(1), ANS are nonindigenous species that threaten the diversity or abundance of native species; or the ecological stability of infested waters; or commercial, agricultural, aquacultural, or recreational activities that depend on such waters. In support of GLMRIS, the USACE GLMRIS Fisheries Economics Team is conducting baseline studies of fisheries in the Great Lakes, Mississippi River, and Ohio River Basins. This study focuses on a unique sector of the fisheries — the subsistence fishery undertaken by Native American tribes in the study area.

Currently, 37 federally recognized tribes reside within the U.S. portion of the Great Lakes Basin, Upper Mississippi River Basin, and Ohio River Basin. Table 1.1 lists the tribes within the study area, and Figure 1.2 shows the locations of tribal reservations within the study area. These tribes, most of which are located next to or near the Great Lakes, are descendants of a larger indigenous population that was reduced and displaced by the arrival of Euro-American populations from the east. In the face of continued immigration, many tribes in the study area were forced to move west. Others sought to remain in their native lands and, through a series of treaties, ceded most of their traditional lands, retaining only small reserves.

Fishing, hunting, and gathering were important elements of these tribes' ways of life, providing most or all of their subsistence. In some, but not all, treaties, tribes reserved the right to hunt, fish, and gather on the lands they ceded, since they perceived that this right was essential to their survival and their way of life. In spite of military, legal, and health challenges, 16 federally recognized tribes retain hunting, fishing, and gathering rights under the treaties (see "Treaty Tribes" in Table 1.1). All of these tribes continue subsistence harvesting in the Great Lakes and Upper Mississippi River Basins to greater or lesser extents.

On the basis of information provided by other federally recognized tribes in the study area that were contacted for this study, those tribes with reservations that provide access to major water bodies and clean water still practice subsistence fishing. Many of the tribes that do not have access to rivers and streams on their reservations fish under the applicable state regulations on public land or are buying lakes for subsistence fishing purposes. In addition, the tribes that live close to contaminated waters have programs in place to help clean these waters in order to provide their members with fishing. The introduction of ANS is another component that could threaten their traditional way of life. This study assesses the economic and cultural importance of subsistence harvesting for tribal communities in the study area.

Figure 2: GLMRIS Study Area

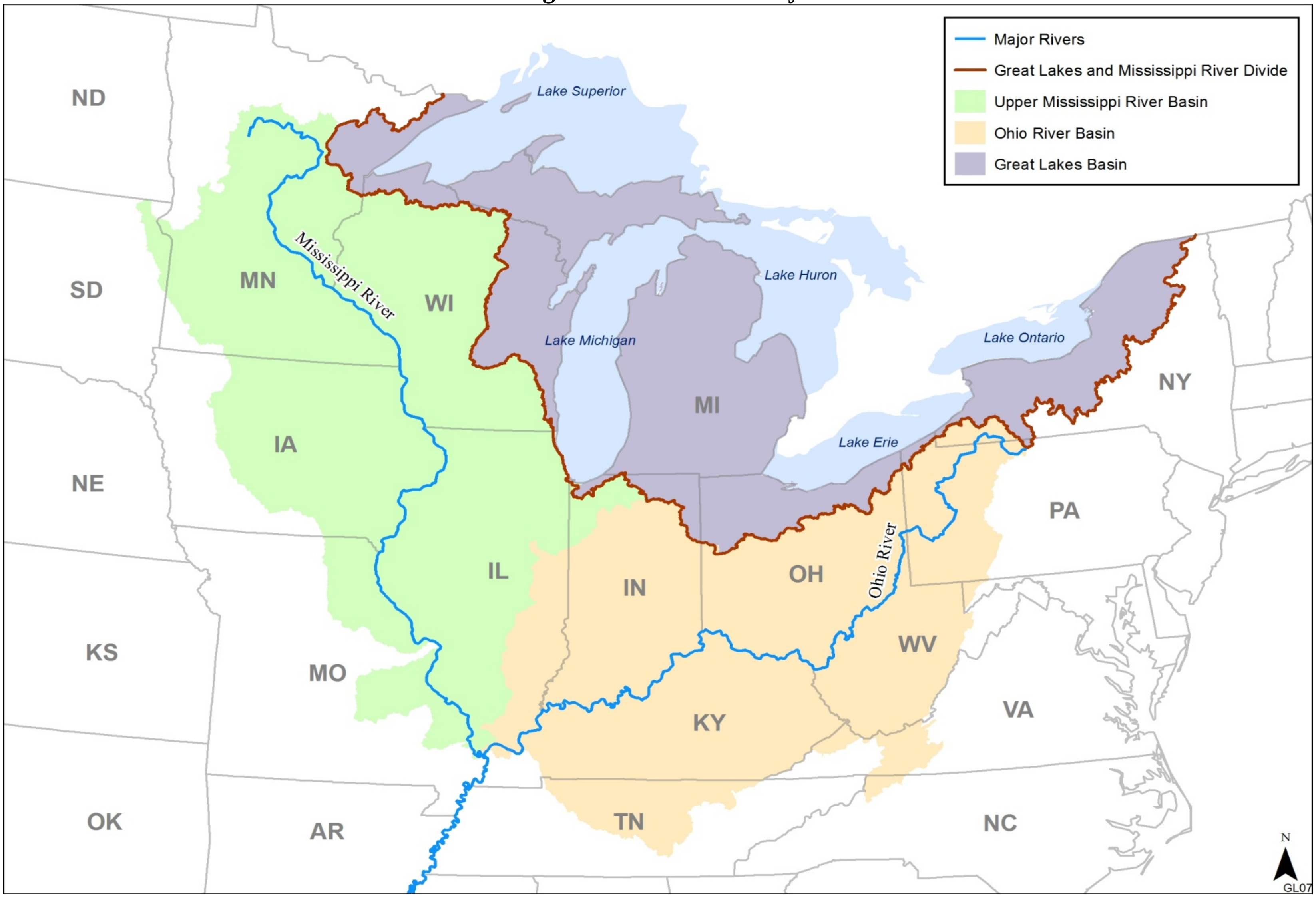


Figure 3: Indian Reservations in the Study Area

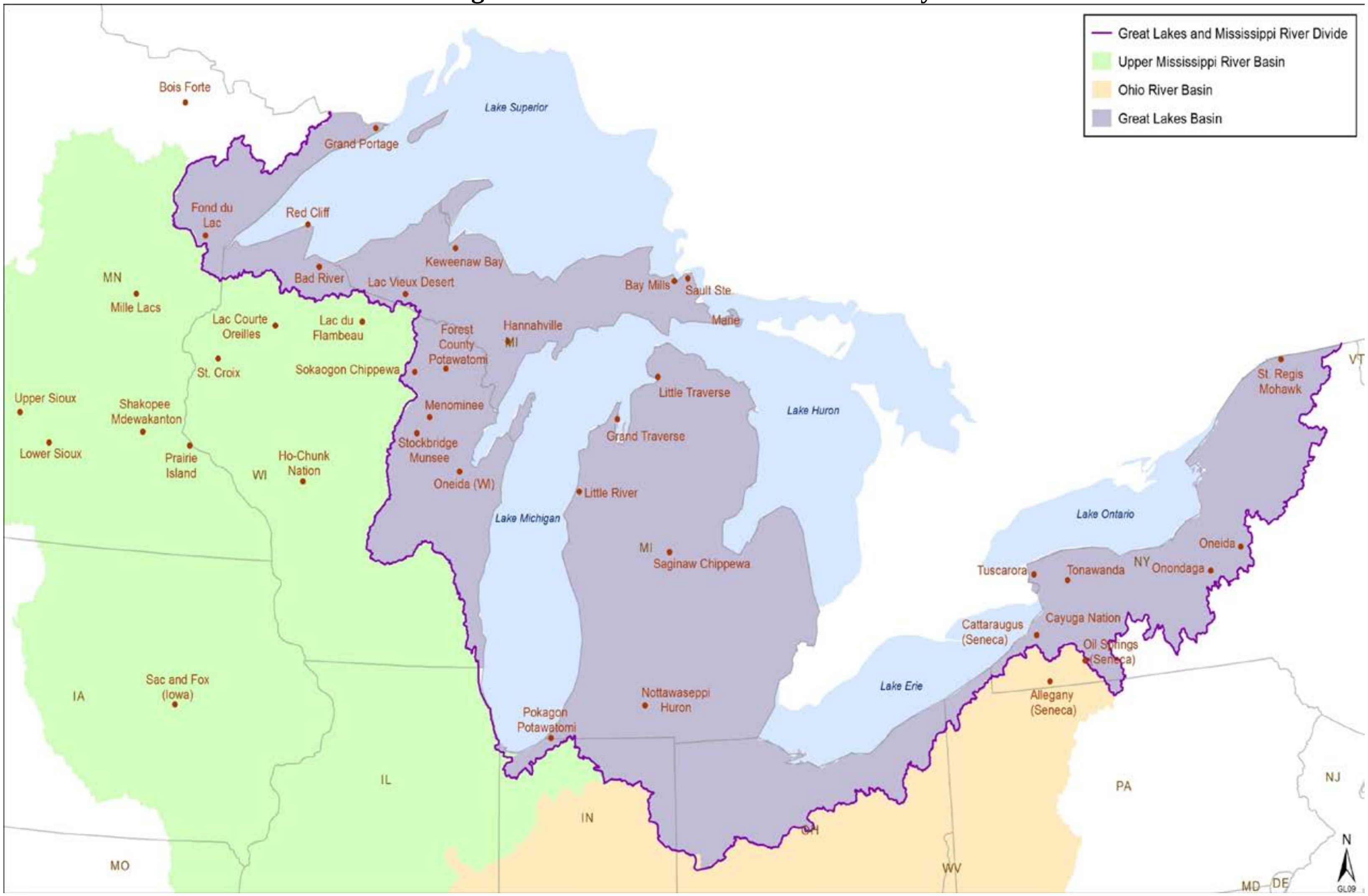


Table 1: Federally Recognized Tribes within the GLMRIS Study Area

Treaty Tribes	State
Grand Portage Band of Lake Superior Chippewa Indians	WI
Fond du Lac Band of Lake Superior Chippewa Indians	MN
Mille Lacs Band of Ojibwe	MN
St. Croix Chippewa Indians of Wisconsin	WI
Lac Courte Oreilles Band of Ojibwe	WI
Lac du Flambeau Band of Lake Superior Chippewa Indians	WI
Lac Vieux Desert Band of Lake Superior Chippewa Indians	MI
Bad River Band of Lake Superior Chippewa Tribe	WI
Red Cliff Band of Lake Superior Chippewa Indians	WI
Keweenaw Bay Indian Community	MI
Sokaogon Chippewa Community	WI
Sault Ste. Marie Tribe of Chippewa Indians	MI
Bay Mills Indian Community	MI
Little Traverse Bay Bands of Odawa Indians	MI
Little River Band of Ottawa Indians	MI
Grand Traverse Band of Ottawa and Chippewa Indians	MI

Non-Treaty Tribes	State
Prairie Island Indian Community	MN
Shakopee Mdewakanton Sioux Community	MN
Lower Sioux Indian Community	MN
Upper Sioux Community of Minnesota	MN
Sac and Fox Tribe of the Mississippi in Iowa	WI
Menominee Indian Tribe of Wisconsin	WI
Oneida Tribe of Indians of Wisconsin	WI
Ho-Chunk Nation	WI
Hannahville Indian Community	MI
Pokagon Band of Potawatomi Indians	MI
Nottawaseppi Huron Band of the Potawatomi	MI
Forest County Potawatomi	WI
Stockbridge-Munsee Community	WI
Saginaw Chippewa Indian Tribe of Michigan	MI
St. Regis Mohawk Tribe	NY
Seneca Nation of Indians	NY
Oneida Nation of New York	NY
Onondaga Nation	NY
Tuscarora Nation	NY
Tonawanda Band of Seneca Indians	NY
Cayuga Nation	NY

Study Methods

This study analyzes tribal subsistence fishing in the Great Lakes, Upper Mississippi River, Ohio River and water bodies joined to them by unimpeded aquatic pathways that would provide access by aquatic nuisance species. To identify tribes in the Great Lakes, Upper Mississippi River, and Ohio River Basins (study area) and to verify the USACE tribal consultation list, maps and online databases were consulted. The Native American Consultation Database was reviewed for tribal contact information (NAGPRA 2011). Other maps that we consulted included the *Indian Land Areas Judicially Established* map (USGS 1978) and the *Early Indian Tribes, Culture Areas and Linguistic Stocks* map (USGS 1991). Relevant treaties were consulted to identify tribes that retain treaty rights within the study area. From this information, it was determined that there are very few tribes residing in the Upper Mississippi River Basin and Ohio River Basin when compared with the number that reside in the Great Lakes Basin.

Background information on traditional methods of subsistence fishing and on cultural values also was gathered. Background research including reviewing copies of treaties and studies on Native Americans was mainly conducted at the University of Wisconsin-Milwaukee Golda Meir library; the New Berlin, Wisconsin, public library; the University of Chicago library; and the Argonne National Laboratory library. Additional background research was conducted using the internet and by conducting personal interviews with tribal authorities on natural and cultural resources authorities.

To identify subsistence activities, we consulted state agencies, intertribal commissions, and tribal natural resource departments. This report describes the subsistence activities we evaluated as part of our study; it discusses the harvesting methods used, the locations of the fish being harvested, the names of the species being taken, and the costs associated with the harvests. The state agencies we consulted were the departments of natural resources and the environment for Minnesota, Michigan, Wisconsin, and New York. The intertribal commissions that we contacted were the 1854 Treaty Authority, Great Lakes Indian Fish and Wildlife Commission (GLIFWC), and Chippewa Ottawa Resource Authority (CORA). We also contacted tribal natural resource departments; Appendix A provides a list of them and briefly describes our efforts in this regard.

The valuation of subsistence harvests used a production cost model, which assumes that the value of subsistence fish harvests is equal to the cost of equipment, travel, and labor expended on subsistence activities. Limitations associated with the production cost model meant that the amount of subsistence value that can be ascribed to social and cultural values, as distinct from food production, could not be determined.

Great Lakes Basin

More than half of the Native American tribes in the study area reside in the Great Lakes Basin (Table 1.2). Of these 27 tribes, 12 are part of negotiated treaty settlements with the U.S. Government. Figure 1.3 shows the ceded territory areas where subsistence rights have been retained. These treaty settlements have secured the tribes' rights to continue and uphold traditional way-of-life practices on the lands ceded to the U.S. Government (see Section 1.5).

The other 15 tribes within the Great Lakes Basin either continue to practice subsistence fishing on their reservations or have historically engaged in subsistence fishing but do not now. The non-treaty tribes consulted indicated that a few members do engage in subsistence fishing off their reservations on public land, under the appropriate state's fishing regulations.

Table 2: Tribes Residing in the Great Lakes Basin

Grand Portage Band of Lake Superior Chippewa Indians
Fond du Lac Band of Lake Superior Chippewa Indians
Red Cliff Band of Lake Superior Chippewa Indians
Bad River Band of Lake Superior Chippewa Tribe
Lac Vieux Desert Band of Lake Superior Chippewa Indians
Keweenaw Bay Indian Community
Sokaogon Chippewa Community
Sault Ste. Marie Tribe of Chippewa Indians
Bay Mills Indian Community
Little Traverse Bay Bands of Odawa Indians
Little River Band of Ottawa Indians
Grand Traverse Band of Ottawa and Chippewa Indians
Menominee Indian Tribe of Wisconsin
Oneida Tribe of Indians of Wisconsin
Hannahville Indian Community
Pokagon Band of Potawatomi Indians
Nottawaseppi Huron Band of the Potawatomi
Forest County Potawatomi
Stockbridge-Munsee Community
Saginaw Chippewa Indian Tribe of Michigan
St. Regis Mohawk Tribe
Seneca Nation of Indians
Oneida Nation of New York
Onondaga Nation
Tuscarora Nation
Tonawanda Band of Seneca Indians
Cayuga Nation

Figure 4: Areas Ceded by Treaty Where Subsistence Rights Were Retained

Upper Mississippi River Basin

Ten Native American tribes reside in the Upper Mississippi River Basin (Table 1.3). Four of them are part of negotiated treaty settlements that allow subsistence fishing within the treaty ceded areas (Figure 1.3). Five of the tribes in the Upper Mississippi River Basin do not practice subsistence fishing. One tribe — Sac and Fox Tribe of the Mississippi in Iowa — chose not to share details regarding their subsistence fishing activities.

The five tribes residing in the Upper Mississippi River Basin that do not have subsistence treaty rights have abandoned subsistence fishing for many reasons. They have access to other food sources, but more importantly, without acknowledged treaty protection, members of these tribes fall under state fishing and hunting regulations that may limit or prohibit traditional harvesting methods. Legal subsistence practices may be limited to resources within reservation boundaries. The majority of these tribes have reservations in urban areas that provide employment opportunities and resources that allow tribal members to buy the fish they would historically have harvested. Contamination of the waters that are on or that flow through their reservations is another reason that tribal members have abandoned subsistence fishing. Furthermore, urban proximity often results in more pollution in the major waterways. The tribal reservations usually include only a small stretch of these waterways, and cleanup can be done only if there is cooperation from surrounding communities.

Table 3: Tribes Residing in the Upper Mississippi River Basin

Mille Lacs Band of Ojibwe
St. Croix Chippewa Indians of Wisconsin
Lac Courte Oreilles Band of Ojibwe
Lac du Flambeau Band of Lake Superior Chippewa Indians of Wisconsin
Prairie Island Indian Community
Shakopee Mdewakanton Sioux Community
Lower Sioux Indian Community
Upper Sioux Community of Minnesota
Sac and Fox Tribe of the Mississippi in Iowa
Ho-Chunk Nation

Ohio River Basin

Currently, one Native American tribe resides within the Ohio River Basin: the Seneca Nation of Indians (SNI). The members of this tribe occupy three separate reservations within New York State. The SNI Allegany Reservation is located on the border of New York and Pennsylvania and is in the Ohio River Basin. The other two SNI reservations are in the Great Lakes Basin.

According to tribal authorities, the SNI practice subsistence fishing in the Allegheny River, which is within the Ohio River Basin.

Treaties

Specific Native American rights to fish and hunt in certain areas of the Great Lakes and Upper Mississippi River Basins are based upon rights reserved when tribes were negotiating the treaties by which they ceded land to the United States. The U.S. Constitution, treaties, statutes, Executive Orders, and federal court decisions recognize the unique relationship between the U.S. Government and federally recognized Indian tribes. Federally recognized Indian tribes exercise inherent sovereign powers over their members and territories (Executive Order 13175, 2000) and may retain reserved rights beyond current reservation boundaries.

Native American societies were sovereign nations governing themselves before the arrival of European settlers. The U.S. Constitution, treaties, statutes, Executive Orders, and federal court decisions recognize their sovereignty and uphold their rights as dependent sovereign nations. Treaties concluded between the U.S. Government and tribal nations that ceded lands to the United States sometimes include rights that the tribes reserve to themselves, such as access to traditional resources (including fisheries, wildlife, culturally important plants, and mineral resources). These rights are not granted by the U.S. Government; they are rights that the tribes had traditionally exercised and that they reserved to themselves in treaties. These treaties are binding, unless specifically abrogated by Congress.

The treaties discussed herein specifically reserve tribal rights to hunt, fish, and gather traditional resources in the ceded lands. The courts have generally upheld these rights. Rights have been upheld for portions of the Great Lakes and Upper Mississippi River Basins and, subsequently, for inland resources.

Big Tree Treaty of 1797

Over the years, many treaties have been concluded between Native American tribes inhabiting the study area and the U.S. Government, but only some of the treaties reserve the rights of the tribes to fish and hunt. The first of these treaties was the 1797 Big Tree Treaty with the Seneca. Under the terms of this treaty, the Seneca ceded large areas in western New York in exchange for a cash payment, but “excepting and reserving to them, the said parties of the first part [the Seneca] and their heirs, the privilege of fishing and hunting on the said tract of land hereby intended to be conveyed” (Agreement with the Seneca 1797).

Unlike subsequent rulings regarding later treaties with the Chippewa and Ottawa, in 1916, the U.S. Supreme Court ruled that the term “privilege of hunting and fishing” in this treaty only meant that tribal members could hunt and fish on the ceded lands to the same extent as anyone else who had purchased ceded lands (*Kennedy v. Becker* 1916). Every New York State resident, including members of the Seneca Nation, was therefore subject to New York State’s hunting and fishing rules and regulations.

Treaties with the Chippewa and Ottawa, 1836-1854

Similar language that reserves hunting, fishing, and gathering rights in later treaties ceding lands in Michigan, Wisconsin, and Minnesota has been interpreted differently, as courts have taken the view that treaties must be understood as the Native Americans who concluded the treaties understood them (Tierny 2011). This approach to interpreting treaties was established in 1832 (*Worcester v. Georgia* 1832).

Traditionally, the Chippewa and Ottawa had lived as fishers, hunters, and gatherers, moving in a seasonal round from resource area to resource area as the seasons and weather dictated. This way of life required the freedom to move over a relatively large area. In the treaties concluded during the 19th century, Native Americans retained relatively small parcels of land, which were insufficient to support a hunting, fishing, and gathering way of life. Therefore, Chippewa and Ottawa elders made sure in treaty negotiations that they retained access to natural resources located beyond reservation boundaries that were necessary for their survival and the continuation of their way of life.

1836 Treaty

A treaty with the Ottawa and Chippewa that concluded on March 28, 1836, ceded the northwestern third of Michigan's Lower Peninsula, the eastern portion of the Upper Peninsula, and adjacent areas of the Great Lakes within the United States (Figure 1.3). This treaty is known as the 1836 Treaty. Article First of the treaty specifies the boundaries of the land ceded to the United States. The land described in Article First is the ceded territory within the State of Michigan where the tribes retain their rights to hunt, fish, and gather by traditional means.

Article 13 of the treaty contains the statement, "The Indians stipulate for the right of hunting on the lands ceded, with the other usual privileges of occupancy, until the land is required for settlement" (Treaty with the Ottawa 1836). These rights of access and harvest are referred to as "Article 13 Rights" by the Ottawa and Chippewa tribes.

In 1979, the notion of settlement as stated in Article 13 was challenged. The court ruled that the waters of the Great Lakes would never be required "for settlement" and that the usual privileges or occupancy included the right to fish, on the basis of the importance of the Great Lakes fishery to the tribes' culture, subsistence, and livelihood (*United States of America v. State of Michigan* 1979).

Following the 1979 ruling and subsequent appeals, tribes were able to continue to use and to regulate traditional fishing methods (e.g., gill nets) in parts of the Great Lakes for subsistence and commercial purposes. Since the tribes had inherent sovereign powers over their members, they had the right to regulate tribal fishing, and the state could interfere only to prevent irreparable harm to fisheries in state waters (McRoy and Bichler 2011). Tribes demonstrated that they could manage the natural resources within their reservations, and they established intertribal organizations to regulate the hunting, fishing, and gathering activities of tribal members on ceded lands and waters beyond the borders of the reservations.

Six years later, in 1985, the tribes, the State of Michigan, the United States, and concerned citizen groups negotiated the conditions under which tribal members could exercise their Article 13 Rights. The federal courts recognized that the agreements were successful and issued a consent decree to govern tribal harvesting. The 1985 decree had a15-year duration and dealt only with Great Lakes waters. The decree was renegotiated and reissued in 2000 with a 20-year duration; it is currently in force.

Negotiators of the 2000 consent decree mutually agreed to leave inland treaty rights to later adjudication. The 2000 decree is concerned mainly with commercial fishing by tribal members and serves to resolve differences over the allocation, management, and regulation of fishing in 1836 Treaty waters in Lake Michigan, Lake Superior, Lake Huron, and connecting waters. It allows for subsistence fishing by commercial fishers in the same waters where commercial fishing is allowed. However, the decree limits the size of nets and the take allowed for subsistence fishers. In addition, subsistence fishers must be licensed by tribes, and the tribes must report the subsistence take to CORA, which provides the information to the Michigan Department of Natural Resources. In response to these conditions, CORA has been delegated certain management and regulatory authority over treaty-based harvests of wild resources on the 1836 ceded lands. The Great Lakes Resources Committee of CORA also promulgates tribal fishing regulations in the Great Lakes.

In 2003, litigation began on “inland harvesting,” defined as subsistence harvesting on lands, lakes, and rivers within portions of Michigan’s Upper and Lower Peninsulas ceded under the 1836 Treaty. The purpose of the litigation was to establish whether inland Article 13 Rights existed, and, if so, where they could be exercised. An agreement in principle was reached in 2006, and the Inland Consent Decree was issued in 2007. Unlike the 2000 Consent Decree, the 2007 Inland Consent Decree was designed to last in perpetuity.

Under the 2007 Inland Consent Decree, Article 13 Rights are affirmed on most public and publicly accessible lands and waters in the ceded territories. The only time harvesting is not permitted within public lands is when an area is protected or deemed necessary for the maintenance and restoration of fisheries and other wildlife populations. The decree covers fishing, hunting, and gathering. In most cases, commercial harvesting is prohibited. Special consideration is given to species, such as elk and bear, that require allocation. These species have limited wild populations, and hunting permits must be allocated between tribal and non-tribal hunters. Bears are a special case. Each tribe is allotted an annual take of two individuals for medicinal/ceremonial purposes beyond the year’s hunting quota.

1837 Treaty

In the 1837 Treaty with the Chippewa, also known as the Pine Tree Treaty, inland portions of Wisconsin and Minnesota, including part of the Upper Mississippi Basin, were ceded to the United States (Figure 1.3) (Arnold 2011). Article 5 of the Pine Tree Treaty states, “The privilege of hunting, fishing, and gathering the wild rice, upon the lands, the rivers and the lakes included in the territories ceded, is guaranteed to the Indians, during the pleasure of the President of the United States” (Treaty with the Chippewa 1837).

1842 Treaty

In the 1842 Treaty with the Chippewa, also known as the Copper Treaty, lands between the 1837-ceded territory and Lake Superior in northern Wisconsin and the western part of Michigan’s Upper Peninsula (Figure 1.3) were ceded. Article 2 of this treaty stated, “The Indians stipulate for the right of hunting on the ceded territory, with the other usual privileges of occupancy, until required to remove by the President of the United States" (Treaty with the Chippewa 1842).

Rights under this treaty were upheld in the 1983 Voigt decision when the Seventh Circuit Court of Appeals reversed a lower court decision and held that Native American usufructary rights (i.e., rights to hunt, fish, and gather) on ceded lands under the 1837 and 1842 Treaties were still in effect (*Lac Courte Oreilles Band of Lake Superior Chippewa Indians v. P. Voigt United States* 1983*)*. A later decision ruled that those usufructary rights had been terminated on private land (*Lac Courte Oreilles Band of Lake Superior Indians v. State of Wisconsin* 1987).

1854 Treaty

The 1854 Treaty with the Chippewa, also known as the La Pointe Treaty, established permanent reservations for the Chippewa. Article 11 of the treaty states, "And such of them [Chippewas of Lake Superior] as reside in the territory hereby ceded, shall have the right to hunt and fish therein, until otherwise ordered by the President" (Treaty with the Chippewa 1854). In the 20th and 21st centuries, federal courts have ruled that Chippewa usufructary rights under the Treaties of 1837 and 1854 remain and that tribes could avoid interference by the state if they demonstrate that they can effectively regulate their own members (McRoy and Bichler 2011).

Several of the tribes who were signatories to the treaties of 1837, 1842, or 1854 formed the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) and the 1854 Treaty Authority. These organizations are tribal resource management agencies with authority delegated from the tribes. The GLIFWC provides support to tribes in the exercise of their rights on ceded land, while protecting the natural resources of those lands. The Lakes Committee of GLIFWC, which represents the tribes that fish commercially in Lake Superior, recommends practices to manage the Lake Superior resources. Regulations on the take and seasons for each species are established under tribally adopted codes.

Defining Subsistence

The term "subsistence" as applied to Native American societies has not been consistently defined and applied. Subsistence takes into account the geographic area, the culture of the people in question, and the degree to which they rely on the resources that sustain them. This section of the report attempts to define what subsistence means to the Native Americans in the GLMRIS study area.

The definition of subsistence as implied in *United States of America v. State of Michigan* (1979) is "the long term consistent pattern of use of the natural resources by Native Americans." Since Indians long relied on fishing, hunting and gathering for their livelihood, they would have expected that reliance to continue on lands they ceded. In *United States of America v. Michigan*, the court relied on the testimony of expert witnesses to build its understanding of subsistence. By studying the history of negotiations and the entire history of the Michigan Indians, the expert witnesses found evidence that supported the abundance of fish in this region and the difficulty of agricultural practices. They showed that the Michigan Indians grew to depend on the fisheries and other wildlife to enable them to secure European goods and that their earliest participation in the European market economy rested on their knowledge of the resources that were available to them. It is this sort of evidence that the court had to evaluate in order to determine whether the Ottawa and Chippewa so depended upon subsistence of the natural resources at the time that they signed the treaty of 1836, they could not have knowingly signed away their right to fish, hunt and gather.

In *United States of America v. State of Michigan*, the court states:

> *Thus, the Indians impliedly reserved the right to subsistence and commercial fishing because of this resource's importance to the Indian community at and before the time they entered into the treaty.*

The definition of subsistence as defined in the 2000 Consent Decree and the 2007 Inland Consent Decree is "the taking of fish for personal or family consumption and not for sale or trade." Both Consent Decrees recognize the signatory's rights to practice traditional subsistence uses of natural resources and to utilize those natural resources in living off the land.

The U.S. Code of Federal Regulations, Title 36, Part 242.16 identifies certain criteria that are considered when making customary and traditional use determinations. These criteria were established for subsistence management on public lands in Alaska, however, there are many similarities that pertain to the treaty-ceded areas within Minnesota, Wisconsin and Michigan. The following eight criteria are considered a working definition of subsistence for GLMRIS as implied and defined in the above treaties and negotiations.

1. A long-term consistent pattern of use, excluding interruptions beyond the control of the community or area;
2. A pattern of use recurring in specific seasons for many years;
3. A pattern of use consisting of methods and means of harvest which are characterized by efficiency and economy of effort and cost, conditioned by local characteristics;
4. The consistent harvest and use of fish or wildlife as related to past methods and means of taking; near, or reasonably accessible from, the community or area;
5. A means of handling, preparing, preserving, and storing fish or wildlife which has been traditionally used by past generations, including consideration of alteration of past practices due to recent technological advances, where appropriate;
6. A pattern of use which includes the handing down of knowledge of fishing and hunting skills, values, and lore from generation to generation;
7. A pattern of use in which the harvest is shared or distributed within a definable community of persons; and
8. A pattern of use which relates to reliance upon a wide diversity of fish and wildlife resources of the area and which provides substantial cultural, economic, social, and nutritional elements to the community or area.

TRADITIONAL SUBSISTENCE ACTIVITIES

The area under investigation consists of the U.S. portions of the five Great Lakes and connecting waters; the Upper Mississippi River north from Cairo, Illinois; the Ohio River Basin; and any inland lakes, streams, and rivers with an unimpeded aquatic connection to the Great Lakes, the Upper Mississippi River, or the Ohio River, where subsistence fishing may take place (Figure 1.2). Before the arrival of Europeans, the study area was dominated by woodlands and prairies, crossed by numerous rivers and streams, and surrounded or bordered by large and small lakes. The ecozones created by this type of vegetation and landscape provided an abundance of natural resources that could be utilized in a seasonal round, in which indigenous bands moved to take advantage of resources, including fish, game, and wild rice.

The tribes who settled adjacent to and near the Great Lakes utilized similar natural resources; therefore, traditional subsistence strategies within the Great Lakes Basin did not vary greatly. Tribes who settled in the Upper Mississippi River and Ohio River Basins shared an environment similar to that of the tribes who settled near the Great Lakes but depended more on agricultural practices to sustain their communities. Subsistence patterns identified in the study area included fishing, hunting, gathering of wild rice, and agriculture. For some groups, such as the Algonquians (e.g., Chippewa/Ojibwe, Ottawa), fishing was more reliable than agriculture because the group occupied an area where fish were abundant and crop cultivation was constrained by the number of frost-free days (Tanner 1987). Other tribal groups, such as the Iroquoians, relied more heavily on cultivation because they lived in a more temperate climate (Tanner 1987). In the area west of Lake Michigan and south and west of Lake Superior, wild rice was an important food source (Tanner 1987). All groups included hunting in their subsistence base.

European contact initiated changes to the way indigenous populations utilized the available natural resources. The arrival of European fur traders caused the Native Americans to intensify their traditional hunting strategies in order to acquire furs to barter for European technology. Later, Euro-American population movements from the East Coast caused displacement of native communities, and they brought them new technology that would be used to modify natural resources (Tanner 1987). In the first half of the 19th century, natural resources began to decline as a result of logging and the introduction of exotic plant species. It was at this time that Native American subsistence patterns were greatly altered and that most land-ceding treaties discussed here were concluded (Tanner 1987).

Traditional subsistence resources utilized by Native Americans varied with the season and the local environment. For example, during the summer and fall seasons, Chippewa men would travel to and camp out at productive fishing sites; however, fishing was conducted year round. In the spring, three to four weeks were given to making maple sugar. In the fall, wild rice would be harvested along with the agricultural crops. Hunting would take place year round but was mostly conducted in summer and winter when the other subsistence resources were running low (Jenks 1900). Some fish species, such as herring and whitefish, could be preserved through winter by smoking and drying, since they were caught in the fall; spring sturgeon could not be preserved (White 1991). The preservation of fish was largely dependent on the climate. Fish could not be preserved through the hot summer months because of the heat and humidity. When the weather was colder, as in the winter, fish would stay fresh longer. Tribes who lived near the Great Lakes fished only along or close to the shore since they used traditional methods and equipment and lacked equipment suited for deep-water fishing (Waukau 1987). They were greatly dependent on the weather. Challenges, such as storms during spawning season or weak ice during a warm winter, required tribes to utilize other resources to supplement the fish harvest.

Today, the tribes that continue to practice subsistence harvesting recognize the importance of maintaining a sustainable resource and, through the treaties, are able to regulate and monitor their own harvesting while still utilizing and promoting traditional fishing methods. The proportion of a tribe directly involved in subsistence harvesting is often small; however, the effects of even a small number of harvesters ripple through the community in important ways (M. DeFoe 2011; Newago 2011). Sharing the harvest is a core cultural value to the native communities, and having the fishing resource to use in this way is an intrinsic, identifiable cultural resource of the Great Lakes tribal communities.

The following sections discuss the traditional methods of fishing, the fish species that were being targeted prehistorically in the study area, and the types of preservation techniques that were traditionally used. A comparison between traditional methods and modern methods is also made, since most of the tribes in the study area practice traditional fishing methods. In addition, hunting, trapping, and plant resources are discussed, since they are important elements in the way of life of the tribes in the study area and, to some extent, can be affected by ANS. Also, the tribes that have treaty rights continue to utilize these resources in traditional ways within the ceded territories.

Fishing Techniques Used in the Past

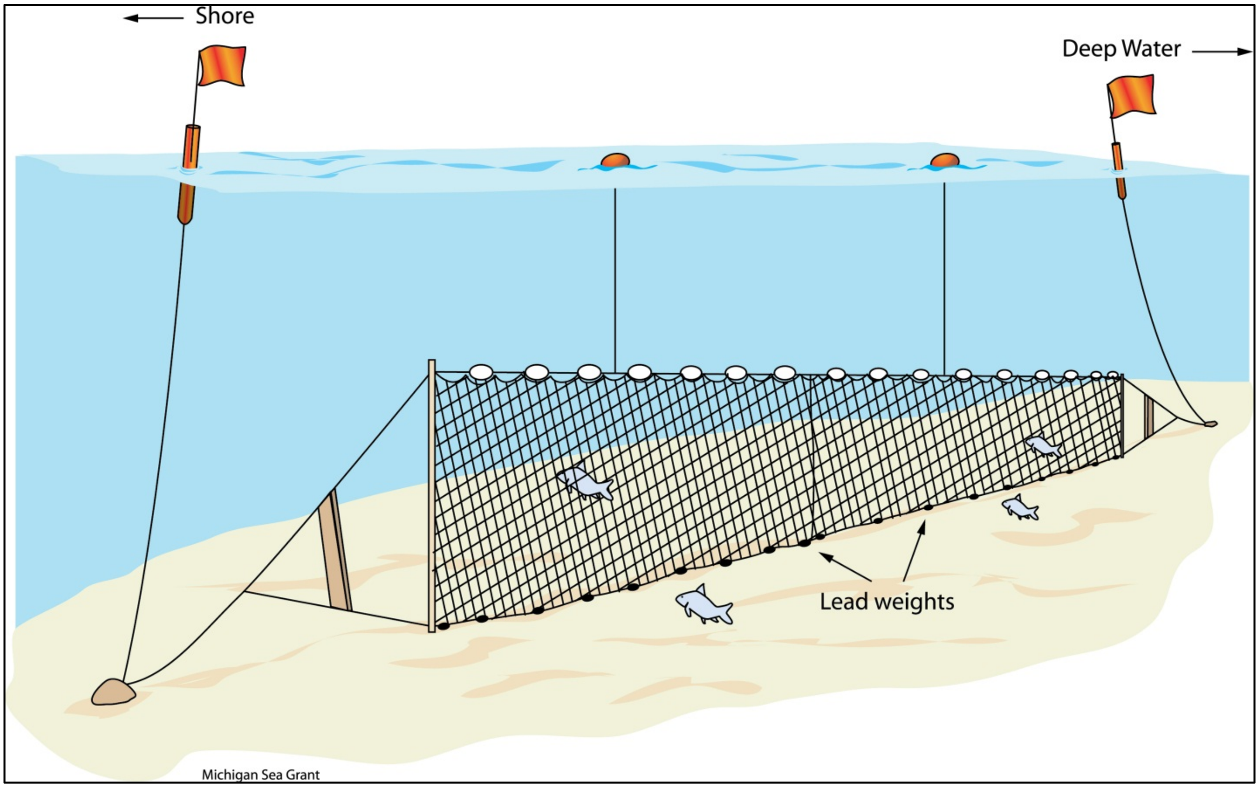
Native Americans fished any water body with an abundance of fish that was available to them. A favored fishing site was one where there was plenty of fish in all seasons. The following discussion provides a description of the various types of techniques used at all fishing sites.

Nets

The net was the most common tool used in fishing. Because nets could be used to catch many fish at once, including different species of fish, and could be used in any type of water, they were desirable tools. Many different types of nets were used, depending on the need of the fisher. Nets like gill nets, seine nets, and trap nets were used most often because of their potential for large catches. The gill net is the most common subsistence fishing method used today.

Gill nets are designed to let fish swim partially through the mesh until their gills become entangled in the netting, preventing them from escaping. Gill nets are “set” or suspended vertically in the water in a location where fish are likely to swim or to be pulled by the current into the net, where they become enmeshed (Figure 2.1). The bottom corners are weighted down with stones, and the top corners are suspended by floats at the surface of the water. The mesh size determines what size of fish will be caught.

Figure 5: Gill Net (Michigan Sea Grant 2011)



Today, gill nets are the most commonly used nets by both tribal commercial and tribal subsistence fishers. Subsistence nets are limited in size, being 200 to 600 feet of 4¼-inch mesh. They are usually set in shallow water and, unlike commercial nets, can be set from the shore. Spots near known spawning areas are favored. Knowledge of the best sites to set nets is handed down within families. By unwritten rules, subsistence harvesters respect the sets of other tribal harvesters. Gill nets can also be set under the ice. Commercial fishers also can use their equipment to set subsistence nets, but these nets are limited in size and must be clearly marked as subsistence or home-use nets. The yield from these nets cannot be sold. Commercial fishers may keep non-target species trapped in their nets for home use.

Similar to a gill net, a seine net hangs in the water with weights on the bottom edge and floats on the top (Figure 2.2). However, unlike a gill net, a seine is designed to surround the fish on all sides as the net is being drawn to close. A traditional seine net would be operated by a fisher in a canoe or by two fishers on shore. Seine nets are used today by commercial and subsistence fishermen and are a permitted method of fishing in the ceded territories.

A trap net shares the design of the gill and seine nets in that it hangs in the water with weights on the bottom edge and floats on the top. Trap nets have wing nets that lead fish into a V-shaped heart and then into a box-shaped pot, where fish are captured (Figure 2.3). Grooved and notched stones were used as net sinkers for these types of nets (Densmore 1979).

Figure 6: Basin Seine Net (ScottForesman 2010)

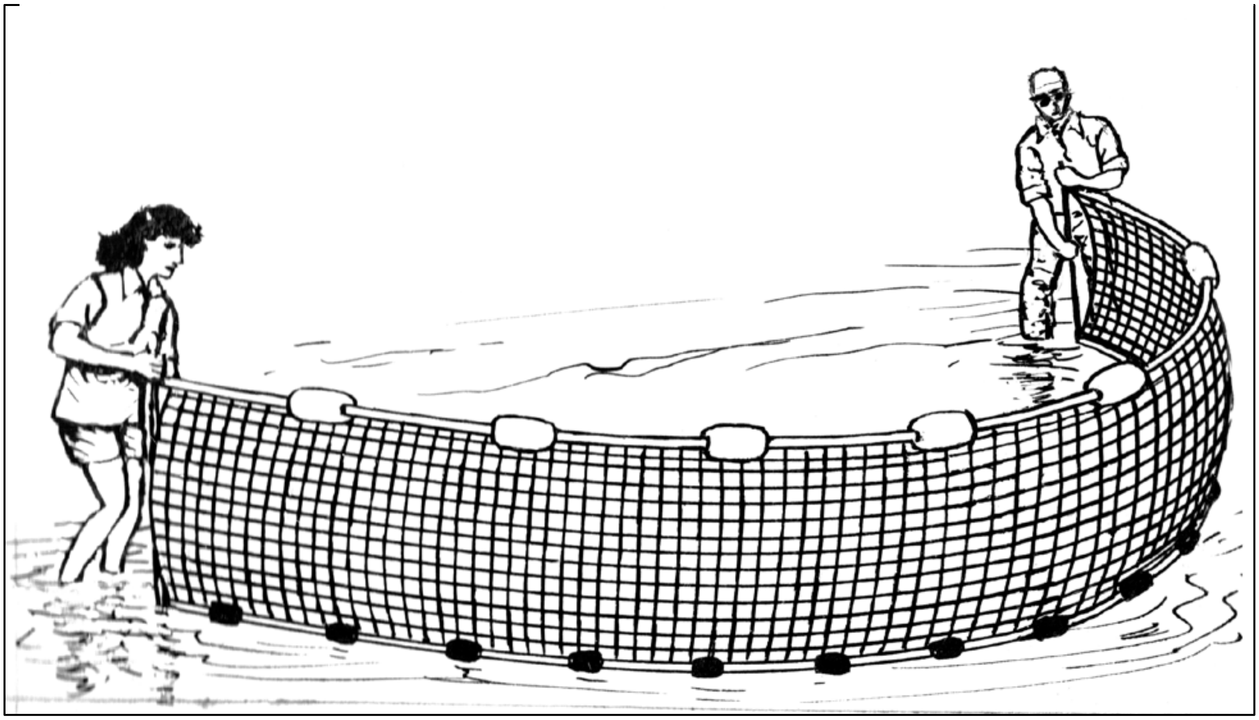
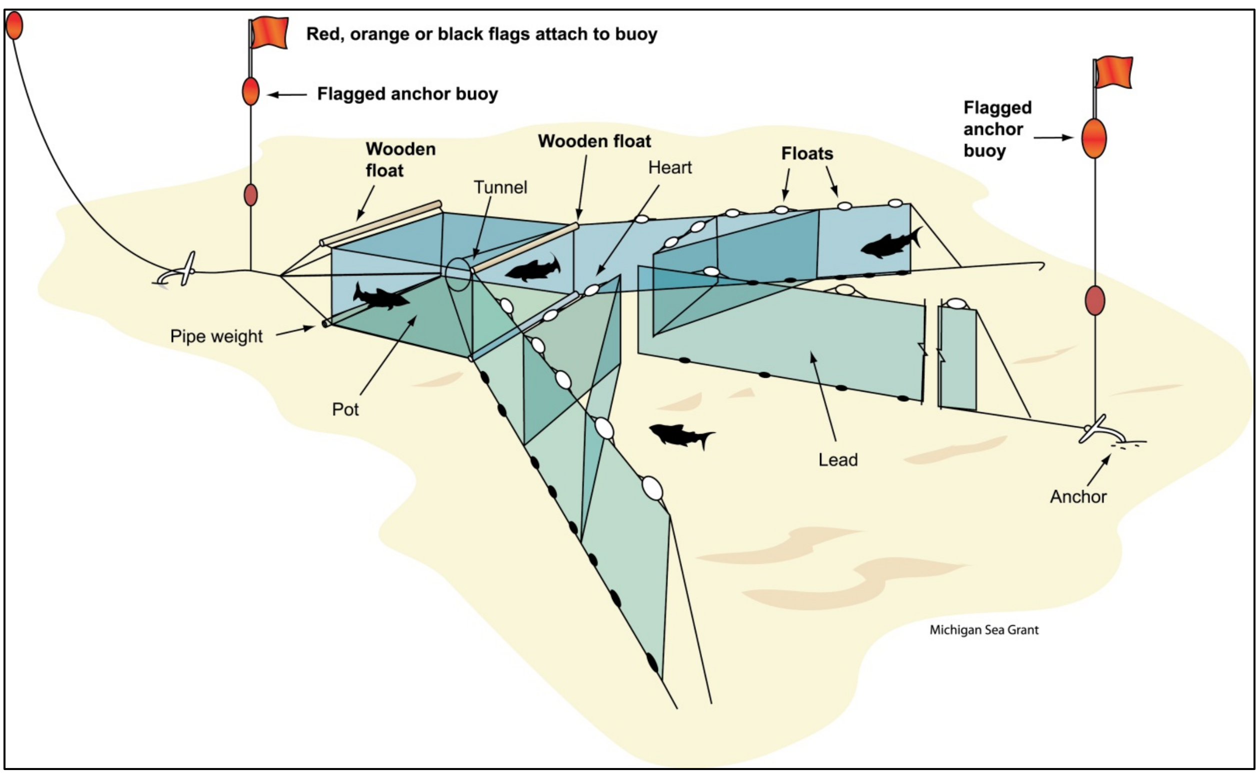


Figure 7: Trap Net (Michigan Sea Grant 2011)



These nets were mostly utilized in the Great Lakes, where they were placed perpendicular to the shore, hung from canoes or floats offshore, or used through holes in the ice during the winter (Rostlund 1952). Today, trap nets are a permitted method most commonly used by commercial fishermen, but they can also be used by subsistence fishermen.

Small hand nets, such as dip nets and scoop nets, also were used wherever fishing was practiced traditionally. For instance, long-handled dip nets were used in Sault St. Marie, where the fish were plentiful (Rostlund 1952). Nets were most commonly used in the Great Lakes Basin. The fish species commonly taken with a net by indigenous fishers were sturgeon, lake trout, grayling, whitefish, smelt, freshwater cod, bass, sunfish, trout, and perch (Rostlund 1952). Small hand nets are still used today by subsistence fishermen and are a permitted method of fishing within the ceded territories.

Weirs and Traps

The use of weirs and traps is one of the oldest Native American fishing methods known from historical records. Many types of weirs and traps were built to catch specific species or sizes of fish, often taking advantage of the unique features of a given water body. Small traps were made with twigs and branches and were constructed to catch small fish. These traps would be placed in shallow water, where the lake current would carry the fish into the trap (Densmore 1979). For example, sturgeon racks were built to catch large Lake Superior fish. Sturgeon racks were gates made out of rocks and strong fibers that were placed at the mouths of rivers flowing into Lake Superior. In the spring, the sturgeon would travel upstream to spawn, and the trap would block the fish. Native Americans then would kill the fish by clubbing them or catching them with hooks (Densmore 1979). Sturgeons were the most common species taken with weirs and traps (Rostlund 1952). Weirs and traps were most commonly documented in the Great Lakes and Ohio River Basins.

Weirs and traps are not commonly used today. CORA regulations state that commercial and subsistence fishing gear shall not be placed in a manner that completely blocks or entirely prevents the free passage of fish into and out of streams that flow into 1836 treaty waters (CORA 2009). Weirs and traps are designed to be placed in these types of locations; therefore, this method is not as productive as the more common methods of netting and angling. However, the use of weirs and traps are permitted methods of subsistence fishing (CORA 2009).

Fish Spears

Unlike nets or traps, spearing was employed to harvest fish individually. Fish spears were used throughout the entire Great Lakes and Ohio River and Upper Mississippi River Basins (Rostlund 1952). They had many specialized uses in the Native American culture and continue to be used today. Three different kinds of fishing spears are utilized: spears, harpoons, and leisters. Traditional spears had straight shafts made of wood with pointed bone or antler hooks securely hafted onto the shaft. Spears would be used on larger fish in shallow water. Harpoons are barbed spears with a string tied to the shaft in order to pull the captured fish out of the water once it is speared. Leisters are three-pronged spears, which were more effective in capturing fish than spears with other designs (Rostlund 1952). The leister’s side prongs, which were flexible, grasped the fish on both sides to hold it in place while it was being pulled from the water. The spears used today must be three-pronged and must be sturdy enough to capture the fish (GLIFWC 2011b; CORA 2009).

Torchlight fishing from canoes on inland lakes was a common spear-fishing technique, especially for catching larger fish. Native Americans would have a large torch in their canoe as they paddled out onto the water. The torch spread light out over the water so the fishers could see the fish, but the fish could not see the canoe (Densmore 1979). Throughout our interviews, there was no mention of torchlight fishing being practiced today.

During the winter, spear fishing was done through holes in the ice on both the Great Lakes and inland lakes. The fisher would lie flat next to a hole that had been cut through the ice. A tripod of sticks was constructed to hold a blanket over the fisher's head and shoulders. With one hand, the fisher would guide a wooden fish decoy around in the water, attempting to be as lifelike as possible, and with the other hand, the fisher would hold the spear, waiting to strike (Densmore 1979). Several important elements are required for successful spear fishing. The fisher must have skill, and the fish must be in sight and within reach of the spear. The spearing method would not produce fish if used in deep and/or muddy water. The best chances of spearing fish were in water where fish were plentiful; however, other fishing methods, such as netting or trapping, were more productive. Therefore, spearing was a cultural preference (Rostlund 1952). Sturgeon, lampreys, and suckers were commonly caught by spear fishing (Rostlund 1952).

Today, spear fishing focuses mainly on the spring spawning runs in rivers and streams (Wilson 2011; Abel 2011). In the larger inland lakes, tribal members spear fish for walleye; however, some winter spear fishing is still conducted on the St. Louis River for suckers and northern pike (Howes 2011).

Angling

A variety of hooks and lines were used to harvest fish. The size and the form of the hook often depended on the species of fish that was being targeted. Although catching fish by hook was not as common as other methods, tribes in the inland regions south of the Great Lakes would use this method to catch catfish.

Traditionally, the tribes in the Great Lakes and the Upper Mississippi River Region used fish hooks made of bone (Densmore 1979). When the Europeans introduced metal, composite fish hooks became more common. These hooks were designed by securing one or more points of bone, wood, or metal to a shank (Rostlund 1952). Tribes in the Ohio River Basin also used fish hooks, but the type of hook they used is not clear (Rostlund 1952).

Trolling was another method used by some tribal groups, such as the Huron. As part of this method, a piece of fishing line with a hook at the end was tied to the wrist of the fisher. As a canoe was paddled down the shoreline, the fisher would pull the line through the water (Densmore 1979). Traditionally, the fish most commonly caught by angling with this method were lake trout, catfish, and perch (Rostlund 1952).

Trotlines are another type of angling that was used traditionally and is still practiced today. A trotline is a heavy fishing line with baited hooks attached at intervals as branch lines. The branch lines are called snoods and are attached by a clip or swivel with a hook at the other end. A trotline can be set so it covers the width of the stream with baited hooks and can be unattended. Trotlines are used to catch many types of fish species. There can be many variations on a trotline, and many terms are used to describe the same technique, such as nightline, longline, and set line. Today angling is a common subsistence fishing method. For the tribes that do not live near the Great Lakes, angling in rivers is the most common method of fishing because netting is not allowed in most rivers and streams. Ten percent of the Fond du Lac tribal members use hook and line to catch lake trout (Howes 2011). Trolling is also permitted under the hook and line regulations for the GLIFWC member tribes (GLIFWC 2011b).

Other Fishing Methods

Other traditional methods of harvesting fish included using poisons, bows and arrows, and fishing lures and catching fish by hand (i.e., by directly grasping the fish). The poisoning of fish happened rarely, but evidence of the use of this method for fish in Lake Superior, the Upper Mississippi River, northern Lake Michigan, northern Lake Huron, and within the Ohio River Basin is recorded. Fish poisoning was accomplished by trapping fish in a pool of water from which they could not escape, then putting a poisonous plant in the water to stun the fish (Rostlund 1952).

Shooting fish with a bow and arrow has been recorded in the Upper Mississippi River and along the western shores of Lake Michigan. This type of fishing was mostly done for sport. It is reported that once guns were introduced to Native Americans, they sometimes used the guns to shoot fish (Rostlund 1952). This method is not practiced today.

Today fish poisoning is an illegal method of taking fish (GLIFWC 2011b). The use of bows and arrows and fishing lures is permitted under the CORA Code (CORA 2009). Capturing fish by using a trotline is a method that is also used today.

Traditional Target Fish Species

The Great Lakes, Upper Mississippi River, and Ohio River Basins are home to numerous fish species. Traditionally, Native Americans established camps and settlements near these waters to take advantage of fish resources; and tribes in these locations were more dependent on fish than other food resources. Native Americans who lived away from these aquatic resources relied more on hunting and agriculture. Table 2.1 lists the principal species of aboriginal food fish found within the Upper Mississippi River Basin, Ohio River Basin, and the Great Lakes Basin. It is important to note that the lamprey referred to in the table is the native lamprey and not the invasive sea lamprey. The invasive sea lamprey is an ANS.

Preparation Techniques and Preservation

The harvesting of fish occurred throughout the year, when weather was favorable, but it also depended on fish migration patterns. Once the fish were harvested, they were either eaten immediately or preserved for future consumption by drying or smoking.

Table 4: Aboriginal Food Fish in the Great Lakes, Upper Mississippi River, and Ohio River Basins

Fish Name	Distribution
American eel	Upper Mississippi River and Ohio River
Catfish	Upper Mississippi River, Ohio River, Great Lakes
Char/lake trout	Great Lakes
Freshwater cod/American burbot	Upper Mississippi River and Great Lakes
Freshwater sheepshead	Ohio River and Great Lakes except for Lake Superior
Gar pikes and bowfin	Upper Mississippi River, Ohio River, Great Lakes except for Lake Superior
Grayling	Lake Superior and between Lake Michigan and Lake Huron
Herring	Ohio River
Lampreys	Upper Mississippi River, Ohio River, Great Lakes
Minnows	Upper Mississippi River, Ohio River, Great Lakes
Mooneyes	Upper Mississippi River, Ohio River, Great Lakes
Muskellunge	Ohio River and Great Lakes
Paddlefish	Upper Mississippi River and Ohio River
Perch	Upper Mississippi River, Ohio River, Great Lakes
Smelt	Great Lakes
Sturgeon	Upper Mississippi River, Ohio River, Great Lakes
Suckers	Upper Mississippi River, Ohio River, southern Great Lakes
Sunfishes	Upper Mississippi River, Ohio River, Great Lakes
Trout perch	Upper Mississippi River and Great Lakes
White bass/yellow bass	Upper Mississippi River, Ohio River, Great Lakes except for Lake Superior
Whitefish	Great Lakes

Source: Rostlund (1952)

Fresh fish was prepared either by roasting or boiling. Preparation for cooking involved cleaning the fish and placing it between the sections of a split stick. The stick was then placed into the ground in front of the fire and rotated to cook the fish evenly (Densmore 1979). Sometimes the fish was not cleaned before cooking; in this case, the fish was cooked, then opened and seasoned with maple sugar before it was eaten (Densmore 1979).

Fresh fish were sometimes boiled to make a broth. The broth would be used to season rice or corn dishes. If a fish was rich in nutrients, all parts would be eaten. The intestines would be cleaned and fried in grease with the roe and seasoned with maple sugar (Densmore 1979).

Drying and smoking of fish was a common method of preserving fish, to make the catch from special fishing expeditions ready for transport and also to make the fish easier to store for winter consumption (Tooker 1991). Fish were hung to dry in the sunlight or in an airy spot. The fish could also be placed on a rack over a slow fire to dry. The fish were dried until they were hard and then packed in layers to be stored (Densmore 1979). Fish were smoked by being placed over smoldering fires. During winter, the fish would be frozen without cleaning. This practice was common in the Great Lakes and Upper Mississippi River regions (Rostlund 1952) and is still practiced today (Newago 2011).

Sometimes the Chippewa, who were located near Lake Superior, would remove the fish from the fire before it was dried. They would then remove the skin and bones and spread the fish on birch bark to be dried more thoroughly. Once the fish was dried, it would be rubbed by hand until the flesh was very soft and fine. It was then mixed with maple sugar and eaten with a spoon; this dish was considered a delicacy (Densmore 1979).

It was an Iroquois tradition to make use of decayed fish. The fish would be hung without removing the viscera and left for months to decay. It would then be chopped and added to soup or cornmeal as a seasoning. The flesh of fish was also pounded or pulverized into meal, which would be stored for future use as a flavoring. The Iroquois would also utilize the bones, by grinding them up into bone meal, and also some of the entrails, and add them to other food for flavor (Tooker 1991).

Today, fish are still smoked, but not for preservation purposes. Fish are often frozen in modern freezers for future use (Plucinski 2011).

Plant Resources

Native Americans traditionally harvested plant resources for a variety of uses, including their use as raw materials for making fishing gear. Plants have many uses — from food, medicine, and charms to dyes and decorative arts. For instance, the Chippewa believed plants were given to them by the Creator and that without them, life would not be sustainable. Native American fishers in both the Algonquin and Iroquois groups were thus accustomed to using a variety of plants to eat with their catch and as raw material for fishing equipment.

Tobacco was also extremely important to the Native American groups and utilized in many different way (see Section 6). Tobacco was offered to the Creator before leaving on any hunt, when the first animal was caught, and before game was consumed by the tribe. The Chippewa, for instance, smoked the root of aster or stalwart to attract game, and they smoked the root tendrils of purple stem aster or swamp aster with tobacco to attract game (Densmore 1974). The Iroquois believed that the burning of tobacco was the only way to talk to the Creator (Morgan 1962 [1851]).

Other plants, such as calamus and wild sarsaparilla, were used by the Chippewa during rituals. The roots of these plants were dried and grated finely to make a decoction of the two. The decoction was then sprinkled on fish nets and allowed to dry before the nets were put in water (Densmore 1979). Many plants that were used as charms were also used as medicines and foods.

Traditionally, the tribes also used plants to construct fishing gear, such as nets and lines. Although contemporary Native Americans in the Great Lakes and Upper Mississippi River Basins purchase netting made of synthetic fibers, traditional fishnets were most commonly made from the roots of spruce trees, willow, or Indian hemp, although other plants may also have been used (Rostlund 1952). Fishing line was made of nettle-stalk fiber or basswood twine (Densmore 1979).

Poisons were also used traditionally to harvest fish. The most common poisons used by Native Americans to harvest fish were Indian turnip, pokeweed, and devil's shoestring (Rostlund 1952).

Wild Rice

Wild rice was a traditional staple of subsistence to the Native American tribes who lived in the wild rice district, from east of the Upper Mississippi River to the southwest shores of Lake Superior, and through the middle portion of Wisconsin extending as far south as Green Bay (Tanner 1987). Wild rice is a cereal grass that grows in shallow lakes and streams and is harvested in the fall. Today, the Chippewa still harvest this rice on their reservations and on the treaty-ceded lands within the study area.

Traditionally, wild rice harvesting occupied a central place in the customs, folklore, and religious beliefs of the Chippewa people. The Chippewa believe they came to reside in their current homeland because of a vision by one of seven prophets in a past time when they lived on the east coast of what is now North America. The vision told that they must move west to keep their traditional way of life, because many new settlers would soon arrive. The Ojibwe people migrated west to Mackinaw Island, where many settled. Some groups of Ojibwe traveled farther west to settle in what is now Minnesota and Wisconsin, remembering the prophet's vision that they must go to the "place where there is food upon the waters" (Leoso 2011). They relied on this food source as much as they relied on the capture of fish in the lakes (Treuer 2001). Ceremonies and offerings were held before, during, and after the rice harvest and during the growing season.

Wild rice is harvested today, much as it was in times before European contact. Traditionally, birch bark canoes were used to navigate through the rice beds. Today, aluminum or fiberglass canoes are used. Poles are used to push the canoe through the rice. Cedar sticks are used as "beaters" to knock the rice off of the stalks into the canoe as it passes through. After the rice has been knocked into the canoe, it is taken back to camp, dried, and cleaned (Stickney 1896; Leoso 2011).

Native populations in the wild rice district traditionally subsisted on maple sugar and fish in the spring, on fish and game in the summer, on wild rice and corn in the fall, and on fish and game in the winter. Families that planned and worked hard would have rice to last through the winter months (Newago 2011). Wild rice was most commonly eaten with soups and stews or teamed with fish and corn. It could also be eaten plain or with maple syrup, roasted and eaten dry, or seasoned with berries (Jenks 1900).

Today, wild rice is still a significant part of the cultural identity among the Great Lakes Chippewa tribes. The ability to harvest wild rice is protected under the treaties, and continuous efforts are made by each tribe that has this resource to protect and revitalize the rice beds. Great effort is also expended to keep the tradition alive by instilling a sense of community among the people as they perform their tasks during ricing season.

Other Gathering

Collecting plants and plant by-products was an important role carried out by the Native American tribes in the study area. Uses of the plants ranged from subsistence and medicinal use to use as materials for making everyday necessities. Today, gathering still plays a key role in the lives of Native American tribes. Under the treaty rights, plant materials and natural resources may be gathered from state lands for personal, medicinal, cultural, and traditional craft uses. Private lands could also be used, if made available to the gatherers.

Traditional plant materials and natural resources being gathered today include maple sap, firewood, pine boughs, mushrooms, wild berries, pine cones, nuts, and fruits. Black ash, basswood, ironwood, and white birch bark are all used in making traditional crafts. The materials being gathered require a tribal permit and are for personal use only, and there are restrictions on them, such as those regarding the types of trees and gathering places that are allowed for use (U.S. District Court 2007; GLIFWC 2011c).

The tradition of gathering maple sap is still important with regard to the identity of certain Chippewa groups, like the Red Cliff Band of Lake Superior Chippewa Indians of Wisconsin (Newago 2011). The right to collect the sap and to maintain sugar bushes on state land is protected under the treaties that fall within the study area and the 2007 Inland Consent Decree. Maple sap is harvested in the spring in the upper Great Lakes region. During this time, families go to the sugar bushes that have been harvested by their own family for hundreds of years, set up camp, and devote three to four weeks to making maple sugar (Jenks 1900).

Hunting and Trapping

Hunting and trapping were part of the traditional subsistence patterns of the tribes in the study area. Hunting played a more important role for tribes in the eastern Great Lakes Basin because they could not rely on the fisheries to the same extent as their western neighbors could and because they did not have the wild rice resource. Nevertheless, the capturing of wildlife was practiced throughout the Great Lakes region; it supplemented traditional diets.

Deer, bison, and moose were hunted within the study area (Tanner 1987). Elk, bears, turkey, caribou, and many other animals were hunted and utilized, depending on the region within the study area. Some mammals, such as marten, fisher, beaver, bobcat, and otter, were captured by trapping. This practice became very popular during the fur trade in the 16th century.

Big game animals were hunted and captured by tracking the animal’s movements through the forest. Once the animal was successfully tracked, an arrow, spear, or throwing weapon was thrown to take the animal. Smaller game animals were captured by trapping pits, dead falls, or rudimentary snares. Once the Indians made contact with European fur traders, they contracted with blacksmiths to make metal foothold traps.

The hunting of migratory birds for sustenance also played an important role in the diets of Native Americans. Many types of migratory birds, such as ducks, geese, cormorants, swans, and pigeons, were targeted by using floating decoys to lure the waterfowl to roosting areas. These birds were then captured by bow, nets or snares (Tanner 1987).

Today, hunting and trapping continues to provide a meat source for the diets of Native American tribes. Under the treaty rights, large and small mammals and migratory birds may be hunted on state lands for personal use. This harvest is regulated by permits, allocations, and reporting requirements by each individual tribe, their treaty inter-tribal organization, and each state. These three entities work together to ensure the conservation and protection of these hunted animals (U.S. District Court 2007; GLIFWC 2011c).

Since hunting and trapping contributed so much food to the traditional diet, great spiritual meaning was and still is given to these practices. Ceremonies and offerings are made to the spiritual beings to ensure the bounty and the ease of capture.

PRESENT-DAY SUBSISTENCE PRACTICES OF TREATY TRIBES

Present-day fishing practices spring from traditional tribal world views. The Lake Superior Chippewa or Ojibwe see themselves as the "People of the Water." Their culture is tied to the waters that have provided sustenance from fish and wild rice and have served as highways for travel, communication, and trade. The tribes consider their homeland to be sacred, with intangible, intrinsic, and spiritual value (Balber 2011; Leoso 2011).

According to their traditional beliefs, the Chippewa were created to fit in their current homeland, as were the indigenous plant and animal species of the area. The Creator has tasked them with a responsibility for stewardship over the lakes and shores of their homeland, and the waters are believed to have a spirit. The Chippewa therefore seek both spiritual and physical sustainability in the use of water resources, and at Native American hatcheries, only native species are to be released into the lakes and streams (Abel 2011; Moore 2011; Wilson 2011). Special water ceremonies are conducted at the beginning and end of each fishing season.

The treaties concluded between the various tribes and the United States in the late 18th and mid-19th centuries allowed some tribes to retain their hunting, fishing, and gathering rights on the lands they ceded to the government. Under these treaty rights, tribes engage in both commercial and subsistence fishing. The tribes recognize the importance of maintaining a sustainable resource and of regulating and monitoring treaty-based harvesting. As previously noted, the percentage of the tribe directly involved in subsistence harvesting is often small. However, the effects of even a small number of harvesters ripple through the community, because subsistence harvesters typically share their take with family and friends and with the elderly and others unable to fish. In a small community, members usually know who is in need of food assistance (M. DeFoe 2011; Newago 2011).

Subsistence harvesting of fish, animals, and plant resources continues in these ceded areas. The courts have generally ruled that tribes may continue to use traditional methods of harvesting. Traditional methods of fishing still in use are gill nets, seine nets, spear fishing, angling, and, reportedly, catching by hand (M. Defoe 2011; Newago 2011). Tribal subsistence fishing methods are regulated by individual tribes and inter-tribal organizations in that there are seasons and limits for certain species of fish. The species of fish that are regulated are watched closely due to their popularity with subsistence fishers and the risk of over-fishing within the ceded territories. Traditional fishing methods utilized within the ceded territories are also highly monitored by each tribe's fish and wildlife divisions, inter-tribal organizations, and each state's department of natural resources, because they have the potential to capture many fish at once, which could eventually deplete the species and lead to an ecological imbalance. The intertribal organizations discussed below help in monitoring fishery health and harvesting methods, such as spearing and netting. These are high-profile methods and must be well accounted for, since spearing and netting are not legal methods of fishing for non-tribal members or for tribal members from outside the ceded territories.

The number of fish harvested by other methods is less important with regard to fishery management, since these methods do not target a specific species and since the amount of fish taken by these methods is comparatively small. Most tribes require their members to report only on the species mandated by the intertribal organizations. Other fishing that is taking place on small streams and lakes within the ceded territories or on the reservations by methods other than spearing and netting is not important with regard to the individual tribe's management practices and thus is not closely watched. This makes capturing data for the entirety of subsistence fishing problematic and is the reason why tribes do not know how many permits and licenses are actually being utilized. Most of the data found in this report are from the regulated treaty areas and could appropriately be referred to as "treaty harvest" data.

In order to manage and conserve the fishing resources for current and future use, many tribes also operate fish hatcheries. Many tribes have a natural resource department that monitors fish populations in reservation waters (Leder 2005; Ashland FWCO 2009). Three intertribal organizations, GLIFWC, CORA, and the 1854 Treaty Authority, monitor and regulate treaty-based harvests on ceded lands beyond the reservations.

Chippewa Ottawa Resource Authority

The Chippewa Ottawa Treaty Fishery Resource Authority was established in 1981, and in 2000, the organization became known as the Chippewa Ottawa Resource Authority (CORA). CORA was established by five member tribes (Table 3.1) to protect the 1836 Treaty rights to fish ceded waters in Michigan (Figure 1.3). The purpose of regulating the member tribes' recreation, commercial, and subsistence fishing rights is to ensure the conservation of fishery resources in the treaty-ceded waters in and around the state of Michigan for the continued use by Indian tribes and others entitled to use the resources (CORA 2009).

The CORA fishing regulations specify three different types of fishing that are conducted within the 1836 treaty ceded areas: commercial, subsistence, and recreational. Subsistence fishing is defined as a treaty fishing activity solely to provide fish for personal or family consumption and not for sale or exchange. Recreational fishing is done for enjoyment, and fish captured during this time of fishing can be sold and exchanged. The same regulations concerning species, bag limits, and locations apply to both subsistence and recreational fishers (CORA 2009).

To ensure the conservation of fishery resources, CORA board members apply for and manage funds for the purposes of enhancing, utilizing, and protecting the Great Lakes and inland water resources. CORA board members also employ staff and exercise all duties and responsibilities of the tribes' members within the CORA charter and the court-ordered 2000 Consent Decree, 2007 Inland Consent Decree, any agreement with the State of Michigan, and any resource management plan adopted by a member tribe. CORA also maintains an intertribal biology staff for fish monitoring and fishery management and enhancement (CORA 2000).

Table 5: CORA Member Tribes

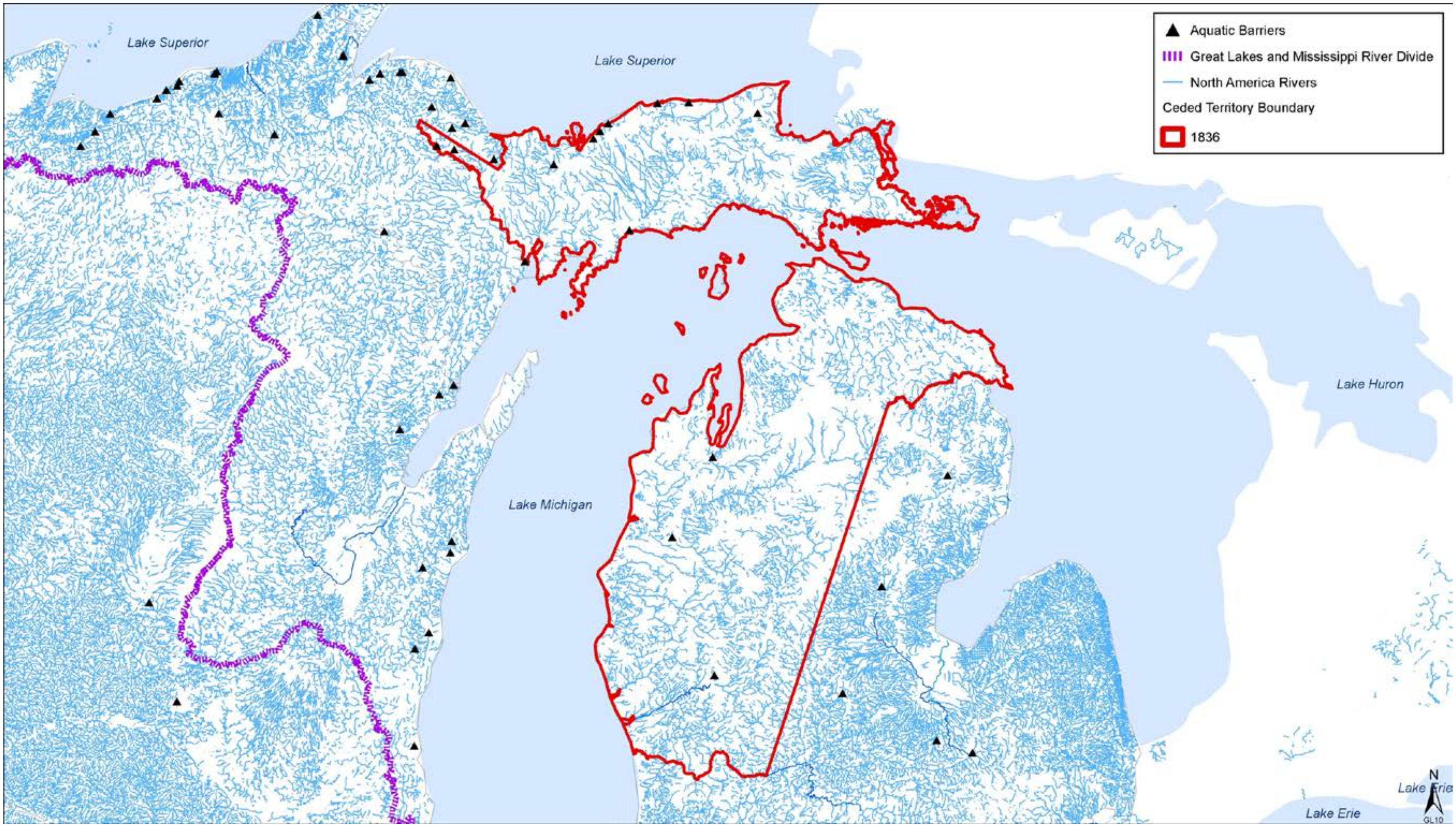
Tribe	Practice Subsistence Fishing in Study Area?
Bay Mills Indian Community	Yes
Grand Traverse Band of Ottawa and Chippewa Indians	Yes
Little River Band of Ottawa Indians	Yes
Little Traverse Bay Bands of Odawa Indians	Yes
Sault Ste. Marie Tribe of Chippewa Indians of Michigan	Yes

The 2000 Consent Decree is a negotiated settlement involving five federally recognized tribes, the United States, and the State of Michigan that resolved differences regarding the allocation, management, and regulation of fishing in 1836 Treaty waters located in Lake Michigan, Lake Superior, Lake Huron, and connecting waters. The 2007 Inland Consent Decree is a negotiated settlement involving the five CORA tribes, the State of Michigan, and the United States that deals with hunting and fishing rights under the principal treaties. This agreement defines the tribes' rights to fish and hunt on ceded land and waters under Article 13 of the 1836 Treaty and establishes the parameters on where, how, and when the tribes may exercise those rights. The 2007 Inland Consent Decree agreement applies only within Michigan state boundaries and takes into account fisheries, wildlife, and land management, such as the gathering of plants, fire wood, and maple sap (U.S. District Court 2007). The treaty-ceded waters in Michigan include Lake Superior, Lake Huron, Lake Michigan, and connecting waters, ceded in Article First of the Treaty of March 28, 1836. Article First specifies the boundaries of the land that was ceded to the United States and that can still be used by the tribes to practice their traditional subsistence and commercial ways of life.

CORA tribes practice commercial, subsistence, and recreational fishing under their 1836 Treaty rights. Commercial fishers use gill nets and trap nets; they mainly target whitefish, although lake trout, salmon, chub, lake herring, menominee (round whitefish), walleye, and perch are also taken. Under the Consent Decrees, CORA tribes must keep records of their catch and fishing efforts. Tribal commercial licenses tend to be passed down within families (CORA 2009). Tribes that practice subsistence fishing under CORA regulations are permitted to use impoundment gear, consisting of traps and weirs, as well as hooks, spears, bows and arrows, artificial lights, seines, dip nets, and one large-mesh or small-mesh gill net per person on Lakes Superior, Huron, and Michigan (CORA 2009). Subsistence fishers must be licensed by their tribe, have a total amount of no more than 100 pounds of all species in their possession, and report their take to tribal natural resource departments.

Inland fishing in waters, which are in the area ceded in Article First of the Treaty of March 28, 1836, is also permitted to tribal members. The types of gear permitted for inland fishing are impoundment and gill nets, which are regulated by the member tribe. Seine nets are permitted but cannot be used in streams; the use of hand nets, dip nets, spears, bows and arrows, hand fishing, trotlines, and the hook-and-line method is also permitted (U.S. District Court 2007). Figure 3.1 shows the available streams and rivers within the 1836 ceded territory that are allowable for subsistence fishing. Tribal members may fish in any water body that has public access. Discussions of each of the five member tribes’ activities are provided in Sections 3.1.1 through 3.1.5.

Figure 8: Stream and Rivers within the Territory Ceded Under the 1836 Treaty



Grand Traverse Band of Ottawa and Chippewa Indians

The Grand Traverse Band of Ottawa and Chippewa Indians are members of CORA and are permitted to practice subsistence fishing in the treaty-ceded waters regulated by CORA.

The Grand Traverse Band has a natural resource department that seeks to protect and enhance the environment and resources that were given to the Chippewa and Ottawa people by the Creator (Grand Traverse Band of Ottawa and Chippewa Indians 2011). The Grand Traverse Band has inland hunting, trapping, and gathering regulations; they seek to provide a system of self-regulation of tribal members' Article 13 Rights and to comply with the 2007 Inland Consent Decree (Grand Traverse Band Natural Resource Department 2008).

Little River Band of Ottawa Indians

The Little River Band of Ottawa Indians (LRBOI) is a member of CORA and is permitted to engage in subsistence fishing in the treaty-ceded waters regulated by CORA. The LRBOI promulgates fishing regulations that seek to provide a system of self-regulation of tribal members' inland Article 13 Rights and to comply with the 2007 Inland Consent Decree (LRBOI 2009). LRBOI also manages an inland fishery.

The LRBOI fishing regulations state that all members seeking to fish and harvest must have a tribal identification card and a photo identification card. General regulations, regulations on methods and gear, species and area restriction regulations, and reporting regulations can be found in the *Fishing Regulation Book* (LRBOI 2009). The fishing regulations also provide for special use permits, which include special needs subsistence and ceremonial needs subsistence. A person must apply for this permit when he or she needs to supply food for a ceremonial gathering, traditional feast, addressing a personal or family hardship, or a celebration.

The LRBOI seeks to maintain biologically sound inland fishery harvest opportunities within its reservation and the 1836 ceded territory. Objectives include tribal outreach activities, interagency cooperation, litigation support, and promotion of the rights of tribal fish harvesting (LRBOI 2009). To meet this goal, the LRBOI Natural Resource Department conducts ongoing biological assessments that focus on culturally significant species, such as historically harvested fish, to provide subsistence fishing opportunities to tribal members. The LRBOI hatchery focuses on research and rehabilitation of lake sturgeon, annual assessments of walleye and northern pike to assess stocking methods and management actions, watershed restoration of inland streams, and monitoring of salmon and trout in inland streams (LRBOI 2011).

Little Traverse Bay Bands of Odawa Indians

The Little Traverse Bay Bands of Odawa Indians is a member of CORA and is permitted to engage in subsistence fishing in the treaty-ceded waters regulated by CORA. The Little Traverse Bay Bands of Odawa Indians has established rules and regulations to regulate the use of natural resources within the reservation lands and any lands described in Article First of the Treaty of March 28, 1836 (Little Traverse Bay Bands of Odawa Indians 2010).

The rules and regulations provide for a special use permit, along with subsistence fishing guidelines, authorizing special needs harvesting and ceremonial needs harvesting. This permit is required when a Band member seeks to supply food for a ceremonial gathering, traditional feast, addressing personal or family hardship, or a celebration. Specific regulations and guidelines for fishing, hunting, and trapping are available in *Natural Resources Rules and Regulations* (Little Traverse Bay Bands of Odawa Indians 2010).

The Little Traverse Bay Band also makes publicly available on its Web site the *2008/2009 Annual Harvest Report*, which covers wildlife and commercial and subsistence fishing. This report outlines information on harvests from reservation land, within the 1836 ceded territory, and within the Great Lakes (Little Traverse Bay Bands of Odawa Indians 2009).

In the *2008/2009 Annual Harvest Report*, subsistence fish harvest for the Great Lakes is reported by four tribal members to occur in Lake Superior and Lake Huron. Species harvested by using gill net and hook and line included salmon, lake trout, whitefish, menominee (round whitefish), and herring (Little Traverse Bay Bands of Odawa Indians 2009). Table 3.2 shows the most common fish species taken by subsistence harvesters.

According to the *2008/2009 Annual Harvest Report*, the subsistence fish harvest within the inland waters of the 1836 ceded territory has escalated since the 2007 Inland Consent Decree came into effect. The reason for this growth in participation is that the tribal members are becoming more familiar with the regulations and their Article 13 Rights. In 2008, 504 inland hunting and fishing licenses were issued by the Little Traverse Bay Bands of Odawa Indians. Of those 504 license holders, 484 were surveyed to determine where they hunted and fished, what they captured, and what methods they used. Of those surveyed, 83% fished in inland lakes and streams, while 16% fished with a spear for walleye. The most common species caught by hook and line were perch, bluegill, bass, smelt, and rock bass. The most common caught by spear, trotline, and hands and dip net were walleye, salmon and rainbow trout. It was determined that the majority of licensed tribal members were exercising their Article 13 Rights on or within the counties next to the reservation, yet it was reported that 34 of 38 counties in the 1836 ceded territory were used for inland fishing (Little Traverse Bay Bands of Odawa Indians 2009).

Table 6: Fish Species Taken by Subsistence Harvesters[a]

Subsistence Fish	Scientific Name	Grand Portage	Fond du Lac	Red Cliff	Bad River	Keweenaw Bay	Bay Mills	Little Traverse Bay	Little River Band	Huron Potawatomi	Stockbridge-Munsee	St. Regis Mohawk	St. Croix	Lac du Flambeau	Lac Vieux Desert	Sault Ste. Marie	Sokaogon
Bass	Various species	X		X	X		X		X			X	X				X
Bluegill (sunfish)	*Lepomis macrochirus*															X	
Bowfin	*Amia calva*																
Bullhead	*Ameiurus spp.*				X		X					X					
Burbot	*Lota lota*	X		X	X	X	X										
Catfish	Various species		X				X			X							
Ciscoes (lake herring, chub, tullibee)	*Coregonus spp.*	X		X	X	X	X	X	X								
Common carp	*Cyprinus carpio*			X			X										
Crappie	Various species				X		X		X								
Grayling	*Thymallus thymallus*																
Lake sturgeon	*Acipenser fulvescens*	X		X	X	X			X			X	X			X	
Menominee (round whitefish)	*Prosopium cylindraceum*	X		X	X		X	X									
Muskellunge	*Esox masquinongy*				X		X		X			X	X	X		X	X
Northern pike	*Esox lucius*	X	X	X	X	X	X		X	X		X	X	X		X	X
Salmon (coho, chinook)	Various species	X	X	X	X	X	X	X	X					X		X	
Shiner	Various species			X													
Smelt	*Osmerus mordax*	X		X	X				X							X	
Splake	*Salvelinus namaycush X Salvelinus fontinalis*						X										
Sucker	*Catostomus spp*			X	X	X	X			X						X	
Trout, brown	*Salmo trutta*			X	X		X		X		X					X	
Trout, brook	*Salvelinus fontinalis*	X		X	X		X		X		X					X	
Trout, lake	*Salvelinus namaycush*	X	X	X	X		X	X	X						X		
Trout, rainbow (steelhead)	*Oncorhynchus mykiss*	X	X	X	X		X	X	X		X					X	
Walleye	*Sander vitreus*	X	X	X	X	X	X	X	X			X	X	X	X	X	X
Whitefish, lake	*Coregonus clupeaformis*	X		X	X	X	X	X	X								
Yellow perch	*Perca flavescens*	X			X		X		X			X				X	

[a] Table 3.2 is not a comprehensive table of all tribes that practice subsistence fishing and all the fish species they harvest. This table shows targeted species from the tribal groups that have shared their targeted species information. Because a tribe is not listed does not mean that the tribe does not engage in subsistence fishing.

Sault Ste. Marie Tribe of Chippewa Indians of Michigan

The Sault St. Marie Tribe of Chippewa Indians of Michigan is a member of CORA and is permitted to engage in subsistence fishing in the treaty-ceded waters regulated by CORA. The Sault tribe has a Conservation Committee that acts as a regulatory agency over the fishing and hunting activity of tribal members. The Sault tribe also has treaty fishing rules and regulations to achieve compliance with the 2007 Inland Consent Decree and provide a system of self-regulation of tribal members' inland Article 13 Rights (Sault Ste. Marie Tribe of Chippewa Indians 2010).

The Sault tribe's Natural Resource Department has an intertribal fisheries and assessment program that operates under three main focus areas. The Great Lakes fisheries management operation provides commercial and subsistence catch statistics to comply with reporting obligations, conducts field studies to assess status of fish populations in the 1836 Treaty-ceded waters of the Great Lakes, analyzes catch and assessment data to determine population status, undertakes research, and develops programs to enhance treaty fishing opportunities and represent the Sault tribe on CORA's Technical Fisheries Committee. The Great Lakes environmental operation addresses environmental issues that are related to the Sault tribe's Great Lakes fishery interests. Work includes conducting fish contaminant studies and participating in educational activities. The fisheries enhancement operation runs and maintains two walleye fish hatcheries. It also conducts research and assessments related to fish stocking programs and manages nontraditional fish species (Sault Ste. Marie Tribe of Chippewa Indians 2011).

In 2010, the Sault tribe issued 3,028 inland fishing licenses, and 43% of the license holders reported fishing efforts in 2010. The licenses cover all types of inland fishing; however, every tribal member has the right to subsistence fish under the 1836 Treaty. The annual harvest report is broken down into the most common species captured over the entire 1836 ceded territory. The requirements of the 2007 Inland Consent Decree do not mandate that specific water bodies be reported; however, some of the spearing activity is reported, by lake. The most common species reportedly captured in 2010 were rainbow, brook, and brown trout; coho, Chinook, and pink salmon; walleye; muskellunge; pike; perch; bluegill; sucker; smelt; and sturgeon (Clarke 2010).

Bay Mills Indian Community

The Bay Mills Indian Community (BMIC) is a member of both CORA and GLIFWC. The Bay Mills Indian Community tribal members are permitted to fish, hunt, and gather in the treaty-ceded waters and lands regulated by these agencies.

The BMIC has a Conservation Committee, started in 1979, that was given authority and responsibility for regulations pertaining to hunting, fishing, and trapping. The Conservation Committee works with federal enforcement agents, officers of GLIFWC, officers of CORA, and enforcement officers of a tribe with whom the BMIC has entered into a cooperative agreement (BMIC 2004). The role of the Conservation Committee is to issue fishing licenses, regulate seasons (there is either a season or no season for fishing provided in order to preserve the resource), set limits on the resource for conservation purposes, review permits and licenses each year to determine whether the number of permits are conducive to conserving the resource, establish regulations, and keep reports of each resource collected (BMIC 2004).

In order to take fish within the ceded territories, a member of the BMIC must have a fishing identification permit issued by the Conservation Committee. There are regulations imposed for the taking of all the different fish species. Certain species of fish have special conservation regulations governing their harvest; they include brook trout, brown trout, crappie, grayling, lake trout, muskellunge, northern pike, rainbow trout, rock bass, smallmouth bass, splake, sturgeon, sunfish, walleye, steelhead, Atlantic salmon, whitefish (BMIC 2004 Table 3.2). General regulations set by the Conservation Committee on the taking of fish can be found in the *Bay Mills Indian Community Tribal Fishing Regulations* and in the *Conservation Code*, which are available to the public.

BMIC members do very little subsistence fishing on inland lakes and streams, except for walleye spearing in the spring. In 2011, however, no walleye spearing permits were issued. The majority of the inland fishing conducted by the BMIC falls under recreational fishing within the 1836 ceded territory. Most of the subsistence fishing is done on the Great Lakes and within the St. Mary's River (Carrick 2012).

Great Lakes Indian Fish and Wildlife Commission

In 1984, six Ojibwe tribes that retain off-reservation treaty rights both on inland waters and on Lake Superior formed the GLIFWC to provide resource management enforcement services to 11 tribes in Minnesota, Wisconsin, and Michigan (Table 3.3). The GLIFWC includes two committees: The Voigt Intertribal Task Force represents tribes with inland treaty rights, and the Lakes Committee represents tribes that fish commercially in Lake Superior (GLIFWC 2011a).

Table 7: GLIFWC Member Tribes

Tribes	Practice Subsistence Fishing in Study Area?
Bay Mills Indian Community	Yes
Keweenaw Bay Indian Community	Yes
Lac Vieux Desert Band of Lake Superior Chippewa Indians	Yes
Bad River Band of Lake Superior Chippewa Tribe	Yes
Red Cliff Band of Lake Superior Chippewa Indians of Wisconsin	Yes
Lac du Flambeau Band of Lake Superior Chippewa Indians of Wisconsin	Yes
Lac Courte Oreilles Band of Ojibwe	Yes
Sokaogon Chippewa Community	Yes
St. Croix Chippewa Indians of Wisconsin	Yes
Mille Lacs Band of Ojibwe	Yes
Fond du Lac Band of Lake Superior Chippewa Indians	Yes

Regulations set forth by the GLIFWC outline important protocols to follow within the 1837 and 1842 ceded territories that are outside reservation lands. These include guidelines for spearing, netting, and hook and line fishing in the Minnesota 1837 ceded territories and Wisconsin 1837 and 1842 ceded territories. Each individual tribe has specific regulations governing the tribally owned fisheries within the reservation. The tribal regulations governed by individual tribes include, but are not limited to, when (the hours) fishing may begin or end, which waters are open to harvest, which landings or monitoring sites can be used, what the quotas for certain species of fish are, and when (the times) a lake is available for netting.

According to publicly available reports located on the GLIFWC Web site, all of the GLIFWC tribes are exercising their inland treaty rights (GLIFWC 2012). These reports only detail the spearing and netting efforts within inland waters of the Minnesota and Wisconsin ceded territories.

The Minnesota 1837 Treaty harvest reports available for review on the GLIFWC Web site, dating from 1998 to 2008, indicated there were 14 lakes with harvests. Mille Lacs Lake was always the one that was the most used by the fishers and that produced the biggest variety of fish species. In the years 2004–2007, Mille Lacs Lake was reportedly the only one that was fished by spearing and netting; however, Mille Lacs Lake has no unimpeded connection to the Great Lakes or the Upper Mississippi River. The 14 lakes were examined to determine whether there was an unblocked aquatic path between them and either the Mississippi River or Lake Superior. Only 5 of the 14 lakes reported in the 1837 ceded territory of Minnesota have an unimpeded connection to the Great Lakes or Upper Mississippi River. Table 3.4 shows the spearing and netting harvests of the lakes that are connected within the 1837 ceded territory within Minnesota.

Table 8: Minnesota 1837 Ceded Territory Inland Spearing and Netting Harvest in Unimpeded Connected Water Bodies, 1998-2008

Lake	County	Fish Species
Goose Lake	Chisago	Walleye, bass, bullhead
Pokegama Lake	Pine	Walleye, sucker
Cross Lake	Pine	Walleye, northern pike, muskellunge, crappie, sucker, bullhead
Rock Lake	Pine	Walleye, northern pike
St. Croix River	Pine	Walleye, sturgeon, sucker

The GLIFWC tribes track the subsistence harvest from the spring spear fishing season from more than 500 inland lakes, flowages, and reservoirs distributed within both the Upper Mississippi and Great Lakes Basins. Walleye is the target species, but records for muskellunge, largemouth bass, smallmouth bass, and northern pike are also kept. Some of these water bodies have only inward drainage, but others have outflows that tie into the broader hydraulic network of Wisconsin. Using geographic information system layers from USGS' National Hydrography Dataset and the aquatic barrier layer provided by the USACE each of 530 water bodies were examined to determine whether there was an unblocked aquatic path between them and either the Mississippi River or Lake Superior or Lake Michigan. To analyze the bounding condition, we assumed that any aquatic tie, no matter how shallow, could allow aquatic access. We found that only 38 of these inland water bodies have unimpeded aquatic ties to either the Great Lakes or the Mississippi. Table 3.5 shows the species taken at each lake in the 2005–2009 spring spearing seasons. The fish taken from these water bodies represents only a very small percentage of the total take from inland spear fishing. Figure 3.2 and Figure 3.3 shows all available streams and rivers within the 1837 and 1842 ceded territories that are allowable for subsistence fishing. Tribal members may fish in any water body that has public access within the ceded territories. Sections 3.2.1 through 3.2.10 provide a discussion of the activities undertaken by member tribes of the GLIFWC.

Keweenaw Bay Indian Community

The Keweenaw Bay Indian Community (KBIC) exercises its subsistence and commercial fishing treaty rights within the 1842 ceded territory. The KBIC has a Natural Resource Department that administers a variety of activities, such as Lake Superior fishery assessments, wildlife and wetlands management, and stocking fish from its hatchery (KBIC 2011).

KBIC tribal members subsistence fish on Lake Superior and on the inland lakes and streams within the ceded territories (Mensch 2011b) (Figure 1.3). Members apply for a subsistence fishing license and, through this license, are allowed to fish for personal use only. Subsistence fishing licenses can also be applied for and used by tribal leaders to provide fish for annual and special events, such as KBIC Pow Wow Feast. Subsistence fishers are not required to report their catches, except for the regulated species catches governed by GLIFWC. Species targeted in subsistence fishing are walleye, various salmonid species, lake whitefish, cisco, sucker species, northern pike, burbot, and a very limited allowable harvest of lake sturgeon (Mensch 2011a) (Table 3.2). Tribal members practice subsistence fishing by netting, spearing, and hook and line (Mensch 2011b). Spearing is conducted on Lake Superior within the Keweenaw Band and Huron Bay, as well as on the inland lakes and rivers (Mensch 2011b).

The KBIC maintains a fish hatchery that has been propagating fish since 1989. Approximately 40,000 brook trout are stocked in local streams each year. The KBIC hatchery also works with the U.S. Fish and Wildlife Service to restore brook trout to Lake Superior and its tributaries (Leder 2005). Walleye have been and are becoming an increasingly important component of fish and wildlife management to the KBIC. KBIC's aquaculture operations are actively exploring options to increase capacity to rear and stock walleye (Mensch 2011a).

Lac Vieux Desert Band of Lake Superior Chippewa Indians

The Lac Vieux Desert Band exercises its subsistence rights within the 1842 ceded territory. According to George Beck, Director of Planning and Environmental, the Lac Vieux Desert Band fishes only on inland lakes and streams. The band members to do not travel to harvest fish on the Great Lakes. Most of the subsistence fishing that takes place on inland waters occurs on the Ontonagon River watershed, where 90% of the harvested fish are walleye, with some lake trout harvested from the inland lakes (Beck 2011).

Table 9: Species Harvested in the 2005-2009 Wisconsin Spearing Season from Connected Water Bodies

Name	County	Species Harvested
Mineral Lake	Ashland	None
Diamond Lake	Bayfield	Walleye, bass, northern pike
Hart Lake	Bayfield	None
Lake Millicent	Bayfield	None
Muskellunge Lake	Bayfield	None
Pike Lake	Bayfield	Walleye, muskellunge
Siskiwit Lake	Bayfield	None
Twin Bear Lake	Bayfield	Muskellunge
Big Trade Lake	Burnett	None
Round Lake	Burnett	None
Lake Minnesuing	Douglas	Walleye
Lake Nebagamon	Douglas	Walleye
Crane Lake	Forest	Walleye
Lake Lucerne	Forest	Walleye, smallmouth bass
Lake Metonga	Forest	Walleye, northern pike
Mole Lake	Forest	Walleye
Pickerel Lake	Forest	None
Pine Lake	Forest	Walleye
Roberts Lake	Forest	Walleye
Windfall Lake	Forest	None
Boulder Lake	Langlade	None
Lower Post Lake	Langlade	None
Pickerel Lake	Langlade	None
Rolling Stone Lake	Langlade	Walleye
Rose Lakes	Langlade	Walleye
Upper Post Lake	Langlade	Walleye
White Lake	Langlade	None
Lake Nokomis	Oneida	Walleye, muskellunge
Upper Post Lake	Oneida	None
Balsam Lake	Polk	Walleye, largemouth bass, northern pike
Big Butternut Lake	Polk	Walleye, largemouth bass
Big Round Lake	Polk	Walleye, largemouth bass, small mouth bass, northern pike
Bone Lake	Polk	Muskellunge, largemouth bass, smallmouth bass
Cedar Lake	Polk	None
Deer Lake	Polk	Muskellunge, largemouth bass
Half Moon Lake	Polk	Walleye, largemouth bass
Magnor Lake	Polk	Walleye
Wapogasset Lake	Polk	Walleye

Source: Krueger (2006, 2007, 2008, 2009, 2010)

Figure 9: Streams and Riveres within the Territory Ceded under the 1837 Treaty

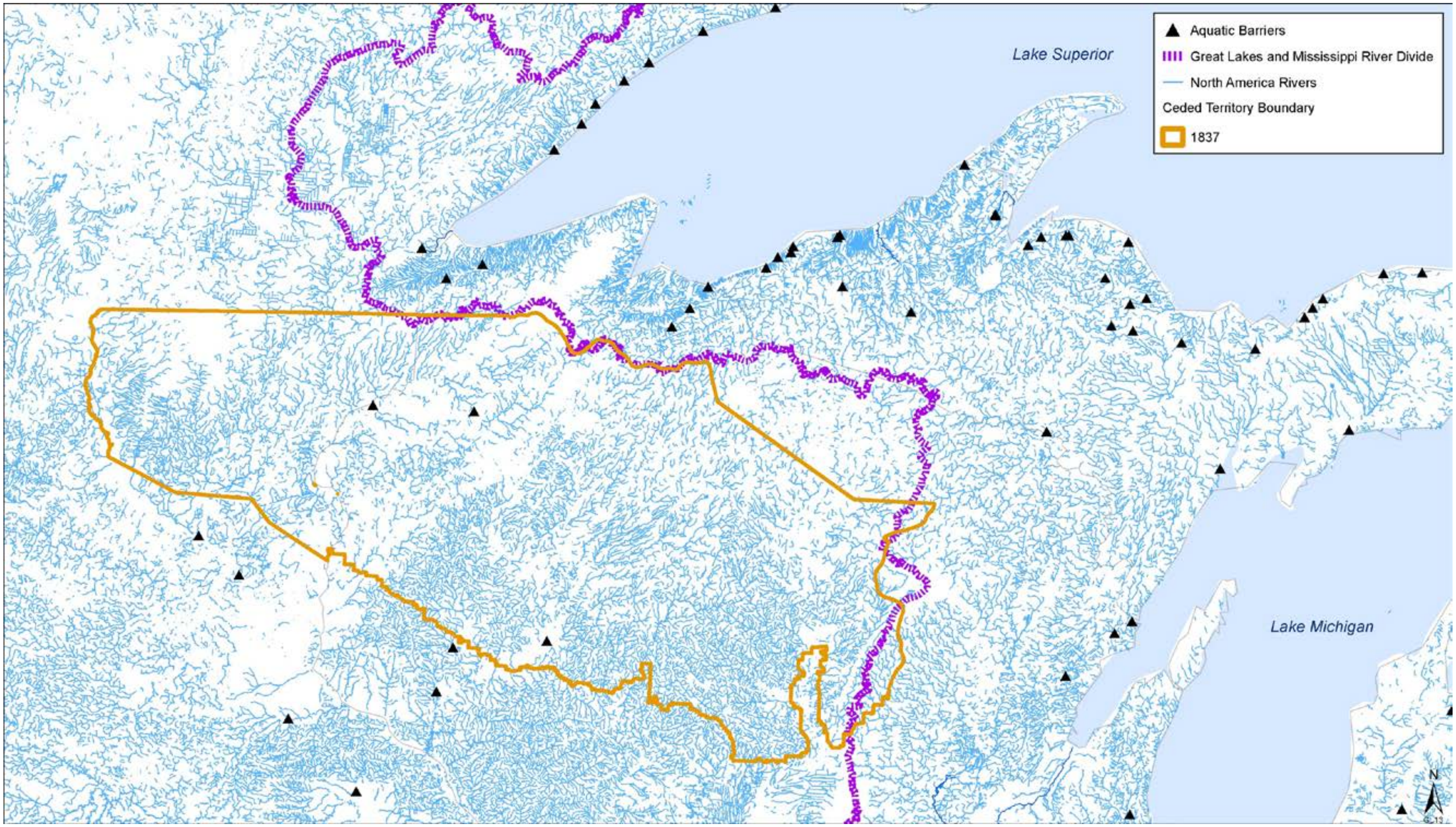
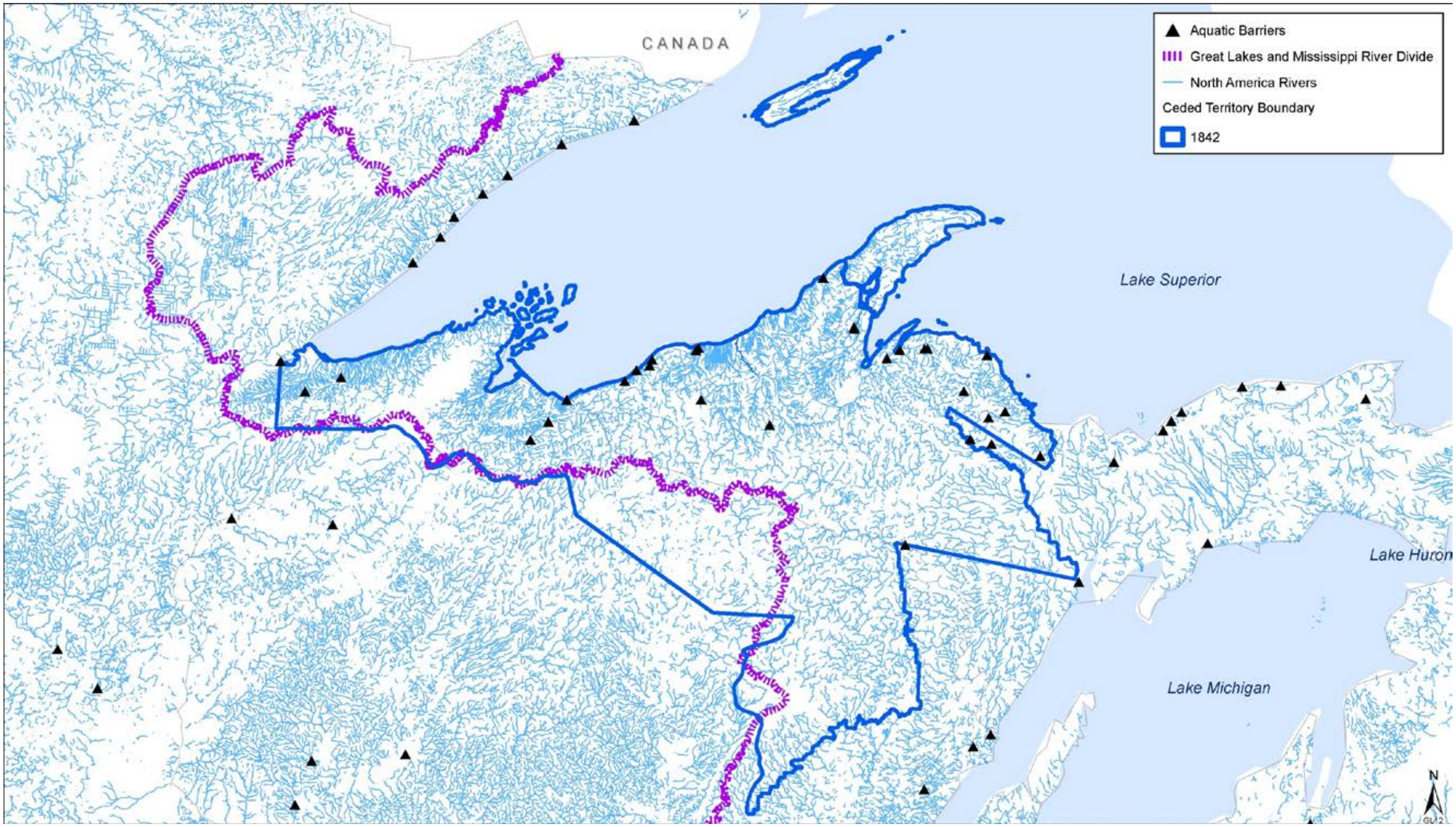


Figure 10: Streams and Rivers within the Territory Ceded under the 1842 Treaty



Bad River Band of Lake Superior Chippewa Tribe

The Bad River Band exercises its subsistence and commercial fishing treaty rights within the 1842 ceded territory. The Bad River Band has a Natural Resources Department that provides assistance in protecting, conserving, managing, and developing the natural resources throughout the Bad River Reservation and its treaty fishing waters (Bad River Natural Resources Department 2010). The majority of the Bad River Band's subsistence fishing is conducted on the Bad River and Kakagon River for walleye, but members also do subsistence fishing in Lake Superior and on Madeline Island (Wilson 2011).

Subsistence fishing is not closely monitored, and no formal statistics are kept on how many subsistence fishermen there are per year and what species are being taken; however, it is estimated that there are 10 practicing subsistence fishermen (Wilson 2011). Lake Superior subsistence fishing is done along the shores of the reservation and Madeline Island by using 100 to 300 feet of gill net (Wilson 2011). Spear fishing focuses on the spring spawning run on inland waters. There is a natural lake sturgeon fishery in the Bad River, one of the only sturgeon fisheries on Lake Superior (Wilson 2011). Walleye, yellow perch, and lake sturgeon are the target species for subsistence fishers (Tillison 2011; Wilson 2011) (Table 3.2).

The Bad River Band has operated a fish hatchery since 1968. The hatchery has concentrated its efforts on raising walleye fry and fingerlings to supplement existing walleye populations within reservation waters. Today the hatchery also raises yellow perch, white suckers, and lake sturgeon (Ashland FWCO 2009).

Red Cliff Band of Lake Superior Chippewa Indians of Wisconsin

The Red Cliff Band exercises its subsistence and commercial fishing treaty rights within the 1842 ceded territory. The Red Cliff Band has a Treaty and Natural Resource Division that incorporates fishery management and a fish hatchery into its program (Red Cliff Band of Lake Superior Chippewa 2004).

The Red Cliff Band has the largest Native American commercial fishing fleet on Lake Superior, with 14 large boats and a fleet of approximately 25 smaller boats. Subsistence fishing or home-use fishing has always been common in Lake Superior and inland lakes and streams. Approximately 15 tribal members regularly fish for subsistence within a year (Newago 2011). Subsistence fishing permits are required, but reporting the catch is not; therefore, the subsistence fishing practice is not highly monitored. Gill and seine nets and angling are the most common methods used for subsistence fishing. Spearing and catching fish by hand is common, but only on the inland lakes during particular times of the year. Lake trout and whitefish are the targeted species in the study area. Table 3.2 shows the most common species of subsistence fish taken by subsistence harvesters.

The Red Cliff Band has operated a fish hatchery since 1994 as a trout- and walleye-rearing facility. In the past few years, the hatchery has been raising Lake Superior lake sturgeon in partnership with the U.S. Fish and Wildlife Service (Ashland FWCO 2009).

Lac du Flambeau Band of Lake Superior Chippewa Indians of Wisconsin

The Lac du Flambeau Band exercises its subsistence treaty rights within the 1842 and 1837 ceded territories. Members of this Band only do subsistence fishing on inland lakes and streams within treaty-ceded territories of Wisconsin, Minnesota, and Michigan. Tribal members travel all over the ceded territory to fish, hunt, and harvest wild rice. On the Lac du Flambeau reservation alone, there are 260 lakes and 71 miles of rivers and streams. Two of the most common rivers fished by Lac du Flambeau tribal members are the Bear River and the Trout River. Inland fishing is done by spearing, angling, and netting, with the most common subsistence species being walleye, sockeye salmon, musky, and northern pike (Wawronowicz 2012).

The Lac du Flambeau Band has operated a fish hatchery since 1960. The hatchery program raises all fish necessary for stocking reservation waters and focuses on walleye and muskellunge. The fisheries and fish culture program also conducts fish population studies involving electro fishing and creel surveys (Lac du Flambeau Band of Lake Superior Chippewa Indians of Wisconsin 2010).

Lac Courte Oreilles Band of Ojibwe

The Lac Courte Oreilles Band of Ojibwe exercises its treaty rights within the 1837 and 1842 ceded territories. Members of this Band only practice subsistence fishing on inland lakes and streams within treaty-ceded territories of Wisconsin, Minnesota, and Michigan. According to Paul Christel, fisheries biologist, no reporting is required for subsistence harvests except for spring spearing season, which GLIFWC monitors. He stated that there are small trout streams around the counties bordering the reservation; however, there is no way to know which streams are being fished (Christel 2012).

The Lac Courte Oreilles Band has a Conservation and Environmental Protection Department that operates a fish hatchery. This department has involved itself in numerous projects, such as stocking walleye and musky within the reservation waters, fish habitat restoration, fish studies, and the eradication of aquatic nuisance species (Christel 2012).

Sokaogon Chippewa Community

The Sokaogon Chippewa Community exercises its treaty rights within the 1837 and 1842 ceded territories. Subsistence fishing is practiced by the tribal members on inland lakes and streams within the ceded territories. Targeted species captured are walleye, northern pike, smallmouth and largemouth bass, and muskellunge.

St. Croix Chippewa Indians of Wisconsin

The St. Croix Chippewa Indians of Wisconsin exercise their treaty rights within the 1837 and 1842 ceded territories. The St. Croix tribal members fish mostly in Wisconsin counties near the reservation, such as Polk, Washburn, Sawyer, Douglas, Burnett, Barron, and St. Croix. Some members, however, do travel to Mille Lacs Lake in Minnesota, among others. The St. Croix

River and Yellow River are the rivers fished most commonly by the St. Croix members. Efficient methods of fish harvest include spearing and netting. Spearing is the primary method used in Wisconsin; netting is more prevalent in Minnesota. The spring harvest of walleye is the largest contributor to the diets of tribal members. Other species that are collected include musky, northern pike, largemouth bass, and sturgeon (Taylor 2011).

The St. Croix Natural Resources Department operates a fish hatchery that raises walleye to stock in area lakes. Other duties of the Natural Resources Department include monitoring wild rice, conducting walleye electrofishing surveys, and carp management (St. Croix Chippewa Indians of Wisconsin 2012).

Mille Lacs Band of Ojibwe

The Mille Lacs Band of Ojibwe exercises its treaty rights within the 1837 ceded territory. The tribal members report their spearing efforts on Mille Lacs Lake to GLIFWC; however, they were hesitant to provide any additional information on which lakes and streams members were fishing and on which species were being targeted. According to Kelly Applegate of the Band’s Fish and Wildlife Division, there are streams flowing into and out of Mille Lacs Lake, and those are where the majority of subsistence fishing, other than that done on Mille Lacs Lake, is being done (Applegate 2012).

Fond du Lac Band of Lake Superior Chippewa Indians

The Fond du Lac Band tribal members exercise their treaty rights within the 1854 and 1837 ceded territories. The Fond du Lac Band has a Natural Resource Department that administers a variety of activities, such as collecting data to manage fishery resources under the 1854 and 1837 ceded territories, exercising and managing treaty-reserved fishing rights within the 1837 ceded territory, and working closely with the Minnesota Department of Natural Resources to monitor and tally harvests in order to strictly regulate fishing limits (Fond du Lac Band of Lake Superior Chippewa 2011).

Approximately 20 to 30 families practice subsistence fishing yearly (Howes 2011). The methods most commonly used are angling, gill netting, and spearing. The targeted species in Lake Superior are lake trout and steelhead, whereas those in the St. Louis River are channel catfish, walleye, and northern pike (Howes 2011) (Table 3.2). The majority of the subsistence fishing (approximately 80%) is conducted on inland lakes and streams. Of all subsistence fishing, 70% is conducted on the reservation, while the other 10% of fishing takes place all over the ceded territories, including Mille Lacs Lake, the largest inland lake in the ceded territories (Howes 2011).

1854 Treaty Authority

The 1854 Treaty Authority is an intertribal natural resource management organization that manages off-reservation hunting, fishing, and gathering rights in the territory ceded under the Treaty of 1854. Member tribes are the Grand Portage and the Bois Forte Bands of Lake Superior Chippewa Indians (1854 Treaty Authority no date.) (Table 3.6).

Figure 11: 1854 Treaty Authority Tribes

Tribes	Practice Subsistence Fishing in Study Area?
Grand Portage Band of Lake Superior Chippewa Indians	Yes
Bois Forte Band of Lake Superior Chippewa Indians	No

The Natural Resource Department of the 1854 Treaty Authority is involved in research and management of fish populations within the 1854 ceded territory. The department focuses on walleye management, and its work is done in cooperation with the Fond du Lac Band of Lake Superior Chippewa Indians and the Minnesota Department of Natural Resources (1854 Treaty Authority no date).

The Grand Portage Band of Lake Superior Chippewa Indians is the only tribe under the 1854 Treaty Authority that harvests fish for subsistence use within the study area. The Bois Forte Band is outside the Upper Mississippi River Basin and the Great Lakes Basin. The Grand Portage Band has a Natural Resource Department that monitors fish and wildlife and that operates a fish hatchery. Figure 3.4 shows the rivers and streams within the 1854 ceded territory that are allowable for subsistence fishing. . Members of the Grand Portage Band practice subsistence fishing in the Grand Portage Zone of Lake Superior (Figure 3.5). Tribal members may fish in any water body that has public access within the ceded territories. The methods most commonly used are gill netting and angling. The species most commonly targeted are lake trout, brook trout, menominee (round whitefish), whitefish, cisco (which includes chubs and herring), walleye, and pike (Moore 2011) (Table 3.2). No reporting of subsistence fish catches is required.

The Grand Portage Band also operates a fish hatchery, which stocks inland lakes and the Grand Portage Zone of Lake Superior. The indigenous species raised and stocked by this hatchery are brook trout, lake whitefish, and lake herring (Moore 2011).

Figure 12: Streams and Rivers within the Territory Ceded under the 1854 Treaty

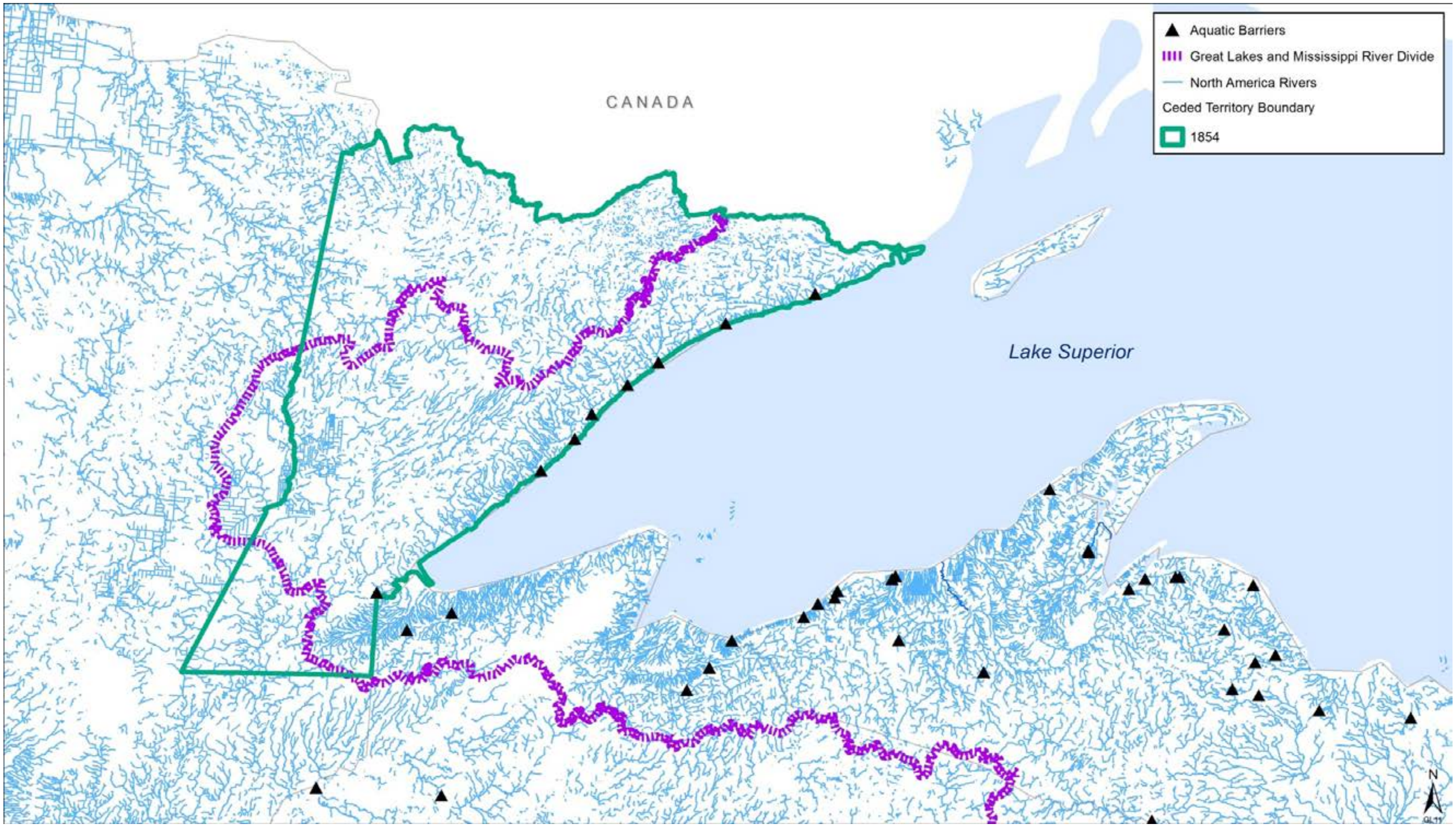
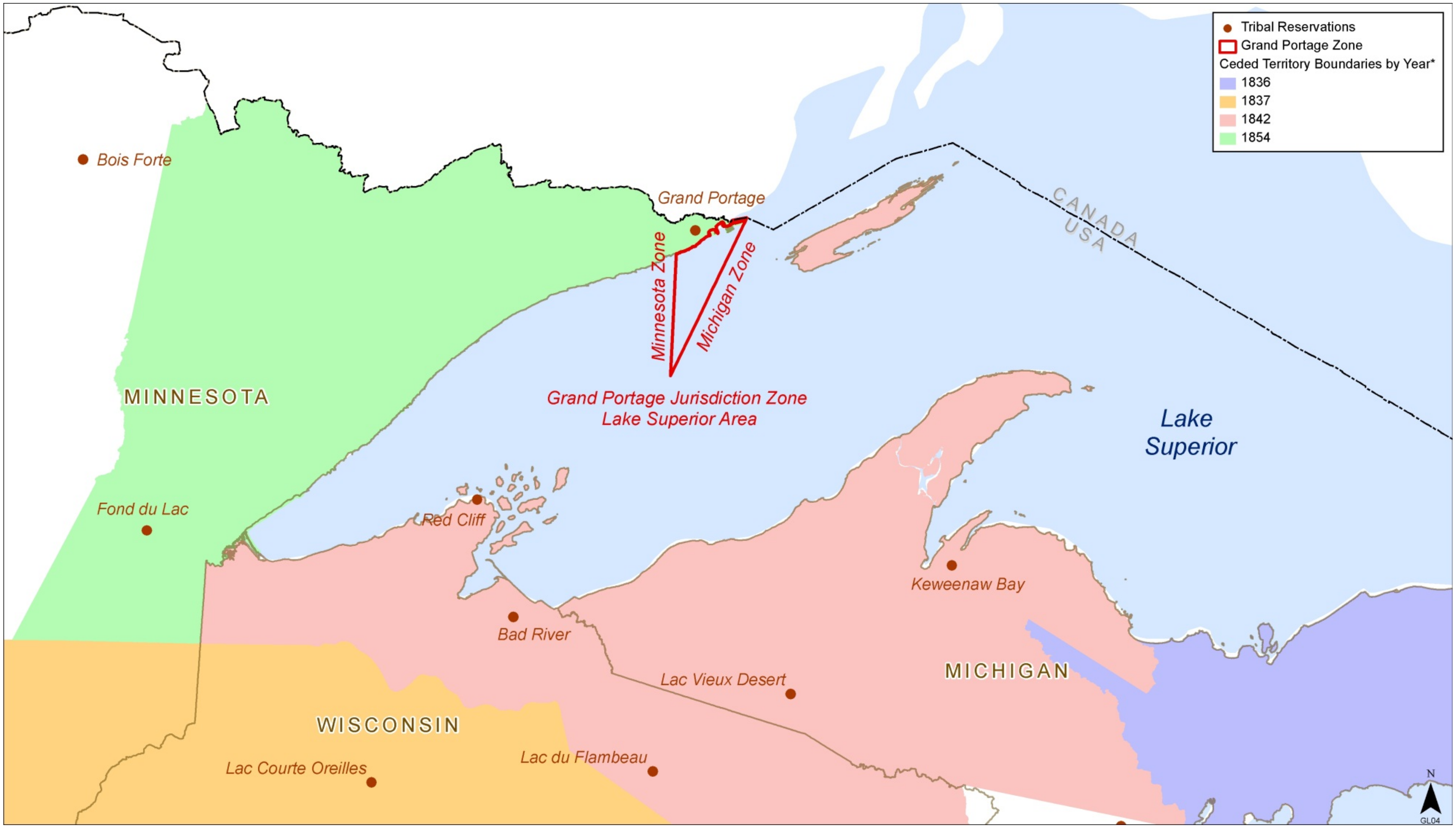


Figure 13: Grand Portage Zone



PRESENT-DAY SUBSISTENCE PRACTICES OF NON-TREATY TRIBES

Although historically, subsistence fishing was an important way of life for most of the Native American tribes in the study area, many tribal groups have faced challenges in keeping this tradition active. The tribal groups that are not party to treaties that reserve hunting and fishing rights do not have enough access to waterways to allow them to continue their traditional subsistence practices. Many of the streams and lakes that are available to them (either streams and lakes on their reservations or inland lakes that they have purchased for fishing) have been contaminated. Many of the tribes are also near metropolitan areas, where it is an ongoing challenge to keep the youth interested in traditional ways of life. Youth are increasingly involved in modern American culture and economic systems, and are less reliant on subsistence harvesting to acquire food for their families.

Non-Treaty Tribes That Practice Subsistence Fishing

There are five tribes within the study area that were available for interviews and that practice subsistence fishing on their tribally owned land. Table 4.1 lists the non-treaty tribes that practice subsistence fishing. The subsistence fishing activities of each of these tribes are described in Sections 4.1.1 through 4.1.5.

Notawaseppi Huron Band of the Potawatomi

The Notawaseppi Huron Band of the Potawatomi is located on Pine Creek Reservation, which is in southwestern Calhoun County in Michigan. The tribal members do not rely solely on their fishing efforts for food; however, they capture fish to supplement their diets. The Nottawa Creek watershed, which is connected to Lake Michigan via the St. Joseph River, is where tribal members can fish for suckers and northern pike within the reservation. Wild rice is also grown and harvested on Nottawa Creek. Tribal members also fish on publicly owned state land under the State of Michigan’s fishing regulations (Rodwan 2012).

The Kalamazoo River is another place where tribal members subsistence fished; they did so until 2010, when one of the largest Midwest oil spills occurred. An Enbridge pipeline burst spilled 840,000 gallons of crude oil into the Kalamazoo River (Klug 2010). Catfish was the targeted fish species from this river, with turtles and muskrats were targeted too (Rodwan 2012).

Table 10: Non-Treaty Tribes that Practice Subsistence Fishing

Notawaseppi Huron Band of the Potawatomi
Stockbridge-Munsee Community
Saginaw Chippewa Indian Tribe of Michigan
Seneca Nation of Indians
St. Regis Mohawk Tribe

Stockbridge-Munsee Community

The Stockbridge-Munsee Community is located in central Wisconsin in the townships of Bartelme and Red Springs in Shawano County. The Red River, which is connected to Green Bay via the Wolf and Fox Rivers, runs through tribally owned land, and tribal members practice subsistence fishing on this river and smaller lakes and streams that drain into the Red River. Trout is the targeted species within the Red River. The tribe also buys privately owned lakes within the area to enable tribal members to fish. Tribal members have limited income, and, if they did not subsistence fish, they would not be able to afford to eat fish (Wollonhaup 2012).

The Stockbridge-Munsee Community has a Conservation Department that strives to manage fish and wildlife for current and future use. Every tribal member fishing on tribally owned land must have a fishing permit issued by the tribe. Some species of fish are regulated, including brook trout, northern pike, rainbow trout, bass, and walleye. For other species of rough fish, there are no limitations (Stockbridge-Munsee Community Band of Mohican Indians 2009).

Saginaw Chippewa Indian Tribe of Michigan

The Saginaw Chippewa Indian Tribe of Michigan is located in central Michigan. The tribe owns 3,700 acres split into 22 allotments. Tribal members practice subsistence fishing under tribal jurisdiction on the Chippewa River and many other lakes and streams throughout the reservation. Tribal members also fish on state owned land, which includes Saginaw Bay, Lake Huron, and tributaries running to Lake Huron. The tribe does not regulate fishing efforts on the reservation, and members fish for anything they can catch; there are no targeted species (Seal 2012).,

Out of approximately 3,400 tribal members, 2,000 live within the state of Michigan. Approximately 200 of the members living in the state do subsistence fishing on tribal land, and 75 of those 200 fishers go outside the reservation and fish on state land. The tribe is covered under the 1836 Treaty but chose not to participate in the Consent Decree negotiations. The tribe is currently in the midst of negotiations with the state of Michigan to establish a clear agreement on hunting and fishing rights off the reservation. The tribe also recently bought a facility along Lake Huron that will be used for fishery research, with the long-term goal being to establish a hatchery. The tribe is also expending effort to bring wild rice back to the reservation (Seal 2012).

Seneca Nation of Indians

The Seneca Nation of Indians is located in western New York on three different reservations: the Allegany Reservation, Oil Springs Reservation, and Cattaraugus Reservation. According to Will Miller, Chief Conservation Officer, there is very little subsistence fishing practiced among the Seneca Nation members. The tribal members do not rely solely on fishing for food; however, some members fish to supplement their diets. Fishing is done on the Allegheny River, Allegheny Reservoir, and Cattaraugus Creek, where the intake is limited because of mercury poisoning. Subsistence fishing is not conducted on Lake Erie, since very little of the lake is accessible to the tribal members from their reservation (Miller 2012).

St. Regis Mohawk Tribe

The St. Regis Mohawk Tribe reservation is located in northeastern New York. The tribal members are very active in subsistence fishing. Tribal members subsistence fish on the St. Regis River, St. Lawrence River, Grass River, Raquette River, and Little Salmon River for bullhead, yellow perch, smallmouth and largemouth bass, musky, pike, walleye, and lake sturgeon. Methods for fishing are mostly hook and line, but netting is also employed for walleye, perch, bullhead, and sturgeon. Trotlines are also used for sturgeon, and spearing for walleye is done in the spring. No reporting or licensing is required for members when they fish on reservation land. The St. Regis Mohawk Tribe also let non-native people on the reservation to fish, but these fishers need a permit. This tribe does no commercial fishing (Snyder 2012).

The St. Regis Mohawk Tribe has an Environment Department with a Water Resource Program Division. This division is seeking to reintroduce Atlantic salmon to tributaries and sections of the St. Regis River. It participates in a lake sturgeon restoration project with the New York State Department of Environmental Conservation (NYSDEC) and the USGS. They conduct fisheries population assessments of threatened and endangered species. They also post fish advisories and monitor contamination within the fish populations found in the reservation waters (St. Regis Mohawk Tribe 2012).

Non-Treaty Tribes That Do Not Practice Subsistence Fishing

Of the 37 tribes within the study area, 7 of the tribes that sent Argonne National Laboratory comments do not practice any form of subsistence fishing (Table 4.2). The most common reasons given for not fishing were water quality, the members' assimilation in metropolitan areas, and a disjointed reservation land base. Sections 4.2.1–4.2.3 discuss these reasons.

Contamination

A major challenge facing tribes that only have access to resources on their reservation is their lack of control over factors outside the reservation borders. The tribes that have a major river running through their reservation have access to the river only where it is within the reservation borders; they cannot control what happens environmentally to that river where it is outside their jurisdiction. The Lower Sioux and Upper Sioux Communities of Minnesota are along the Minnesota River; however, only a very small part of the Minnesota River runs through their reservation. They do not fish in this river because of its contamination. In our interview with Megan Alrich, Water Quality Specialist for the Upper Sioux Community of Minnesota, she stated that if the tribal community did expend the effort to clean up its portion of the Minnesota River, that effort would be wasted, since no other groups outside the reservation would expend the same amount of effort (Alrich 2012).

Table 11: Non-Treaty Tribes that Do Not Practice Subsistence Fishing

Prairie Island Indian Community
Shakopee Mdewakanton Sioux Community
Lower Sioux Indian Community
Upper Sioux Community of Minnesota
Ho-Chunk Nation
Onondaga Nation
Oneida Tribe of Indians of Wisconsin

The Oneida Tribe of Indians of Wisconsin does no subsistence fishing now because of contaminated waters; however, it is trying to restore this practice by restoring the contaminated waters on the reservation, operating fish hatcheries, and removing barriers so the fish could reach those reservation waters. The members of this tribe have historically fished in Fox Creek and Duck Creek. Currently, they operate a largemouth bass and bluegill fish hatchery. Their initiative is to create healthy fisheries so the tribal members could restore their traditional way of life if they chose to. However, one large concern is the nation's proximity to the metropolitan area of Green Bay (Snitgen 2012).

The Onondaga Nation has also been deprived of subsistence fishing because of contamination. Its reservation is within the Onondaga Lake drainage basin, which is one of the most polluted lakes in the United States. The major river that runs through the reservation is also polluted; it is contaminated with underground salt mining runoff that has raised its water temperature and killed its fish (Shenandoah 2012). There are also numerous Superfund sites (i.e., sites requiring cleanup) surrounding the reservation.

Metropolitan Areas

The Prairie Island Indian Community and the Shakopee Mdewakanton Sioux Community reservations are located close to the Minneapolis and St. Paul metropolitan areas in Minnesota. Community members indicate that although they have sufficient sources of water in which to fish (e.g., Vermillion River, Mississippi River, Minnesota River), their proximity to urban areas and integration into the local economy has made subsistence harvesting less of a necessity (Whit 2012).

According to Mike Whitt, Natural Resources Manager of the Shakopee Mdewakanton Sioux Community, it is hard to keep the youth interested in traditional ways of life when they have to split their time between jobs and commitments in the city and their families at home. Most of the tribal members, who do not live on the reservation, live in the metropolitan areas (Whitt 2012).

Scattered Land Base

The Ho-Chunk Nation has a situation that is unique when compared with that of other tribes in the study area. Its tribally owned lands are scattered throughout 20 counties in Wisconsin, Minnesota, and Illinois. If the members fish, they do so under each state's regulations. The Ho-

Chunk Nation has a Natural Resources Department that focuses on conservation, preservation, and protection of natural resources on all tribal lands. Its efforts focus on wildlife: endangered resources, outreach and education, animal surveys, inventories of all of its lands to ensure their cultural and natural resources are protected and managed, and forestry management (Ho-Chunk Nation 2008).

Non-Treaty Tribes Unavailable For Interviews

Several tribes within the study area were either unavailable for interviews or were hesitant to share information about their subsistence practices (see Appendix A for Tribal Contact Efforts). Table 4.3 lists the tribes that are not under treaty rights and that Argonne National Laboratory was not able to contact. No information is known about the subsistence practices of these tribes.

Table 12: Non-Treaty Tribes Unavailable for Interviews

Sac and Fox Tribe of the Mississippi in Iowa
Menominee Indian Tribe of Wisconsin
Hannahville Indian Community
Pokagon Band of Potawatomi Indians
Forest County Potawatomi

CATCH AND VALUATION ASSOCIATED WITH TREATY RIGHTS SUBSISTENCE FISHING

Tribal Subsistence Fish Harvests

Data on subsistence fish harvests in each of the five Great Lakes and their tributaries were not available from a single source, and only one source, CORA, provided comprehensive data over a recent time period. CORA data were limited to subsistence fishing in Michigan state waters that were ceded under the Treaty of March 28, 1836, including portions of Lake Huron, Lake Michigan, Lake Superior, and St. Mary's River, which connects Lake Superior with Lake Huron. The CORA Michigan data included 25 species of fish and two fishing methods: gill net and spear. The data received from CORA were from 2006 to 2010. These numbers are based on reported data, have not been extrapolated to estimate total harvests, and as a result, may under-represent subsistence harvests.

The subsistence catch in Michigan waters in Lake Michigan was larger than that in the other two lakes. On average, 11,357 pounds of fish were caught over the period from 2006 to 2010, with 11,240 pounds (98.9%) being caught by gill net, and 117 pounds (1.1%) being caught by spear fishing (Table 5.1). In Lake Superior, 4,752 pounds (99.5%) were caught by gill net, and 23 pounds (0.5%) by spear fishing. The subsistence catches in St. Mary's River (1,479 pounds) and in Lake Huron (1,383 pounds) were relatively small.

The subsistence fish caught in the largest quantity in Michigan waters in Lake Michigan was walleye, with 4,432 pounds caught by gill net and 93 pounds caught by spear fishing over the period from 2006 through 2010 (Table 5.1). Other fish caught in larger numbers were whitefish (1,531 pounds) and suckers (1,120 pounds); all were caught with gill nets. A fairly large share of salmon caught in Lake Michigan was caught with spears (25 pounds of a total of 180 pounds, or 13.8%). None of the other species caught for subsistence use in Lake Michigan amounted to more than 1,000 pounds on average over the period from 2006 through 2010, and all were caught with gill nets.

In Lake Superior, salmon (1,313 pounds) and whitefish (1,142 pounds) were the only species for which more than 1,000 pounds were landed. Salmon was the only fish caught regularly with spears (25 pounds of a total of 1,313 pounds caught, or 1.9%). In St. Mary's River and Lake Huron, whitefish was the most numerous fish caught for subsistence, but no fish catch in either area amounted to more than 500 pounds on average over the period from 2006 through 2010. Although almost all fish taken in both areas were caught with gill nets, a larger-than-average amount of salmon (29 pounds from a total catch of 223 pounds, or 13.0%) and northern pike (28 pounds from a total catch of 93 pounds, or 30.1%) was caught in St. Mary's River by using spear fishing methods.

Table 13: Reported Harvest for CORA-Licensed Subsistence Fishing in Michigan by Method: Annual Average Weight in Pounds, Over the Period 2006-2010

	Lake Huron		Lake Michigan		Lake Superior		St Mary's River	
Fish Species	Gill Net	Spear	Gill Net	Spear	Gill Net	Spear	Gill Net	Spear
Atlantic salmon	0	0	0	0	0	0	0	1
Bass	21	0	85	0	2	0	10	0
Brown trout	13	0	14	0	12	0	2	1
Bullhead	1	0	13	0	0	0	13	0
Burbot	10	0	210	0	22	0	23	0
Carp	10	0	471	0	0	0	6	0
Catfish	34	0	0	0	0	0	0	0
Freshwater drum	0	0	29	0	0	0	4	0
Gizzard shad	0	0	20	0	0	0	0	0
Lake herring	52	0	0	0	655	1	134	3
Lake trout	245	0	739	0	246	0	4	0
Menominee (round whitefish)	52	0	70	0	145	0	53	0
Musky	0	0	0	0	6	0	5	0
Northern pike	9	0	515	0	56	0	93	28
Pink salmon	0	0	0	0	5	0	4	0
Rainbow trout	0	0	314	0	124	0	11	2
Rockbass	0	0	17	0	0	0	1	0
Salmon	4	5	180	25	1,313	25	223	29
Smelt	0	0	1	0	347	0	36	0
Splake	0	0	6	0	10	0	0	0
Steelhead	6	0	870	0	108	0	14	0
Suckers	33	0	1,120	0	392	0	169	0
Walleye	321	0	4,432	93	151	17	254	11
Whitefish	513	0	1,531	0	1,142	3	332	8
Yellow perch	60	0	602	0	16	0	89	0
Total	1,383	5	11,240	117	4,752	23	1,479	84

Source: CORA (2010)

In addition to subsistence fishing in the Great Lakes, there are relatively small subsistence fish harvests in lakes and streams in areas of the Upper Mississippi Basin surrounding the Great Lakes. The data in Table 5.2 represent the reported counts for species harvested for subsistence by spear fishing in publicly accessible lakes ceded in the Treaties of 1837 and 1842 in Wisconsin. No data were available for other states in the Upper Mississippi Basin. These numbers are based on reported data, have not been extrapolated to estimate total harvests, and as a result, may under-represent subsistence harvests.

Table 14: Subsistence Spear Fishing in Wisconsin Water Bodies, 2005-2009

	All Wisconsin Water Bodies	Wisconsin Water Bodies Connected to the Great Lakes or the Mississippi
Fish Species	Number	Number
Bass	179	21
Muskellunge	265	17
Northern Pike	31	1
Walleye	24,940	954

Sources: Krueger (2006, 2007, 2008, 2009, 2010)

Tribal Subsistence Fishing Valuation

A production cost model is used to value tribal subsistence fish catch. The model assumes that households make the choice between subsistence production and wage-based activities in order to maximize household satisfaction, and that the value of subsistence production equals the amount participants spend on materials, equipment, and labor for activities related to subsistence fishing activities. Valuation of the labor required to catch fish is an important part of subsistence valuation, for while employment opportunities in many rural communities in the Michigan, Wisconsin, and Minnesota are limited compared to areas with substantial natural and agricultural resources, or to urban areas, subsistence production requires a wide range of training and skills, and requires time to prepare, engage, and process the subsistence fish.

It is recognized that the household decision to participate in subsistence activities has a number of components beyond the provision of food. There are also social elements to subsistence, including education and cultural elements, the expression of ethics and values, tribal identity, spirituality and ideology, and traditional knowledge and language, in addition to health benefits (TetraTech 2011). Valuation of subsistence production does not, however, ascribe any portion of subsistence value to any specific component of subsistence, meaning that it is not possible to determine how much of the total valuation of subsistence activity comes from the provision of food, and how much comes from the expression of social and cultural values. Production cost is, therefore, only a partial proxy for total subsistence value, and does not measure the social and cultural aspects of subsistence.

To measure the value of subsistence production, cost data were collected from tribal members through telephone and personal interviews conducted in the Fall of 2011. While it is recognized that subsistence fishing occurs in many tribal communities, the relatively low response rate to the surveys, and inadequacies and inconsistencies in the data received from the various parties, meant that the extent to which tribes participate in these activities has not been accurately measured. Because of these data limitations, the purpose of this valuation is to provide information on the production cost of generic subsistence fishing activities for a representative single household based on the limited data that was gathered through the interview process, rather than provide estimates of the value of all subsistence activity in Michigan, Wisconsin, and Minnesota. In addition, as cost data received were not specific to particular species of fish, the analysis does not value subsistence activities with respect to individual species of fish; only the cost of participating in subsistence fishing activity as a whole.

Tribes fish for subsistence purposes primarily using gill nets or spears. Gill nets are either purchased ready-made (a 300-foot net of 4.5-inch mesh costs between $280 and $350) or sewn from materials purchased in fishing tackle stores (Newago 2011). Handmade nets are made of monofilament, and a 300-foot net costs about $180. Although commercial fishers hand-sew their own nets, subsistence fishers usually buy theirs. Most subsistence fishermen have one or two 300-foot nets (Moore 2011; Deschampe 2011). Spearfishing requires waders and spears. A homemade spearhead is usually used; purchased spearheads cost between $15 and $20 (Plucinski 2011). In addition to fishing, many tribal reservations harvest the wild rice plots they have on inland lakes. Rice is harvested by using a canoe, handmade cedar beaters, and a push-pole, which costs about $50 (Howes 2011). The canoe is usually towed to the rice stands by a boat with an outboard motor. Although some tribal members may use small non-motorized fishing craft for subsistence fishing, most subsistence fishing occurs in small motorized craft. Although no data were provided on the cost of boating equipment, it was assumed that boat purchase cost was $2,000, and that the cost of fishing equipment and would be depreciated over a 20-year period.

The cost of fuel used for trips to fishing locations and for the fishing activities themselves is relatively small. Fishing takes place either close to shore in one of the Great Lakes or onshore in tributaries that run into the Great Lakes. Subsistence nets are typically placed within 300 feet of the shore and gathered from 14- or 16-foot skiffs with outboard motors (Plucinski 2011). Fuel consumption is about six gallons over a two-day fishing period, meaning that a two-day subsistence fishing trip would cost $21 in fuel, assuming gasoline costs of $3.50 per gallon (Gasbuddy.com 2011). Although interviews indicated that the number of hours in any given subsistence fishing trip varied, evidence from Alaska suggests that households participated in subsistence for an average of about nine weeks per year (TetraTech 2011), and these data are utilized for the analysis of subsistence valuation in Michigan, Wisconsin, and Minnesota. Assuming each subsistence trip would last two days, there would be approximately 42 trips each year made by an individual household. It is assumed that participation in subsistence occurs during time that might otherwise be used for wage-earning employment, meaning an average of 160 hours were available for subsistence activities per month, and that one person per household would otherwise be working during the time used for participation in subsistence.
Data from interviews indicate that tribal subsistence fishing travel costs for residents who live on tribal lands are small, as they typically do not include lodging costs or camping fees. While it is recognized that some tribal members may have to travel longer distances to subsistence fishing locations, and may have higher travel costs, including lodging, for the purposes of the analysis, it was assumed that subsistence fishing activities would mean a 25 -mile round trip. It was assumed the trip would be in a vehicle with gas consumption of 25mpg, and although it was assumed that vehicles used for subsistence activities were not purchased specifically for this purpose, a portion of vehicle maintenance and operating (taxes and insurance) costs were ascribed to subsistence activities.

To estimate labor costs, it was assumed that individuals within a given household could, based upon the general skills required, be expected to earn at least as much as wage earners as a whole, should they choose to shift entirely to wage-based economic activities. Annual average hourly wages for May 2011 in the three states, Michigan ($21.01), Minnesota ($22.19), and Wisconsin ($19.92) were therefore used to estimate the value of labor that can be ascribed to subsistence activities.

Table 5.3 summarizes the results of the valuation of subsistence activities using the production cost model, including equipment, travel and labor costs, with results provided for Michigan, Minnesota, and Wisconsin.

Table 15: Annual Individual Household Subsistence Activity Valuation (2011 Dollars)

State	Valuation
Michigan	15,665
Minnesota	16,471
Wisconsin	14,921

CULTURAL VALUES

Cultural values are the commonly held ideas and lifeways that are practiced within a society. The way a group of people interprets the landscape, utilizes its resources, and lives within a place is based on the cultural values embedded within the everyday life of the people. Cultural values make up the paradigm through which people view the world around them and, in turn, live within that world.

The Great Lakes, Upper Mississippi River, and Ohio River Basins (Figure 1.2) have been the home of Algonquian- and Iroquoian-speaking tribes, as well as of Siouan- and Muskogean-speaking tribes, at least periodically. By the latter part of the 19th century, the only tribes that remained were the Chippewa, Ottawa, and Potawatomi from the Algonquin stock; the Seneca, Tuscarora, Cayuga, Mohawk, and Oneida and Onondaga from the Iroquois stock; and a few Siouan tribes located in the western Upper Mississippi River Basin. The number of tribes residing in the Upper Mississippi River Basin and the Ohio River Basin is small compared to the number of tribes residing in the Great Lakes Basin. A discussion of the Algonquin and Iroquoian ways of life follows here. It details their beliefs and discusses why subsistence fishing is a cultural identifier to these different groups. The Siouan groups are not discussed, since in interviews, these tribes indicated they do not subsistence fish within the study area.

Algonquin

The beliefs of the Algonquin peoples, including the Chippewa (Ojibwe), are based on a connection between the physical world, the plant world, the animal world, and the human world (Johnston 1976; Newago 2011). The Algonquin people believe that everything is life giving and that life-giving power deserves respect. All life is unified, and every living thing is tied to another, so that without one part, the other parts could not sustain themselves (L. DeFoe 2011). According to traditional Chippewa cultural values and beliefs all parts of the natural world as interconnected. Parts of the natural environment that western people may see as inanimate are viewed as having a spirit or being imbued with a life force. Disturbing one part ripples through the whole circle of life (Newago 2011; Pavlat 2011).

In the traditional Chippewa belief system every living creature is endowed with unique and singular powers (Johnston 1976). The fish are looked upon as relatives (Pavlat 2011; Newago 2011). The pike represents swiftness and elegance, and the sucker represents calmness and grace. The sturgeon represents depth and grace, while the whitefish represents abundance, fertility, and beauty (Johnston 1976). Sturgeon is a sacred fish, and parts of the sturgeon are used in traditional medicines and ceremonies; however, all fish are treated with respect (Plucinski 2011). These animals symbolize an ideal to be sought, attained, and perpetuated, and the Chippewa seek to emulate the character of these animals by observation and prayer (Johnston 1976).

The Algonquin honor every being's place in life so that the power of that being will not be lost (Pflug 1998). According to one elder, Melvin Eagle of the Mille Lacs Band of Ojibwe, the fish were shown to the Indian people by the Creator so the Indian people could eat those fish in order to live (Treuer 2001). Because of this belief, Algonquin hunters are taught to give thanks for what they receive. Rituals were continually enacted to ensure the abundance of both animals and plants (Pflug 1998). Tobacco offerings were made to the Creator before fishing commenced and before the fish were eaten. Tobacco offerings would be placed in the water or smoked. Archie Mosay of the St. Croix Chippewa Indians remembers the pipe ceremony, where the hunters would give tobacco offerings when they wanted to fish and pick rice and when they wanted to eat what they had harvested. It is believed that the Creator gives permission for the Indian to have a traditional diet of rice and fish (Treuer 2001). Offering tobacco shows respect to the Creator for allowing the meal.

Present-day Chippewa members continue the respect and reverence of their ancestors toward the fishing resource. They express how valuable the fishing resource is to their communities and cultural identity (Pavlat 2011; Leoso 2011; Balber 2011; L. DeFoe 2011). They are a fishing people and have been for hundreds of years, and they believe that the natural fishing resource is an identifiable cultural resource. It is a way of life to them, and to express the resource in monetary terms minimizes its true value. They believe that having the right to fish or the potential use of the fisheries is the true important value; having that resource has a value beyond that of the commercial value of their harvest (Moore 2011; Deschampe 2011; Mensch 2011b).

The Lake Superior Chippewa tribes pride themselves on maintaining the ecosystem that will allow them the continued use of the fishery resource (Moore 2011). They believe that it is a cultural obligation to protect the resource for current and future use. If the resource deteriorates, the value also lessens (Deschampe 2011). According to their holistic beliefs, loss of one fish species, whether it is harvested or not, will affect the food web and, in turn, affect the entire environment (Deschampe 2011). The Chippewa hold a belief that is an oral tradition passed down from generation to generation. This belief states that no action is executed if it has the potential to harm the next seven generations (L. DeFoe 2011).

Traditionally, the fisheries were a natural resource that the tribes learned to utilize; later, fishing for sustenance and nutrition became a necessary part of their lives. Only two generations ago, if subsistence fishing was not conducted, there would not be any meat to go with the meal (L. DeFoe 2011). Fisheries used to be more plentiful before pollution started contaminating the water. Today subsistence fishers notice the decline in the amount of fish per catch compared with that 20 years ago (L. DeFoe 2011).

Hospitality between tribal members is a core cultural value also. The subsistence harvest was, and still is, shared with family, close friends, and those in need within the community (L. DeFoe 2011; Newago 2011). Traditionally, feasts were a common practice before the modernization of the tribes and the decline of the resource. Feasts were held when hunting was profitable, and food was in abundance. This type of celebration signified the importance of offering thanks to the Creator for providing and maintaining the equal distribution of food within the society (Pflug 1998).

Ceremonies or rituals are still a common practice today. Some groups of Chippewa conduct water ceremonies in the traditional Midé religion before the fishing season commences and at the close of the fishing season (Leoso 2011). Songs are also sung to and for the water spirit (Leoso 2011). Individual fishermen give thanks and pray while offering tobacco to the water spirit (L. DeFoe 2011). Fishing characters in stories are part of the traditional religion, and the stories are passed down orally from generation to generation (M. DeFoe 2011).

Iroquois

The beliefs of the Iroquoian people are based on the "Great Cycle of All Things" (Williams 2007). It is believed that all things have life and exercise will. All phenomena, all emotion, all changes, and all activity are interpreted as the results of the exercise of supernatural power directed by the Creator (Hewitt 1974). Most of the objects in nature are believed to have their own spirit that provides invisible aid to the Creator (Morgan 1962 [1851]).
Tobacco, for instance, played an important role in the Iroquoian society. The tribes believed that tobacco was given to them as the means of communications with the spiritual world. Tobacco would be burned and an invocation offered to the Creator. In this manner, the Iroquois could send up their thanks and petitions to the Creator with the tobacco smoke (Snow 1994). The many feasts that were held represented the Iroquois giving thanks to the aids of the Creator for their ministering of the Iroquois peoples' wants (Snow 1994).

Rituals were often enacted to please the Creator's invisible helpers and to bring about good fortune. Tobacco would also be placed in the water for the soul of the water spirit, who was an invisible aid to the Creator (Rostlund 1952). A fish preacher would be available to preach a sermon to the fish; he had a special gift in that he could speak directly to the fish and tell the fish about the purpose they would be serving by allowing themselves to be caught. The Iroquois believed that this preacher had the power to attract the fish into the nets (Rostlund 1952).
The Iroquois would also sing songs and give humorous speeches to the fish to attract them into the nets. It was believed that fish bones and fish were never to be thrown into the fire because the other fish would hear of this action and not let themselves be caught (Rostlund 1952).

Sensitive Areas and Religious Sites

According to members of the Chippewa bands, their entire homeland is sacred. They believe they were created to fit into their homeland, and they were placed there by the Creator to protect its resources; thus, the intrinsic value of water defines them as a people (Plucinski 2011; Newago 2011; Pavlat 2011; Leoso 2011). Subsistence fishing is a way of life to the Great Lakes tribes and always has been since their migration story brought them here hundreds of years ago. They believe that having this resource, having the right to use this resource, and being good stewards of this resource are why they were brought to this place. When the tribal members' ancestors signed the treaties, they had no concerns over land ownership. They lived their lives by relying on the natural resources that their homeland had to offer, and in signing the treaties, they felt they were protecting those natural resources for themselves and future generations (Deschampe 2011; Newago 2011). Tribal members interviewed were reticent to discuss the exact locations of sacred places and are not likely to do so unless they feel that these places are directly threatened by a proposed action.

CONCLUSIONS

This report has explored the value of the subsistence harvest to Native American fishers in the Great Lakes, Upper Mississippi River, and Ohio River Basins (Figure 1.1), areas that would be affected by the migration of aquatic nuisance species between basins. The majority of the 37 federally recognized Native American tribes located in these basins are found in the Great Lakes Basin (Figure 1.2). Most, but not all, subsistence fishing occurs in the western half of the Great Lakes Basin, primarily because the tribes that have retained subsistence fishing rights under treaty are all located in Michigan, Wisconsin, and Minnesota (Figure 1.3).

The value of the subsistence harvest includes its importance as a food source, the monetary value of the fish harvested, and social and cultural value of subsistence fishing within Native American communities. Using a production cost model, which assumes that the value of the subsistence fish harvests is equal to the cost of equipment, travel, and labor expended, the annual value of subsistence fishing activities to an individual subsistence household would be between $15,000 and $16,500. It was also found that even among federally recognized tribes with reserved subsistence fishing rights, only a small percentage of the population are active subsistence harvesters. However, since they tend to share their harvest within their communities according to culturally approved patterns, the importance of the subsistence harvest ripples through the community.

The value of subsistence fishing to Native American tribes must also be viewed in its cultural context. While each tribe has its distinct traditions and culture, many of the federally recognized tribes in the study area are related culturally and linguistically. They are descended from ancestral populations that relied at least partly on harvesting natural resources. Maintaining this traditional ancestral right has value far beyond the monetary value of the fish. Tribal traditions generally include a holistic view of the natural world in which natural features and phenomena are often imbued with a life force and in which the various species and features of the natural world are bound together in a web. Damaging one part damages the whole. Traditions often include a belief that they have been placed where they are by divine intent and that they have been given a charge to protect the environment in which they find themselves, including protecting and managing traditional fisheries. The tribes that maintain fish hatcheries along the shores of the Great Lakes raise only native species, such as walleye and sturgeon.

Today the traditional beliefs of their ancestors still resonate throughout the study area. Tribal communities take their stewardship role over the natural resources very seriously, placing a high value on protecting and preserving natural resources, including native fisheries, for future generations. The value of the fisheries goes beyond a monetary value; it is a cultural value that defines the existence of the Great Lakes tribes.

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APPENDIX: TRIBAL CONTACT EFFORTS

Tribe	Contact	Visit	Summary
Grand Portage Band of Lake Superior Chippewa Indians	Seth Moore – Fish and Wildlife Biologist Norman Deschampe – Chairman	Yes	Tribal contacts were visited on 11/29/2011. Subsistence and commercial data and cultural information were received.
Bois Forte Band of Lake Superior Chippewa Indians	Corey Strong – Department of Natural Resources Commissioner	No	Tribal contact was emailed on 9/22/2011. Tribe does not do commercial or subsistence fishing within project study area.
Fond du Lac Band of Lake Superior Chippewa Indians	Thomas Howes – Natural Resources Program Manager Leroy DeFoe – Tribal Preservation Officer	Yes	Tribal contacts were visited on 11/31/2011. Subsistence data and cultural information were received. Tribe does not commercial fish.
Mille Lacs Band of Ojibwe	Kelly Applegate – Wildlife Biologist	No	Tribal contact was spoken to on phone. He was hesitant to give any information on location of fishing waters and species targeted.
St. Croix Chippewa Indians of Wisconsin	Don Taylor – Natural Resources	No	Tribal contact was emailed on 10/10/2011 and spoken to on 2/7/2012. Tribe does subsistence fishing in St. Croix River System, Mille Lacs Lake, and small lakes and streams within northwest WI.
Lac Courte Oreilles Band of Ojibwe	Paul Christal – Fisheries Biologist	No	Tribal contact was spoken to on phone on 9/29/2011 and on 2/13/2011. Tribe exercises its treaty rights throughout the ceded territories. There is no reporting.
Red Cliff Band of Lake Superior Chippewa Indians of Wisconsin	Chad Abel – Division Program Manager Bryan Bainbridge – Natural Resources Department Marvin DeFoe – Vice-Chairman Charles Newago – Subsistence Fisher	Yes	Tribal contacts were visited on 10/25/2011. Subsistence and commercial data and cultural information were received.

Tribe	Contact	Visit	Summary
Bad River Band of Lake Superior Chippewa Tribe	Tim Wilson – Tribal Fisheries Specialist Ed Leoso – Fisheries Technician Mike Plucinski – Subsistence Fisher	Yes	Tribal contacts were visited on 11/28/2011. Subsistence and commercial data and cultural information were received.
Lac du Flambeau Band of Lake Superior Chippewa Indians of Wisconsin	Larry Wawronowicz – Natural Resources Director	No	Tribal contact was spoken to on phone on 11/8/2011 and on 2/1/2012. Tribal members subsistence fish on inland lakes and streams within treaty-ceded territories of WI, MN, and MI and within the boundaries of their reservation.
Sokaogon Chippewa Community	Beth Meedke	No	Tribal contact was spoken to on phone on 9/26/2011. Tribal members do subsistence fishing within the ceded territories of WI and MI.
Lac Vieux Desert Band of Lake Superior Chippewa Indians	George Beck – Director of Planning and Environmental	No	Tribal contact was spoken to on phone on 10/3/2011. Tribe doe subsistence fishing in the Ontonagon watershed and in inland lakes within the ceded territories. Tribe does no commercial fishing.
Keweenaw Bay Indian Community	Gene Mensch – Fisheries Biologist	No	Tribal contact was emailed on 10/20/2011. Some subsistence and commercial data were received.
Sault Ste. Marie Tribe of Chippewa Indians of Michigan	Cecil Pavlat – Tribal Preservation Officer Eric Clark – Biologist	No	Contact was made with Mr. Pavlat on 11/15/2011 by phone. Cultural information was received. Contact with Eric Clarke was made on 1/31/2012. Tribe does subsistence fishing on inland lakes and streams within the ceded territory of MI. Received annual harvest report for inland fishing and Great Lakes subsistence report from CORA.
Bay Mills Indian Community	Justin Carrick, Conservation Department	No	Contact was made on 2/1/2012. Inland subsistence fishing is done only for walleye. All Other subsistence fishing is conducted on Great Lakes and St. Mary’s River. Received Great Lakes subsistence data from CORA.

Tribe	Contact	Visit	Summary
Little Traverse Bay Bands of Odawa Indians	D. Browne – Conservation Duty Officer	No	Tribal contact was not able to be made. Contact efforts were made by phone and e-mail. CORA provided statistical information on subsistence fishing. Annual Harvest Report for 2009 is provided on tribe's Web site.
Little River Band of Ottawa Indians	Jimmy Mitchell – Natural Resources Department Program Manager	No	Tribal contact was made on 1/31/2012. Tribe subsistence fishes all over the 1836 ceded territory. No reporting is required for species not regulated by the state. CORA provided statistical information on subsistence fishing.
Seneca Nation of Indians	William Miller- Conservation Department for Allegany Reservation	No	Tribal contact was made on 2/7/2012. Tribe does not do subsistencing fish, but members participate in fishing to supplement their diets within tribally owned waters.
Haudenosaunee Environmental Task Force (HEFT)	David Arquette – HETF Director	No	Spoke to Mr. Arquette on the phone 1/25/2012. E-mailed him information, and he was going to bring up this topic at the next meeting on 2/10/2012. I have not heard from him since the 1/25/2012 meeting after numerous attempts by e-mail and phone.
St. Regis Mohawk Tribe	Jim Snyder – Fish and Wildlife Technician	No	Tribal contact was made on 2/21/2012. Tribe does heavy subsistence fishing on reservation waters. Not regulated.
Oneida Nation of New York	Michael Massena, Environmental Manager	No	Tribal contact was not able to be made. Multiple attempts were made by phone and e-mail.
Onondaga Nation	Jeanne Shenandoah – Conservation Department	No	Contact was made on 2/1/2012. No subsistence fishing is taking place because of contaminated waters.
Tuscarora Nation	Neil Patterson – Environmental Director	No	Tribal contact was not able to be made. Multiple attempts were made by phone and e-mail.
Tonawanda Band of Seneca Indians	Mardell Sundown – Environmental Director	No	Tribal contact was made on 2/8/2012. Ms. Sundown told me that they were going to discuss this at the next HETF meeting on 2/10 and that Mr. Arquette would be giving me the results.

Tribe	Contact	Visit	Summary
Cayuga Nation	Dan Hill – Environmental Director	No	Tribal contact was not able to be made. Multiple attempts were made by phone and e-mail.
Prairie Island Indian Community	Brad Frazier – Environmental Specialist	No	Tribal contact was made on 1/30/2012. No subsistence fishing is taking place because urban areas are so close.
Shakopee Mdewakanton Sioux Community	Mike Whitt – Natural Resources Manager	No	Tribal contact was made on 1/31/2012. No subsistence fishing is taking place because urban areas are so close.
Lower Sioux Indian Community	Deb Dirlam – Office of Environment Director	No	Tribal contact was made on 1/16/2012. No subsistence fishing is taking place because of contamination.
Upper Sioux Community of Minnesota	Megan Alrich – Water Quality Specialist	No	Tribal contact was made on 1/26/2012. No subsistence fishing is taking place because of contamination.
Sac and Fox Tribe of the Mississippi in Iowa	Kelly Schott – Natural Resources Technician	No	Tribal contact was made on 2/6/2012. She was not at privilege to discuss subsistence fishing until council approved. Have not heard back from Ms. Schott.
Menominee Indian Tribe of Wisconsin	Richard Annamitta – Fishery Biologist, Donald Reiter – Fish and Wildlife Biologist	No	Tribal contact was not able to be made. Multiple attempts were made by phone and e-mail.
Oneida Tribe of Indians of Wisconsin	Jim Snitgen – Conservation Department	No	Tribal contact was made on 1/17/2012. No subsistence fishing is taking place because of contamination.
Ho-Chunk Nation	Randy Poelma – Aquatic Biologist	No	Tribal contact was made on 2/7/2012. No subsistence fishing is taking place because land base is scattered among many counties and states.
Hannahville Indian Community	Carol Bergquist – Director Environmental Programs	No	Tribal contact was not able to be made. Multiple attempts were made by phone.
Pokagon Band of Potawatomi Indians	Mark Parrish – Environmental Director	No	Tribal contact was not able to be made. Multiple attempts were made by phone and e-mail.

Tribe	Contact	Visit	Summary
Nottawaseppi Huron Band of the Potawatomi	John Rodwan – Environmental Director	No	Tribal contact was made on 1/31/2012. Subsistence fishing takes place on reservation waters. Not regulated. Tribes do not need fish to survive; fishing is done more to supplement their diets.
Forest County Potawatomi	Natural Resources Department	No	Tribal contact was not able to be made. Multiple attempts were made by phone.
Stockbridge-Munsee Community	Randall Wollenhaup – Fish and Wildlife Biologist	No	Tribal contact was made on 1/31/2012. Tribe subsistence fishes on tribally owned land. Not regulated. If members did not fish, they would not be able to buy fish to supplement their diets.
Saginaw Chippewa Indian Tribe of Michigan	Don Seal – Planning Director	No	Tribal contact was made on 2/1/2012. Tribe subsistence fishes on reservation land and land owned by the state. Not regulated.

ATTACHMENT 5

PROFESSIONAL FISHING TOURNAMENTS

Pro-Fishing Tournaments in the U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins – Baseline Assessment

August 2013

U.S. Army Corps of Engineers

Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

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REPORT PURPOSE

In support of the Great Lakes and Mississippi River Interbasin Study (GLMRIS), the Fisheries Economics Team was formed in order to establish the current *economic* values associated with fisheries resources and associated industries within the Great Lakes, Mississippi River, and Ohio River Basins. This report is a qualitative assessment of professional (pro) fishing tournaments within the three basins.

Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since native and commercial fish species have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, this baseline assessment displays an array of professional fishing tournaments that *could* be affected if no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins (i.e., the future without-project condition). Further, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future fishing harvests in the case where Federal action is taken to prevent the transfer of ANS between the basins (i.e., the future with-project condition). Since these management plans were not available, this qualitative assessment serves as a baseline of professional fishing tournaments within the Great Lakes, Upper Mississippi River, and Ohio River Basins *could* be affected in the future with-project condition.

Specifically, the purpose of this report is to provide descriptions of the types of tournaments which occur in the study area as well as information on the rules and other elements which characterize fishing tournaments. The report attempts to illustrate the details of the various types of tournaments which occur by examining a small sample of tournaments. Fishing tournaments occur frequently in the study area, as indicated by the cursory results of this qualitative analysis, and undoubtedly have an economic impact to the overall region. However, this report does not attempt to measure the monetary impacts or effects of fishing tournaments. Some statistics are provided for individual tournament participation and entry fees, but these numbers are by no means comprehensive and should not be assumed a representation of economic value of this industry. This report serves to acquaint its audience with the general elements of fishing tournaments, not to provide economic valuation of the activity.

This document uses a common definition of fishing "tournament" based on the State of Wisconsin Department of Natural Resources:

an organized fishing event, in which anglers fish for prizes or recognition in addition to the satisfaction of catching fish.[1]

[1] State of Wisconsin, Department of Natural Resources. "Order of the State of Wisconsin Natural Resources Board Repealing and Recreating Rules". http://www.dnr.state.wi.us/fish/fishingtournaments/FH-22-06A-10-3-2008.pdf

GLMRIS BACKGROUND INFORMATION:

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River basins by aquatic pathways

An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (FY13). As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies,* Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

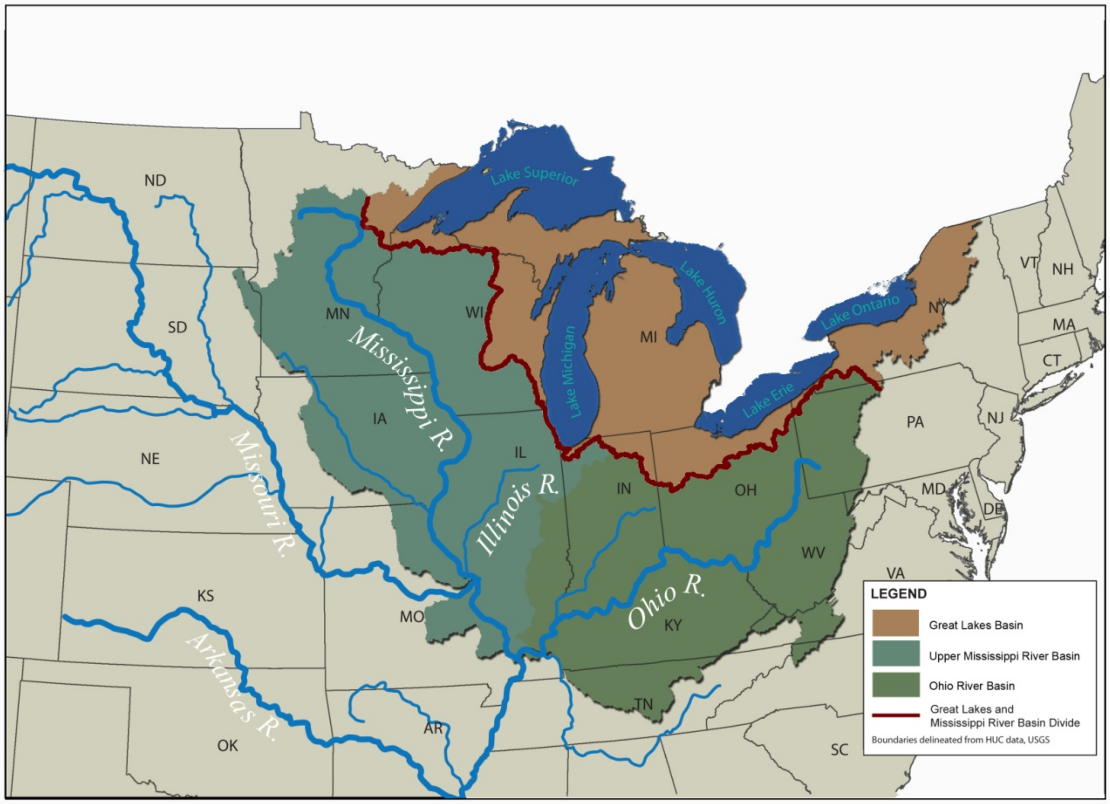
Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

GLMRIS STUDY AREA

The GLMRIS study area includes portions of the Great Lakes, Mississippi River, and Ohio River Basins that fall within the United States.

Figure 1: GLMRIS Study Area Map



Potential aquatic pathways between the Great Lakes, Mississippi River, and Ohio River Basins exist along the basins' shared boundary (illustrated in *Figure 1: GLMRIS Study Area Map*). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi and Ohio River Basins (green shaded areas) and the Great Lakes Basin (brown shaded area).

NAVIGATION AND ECONOMICS PRODUCT DELIVERY TEAM:

In support of the Great Lakes and Mississippi River Interbasin Study, the Navigation and Economics Product Delivery Team (PDT) was formed. The PDT was tasked with assessing the current value of *economic* activities within the GLRMIS detailed study area that *could* change with the implementation (FWP condition) or lack of implementation (FWOP condition) of a GLMRIS project. The PDT is comprised of several sub-teams, each of which focuses on a specific economic activity within the GLRMIS study area. These categories include:

Navigation Related Economic Categories

- Commercial Cargo
- Non-Cargo Related Navigation

Other Related Economic Categories

- Flood Risk Management
- Hydropower
- Commercial and Recreational Fishery[2]
- Water Quality
- Water Supply
- Regional Economics

Fisheries Economics Team:

The Fisheries Economics Team (Team) was formed in order to assess the current *economic* value of commercial, recreational, charter, and subsistence fishing activities, as well as pro-fishing tournaments within the Great Lakes Basin, Upper Mississippi River and Ohio River Basins. The results of these analyses serve to demonstrate the various economic activities could be impacted in the future.

Pro-Fishing Tournament Focus:

This document highlights various characteristics of pro-fishing tournaments within the Great Lakes, Upper Mississippi River, and Ohio River Basins.

Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since native and commercial fish species have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Fisheries management techniques could also change the quality or quantity of available fisheries in the FWOP condition. Consequently, this baseline economic assessment demonstrates the pro-fishing tournaments that *could* be affected if no Federal action

[2] Subsistence and charter fishing are also addressed, as well as pro-fishing tournaments.

is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins (i.e., the future without-project condition).

Further, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future fishing regulations in the case where Federal action is taken to prevent the transfer of ANS between the basins (i.e., the future with-project condition). Since these management plans were not available, this assessment serves as a baseline of what professional fishing tournaments within the Great Lakes, Upper Mississippi River, and Ohio River Basins *could* be affected in the future with-project condition.

TOURNAMENT BOUNDARIES AND GOVERNANCE

Figure 1 shows the Great Lakes. For this analysis, only American waters of the Great Lakes were considered. Lake Superior, Lake Michigan, and Lake Erie fall under the jurisdiction of more than one state. For example, the majority of Lake Michigan is under the jurisdiction of either Wisconsin (west) or Michigan (east), with a small portion under Illinois's jurisdiction (the southwest portion of the lake), and an even smaller portion is Indiana's jurisdiction (the very southern tip of the lake). The lakes' borders were determined by collaboration between the U.S. Federal Government, applicable state governments, and Canada.

Figure 2. Great Lakes Map

Source: U.S. Army Corps of Engineers

For fishing contests held on the Great Lakes, a tournament's boundaries are typically limited to the waters of the state in which the tournament is held. For fishing events held on the Ohio and Upper Mississippi Rivers, these state boundaries do not apply and most states have reciprocity with regard to fishing licenses and other fishing regulations from bordering states. In most tournaments, anglers are required to have global positioning systems (GPS) tracking systems on their boats to ensure they stay within the tournament boundaries.

Specific criteria for fishing tournaments are available on a state-by-state basis. These are often state statutes used to regulate permitting associated with the tournaments. Criteria such as the number of participants, number of boats, and prize value are used to determine if each fishing tournament requires a permit from the state government.[3] Tournament fishing is regulated by each state's Department of Natural Resources (or equivalent - in New York it is the Department of Environmental Conservation).

State governments require the purchase of tournament permits in order to cover the cost of the fishing tournament programs and other administrative tasks. Permitting by state governments also serves as a limiting factor to the number of tournaments. Tournaments may be limited by a state in order to prevent over-fishing on a particular water-body or of a particular fishery, to maintain the viability of the fishery or water-body, and prevent over-crowding for non-tournament anglers. In the Great Lakes states[4] as well as states bordering the Ohio and Mississippi Rivers, fishing tournaments are often prohibited on holiday weekends and on the opening days of popular fishing seasons. As part of the permitting process, some states require tournament organizers describe how a tournament will be beneficial to the local economy and how harm to the fishery resource will be avoided.

General tournament permitting regulations are maintained by state governments, but each tournament is regulated by its own set of rules. The general elements covered in the tournament rules include:

- Entry fees, application procedures and deadlines, and eligibility
- Tournament dates, times, and allowable fishing hours
- Bad weather rules, contingency procedures, and emergency procedures
- Tournament fishing boundaries
- Team structures, including definitions of different competition categories
- Boat size restrictions
- Equipment descriptions (rod and lines, lures, engines, live wells[5], etc.)
- Limitations on number of fish caught (generally based on species) and rules for catch-and-release, catch-and-hold, and other restrictions
- Fish weigh-in or measurement procedures
- Points calculation, winner determination, tie-breaking procedure, and awarding prizes
- Sportsmanship, misconduct, and disqualification rules

[3] These are permits obtained by the tournament organizer for the tournament as a whole. Each angler is also required to obtain a state fishing license for the state in which the tournament takes place.
[4] For this analysis, "Great Lakes states" refers to the U.S. states which border the Great Lakes, specifically: Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, Pennsylvania, and New York.
[5] A live well is a container designed to hold live fish on a boat. It is a small tank incorporated in the boat with an aerator and water pump to keep fish alive during tournament fishing.

GENERAL TOURNAMENT FORMATS AND CHARACTERISTICS

Fishing tournaments are usually held for the purpose of competing and winning prizes. Some tournaments also serve as fundraisers for local charities, where proceeds are donated rather than given to the tournament winner as a prize. Some fishing tournaments are organized locally by fishing clubs, private businesses (e.g. resorts, sporting goods stores), and local government organizations (e.g. chambers of commerce, tourism bureaus).[6] Other tournaments are organized by national organizations as part of a nationwide or regional series of tournaments. In the Great Lakes states, tournaments are held at all times of the year, on open water and on ice. In states bordering the Ohio and Upper Mississippi Rivers, tournaments typically occur in early spring (March or April) through fall (September or October).

There are several formats used for tournament fishing. For some tournaments, fish are held in live wells by anglers, brought to a central location at the end of the fishing day to be weighed, and subsequently released; the heaviest total weight wins. In many catch-and-release tournaments, fish are measured boat-side by a witness. The witness may be a fishing partner in the same boat or a tournament official summoned to the angler's boat. Each fish is released immediately after it is measured and the longest total length wins. In other catch-and-release tournaments, anglers measure their own fish with a tournament-provided ruler and document their catch with a digital camera. Other tournaments award prizes for the single largest fish caught. In other tournament types, fish are harvested and displayed, kept by anglers for their use, or the fish is donated to local charities.[7]

Some tournaments are events put on over one day or one weekend annually, while other tournaments are structured more like derbies, where anglers fish and record their catch with a derby official over the course of a season and the largest recorded fish at the end of the timeframe wins a prize. Still other tournaments are formatted as "trails" or series of tournaments. A tournament "trail" is usually comprised of several individual tournament events over the course of one fishing season. Anglers (or teams of anglers, as applicable) must compete in a minimum number of tournaments which are defined as part of the tournament trail to be eligible for trail prizes. Overall winners of the tournament trail are determined by their cumulative performance in the individual events over the course of the fishing season. For all tournament types, winners are determined and prizes awarded by the greatest weight, length, or number of fish caught. Prizes are typically monetary awards or merchandise furnished by tournament sponsors and tournament fees.

Tournaments often have different levels of competition based on the seriousness and competitiveness of the angler, the cost of participating in the tournament, the strictness of the rules, and the size of the prize or payout. These divisions also provide limits on the number of fish that can be harvested. "Recreational", "open", or "amateur" divisions of fishing tournaments are typically for novice or recreational fishermen, have the most relaxed rules, the smallest entry

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[6] State of Wisconsin, Department of Natural Resources. "Contemplating Competition, Do fishing tournaments fit on Wisconsin waters?". http://www.dnr.state.wi.us/wnrmag/html/stories/2006/jun06/fishcon.htm
[7] Ibid.

fee, and the lowest prize earning potential. Professional divisions are comprised of the most competitive anglers competing for the largest prizes. Often, professional division entrants are licensed boat captains, fishing guides, or commercial fishermen, who are required to enter themselves as "professionals" in fishing competitions. Many smaller, local tournaments do not separate tournaments into different divisions, but may have a rule declaring whether "professional" fishermen are allowed to compete. In some tournaments, pro-fishermen are required to be paired with a co-angler. Co-anglers either enter the tournament independently and are paired with pro-anglers or are partners with the pro-anglers and are exchanged between teams based on a random drawing. Co-anglers can be amateur fishermen who compete in a lower division of the tournament than the professionals or they can be dedicated observers who do not compete in any level of the tournament. The purpose of a co-angler is to observe pro-anglers, ensure rules are being followed, and to record details of the catch on official tournament score sheets.

Most non-ice fishing tournaments which occur on the Great Lakes, Ohio River, and Upper Mississippi River involve fishing from a boat, rather than fishing from shore. As such, most tournament rules indicate that more than one angler must be in each boat for safety reasons. In some tournaments, anglers may fish from the same boat, but tournament results are based on individual scores. Another tournament type is a team format where groups compete from the same boat and the total scores of each boat determines the winning team.

Many tournaments organized by local fishing groups are small events geared to interest anglers only. Other types of fishing events incorporate a festival-like atmosphere including non-fishing related activities to attract family members or other spectators not involved in fishing.[8] These types of tournaments typically attract larger crowds, which may bring in more revenue for host organizations. The popularity of a fishing tournament is dependent on the type of atmosphere perceived by both fishermen and non-fishermen spectators, as well as the level of advertising or media coverage. Local tournaments with small levels of participation and few spectators may only be advertised through a flier at the local sporting goods store. On the other hand, larger tournament events or series of events may be advertised on websites, through tournament sponsors, and may be broadcast via regional or national television networks, depending on the scale of tournament. Television broadcasts of fishing events have increased in number and in audience popularity with the recent rise of cable and satellite television stations which are dedicated to outdoor activities. Some tournaments are broadcast on regional television stations, while some events have nation-wide television coverage. Using television to increase the viewing audience increases interest in tournament fishing which likely creates larger sponsorship interest and payouts and leads to an increase in value in the overall tournament. For example, the Forrest L. Woods (FLW) fishing organization hosts many tournaments annually and includes sponsors such as Wal-Mart, the US National Guard, and Everstart. As part of its tournament coverage, FLW hosts a weekly television program which is broadcast in more than 75 million homes in the US and Canada, and over 429 million homes in Europe, Africa, and Asia.[9]

[8] O'Keefe, Daniel M. and Steven R. Miller. Michigan Sea Grant. "2009 Lake Michigan Tournament Fishing Study". January 2011. http://www.miseagrant.umich.edu/downloads/fisheries/11-201-Lk-MI-Tournament-Fishing-Study.pdf

[9] FLW Outdoors. http://www.collegefishing.com/tournament/versus.cfm

FISHING TOURNAMENTS BY GREAT LAKE

Some states in the Great Lakes region have detailed information available regarding tournament fishing. For example, the State of Wisconsin Department of Natural Resources conducted several studies of fishing tournaments, and has a large online database of tournaments. According to one such study, permitted tournament fishing in Wisconsin is only mildly popular; 17 percent of surveyed anglers participated in some kind of fishing tournament in 2010.[10] In Wisconsin, fisheries biologists estimate that there are between 350 and 400 permitted tournaments each year, throughout the state, not exclusive to the Great Lakes.10 However, small fishing events do not require permits and fisheries biologists estimate there are a total of 600 to 700 fishing tournaments each year in Wisconsin (including both permitted and non-permitted events).[11] This implies that approximately 42 percent of tournaments in the region were events which were small enough to not require permits. Wisconsin DNR also estimates that there are 600 to 700 permitted and non-permitted tournaments each year in Minnesota and Michigan, but five to six times less in states such as Illinois and Indiana.[11] Similarly, the State of Minnesota Department of Natural Resources reports that the popularity of fishing tournaments has increased in the past few years and between 450 and 600 fishing tournaments now occur annually in the state.[12]

Some states have limited information available regarding fishing tournaments. Given the vast number of tournaments which occur on the Great Lakes and the varying information available, this analysis provides only a snapshot of the fishing tournaments which take place on the Great Lakes. This section attempts to illustrate the details of the various types of tournaments which occur on the Great Lakes by examining a sample of tournaments. Any statistics provided were found readily available from some states' DNR (or equivalent) or from tournament publications. Along the same lines, if statistics regarding tournament fishing were not readily available from an appropriate source, no attempt was made to calculate or quantify additional findings. The tournaments presented in this report should not be considered a statistically representative sample and summary statistics of these tournaments would not be representative of all tournaments in the region. The level of research required to calculate and analyze meaningful statistics related to fishing tournaments is beyond the scope of this report. The focus of this effort is to provide a qualitative assessment of the characteristics of fishing tournaments to serve as a baseline against which to compare future effects.

In the section below, tournaments are presented based on the Great Lake in which they occur.

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[10] State of Wisconsin, Department of Natural Resources. "Public Awareness of, Participation in, and Opinions about Fishing Tournaments in Wisconsin". http://dnr.wi.gov/org/es/science/publications/PUB-SS-1064-2010.pdf

[11] State of Wisconsin, Department of Natural Resources. "Contemplating Competition, Do fishing tournaments fit on Wisconsin waters?". http://www.dnr.state.wi.us/wnrmag/html/stories/2006/jun06/fishcon.htm

[12] State of Minnesota, Department of Natural Resources. Fishing Tournament Information. http://www.dnr.state.mn.us/fishing/tournaments/index.html

Lake Superior

Minnesota, Wisconsin, and Michigan border Lake Superior. Fisheries harvested during tournaments on Lake Superior include lake trout, brown trout, coho salmon, King (Chinook) salmon, bass, and walleye. Most tournaments on Lake Superior occur during the summer months (May through September).

Bay Mills Invitational

One such tournament that occurs on Lake Superior is the Anglers Insight Marketing (AIM) Pro Walleye Series™ Bay Mills Invitational. The 2011 tournament marked the second annual occurrence of this tournament. The Bay Mills Invitational took place from June 2 through June 4, 2011 at the Bay Mills Casino in Brimley, Michigan. The AIM Pro Walleye Series™ is a series of four walleye fishing tournaments which occur annually. Anglers take part in any or all of the four events, with the overall winner (the "Angler of the Year") determined by overall points standings at the last tournament of the year. The Bay Mills Invitational is the only event in the Pro Walleye Series™ which takes place on the Great Lakes.[13]

The 2011 Bay Mills Invitational had 31 competitors while the 2010 tournament had 43 entrants. The total payout for the event in 2011 was $96,500, and each pro angler received at least $300 in prizes. The first prize angler won $40,000 and the remaining payouts were to the rest of the top sixteen pro anglers according to a payout schedule. The Bay Mills Invitational is an invitation-only professional fishing tournament. Each professional angler must pay a $1,500 entry fee to compete. Tournament fishing begins each day at the Bay Mills Casino, located off of Brimley Bay in Michigan. Anglers can fish in Brimley Bay, Lake Superior, or the nearby St. Mary's River. Daily weigh-in occurs at 4:30 PM at the Bay Mills Casino. The tournament utilizes artificial bait only and is a walleye-only tournament. Anglers in AIM tournaments utilize the AIM Catch-Record-Release™ (CRR™) format. In CRR™, anglers measure each walleye caught on an official AIM ruler and take a digital photograph, record the length of each walleye on the official scorecard, and then immediately release the live fish. No fish are brought to the weigh-in stage, and each angler selects the seven largest walleyes to be tallied for his daily weight (the length of each walleye is converted to pounds and ounces using a standardized formula). This CRR™ method reduces tournament-related fish mortality.[14]

Lake Superior Salmon Classic

The City of Silver Bay, Minnesota hosts the annual Lake Superior Salmon Classic Fishing Tournament (LSSC). This is an example of a smaller, locally-supported tournament which is not part of a national tournament trail and typically has less stringent rules, smaller entry fees, and lower prize amounts. The 2012 tournament is scheduled for July 21-22, 2012 and the 2011 event on July 16 and 17 marked the 11th annual occurrence of this tournament.[15] According to permit

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[13] Anglers Insight Marketing (AIM) Fishing tournaments. http://www.aimfishing.com/
[14] Ibid.
[15] Silver Bay Marina Fish Tournament, Lake Superior Salmon Classic. http://www.silverbay.com/lsscfc.htm

information from Minnesota DNR, there are an estimated 200 anglers and 100 boats expected to enter the 2012 tournament.[16] Competitors must purchase a $20 ticket to enter the tournament and there are three divisions: coho salmon, King salmon, and lake trout. Only fish of these species will be counted in tournament standings. Raffle tickets are also available. Proceeds from the tournament and raffle benefit the Silver Bay Parent Teacher Student Organization (PTSO). Fishing is allowed from 4:00 AM to 6:00 PM on the first day of the tournament and from 4:00 AM to 2:00 PM on the second day. All tournament boats must begin the tournament at the Silver Bay Marina. Each angler can enter one fish in each division (King, coho, and lake trout), and the heaviest fish wins. Anglers bring their fish to be weighed-in at any point during the tournament and can then replace their entered fish with a heavier fish at any time during the tournament hours. In the event of a tie, the fish that was weighed-in first will be the winner. The anglers to catch the top five fish in each division win cash prizes and merchandise, with a portion of entry fees benefitting the Silver Bay PTSO.[15]

Lake Michigan

Wisconsin, Illinois, Indiana, and Michigan border Lake Michigan. Most tournaments on Lake Michigan occur during April through September, but there are some ice-fishing tournaments during the winter, particularly December through February. Fishing contests in the winter and spring/early summer tend to focus on trout, particularly rainbow and brown trout. Tournaments on Lake Michigan in the summer and fall (June through September) harvest Chinook and coho salmon, brown trout, rainbow trout, lake trout, brook trout, bass and yellow perch. A cursory analysis of fishing tournaments suggests that July is the most popular month for tournaments to be held.

Dream Weaver Charity Tournament

While many fishing tournaments take place solely for the purpose of earning money and prizes, some serve as charitable fundraisers. The Dreamweaver Charity Tournament took place July 23, 2011 at Muskegon, Michigan on Lake Michigan as an annual fundraiser for the Benefits4Kids organization. The tournament is limited to 60 boats. For the 2011 tournament, entrants paid $75 each to register. Fishing is open on any port on Lake Michigan. Fishing begins at 5:00 AM and entrants must be in line for weigh-in at Muskegon by 1:00 PM. There is a Michigan DNR limit of three anglers per boat and nine fishing rods per boat in the water at any one time (maximum of three rods per angler). Lures are limited to those provided in the “lure pack” by tournament organizers. Anglers fish for the largest fish and are allowed to weigh-in up to five fish of any of the following species: King salmon, coho salmon, steelhead trout, brown trout, and lake trout. Each fish weighed-in is worth 10 points, plus one additional point per pound of each fish. The anglers with the top-10 scores are rewarded with raffle tickets (1st place wins 20 tickets, 2nd place wins 18 tickets, 3rd place wins 16 tickets, and etc.) which are good for prizes donated by tournament sponsors. The angler who catches the single heaviest fish of the tournament will also

[16] State of Minnesota, Department of Natural Resources. 2012 Fishing Tournament List. As of March 29, 2012. http://files.dnr.state.mn.us/recreation/fishing/tournaments/tourneylist.pdf

be awarded with a cash prize.[17] In the 2010 Dreamweaver Charity Tournament, 58 boats fished, and $9,600 was raised for Benefits4Kids.

Tight Lines for Troops

Another charity fishing event is the Tight Lines for Troops fishing tournament. The 3rd Annual Tournament was scheduled for May 18-19, 2012 in Manistee, Michigan, on Lake Michigan. In this tournament, veterans fish for free and local charter operators and other businesses associated with fishing in the area donate their time and equipment to host the event. Non-veteran fishermen also fish in a traditional tournament event where prizes are available and all proceeds benefit disabled veterans. Tournament anglers fish for salmon and prizes are awarded based on the heaviest fish caught in the various divisions.[18]

Hoosier Coho Club Events

The Indiana portion of Lake Michigan is the smallest of the four states which border the lake at 1 percent of the lake area and 43 miles of shoreline. Most of the area is highly industrialized, except for Dunes National Lakeshore and the Indiana Dunes State Park.[19]

In Indiana, the Hoosier Coho Club hosts a few annual fishing tournaments at Michigan City, Indiana on Lake Michigan. The 2011 Hoosier Coho Club Pro-Am Tournament was held on April 23, 2011 and there were 14 entrants in the pro division and 17 in the amateur division. The Club also held the Hoosier Coho Classic event on April 29-30, 2011. There were 29 competitors in the Pro Division, 19 anglers in the Amateur Division, and 18 anglers in the vessel length 24-feet and below category. The entry fees for the 2011 event were $425 for the Pro Division, $225 for the Amateur Division, and $100 for the 24-feet and under category. The first-place prizes for those categories are $7,500, $2,500, and $1,250, respectively.

The Hoosier Coho Club also hosts the annual Salmon Slam contest which occurred on September 17, 2011. Anglers are limited to 10-fish in the 1-day tournament, and the winner receives a $500 cash prize for the largest combined catch, and there is a contest for the single largest fish caught during the competition. The Club also hosts a Powder Puff Derby for female anglers. This derby was on August 21, 2011 and awards prizes based on the single largest fish caught by each angler. The top angler won $200, and prizes are awarded for the top 10 finishers. There were 31 competitors in the 2011 Powder Puff Derby.[20]

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[17] Dreamweaver Charity Tournament, on "Michigan Sportsman". http://www.michigan-sportsman.com/forum/showthread.php?t=362754

[18] Tight Lines for Troops. http://www.tightlinesfortroops.com/

[19] State of Indiana, Department of Natural Resources. Lake Michigan Fishing. http://www.in.gov/dnr/fishwild/3625.htm

[20] Hoosier Coho Club. http://www.hoosiercohoclub.org/home.html

Lake Michigan Tournament Trail

The Lake Michigan Tournament Trail is a series of fishing tournaments which take place from May through September at various locations on Lake Michigan. Table 1 shows the tournaments scheduled for the 2012 Lake Michigan Tournament Trail, as well as their scheduled dates and locations. The 2011 Tournament Trail was comprised of the same tournaments. Figure 2 shows a map of all the tournament locations.

Table 1. Lake Michigan Tournament Trail, 2012 Tournaments

Date (2012)	Tournament Name	Location
May 5-6	Hoosier Coho Club Classic	Michigan City, IN
May 11-12	SW MI Steelheaders' Summer Challenge	St. Joseph, MI
May 25-27	Onekama Marine Memorial Weekend Shake Down	Onekama, MI
June 1-3	Offshore Challenge	Grand Haven, MI
June 8-10	Sheboygan Salmon Cup	Sheboygan, WI
June 22-24	MCSFA Budweiser Pro/Am	Manistee, MI
July 7-8	Miesfeld's Super Salmon Weekend	Sheboygan, WI
July 14-15	Salmon Shoot Out	Muskegon, MI
July 19-22	Ludington Offshore Classic	Ludington, MI
July 25-29	Salmon Splash Tournament Week	Manistee, MI
August 3-5	Big Red Classic	Holland, MI
August 11-12	Waypoint Big Lake Classic	Saugatuck, MI
August 17-19	Sturgeon Bay Offshore Challenge	Sturgeon Bay, WI
August 24-26	Benzie Fishing Frenzie	Frankfort, MI
August 31 – Sept 2	Big Jon Salmon Classic	Traverse City, MI

Source: Tournament Trail/333 Championship Series, http://www.tournamenttrail.net/2012-dates/

Figure 3. Lake Michigan Tournament Trail fishing tournament locations, 2012
Source: U.S. Army Corps of Engineers-generated map. Tournament locations from: http://www.tournamenttrail.net/2012-dates/

Each tournament is an independent, local event sponsored and hosted by local organizations. So anglers can compete in a single event or can enter several tournaments in the series and use their combined scores to compete in the 333 Championship Series. The 333 Championship Series combines anglers' scores from their Tournament Trail events to a total at the end of the season, and prizes are awarded to the team with the highest cumulative score. Teams compete in the local tournaments for prizes and catch additional fish during the tournaments for the 333 Championship which are scored using different criteria. 333 Championship winners are eligible for large cash prizes (up to $10,000 for the overall winner) as well as merchandise prizes provided by sponsors. In 2011, almost 1,200 teams participated in all Lake Michigan Tournament Trail fishing tournaments. Teams usually include between two and four anglers each, meaning that between 2,400 and 4,800 anglers participated in the tournaments in 2011.[21] These numbers do not account for teams which may have entered more than one tournament and may include double-counting.

The 333 Championship Series is a larger tournament event, and as of the 2011 fishing season, it began television broadcasts. The tournament developed a series called 333 TV which airs weekly episodes during the fishing season on regional channels and episodes are syndicated on a

[21] Lake Michigan Tournament Trail Series. http://www.tournamenttrail.net/

national sports network, Legacy Broadcast Network. Tournament organizers formatted the show as a reality television series which follows fourteen teams through various tournaments on the trail. In order to facilitate the show, the tournament has added a level of competition called the 333 Broadcast Championship in which the contestants on the reality show participate. According to the 333 Series' website, the long term goals for the television show include increased sponsorship, better payouts for contestants, bigger audiences for bigger events, and nationwide top-level network coverage of fishing events.[22]

Lake Huron

Lake Huron is bordered by Michigan. Lake Huron fisheries include King salmon, coho salmon, Atlantic salmon, steelhead, lake trout, brown trout, bass, and walleye. Most tournament fisheries in Lake Huron target walleye in the Saginaw Bay area of Michigan during the summer months.

Harbor Beach Can-2-Can Salmon-Trout Fishing

In Michigan, the Thumb Area Steelheaders group hosts the Harbor Beach Can-2-Can Salmon-Trout Fishing Tournament, sponsored by the Harbor Beach, Michigan Parks and Recreation Department. The Thumb Area chapter of the Steelheaders is a non-profit group dedicated to protecting, maintaining, and improving the Lake Huron sport fishery. Work by the group includes raising salmon and trout fingerlings and purchasing pens for fish.

In 2011, the event began at 5:00 AM on May 14th and all boats were to return to the harbor by 1:00 PM. The tournament begins with an official boat check, and anglers can begin fishing as soon as their boat has been cleared by tournament officials. The entry fee for the tournament is $250 per person; 90 percent of collected fees are used for tournament prizes and the remaining 10 percent of proceeds go to the Thumb Area Steelheaders. Of the 90 percent of funds allocated for prizes, 50 percent goes to the top angler, 20 percent to second place, 15 percent to third place, 10 percent to fourth place, and 5 percent to fifth place. Tournament sponsors also provide additional cash or merchandise prizes and the anglers who catch the four largest fish of the tournament each receive $250. Each vessel is limited to a maximum of 12 fishing rods and only salmon or trout species will be weighed for tournament standings. Upon returning to the harbor, fish are weighed and tagged by officials who record the total weight of the catch and weight of the largest single fish for each angler. The tournament is limited to Michigan waters on Lake Huron between the Light House Park Green Can and the Forestville Water Tower Can. [23]

Michigan Walleye Tour

The Saginaw Bay Walleye Club, Inc. hosts the annual "Michigan Walleye Tour". The Walleye Tour consists of five weekend fishing tournaments (four qualifying events and one state championship) between April and September, two of which take place on Lake Huron. In the 2011 Walleye Tour, the Lund/Mercury Qualifier was held June 11-12 in Linwood, Michigan on Saginaw Bay of Lake Huron, and the Lund/Mercury Qualifier was held July 16-17 in East

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[22] Lake Michigan Tournament Trail Series, "The Vision". http://www.tournamenttrail.net/333-tv/the-%e2%80%9cvision%e2%80%9d/

[23] Harbor Beach Can-2-Can Salmon-Trout Fishing Tournament. http://hbcan2can.com/

Tawas/Tawas City, Michigan on Saginaw Bay of Lake Huron. In both of these tournaments, entrants compete in teams of two anglers over the two-day tournament. In the 2011 Linwood tournament, there were 36 teams in the competition which caught a combined total of 328 walleye, or 775 pounds of fish. In the 2011 Tawas City tournament, there were 35 teams in the competition with 334 total walleye or 1,100 pounds caught. For the tournament qualifying events (which includes the Linwood and Tawas City events), cash prizes are given to the top ten teams, with the first place team receiving $8,000, 2nd place $4,000, and third place $1,800. Teams can also win a $200 "Cool Under Pressure Award" for advancing the most from day one to day two of the tournament. The "Team of the Year" based on the four qualifying events wins a $2,000 cash prize. At the State Championship event, there is up to $45,000 available in cash and prizes. Anglers must be a member of the Saginaw Bay Walleye Club, and have paid the current $25 registration fee in order to compete in the tournaments. Anglers are limited to five walleye per team at the weigh-in. All fish caught during the tournament and retained for the weigh-in must be kept in an aerated live well or cooler to keep fish alive so they can be released after weigh-in. There is a penalty for dead fish of 0.25 pounds per dead fish. Tournament winners are determined based on the largest overall weight of all the fish.[24]

Annual Walleye Bonanza

The Sterling Sportsmen Association also holds an annual walleye tournament on Saginaw Bay of Lake Huron. The 2011 event was the 11th Annual Walleye Bonanza and was held August 6, 2011. The tournament is held from 6:30 AM to 2:30 PM beginning and ending at the Eagle Bay Marina in Standish, Michigan. Anglers pay $20 per person and must compete in teams of at least two anglers per boat. There is no maximum limit on the number of anglers per boat, but each person is limited to three fishing lines. Teams submit their largest five walleye to be weighed and prizes are awarded based on the largest total weight. The prize for the top team is at least $1,000 depending on the number of entrants. Event organizers expected between 50 and 100 boats for the 2011 tournament. Proceeds from the tournament go toward the operating costs of the Sterling Sportsmen Association as well as the scholarship fund and hunting safety courses. This tournament is designated as an "all-amateur event" and professional fishermen were asked not to compete.[25]

Au Gres Fireman's Walleye Tournament

Similar walleye tournaments are held throughout the Saginaw Bay region during the summer. On June 18, 2011, there was the Au Gres Fireman's Walleye Tournament. The 2011 event had 51

[24] Saginaw Bay Walleye Club, Inc., Michigan Walleye Tour. http://www.michiganwalleyetour.com/

[25] The Arenac County Independent, "11th Annual Walleye Bonanza to be held Aug. 6". July 22, 2011. http://www.arenacindependent.com/detail/89361.html?content_source=&category_id=1&search_filter=&list_type=&order_by=&order_sort=&content_class=1&sub_type=&town_id=8

boats enter. The top angler won $1,000 for the top five walleye. Entrance fees are $25 per angler for the one-day event.[26]

Lake Erie

Lake Erie is bordered by Michigan, Ohio, Pennsylvania, and New York. Tournament fisheries on Lake Erie include bass, trout, walleye, perch, salmon, and steelhead. The majority of these tournaments occur in the summer months; however ice fishing is available on Lake Erie during the winter.

Tom Morrison Steelhead Catch and Release

In Erie, Pennsylvania, the Pennsylvania Steelhead Association holds an annual tournament. The Tom Morrison Steelhead Catch and Release Tournament was held March 26, 2011. The tournament is an informal format, where teams of two or more catch steelhead, record the fish length and time caught, and immediately return the fish to the water alive and uninjured. The tournament begins at sun-up and ends at 5 PM. The tournament is only open to members of the Steelhead Association and registration is not required.[27]

Bassmaster Weekend Series

The American Bass Anglers (ABA) hosts one of its annual Bassmaster Weekend Series tournaments on Lake Erie. The Bassmaster Weekend Series is an example of a large, national fishing series which takes place on the Great Lakes. The 2012 Lake Erie event is scheduled for August 25-26, 2012 and begins at the Sandusky/Shelby Street Ramp in Sandusky, Ohio. The Lake Erie tournament is part of the Ohio Division of the American Bass Anglers Bassmaster Weekend Series. The Bassmaster Weekend Series tournaments are comprised of 20 different divisions, most of which are in the southeastern United States. There are 105 individual tournament events scheduled for 2012 from January through November. The Lake Erie ABA tournament is a two-day tournament event. There is only one two-day event per division and the rest of the events are one-day tournaments. Some of the tournaments in the Bassmaster Series are featured on the national television network, World Fishing Network. These broadcasts have increased the audience and interest in the tournaments which has increased the level of participation, sponsorships, and payouts.

Bassmaster Weekend Series tournaments are open to members of Bass Anglers Sportsman Society (B.A.S.S) and ABA who are age 16 and older. Professional anglers who have fished two or more tournaments with an entry fee of more than $1,500 in the previous six months are excluded from participating in the Weekend Series tournaments. The entry fee for the 2012 Lake Erie Weekend Series Tournament is $300 per angler and $150 per co-angler. The top 20 percent of anglers receive cash prizes with first place angler receiving up to $16,000 including cash prizes and other sponsor awards. The top 40 boaters and co-anglers (by points) in each divisional

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[26] Saginaw Bay Area Up To-date Fishing Report Forum Index – Fishing Tournament Board. Au Gres Fireman Tournament. http://www.saginawbay.com/appiesboard/viewtopic.php?t=7903

[27] PA Steelhead Association, Tom Morrison Steelhead Catch and Release Tournament. http://pasteelhead.com/Default.aspx?pageId=942837

two-day qualifier advance to the regional qualifier event. There are four regional qualifying events held per year. The regional qualifier for the Ohio Division is scheduled for October 19-20, 2012 at Smith Mountain, Virginia. The top 50 anglers in each regional qualifier advance to the Bassmaster Weekend Series Championship. The Series Championship is scheduled for November 4-10, 2012 in Jasper, Texas. The winner of the Series Championship wins $205,000 in cash and sponsorship prizes and is automatically eligible for the next year's Series Championship.[28]

National tournament series such as the ABA Bassmaster Weekend Series tournaments are subject to much more stringent rules than smaller, locally-organized fishing events. Some of the rules include:

- Tournament waters are off-limits up to 14 days prior to competitions
- Anglers are prohibited from using their cell phones or VHF radios for the purpose of locating fish during competitions
- Cell phones can only be used if the phone is on speaker mode so the co-angler can hear the conversation and ensure that fishing locations are not being exchanged
- A designated tournament official must be granted access to competitors' boats and cell phones during the competition
- Anglers may be subjected to polygraph tests at the discretion of the tournament director
- Outboard motors cannot exceed 250 horsepower
- Competitors agree to have their boats subjected to an inspection by tournament officials to verify that boats and motors are consistent with Coast Guard, State, and tournament regulations
- Changing or altering standard factory parts of an engine to increase the horsepower over the factory horsepower is prohibited
- Fishing while standing on the outboard motor or boat seats is not allowed
- An electric trolling motor may be used for slow maneuvering, but trolling is prohibited as a method of fishing
- Boaters will fish from the front deck and co-anglers will fish from the back deck, no exceptions
- Co-anglers are prohibited from operating the boat except in emergencies and for loading and un-loading from trailers
- Tournament standings, awards, and final winners are determined by the pounds-and-hundredths weight of each competitor's catch during the competition days of the tournament
- Only largemouth, smallmouth, spotted, or redeye bass will be counted
- Boaters are limited to five fish per tournament day and co-anglers are limited to three fish[28]

Erie Pennsylvania Sport Fishing Association, Spring Trout Challenge

The Erie Pennsylvania Sport Fishing Association (EPSFA) has hosted several annual fishing tournaments on Lake Erie since 2006. In 2011 the EPSFA hosted the Spring Trout Challenge, the Walleye Challenge, the Summer Slam, the Fall Trout Challenge, the Team of the Year, and the

[28] American Bass Anglers. http://www.americanbassanglers.com/

Big Fish Derby. The 2011 Spring Trout Challenge was scheduled for April 17, but the tournament was canceled due to poor weather. The 2010 Spring Trout Challenge was held April 18, 2010 and 19 teams participated in the event. Competitors must pay a $75 entry fee to participate in this one-day tournament which occurred from 7:30 AM to 2:30 PM. A maximum of 6 fish at least 15 inches in length per angler are allowed to be weighed in and allowable species are steelhead, brown trout, palamino, and salmon. Each fish brought to the weigh-in receives 10 points plus 1 point per pound and winning team will be determined based on the highest number of points. Cash prizes are awarded to the winning teams and 90 percent of entry fees are returned to entrants as prize money. Ten percent of entry fees are retained by the EPSFA for tournament administration fees. Fishing is only permitted in the Pennsylvania waters of Lake Erie. A "big fish" award is also up for grabs for an additional $10 entry fee. All contestants must fish from a boat, but there are no restrictions on the size of the boat. Each team must consist of at least two participants and each boat (team) is limited to 6 rods in the water, with 2 lures per rod.[29]

EPSFA Walleye Challenge

The EPSFA 2011 Walleye Challenge was held June 18, 2011 from 6:00 AM until 2:00 PM. Thirty-five teams participated in the 2011 tournament. Competitors must pay a $150 entry fee to participate in the one-day tournament. A maximum of 9 walleye at least 18-inches in length can be weighed in for tournament points. Each boat can fish at most eight rods, however, only two rods per angler are allowed, and each rod can use two lures. Points per fish and cash prizes are determined in the same manner as for the EPSFA Trout tournament. The angler who catches the largest walleye will also receive a trophy and a $75 cash prize. For this walleye tournament, each boat must be at least 16-feet in length and all participants must fish from a boat. All boats must launch from and fish in Pennsylvania waters of Lake Erie; any fish caught outside of Pennsylvania boundaries will be disqualified.[29]

EPSFA Summer Slam

The 2011 EPSFA Summer Slam tournament occurred on August 6 and 7, 2011. Unlike the other EPSFA tournaments, the Summer Slam includes an Open Division and an Amateur Division. In the 2011 event, 22 teams competed in the Open Division and 32 teams in the Amateur Division. The entry fee is $400 per boat in the Open Division and $200 per boat in the Amateur Division. The fishing tournament takes place from 6:00 AM to 2:00 PM over both fishing days; Amateur Division fishing ends at 1:30 PM on both days of the tournament. Fishing in both divisions is limited to the Pennsylvania waters of Lake Erie. Teams must be a minimum of two anglers, and there is no maximum team size, though each boat is limited to eight fishing rods in the Open Division and six in the Amateur Division with two lures per line allowed in both divisions. In the Open Division only, each team must provide an observer. Observers are exchanged between teams via drawing and will log each fish caught including time, estimated weight, species, lure used, and which angler caught the fish. Observers must stay with the catch until weigh-in in order to ensure the validity of the fish caught. Observers are not required in the Amateur Division, but a team member must log the catch information. In both divisions, boats must be at

[29] Erie Pennsylvania Sport Fish Association. http://www.epsfa.com/

least 17-feet in length and all boats must be equipped with a tournament flag, GPS system, and VHF radio.[29]

According to Pennsylvania State rules, a maximum of 24 walleye and 20 trout can be kept per four-person team. Only the 12 best fish (with no more than 6 being steelhead) can be weighed-in for points, but each team may weigh-in up to 12 walleye if they are not weighing any trout. All fish must be at least 18-inches in length. This tournament does not allow culling; the first legal fish caught must be kept and fish cannot be swapped or returned to the water once caught in place of a larger fish. In the Amateur Division, no more than 18 walleye and 15 trout can be kept per 3-person team and the 8 best fish (no more than 4 steelhead) can be weighed-in for points. A team can weigh-in 8 walleye if they have no trout. The minimum length of 18 inches is the same for both divisions. Fish under 18-inches will be disqualified and will receive a 10-point penalty. Each legal fish will score 10 points plus one point per pound. The first place team in the Open Division will win $10,000 in cash and merchandise and prize payouts will be given to the top-ten teams. Daily prizes will also be given for the largest fish of the day. The first place team in the Amateur Division will receive $2,000 in cash and merchandise, and prizes will be given for the top-ten teams and additional daily prizes for the largest fish.[30]

According to the tournament rules, any captain or team member, excluding an observer, who is a licensed fishing charter boat captain or ex-fishing charter boat captain, fishing guide, commercial fisherman, currently represents a major fishing related product or who currently promotes a major fishing product whose sales may be increased by fishing this tournament will be required to enter the Open Division only. All others may enter the Amateur Division. Individuals, who possess a Coast Guard license but never used that for fishing related purposes, may enter the Amateur Division. Amateurs may enter the Open Division if they choose.[30]

EPSFA Fall Trout Challenge

The EPSFA 2011 Fall Trout Challenge was held October 23, 2011. In the 2011 occurrence of this annual tournament, 14 teams participated; there were four three-man teams, nine two-man teams, and one one-man team. The rules for the Fall Trout Challenge are the same as for the Spring Trout Challenge.[30]

EPSFA Team of the Year

The EPSFA “Team of the Year” is a challenge that rewards fishermen who participate in at least three of the four EPSFA annual fishing tournaments (Spring Trout Challenge, Walleye Challenge, Summer Slam, and Fall Trout Challenge). Teams must enter the “Team of the Year” Challenge before Walleye Challenge, and must submit an additional $80 entry fee to be eligible for Team of the Year prizes. The winner is determined by combining anglers’ best scores from three out of the five possible tournament days and the winner is announced at the end of the Fall Trout Challenge. The winning team will receive four jackets, a trophy, and a cash prize. The top three teams are awarded cash prizes as a percentage of the Team of the Year entry fees, less the cost of the jackets and trophies. This is a team award, and at least two of the same EPSFA members must participate in the qualifying tournaments to be eligible for the Team of the Year Award.[30]

EPSFA Big Fish Derby

The EPSFA also hosts an annual "Big Fish Derby" in both walleye and steelhead divisions for EPSFA members. The derby runs each year from the day after the Spring Trout Challenge until December 31st of that year. Competitors must submit an entry form and $10 for each division to be eligible for the derby. Fish eligible for the derby will be taken only from the Pennsylvania waters of Lake Erie. Fish caught for other EPSFA tournaments are not eligible for the Big Fish Derby. All fish caught for the derby will be weighed in and verified at either Poor Richards or the East End Angler sporting goods stores in Erie, Pennsylvania. Each angler can re-submit a larger fish at any time during the derby, but only one walleye and one steelhead entry will be on the score board for each competitor at any time. The derby features a 90 percent payback for each division (walleye and steelhead) and the top three anglers, based on fish length, in each division will receive cash prizes. First place receives 50 percent of remaining entry fees, second place receives 30 percent, and third place 20 percent. Winners are determined and prizes awarded at the January monthly EPSFA meeting.[30]

Southtowns Walleye Tournament

In the state of New York, the Southtowns Walleye Association of Western New York, Inc. began hosting an annual walleye tournament on Lake Erie in 1985. The tournament has grown to be one of the largest of its kind in North America. In 2010, the club gave over $34,000 in cash and prizes. The Southtowns Walleye Association also sponsors the annual Lake Erie Eastern Basin Fishing Championship in August which is a charity benefit for the Roswell Park Cancer Institute.[31]

Annual Greater Niagara Basseye Celebrity Challenge

On July 8, 2011, the 9th Annual Greater Niagara Basseye Celebrity Challenge was held in Niagara, New York on Lake Erie as a fundraiser for the Cystic Fibrosis Foundation. This tournament pairs celebrities and anglers with professional fishing guides for this one-day catch and release tournament. More than 40 boats and 200 anglers and captains participated in the 2011 event for bass and walleye. Each boat contains two anglers and a celebrity (or three anglers) and one professional fishing guide and tries to catch as many fish as possible. Boat, bait, tackle, and food for competitors are donated by event sponsors. After the fishing day, the tournament concludes with an awards dinner and fundraiser. Anglers receive points based on the number of fish caught; a walleye is worth 100 points, a bass is worth 50 points, and a "BassEye" worth 150 points. Therefore, if an angler catches one bass and one walleye (a Basseye), the angler receives 300 points – 100 for the walleye, 50 for the bass, and 150 for the Basseye.[32]

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[30] Erie Pennsylvania Sport Fish Association. http://www.epsfa.com/
[31] Southtowns Walleye Association of WNY Inc. http://www.southtownswalleye.org/index.html
[32] Greater Niagara Basseye Celebrity Challenge. http://www.basseye.org/

Lake Ontario

Lake Ontario is bordered by New York. Fisheries on Lake Ontario utilized for tournaments include walleye, salmon (King, coho, and Atlantic), brown trout, lake trout, silver fish, pike, perch, muskellunge (also known as muskie or musky), bass, and steelhead. Rainbow trout and steelhead are generally considered to be the same species for tournament harvests. Similar to the other Great Lakes, the majority of fishing tournaments occur during the spring and summer months (April through September), but some small ice fishing tournaments do occur during the winter.

Sodus Point Bait and Tackle Shop Ice Fishing Derby

At Sodus Point, New York on Lake Ontario, the Sodus Point Bait and Tackle Shop (also known as Warren's Hook, Line, and Sinker) sponsors and hosts an ice fishing derby and tournament. The derby occurs every weekend during ice fishing season. Anglers fish for pike and perch on alternating weekends, and the largest fish of the weekend wins a prize. For each weekend derby, there is a $5 entry fee, and the winner receives $25 worth of tackle.[33]

Sodus Point Ice Fishing Tournament

The Sodus Point ice fishing tournament event took place on February 12-13, 2011. The 2012 Sodus Point Lodge Polar Ice Fishing Tournament is scheduled for February 25-26, 2012. There were 138 anglers who participated in the 2010 tournament. This tournament has an entry fee of $10, with the possibility of winning thousands of dollars in prizes including trout and salmon charters. All fishing is done on Sodus Bay of Lake Ontario. Fishing begins at 6:00 AM and ends at 3:00 PM on Saturday, and 1:00 PM on Sunday. Anglers can catch pike, no less than 5 pounds, and perch, no less than 10 ounces. There is a daily weigh-in for the tournament, and daily and overall tournament winners will be chosen based on the overall weight of the catch. The winner of the Pike division wins $500 and the winner of the perch division wins $360, with the top five fishermen receiving trophies.[33]

Lake Ontario Pro-Am Series

Lake Ontario is also home to the large Lake Ontario Pro-Am Series. This is a series of tournaments which take place at four different locations in New York State on the shore of Lake Ontario during the summer. The four fishing events occur in four different New York counties: Niagara, Orleans, Oswego, and Wayne. The tournament is restricted to the New York State waters of Lake Ontario. Tournaments of this magnitude have more strict rules than local or charitable tournaments.[34]

Anglers in the Lake Ontario Pro-Am compete in the Pro, Amateur, or Open Divisions. Any captain or team member, excluding observer, who is (or has been within the past 5 years) a licensed charter boat captain, fishing guide, or commercial fishermen, is required to enter the Pro

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[33] Sodus Point Lodge, Sodus Point, New York. http://www.asoduspointlodge.com/index.htm
[34] Lake Ontario Pro-Am Series, New York State. http://www.lakeontarioproam.net/

Division. All others may enter the Amateur Division. Amateurs may enter the Pro Division if openings are available. Scores for the Pro-Am competition are calculated by adding 10 points per fish, then one point per pound. Anglers can participate in any or all events.[34]

Lake Ontario Pro-Am Series Challenge Cup

Teams can compete in any number of tournaments they wish. If teams compete in all four events, they are eligible for the Challenge Cup. The Lake Ontario Pro-Am Series Challenge Cup is designed to determine the most consistent fishermen on the lake. Contestants pay a separate entry fee ($300 for Pros and $200 for Amateurs) and commit their team for all four of the Pro-Am Tournaments. The Challenge Cup is divided into the Western Division comprised of the Orleans and Niagara Tournaments, and the Eastern Division which includes the Oswego and Wayne Tournaments. Each division will have a winner and the Challenge Cup will go to the Professional and Amateur teams compiling the highest number of points after all four tournaments. Points are determined based on the place each team finished in each tournament, not the points accumulated in each tournament. For example, the first place team receives 100 points, the second place team gets 97, the third place team gets 94, and this trend continues except all teams below twentieth place receive 62 points. The points are awarded after each fishing day, and additional points are awarded for bonuses and based on each team's placement in relation to other Challenge Cup participants. The Challenge Cup Champion will be awarded after the second leg of the Eastern Division Tournament (Wayne County). Each portion of the Pro-Am tournament also features additional sponsored contests for the biggest overall fish and the biggest come-back award for the greatest point differential between day one and day two.[35]

For all four portions of the Lake Ontario Pro-Am, tournament fishing lasts two days, with scheduled fishing time from 5:30 AM to 2:00 PM. Tournament fishing is limited to the US waters of Lake Ontario only and no fishing on tributaries is allowed. Each team is responsible for staying inside the tournament boundaries. There is no limit on the number of anglers per team, but each angler is allowed no more than two fishing rods, and each boat is allowed no more than eight fishing rods in the professional (Pro) division. In the amateur (Am) division, each boat can have only six fishing rods. Each team is required to provide an observer who serves to record the information of each fish caught on the official score sheet but are not allowed to operate boats or assist teams. Observers will be exchanged between teams on a random basis. All boats must be a minimum length of 18-feet and equipped with VHF radio and GPS unit in order to record catch locations on the official score sheet. The day's catch will be stored in a cooler and the cooler will be transported immediately to the weigh-in site after returning to port.[35]

Anglers in the Pro Division are limited to 12 fish per boat including a maximum of 3 silverfish per angler and 2 lake trout per angler. The first legal limit of 12 fish brought on board the boat must be kept. Anglers in the Amateur Division are limited to 9 fish per boat including a maximum of 3 silverfish per angler and 1 lake trout. The first legal limit of 9 fish brought on board must be kept. Anglers in the recreational division are limited to 3 fish and a maximum of 1 lake trout. "Legal" catches are determined by size requirements; the minimum size for steelhead is 21 ½ inches, the minimum size for Atlantic salmon is 25 ½ inches, and the minimum size for

[35] Lake Ontario Pro-Am Series, New York State. http://www.lakeontarioproam.net/

all other trout and salmon is 18 inches. Fish are measured using a certified measuring board. Fish submitted for weigh-in that are less than the minimum size will be disallowed and 10 points plus 1 point per pound of the undersized fish will be deducted from the team's overall score.[35]

Skip Harman Memorial Lake Ontario Pro-Am Salmon Team Tournament

The Niagara County tournament is held in the ports of Wilson and Olcott. The Niagara County portion of the Lake Ontario Pro-Am was held on June 4-5, 2011 and is also known as the annual Skip Hartman Memorial Lake Ontario Pro-Am Salmon Team Tournament. The Niagara Pro-Am tournament is the anchor of "tournament week" in Niagara which includes the Sabres Alumni Spring Salmon Spectacular, the Don Johannes Memorial fishing event, the Pete DeAngelo Three-Fish event, and finally the Pro-Am tournament on Saturday and Sunday.[36]

Orleans County Lake Ontario Pro-Am

The Orleans County portion of the Lake Ontario Pro-Am is held at Oak Orchard, New York. The 2011 tournament occurred on June 11-12.[36]

Oswego County Pro-Am Salmon and Trout Team Tournament

The Oswego County portion of the Lake Ontario Pro-Am is known as the Oswego County Pro-Am Salmon and Trout Team Tournament. The 2011 tournament was held July 9-10, 2011. Oswego County has a choice of three tournament launch sites: the Lighthouse Marina in Port Ontario, the New York State boat launch at Mexico Point and various marinas on the Little Salmon River, and three marinas in the Port of Oswego. In the 2011 Lake Oswego Pro-Am, 57 tournament teams competed. The Oswego event features the normal Pro-Am tournament rules and configuration, as well as an additional sponsored contest for the biggest steelhead.[36]

Wayne County Trout and Salmon Team Tournament Series

The Wayne County portion of the Lake Ontario Pro-Am occurs from Sodus Point. The Wayne County Pro-Am is also known as the annual Wayne County Trout and Salmon Team Tournament Series. Sixty-eight teams participated in the 2011 Wayne County Pro-Am, from July 16 through 17, 2011.[36]

Niagara River Anglers Tournaments

The Niagara River Anglers Association hosts two tournaments on Lake Ontario (and the lower Niagara River) at Lewiston Landing in New York. The first is a smallmouth bass tournament which was held in late July 2011. The winner of this tournament is based on the largest combined weight of two smallmouth bass. The top three anglers receive cash prizes, with the amount of prizes determined by the number of entrants, and 2nd and 3rd place are guaranteed at

[36] Lake Ontario Pro-Am Series, New York State. http://www.lakeontarioproam.net/

least $1,000. Fishing occurs from sunrise until 2:00 PM. Tournament entrance fees are $30 per angler, which includes two raffle tickets for door prizes.[37]

The Niagara River Anglers Association also hosted a walleye tournament in September 2011. The winners of this tournament are also based on the largest two fish caught. The entrance fee is $20 per angler, and the top three anglers receive cash prizes of 50 percent, 30 percent, and 20 percent, respectively, of the total entry fees.[37]

Pay Every Day Derby

Lake Ontario is also home to the Pay Every Day Derby, which occurred from May 1, 2011 to September 3, 2011. This derby targets salmon and trout. In the derby, anglers can win $1,000 per day of the derby for the largest qualifying trout or salmon caught on the lake and weighed in at an authorized weigh station. In the event of poor weather and wave conditions on the lake which precludes fish from being caught on a particular day of the derby, half of the prize money for that day will be rolled over into the following day's prize, and this will continue until a winning fish is caught. There is also an additional prize offered for the largest fish of each month of the derby. Participants must register by 7:00 AM on the day they wish to fish in the derby. Fish eligible for the derby include salmon, brown trout, lake trout, and rainbow (steelhead) trout. Fish must meet minimum weight requirements including 20 pounds from May 1 until June 1, 23 pounds from June 1 through July 15, 26 pounds from July 15 through August 15, and 28 pounds from August 16 through September 3. The Pay Every Day Derby website did not list number of participants in the Derby, but participation levels are likely high as additional prizes are offered when derby participation reaches 2,000 entrants. To participate in the derby, anglers purchase a pass; a season pass is $100, and a 2-day pass is $35.[38]

Other Tournaments

Additional tournaments scheduled for Lake Ontario in 2011 include:

- 5th Annual Buffalo Sabres Alumni Spring Salmon Spectacular, June 2, 2011
- 10th Annual Don Johannes Memorial Big Fish Contest, June 3, 2011
- 5th Annual Pete DeAngelo Memorial Three-Fish Contest, June 3, 2011
- 35th Annual Fish Odyssey Derby, August 20-28, 2011
- Lake Ontario Counties (LOC) derby, May 4-13, June 16-July 29, and August 17-September 3, 2011.

[37] Niagara River Anglers Association. http://www.niagarariveranglers.com/
[38] The Pay Every Day Derby. http://www.payeverydayderby.com/index.php

FISHING TOURNAMENTS IN THE OHIO RIVER BASIN

The Ohio River begins in Pittsburgh, Pennsylvania at the confluence of the Allegheny and Monongahela rivers and flows 981 miles to join the Mississippi River at Cairo, Illinois. The average depth of the Ohio River is 24 feet, its deepest point is 132 feet near Louisville, Kentucky, and the widest point is 1 mile wide at the Smithland Dam. There are 20 dams and 49 power generating facilities along the river. These dams create "pools" which are popular sites to hold fishing tournaments. States which have the Ohio River as a border or through which the river runs are: Pennsylvania, West Virginia, Ohio, Kentucky, Indiana, and Illinois.[39] Figure 3 shows the Ohio River and Ohio River Basin.

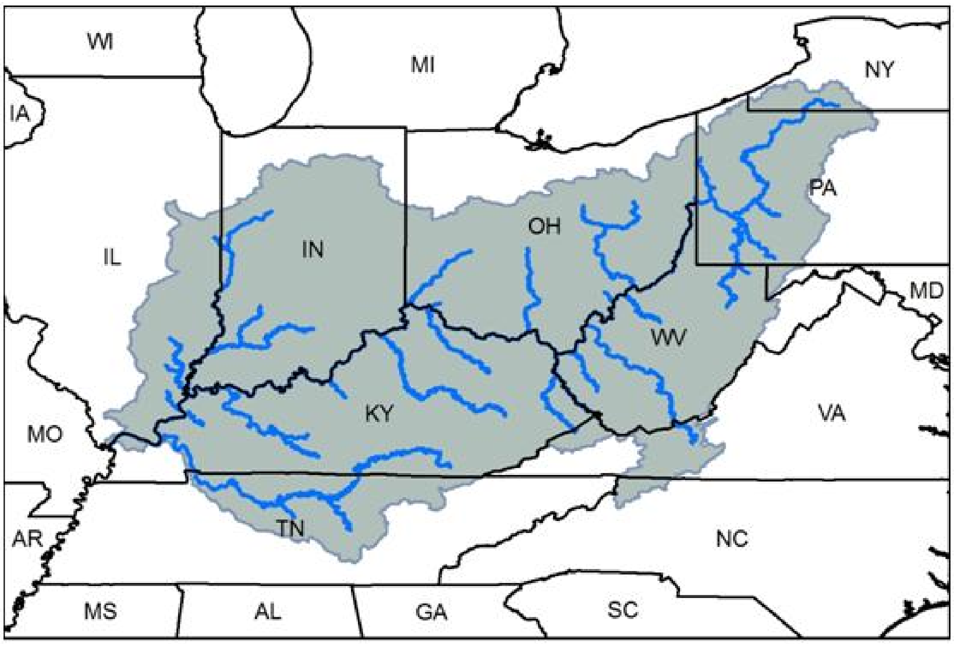

Figure 4. Ohio River and Ohio River Basin
Source: U.S. Army Corps of Engineers

When operating a vessel on the Ohio River, all applicable state laws from the states bordering the river are in effect. For example, a boater on the portion of the Ohio River which borders Ohio and West Virginia is subject to the state laws of both states. The Ohio River is also considered to be "federal waters" and boaters need to comply with all U.S. Coast Guard requirements.[40]

According to the State of Ohio, Department of Natural Resources, Ohio Bass Tournament Report for 2010, the Ohio River ranks as the second most fished water, in terms of number of bass

[39] The Ohio River, All things fishing on the Ohio River. http://theohioriver.com/
[40] State of Ohio, Department of Natural Resources, "Ohio River Boating". http://www.dnr.state.oh.us/watercraft/ohioriver/tabid/2302/Default.aspx

tournaments per year, in the state of Ohio, with 30 bass tournaments in 2010. The total number of bass tournaments in the state of Ohio in 2010 was 227.[41]

The State of West Virginia, Division of Natural Resources (DNR) maintains records of all fishing tournaments which occur in the state as part of their permitting process. According to the West Virginia DNR, there are 426 fishing tournaments scheduled for 2012 throughout the state. Of those, 117 will take place on the Ohio River. The majority of fishing tournaments scheduled to occur on the Ohio River are bass or catfish tournaments. All of the 2012 West Virginia fishing tournaments on the Ohio River will occur on various pools of the Ohio River including the Hannibal Pool, Belleville Pool, Willow Island Pool, Racine Pool, and R.C. Byrd Pool.[42]

In Kentucky, the Department of Fish and Wildlife Resources has instituted a voluntary Tournament Reporting Program for bass tournaments in which bass tournament organizers can choose to report their tournament statistics. According to the Tournament Reporting Program, there were 35 bass fishing tournaments on the Kentucky portion of the Ohio River in 2009 (the most recent year for which data is available). The majority of tournaments (31) occurred between March and August. Kentucky fishing tournaments on the Ohio River occurred on the following Ohio River Pools: Greenup, Markland, McApline, Meldahl, and Smithland. A total of 998 anglers participated in the tournaments and 1,685 bass were caught. This is a voluntary bass tournament reporting system and should not be assumed to be a complete list of fishing tournaments in Kentucky.

Fisheries harvested during tournaments on the Ohio River include carp, catfish, bass, and walleye. Similar to the analysis of Great Lakes fishing tournaments, this section provides only a snapshot of the fishing tournaments which take place on the Ohio River. This provides a sample of tournament types, not a comprehensive listing of tournaments.

Paddlefest Kayak Fishing Tournament

The Northern Kentucky Fly Fishers host the annual Paddlefest Kayak Fishing Tournament in Cincinnati, Ohio. The tenth annual tournament occurred on June 24, 2011 from 4-8 PM. The tournament occurs on the Ohio River in the area surrounding Coney Island near Cincinnati. This is a catch-and-release carp tournament in which anglers provide their own boats, photograph each fish next to a tournament-provided ruler to verify the length of the fish, and record the length of each fish on the official scorecard. All fish must be caught via hook and line on a hand-held rod with bait or an artificial lure. All fish must be caught from a kayak, canoe, or similar non-motorized paddle or pedal boat, and there are a maximum of 2 anglers allowed per boat. One point is awarded for each fish caught and properly documented. If a fish is caught using a fly rod and fly, three bonus points are awarded; two bonus points are awarded for a non-fly rod and an artificial lure. The longest fish of the tournament receives six bonus points. The angler with the

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[41] State of Ohio, Department of Natural Resources, Ohio Bass Tournament Report 2010. http://www.dnr.state.oh.us/Home/FishingSubhomePage/programs__activitiesplaceholder/fishingobfdefault/tabid/6145/Default.aspx

[42] State of West Virginia, Division of Natural Resources, Wildlife Resources, Fishing Tournament Dates. http://www.wvdnr.gov/Fishing/tournaments.shtm

most points wins the grand prize of a day of fishing from a custom skiff donated by Knee Deep Expeditions. The Paddlefest Tournament is a charity tournament and all proceeds are donated to The Ohio River Way to promote the Ohio River Water Trail and to help build the Ohio River Bike Trail.[43]

Catfish Country Tournament Series

The fishing group Catfish Country hosts an annual series of catfish tournaments on the Ohio River. The tournaments are held from April through October at various locations on the Ohio River. Table 2 shows the 2011 tournament schedule and locations. All tournaments are governed by the same set of rules and every angler must abide by the fishing regulations of the state in which the tournament is held. Every tournament in the series is open to the public. There is a maximum team size of three anglers per boat, and each boat must pay a $60 entry fee. Only catfish (including flathead, blue, and channel cats) may be weighed in and a maximum of 5 fish can be weighed in, all of which must be alive at the time of weigh-in. All fish over 20 pounds must be released after weighed in. All fish must be caught by rod and reel. The hours of fishing vary by tournament. If there are four or fewer boats entered in a tournament, the first place prize is $40 per boat entered and second place is $20 per boat entered. If between five and nine boats enter a tournament the payout is $35 per boat entered for first place, $15 per boat entered for second place, and $10 per boat entered for the single largest fish caught during the competition. If ten or more boats enter a tournament, first prize is $25 per boat entered, second place is $15 per boat entered, third place is $10 per boat entered, and the same $10 per boat prize for the largest fish.[44]

[43] The Ohio River Way – Kayak Fishing Tournament. http://www.ohioriverway.org/paddlefest/schedule-of-events/kayak-fishing-tournament/

[44] Catfish Country. http://catfishcountry.com/default.aspx

Table 2. Catfish Country Tournament Series, 2011 Tournament Schedule

Date (2011)	Time	Location
April 23	8am-2pm	Big Bone, Kentucky
May 7	8am-2pm	Augusta, Kentucky
May 21	7am-1pm	Tanner's Creek, Indiana
June 4	7am-1pm	Craig's Creek, Kentucky
June 18	7pm-1am	Schmidt Field, Ohio
July 2	7pm-1am	Augusta, Kentucky
July 16	7pm-1am	Big Bone, Kentucky
July 30	7pm-1am	Manchester, Ohio
August 13	7pm-1am	Schmidt Field, Ohio
August 27	7pm-1am	Tanner's Creek, Indiana
September 24	8am-2pm	Aberdeen, Ohio
October 8	8am-4pm	Craig's Creek, Kentucky

Source: Catfish Country. http://catfishcountry.com/default.aspx

FLW Tournament Series

The Forrest L. Wood (FLW) Wal-Mart Bass Fishing League hosts some of its tournaments on the Ohio River. The FLW is another example of a large, national tournament series with more stringent rules. One Bass Fishing League event which takes place on the Ohio River occurs at Tanner's Creek in Lawrenceburg, Indiana. The tournament begins at 6 AM on August 18, 2012 at the Lawrenceburg City Ramp and weigh-in begins at 2 PM in the same location. The entry fee for this tournament is $200 per angler and $100 per co-angler. The catch limit for this event is 5 bass, which must be no more than 12-inches each. This tournament is a qualifying event in the Bass Fishing League series, and takes place in the Hoosier Division. The top 40 anglers and co-anglers receive payouts for this tournament and prizes range from $6,000 to $200 for anglers and from $3,000 to $100 for co-anglers.[45]

There is another Bass Fishing League tournament at Tanner's Creek in Lawrenceburg, Indiana on September 8 and 9, 2012. As a two-day event, this is a "Super Tournament", so entry fees are

[45] FLW Walmart Bass Fishing League. http://www.flwoutdoors.com/bassfishing/bfl/

$300 per angler and $150 per co-angler, and payouts range from $9,000 to $300 for the top 40 anglers and from $4,500 to $150 for the top 40 co-anglers.[45]

Another Bass Fishing League tournament event in the Hoosier Division occurs at the Rocky Point Marina in Cannelton, Indiana. This tournament is scheduled for July 28, 2012. The Rocky Point tournament is a Qualifying Event and has the same entry fees and payout schedule as the Tanner's Creek Qualifying Event. For the Rocky Point Tournament, fishing begins at 6 AM and weigh-in begins at 2 PM at the marina. The same catch limits apply (5 bass, less than 12 inches).[45]

In the Buckeye Division of the Bass Fishing League tournament series, there are two tournaments which occur on the Ohio River. The Maysville Tournament is scheduled for July 14, 2012 at the Maysville River Park in Maysville, Kentucky. Fishing begins at 6:30 AM and weigh-in begins at 2:30 PM. The Maysville Tournament is a Qualifying Event and therefore has a $200/$100 entry fee for anglers/co-anglers, same payout schedule, and catch restrictions as the Tanner's Creek Qualifying Event. The other Ohio River tournament in the Buckeye Division is at Tanner's Creek in Lawrenceburg, Indiana on August 4, 2012. Fishing for this tournament begins at 6:30 AM and weigh-in starts at 2:30 PM. This Qualifying Event tournament has the same rules as the August 18, 2012 Tanner's Creek Event.[45]

There is one tournament on the Ohio River in the Illini Division of the Bass Fishing League Tournament Series. This tournament takes place at the Golconda Marina in Galconda, Illinois. The tournament begins at 6 AM on July 14, 2012 and weigh-in begins at 2 PM the same day. This tournament is subject to the rules associated with Qualifying Event tournaments in the Bass Fishing League series.[45]

The Wal-Mart Bass Fishing League is a 24-division league which is a subset of the national FLW tournament series. Top anglers in the Bass Fishing League can move up to the more prestigious (and more competitive) professional EverStart Series or FLW Tour. The Bass Fishing League includes five qualifying events per division (four Saturday tournaments plus one two-day Super Tournament), no-entry-fee regional tournaments, and a no-entry-fee championship tournament. The four Saturday one-day events pair a boater/angler and one co-angler per boat with a maximum field of 200 participants in each tournament. The winners are determined by the heaviest total catch over the one-day tournament. For the two-day Super Tournament events, the full field of anglers competes on Saturday and the top 20 percent of anglers compete in Sunday's final round. The winners are determined by the heaviest two-day catch. The top 40 boaters and the top 40 co-anglers from four Bass Fishing League Divisions advance to one of seven regional championship tournaments. Regional championships are three-day tournament events and the winners are determined by the heaviest three-day catch. The top 24 boaters and 24 co-anglers receive prize money in these events, but only the top six boaters and top six co-anglers from each regional championship advance to the Bass Fishing League All-American Championship. The Championship is a three-day tournament. The full field of anglers from the seven regional tournaments competes in the first two days of the Championship tournament. Only the top 10 boaters and top 10 co-anglers continue on to the third day of the competition. The winning boater and co-angler are determined by the heaviest total three-day catch.[46]

As a national tournament series, the rules of the Bass Fishing League tournaments are stricter than locally-organized tournaments. Participation in the tournaments is open only to members of the FLW Outdoors organization who are age 16 and older. Boaters and co-anglers can either enter as teams or separately and will be paired based on a random drawing. The winner of each tournament (as determined by overall weight) will be awarded 200 points, second place receives 199 points, third place receives 198 points, and etc. The top boaters and co-anglers who advance to the regional championship tournaments and later the national championship tournaments are determined by overall points. The Bass Fishing League Tournament Series does not allow practice fishing in the tournament area before the tournament begins. Also, once the tournament has begun, contestants cannot solicit or receive information about catching fish in tournament waters from anyone other than the boater or co-angler in their boat. Boaters are allowed to fish from the front deck of the boat only, while co-anglers can only fish from the back deck or seating area of the boat. Boaters will have complete control of boat operation and of waters to be fished. In the event of an emergency, co-anglers may operate the outboard or trolling motor, but may not fish from the front deck at any time.

The use of mobile communications such as radios and cell phones is strictly prohibited during tournament fishing and co-anglers are prohibited from recording GPS waypoints or using any kind of GPS device on the tournament day. All boats must be propeller-driven, a minimum of 16-feet in length, be equipped with wheel steering, meet all U.S. Coast Guard safety requirements, and contain a properly aerated live well. Fishing is defined as having a lure attached to a line and a rod and reel with the lure in the water. All bass must be caught alive, only artificial lures may be used; only one rod may be used at a time, and trolling is prohibited. Every effort must be made to keep bass alive and eight ounces will be deducted from the total weight for each dead bass presented at weigh-in. Anglers who are not at the weigh-in area at the appointed time will be penalized one pound per minute and any angler more than 15 minutes late will lose credit for that day’s weight. Scoring is determined by the pounds and ounces of each angler’s catch. Only largemouth, spotted, redeye, or smallmouth bass are accepted species, the daily limit of fish is five, and each fish must be 12 inches or less unless state regulations indicate otherwise. Each contestant agrees to submit to a polygraph or voice stress analysis if deemed necessary by tournament officials.[46]

FLW Outdoors is named after Forrest L. Woods, the founder of Ranger Boats, and is regarded as the largest fishing organization in the world. FLW Outdoors offers anglers worldwide the opportunity to compete for millions of dollars in cash and prizes over the course of almost 200 tournaments operated annually. FLW Outdoors offers a hierarchy of tournament circuits to accommodate anglers from novice to professional, which include a series of qualifying circuits that allow anglers to advance to the next level of competition and higher payouts. The organization is regarded as the most lucrative bass fishing tournament organization in the world. FLW Outdoors was founded in 1996 under the premise of answering the demand among bass anglers for an organized tournament circuit. The goal was to increase participation in the sport of

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[46] FLW Walmart Bass Fishing League. http://www.flwoutdoors.com/bassfishing/bfl/

bass fishing by supplying tournaments and to increase the sport's fan base using print, online, and television coverage.

The first television broadcast of the FLW Tour occurred in November 1997 on Fox Sports and more than 2 million households watched the live coverage. Today, FLW fishing events and a weekly show are broadcast in more than 75 million homes in the US and Canada and over 430 million homes in Europe, Africa, and Asia. Television broadcasts appear on networks such as World Fishing Network, NBC Sports Network, and Matchroom Sports (international broadcasts). The FLW events are sponsored by large companies including Wal-Mart, the US National Guard, BP, Everstart, and several others.[47]

West Virginia Bass Federation Tournaments

The West Virginia Bass Federation holds an annual tournament series called the Buddy Trail. There are two divisions of the Buddy Trail, with five tournaments in each division. Two of these tournaments occur on the Ohio River; May 21, 2011 on the Belleville Pool of the Ohio River in Belpre, West Virginia and June 4, 2011 on the Willow Island Pool of the Ohio River in New Martinsville, West Virginia were the events in 2011. All Buddy Trail tournaments occur from 7 AM to 4 PM on the tournament day. Entry fees for each Buddy Trail tournament are $100 per boat. Each tournament is limited to 70 boats and each boat is limited to catching six bass. The winning team is determined by the overall weight of the bass. Of the total entry fees, 74 percent are returned as prizes to the top ten percent of teams in each tournament, 10 percent is used for prize money for the West Virginia Bass Federation Invitational tournament, and 16 percent is used for administrative fees by the West Virginia Bass Federation. In 2011 the Belleville Pool tournament was cancelled due to bad weather, and the Willow Island Pool tournament had 51 two-man-teams participate.[48]

H&H Bass Club Tournaments

In Kentucky, the H&H Bass Club hosts twelve annual tournaments all located on lakes in Kentucky or the Ohio River. According to the club's website, one of their annual tournaments will occur on the Ohio River in 2012. On June 9, 2012 the club will host a bass tournament from 6 AM to 3 PM. Members of the club can compete in the annual tournament series and awards and prizes are given at an end-of-the-year banquet to the year's top finishers based on combined scores. The H&H Bass Club is a not-for-profit organization formed for men, women, and couples who love to fish and enjoy the great outdoors.[49]

[47] FLW Outdoors. http://www.collegefishing.com/tournament/versus.cfm
[48] West Virginia Bass Federation. http://www.wvbass.com/tournament.html
[49] Northern Kentucky H&H Bass Club. http://www.hhbassclub.org/

FISHING TOURNAMENTS IN THE UPPER MISSISSIPPI RIVER BASIN

The Upper Mississippi River flows approximately 1,300 miles, from Lake Itasca in northern Minnesota to its confluence with the Ohio River at the southern tip of Illinois. This 1,300 miles comprises over half of the length of the entire Mississippi River. There are approximately 500 boat access points and marinas along the Upper Mississippi River and the river supports more than 127 species of fish.[50] Figure 4 shows the Upper Mississippi River, some of the major cities along the river, and the states for which the river forms a border.

Figure 5. Upper Mississippi River
Source: U.S. Army Corps of Engineers

There are 29 locks and dams on the Upper Mississippi River. These locks and dams are numbered sequentially from north to south. The water behind a dam carries a pool name that matches the dam's number. For example, Pool 13 is created by Lock and Dam 13 just north of Clinton, Iowa. These pools created by the lock and dam system are popular locations for fishing tournaments on the Upper Mississippi River.[51]

The organization called Big River Bass maintains a website about bass fishing on the Upper Mississippi River. This website includes a listing of bass tournaments on the Upper Mississippi. According to Big River Bass, there were 113 bass fishing tournaments scheduled to occur on the Upper Mississippi in 2011. These tournaments were scheduled for April through October 2011

[50] Upper Mississippi River Basin Association, River and Basin Facts. http://www.umrba.org/facts.htm
[51] Big River Bass, Upper Mississippi River Overview. http://www.bigriverbass.com/UMR_overview.php

from Minnesota to southern Illinois. The tournaments range from elements of large, national fishing series to small, locally organized tournaments.[52] The Upper Mississippi River is also home to many tournaments for other species including catfish, walleye, carp, bluegill, and crappie. A few of these tournament events are described in more detail below.

Bass World Sports Tournament Association Team Tournament Trail

The Bass World Sports Tournament Association hosts an annual series of tournaments called the Team Tournament Trail. The Team Tournament Trail consists of 16 divisions. In 2012, six of these divisions occur on the Mississippi River: Alton Marina in Alton, Illinois; Louisiana, Missouri Boat Ramp at Pool 24; Lansing, Iowa Boat Ramp at Pool 9; Harper's Ferry, Iowa Boat Ramp at Pool 10; Dubuque, Iowa Schmitt Harbor Boat Ramp at Pool 12; and Savanna, Illinois at Pool 13. Each division is comprised of six fishing events which occur throughout the fishing season (typically beginning in April or May and ending in August or September). Each tournament has an entry fee of $150 per boat. Each boat must be comprised of no more than two anglers, both of whom must be members of the BWSTA. Only artificial lures are allowed, all fish must be caught using a rod and reel, and trolling is not allowed. Boats must be at least 15-feet long with a properly functioning live-well and aerator. Only largemouth, Kentucky, and smallmouth bass are allowed to be weighed and each team can bring a maximum of 5 fish to weigh-in. Tournament winners are determined by the overall weight of the catch. The top 20 percent of teams receive cash prizes. Each team is awarded points based on their finishing position in each tournament event and the top teams from each division advance to the Team Classic Tournament at the end of the season and are eligible for prizes and awards.[53]

FLW Tournament Series

The FLW Wal-Mart Bass Fishing League hosts one division of its tournament series on the Mississippi River. The Bass Fishing League tournament series was described in detail in the Ohio River section of this report. In the Mississippi River Division of the Bass Fishing League, there are four events scheduled for 2012: Lacrosse, Wisconsin on May 12, 2012 from 6 AM to 2 PM; July 12, 2012 at the Alma Marina in Alma, Wisconsin; August 25, 2012 at the Washington Street Ramp in Prairie Du Chien, Wisconsin; and September 22, 2012 at the West Copeland and Clinton Street Boat Ramp in Lacrosse, Wisconsin. For all Mississippi River tournaments in the Bass Fishing League, anglers are limited to 5 bass, no more than 14-inches in length.[54]

Children's Therapy Center Charity Bass Tournament

An example of a small, local tournament organized as a charitable fundraiser is the Children's Therapy Center Charity Bass Tournament in Albany, Illinois. The 2012 event is scheduled to occur on September 22 and will mark the 38th annual occurrence of the fundraiser. Tournament check-in begins at 5 AM at the Albany City Ramp and weigh-ins for the final group of anglers

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52 Big River Bass, Upper Mississippi River Tournament Schedule. http://www.bigriverbass.com/UMR_tournsched.php
53 Bass World Sports Tournament Association. http://www.bassworldsports.com/
54 FLW Walmart Bass Fishing League. http://www.flwoutdoors.com/bassfishing/bfl/

begins at 4 PM, with an awards banquet at 4:30 PM. Fishing occurs in Pool 13 near Albany, Illinois. Only artificial lures may be used and fishing rods are limited to 8-feet in length. Each angler is limited to using one fishing rod at a time. All tournament boats must be at least 12-feet in length and combustion engines used to power boats may not exceed the horsepower limitations enacted by the U.S. Coast Guard. All boats must have a tournament-accepted, aerated live well. All fish should be kept alive, and a 1-pound penalty will be assessed at weigh-in for all dead fish. Scoring will be determined by the pounds and ounces accumulated during tournament fishing. Each boat (two anglers per boat are allowed) is limited to weighing in five fish, and all fish must be largemouth, smallmouth, or Kentucky spotted bass. Competitors are not allowed to possess more than five fish at any time during the tournament. The winning team will be determined by heaviest overall catch, and will win $3,000. The top 15 teams receive cash payouts and other tournament proceeds benefit the Children's Therapy Center of the Quad Cities. In 2011, 91 two-man teams competed in the tournament, and a total of 297 bass or 671.12 pounds were weighed-in.[55]

Mississippi Walleye Club Tournaments

The Mississippi Walleye Club holds six walleye tournaments on the Mississippi River each year. These six tournaments are for Walleye Club members only. The Club also hosts one tournament at the end of the fishing season which is open to the public. For the six annual member-only tournaments, club members compete in teams of two to catch walleye, which are then released after weigh-in. The tournaments are usually held on Sundays and occur on the Mississippi River from Lansing, Iowa, to Albany, Illinois. Table 3 shows the tournaments scheduled for 2012 for the Mississippi Walleye Club. In 2011, an average of 20 anglers competed in each of the six member-only tournaments.[56]

Table 3. Mississippi Walleye Club 2012 Tournaments

Date (2012)	Tournament Location
11-Mar	Hawthorne Ramp, Dubuque, Iowa
22-Apr	Bellevue, Iowa City Ramp
6-May	Guttenberg, Iowa City Ramp
10-Jun	East Dubuque, Illinois
23-Sep	Bellevue, Iowa City Ramp
21-Oct	Massey Ramp, Dubuque, Iowa
18-Nov	Open Tournament, Schmidt Harbor, Dubuque, Iowa

Source: Mississippi Walleye Club.
http://www.mississippiwalleye.com/Tournaments/Tournaments.htm

[55] Children's Therapy Center of the Quad Cities, 38th Annual Charity Bass Tournament. http://www.ctcbass.com/

[56] Mississippi Walleye Club. http://www.mississippiwalleye.com/default.htm

Great River Golden Reel Fishing Rodeo

The Great River Golden Reel Fishing Rodeo is scheduled to occur on August 11, 2012 in Burlington, Iowa. The 2012 event marks the first occurrence of this event, but organizers hope the Fishing Rodeo becomes an annual tournament on the Mississippi River. This event is a "mixed bag" tournament in that anglers fish for catfish, bass, bluegill, and crappie. This is a one-day tournament and awards and $10,000 in cash prizes will be given in several categories including top boat, biggest fish of each species (catfish, bass, bluegill, and crappie), top female angler, top junior angler, a Grand Slam prize for catching fish of all species, and "Toilet Bowl" prize for the angler that comes in last.[57]

[57] Iowa Sportsman Forum. http://www.iowasportsman.com/forum/viewtopic.php?showtopic=708360

SUMMARY

A total of 70 fishing tournaments on the Great Lakes, Upper Mississippi River, and Ohio River were examined as part of this study. This should be considered a small sample of tournaments which occur in the region (Wisconsin DNR identified 600-700 tournaments annually in that state) and should not necessarily be assumed to be a representative sample. For these reasons, no attempt has been made to quantify these data as those calculations would falsely represent the tournament fishing industry. However, the tournaments identified as part of this analysis begin to paint the picture of the varying types of tournaments and the general characteristics associated with different tournament formats. Based on the research conducted, some generalities can be made regarding fishing tournaments in the study area.

Bass and walleye appear to be the most popular targets of tournament fishing in the study area. Tournaments which target salmon and trout are found only on the Great Lakes. Similarly, there were no catfish tournaments found on the Great Lakes, only on the Ohio and Upper Mississippi. Tournaments on the Great Lakes seem to have more variety in the species targeted. These tournaments are more likely to target more than one type of fish per tournament, rather than focusing on only bass or walleye as is more common on the Ohio and Mississippi Rivers.
Ice fishing tournaments are less popular and less frequent than open-water tournaments. As such, nearly all tournaments occurred during the spring, summer, and fall with open-water tournaments occurring between March and November. The majority of tournaments occur in the summer, from May through August.

None of the identified tournaments involved fishing from shore which suggests an overall popularity of fishing from boats. All of the tournaments except one required a motorized fishing vessel. Many tournaments required motors and had rules regarding the specifications of motors, but trolling was generally prohibited as a method of fishing.

The Upper Mississippi and Ohio River showed more occurrences of tournaments which are part of large, tournament trails such as the FLW series. The tournaments examined for the Great Lakes were more likely to be hosted by community organizations or consist of regional tournament trails of smaller magnitude.

In terms of tournament characteristics, on all water-bodies examined, tournament winners are likely to be determined by the weight of the overall catch. Most tournaments identify a maximum number of fish which can be weighed-in by each angler or team and winners are based on heaviest total weight, or most points as determined by the weight of the fish. Traditional catch-and-release tournaments are less common, though some tournaments have strict rules intended to prevent fish mortality, including storing fish in live-wells and returning them to the water after weigh-ins. Tournament entry fees charged by one-day tournaments hosted by local fishing organizations are typically less than $100 and range from $5 to $50. Tournament trails which include several events or span multiple days charge higher entry fees which range from $100 to $400 per angler or team. Similarly, higher entry fees are associated with higher earnings potential. Tournament prize money is typically a percentage of entry fees divided among the top finishers in the tournament. Sponsors also contribute to cash or merchandise prizes, so tournaments with larger, more well-known sponsors also have larger prizes.

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ATTACHMENT 6

COMMERCIAL CARGO NAVIGATION

Commercial Cargo Reports:

Baseline, Future Without-Project, and Future With-Project Assessments

September 2013

U.S. Army Corps of Engineers
Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

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EXECUTIVE SUMMARY:

In support of the Great Lakes and Mississippi River Interbasin Study (GLMRIS), eight alternative plans were developed by the Project Delivery Team (PDT) in order to prevent the transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River Basins. The commercial cargo navigation industry currently uses the Chicago Area Waterway System (CAWS) to connect ports on the inland waterway such as Pittsburgh, Minneapolis-St. Paul, and New Orleans to Great Lakes ports. The objective of this report is to display the potential impact to commercial cargo traffic on the CAWS from the implementation of the various alternative plans. To meet the objective, this analysis calculated historical and current statistics to establish baseline CAWS commercial cargo levels, projected the future CAWS commercial cargo traffic levels assuming current conditions are maintained, and estimated the tonnage and transportation savings impacts from ANS technology implementation. Each step of the analysis is presented in the Baseline Condition, the Future Without-Project (FWOP) Condition, and the Future With-Project (FWP) Condition sections.

For the purposes of the commercial cargo analysis, the CAWS is defined as all the commercially-navigable channels between Lockport Lock and Dam and Lake Michigan, which included: the Chicago Sanitary and Ship Canal upstream of mile 291.1 (Lockport Lock and Dam), the navigable portions of the North Branch of the Chicago River, the South and Main Branches of the Chicago River, the Cal-Sag Channel, the commercially-navigable portions of the Little Calumet River, the Calumet River, and Lake Calumet. The sources of information for the analysis include the Waterborne Commerce Statistics Center (WCSC) database, the Lock Performance Monitoring System (LPMS) database, news reports, industry newsletters, other governmental agency forecasts, interviews with shippers conducted by the University of Tennessee Center for Transportation Research (CTR), and U.S. Army Corps of Engineers (USACE) documents describing the ANS technologies.

The eight alternative plans considered in GLMRIS include the following:

- No New Federal Action
- Non-Structural
- Control Technology without a Buffer Zone – Flow Bypass
- Control Technology with a Buffer Zone
- Lakefront Hydrologic Separation
- Mid-System Hydrologic Separation
- Mid-System Separation – Cal Sag Open
- Mid-System Separation – CSSC Open

The commercial cargo navigation impacts are displayed as average annual losses in transportation cost savings throughout the 50-year project evaluation period (years 2017 through 2066). The key findings associated with the commercial cargo navigation analysis are displayed in Table 1.

Table 1: Key Findings

GLMRIS ALTERNATIVE PLANS	AVERAGE ANNUAL COMMERCIAL CARGO NAVIGATION IMPACTS[1] (Million $)	NOTES
No New Federal Action	$0.00	No losses in transportation cost savings would be expected for this alternative.
Non-Structural	Not Evaluated; Likely Minimal	This alternative was not evaluated due to uncertainty regarding which non-structural measures would be implemented. There would likely be some losses in transportation cost savings for commercial cargo navigation, but these losses would likely be minimal and less than the amounts other alternatives.
Control Technology without a Buffer Zone - Flow Bypass	$0.75	This alternative includes adding locks in the CAWS or modifying existing locks, so commercial cargo movements are likely to be impacted by increased lockage times. Increased lockage times translate into greater overall shipping times which translate into decreases in transportation cost savings.
Control Technology with a Buffer Zone	$0.50	This alternative includes adding locks in the CAWS or modifying existing locks, so commercial cargo movements are likely to be impacted by increased lockage times. Increased lockage times translate into greater overall shipping times which translate into decreases in transportation cost savings.
Lakefront Hydrologic Separation	$211.77	In this alternative, both shallow draft and deep draft commodity movements could no longer occur on the CAWS and would need to switch to truck or rail, find alternative sources for input, sell their output in different markets, or shut down. Since the tonnage moving past the Lakefront Hydrologic Separation barriers is less than the tonnage moving past the Mid-System Hydrologic Separation barriers, this alternative has less of an impact to commercial cargo transportation cost savings.
Mid-System Hydrologic Separation	$251.76	In this alternative, many shallow draft movements could no longer occur on the CAWS and would have to switch to truck or rail, find alternative sources for input, sell their output in different markets, or shut down. Deep draft movements not affected by physical barriers could still occur on the CAWS. Since the tonnage moving past the Mid-System Hydrologic Separation barriers is greater than the tonnage moving past Lakefront Hydrologic Separation barriers, this alternative has a greater impact on commercial cargo transportation cost savings.

Hybrid - Mid System Separation Cal-Sag Open	$7.30	In this alternative, some of the shallow draft movements could no longer move on the CAWS and would need to switch to truck or rail, find alternative sources for input, sell their output in different markets, or shut down. Some shallow draft movements that could still occur would need to take new routes in order to avoid the physical barriers. Since not all movements are forced off of the waterway, the loss in transportation cost savings is less than the alternatives recommending complete hydrological separation.
Hybrid - Mid System Separation CSSC Open	$8.83	In this alternative, some of the shallow draft movements could no longer move on the CAWS and would need to switch to truck or rail, find alternative sources for input, sell their output in different markets, or shut down. Some shallow draft movements that could still occur would need to take new routes in order to avoid the physical barriers. Since not all movements are forced off of the waterway, the loss in transportation cost savings is less than the alternatives recommending complete hydrological separation.
1. Normally, it is cheaper to move bulk commodities via waterways (waterborne transportation) than it is on land (i.e., via truck and rail). The difference between the costs of moving commodities on land and the cost of moving them on the waterway is called "transportation cost savings." This column displays the *losses* in transportation cost savings if a GLMRIS alternative is implemented. Several of the GLMRIS alternative plans include measures that would decrease the efficiency of moving goods on the waterway, so the cost of shipping these goods via waterways increases. Therefore, there are fewer savings associated with moving the goods via water versus land. *The greater the losses in transportation cost savings, the greater the cargo navigation impacts.*		

INTRODUCTION

GLMRIS Background Information:

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River basins by aquatic pathways. An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (FY13). As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

Significant issues associated with GLMRIS may include, but are not limited to:

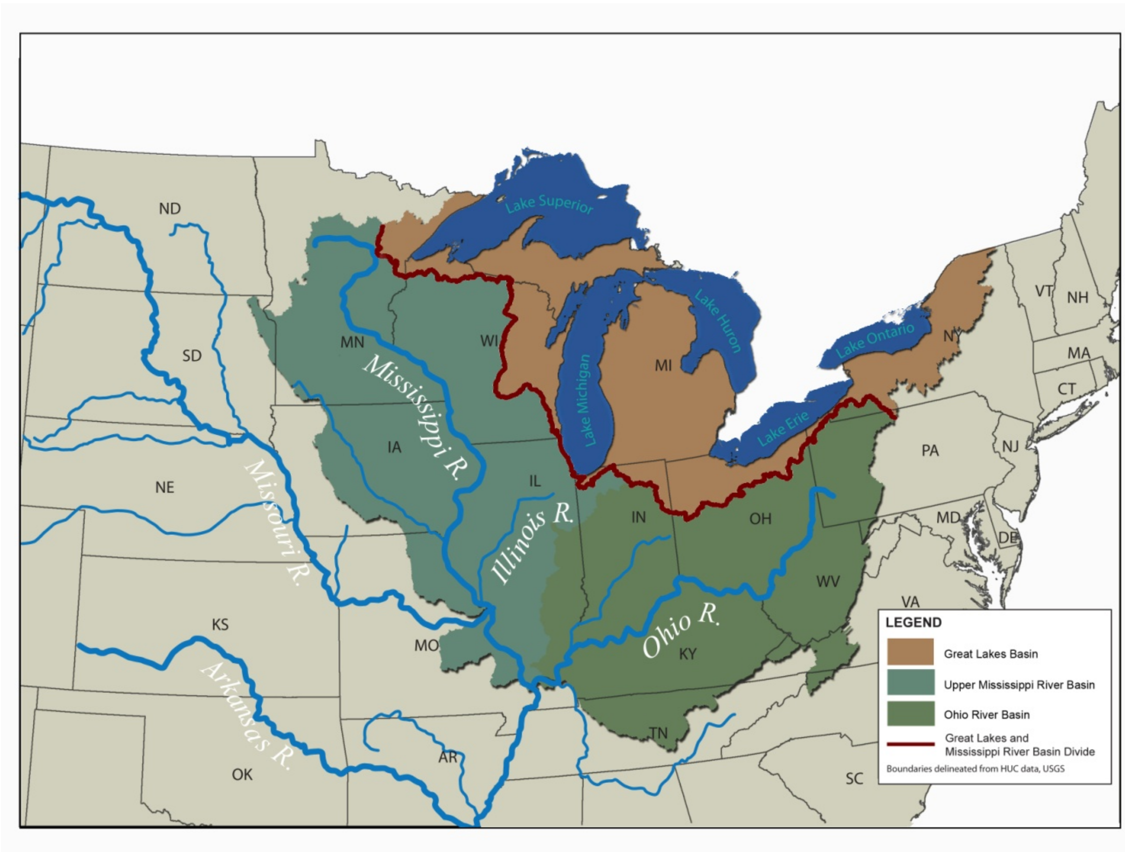
- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and

- Statutory and legal responsibilities relative to the lakes and waterways.

GLMRIS Study Area

The GLMRIS study area includes portions of the Great Lakes, Mississippi River, and Ohio River Basins that fall within the United States.

Figure 1: GLMRIS Study Area Map

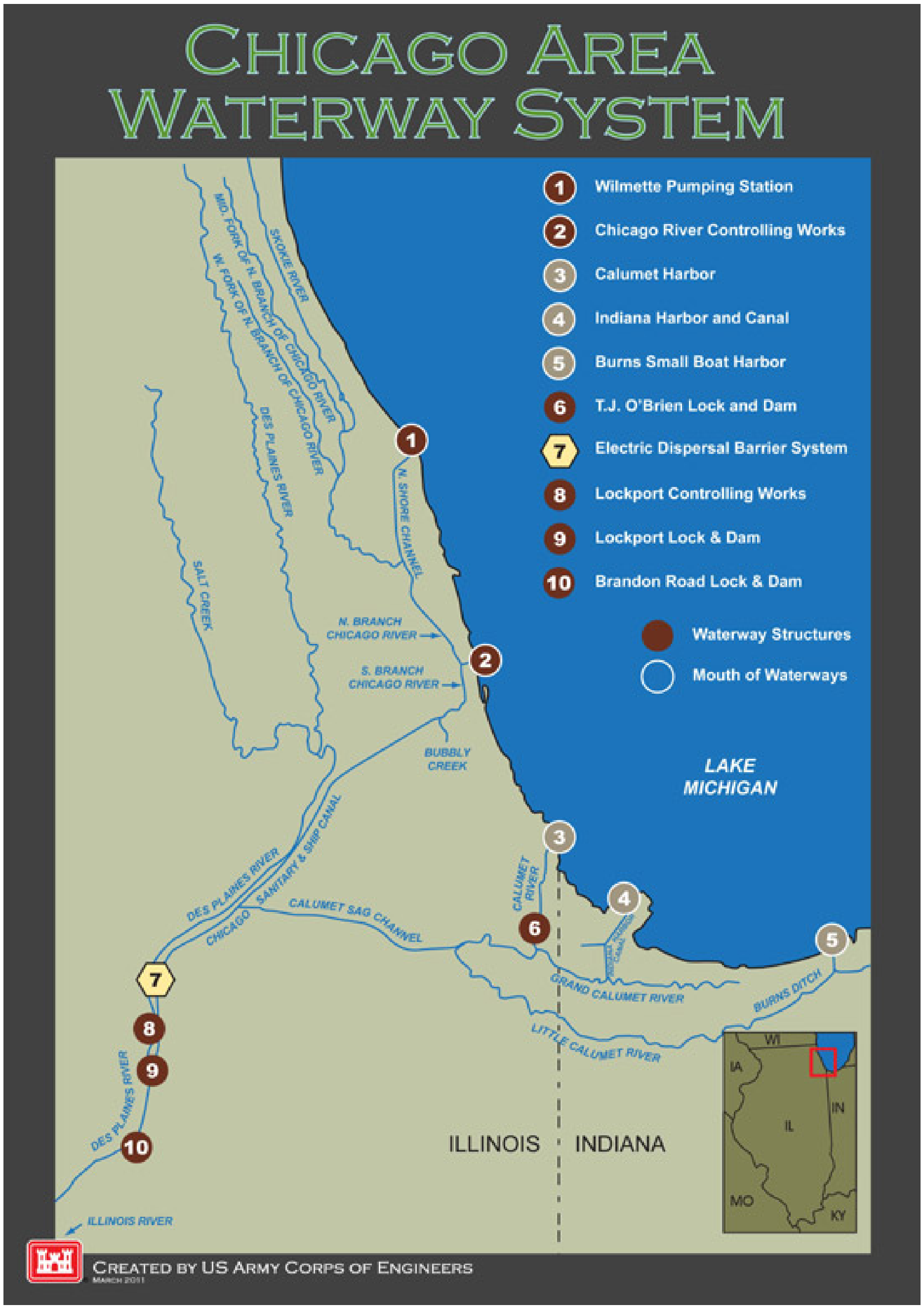


Potential aquatic pathways between the Great Lakes, Mississippi River, and Ohio River Basins exist along the basins' shared boundary (illustrated in *Figure 1: GLMRIS Study Area Map*). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi and Ohio River Basins (green shaded areas) and the Great Lakes Basin (brown shaded area).

Focus Area I, the Chicago Area Waterway System (CAWS), as shown in Figure 2, is the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins and, therefore, poses the greatest potential risk of aquatic nuisance species (ANS) transfer between the basins, via an aquatic pathway.

Figure 2: Chicago Area Waterway System (CAWS)



Navigation and Economics Product Delivery Team

In support of the Great Lakes and Mississippi River Interbasin Study, the Navigation and Economics Product Delivery Team (PDT) was formed. The PDT was tasked with assessing the current value of *economic* activities within the GLRMIS detailed study area that *could* change with the implementation (FWP condition) or lack of implementation (FWOP condition) of a

GLMRIS project. The PDT is comprised of several sub-teams, each of which focuses on a specific economic activity within the GLRMIS study area. These categories include:

Navigation Related Economic Categories

- Commercial Cargo
- Non-Cargo Related Navigation

Other Related Economic Categories

- Flood Risk Management
- Hydropower
- Commercial and Recreational Fishery
- Water Quality
- Water Supply
- Regional Economics

Commercial Cargo Navigation Team

In support of the GLMRIS Navigation and Economics Team, the Cargo Navigation Team was formed. This team's objective was to determine the impacts to commercial cargo navigation activities within the CAWS assuming that a GLMRIS project is implemented to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins. This objective was completed via three complementary assessments, to include the: (1) baseline condition, (2) future without-project condition (the case where no new Federal action is taken to prevent the transfer of ANS between the basins), and (3) the future with-project condition (the case where new Federal action is taken to prevent the transfer of ANS between the basins). The completion of these three assessments aids in the demonstration of the impacts to navigation under the various GLMRIS alternative plans.

Structure of Report

The report is broken down into three main sections. In the first section, the baseline conditions for the CAWS navigation industry are assessed. The baseline conditions include: the types of commodities traveling the waterway, the flows and tonnages for each of these commodities, the origins and destinations for these commodities, the trends for each commodity, the characteristics of the vessel fleet transiting the CAWS, and the rates savings from the CAWS waterway movements.

In the second section, the likely tonnage levels and commodity breakdowns that would occur in the Future Without-Project (FWOP) scenario are established. The FWOP scenario assumes no new Federal action will be taken to prevent the transfer of ANS via the CAWS. The tonnage levels for the waterways are based on expectations for industries within the regional economy and include the inland waterway navigation industry.

Finally, the Future With-Project (FWP) analysis presents the impacts to the CAWS navigation industry from each of the alternative plans considered in GLMRIS. A part of the FWP analysis will compare the without project condition to the with-project condition.

BASELINE CONDITION

Introduction

The U.S. Army Corps of Engineers, Planning Guidance Notebook, ER 1105-2-100 establishes the steps for evaluating changes to the inland navigation system.[1] When evaluating the potential impacts to commercial cargo on CAWS from ANS control measures, the first step is to determine the baseline condition CAWS traffic statistics. For this report, the CAWS traffic statistics are segmented into three broad categories of commodities, vessels, and locks. These three broad categories contain more detailed information such as the types of commodities traveling the waterway, the flows and tonnages for each of these commodities, the origins and destinations for these commodities, the trends for each commodity, the characteristics of the vessel fleet transiting the CAWS, and the trends for the various locks. The baseline condition CAWS traffic, vessel, and lock statistics were generated by the USACE Planning Center of Expertise for Inland Navigation (PCXIN).

Next, ER 1105-2-100 lists steps to establish a baseline level of waterway benefits. One benefit of the waterway is the transportation rate savings. Transportation rate savings equal the difference between the cost of transporting the commodities on the waterway and the cost of the least-costly land alternative route, whether it is by truck, rail, or both. For GLMRIS commercial cargo analysis, the University of Tennessee Center for Transportation Research (UTK-CTR) estimated the baseline rate savings experienced by the CAWS users. The method to calculate the rate savings as well as the baseline rate savings are presented in this section.

Method

Calculation of Traffic, Vessel, and Lock Statistics

To generate the CAWS baseline statistics, the PCXIN followed a few general steps. First, a study area was defined to ensure consistency when reporting statistics and analyzing the impacts to changes in the CAWS. Then the relevant data was pulled from two main USACE databases: the Waterborne Commerce Statistics Center (WCSC) database and the Lock Performance Monitoring System (LPMS) database. Finally, the PCXIN generated the pertinent tables and graphs of CAWS commercial cargo baseline statistics with spreadsheet applications.

Definition of Study Area

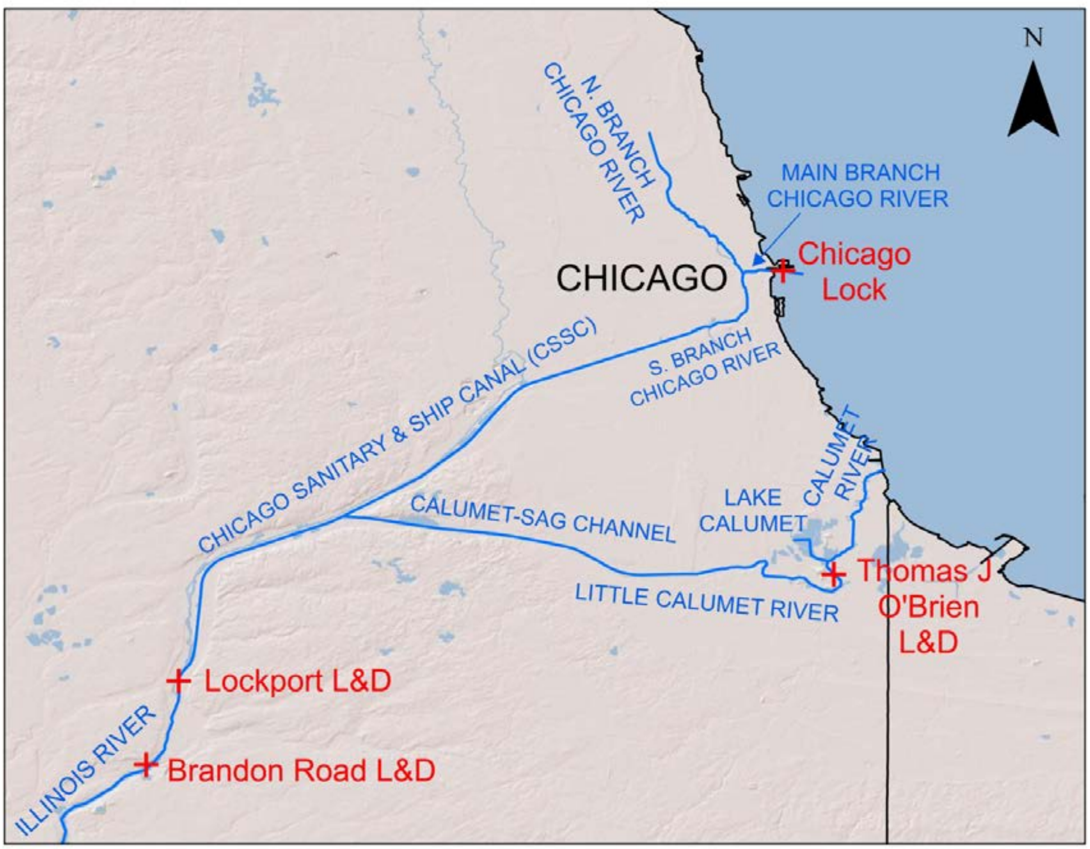
The *GLMRIS - Baseline Assessment of Cargo Traffic on the Chicago Area Waterway System* (2011) defined the CAWS as all the commercially-navigable channels between Lockport Lock and Dam and Lake Michigan. As shown in **Figure 3,** this area includes: the Chicago Sanitary and Ship Canal (CSSC) upstream of mile 291.1 (Lockport Lock and Dam), the North Branch, the Main Branch, the South Branch of the Chicago River, the Calumet-Saganashkee (Cal-Sag)

[1] ER 1105-2-100, 22 April 2000, page 3-6 and 3-7.

Channel, the Little Calumet River, the Calumet River, and Lake Calumet. Commercial navigation in these river reaches is supported by the Lockport, Thomas J. O'Brien, and Chicago Harbor locks and dams.

The FWOP analysis remains consistent with the original *GLMRIS - Baseline Assessment of Cargo Traffic on the Chicago Area Waterway System* (2011) report by defining the CAWS as all waterways upstream of Lockport Lock and Dam. However, data for Brandon Road Lock and Dam, which is located at mile 285.8 of the Illinois River, has been added for the FWOP and FWP analyses. Brandon Road Lock and Dam was not highlighted in the early phases of GLMRIS, but recently it has received more attention as a potential site for the implementation of ANS technologies. It should be noted that the CAWS definition may or may not coincide with definitions for other project purposes.

Figure 3. The Chicago Area Waterway System (As Defined for Inland Waterway Navigation Analysis)



Sources of Data

The update of the CAWS historical and baseline characteristics is based on data from two databases: (1) the WCSC database, and (2) the LPMS database. Recompilations and additional analysis of this data were prepared by the PCXIN.

(1) Waterborne Commerce Statistics Center Data

The Waterborne Commerce Statistics Center (WCSC), under the authority of the Rivers & Harbors Act of 1922, collects confidential monthly reports submitted by individual towing companies (USACE NDC "WCSC Mission", 2012). These reports contain information on the dock-to-dock movements of commodities being transported on the waterways including the type and tonnage of the commodities. The USACE uses the statistics from these reports to analyze the feasibility of new projects and to set priorities for investment in projects. The dock-to-dock movement data, in some form, are essential to navigation system modeling.

(2) Lock Performance Monitoring System

The Lock Performance Monitoring System (LPMS) consist of data collected at most Corps-owned and/or Corps-operated locks. Data is collected at each lock and electronically transmitted to the central database, which is managed and distributed by National Data Center (NDC). The data, from years 1980 to present, includes the number of vessels and barges locked, type and dates of lockages, durations of, and causes for, periods of lock unavailability, barge type, size, and commodity type, and tonnages carried (NDC "LPMS" 2012).

Traffic, Vessel, and Lock Statistics Procedures

After extracting the data from the databases described above for the defined study area, the PCXIN used Microsoft Access and Excel to generate the baseline CAWS commercial cargo statistics. These statistics were then put into tabular and graphical format to assist in describing and analyzing the CAWS commercial cargo navigation activity.

Calculation of Rate Savings

Introduction

The rate analysis was conducted by the University of Tennessee Center for Transportation Research (UTK-CTR) under contracts with Marshall Research Corporation (MURC 2011-232) and the Huntington District of the U.S. Army Corps of Engineers (Corps) (W91237-11-C-0017) in order to facilitate the calculations of the National Economic Development (NED) and Regional Economic Development (RED) benefits attributable to CAWS navigation. Toward this objective, the study provides a full range of transportation rates and supplemental costs for a sampling of 2,265 waterborne commodity movements in years 2007, 2008, and 2009, which, in total or in part, were routed in the Chicago Area Waterway System. The sampling technique utilized selected the highest annual tonnage observation by five digit commodity and by origin/destination dock for the three year time period. This sampling method was used to obtain the most diverse commodity and geographic representation of commodity flows in the CAWS region.

The first step in the study was to conduct interviews with the dock operators and shippers in the CAWS to ascertain physical operating conditions, specific commodity moves, modal choices during an unanticipated closure, and future operating changes. In total, 86 interviews were conducted in the field and four interviews by telephone representing 139 docks. Six docks declined to be interviewed or were out of business or closed, representing less than four percent of the total sample tonnage.

Freight rates for each sample movement are calculated based on the actual water-inclusive routing, as well as for competing all-land alternative and five closure periods (15, 30, 60, 90, and 180 day). All computations reflect those rates and fees which were in effect in the fourth quarter of 2011. Results are documented on a movement-by-movement basis, including a separate worksheet for each observation. These disaggregated data are also integrated into individual spreadsheets for each of the eight commodity groupings. A full description of the study's scope and guidelines, UTK-CTR's methods of rate research and construction, and supporting assumptions is provided below.

Study Parameters

A sample of 2,265 movements was identified for inclusion in this analysis. These movements originated, terminated or passed through the CAWS (defined as the river reach between Lockport Lock and Chicago River Lock or O'Brien Lock). Dock-to-dock tonnages were over-sampled to include representative commodity origin destination pairs. Reported rates for both the water movement and the all-land alternative are based on the actual location of shipment origins and destinations.

Water Routings

Because many of the sample movements have off-river origins and/or destinations, a full accounting of all transportation costs for waterborne movements also requires the calculation of railroad and/or motor carrier rates for movements to or from the nearest appropriate port facility. Additionally, all calculations reflect the loading and unloading costs at origins and destinations, and all transfer costs to or from barges. Finally, when a fleeting point or closed dock was shown in the sample movement data as the origin or destination, the nearest dock to the named point that handled the commodity was used to construct the transportation rates or external costs.

Land Routes

With the exception of over-dimension shipments and intra-pool sand dredging, rail or truck rates are calculated for all movements (see Section VI for a discussion of exceptions.). For over dimension truck and intra-pool dredged materials, the land rate was estimated as compared to a specific modeled rate. As in the case of the barge-inclusive routings, many all-land routes require the use of more than one transport mode. Therefore, when appropriate, calculations include all requisite transfer charges.

To facilitate the calculation of rates and external costs, the land miles by mode were calculated. The land miles consisted of the rail route and rail miles or truck route and truck miles. The source of the rail miles comes from a rail routing and mileage program developed by Oak Ridge Nation Laboratory (ORNL). The UTK-CTR prepared the rail routes, and ORNL produced the practical miles. The truck route miles were developed from both MapQuest and Google Maps.

Seasonality and Market Anomalies

To accurately reflect NED benefits, it is necessary to develop rates which portray the normal market conditions which are anticipated over the project life. For this reason, every attempt was made to purge the data of anomalous or transitory influences. As a part of all shipper surveys and interviews, respondents were directed to ignore temporary market disruptions and provide information reflective of "normal" operating conditions. As a result of the commodity mix represented within the sample, we detected no need to adjust for seasonal fluctuations. Annual contract barge rates with a fuel escalation feature and five year average spot market grain rates provide an annual average barge rate that is comparable to the multi-year contract rail rates that remove seasonality. The result is consistent rate treatment for each mode.

The development of RED rates for unanticipated river closures is dependent upon the modal choice of the dock operators and shippers, given in response to questioning during interviews. The land mile calculations reflected the shipper's modal choice for each observation and each closure period. The modal choice reflects equipment availability, enterprise cash flow needs, and inventory availability.

Judgments and Assumptions

Based on information collected from shippers, receivers, carriers, river terminal operators, stevedores, federal agencies, and private trade associations, UTK-CTR was able to identify probable origins and destinations for the majority of those movements that originated or terminated at off-river locations. In the absence of specific shipper/receiver information, it is assumed that the river origin and destination are the respective originating and terminating points for both river and alternative modes of transportation. In every case, an attempt was made to gather information from all shipping ports. However, in some instances, 2007, 2008, and 2009 logistical data are not available from these ports. In other cases, port representatives declined to provide the requested information.

Specific commodity groups are discussed in more detail later in this section. However, for those movements that originate or terminate at a river port location, it is assumed that rail service could also be utilized by the shipper or receiver if that port is rail served. Exceptions to this assumption are noted on individual worksheets. When the shipper or receiver is served by truck only, the interviewer asked specifically if the shipper would trans-load to rail. Only those shippers responding in the affirmative were shown to do so. Further, only those shippers who ship more than 150,000 tons annually and who are adjacent to rail tracks would be assumed to undertake the significant capital expenditures necessary to acquire direct rail service. Mileage allowances made by carriers to shippers for the use of private equipment are also ignored as are rebates to shippers.

For short run unanticipated river closures, the modal choice decision assumed the shippers knowledge of equipment and carrier service availability coupled with loading and unloading capacity. It was assumed that no new capacity would be built unless specifically addressed by the shipper in the interview.

For the long run, in all cases, it is assumed that the alternative modes of transportation would have the physical capacity to accommodate the additional tonnage represented by each commodity movement. This is documented in the Economic and Environmental Principles and

Requirements for Water and Related Land Resources Implementation Studies (P&R). Commodity specific judgments and assumptions include:

Coal & Petroleum Coke

A number of assumptions are made for land haul rates on the movements of coal to utility destinations that are not rail served. Volumes to these utility destinations are, in many cases, substantial, so that long-haul truck transportation cannot be considered a viable option. In the absence of water transportation, receiving utilities would have to carefully evaluate those available options which might ensure their ability to continue to receive large volumes of coal. These considerations might include the replacement cost of transfer and handling facilities, the construction cost of switch or main line rail track, the cost of new or improved highway access, the economies of buying or leasing rail equipment, the possibility of shifting origins to assure adequate coal supply, or utility plant closure. For their part, we may assume that rail carriers would be willing to construct additional track capacity if volumes are sufficient. However, these construction costs would most likely be passed on to the shipper via higher rates.

To accommodate those instances in which sample barge movements are to non-rail served utilities, the following judgments and assumptions have been incorporated:

- If the receiving utility is not rail served, rates are applied to the nearest trans-load facility, and trucking costs from the railhead to the destination are applied. If the shipping point is not rail served, a motor carrier charge is applied from the mine origin to the nearest trans-load. It is assumed that transfer facilities would be available at both origin and destination for transfer between rail and truck.

- If the receiving utility is rail served for supplies only, but not coal, the rail car unloading cost of the utility is inflated to accommodate a rail track expansion to the coal stockpile.

- In some instances, movements involve a truck haul from multiple origins to a concentration or preparation point for loading to rail. In these instances, where shipments originate at several mines within the same general area, a representative rail origin is selected as the transfer location.

Aggregates

Land haul rates on limestone and sand and gravel reflect the modes necessary to transport the shipments from actual origins to actual destinations. If origins or destinations are not rail served, a trucking charge is applied from the nearest rail station. For those movements where both rail and truck transportation are an option, the least cost land transportation option was selected. However if it was deemed impractical, in the absence of water transportation, to transport large volumes of these commodities for long distances by truck then rail would be considered. Limiting factors of truck transport include lower cargo carrying capacity, the inability to round-trip more than three times per day, and the absence of loaded back-haul opportunities.
With regard to waterway improvement materials, we assume that land movements would require a truck haul at the destination for delivery to river bank work locations. It should be noted that a

significant amount of channel improvement and bank stabilization work is conducted off shore or at locations without highway access, making land transportation impractical.

Grain

The computation of rates for grain is based upon the survey responses of the shippers and receivers. Specifically, if a country elevator gathers grain then ships it to the river terminal, we assume a 20 mile truck haul from the farmer's field to the country elevator. If the grain moves for export, a multi car movement is considered due to shipper track capacity. For domestic shipments, the computation of rail rates is based on the track capacity of the country elevator or domestic receiver. We assume that the grain shipper would maximize the use of his facilities and utilize gathering rates to reach the track capacity of the receiver.

The rail rating of feed ingredients follows assumptions similar to those used for the rating of grain - namely rates constrained by track capacity. Rail and barge transit programs for meals (soybean, cottonseed, oilseed, and fish) were not considered.

Rate Savings Estimation Procedures

As a result of pricing flexibility and differential rates allowed by surface transportation deregulation, it is sometimes difficult to determine the exact rate charged by a carrier on shipments moving under contract. Barge rates are a matter of negotiation between shipper and barge line operator, and these rates are not published in current tariff form. Each carrier's rates are based on individual costs and specific market conditions, so that these rates will vary considerably between regions, across time, and from one barge line to another.

Contract rates are also common in rail and motor carrier transportation and, like barge rates, may be maintained in complete confidentiality. In other cases (particularly grain), tariff rates with an index are still applied. However, there is rarely any dependable means for determining whether a contract rate or a tariff rate should be used to price a particular movement. A further complication is the use of rebates and allowances as an incentive by carriers to shippers to induce higher traffic volumes.

Barge Rates

With the exception of grain and feed ingredients and average trade publication spot market rate quotes, unobservable barge rates are calculated through the application of a computerized barge costing model developed by the Tennessee Valley Authority. The TVA model (now maintained at the UTK-CTR) has been refined to include 2011 fixed and variable cost information obtained directly from the towing industry and from 2011 data published within the Corps' annual Estimated Towboat and Barge Line-Haul Cost of Operating on the Mississippi River System (This is an update of data and equations using a 2000 report methodology). Additionally, 2010 data from the Waterborne Commerce Statistical Center trip reports and 2011 data from the Lock Performance Monitoring System are incorporated into UTK-TRC BCM costing parameters.
The UTK-CTR model contains three costing modules: a one-way general towing service module, a round-trip dedicated towing service module, and a round-trip general towing service module.

The one-way module calculates rates by simulating the use of general towing conditions between origin and destination, including the potential for a loaded return. The dedicated towing service module calculates costs based on a loaded outbound movement and the return movement of empty barges to the origin dock. The round-trip general towing service module is similar to the one-way, except that it provides for the return of empty barges to the point of origin. This module does not calculate costs for towboat standby time during the terminal process but does include barge ownership costs (maintenance, replacement cost, supplies, insurance, and administration) for both the terminal and fleeting functions. It does not require that the empty barges be returned with the use of the same towboat. Depending on the module in use, inputs may include towboat class, barge type shipment tonnage, the interchange of barges between two or more carriers, switching or fleeting costs at interchange points or river junctions, barge ownership costs accruing at origin and destination terminals, fuel taxes, barge investment costs, time contingency factors, return on investment, and applicable interest rates.

Barge rates on dry commodities are calculated with the use of the general towing service round-trip costing module. Inputs, based on information from carriers and the Corps' Lock Performance Monitoring System (LPMS) database were programmed into the module to simulate average towboat size (horsepower) and corresponding tow size (barges) for each segment of the Inland Waterway System. Other inputs include barge types, waterway speeds, horsepower ratios, and empty return ratios.

An example of a typical shipment cost in this analysis would be a dry bulk commodity (iron ore intermediates or cement clinker) originating on the Mobile River at Mobile, Alabama and terminating on the Illinois Waterway at Chicago, IL. Based on the modeling process, this shipment would be assumed to move in a four barge tow from Mobile to the Mississippi River at New Orleans, a twenty-four barge tow from New Orleans to Cairo, a twenty barge tow from Cairo to St Louis, a 9 barge tow from St Louis to Lockport, and a two barge tow from Lockport to Chicago. At each interchange point, appropriate fleeting charges would be calculated. Empty return (back haul) factors would also be included for each segment of the movement.

With the exception of movements involving some Northbound and tributary rivers, barge rates for grain and dry feed ingredients are estimated on a percentage of base rates formerly published in Waterway Freight Bureau Tariff 7.[2] For movements with origins or destinations in the Illinois Waterway or Great Lakes barge served area, the five year average percent of base for the Lower Ohio, Mid Ohio, Upper Mississippi, Illinois, and Missouri Rivers is used. For movements on the Tennessee, Gulf Inter Coastal Waterway, and Arkansas, a tariff arbitrary charge is added to the New Orleans base rate where applicable. Rates for those movements that traversed the Tennessee -Tom Bigbee Waterway are calculated through the use of the TVA general towing service round-trip costing module.[3]

Barge rates for asphalt, heavy fuel oils, and light petroleum products are calculated through the use of the dedicated service round-trip costing module. Twenty hours standby time is allocated at origin and destination for towboat terminal functions. Finally, rates for sodium hydroxide,

[2] The expression of barge rates for agricultural commodities as a percentage of waterway Freight Bureau Tariff 7 is consistent with industry standards.

[3] There is no basis for rates via the Tenn-Tom in the Waterway Freight Bureau Tariff.

vegetable oils, lubricating oils, liquid chemicals, and molasses are calculated through the use of the general service round-trip costing module. As a result of comparable barge sizes, these commodities normally move in the same tow with dry commodities.

Barge rates calculated by the UTK-CTR model reflect charges that would be assessed in an average annual period of typical demand for waterway service. It should be noted that the model does not explicitly consider market factors such as intra or inter modal competitive influences, favorable back haul conditions created by the traffic patterns of specific shippers, or the supply and demand factors which affect the availability of barge equipment. These and other factors can influence rate levels negotiated by waterway users. The model does, however, calculate rates based on the overall industry's fully allocated fixed and variable cost factors, including a reasonable rate of return on assets. The rate of return assigned to this project by the Huntington District of the Corps of Engineers is four percent. To offset abnormal market conditions a five percent charge is added to the rates for contingencies. It is UTK-CTR's judgment that the transportation rates (with the exception of the mandated low rate of return on investment) are representative of the industry and provide a reasonable basis for the calculation of NED benefits.
The spot market hopper barge rates were derived from the River Transport News published by the Criton Corporation of Silver Springs, Maryland. The average spot market rate for the second, third, and fourth quarters 2011 was utilized.

Railroad Rates

In 2007, rail shippers received rate relief from the Surface Transportation Board (STB) in the calculation of fuel surcharges. The result of the STB decision was a new calculation method for surcharges based upon mileage with the Class 1 rail carriers adopted the ALK practical mileage software program to estimate mileage. A further complication in rail rate calculation was the failure of Global Insight, Inc. to correct and update the Reebie Rail Costing Model they purchased in 2004 when Global Insight acquired Reebie & Associates.

To resolve the above analytical issues, UTK-CTR developed a rail rate estimating technique using the attributes of rail shipping exhibited in the STB Waybill Sample. This technique was first employed in the Upper Mississippi and Illinois Rivers 2006 Transportation Rates Project for the Army Corps of Engineers, and was used in the Ohio River Transportation Rate Study 2010.
The UTK-CTR rail rate estimating method has six steps. First, UTK-CTR field or telephone interviews the dock operator to establish the off river origin and/or destination, the mode and carrier of transport to or from the dock, rail track capacity at the dock, and river dock handling capability. Second, a rail route is constructed from either the off river origin or the dock origin. Third, the STB Waybill Sample for 2009 was sorted by seven digit STCC number (or five digit if insufficient observations) by carrier, by single car-multi car-small unit train-large unit train, and by distance (less than 500 miles or greater than 500 miles). Fourth, the average revenue per mile was calculated. Fifth, the revenue per mile is indexed from 2009 to fourth quarter 2011 (8.4%) from the American Association of Railroads. Last, carrier mileage was multiplied by the adjusted revenue per mile, and the result was divided by the average weight per car to produce an estimate of the rail rate per short ton for the land move.
Railroad mileage was computed by a software package from the Oak Ridge National Laboratory (ORNL) and National Transportation Research Center in 2011. Specific rail routing was

developed by UTK-CTR, and the practical rail mileage was prepared by ORNL. Specific routes and miles for each movement were developed.

Motor Carrier Rates

Truck rates for off-river movements were obtained from the shipper and dock surveys conducted by UTK-CTR for the U.S. Army Corps of Engineers. In addition, UTK-CTR maintains transportation trade publications that report various regional trucking rates and costs. Further, UTK-CTR reviewed the Security and Exchange Commission filings for 2011 for three truckload carriers (Prime Transportation, Knight Trucking, and Malone Trucking) to determine the revenue per mile received by the carriers for three different types of carrier services. In addition, dock operators were queried about the rates paid for various types of service (local or long haul). The truck rate methods UTK-CTR uses consist of a rate per loaded mile for moves over 100 miles or a shuttle truck rate per hour for moves under 100 miles. Each rate is footnoted in the individual rate sheets. The truckload weight limit is one ton less than weight allowed by the individual state highway axel load and bridge formula for truckload and permitted load limits. Truck mileage was determined by Google Maps or Map Quest.

Handling Charges

Handling charges between modes of transportation are estimated on the basis of information obtained from shippers, receivers, stevedores, and terminal operators. Handling charges for the transfer of commodities from or to ocean-going vessels are on the basis of information obtained from ocean ports or stevedoring companies. For import or export movements that involved mid-stream transfer operations, handling costs to or from land modes at a competing port with rail access are applied.

Except as noted within individual worksheets, it is assumed that movements of bulk products (for example, grain or fertilizer) would be handled through elevators or storage facilities. It was also assumed that liquid commodities transferred between modes would require tank storage. Additional costs are incurred at both river and inland locations if shipments remain in storage past the free-time period allocated by the facilities involved. Storage charges are usually assessed on a monthly basis.

Loading and Unloading Costs

Because loading and unloading costs are not usually documented by shippers and receivers, they are particularly difficult to obtain.[4] Moreover, these costs can vary considerably across firms. In an attempt to provide the best possible estimates of these costs, we use available shipper and receiver information in combination with data from Corps studies performed by other researchers, as well as previous UTK-CTR studies. These data are revised to reflect 2011 conditions then averaged as required. In those cases where varying sources produced disparate estimates, we relied most heavily on shipper and receiver estimates.

Methodological Standards

[4] Loading and unloading costs are often considered a part of through-put or production costs.

Two points should be noted regarding the methodological standards applied within this study. First, the standards described above reflect essentially the same processes TVA and UTK-CTR have applied (or will apply) in developing transportation rates for other recent (or ongoing) Corps studies. Specifically, the outlined methodology was used in the 1996 and 2000 Ohio River Studies and the 1996 and 2006 Upper Mississippi Navigation Feasibility Study and was applied in the Missouri River Master Manual Review process, the Soo Locks Study and Port Allen Cutoff assessment. Thus, inter-project comparison is facilitated by this uniform approach. More importantly, recent methodological improvements enable TVA and UTK-CTR to produce transportation rate/cost materials which are, simultaneously, more complete and more reliable than the transportation data TVA (or other agency) has produced for similar studies in the past. Each rate study for each District of the USACOE is integrated into a series of data bases for quick accessibility and data manipulation.

Results

CAWS Traffic

Historic and Existing Traffic

(1) Tonnage Trends

The WCSC allows commercial cargo navigation for the CAWS to be broken down into two categories, shallow draft traffic and deep draft CAWS traffic. For the purpose of this analysis, shallow draft traffic is defined as any movement with a draft below fifteen feet and deep draft is defined as any movement with a draft greater than or equal to fifteen feet. While shallow draft traffic mostly operates in the CAWS river area, the deep draft traffic often consists of movements going between the Great Lakes, the Calumet River, and Lake Calumet.

Table 2: Tonnages for CAWS Shallow Draft, CAWS Deep Draft, and Illinois Waterway, 1994-2011

	CAWS			
Year	Shallow Draft	Deep Draft	Total	Illinois Waterway
	THOUSAND TONS			
1994	25,087	3,686	28,773	51,160
1995	20,078	4,513	24,591	47,604
1996	20,897	4,712	25,609	46,156
1997	19,307	4,041	23,348	43,292
1998	18,594	4,548	23,142	42,059
1999	17,887	4,298	22,185	43,943
2000	18,249	3,934	22,183	44,347
2001	17,047	3,990	21,037	43,515
2002	17,131	4,128	21,259	43,061
2003	19,629	3,909	23,538	45,133
2004	20,810	4,021	24,831	45,422
2005	21,203	5,982	27,185	44,109
2006	20,088	8,794	28,882	43,725
2007	17,090	8,965	26,055	41,243
2008	15,930	8,490	24,420	37,301
2009	13,422	6,737	20,159	36,429
2010	13,205	6,513	19,718	36,121
2011	13,669	8,361	22,030	36,351
Annual % Growth	-3.51%	4.94%	-1.56%	-1.99%
SOURCE: Waterborne Commerce Statistics				

Shallow draft and deep draft were separated in this analysis because they show two distinct trends. As shown by **Table 2**, shallow draft traffic on the CAWS has declined greatly over the last 18 years. According to the *Baseline Assessment of Cargo Traffic on the Chicago Area Waterway System* (2011), the highest level of shallow draft commodity traffic on the CAWS in the last twenty years occurred in 1994 when approximately 25.1 million tons moved on the waterway. After remaining relatively steady for many years, shallow draft traffic experiences a steep decline until reaching a minimum of 13.2 million tons in 2010. The steep drop off in traffic between 2006 (20 million tons) and 2009 (13.4 million tons) was likely an effect of the national recession between December 2007 to June 2009 (NBER, 2012). The drop from a high in 1994 of 25.1 million tons to a low in 2010 of 13.2 million tons represents an overall 47 percent decrease or an annual decrease of 3.9 percent. In contrast, shallow draft traffic on the Illinois only declined by 29 percent or at an annual rate of 2.0 percent.

While shallow traffic has decreased since 1994, WCSC data in **Table 2** shows that deep draft traffic has actually increased over time. From 1994 to 2004, deep draft traffic hovered around 4 million tons. However, between 2004 and 2007, deep draft traffic increased by 123 percent from 4 million tons to 8.9 million tons. After a drop to 6.5 million tons in 2010, tonnage levels rebounded to 8.3 million in 2011. The 4.6 million ton increase in deep draft CAWS traffic since 1994 has partially offset the 11.4 million tons decrease in shallow draft CAWS traffic.

Table 3: Historical Tonnages for Locks on the CAWS, 1994-2011

	Brandon Road	Lockport		O'Brien		Chicago	
Year	Thousand Tons	Thousand Tons	% CAWS	Thousand Tons	% CAWS	Thousand Tons	% CAWS
1994	19,235	19,084	76.07%	11,886	47.38%	812	3.24%
1995	14,281	14,153	70.49%	11,256	56.06%	308	1.53%
1996	14,161	14,019	67.09%	11,891	56.90%	161	0.77%
1997	14,670	14,586	75.55%	9,409	48.73%	129	0.67%
1998	15,202	15,086	81.13%	7,829	42.10%	134	0.72%
1999	14,617	14,538	81.28%	6,882	38.47%	127	0.71%
2000	15,521	15,313	83.91%	7,311	40.06%	245	1.34%
2001	13,932	13,821	81.08%	5,555	32.59%	253	1.48%
2002	14,489	14,240	83.12%	6,051	35.32%	125	0.73%
2003	14,329	13,959	71.11%	5,934	30.23%	129	0.66%
2004	15,870	15,555	74.75%	8,210	39.45%	171	0.82%
2005	15,744	15,424	72.74%	8,173	38.55%	106	0.50%
2006	14,184	13,893	69.16%	7,276	36.22%	127	0.63%
2007	11,643	11,455	67.03%	6,052	35.41%	148	0.87%
2008	11,313	11,269	70.74%	5,784	36.31%	48	0.30%
2009	9,289	9,242	68.86%	4,127	30.75%	24	0.18%
2010	9,115	9,066	68.66%	4,903	37.13%	10	0.08%
2011	9,598	9,369	68.54%	5,881	43.02%	31	0.23%
Annual % Growth	-4.01%	-4.10%		-4.05%		-17.48%	
SOURCE: Waterborne Commerce Statistics							

As shown in **Table 3**, tonnage densities on the CAWS generally diminish toward Lake Michigan. Brandon Road Lock and Dam is the lowest and most heavily used of the CAWS locks with a five year average (2007 to 2011) of 10.2 million tons. Slightly closer to Lake Michigan and with a little less tonnage is Lockport Lock and Dam which averaged 10.08 million tons. Though Brandon Road has seen more tonnage than Lockport, the historical tonnage levels are very similar between the two locks. In fact, the difference only ranges from 44,000 tons to 370,000 tons. Thomas J. O'Brien Lock and Dam is the next closest to Lake Michigan and it processed an average of 5.35 million tons from 2007 to 2011. Finally, on the edge of Lake Michigan, is Chicago Lock, which processed an average of 52,000 tons or less than 1 percent of total tonnage on the CAWS.

The locks in the Chicago region exhibit the same downward historical tonnage trends as the overall CAWS traffic. From 1994 to 2011, the tonnage at Brandon Road and Lockport dropped by 50.1 percent and 50.9 percent, which equates to an annual decreases of 4.0 percent and 4.1 percent, respectively. O'Brien has historically had lower tonnage levels than Brandon Road and Lockport, but since 1994, O'Brien shows nearly the same total percentage drop (50.5 percent) and annual percentage drop (4.1 percent) in tonnage as Brandon Road and Lockport. Chicago has the least commodity traffic of the four and experienced the largest total percentage (96 percent) drop when tonnages decreased from 812,000 tons in 1994 to 10,000 tons in 2010. However, it should be noted that although commodity traffic is quite low at Chicago Lock, the facility is heavily utilized, especially during the summer months for tour boat and recreational traffic.

Although a large majority of CAWS traffic typically transits Lockport, its percentage of CAWS traffic has shrunk over time. In 1994, Lockport accounted for 76 percent of tonnage on the CAWS, but by 2010 that number had decreased to 68 percent of tonnage on the CAWS. Similarly, O'Brien's share of total CAWS traffic diminished from 48 percent to 31 percent and Chicago's share diminished from 3 percent to less than 1 percent. By comparing the annual growth rates in **Table 3** to the annual growth rat**e**s **Table 2**, it becomes apparent that traffic at each of these locks diminished at a faster rate than traffic on the CAWS. This fact highlights the importance of internal traffic that does not transit any of the locks.

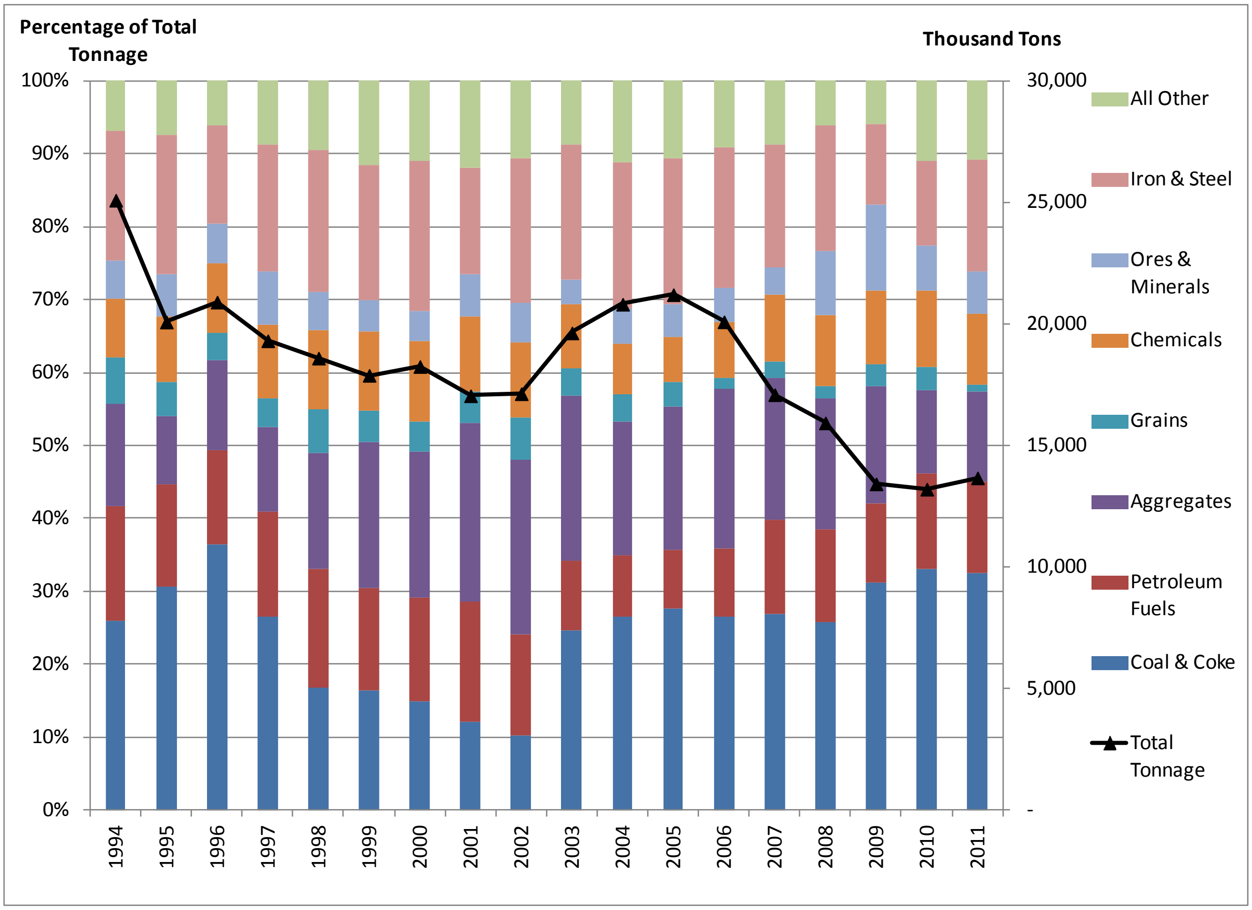
(2) Traffic Trends

Commercial commodities traveling on the CAWS have been divided into the following nine categories:

Group 1 **–** The Coal and Coke category consists of coal, metallurgical coke, petroleum coke, and other related commodities.
Group 2 **–** The Petroleum Fuels category consists of gasoline, gas oils, fuel oils, kerosene, and other related commodities.
Group 3 **–** The Aggregates category consists of sands, pebbles and crushed stone, limestone, and other related commodities.
Group 4 **–** The Grains category consists of farm products such as wheat, corn, soybeans, and other related commodities.
Group 5 **–** The Chemicals category consists of antifreeze and deicer, propylene glycol, ethanol glycol, fertilizers and other related commodities.
Group 6 **–** The Ores and Minerals category consists of salt, clays, and other related commodities.
Group 7 **–** The Iron and Steel category consists of iron ore, pig iron, iron and steel bars, and other related commodities.
Group 8 **–** The All Others category consists of crude petroleum, asphalt, wood, cement, iron or steel scraps, paper, autos, machinery, and other related commodities.[5]

[5] For this analysis, asphalt is included in "Group 2: Petroleum Fuels" tonnage for any historic years (2011 and prior) and included in "Group 8: All Others" tonnage for projected years (2012 and later). This change was made to match the groupings used by the University of Tennessee, Center for Transportation Research in their transportation rate analysis of current and future movements.

Figure 4: Total Tonnage for CAWS Shallow Draft and Percent of Total Tonnage by Commodity Group



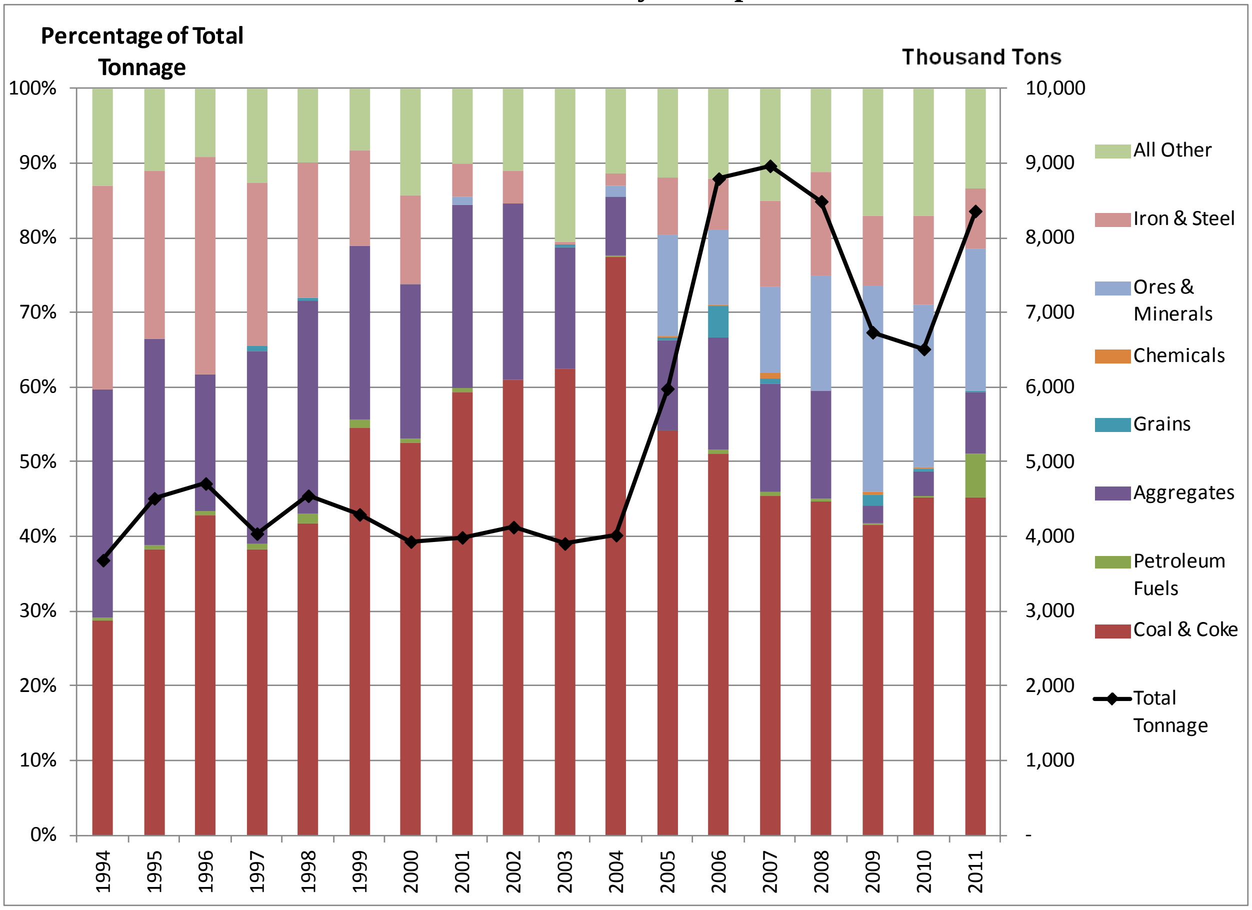
As shown in **Figure 4**, the three leading commodities for CAWS shallow draft traffic are the following: 1) coal and coke, 2) iron and steel, and 3) aggregates.

With a total of 81.3 million tons moved on the CAWS since 1994, the coal and coke group, which consists of both coal and petroleum coke, has accounted for the largest percentage (24.7 percent) of CAWS tonnage. Coal and coke traffic moving on the CAWS serves the electric utility, iron and steel, lime, cement, and chemical industries, as well as other industrial consumers. Most of the petroleum coke traffic moving on the CAWS originates at refineries in the Chicago area, the upper Midwest, and at refineries on the Lower Mississippi/Gulf Coast. Most of the coal traffic moving on the CAWS is actually western coal that accesses the waterway on the CAWS itself. Central Appalachian coking coal frequently originates along the Middle Ohio River. The reduction in coal and coke traffic from 1994 to 2009 is accounted for by a shift to direct rail delivery for an area electric utility plant and the closure of Chicago-area coking facilities. Since 2009, coal delivered to Midwest Generation's Fisk Generating Station in the city's Pilsen neighborhood and its Crawford Generating Station in Little Village has accounted for a majority of coal and coke group tonnage. In 2010, these power stations received and shipped approximately 55 percent of total coal and coke moving on the CAWS. However, it should be noted that Midwest Generation closed both Fisk and Crawford in 2012 (Wernau, 2012).

The commodity group with the next highest tonnage levels from 1994 to 2011 was iron and steel with 57.6 million tons or 17.5 percent of total CAWS tonnage. During this time, iron and steel decreased a total of 53 percent or an annual rate of 4.3 percent. Traffic in the iron and steel group consists of iron and steel scrap, pig iron, iron and steel plates, ferroalloys, iron ore, iron and steel bars and rods, primary iron and steel products, and iron and steel pipe and ingots. Iron and steel traffic on the CAWS serves the raw material input needs of steel mills in the Chicago area and elsewhere, as well as the intermediate iron and steel product needs of downstream steel manufacturers both in the Chicago area and other markets, especially along the Lower Mississippi and Gulf Coast. Iron and steel traffic, including iron ore, scrap, and intermediate iron and steel products, originates along the Gulf Coast and Lower Mississippi, some of it at import terminals, along the Ohio and Tennessee rivers, along the Upper Mississippi, and at Chicago-area docks. Iron and steel traffic utilizing the CAWS is destined for Chicago-area terminals on the CAWS and elsewhere, the Lower Mississippi and Gulf Coast, the Ohio, the Tennessee and the Upper Mississippi.

Aggregates with 57 million tons or 17.3 percent of total CAWS tonnage represent the third highest commodity traveling on the CAWS. Aggregates traffic on the CAWS is dominated by sand and gravel (75 percent in 2011) and limestone (20 percent in 2011), with smaller quantities of gypsum and waterway improvement materials. From 1994 to 2011 period, aggregates traffic ranged between 10 percent (1995) and 25 percent (2001) of total traffic. Aggregates traffic decreased at an annual rate of 4.2 percent over the historic period. In contrast to iron and steel, which are moved across the country, aggregates traffic typically stays in the CAWS region and supports construction activities in the Chicago area. Sand and gravel traffic ordinarily originates in quarries along the CAWS or Illinois Waterway and moves to area aggregates yards for distribution to construction sites.

Figure 5: Total Tonnage for CAWS Deep Draft and Percent of Total Tonnage by Commodity Group



The main commodity group being moved by CAWS deep draft traffic is coal and coke. As coal and coke steadily increased from 1 million tons in 1994 to 3.7 million tons in 2011, it accounted for 28.7 percent (1994) to 77 percent (2007) of total tonnage. The deep draft coal was shipped to locations in Michigan, Wisconsin, Ohio, and Canada. As shown in **Figure 5**, CAWS deep draft tonnage increased by 123 percent between 2004 and 2007. This growth was fueled by an average increase of 948,000 tons in the four commodity groups: aggregates ores and minerals the iron and steel and all other. As the coal and coke percentage of total tonnage of CAWS deep draft traffic fell from 77 percent (2004) to 45 percent (2007), the other commodity groups grew in the following amounts:

- Aggregates grew from 7 percent to 14 percent of total CAWS deep draft tonnage
- Ores and minerals went from 1 percent to 11 percent of total CAWS deep draft tonnage
- Iron and steel increased from 1 percent to 11 percent of total CAWS deep draft tonnage
- All other rose from 11 percent to 15 percent of total CAWS deep draft tonnage

Though all four commodities groups grew during this period, only ores and minerals were able to maintain the tonnage levels. The source of increased tonnage in ores and minerals is largely due to movements of salt being imported into the Chicago region from Canada. The salt traffic is used primarily for roadway application during winter weather, while the remaining traffic serves the needs of Chicago area manufacturers. A large majority of the traffic in this category originates along the Lower Mississippi and Gulf Coast. The principal destination for this traffic is salt distributors as well as iron and steel and other metals manufacturers in the Chicago urban area.

Table 4: Historical Tonnage for Brandon Road, Lockport, Thomas J O'Brien, and Chicago Locks and Dams

Lock / Commodity	1994	2000	2005	2006	2007	2008	2009	2010	2011	Annual % Growth 94-11
	THOUSAND TONS									
Brandon Road:										
Coal & Coke	3,631	2,592	2,667	2,041	1,459	1,729	1,405	1,615	1,554	-4.9
Petroleum Fuels	2,569	2,053	1,318	1,584	2,056	1,862	1,369	1,476	1,577	-2.8
Aggregates	2,399	1,973	2,345	2,155	1,516	1,097	1,004	521	651	-7.4
Grains	1,594	753	674	293	365	258	415	427	109	-14.6
Chemicals	1,757	1,835	1,216	1,431	1,417	1,399	1,283	1,318	1,241	-2.0
Ores & Minerals	1,390	751	960	939	647	1,408	1,577	751	764	-3.5
Iron & Steel	4,221	3,635	4,148	3,789	2,744	2,742	1,533	1,578	2,153	-3.9
All Other	1,674	1,929	2,416	1,952	1,439	818	703	1,429	1,549	-0.4
Total	19,235	15,521	15,744	14,184	11,643	11,313	9,289	9,115	9,598	-4.0
Lockport:										
Coal & Coke	3,631	2,442	2,667	2,038	1,459	1,726	1,405	1,613	1,549	-4.9
Petroleum Fuels	2,569	2,053	1,318	1,584	2,063	1,862	1,369	1,476	1,577	-2.8
Aggregates	2,399	1,973	2,309	2,155	1,513	1,097	1,004	521	638	-7.5
Grains	1,592	753	674	293	365	258	415	426	108	-14.6
Chemicals	1,739	1,802	1,183	1,413	1,417	1,399	1,283	1,318	1,241	-2.0
Ores & Minerals	1,329	750	957	930	645	1,408	1,577	751	750	-3.3
Iron & Steel	4,164	3,616	4,093	3,718	2,717	2,706	1,490	1,532	2,080	-4.0
All Other	1,661	1,924	2,223	1,762	1,276	813	699	1,429	1,426	-0.8
Total	19,084	15,313	15,424	13,893	11,455	11,269	9,242	9,066	9,369	-4.1
O'Brien:										
Coal & Coke	4,693	1,947	2,438	2,019	1,571	1,575	1,158	1,341	1,801	-5.5
Petroleum Fuels	936	504	291	308	551	433	183	340	478	-3.9
Aggregates	404	249	241	323	124	91	19	24	44	-12.2
Grains	1,025	265	482	251	342	224	349	409	100	-12.8
Chemicals	632	346	131	211	273	286	225	195	285	-4.6
Ores & Minerals	413	357	340	308	269	542	716	622	642	2.6
Iron & Steel	3,100	2,910	3,276	2,970	1,993	2,069	993	1,259	1,793	-3.2
All Other	683	733	974	886	929	564	484	713	738	0.5
Total	11,886	7,311	8,173	7,276	6,052	5,784	4,127	4,903	5,881	-4.1
Chicago:										
Coal & Coke	114	W	W	W	W	0	0	0	0	NA
Petroleum Fuels	W	W	W	W	W	15	0	10	W	NA
Aggregates	W	0	0	0	0	0	0	0	0	NA
Grains	65	0	5	0	0	0	W	0	W	NA
Chemicals	W	W	W	W	W	W	3	0	W	NA
Ores & Minerals	W	0	0	W	0	0	0	0	0	NA
Iron & Steel	76	W	W	8	W	W	W	0	12	NA
All Other	W	W	0	W	0	0	0	0	W	NA
Total	812	245	106	127	148	48	24	10	31	-17.5

NA = Not Available, W = Data withheld to protect confidential business information
SOURCE: Waterborne Commerce Statistics

The historic major commodity group tonnage levels at four selected locks on the CAWS (Brandon Road Lock and Dam, Lockport Lock and Dam, Thomas J. O'Brien Lock and Dam, Chicago Lock) are shown in **Table 4**. Several relationships can be seen in this table.

First, the diversity of the commodities passing through a lock depends on the location of the lock in the CAWS. Locks further away from Lake Michigan process a more balanced tonnage level among commodity groups than locks closer to the Lake Michigan. For example, in 2011 the tonnage at Brandon Road Lock and Dam and Lockport Lock and Dam was spread relatively evenly among five commodity groups: 1) iron and steel, 2) petroleum fuels, 3) coal and coke, 4) all others, and 5) chemicals. The percentages of total tonnage for these commodity groups range from 13 percent (chemicals) to 22 percent (iron and steel). However, the majority of traffic going through Thomas J. O'Brien Lock and Dam is coal and coke (30.6 percent of tonnage in 2011) or iron and steel (30.5 percent in 2011).

Second, iron and steel transits the entire CAWS. Iron and steel was one of the leading commodities for CAWS shallow draft traffic as well as for traffic through Brandon Road, Lockport, and O'Brien in 2011, where it accounted for 22 percent, 22.2 percent, and 30.4 percent of tonnage respectively. Movements of pig iron, iron and steel bars, and scrap iron move back and forth between the Great Lakes, Chicago, and other parts of the country including the Gulf Coast and Ohio River System. This is the reasoning for all three locks showing iron and steel as a leading commodity. Furthermore, the movement of iron and steel throughout the CAWS is why the annual percent decrease in tonnage is similar at Brandon Road (3.7 percent), Lockport (3.9 percent), and O'Brien (3.0 percent).

Finally, the tonnage at the CAWS locks for all commodities follows a pattern similar to the shallow draft tonnage. As seen in **Table 4**, tonnage for all commodities at all locks decreased from 1994 to 2011, with the exception of the ores and minerals group and the all others group at O'Brien. The commodity groups with the largest annual percent decrease at Brandon Road, Lockport, and O'Brien are the grains (14 percent, 14 percent, 12 percent, respectively) and aggregates (7 percent, 7 percent, 12 percent, respectively). However, the commodity groups with the largest tonnage decreases at Brandon Road, Lockport, and O'Brien are the coal and coke group and the iron and steel group. Coal and coke drops 2.8 million tons at O'Brien and 2 million tons at both Brandon Road and Lockport. Iron and steel declines to 1.3 million tons at O'Brien and 2 millions at both Brandon Road and Lockport. While the annual percent decline in total CAWS shallow draft traffic from 1994 (25.09 million tons) to 2011 (13.67 million tons) was 3.5 percent, the annual percent decline at all three locks was 4.0 percent or greater. This highlights the importance of internal traffic which does not transit the locks.

(3) Commodity Traffic by Direction of Movement

Traffic moving on the CAWS can be defined as being inbound, outbound, internal, or through. Inbound traffic is defined as any movement traveling from the Great Lakes or Illinois River while outbound traffic is defined as any movement to the Great Lakes or Illinois River. Internal traffic is defined as any movement that stays within the CAWS, i.e. the navigable waterways between Lockport Lock and Dam and Lake Michigan. Any commodities that do not originate or are not destined for the Chicago region but still travel on the CAWS waterways are defined as through traffic. While **Table 5** shows how the shallow draft CAWS traffic can be broken down by commodity and by direction, **Table 6** provides the same breakdown for deep draft CAWS traffic.

From 2007 to 2011, 73 percent of shallow draft tonnage on the CAWS was upbound (toward the lake). The upbound shallow draft tonnage was dominated by coal and coke, aggregates, iron and steel, and chemicals. These commodities collectively accounted for about 74 percent of upbound shallow draft tonnage. Downbound tonnage was mostly iron and steel, petroleum fuels, coal and coke, and the all other which comprised about 75 percent of downbound traffic.

For deep draft traffic, the tonnage was almost evenly split with 56 percent of five year average tonnage traveling upbound and 44 percent moving downbound. The upbound deep draft tonnage was dominated by a single commodity, coal and coke, which constituted 79 percent. The deep draft tonnage moving upbound was mostly split amongst ores and minerals (36 percent), iron and steel (18 percent), aggregates (17 percent), and all other (12 percent).

The majority (39 percent) of shallow draft tonnage between 2007 and 2011 moved inbound to Chicago. Internal traffic comprised 30 percent of total traffic, followed by outbound (21 percent) and through traffic (10 percent). For inbound shallow draft tonnage, 99 percent was upbound. This upbound was relatively evenly split amongst the following seven commodities: iron and steel (18 percent), chemicals (18 percent), ores and minerals (16 percent), petroleum fuels (13 percent), coal and coke (12 percent), aggregates (12 percent), and all other (11 percent). Internal traffic accounts for 30 percent of tonnage moving on the CAWS with 97 percent being upbound. These upbound internal movements were dominated by coal and coke (65 percent) and aggregates (32 percent). Rather than moving towards the Great Lakes, 99 percent of outbound tonnage was sent downbound on the Illinois. The outbound downbound movements consisted of coal and coke (22 percent), petroleum fuels (22 percent), and iron and steel (21 percent). An average of 1.5 million tons of through traffic occurred in the CAWS, but the tonnage was close to evenly split between upbound (48 percent) and downbound (52 percent). The downbound through tonnage was largely four commodities: iron and steel (41 percent), petroleum fuels (23 percent), and all other (22 percent). The upbound through tonnage consisted of a similar commodity breakdown with iron and steel accounting for 25 percent, coal and coke accounting for 22 percent, and petroleum fuels and all other accounting for 16 percent each.

Deep draft tonnage is focused mostly in the Lake Calumet and Calumet river regions. The first noticeable trend in **Table 6** is that there is no internal or through deep draft tonnage. This is logical because deep draft vessels cannot move through the majority of the CAWS. Another obvious trend in **Table 6** is that some inbound tonnage is upbound and some outbound tonnage is downbound. This does not seem logical, but these tonnages appear because a few deep draft movements moved in both directions and the tonnage was applied to the first direction. It is also apparent that the deep draft traffic is evenly split between inbound (50 percent) and outbound (50 percent). While 89 percent of the deep draft tonnage going to the Great Lakes is coal and coke, the main commodities making up the inbound downbound deep draft tonnage are ores and minerals (42 percent), iron and steel (20 percent), aggregates (19 percent), and all other (14 percent).

Table 5: A Five Year (2007 to 2011) Average Tonnage of CAWS Shallow Draft Traffic by Direction of Movement (Thousand Tons)

	Total			Inbound			Outbound			Internal			Through		
Commodity	Up	Down	Total	Up	Down	Total	Up	Down	Total	Up	Down	Total	Up	Down	Total
Coal & Coke	3,633	709	4,342	701	1	701	11	653	664	2,760	14	2,774	161	42	203
Petroleum Fuels	914	907	1,821	767	23	790	4	669	673	30	36	66	113	179	292
Aggregates	2,037	277	2,315	670	12	682	4	254	258	1,332	12	1,344	31	0	31
Grains	47	269	316	34	0	35	0	201	201	0	0	0	13	67	80
Chemicals	1,071	364	1,435	1,000	32	1,033	0	298	298	15	34	49	55	0	55
Ores & Minerals	944	105	1,049	894	0	894	0	75	75	0	23	23	50	7	57
Iron & Steel	1,208	942	2,150	1,021	2	1,023	3	616	619	1	4	5	183	319	502
All Other	831	405	1,236	612	4	616	5	228	233	98	1	99	116	172	288
Total	10,685	3,978	14,663	5,700	74	5,774	26	2,995	3,021	4,236	125	4,361	722	785	1,507

Table 6: A Five Year (2007 to 2011) Average Tonnage of CAWS Deep Draft Traffic by Direction of Movement (Thousand Tons)

	Total			Inbound			Outbound			Internal			Through		
Commodity	Up	Down	Total	Up	Down	Total	Up	Down	Total	Up	Down	Total	Up	Down	Total
Coal & Coke	3,459	23	3,482	0	23	23	3,459	0	3,459	0	0	0	0	0	0
Petroleum Fuels	11	104	114	7	104	110	4	0	4	0	0	0	0	0	0
Aggregates	55	663	718	3	663	666	51	0	51	0	0	0	0	0	0
Grains	42	0	42	0	0	0	42	0	42	0	0	0	0	0	0
Chemicals	2	20	22	0	20	20	2	0	2	0	0	0	0	0	0
Ores & Minerals	0	1,438	1,438	0	1,438	1,438	0	0	0	0	0	0	0	0	0
Iron & Steel	132	730	862	76	691	768	56	38	94	0	0	0	0	0	0
All Other	665	471	1,137	383	467	849	283	4	287	0	0	0	0	0	0
Total	4,365	3,448	7,813	469	3,405	3,874	3,897	43	3,939	0	0	0	0	0	0

(4) Commonality of Lock Traffic

When analyzing the potential impact of Aquatic Nuisance Species (ANS) technologies, a key characteristic of inland waterway navigation to consider is the relationship of locks in the system. This relationship can be ascertained by calculating the commonality of lock traffic. **Table 7** shows the common tonnage between Brandon Road, Lockport, Chicago, Thomas J O'Brien, and La Grange Lock and Dam on the Illinois Waterway from 2007 to 2011. La Grange is shown because it is located near the junction of the Mississippi and the Illinois and aids in illustrating the connection between Chicago and other parts of the country.

Table 7: Commonality of Traffic Between Brandon Road, Lockport, Chicago, O'Brien, and La Grange Locks

					Brandon Road	Lockport	Chicago	O'Brien	La Grange
The percentage of tonnage from	Brandon Road	**in**	2011	**that also went through**	100%	98%	0%	53%	76%
The percentage of tonnage from	Lockport	**in**	2011	**that also went through**	100%	100%	0%	54%	76%
The percentage of tonnage from	Chicago	**in**	2011	**that also went through**	56%	61%	100%	15%	44%
The percentage of tonnage from	O'Brien	**in**	2011	**that also went through**	86%	87%	0%	100%	67%
The percentage of tonnage from	La Grange	**in**	2011	**that also went through**	29%	28%	0%	15%	100%
The percentage of tonnage from	Brandon Road	**in**	2010	**that also went through**	100%	99%	0%	47%	79%
The percentage of tonnage from	Lockport	**in**	2010	**that also went through**	100%	100%	0%	47%	78%
The percentage of tonnage from	Chicago	**in**	2010	**that also went through**	0%	0%	100%	0%	0%
The percentage of tonnage from	O'Brien	**in**	2010	**that also went through**	88%	88%	0%	100%	70%
The percentage of tonnage from	La Grange	**in**	2010	**that also went through**	29%	28%	0%	14%	100%
The percentage of tonnage from	Brandon Road	**in**	2009	**that also went through**	100%	99%	0%	39%	78%
The percentage of tonnage from	Lockport	**in**	2009	**that also went through**	100%	100%	0%	39%	77%
The percentage of tonnage from	Chicago	**in**	2009	**that also went through**	80%	80%	100%	0%	80%
The percentage of tonnage from	O'Brien	**in**	2009	**that also went through**	87%	87%	0%	100%	76%
The percentage of tonnage from	La Grange	**in**	2009	**that also went through**	28%	28%	0%	12%	100%
The percentage of tonnage from	Brandon Road	**in**	2008	**that also went through**	100%	100%	0%	45%	78%
The percentage of tonnage from	Lockport	**in**	2008	**that also went through**	100%	100%	0%	45%	78%
The percentage of tonnage from	Chicago	**in**	2008	**that also went through**	10%	10%	100%	0%	10%
The percentage of tonnage from	O'Brien	**in**	2008	**that also went through**	87%	87%	0%	100%	71%
The percentage of tonnage from	La Grange	**in**	2008	**that also went through**	34%	34%	0%	16%	100%
The percentage of tonnage from	Brandon Road	**in**	2007	**that also went through**	100%	98%	0%	44%	76%
The percentage of tonnage from	Lockport	**in**	2007	**that also went through**	100%	100%	0%	45%	75%
The percentage of tonnage from	Chicago	**in**	2007	**that also went through**	2%	2%	100%	0%	1%
The percentage of tonnage from	O'Brien	**in**	2007	**that also went through**	84%	84%	0%	100%	69%
The percentage of tonnage from	La Grange	**in**	2007	**that also went through**	31%	31%	0%	15%	100%

SOURCE: Waterborne Commerce Statistics and Lock Performance Monitoring System

Several interactions can be seen in **Table 7**. One obvious relationship is that 100 percent of the tonnage transiting Lockport also transits Brandon Road and 98 percent to 100 percent of the tonnage that transits Brandon Road also transits Lockport. Since the locks are only separated by approximately five miles and the town of Joliet, IL, this relationship makes sense. Another connection is an average of 77 percent of the tonnage going through Brandon Road, 77 percent of the tonnage going through Lockport, and 70 percent of the tonnage going through O'Brien also transits La Grange at the mouth of the Illinois. This speaks to the flow of tonnage between

Chicago and the rest of the country. Despite declining tonnage levels transiting the CAWS from 2007 to 2011, the association between locks remained relatively constant with the exception of Chicago.

(5) Origin-Destination Patterns

Understanding CAWS commercial cargo navigation requires also analyzing the extent of the commodity movements. **Table 8** shows the five year tonnage averages for various origin and destinations for commodities that are moved on the CAWS. Commodity traffic touching the CAWS is shipped or received from states as distant as Texas, Louisiana and Florida on the Gulf Intercoastal Waterway (GIWW) and Lower Mississippi, Minnesota on the Upper Mississippi, Pennsylvania and West Virginia on the Ohio, Tennessee and Alabama on the Tennessee/Cumberland, Michigan, Wisconsin, and Canada. As seen in other tables, the main commodity being moved is coal and coke group which includes coal, metallurgical coke, petroleum coke, and other related commodities. While Illinois is the main origin for tonnage moving on the CAWS, other important origin states include Louisiana (averages 3 million tons a year), Canada (averages 2.1 million tons per year), and Michigan (averages 1.3 million tons a year). The main destination states for CAWS commodities are Illinois (averages 14.8 million tons), Michigan (averages 1.6 million tons), Louisiana (averages 1.5 million tons), and Wisconsin (averages 1 million tons).

Table 9 shows the percentages of total tonnage for each origin and destination state pair for 2007 to 2011. Illinois to Illinois movements account for an average of 29 percent of total tonnage moving on the CAWS. The other main origins to destinations pairs were Louisiana to Illinois which accounted for an average of 12 percent of tonnage, and Canada to Illinois which accounted for an average of 9.4 percent of tonnage.

Table 8: Five Year Average Tonnage (2007 to 2011) for State Origin and Destinations Moved via CAWS

STATE	STATUS	COAL & COKE	PETROLEUM FUELS	AGGREGATES	GRAINS	CHEMICALS	ORES & MINERALS	IRON & STEEL	ALL OTHERS	TOTAL
		THOUSAND TONS								
Alabama	ORGIN	2	1	0	16	5	0	85	37	146
Alabama	DEST	7	51	0	9	4	0	82	0	154
Arkansas	ORGIN	1	7	19	1	0	1	4	6	38
Arkansas	DEST	0	0	0	12	0	1	101	4	119
Canada	ORGIN	19	31	174	0	15	1,292	527	44	2,102
Canada	DEST	762	0	33	47	2	0	14	54	912
Florida	ORGIN	0	0	0	0	0	0	0	0	0
Florida	DEST	0	0	0	0	1	0	3	0	4
Iowa	ORGIN	0	0	0	0	0	0	0	5	5
Iowa	DEST	11	0	0	0	0	0	1	2	14
Illinois	ORGIN	7,519	1,237	2,280	259	402	101	736	629	13,163
Illinois	DEST	3,555	1,072	2,944	45	1,136	2,422	1,985	1,669	14,829
Indiana	ORGIN	52	332	2	58	6	7	350	171	977
Indiana	DEST	182	131	34	13	55	51	190	107	763
Kansas	ORGIN	0	0	0	0	0	0	0	0	0
Kansas	DEST	0	0	0	0	0	0	0	0	0
Kentucky	ORGIN	13	2	25	2	48	0	18	2	110
Kentucky	DEST	100	6	0	0	2	5	111	6	230
Louisiana	ORGIN	149	140	8	5	697	914	944	216	3,074
Louisiana	DEST	307	534	0	230	124	0	183	91	1,469
Michigan	ORGIN	0	3	455	0	54	3	2	783	1,300
Michigan	DEST	1,492	0	16	0	0	0	17	126	1,650
Minnesota	ORGIN	16	4	6	0	0	0	2	0	28
Minnesota	DEST	18	0	0	0	0	0	1	141	160
Missouri	ORGIN	6	0	8	3	4	7	9	384	422
Missouri	DEST	79	4	1	0	3	4	43	31	164
Mississippi	ORGIN	0	13	0	2	0	0	0	46	62
Mississippi	DEST	13	3	0	0	2	0	5	2	24
New York	ORGIN	0	0	0	0	0	0	0	0	0
New York	DEST	37	0	0	0	0	0	0	0	37
Ohio	ORGIN	19	5	3	0	0	136	28	6	197
Ohio	DEST	198	4	0	0	2	0	6	65	275
Oklahoma	ORGIN	9	4	0	0	0	0	3	7	23
Oklahoma	DEST	1	5	0	0	0	0	15	1	21
Pennsylvania	ORGIN	7	4	0	0	0	1	0	0	12
Pennsylvania	DEST	4	0	0	0	1	0	2	0	8
Tennessee	ORGIN	0	53	6	4	1	0	14	8	86
Tennessee	DEST	37	17	0	6	3	3	127	20	213
Texas	ORGIN	2	103	0	0	221	2	26	7	362
Texas	DEST	14	103	0	1	115	0	79	8	320
Wisconsin	ORGIN	0	0	42	12	0	0	7	6	67
Wisconsin	DEST	959	4	4	0	0	0	49	64	1,079
West Virginia	ORGIN	31	6	3	0	1	0	23	0	64
West Virginia	DEST	4	11	0	0	12	0	2	0	30

Table 9: Percent of Total Tonnage Moving Between Various Origins and Destinations

ORIGIN	DESTIN	2007	2008	2009	2010	2011	AVERAGE
AL	IN	0.1%	0.1%	0.4%	0.2%	0.4%	0.2%
AL	IL	0.5%	0.8%	0.3%	0.4%	0.3%	0.4%
AR	IN	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
AR	IL	0.1%	0.2%	0.0%	0.1%	0.2%	0.1%
CN	IL	6.9%	9.8%	12.1%	8.7%	9.7%	9.4%
FL	IL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
FO	IL	1.8%	1.4%	0.8%	1.8%	1.3%	1.4%
IA	OH	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
IA	IL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IL	LA	4.4%	4.9%	8.1%	7.6%	4.5%	5.9%
IL	IL	30.5%	28.1%	30.9%	29.9%	28.2%	29.5%
IL	MS	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
IL	TN	1.8%	1.1%	0.4%	0.5%	0.4%	0.8%
IL	TX	1.1%	1.0%	0.5%	1.1%	0.8%	0.9%
IL	IA	0.0%	0.1%	0.1%	0.0%	0.0%	0.1%
IL	IN	0.8%	0.3%	0.4%	0.4%	0.7%	0.5%
IL	MI	6.7%	8.2%	6.3%	6.5%	8.8%	7.3%
IL	AR	0.7%	0.9%	0.2%	0.3%	0.2%	0.5%
IL	KY	0.4%	0.7%	1.9%	1.4%	0.9%	1.0%
IL	AL	0.2%	0.1%	0.3%	0.4%	0.7%	0.3%
IL	MO	0.8%	0.8%	0.5%	0.4%	0.2%	0.6%
IL	OH	2.4%	0.9%	0.9%	0.7%	0.8%	1.1%
IL	CN	3.9%	3.1%	3.8%	4.9%	4.6%	4.1%
IL	OK	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
IL	MN	0.4%	0.2%	0.1%	0.2%	0.3%	0.2%
IL	WI	5.0%	4.9%	3.6%	4.9%	5.3%	4.7%
IL	FL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IL	WV	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
IL	PA	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
IL	FO	0.1%	0.3%	0.6%	0.6%	0.4%	0.4%
IL	NY	0.0%	0.0%	0.9%	0.0%	0.0%	0.2%
IL	KS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IN	IL	1.8%	1.2%	0.7%	2.1%	3.5%	1.9%
IN	MN	0.3%	0.5%	0.4%	0.5%	0.6%	0.5%
IN	LA	0.4%	0.4%	1.2%	1.3%	0.5%	0.8%
IN	AL	0.3%	0.4%	0.2%	0.2%	0.6%	0.3%
IN	OK	0.1%	0.1%	0.0%	0.1%	0.0%	0.1%
IN	TX	0.5%	0.7%	0.3%	0.2%	0.7%	0.5%
IN	OH	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
IN	MS	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%
IN	PA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IN	AR	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
IN	MO	0.3%	0.1%	0.1%	0.0%	0.1%	0.1%
IN	IN	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
IN	IA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IN	TN	0.1%	0.0%	0.1%	0.1%	0.0%	0.0%
IN	WV	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
IN	KY	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
IN	FL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
KY	IL	0.3%	0.4%	0.3%	0.3%	0.4%	0.4%
KY	IN	0.3%	0.2%	0.0%	0.0%	0.1%	0.1%
LA	IL	10.7%	13.1%	13.8%	11.2%	11.4%	12.0%
LA	IN	1.7%	2.9%	0.8%	1.2%	1.4%	1.6%
LA	WI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MI	IL	8.1%	7.1%	4.1%	4.3%	4.3%	5.6%
MI	MS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MN	IL	0.2%	0.0%	0.3%	0.1%	0.0%	0.1%
MN	IN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MO	IL	1.6%	1.1%	0.8%	2.8%	2.8%	1.8%
MO	IN	0.1%	0.2%	0.1%	0.0%	0.0%	0.1%
MO	WI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MS	IL	0.4%	0.1%	0.3%	0.3%	0.2%	0.3%
MS	IN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
MS	WI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OH	IN	0.2%	0.1%	0.0%	0.3%	0.5%	0.2%
OH	IL	0.9%	0.5%	0.7%	0.7%	0.6%	0.7%
OH	LA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OK	IL	0.0%	0.0%	0.1%	0.1%	0.0%	0.1%
OK	IN	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%
OK	OH	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
PA	IL	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
PA	IN	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
TN	IL	0.2%	0.5%	0.4%	0.4%	0.0%	0.3%
TN	IN	0.1%	0.1%	0.0%	0.0%	0.0%	0.1%
TX	IL	1.7%	1.8%	1.3%	1.2%	1.1%	1.4%
TX	IN	0.0%	0.1%	0.2%	0.2%	0.3%	0.2%
TX	WI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WI	IL	0.0%	0.0%	0.2%	0.4%	0.7%	0.3%
WI	LA	0.1%	0.0%	0.1%	0.0%	0.0%	0.1%
WI	TX	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WV	IN	0.2%	0.0%	0.0%	0.2%	0.5%	0.2%
WV	IL	0.0%	0.0%	0.0%	0.3%	0.1%	0.1%

Comparison of Waterborne Commerce Data With Lock Performance Monitoring System Data

As discussed in the Methods section of this report, the USACE relies on two sources of data: (1) the Waterborne Commerce Statistics Center WCSC, and (2) LPMS. The WCSC database contains information on the origin and destination, the commodity type, and the tonnage for each movement and is reported by the vessel operating companies. The LPMS database contains information on the towboat name, number and type of barges in the tow, the commodity type, and the barge tonnage and is logged by the lock master.

Each data source has its strengths. The LPMS does not report origin and destination information, so the WCSC database is relied upon when analyzing commodity movements across the country. Since the vessel operators report the data for the WCSC, then it is considered to have more accurate loading tonnage values as well as commodity descriptions.
In contrast, the LPMS database is the sole source for lock transit timing information and it is considered to have more reliable barge counts as they are collected through observation.

However, each data source has its weaknesses. For WCSC data, owners and operators sometimes experience confusion over who is responsible for reporting a vessel's movements. The confusion arises when a vessel operator charters or leases the vessel to another company, or drop barges at a fleeting area to be picked up by another towing company for the last leg of the waterborne movement. For LPMS data, the tonnage estimates are usually high because USACE lock personnel make tonnage estimates based upon what are generally thought to be typical loadings for the type of barge being moved through the lock. Confusion over reporting responsibilities in WCSC and generalized LPMS tonnage estimates means that the tonnages estimates from these two distinct sources rarely match.

Table 10: Comparison of WCSC and LPMS Tonnages Reported for Brandon Road, Lockport, O'Brien, and Chicago Locks

Year	Brandon Road			Lockport			O'Brien			Chicago		
	WCSC THOUSAND TONS	LPMS	Percent Diff	WCSC THOUSAND TONS	LPMS	Percent Diff	WCSC THOUSAND TONS	LPMS	Percent Diff	WCSC THOUSAND TONS	LPMS	Percent Diff
2007	11,643	13,862	19.1%	11,455	13,508	17.9%	6,052	7,295	20.5%	148	168	13.4%
2008	11,313	12,665	12.0%	11,269	12,461	10.6%	5,784	6,822	18.0%	48	105	119.8%
2009	9,289	10,466	12.7%	9,242	10,241	10.8%	4,127	4,641	12.5%	24	79	228.1%
2010	9,115	10,010	9.8%	9,066	9,854	8.7%	4,903	5,132	4.7%	10	102	9.2105
2011	9,598	10,761	12.1%	9,369	10,553	12.6%	5,881	6,456	9.8%	31	92	196.9%

SOURCE: Waterborne Commerce Statistics and Lock Performance Monitoring System

Table 11: Comparison of WCSC and LPMS Barge Counts Report for Brandon Road, Lockport, O'Brien, and Chicago Locks

	Brandon Road			Lockport			O'Brien			Chicago		
Year	WCSC (Barges)	LPMS (Barges)	Percent Diff	WCSC (Barges)	LPMS (Barges)	Percent Diff	WCSC (Barges)	LPMS (Barges)	Percent Diff	WCSC (Barges)	LPMS (Barges)	Percent Diff
2007	7,009	8,427	20.2%	6,892	8,124	17.9%	3,794	4,475	17.9%	26	50	92.3%
2008	6,720	7,587	12.9%	6,694	7,440	11.1%	3,576	4,259	19.1%	6	39	550.0%
2009	5,559	6,376	14.7%	5,528	6,204	12.2%	2,608	2,902	11.3%	13	50	284.6%
2010	5,429	6,090	12.2%	5,397	5,975	10.7%	3,089	3,192	3.3%	0	125	NA
2011	5,756	6,452	12.1%	5,608	6,293	12.2%	3,632	3,874	6.7%	19	210	1005.3%

SOURCE: Waterborne Commerce Statistics and Lock Performance Monitoring System

While **Table 10** compares the tonnages recorded by the WCSC with those recorded by the LPMS for the Brandon Road, Lockport, O'Brien and Chicago locks for the period 2007-2011, **Table 11** contrasts the barge counts for the same locks during the same period. As shown in **Table 10** and **Table 11** the CAWS differs from other areas of the country because the LPMS tonnages and barge counts are consistently higher than the WCSC tonnages and barge counts. From 2007 to 2011, LPMS was greater in tonnage than WCSC by an average of 13 percent at Brandon Road, 12 percent at Lockport, 13 percent at O'Brien, and 296 percent at Chicago.

The average percent difference in barge counts between WCSC and LPMS showed similar discrepancies. Brandon Road barge counts were off by an average of 14 percent while Lockport barge counts were different by an average of 13 percent, O'Brien varying by 12 percent at O'Brien, and 483 percent at Chicago. Since the percent differences for tonnages and barge counts are similar and count of barges is based on observation by Corps personnel, it is likely that there is underreporting to the WCSC for the CAWS area. Underreporting is not uncommon on the inland waterway system, particularly in situations such as the CAWS where barges are routinely transferred between linehaul carriers and local towing companies.

CAWS Vessels

An important goal of towing companies operating on the inland navigation system is to select equipment and to configure tows to operate as efficiently as possible along each waterway. The needs of specific waterways are balanced against efficiencies for the entire waterway movement. A variety of factors enters into equipment selection and tow configuration, including length of haul, lock size constraints, backhaul opportunities, and channel configuration and constraints. This section examines navigation conditions and constraints on the CAWS as well as tow, equipment and lockage characteristics for the waterway segment. The data presented in this section is drawn from the Lock Performance Monitoring System (LPMS). Compilations and analyses are prepared by the Planning Center for Expertise for Inland Navigation (PCXIN).

Navigation Operations and Constraints

While Brandon Road Lock and Lockport Lock have similar characteristics, these locks vary in size and traffic levels from Thomas J. O'Brien Lock and Chicago Lock. Both Brandon Road and Lockport measure 600'x110' and regularly handle up to two-cut lockages. In contrast, O'Brien and Chicago which measure 1000'x110' and 600'x80' respectively only deal with single cut lockages. The difference in lock sizes has not been problematic because the locks operate below capacity and because tow sizes and configurations are constrained by channel and other restrictions at various points in the CAWS.

Tows navigating on the CAWS frequently re-fleet and exchange towboats in the vicinity of Lemont, above the Lockport facility at around mile 299.5. Tows destined for locations above Lemont re-fleet to negotiate channel conditions along the route to the destination terminal. Tows destined for locations below Lemont re-fleet for linehaul movements on the Illinois Waterway and beyond. For tows that are sufficiently large, the re-fleeting process takes place farther downstream, between mile 292 and mile 293. This is necessary for the larger tows because above mile 293 the tows must be 70 feet wide or less to enable passing in the reaches where it is feasible.

Tows moving upstream from the re-fleeting areas normally switch towboats from boats with fixed pilot houses to those with retractable pilot houses. Tows moving downstream normally do the reverse. Towboats with retractable pilot houses are necessary upstream of the re-fleeting areas because the CAWS has approximately 120 bridges crossing the waterway, many of which have low hanging structures. This retractable feature is necessary for the towboats to clear the low hanging bridge structures and for pilots to be able to see over barges when moving empties. Tows that enter Lake Michigan from the CAWS will sometimes switch towboats to navigate the lake. If this happens, it is frequently because the pilot is not licensed to operate on the lake. Sometimes towboats are switched out for tugboats, which, in contrast to the towboats, have pointed bows which give the boats greater stability when navigating on the lake.

The navigation channels on the CAWS have numerous constraints that influence the size, configuration, and loading of tows, as well as tow speeds. In some areas, notably the Calumet River, channel circuity is limiting on tow size and tow configuration. In other areas, like the North Branch of the Chicago River, tows have to be light-loaded to navigate because of reduced channel depth due to shoaling. Abandoned bridge piers are a problem in certain areas. Narrow channels and circuity in some areas result in one-way traffic. An electric fish barrier, located above Lockport at about mile 296.5, restricts navigation to one-way traffic with no passing. In addition, no mooring is allowed in the area, no one can be on deck and the barges must be tethered together with steel cables. Additionally, the City of Chicago limits tow sizes to two barges on the North Branch, South Branch, and the Chicago River. Because of navigation channel restrictions, many areas of the CAWS are speed restricted (i.e. no wake zones).

The numerous bridges on the CAWS pose some special restrictions to navigation. Navigation channels narrow at bridges. Drawbridges frequently do not open upon request, requiring tows to wait while holding position. Clear height under opening bridges is sometimes a problem when the bridge does not open completely. Some bridges have restrictions on their hours of operation and some bridges occasionally break down and cannot open. Each bridge is unique.

As a matter of policy, the locks on the CAWS are open for commercial navigation 24 hours a day year –round. As a practical matter, weather conditions can be limiting. High water and current conditions can halt navigation on the CAWS. The Chicago and O'Brien Locks sometimes close during high water events to help limit polluted water from entering Lake

Michigan. Icing conditions at the locks can prevent the complete opening of the lock gates, which can necessitate a restriction on tow widths for tows using the chambers.

Existing Vessel Traffic and Trends

Tow sizes and barge loadings at the CAWS locks are frequently influenced by factors other than simple lock capacity. Barges transiting the CAWS locks sometimes originate at or are destined for terminals on channels with depth restrictions, for example on the North Branch and South Branch of the Chicago River. In order to access these areas, shippers are sometimes compelled to light-load barges. Tows transiting the CAWS locks (particularly the Chicago Lock) are influenced by a City of Chicago regulation limiting tow sizes on the Chicago River and the North and South branches to two barges. Tow sizes at the O'Brien Lock are influenced by channel restrictions on the Calumet River.

There are several highlighted trends found in the summary of vessel traffic for Lockport Lock and Dam, Thomas J O'Brien Lock and Dam, Chicago Lock, and Brandon Road Lock and Dam for selected years between 2000 and 2011 that is presented in **Table 12**. As expected, the highest tonnages, largest tows, and greatest numbers of tows and barges on the CAWS pass through Brandon Road and Lockport while the smallest tows, least tonnage, and the smallest numbers of tows and barges pass through Chicago. In 2011, Brandon Road processed the most barges (10,568), but Lockport processed the most number of commercial tows (2,695). In daily terms, the Brandon Road managed 7 tows per day and 29 barges per day or while Lockport handled 7.4 tows per day and 28.8 barges per day. In comparison, O'Brien processed a lower number of tows per day (4.8), but a greater number of barges per day (17.2). The limited commercial cargo traffic at Chicago means that it has the lowest tows per day (0.6) and barges per day (0.7). In 2011, Brandon Road had the most barges per tow and the heaviest tows at 4 barges per tow and 4,218 tons per tow. However, Lockport was not far behind with an average of 4 barges per tow and tows weighed 3,916 tons. Over the same time, the average tow through O'Brien consisted of 3.6 barges per tow weighing 3,710 tons, while Chicago averaged 1.2 barges per tow weighing 418 tons.

Table 12: Tonnage, Barge Counts, and Number of Tows Transiting Brandon Road, Lockport, O'Brien, and Chicago Locks

Project/Item	2000	2005	2006	2007	2008	2009	2010	2011	Avg. Annual Rate of Change
Brandon Road									
Tons (000)	16,940,484	17,336,609	17,811,849	13,862,037	12,665,246	10,465,777	10,010,190	10,760,631	-3.7%
Barges	17,467	17,557	17,895	13,935	12,093	10,662	9,702	10,568	-4.1%
Tows	2,888	2,734	2,959	2,590	2,420	2,310	2,367	2,551	-1.0%
Barges per Tow	6	6	6	5	5	5	4	4	-3.1%
Tons per Tow	5,866	6,341	6,020	5,352	5,234	4,531	4,229	4,218	-2.7%
Lockport									
Tons (000)	16,788,986	16,929,707	17,248,750	13,507,517	12,460,893	10,240,591	9,853,988	10,552,834	-3.8%
Barges	17,224	17,024	17,430	13,411	11,906	10,414	9,644	10,497	-4.0%
Tows	2,865	2,735	2,979	2,647	2,459	2,345	2,460	2,695	-0.5%
Barges per Tow	6.0	6.2	5.9	5.1	4.8	4.4	3.9	3.9	-3.6%
Tons per Tow	5,860	6,190	5,790	5,103	5,067	4,367	4,006	3,916	-3.3%
O'Brien									
Tons (000)	8,436,175	9,048,078	9,479,767	7,294,890	6,822,254	4,641,383	5,131,780	6,455,575	-2.2%
Barges	8,800	9,101	9,681	7,573	7,063	4,946	5,065	6,268	-2.8%
Tows	2,281	2,207	2,362	2,082	1,921	1,388	1,551	1,740	-2.2%
Barges per Tow	3.9	4.1	4.1	3.6	3.7	3.6	3.3	3.6	-0.6%
Tons per Tow	3,698	4,100	4,013	3,504	3,551	3,344	3,309	3,710	0.0%
Chicago									
Tons (000)	146,442	111,319	127,800	167,800	105,484	78,740	102,105	92,053	-3.8%
Barges	162	45	69	78	53	60	175	268	4.3%
Tows	110	44	62	71	48	59	166	220	5.9%
Barges per Tow	1.5	1.0	1.1	1.1	1.1	1.0	1.1	1.2	-1.6%
Tons per Tow	1,331	2,530	2,061	2,363	2,198	1,335	615	418	-9.2%

SOURCE: Lock Performance Monitoring System

As demonstrated with the WCSC data, the LPMS data shows that the tonnage for all locks has decreased since 2000. Between 2006 and 2010, the numbers of barges processed at Lockport and O'Brien have diminished by 45 and 26 percent, respectively. While the number of tows and barges has decreased at Brandon Road, Lockport, and O'Brien, Chicago has actually seen a 100 percent increase in the number of tows and a 65 percent increase in the number of barges since 2000. It should be noted that Chicago Lock handles small tonnages and has somewhat irregular commercial traffic patterns.

Table 13: Tow Size Distributions for Brandon Road, Lockport, O'Brien, and Chicago Locks for Selected Years

Project/Item	2000	2005	2006	2007	2008	2009	2010	2011
Brandon Road								
Barges per Tow								
1-2	76.4%	74.9%	76.7%	77.8%	79.1%	78.3%	82.4%	82.8%
3-4	15.7%	17.8%	16.8%	16.6%	16.1%	16.6%	14.9%	13.7%
5-6	5.5%	5.3%	4.4%	4.2%	3.0%	3.8%	2.3%	2.8%
7-10	2.2%	1.7%	1.8%	1.2%	1.6%	1.1%	0.4%	0.7%
>10	0.3%	0.3%	0.4%	0.2%	0.2%	0.2%	0.1%	0.0%
Lockport								
Barges per Tow								
1-2	22.8%	18.2%	21.5%	27.0%	29.1%	33.1%	37.1%	38.4%
3-4	18.0%	20.8%	23.4%	25.8%	26.4%	25.4%	28.6%	26.0%
5-6	20.6%	21.8%	21.2%	19.6%	21.3%	23.5%	22.5%	27.1%
7-10	25.8%	23.8%	20.8%	20.4%	17.0%	13.3%	9.9%	7.1%
>10	12.8%	15.4%	13.1%	7.2%	6.2%	4.6%	2.0%	1.4%
O'Brien								
Barges per Tow								
1-2	36.7%	29.7%	29.5%	37.4%	38.6%	38.3%	44.6%	41.9%
3-4	22.0%	22.8%	24.2%	28.1%	26.5%	28.4%	31.9%	24.1%
5-6	37.7%	44.7%	44.9%	34.1%	34.5%	33.3%	23.4%	34.0%
7-10	3.5%	2.8%	1.3%	0.3%	0.3%	0.1%	0.2%	0.1%
>10	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
Chicago								
Barges per Tow								
1-2	100.0%	100.0%	96.8%	97.2%	100.0%	100.0%	100.0%	100.0%
3-4	0.0%	0.0%	3.2%	2.8%	0.0%	0.0%	0.0%	0.0%
5-6								
7-10								
>10								
SOURCE: Lock Performance Monitoring System								

Table 13 shows the tow size distributions at the CAWS locks for selected years between 2000 and 2011. Although the average tow on the for Brandon Road, Lockport, and O'Brien falls into the 3 to 4 barge range, a fairly wide range of tow sizes occurs at these locks. Though Brandon Road and Lockport average tow sizes of 4.0 and 3.9 barges respectively, both see tows that have greater than 10 barges. For Brandon Road, 83 percent of tows are in the 1-2 barge range, with only a 15 percent occurring in the 3 to 4 barge range. In contrast, the tow sizes for Lockport and O'Brien are spread relatively evenly among the 1 to 2, 3 to 4, and 5 to 6 ranges. Tow sizes at the Chicago lock were almost exclusively in the 1 to 2 barge range.

Vessel Characteristics

The CAWS locks are unusual from the standpoint that they are three different sizes, although they are relatively close in proximity. The Brandon Road and Lockport lock measures

600’x110’, which makes them compatible with downstream locks on the Illinois Waterway. At 1000’x110’, O’Brien is a greater size than Brandon Road and Lockport, but the traffic levels are typically half those of the Brandon Road and Lockport facilities. The diversity of shippers in the Chicago area accounts for a variety of barge types and sizes at the locks.

The towboats utilized on the CAWS are typically divided into two types: linehaul vessels and telescoping pilot towboats. Linehaul vessels are generally larger horsepower vessels (>7,000 HP) and navigate the Illinois Waterway from a point shortly upstream of the Lockport facility to beyond the junction of Illinois and Mississippi. These vessels are restricted by the Lemont Railroad Bridge at river mile 300 on the Chicago Sanitary and Ship Canal. Telescoping pilot vessels are specifically designed towboats with retractable pilot houses which enable them to clear low steel at numerous bridges in the Chicago area. Though some shipping companies have retractable pilot vessels with horse power greater than 7,000 HP, most telescoping pilot vessels range between 1,000 HP to 3,000 HP.

CAWS Locks

Operating Hours

Brandon Road Lock and Dam, Lockport Lock and Dam, Thomas J. O’Brien Lock and Dam, and Chicago Lock operate year-round on a 24-hour basis except during intermittent periods where the locks are closed for inspection or scheduled maintenance and repair work. In recent years, one or more of the locks have been temporarily closed because of activities associated with ANS control. The locks do not normally close because of adverse weather conditions.
An exception to this, as an example, would be the occasional closures of the Chicago Lock that occur because of flooding on the Chicago River. The lock has been closed in the past to prevent combined storm and sanitary discharge into the lake. On occasion, adverse weather conditions (e.g. fog, high water) prevent tows from navigating on the CAWS, and as a result, lockages at the CAWS locks cease.

Lockage Policy and Procedures

Lockages through the CAWS facilities are generally carried out on a first-come, first-served basis, with certain caveats. First priority in lockages is given to vessels belonging to federal, state and local entities, especially those deployed for public safety and emergencies. Second priority is given to commercial passenger vessels. Third priority is given to commercial cargo tows and last priority is given to recreational vessels. In order to fully utilize the capacity of the locks, recreational craft may share the lock chamber with commercial cargo tows under certain conditions, intended to maintain safety in the lockage process.

Lockages at the CAWS locks are typically single-cut lockages. Multiple-cut lockages occur only at Brandon Road and Lockport because these facilities are equipped with tow haulage units. The tow haulage units are used to extract unpowered cuts from the chamber and align them along the guide wall to await lockage of the towboat. Lockages at the O’Brien facility are restricted to single cuts because channel restrictions elsewhere on the Calumet River limit tow sizes. Lockages through the Chicago Lock are limited to single cuts largely because of a regulation imposed by the City of Chicago that limits tow sizes to 2 barges on the Chicago River and the North and South branches.

Lockage Characteristics

The lockages at the Brandon Road, Lockport, O'Brien, and Chicago by type of lockage for 2001, 2006 and 2011 are shown in **Table 14**. The lockage categories are defined as follows:

- ***Commercial Cargo*** **–** Includes any lockage of tow or tug boats, dry cargo vessels, liquid cargo vessels, or fishing vessels.
- ***Passenger*** **–** Includes any lockage of a passenger boat or ferry including the tourboat-type commercial vessels.
- ***Other*** **–** Includes any lockages of recreational vessels and lockages of any local, state or federal government vessels. Recreational vessels are any pleasure craft or recreational fishing vessels.

The first noticeable trend in **Table 14** is that commercial cargo is more important for locks farther inland. While commercial lockages made up about 78 percent of total lockages at Brandon Road and 82 percent of total lockages at Lockport in 2011, these lockages are only about 16 percent of total lockages at O'Brien and one percent of total lockages at Chicago.
Second, locks closer to Lake Michigan conduct more lockages. This is consistent with passenger and recreational traffic becoming more prevalent as one approaches Lake Michigan. Tour boat type and recreational commercial traffic are more important on the CAWS than on most other parts of the inland navigation system. At Chicago, almost all lockages are either passenger (69 percent), meaning largely tour boats, or other (29.7) meaning recreational vessels. At O'Brien, the movement of recreational craft to and from marinas on the CAWS is shown by other lockages, amounting to 68 percent.

Table 14: Number of Lockages by Type for Brandon Road, Lockport, O'Brien, and Chicago for Select Years Between 2001 and 2011

Project/Item	2001	%	2006	%	2011	%	% Change 2001-2011
Brandon Road							
Commercial Cargo	3,607	79.8%	3,816	84.9%	2,758	78.4%	-30.8%
Passenger	15	0.3%	2	0.0%	2	0.1%	-650.0%
Other	900	19.9%	675	15.0%	757	21.5%	-18.9%
Total	4,522	100.0%	4,493	100.0%	3,517	100.0%	-28.6%
Lockport							
Commercial Cargo	3,532	83.0%	3,757	86.9%	2,889	82.0%	-22.3%
Passenger	8	0.2%	4	0.1%	3	0.1%	-166.7%
Other	716	16.8%	560	13.0%	631	17.9%	-13.5%
Total	4,256	100.0%	4,321	100.0%	3,523	100.0%	-20.8%
O'Brien							
Commercial Cargo	2,032	23.4%	2,362	32.3%	1,740	31.1%	-16.8%
Passenger	12	0.1%	14	0.2%	30	0.5%	60.0%
Other	6,652	76.5%	4,931	67.5%	3,826	68.4%	-73.9%
Total	8,696	100.0%	7,307	100.0%	5,596	100.0%	-55.4%
Chicago							
Commercial Cargo	83	0.5%	62	0.4%	220	1.4%	62.3%
Passenger	9,582	63.4%	10,832	66.1%	10,758	68.9%	10.9%
Other	5,438	36.0%	5,497	33.5%	4,645	29.7%	-17.1%
Total	15,103	100.0%	16,391	100.0%	15,623	100.0%	3.3%
SOURCE: Lock Performance Monitoring System							

As the tonnages for the CAWS have declined since 2001, so have the number of lockages for Brandon Road, Lockport, and O'Brien. As shown in **Table 14**, the 28.6 percent decrease in total lockages at Brandon Road and the 20.8 percent decrease in total lockages at Lockport were led by a drop of 843 commercial lockages at Brandon Road and a drop of 643 commercial lockages at Lockport. On the other hand, the 55.4 percent decrease in lockages experienced by O'Brien was led by a drop of 2,826 recreational vessel lockages. While the number of lockages at the other locks decreased from 2001 to 2011, Chicago actually saw a slight increase of 3.3 percent. Though the number of recreational vessel lockages at Chicago decreased by 793, the number of passenger lockages (i.e. tourboats) increased by 1,176

Table 15: Commercial Cargo Lockage Characteristics at Brandon Road, Lockport, O'Brien, and Chicago for Select Years

Project/Item	2000	2005	2008	2010	2011
Brandon Road					
Commercial Cargo Cuts	3,719	3,598	2,814	2,523	2,758
% Single Cuts	55%	52%	72%	88%	85%
% Double Cuts	45%	48%	28%	12%	15%
%>2 Cuts	0%	0%	0%	0%	0%
Lockport					
Commercial Cargo Cuts	3,660	3,541	2,804	2,614	2,695
% Single Cuts	73%	71%	86%	94%	93%
% Double Cuts	27%	29%	14%	6%	7%
%>2 Cuts	0%	0%	0%	0%	0%
O'Brien					
Commercial Cargo Cuts	2,282	2,207	1,921	1,552	1,740
% Single Cuts	100%	100%	100%	100%	100%
% Double Cuts	0%	0%	0%	0%	0%
%>2 Cuts	0%	0%	0%	0%	0%
Chicago					
Commercial Cargo Cuts	155	44	50	170	220
% Single Cuts	100%	100%	100%	100%	100%
% Double Cuts	0%	0%	0%	0%	0%
%>2 Cuts	0%	0%	0%	0%	0%
SOURCE: Lock Performance Monitoring System					

If a tow consists of more barges than can fit in a lock, then the tow is cut into two or more groups. **Table 15** shows the number of cuts for commercial cargo lockages for selected years between 2000 and 2011. One obvious trend is the inverse relationship between tonnage and percentage of single cut lockages. As the CAWS commercial cargo tonnage has decreased, the percentage of double cut tows has decreased at Brandon Road and Lockport. Since 2000, the number of commercial cuts has decreased at O'Brien and fluctuated up and down at Chicago, but both locks have consistently only had single cut tows due to physical restrictions on the Cal-Sag Channel and Chicago River, which prevent large tows.

Lock Transit Times

The time required for a tow to transit a lock is comprised of two basic components: processing or lockage time and delay time. Processing time is the amount of time a lock is obligated to serve a particular vessel. Delay time is the amount of time a vessel may have to wait to be served. The processing time for each tow can be further subdivided into four separate activities: approach time, entry time, chambering time, and exit time. The processing time would also include turnback times and any time between cuts for multiple-cut lockages.

Table 16: Average Processing, Delay, and Transit Times for Tows at Brandon Road, Lockport, O'Brien, and Chicago for Select Years

	Hours per Tow				
Project/Item	**2000**	**2005**	**2008**	**2010**	**2011**
Brandon Road					
Processing Time	1.3	1.4	1.1	0.9	0.9
Delay Time	1.2	1.5	0.7	0.4	0.4
Total	2.5	2.9	1.9	1.3	1.4
Lockport					
Processing Time	1.7	1.7	1.4	1.3	1.3
Delay Time	2.0	1.4	0.8	0.6	0.8
Total	3.6	3.1	2.2	1.8	2.1
O'Brien					
Processing Time	0.6	0.7	0.7	0.7	0.7
Delay Time	0.1	0.1	0.1	0.1	0.1
Total	0.7	0.8	0.8	0.8	0.8
Chicago					
Processing Time	0.2	0.2	0.2	0.2	0.2
Delay Time	0.1	0.1	0.1	0.1	0.1
Total	0.2	0.3	0.3	0.3	0.3
SOURCE: Lock Performance Monitoring System					

The average processing times, delay times, and total times for the Brandon Road, Lockport, O'Brien, and Chicago is displayed in **Table 16**. In 2011, the average processing times for the CAWS locks were 0.9 for Brandon Road, 1.3 hours at Lockport, 0.7 hours at O'Brien, and 0.2 hours at Chicago. The longer processing times at Brandon Road and Lockport relative to Chicago and O'Brien locks are the result of larger average tow sizes and higher percentage of double cut tows at Brandon Roads and Lockport. Though similar in many respects, Lockport has a slightly longer processing time than Brandon Roads due to the much higher lift at Lockport. Between 2000 and 2011, average processing times diminished at Brandon Road and Lockport, increased slightly at O'Brien, and remained constant at Chicago. The delay data in **Table 16** shows average delay times for 2011 of 0.4 hours at Brandon Road, 0.8 hours at Lockport, 0.1 hours at O'Brien, and 0.1 hours at Chicago. The average delay time dropped for Brandon Road and Lockport relative to 2000 values, but remained relatively unchanged for O'Brien and Chicago. The reduction in processing and delay times results from a reduction in tow arrivals and average tow size in 2010 relative to 2000.

CAWS Rates

The U.S. Army Corps of Engineers, Planning Guidance Notebook, ER 1105-2-100 categorizes four types of navigation NED benefits[6]. This baseline condition section focuses on one of these benefits, transportation rate savings. Transportation rate savings can most easily be defined as the reduction in the economic cost of transporting freight over the waterway compared to transporting freight via land. Savings can be aggregated to many levels, the most basic being by movement. The University of Tennessee Center for Transportation Research (UTK-CTR) sampled 2,265 CAWS movements and developed rate savings seen in **Table 17**.

Based on the fourth quarter 2011 cost levels, those users of the CAWS saved on average approximately $26.30 per ton over the best possible land routing. To facilitate the use of the shipper savings, the individual movement rate sheets were grouped by the U.S. Army Corps of Engineers into commodity groups. Two commodity group modifications were undertaken to maintain confidentiality and consistency. Coke that is made from coal and petroleum coke were included in the Coal & Coke grouping. Also, lubricating oil was included in All Other grouping. Savings for each of the eight commodity groupings identified for this analysis are summarized below.[7]

Table 17: Average Per Ton NED Savings for Baseline Condition by Commodity Group

Commodity Group	Average Per Ton NED Savings ($ Per Ton)
Aggregates	$ 9.34
All Other	$ 26.06
Chemicals	$ 34.11
Coal & Coke	$ 16.05
Grain	$ 25.31
Iron & Steel	$ 33.67
Ore & Minerals	$ 60.90
Petroleum Fuels	$ 19.83
Total	$ 26.30

SOURCE: Survey and analysis conducted by University of Tennennesse, Center for Transportation Research

During the preparation of this study, it was observed that, in a few instances, the selection of barge transportation is more costly than the land alternative. There are a number of scenarios which work individually or in combination to explain this phenomenon. First, in some cases, the sample may occasionally capture a transitory use of a barge which occurs when alternative

[6] ER 1105-2-100, 22 April 2000, page 3-5.
[7] All rates and rate differentials are weighted average.

modes lack capacity or when rail cars are in short supply. That is to say, for some shippers and receivers, barge is the only mode of choice when other transportation markets are unusually active. Secondly, long term contracts and large capital investments may lead to discontinuities in the relationship between relative rates and modal choice. In many areas, barge shippers and receivers are captive to the navigation mode because they lack the industrial footprint to build the infrastructure for a modal change. While this can be a short-run situation, it may, nonetheless, help to explain what appears to be unreasonable behavior. Next, the analysis superimposes 2007, 2008, or 2009 transport market conditions on set of 2011 modal choice decisions. In the vast majority of cases, this dichotomy is of little importance. However, in a few cases, transportation rates may have changed sufficiently, so that in 2011, barge would no longer have been the mode of choice. Finally, regulatory constraints on the new construction of coal and hazardous materials handling facilities may preclude the development of facilities necessary for some shippers to take advantage of changes in the vector of available transportation rates.

FUTURE WITHOUT-PROJECT CONDITION

Introduction

Once the baseline historic and current levels of commercial cargo traffic for the Chicago Area Waterways System (CAWS) were established, the next step of the commercial cargo analysis involved defining a future without-project (FWOP) condition. The objective of the FWOP condition is to project future commercial cargo CAWS traffic. The FWOP condition attempts to predict how much traffic will be moving on the waterways assuming that no new Federal action will be taken to prevent the transfer of ANS between the Great Lakes or the Mississippi River Basins.

In this analysis, the basis for the future traffic projections is news reports, industry newsletters, government forecasts, and interviews with shippers conducted by the University of Tennessee, Center for Transportation Research (UTK-CTR). The FWOP condition will also establish a baseline for comparison when assessing the commercial cargo navigation impacts associated with the implementation of the various alternative plans considered in GLMRIS.

Method

Development of Traffic Projections

Introduction

Historic and forecasted traffic demands by major bulk commodity group for the CAWS are shown in Table 18. Much of the underlying rationale for increased or decreased use of the CAWS under the Future Without Project (FWOP) condition are based on the report, *Industry and Freight Profiles for Traffic Moving in the Chicago Area Waterway System* (Profiles)[8]. This study was completed in June 2012 by Chrisman Dager (UTK-CTR) et al for the PCXIN and it documents the results of interviews conducted with major users of the CAWS.

The forecast of potential traffic reflects the level of traffic that would be expected to materialize if ANS technologies on the CAWS were not considered. It should be noted that due to the controversial nature of the GLMRIS project, some companies are making decisions not to reinvest in the area and are moving storage capacity to other areas and employing other transportation modes. Simple uncertainty regarding the availability of navigation can divert waterway traffic well in advance of any actual closure. For example, uncertainty in availability of waterway navigation may force a shipper to invest in access to transportation alternatives, then the waterway traffic, once lost, is less likely to be recovered.

Actual waterway traffic is the most visible component of traffic demand, and consequently, existing traffic served as the starting point for identifying and forecasting waterway traffic

[8] This report is an internal USACE report because it contains proprietary information.

demands. **Table 18** shows the historic tonnage shipped in the CAWS by major commodity category between 1994 and 2011.

Results

Regional Trends

Prior to discussing the specific forecast used for the FWOP analysis, it is important to understand the dynamics of the inland waterway system from a regional perspective. The discussion in Sections 1 and 2 are primarily based upon the *Freight Mobility Plan, Public Comment Draft* (FMP) published in November 2012 by the Illinois DOT as part of the Illinois State Transportation Plan. The plan contains the most current data and predictions of future demands by mode including: truck, water, rail, and air. For purposes of this study, waterborne traffic is of utmost importance.

According to the FMP, in 2010, 1.26 billion tons of goods moved from, to, and within Illinois via roads, railroads, waterways, and air freight facilities. Of the total freight, 135.2 million tons (11 percent) were moved using waterborne vessels and waterways.

The top three commodity groups in Illinois-based freight traffic accounted for 45 percent of tonnage in 2010. Petroleum and asphalt products (except gasoline), coal, and live animals/animal feed were the largest commodity flows, reflecting the significance of the agricultural and energy supply chains to Illinois' economy.

The FMP provides projections through the year 2040 based on the federal Freight Analysis Framework (FAF) developed by the U.S. Department of Transportation. Total Illinois-based freight tonnage is expected to increase to 1.7 billion tons, which is an increase of one percent from 2010 levels on an average annual basis. Waterborne tonnage is forecast to increase, but at a lower rate to 149.1 million tons or approximately 0.33 percent during the 30 year forecast period.

Chicago Area

Chicago became one of the three main centers of inland distribution for the United States because of its excellent and robust transportation network. These factors have helped make Illinois and Illinois industry integral to global systems of trade despite being in the interior of the continent. Chicago ranks seventh in the world on the 2012 A.T. Kearney Global Cities Index (GCI) which measures the global engagement of a city in relation to its business activity, human capital, information exchange, cultural experience, and political engagement, and is the only city in the top ten that is situated far from coastal waters (AT Kearney, 2012). The information pertaining to commodity flows below was contained in the FMP report.

General

Waterborne commodity flows in Illinois are overwhelmingly outbound, with 104 million tons leaving Illinois for other states in 2010. Comparatively, only 17 million tons entered Illinois from other states. Instate flows, both originating and ending in the Illinois Bureau of Economic Analysis economic area (BEA), were counted at nearly 14 million tons. Both originate and are destined for the Chicago BEA area, emphasizing the critical importance of the lock and canal system as well as the Great Lakes freighter sector.

Outbound

Of the 104 million outbound tons originating in Illinois in 2010, including transshipments[9], 82 percent of these movements originated in the Illinois counties of the St. Louis BEA. As little as nine percent of Illinois outbound waterborne commerce originated in the Chicago area. The Chicago area is extensive, and its inclusion of Lake Michigan, the Illinois River, its connecting lock and canal system, and the Mississippi River explain its ranking as the second largest originating BEA behind St. Louis. New Orleans ranks first as destination, at 22.9 percent, followed by Baton Rouge at 16.8 percent, and Memphis at 11.0 percent.

Inbound

Much smaller than Illinois outbound waterborne commodity flow, inbound shipments via water transportation totaled 13 percent of all waterborne commerce in Illinois in 2010. In that year 17.4 million tons of freight were shipped inbound. A majority of these inbound shipments were destined for the Chicago BEA in 2010. Examining the movements headed to Chicago from outside Illinois in 2010, roughly 31 percent (2.7 million tons) began in New Orleans, with 29 percent (2.5 million) beginning in Northern Michigan. Fifteen percent (1.3 million tons) began in Baton Rouge BEA that year.

Looking toward 2040, many of these patterns should hold constant, as several of the key commodity flows originating in New Orleans, such as fertilizer, are expected by the Freight Analysis Framework (FAF) to increase robustly or maintain share. As an origin and destination pair, Michigan-Illinois water freight movements will also likely remain constant or increase. Principal commodities conveyed such as cement, stone, and building materials are projected by the FAF to increase by 25 percent between 2010 and 2040.

Instate Flow

Of a total of 13.6 million tons traveling by water within the state, 46.2 percent or nearly 6.3 million tons have Chicago as a destination. Chicago-to-Chicago freight movements alone represent 36.6 percent or nearly 5 million tons of the total intrastate commodity flow.

Overall Forecast Results

[9] Transshipment is a movement where the commodity is held at an intermediate destination before being moved to final destination.

Total Traffic demands for the CAWS expressed as total tonnage for the forecast period (2012-2065) are shown in Table 18. Using 2011 as a base year, total tonnage increases from 13.6 million tons in 2011 to 18.4 million tons in 2065. This represents an average annual growth rate of approximately 0.6 percent. This projected total waterborne tonnage is also consistent with the pre-recessionary average tonnage experienced in the period between 1994 and 2006 of 19.3 million tons.

Table 18: CAWS Historic & Forecast Waterborne Tonnage By Commodity Group

Source	Year	Coal	Petroleum Fuels	Aggregates	Grains	Chemicals	Ores	Iron & Steel	All Others	Total
		THOUSAND TONS								
HISTORIC	1994	7,574	3,928*	4,675	1,599	1,988	1,329	5,470	2,197	28,760
	1995	7,887	2,795*	3,149	918	1,819	1,176	3,808*	2,001	23,553
	1996	9,635	2,714*	3,412	794	1,983	1,153	4,160	1,729	25,580
	1997	6,682	2,780	3,299	767*	1,931	1,401	4,238	2,217	23,315
	1998	5,030	3,009*	4,261	1,124*	1,999	992	3,613*	2,220	22,248
	1999	5,277	2,503*	3,580*	775	1,956	752	3,868	2,426	21,137
	2000	4,777	2,625*	4,438	753	2,022	750	4,231	2,567	22,163
	2001	4,443	2,793*	5,158	738	1,743	993*	2,682	2,426	20,976
	2002	4,272	2,361	4,107*	1,004	1,755	919	3,399*	2,286	20,103
	2003	7,284	1,854	4,439*	764*	1,702	687	3,617*	2,528	22,875
	2004	8,640	1,762*	4,105	800	1,448	999*	4,171*	2,776	24,701
	2005	9,119	1,705*	4,878	706*	1,322	960*	4,707	2,960	26,357
	2006	9,812	1,899*	5,683	670	1,568	940*	4,468	2,899	27,939
	2007	8,676	2,187*	4,622	437	1,654	645*	3,905	2,846	24,972
	2008	7,903	2,032*	4,099	258	1,546	1,408*	3,912	1,939	23,097
	2009	6,981	1,458*	2,327	513	1,362	1,577*	1,500*	1,937	17,655
	2010	7,321	1,735	1,495*	452	1,389	818*	1,542*	2,561	17,313
	2011	8,239	1,697*	2,398	127	1,332	799*	2,104*	2,581	19,277
PROJECTED	2015	5,902	1,987	3,808	605	1,332	2,195	3,278	3,536	22,643
	2020	7,902	1,987	3,808	657	1,332	2,190	4,013	4,513	26,402
	2025	7,902	1,987	3,808	657	1,332	2,190	4,013	4,513	26,402
	2030	7,902	1,987	3,808	657	1,332	2,190	4,013	4,513	26,402
	2035	7,902	1,987	3,808	657	1,332	2,190	4,013	4,513	26,402
	2040	7,902	1,987	3,808	657	1,332	2,190	4,013	4,513	26,402
	2045	7,902	1,987	3,808	657	1,332	2,190	4,013	4,513	26,402
	2050	7,902	1,987	3,808	657	1,332	2,190	4,013	4,513	26,402
	2055	7,902	1,987	3,808	657	1,332	2,190	4,013	4,513	26,402
	2060	7,902	1,987	3,808	657	1,332	2,190	4,013	4,513	26,402
	2065	7,902	1,987	3,808	657	1,332	2,190	4,013	4,513	26,402

HISTORIC SOURCE: Waterborne Commerce Statistics Center
PROJECTED SOURCE: PCXIN, UT-CTR surveys, Government agency reports, Industry newsletters
* Deep draft tonnage withheld to protect confidential business information

Table 19 presents a summary of industry specific actions and trends influencing the future utilization of the CAWS by commodity group. Where possible, projections are based on data obtained from primary industry sources as provided in the Profiles report. Each of the eight commodity categories are discussed below.

Table 19: Forecast Summary of Industry Specific Actions and Trends by Commodity Group

Commodity Group	Near Term Trend Determined By	Long Term Trend
Coal	Industry interviews, news reports	Held flat
Petroleum Fuels	Industry interviews	Held flat
Aggregates	Industry interviews	Held flat
Grains	USDA forecast report	Held flat
Chemicals	Held flat	Held flat
Ores and Minerals	10 year rolling average	Held flat
Iron Ore and Steel	U.S. Federal Reserve growth report combine with historic WCSC percentages	Held flat
All Others	10 year rolling average	Held flat

SOURCE: USACE Planning Center of Expertise for Inland Navigation

Group 1 – Coal and Coke

Two major industry actions influenced the projections for this category. The first was the recent closure of two coal burning steam plants, Fisk Generating Station and Crawford Generating Station. The two plants, combined, received nearly 2.7 million tons of coal annually by barge. The second action was the announcement of a proposed coal gasification/coke plant located next to the Detroit Edison transfer dock on Lake Calumet. The new proposed plant is estimated to use two million tons of coal annually beginning in 2016. This influx is sourced from the Great Lakes and will likely be of western origin, since the characteristics of western coal are suitable for gasification.

Group 2 – Petroleum Fuels

According to the Profiles report, there are two major crude oil refineries located within the CAWS. The BP Whiting Refinery is located on Indiana Harbor, while the CITCO Lemont Refinery is located along the Chicago Sanitary and Shipping Canal. Both refineries produce refined petroleum products including: gasoline, diesel, jet fuel, asphalt, petroleum coke, and hydrocarbon solvents. While 99 percent of crude oil is received by pipelines and low-viscosity products like gasoline and diesel fuel are distributed by pipelines, both plants depend on barge for distribution of bulk output, such as petroleum coke, asphalt, and high sulfur residuals.

The BP refinery is the fifth largest refinery in the U.S. with a crude distillation capacity of 405,000 barrels per day (bpd). BP is investing billions of dollars in this facility in order to process heavier, sour crude oil as lighter sweet crude oil supplies diminish. BP hopes to increase gasoline and diesel production by 15 percent with these improvements in 2013. Since most of the crude as input and plant output uses pipelines for distribution, only a modest increase in barge tonnage on the CAWS is expected in this category through 2014 and in future years. However, asphalt tonnage as a by-product will increase and is discussed under Category 8.

Group 3 – Aggregates

The primary use of commodities in this category pertains to the production of concrete for construction activities within Chicago's downtown.

Ozinga Ready Mix Concrete Inc. and Prairie Material operate five docks in the CAWS for receiving materials and distribution of concrete. Ozinga has proposed a cement and slag grinding manufacturing facility for the Chicago area at Lake Calumet. The plant is currently in the permitting phase and is expected to be complete by 2020. The shipment of cement is discussed later under the "All Others" commodity category.

During the research conducted for this report, it was determined that the shipping of sand was underreported in the WCSC database. By comparing reported WCSC data with information obtained from those receiving blended sand, it appears about 1.41 million tons of sand is not being reported. This amount was applied in the 2012 forecast.

Group 4 – Grains

As shown in Table 18, the use of the CAWS for grain shipments is highly variable with a maximum of 1.6 million tons in 1994 to a minimum of 113 thousand tons in 2011. As pointed out in the FMP, weather is a major factor in productions of grains and in 2011 the Midwest experienced a severe drought. In addition, worldwide grain production and demand can impact the markets from year to year.
Given this variable market, the base year for 2012 was determined on a 10 year rolling average. Using USDA forecasts for U.S. grain production an annual growth rate of 1.65 percent was applied from 2013-2020.

Group 5 – Chemicals

There are four firms on the CAWS that distribute propylene glycol industrial grade (PGI) and/or ethanol glycol. The PGI is used to deice aircraft and runways at Chicago's O'Hare International Airport and the ethanol glycol is used as antifreeze for American and Japanese automobile manufacturers. IMTT – Illinois is a major distributor of PGI and has 148 tanks with a total capacity of 1.0 million barrels. PGI is barged to its terminals at Lemont and blended with other chemicals on site. IMTT also blends and packages ethylene glycol (antifreeze) for major automobile manufacturers. In addition, the Fram Group, Prestone Division produces ethylene glycol for the auto industry and is also served by barge.

A number of other chemical products are also distributed using the CAWS including mineral oil, benzene, toluene, sulfuric acid and salts. The use of the CAWS for chemical shipments has witnessed a steady decline from a high of 2.0 million tons in 2000 to a low of 1.3 million tons in 2005. Given that storage tank facilities are being proposed in other locations for future expansion, chemical use of the CAWS is expected to remain stagnant over the forecast period.

Group 6 - Ores and Minerals

The primary commodity using the CAWS under the Ores group is salt. A number of firms receive, store and, distribute salt including: Kinder Morgan, Cargill, Morton Salt, and North American Salt. Movement of salt into the Chicago area is by barge from the Gulf, by deep draft vessel from the Great Lakes, and by rail from the Midwest. Salt is used locally for water softening, deicing of roads, and as a food additive.

A modest growth rate from the 2011 base year is anticipated given the expansion of the road network in the Chicago area and the need for deicing. A ten year rolling average was use through the year 2020.

Group 7 - Iron and Steel

Maryland Pig Services and Scrap Corp. of America produce pig iron for direct input into steel mill and foundry production. Both of these pig iron facilities are located on Lake Calumet. Lakes and Rivers Transfer, a firm providing stevedoring services for pig iron and other products, is located at Burns Harbor. Movement of pig iron in the CAWS during the period 2007-2009 was 1.15 million tons and made up roughly 45 percent of all barge tonnage movement in this category.

Steel manufacturing is an important segment of the regional economy and employs over 28 thousand workers. However, during the period 2007-2009, the maximum annual tonnage for this commodity was only 311 thousand tons. This is likely due to the recessionary period during this time frame, especially since products include large plate steel for the automotive industry and cold finished steel for the fastener and piping and tubing industries.

Following national trends, steel production and the resulting use of the CAWS for this commodity group has shown a decline from a high of 4.2 million tons in 1994 to a low of 1.5 million tons in 2012. However, the category rebounded in 2011 to 2.0 million tons and is expected to rise with the automotive industry. Based on the Chicago Fed report, a conservation increase of 4.13 percent was used from the base year of 2011 to 2020. This brought tonnage to its pre-recessionary level of about 3.0 million tons per year.

Group 8 - All Other

Over time the “All Others” group has remained relatively consistent since 1994, except for the recessionary period in 2008-2009. The commodities have rebounded nicely since 2009 and in 2012 have doubled pre-recessionary levels at roughly 1.4 million tons. For forecasting purposes, a 10 year rolling average was used through 2019 for unspecified commodities.

As mentioned above, the Ozinga cement and slag grinding production facility on Lake Calumet is expected to be on-line by 2020 and will be used to provide cement for the production of ready-mix concrete at two plants located on the CAWS.

Another major trend for this group is an increase in asphalt shipments on the CAWS. The increase in asphalt is consistent with the FMP which lists asphalt as one of the top three commodity groups.

As discussed above, the great majority of crude petroleum is transported using pipelines from Canada, Texas, and the Gulf of Mexico. Referring to Table 18 the use of the CAWS for crude petroleum has been sporadic since 1994. For forecasting purposes a five year average of only

4,100 tons was used to account for use of the CAWS during pipeline outages or other unusual circumstances.

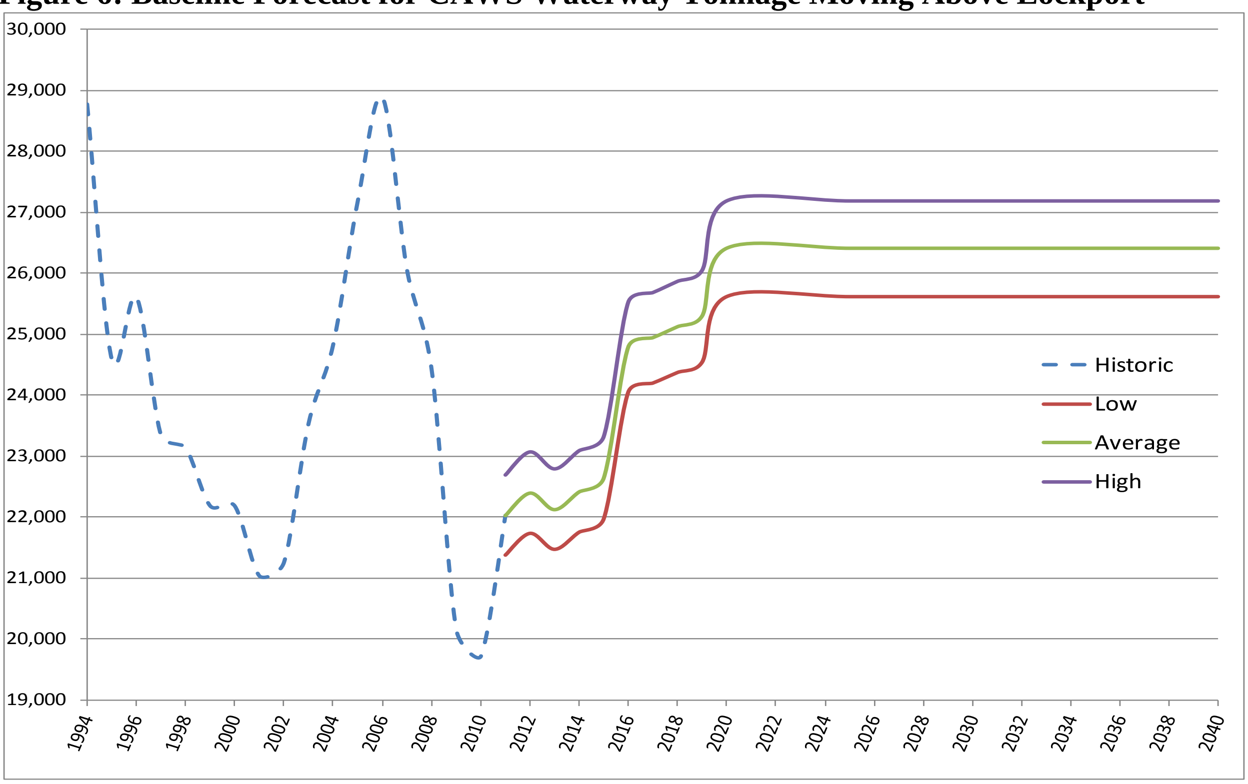
Total Tonnage Projections

Figure 6 shows the growth curve for the total of all commodities using the CAWS above Lockport under the FWOP. To account for risk and uncertainty, a standard deviation of three percent was applied to the forecasted tonnage, denoted by the high projection (purple line) and the low projection (red line).

This graphic depiction shows the dramatic decline in use of the CAWS brought about by the economic recession. In 2010, the use of the CAWS reached its lowest point since 1994. The 2011 data shows a slight rebound. The first forecast year (2012) depicts a sharp increase primarily resulting in the discovery that sand was being underreported within the Aggregates category. In addition, increases are also due in large part, to BP's use of the CAWS for the distribution of asphalt under the All Others category.

Projections remain relatively flat until 2016, when the coal gasification plant on Lake Calumet is expected to come online. After 2016, waterway traffic projections show modest increases until 2020 when CAWS tonnage reaches pre-recessionary levels of roughly 26.4 million tons. Projections remain flat for the balance of the forecast period since technological advances in energy and fuel are unpredictable and could dramatically change the use of the CAWS.

Figure 6: Baseline Forecast for CAWS Waterway Tonnage Moving Above Lockport



FUTURE WITH-PROJECT CONDITION

Introduction

The baseline conditions presented for commercial cargo navigation displayed the historical and current Chicago Area Waterway System (CAWS) commercial cargo statistics for various commodities, vessels, and locks along with the current rate savings experienced by CAWS users. The future without-project (FWOP) condition section utilized the baseline condition along with news reports, industry newsletters, government forecasts and interviews to project future commercial cargo traffic levels. The projections for the FWOP condition were based on the assumption that no new Federal action will be taken to prevent the transfer of ANS between the Great Lakes and the Mississippi River Basins. Therefore, the objective of this future with-project (FWP) condition section is to use the baseline historical traffic statistics along with the FWOP traffic projections to analyze the impact to current and future commercial cargo navigation traffic from the various alternative plans considered in GLMRIS, some of which include measures such as hydrologic separation.

The presentation of the commercial cargo navigation FWP condition analysis is segmented into three parts. The first part identifies the alternative plans considered in GLMRIS that will impact navigation and discusses how the various alternative plans will impact the CAWS commercial cargo industry. Next, the FWP condition section presents the estimates for affected tonnage and increased costs from each solution. Finally, the FWP condition section outlines potential mitigation measures to reduce the impact to commercial cargo navigation as well as summarizes some of the challenges of the mitigation measures.

Alternatives

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Project Delivery Team identified a range of options and technologies to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins by aquatic pathways. Throughout the course of the study, the ANS control technologies were screened using a number of criteria. USACE then developed a list of eight alternatives, each representing a combination of the various control technologies. From this list of eight alternatives, the proposed alternatives that would impact navigation were identified. As shown in **Table 20**, the alternatives that would navigation were separated into three broad categories: complete hydrological separation alternatives, partial hydrological separation alternatives, and no hydrological separation alternatives.

Table 20: List of Alternatives and Technology Locations Analyzed for Commercial Cargo Impacts

ALTERNATIVE				
Formal Name	**Common Name**	**Hydrological Separation**	**Technology**	**Technology Location(s)**
No New Federal Action			None	
Nonstructural Control Technologies				
Mid-System Control Technologies without a Buffer Zone	Flow Bypass Alternative		Addition of new locks and electric barriers.	Stickney (IL), Alsip (IL)
Technology Alternative with a Buffer Zone	CAWS Buffer Zone Alternative		Addition of new locks and electric barriers.	Near Chicago Lock, TJ O'Brien Lock and Dam
Lakefront Hydrologic Separation		Complete	Concrete Dam that will span bank to bank.	Chicago Lock, Calumet City (IL)
Mid System Hydrologic Separation		Complete	Concrete Dam that will span bank to bank.	Stickney (IL), Alsip (IL)
Mid-System Separation Cal-Sag Open Control Technologies with a Buffer Zone	Hybrid Cal-Sag Open Alternative	Partial	Concrete Dam that will span bank to bank.	Stickney (IL)
Mid-System Separation CSSC Open Control Technologies with a Buffer Zone	Hybrid CSSC Open Alternative	Partial	Concrete Dam that will span bank to bank.	Alsip (IL)

Non-Structural Control Technology Alternatives

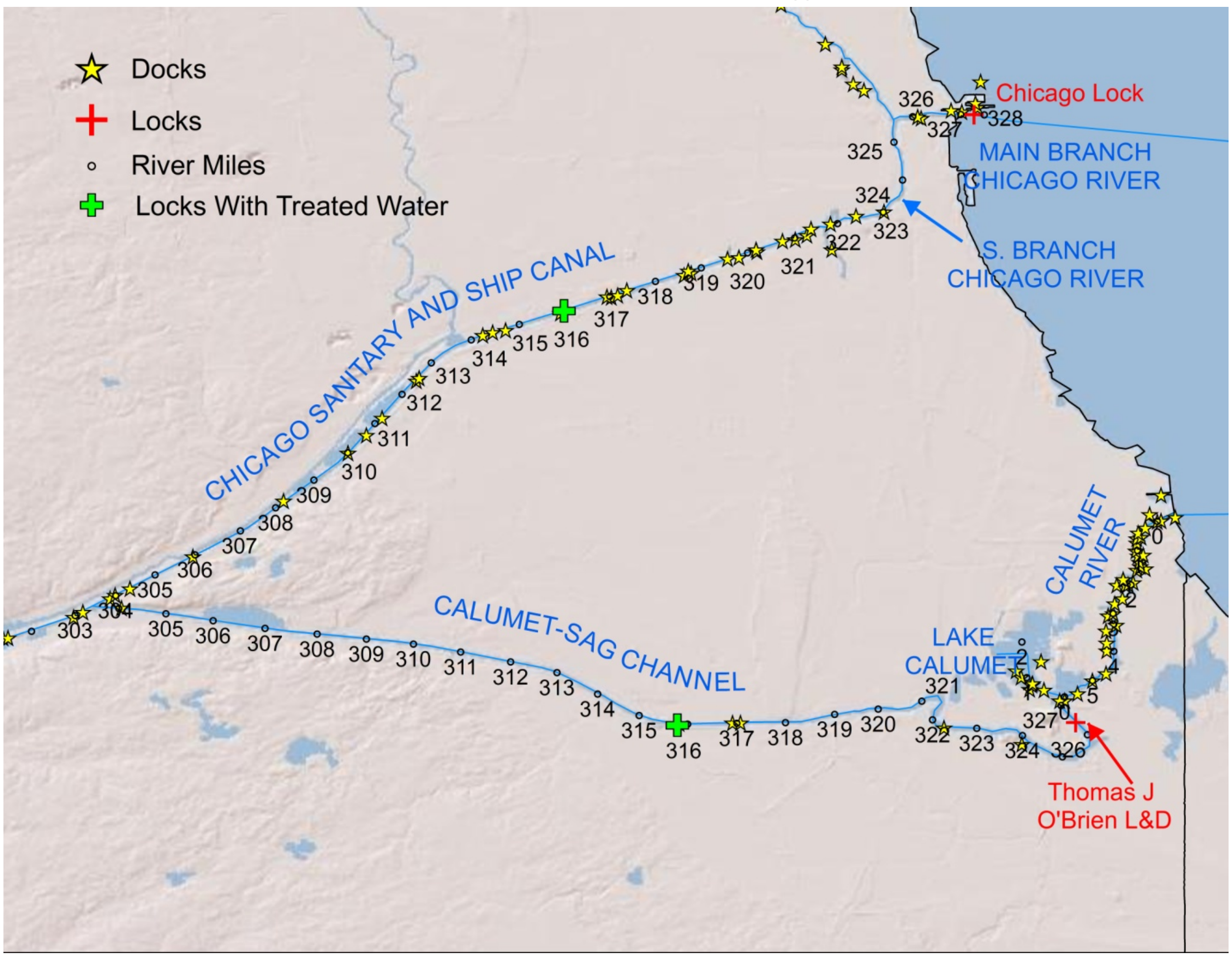
Non-structural approaches are defined as alternatives that do not require engineered construction for controlling interbasin transfer of ANS through the CAWS. Examples of non-structural control approaches include education and outreach to commercial cargo industry, application of biocides, manual removal of species from the water, or laws and regulations governing vessel movements. At the time of the commercial cargo navigation FWP condition analysis, the specific location and type of non-structural control that may be implemented was unclear, so a quantitative FWP condition assessment was not performed for this alternative.

However, it is likely that some of these measures would impact commercial cargo navigation in the form of traffic restrictions or temporary waterway closures. These measures would cause some losses in transportation rate savings for commercial cargo navigation, but these losses would likely be minimal and less than the amounts other alternatives.

Flow-Bypass and CAWS Buffer Zone Alternatives

Several alternatives propose preventing the transfer of ANS between the Great Lakes and Mississippi River basins by using technologies rather than physical barriers. The suggested ANS controls include electric barriers, ballast and bilge regulations, sluice gates, new locks, water treatment facilities, and other technologies. While none of these technologies will completely block CAWS navigation, a few technologies will increase costs by slowing or delaying commercial cargo movements. As shown in **Table 20**, both the Flow Bypass alternative and the CAWS Buffer Zone alternative contain ANS control technologies that will impact navigation on either the CSSC or the Cal-Sag Channel.

Figure 7: Location of Locks with Treated Water Proposed in the Flow Bypass Alternative and of Lock that will be Modified in the CAWS Buffer Zone Alternative



The Flow Bypass Alternative (i.e., the Mid-System Technology Control Without a Buffer Zone Alternative), includes two new locks with treated water, shown in **Figure 7**, in the general area of the natural divide of the Great Lakes and Mississippi River Basins. These locks would remain closed and empty until a vessel approached. When a vessel approaches, the treated water would be pumped into the lock from a nearby water treatment facility to ensure the water would be clear of ANS. To ensure that ANS would not be able to bypass the technology locations during a flood event, FRM mitigation is required to detain the storm water to maintain operation capacity of the Flow Bypass Technologies. Navigation throughout the system would be maintained, but the pumping of the treated water means that there would be delays compared to current conditions to allow for the lock chamber to be completely filled for each lockage.

The CAWS Buffer Zone alternative, also known as the Technology Alternative with Buffer Zone proposes modifications to the Chicago and T.J. O'Brien Locks to eliminate the direct transfer of water from Lake Michigan to the CAWS. The modifications would include a specialized filling and emptying system along with an electric barrier at the entrance of the lock. Brandon Road Lock and Dam would also be altered to include an electric barrier and ensure positive flow at the downstream entrance of lock. For commercial cargo navigation, the modifications proposed in CAWS Buffer Zone alternative would likely increase costs due to delays caused by slower lock processing times.

Lakefront and Mid-System Hydro-Separation Alternatives - Complete

According to ANS control documentation, hydrologic separation can be described in the following manner:

> "Hydrologic separation is the use of physical means to permanently separate two or more connected watersheds to prevent the mixing of all untreated surface waters between the watersheds. The design of the physical barrier would have to account for site-specific conditions and generally, would consist of a physical blockage constructed in a channel, river, lake, or wetland and possibly auxiliary structures outside of the water body. The structure would be designed to prevent the mixing of untreated water from disconnected watersheds." [10]

For commercial cargo navigation, a hydrological separation means towboats and barges cannot move past certain points on the navigable waters of the CAWS. As shown in **Table 20**, two of the current alternatives, Lakefront Hydrologic Separation alternative and Mid-System Hydrologic Separation will block navigation by placing physical barriers on the Chicago Sanitary and Ship Canal (CSSC) and the Calumet Sag Channel.

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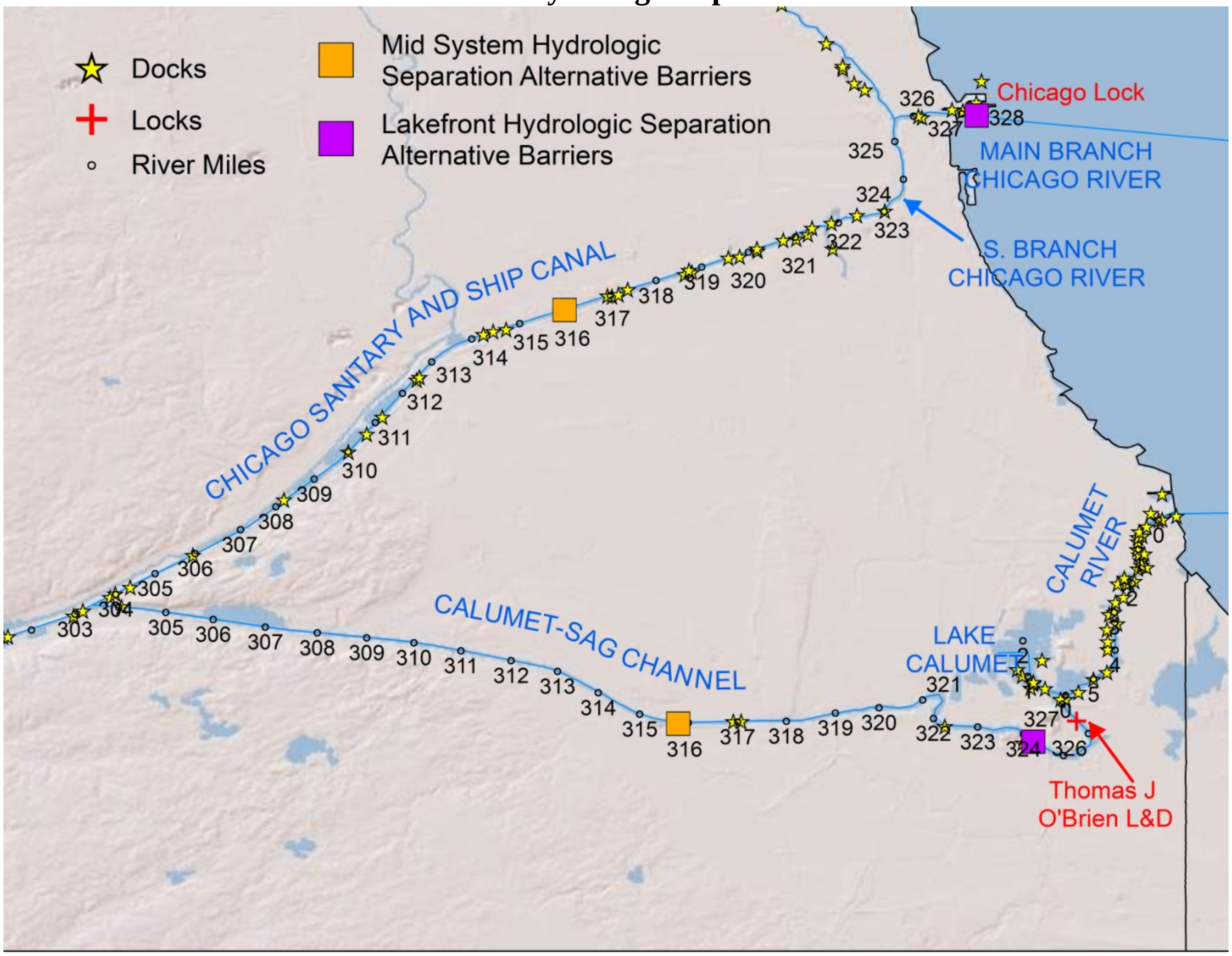
[10] USACE, 2012, "Hydrological Separation". Available at: http://glmris.anl.gov/documents/docs/anscontrol/HydrologicSeparation.pdf

Figure 8: Location of Barriers in Mid-System Hydrologic Separation Alternative and Lakefront Hydrologic Separation Alternative



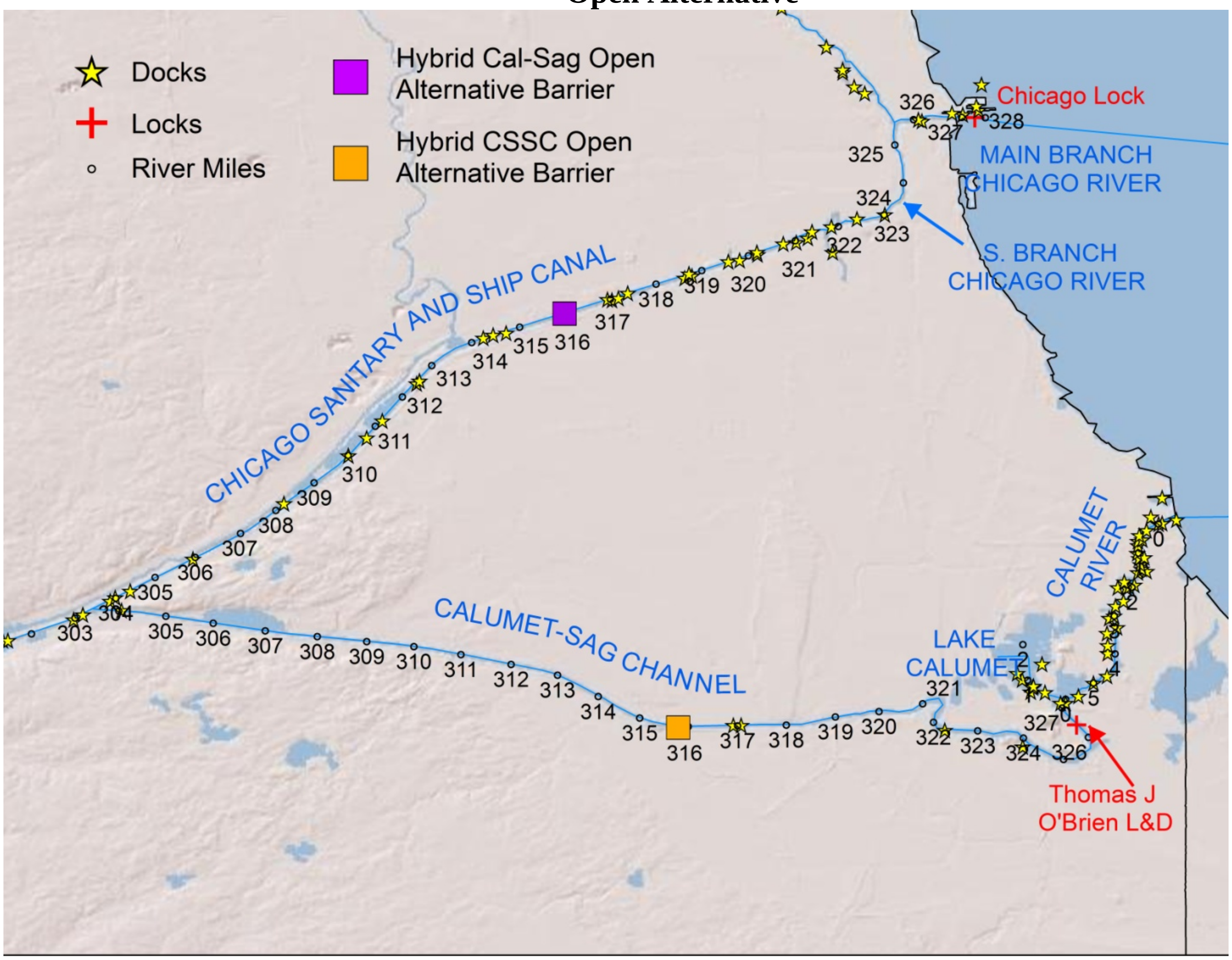
The Lakefront Hydrologic Separation Alternative aims to minimize the impacts to Lake Michigan water quality in relation to other hydrologic separation alternatives by placing the physical barriers generally in the area of the mixing areas of the CAWS outlets to Lake Michigan. This alternative includes four barrier locations, but only two locations, a barrier near Chicago Lock close to Michigan Avenue and a barrier at river mile 324.5 on the Cal-Sag Channel will impact navigation.

The Mid System Separation Alternative, minimizes the amount of flood risk management (FRM) mitigation necessary in the CAWS area in relation to other hydrologic separation alternatives by placing barriers in the area of the "historic" or "natural" divide between the Great Lakes and Mississippi River basin. As shown in **Figure 8**, there are two potential sites, one on the CSSC in Stickney, IL and one on the Cal-Sag Channel in Alsip, Illinois, for the barriers in the Mid System Separation Alternative.

CAWS Buffer Zone/ Technology Alternatives

Rather than completely separate the Great Lakes from the Mississippi River basin, several of the alternatives combine a single hydrological separation barrier with other ANS control technologies, such as carbon dioxide barriers, positive flows, and buffer zones. This means that navigation on only one of the navigable waters is hindered. As shown in **Table 20**, both the Mid-System Separation Cal-Sag Open Control Technologies with a Buffer Zone alternative and the Mid-System Separation CSSC Open Control Technologies with a Buffer Zone alternative proposed a single hydrological separation barrier on either the CSSC or the Cal-Sag Channel, respectively.

Figure 9: Location of Barriers in Hybrid Cal-Sag Open Alternative and Hybrid CSSC Open Alternative



The Mid-System Separation Cal-Sag Open Control Technologies with a Buffer Zone alternative, also known as the Hybrid Cal-Sag Open alternative, places a physical barrier at Stickney, IL on the CSSC as shown in **Figure 9**. The Hybrid Cal-Sag Open alternative also proposes modifications to T.J. O’Brien Lock to eliminate direct transfer of water. The modifications to T.J. O’Brien involve treating water used in the locking process to remove any possible ANS. The

Hybrid Cal-Sag Open alternative will have two impacts on the commercial cargo navigation industry. One impact would be that any commercial cargo movements past Stickney, Illinois on the CSSC would need to either move off the water or re-route onto Cal-Sag Channel and Lake Michigan. Another impact would be that the modifications to T.J. O'Brien Lock would likely delay any vessels transiting the locks.

The Mid-System Separation CSSC Open Control Technologies with a Buffer Zone alternative, also known as the Hybrid CSSC Open alternative, is very similar to the Hybrid Cal-Sag Open alternative except the CSSC remains open to navigation rather than the Cal-Sag Channel. The Hybrid CSSC Open alternative places the hydrological barrier in Alsip, Illinois on the Cal-Sag Channel. Furthermore, modifications are made to Chicago Lock to eliminate direct transfer of water. The types of impacts to navigation would be the same as would occur under Hybrid Cal-Sag Open alternative, but different commercial cargo movements would be affected.

Costs to Navigation[11]

One purpose for investing public funds in the waterborne navigation system is to generate economic benefits to the Nation. These benefits are called National Economic Development (NED) benefits because they represent resource cost savings in the transportation of freight commodities. Any change to the CAWS that affects navigation will impact the NED benefits. The degree of the change in NED benefits will depend on the ANS control technologies employed. Therefore, this FWP report discusses the types of cost imposed on the navigation industry by the alternative groups: complete hydrological separation group, partial hydrological separation group, and the other ANS technologies group.

The cost imposed by alternatives that prevent the movement of commodities on the CAWS is the elimination of the transportation rate savings.[12] Transportation rate savings can most easily be defined as the reduction in the economic cost of transporting freight over the waterway compared to transporting freight via land. If commodities are not able to move on the waterway, then shippers would switch to truck or rail, find alternative sources for input, sell their output in different markets, or shut down. Switching to an all overland mode of transportation would result in an increase in freight transportation costs.

Partial hydrological separation alternatives such as alternative Hybrid Cal-Sag Open Alternative and Hybrid CSSC Open Alternative would increase freight costs and reduce the transportation rate savings in a variety of forms. By blocking only one of the navigable waterways, the trip miles for many commodity movements would increase since shippers would have to transit Lake Michigan. The additional 19 miles or greater in distance means that costs for fuel, labor, and other resources would also increase. Forcing commodities to transit Lake Michigan also means that shippers would have to refleet since inland towboats are not designed to go out on the lake and lake towboats are too tall for the main branch of Chicago River. Though barges can go out on the lake, shippers would have to alter loading practices since the load limit is an average of 2

[11] This analysis focused on the costs to transportation rate savings and did not consider the potential benefits to waterway traffic. For example, the diversion of some waterway traffic to the next least expensive overland route would reduce delays on the waterway system. These benefits were not calculated due to difficulty of estimation.
[12] The U.S. Army Corps of Engineers, Planning Guidance Notebook, ER 1105-2-100, 22 April 2000, page 3-5.

ft of free board (top of water to deck) for inland waterways and an absolute of 3 ft of free board on Great Lakes. The requirement to refleet and the different loading practices mean additional steps in the transportation process and increased costs.

Alternatives that include ANS control technologies such as electric barriers or locks filled with treated water would allow for the movement of commodities on the CAWS, but they would still impose a cost. In the short run, the electric barrier and new locks would slow the transit time of commodities moving on the CAWS. A slower transit time means a higher transportation cost due to increased spending on fuel, labor, and other resources and a reduction in transportation rate savings. In the long run, the shippers could adjust to changes in the CAWS system, but since the capacity of the CAWS would be decreased, it is possible that delays would still occur.

Method

Identification of Impacted Tonnage and Costs

Model

The Commercial Cargo Tool (CCT) combines SQL Server and Excel to pull data from USACE databases, to identify the commercial cargo movements affected by each of proposed ANS alternatives, to estimate the potential changes in rate savings caused by the alternatives, and to create tables for presentation. The CCT relies on historical movement data from the WCSC TOWS database, projected movement data through year 2020 from the PCXIN, and cost and rate data from the University of Tennessee, Center for Transportation Research (CTR) study. The output of the CCT was the tonnage affected by the alternative and the loss in transportation rate savings (i.e. increase in costs) that occurred with each alternative.

Data Sources

The following data sources were used to analyze the impact of the ANS alternatives:

1. Waterborne Commerce Statistics TOWS database – The Waterborne Commerce Statistics Center (WCSC), under the authority of the Rivers & Harbors Act of 1922, collects confidential monthly reports submitted by individual towing companies (USACE NDC "WCSC Mission", 2012). These reports contain information on the dock-to-dock movements of commodities being transported on the waterways including the type and tonnage of the commodities. For the analysis of the alternatives, the key information is data on the origin of a movement, destination of a movement, the route taken between the origin and destination points, and the commodity type and tonnage involved with the movement.

2. CAWS Forecasted Tonnage – To calculate the cost to future years of ANS alternatives, the CCT relies on tonnage projections through year 2020. The development of these projections was done by the Planning Center of Expertise for Inland Navigation (PCXIN) and is discussed in the Future Without Project of the report entitled "Creation of Traffic Projections".

3. The University of Tennessee, Center for Transportation Research (CTR) survey - The CTR conducted a transportation rate analysis of current commodity movements routed on

Chicago Area Waterways (CAWS). This transportation analysis was prepared under contract with the USACE Planning Center of Expertise for Inland Navigation (PCXIN) and is documented in a separate section of this report (*Appendix 1: Transportation Rate and Social Cost Analysis: Chicago Area Waterway System*). CTR estimated transportation costs from ultimate origin to ultimate destination by the current water routing and by the least cost alternative land routing. The differential between water route and least cost alternative routing is the transportation rate savings – a metric specific to each CAWS movement analyzed by the CTR. All costs were accumulated for each routing. These separable costs included as appropriate: loading at the origin, drayage (truck) costs to linehaul terminal (river for the water route and inland rail for the overland route), transfer to linehaul mode costs, linehaul costs (barge costs for the waterway route and rail for the overland route), transfer to truck, drayage cost, and unloading costs at final destination. Not all moves involved all of these cost components, and least cost alternative modes relying on truck did not incur transfer costs. These movement-specific costs and the estimated transportation rate savings are used in calculations performed in the CCT.

4. Lock Performance Monitoring System - The Lock Performance Monitoring System (LPMS) consist of data collected at most Corps-owned and/or Corps-operated locks. Data is collected at each lock and electronically transmitted to the central database, which is managed and distributed by National Data Center (NDC). The data, from years 1980 to present, includes the number of vessels and barges locked, type and dates of lockages, durations of, and causes for, periods of lock unavailability, barge type, size, and commodity type, and tonnages carried (NDC "LPMS" 2012). This analysis of ANS alternatives utilized LPMS data on number and timing of lockages in the CAWS.

5. The Shallow-Draft/Inland Vessel Operating Cost (SDIVOC) Report – In 2006, Informa Economics conducted a survey of inland barge operators designed to capture the costs associated with the operation of towboats and barges. The results of the survey were presented in an internal USACE report and provide estimates for operating costs for various vessel types**.** The vessel operating costs from this report were combined with LPMS data to generate lock delay costs.

Calculations

The steps followed by the CCT depend on the type of hydrological separation proposed within the alternative. As shown in Table 20, the alternatives either proposed no hydrological separation, partial hydrological separation where only one branch is closed off to navigation, or a complete hydrological separation where both branches are shut off from navigation.

(1) Alternatives With No Hydrological Separation

Since the construction of new locks such (Flow Bypass Alternative) or by modifications to current locks (CAWS Buffer Zone Alternative) would likely only delay commercial cargo traffic and not prevent it, then the cost imposed on navigation of these alternatives equals the cost of being delayed by the technologies. Calculation of the delay costs was done using the following steps:

1. Identify the movements affected by the technologies - The CCT identified the commodity movements that travel past the technology locations proposed in Flow Bypass Alternative and CAWS Buffer Zone Alternative.

2. Identify a representative lock for statistics –
   - *The Flow Bypass Alternative* – This alternative proposes new locks, so estimates need to be made regarding the average transit time for the locks, average tons per tow through the locks, and delay costs at the locks. The statistics for Thomas J. O'Brien Lock were chosen because its height differential and tonnage levels are comparable to those likely experienced by the proposed technology sites for the Flow Bypass Alternative.
   - *The CAWS Buffer Zone Alternative* – This alternative proposes modifications to Chicago Lock and Thomas J O'Brien Lock, so the statistics for the respective locks was used in calculations.

3. Convert national delay costs – The national lock delay costs from the PCXIN are in dollars per hour. To estimate the potential delay cost for the tonnage moving past the proposed sites in an alternative, the delay costs need to be converted from dollars per hour into dollars per ton. The delay costs were converted using the following equation
   - $\text{Avg Delay Costs } (\$\ ton^{-1}) = \left[\frac{\text{Avg Delay Cost } (\$\ hr^{-1}) * \text{Avg Transit Time } (hrs\ tow^{-1})}{\text{Avg Tons Per Tow } (tons\ tow^{-1})}\right]$
   - *Average Delay Costs* ($\$\ hr^{-1}$) - A list of national lock delay costs ($ per hour) was obtained from the USACE Planning Center of Expertise for Inland Navigation (PCXIN). The 2005 to 2011 delay costs for Thomas J. Obrien Lock were averaged to create a single value.
     - The national lock delay costs are calculated by combining LPMS equipment distribution and timing data with vessel operating cost equations from the IWR / Informa (2006) report entitled "The Shallow-Draft/Inland Vessel Operating Cost (SDIVOC) Report". Inputs into the vessel operating cost equations include fuel costs, horsepower, crew size, and others. Annual the vessel operating cost equations are brought to current dollar levels by updating inputs such as fuel costs.
   - *Average Transit Time* - At the time of analysis, the impact of the technologies proposed in the Flow Bypass Alternative and CAWS Buffer Zone Alternative was unknown, so a proxy was need for the time to transit the alternative technologies. The annual transit times for Thomas J O'Brien Lock (hours per tow) was obtained from the LPMS. The 2005 to 2011 transit times were averaged to create a single value.
     - Some of these transiting times are shown in "**Table 16: Average Processing, Delay, and Transit Times for Tows at Brandon Road, Lockport, O'Brien, and Chicago for Select Years**".
   - *Average tons per tow* - The annual average tonnage per tow for Thomas J O'Brien Lock was obtained from the LPMS. The 2005 to 2011 tonnage per tow were averaged to create a single value.

- Some of these tons per tow values are shown in "**Table 12: Tonnage, Barge Counts, and Number of Tows Transiting Brandon Road, Lockport, O'Brien, and Chicago Locks**".

4. Calculate total cost for all tonnage – For each alternative, the tonnage identified by the CCT as being impacted by either Flow Bypass Alternative or CAWS Buffer Zone Alternative is multiplied by the average delay cost in dollars per ton. This gives an annual total cost in dollars for the alternative

(2) Alternatives With Incomplete Hydrological Separation

Another set of alternatives (Hybrid Cal-Sag Open Alternative and Hybrid CSSC Open Alternative) propose placing a hydrological separation barrier on either the Chicago Sanitary and Ship Canal (CSSC) or the Cal-Sag Channel. Analyzing different locations for the placement of the single barrier necessitated the use of the CCT because it relies on more detailed WCSC data. For analysis of the single-point barriers, the CCT performs three separate operations: 1) calculating costs stemming from any additional mileage travelled along a new water route, 2) capturing changes in tow characteristics on a new water route,[13] and 3) calculating the adjusted rate savings and resulting diverted tonnage, if any.

(a) Additional Mileage Costs

This operation involves calculating additional water line haul costs due to any additional mileage resulting from a waterway re-routing.[14] A number of steps are involved in this calculation.

Step 1 - Each movement's **waterway line haul cost per tonmile** was calculated by taking the total waterway line haul cost for the movement and dividing it by the product of each movement's tonmiles (the product of each movement's tonnage and total current waterway miles).

Step 2 – Each movement's **adjusted mileage** was calculated, based on the impact of any necessary re-routing on the CAWS. The adjusted miles were dependent upon the barrier location and the original route used. For example, if a movement that normally traversed the CSSC could no longer do so due to a proposed barrier on the CSSC, the movement would be re-routed to the Cal Sag Channel and Calumet Harbor/River. The adjusted miles were calculated as original trip mileage plus (or minus) the difference between the re-routed CAWS mileage minus the original CAWS mileage. The CAWS mileage for re-routed and original routes were calculated using the total waterway miles found in the TOWS database:

[13] Tow sizes are generally restricted to 1 barge tows on the CSSC and 3 barge tows on the Cal-Sag. Additionally, tows using the Chicago River must use retractable pilot house towboats. The higher operating costs for moves on the western arm of the CAWS is reflected by using a $1.00 per ton surcharge on moves switching to this route.
[14] All other costs associated with the total Waterway Rate (e.i. transfer costs) are not recalculated, only the waterway line haul cost.

CAWS Waterway Name	Miles
Cal Sag Channel	24
Lake Calumet	2
Calumet Harbor/River	6
Chicago Sanitary Ship Canal (CSSC)	18
Chicago River South Branch	5
Chicago Harbor/River	2
Lake Michigan[15]	12

Step 3 – The **adjusted waterway trip tonmiles** were calculated by multiplying each move's tons by the adjusted water miles.

Step 4 – The **adjusted total waterway line haul cost** were calculated by multiplying adjusted tonmiles by the waterway line haul cost per ton (from step 1). Any additional applicable surcharge will also be added to this total cost (surcharge rate multiplied by tonnage).

Step 5 – The **adjusted waterway line haul rate** was calculated by dividing the total adjusted waterway cost by the movement tonnage.

Step 6 – The **adjusted waterway rate** was calculated for each movement by adding the adjusted waterway line haul rate to all other costs associated with the total waterway rate (see footnote #2).

Step 7 – The **total adjusted waterway cost** was calculated by multiplying the adjusted waterway rate by the tonnage for each movement.

(b) Tow Characteristics

Tow sizes are generally restricted to 1 barge tows on the CSSC and 3 barge tows on the Cal-Sag. Additionally, tows using the Chicago River must use retractable pilot house towboats. The higher operating costs for moves on the CSSC and Chicago River are reflected by using a $1.00 per ton surcharge. [16] The surcharge was only applied to movements that were re-routed to the CSSC and where the original routing did not traverse any portion of the CSSC or Chicago River.

(c) Adjusted Waterway Rate Savings

This third and final operation accumulates both the mileage-related change in costs and the route characteristics change in costs to arrive at a total adjusted waterway cost. The difference between total adjusted waterway cost and the current waterway cost represents the economic impact of the incomplete separation on commercial cargo traffic. Movements with a negative adjusted rate savings per ton (meaning the all-land rate is less than the adjusted water rate) are

[15] Several movements had to be re-routed onto Lake Michigan due to barrier locations, the estimated mileage between Lake Michigan via Chicago Harbor and Lake Michigan via Calumet Harbor was 12 miles.
[16] The total surcharge cost is added to the adjusted water way line haul cost, and is reflected in the adjusted waterway rate.

assumed to divert from the waterway, either by shifting to another mode/route or to another source. The existing rate savings for that movement represent the economic impact of the barrier.

(3) Method for Complete Separation Alternatives

The final group of analyzed alternatives, the Lakefront Hydrologic Separation Alternative and the Mid-System Hydrologic Separation Alternatives, propose completely separating the Mississippi River basin from the Great Lakes. This analysis assumes that complete hydrological separation results in all affected movements leaving the inland waterways, so all NED benefits are lost. This means that the cost of the alternative equals the transportation rate savings.
To calculate the cost for each alternative, the CCT followed several steps. First, the CCT identified the affected movements. Since the UT-CTR provided rate savings per ton estimates for each movement in their study, the CCT was able to calculate the total rate savings for a movement by simply multiplying the rate savings per ton by the movement tonnage. Next, the CCT estimated the total cost for an alternative by summing the total rate savings for all movements affected by an alternative. These estimates are presented in the Results section.

Identification of External Social Costs

For the social cost of a closure of CAWS please review entitled, "APPENDIX 2: EXTERNAL COSTS DUE TO AN UNANTICIPATED CLOSURE OF THE CHICAGO AREA WATERWAY SYSTEM TO WATERBORNE COMMERCE".

Results

Impact to Navigation Industry From ANS Control Technologies

The alternatives have been divided into groups based on the hydrological separation impact.

Flow-Bypass and CAWS Buffer Zone Alternatives

While the technology alternatives such as Flow Bypass Alternative and CAWS Buffer Zone Alternative will not block CAWS navigation, the proposed technologies will likely slow or delay commercial cargo movements. To account for the cost of commercial cargo traffic being slowed or delayed by the new locks recommended in the Flow Bypass Alternative or the modifications to current locks proposed in the CAWS Buffer Zone Alternative, this analysis relied on LPMS data and the SDIVOC Report to estimate the cost of delay.

(1) Flow Bypass Alternative

Since the new locks proposed in the Flow Bypass Alternative are in the same location as the physical barriers proposed for the Mid-System Hydrologic Separation Alternative, then the tonnage affected for the Flow Bypass Alternative is the same as the tonnage affected for the Mid-System Hydrologic Separation Alternative. The main commodity groups moving through these points are the coal group, the iron and steel group, and the aggregate group which account for an average of 69 percent of tonnage. A noticeable trend in **Table 21** is the 2.4 million ton decline in the coal commodity group between 2010 and 2012 due to the closure of two coal fired power plants within the region.

Table 21: Total Tonnage Affected by the Flow Bypass Alternative

	Thousand Tons by Commodity Group			
Commodity Group	**2010**	**2012**	**2017**	**2020**
Coal	3,774	2,780	1,365	1,365
Petroleum Fuels	680	684	741	738
Aggregates	984	2,533	2,533	2,533
Grains	412	528	573	602
Chemicals	272	265	265	265
Ore	622	741	778	739
Iron & Steel	1,447	2,068	2,532	2,859
All Others	789	883	762	813
Total Affected Tonnage	**8,979**	**10,481**	**9,549**	**9,913**

Though the tonnage affected for the Flow Bypass Alternative is the same as the tonnage affected for the Mid-System Hydrologic Separation Alternative, the costs are reduced. For the Mid-System Hydrologic Separation Alternative, the lost rate savings was an average of $232.5 million, but for the Flow Bypass Alternative, the delay costs average $0.73 million and range from $0.67 million in 2010 to $0.75 million in 2020. The reason for the difference is because the delay cost for a vessel is around $0.06 per ton, but the rate savings for a movement ranges between $9 per ton and $60 per ton. A noticeable trend in **Table 22** is that the main commodity groups affected by an increase in cost would be coal commodity group, the iron and steel commodity group, and the aggregate commodity group.

Table 22: Additional Costs for Movements Affected by the Flow Bypass Alternative

	Additional Costs (Thousand $) by Commodity Group			
Commodity Group	**2010**	**2012**	**2017**	**2020**
Coal	$ 284	$ 209	$ 103	$103
Petroleum Fuels	$ 51	$ 51	$ 56	$ 56
Aggregates	$ 74	$ 191	$ 191	$191
Grains	$ 31	$ 40	$ 43	$ 45
Chemicals	$ 20	$ 20	$ 20	$ 20
Ore	$ 47	$ 56	$ 59	$ 56
Iron & Steel	$ 109	$ 156	$ 191	$215
All Others	$ 59	$ 67	$ 57	$ 61
Total Affected Tonnage	**$ 676**	**$ 789**	**$ 719**	**$747**

(2) CAWS Buffer Zone Alternative

The CAWS Buffer Zone Alternative proposes modifications to Chicago Lock and Thomas J O'Brien Lock and Dam. The tonnage affected is close to the amount of tonnage affected by alternative Lakefront Hydrologic Separation Alternative which recommends hydrological separation near Chicago Lock and near Thomas J O’Brien Lock and Dam at river mile 324.5 on the Cal-Sag Channel. The main commodities passing through these points are coal, iron and steel, and asphalt which is part of the all other category. While the majority of the commodity tonnage levels remain constant into 2020, asphalt and iron and steel moving past these points are expected to increase by 517 thousand tons and 1.2 million tons, respectively.

Table 23: Total Tonnage Affected by the CAWS Buffer Zone Alternative

	Thousand Tons by Commodity Group			
Commodity Group	**2010**	**2012**	**2017**	**2020**
Coal	1,341	1,365	1,365	1,365
Petroleum Fuels	350	360	417	415
Aggregates	24	38	38	38
Grains	409	548	595	625
Chemicals	195	190	190	190
Ore	622	741	778	739
Iron & Steel	1,259	1,801	2,205	2,489
All Others	713	799	689	735
Total Affected Tonnage	**4,912**	**5,842**	**6,278**	**6,596**

The costs for CAWS Buffer Zone Alternative averaged $0.487 million and ranged from $0.370 million in 2010 to $0.497 million in 2020. As with the Flow Bypass Alternative, the costs for alternative CAWS Buffer Zone Alternative are comparatively a small percentage of the $191 million loss in transportation rate savings that occurs for the Lakefront Hydrologic Separation Alternative. The reason for the difference between the cost for alternative CAWS Buffer Zone Alternative and the cost of Lakefront Hydrologic Separation Alternative is because the alternative CAWS Buffer Zone Alternative only causes delays while alternative Lakefront Hydrologic Separation Alternative causes commodity movements to leave the inland waterway system. The delay cost for a vessel is around $0.08 per ton, but the lost rate savings range between $9 per ton and $60 per ton. Since delay costs do not differ by commodity type, the commodity groups experiencing the largest cost increase from the CAWS Buffer Zone Alternative would be the commodity groups with the greatest affected tonnage, the iron and steel commodity group and the coal commodity group.

Table 24: Additional Costs For Movements Affected by the CAWS Buffer Zone Alternative

	Additional Costs (Thousand $) by Commodity Group			
Commodity Group	**2010**	**2012**	**2017**	**2020**
Coal	$ 101	$ 103	$ 103	$ 103
Petroleum Fuels	$ 26	$ 26	$ 30	$ 30
Aggregates	$ 2	$ 3	$ 3	$ 3
Grains	$ 31	$ 40	$ 44	$ 46
Chemicals	$ 15	$ 14	$ 14	$ 14
Ore	$ 47	$ 56	$ 59	$ 56
Iron & Steel	$ 95	$ 135	$ 166	$ 187
All Others	$ 54	$ 60	$ 52	$ 55
Total Affected Tonnage	**$ 370**	**$ 440**	**$ 473**	**$ 497**

Hydrologic Separation Alternatives – Complete

For the complete hydrologic separation alternatives, all affected tonnage was assumed to move off of the waterway. With this assumption, the cost of each alternative that proposes hydrologic separation is simply equal to the complete transportation savings. Therefore, the costs presented for the following alternatives represent the complete transportation savings.

(1) Lakefront Hydrologic Separation Alternative

Lakefront Hydrologic Separation Alternative implements a complete hydrological separation by putting physical barriers near Chicago Lock close to Michigan Avenue and a barrier at river mile 324.5 on the Cal-Sag Channel will impact navigation. The tonnage affected, shown in **Table 25,** is any movement that passes through Chicago Lock or through RM 324.5 on the Cal-Sag Channel. The main commodities passing through these points are coal, iron and steel, and asphalt which is part of the all other category. While the majority of the commodity tonnage levels remain constant into 2020, iron and steel moving past these points are expected to increase by 97%.

Table 25: Tonnage Affected by the Lakefront HydrologicSeparation Alternative

	Thousand Tons by Commodity Group			
Commodity Group	**2010**	**2012**	**2017**	**2020**
Coal	1,341	1,365	1,365	1,365
Petroleum Fuels	350	360	417	415
Aggregates	24	38	38	38
Grains	409	524	569	597
Chemicals	195	190	190	190
Ore	622	741	778	739
Iron & Steel	1,259	1,801	2,205	2,489
All Others	713	799	689	735
Total Affected Tonnage	**4,912**	**5,818**	**6,252**	**6,569**

The iron and steel commodity group and all other commodity group have at least a $10 per ton higher rate savings than the coal commodity group. This higher per ton rate savings means that despite the coal commodity group having the greatest amount of tonnage impacted in 2010 by the Lakefront Hydrologic Alternative, the all other group including asphalt and the iron and steel group would experience the greatest loss in 2010 from implementation of the Lakefront Hydrologic Alternative, as shown in **Table 26**.

Table 26: Lost Rate Savings That Occurs From the Lakefront HydrologicSeparation Alternative

	Lost Rate Savings (Thousand $) by Commodity Group			
Commodity Group	**2010**	**2012**	**2017**	**2020**
Coal	$ 22,512	$ 22,924	$ 22,924	$ 22,924
Petroleum Fuels	$ 5,469	$ 5,444	$ 8,467	$ 8,476
Aggregates	$ 1,066	$ 1,650	$ 1,650	$ 1,650
Grains	$ 10,955	$ 13,626	$ 14,788	$ 15,532
Chemicals	$ 6,520	$ 6,398	$ 6,398	$ 6,398
Ore	$ 22,468	$ 26,787	$ 28,132	$ 26,712
Iron & Steel	$ 38,656	$ 55,055	$ 67,402	$ 76,103
All Others	$ 51,983	$ 58,113	$ 50,154	$ 53,490
Total Loss of Rate Savings	**$ 159,629**	**$ 189,996**	**$199,914**	**$ 211,285**

(2) Mid–System Hydrologic Separation Alternative

Similar to the Lakefront Hydrologic Separation Alternative, the Mid-System Hydrologic Separation Alternative proposed complete hydrological separation with two physical barriers.

However, this alternative moves the barriers away from Lake Michigan to Stickney, Illinois on the Chicago Sanitary and Ship Canal (CSSC) and Alsip, Illinois on the Cal-Sag Channel. These points are near the natural divide between the Great Lakes and Mississippi River basin. The main commodity groups moving through these points are the coal group, the iron and steel group, and the aggregate group, which account for an average of 64 percent of tonnage. A noticeable trend in **Table 27** is the 63 percent decline in the coal commodity group between 2010 and 2012. This is attributed to the closures of Midwest Generation's Crawford and Fisk power plants.

Table 27: Tonnage Affected by the Mid-System HydrologicSeparation Alternative

	Thousand Tons by Commodity Group			
Commodity Group	**2010**	**2012**	**2017**	**2020**
Coal	3,774	2,780	1,365	1,365
Petroleum Fuels	680	684	741	738
Aggregates	984	2,533	2,533	2,533
Grains	412	528	573	602
Chemicals	272	265	265	265
Ore	622	741	778	739
Iron & Steel	1,447	2,068	2,532	2,859
All Others	789	883	762	813
Total Affected Tonnage	**8,979**	**10,481**	**9,549**	**9,913**

As shown in **Table 28,** the commodity groups with the most to lose in 2010 from implementation of the Mid-System Hydrologic Separation Alternative are the all other commodity group and the iron and steel commodity group. An average of $232.5 million in rate savings will be lost every year with the implementation of Mid-System Hydrologic Separation Alternative. The industry with the greatest loss in transportation rate savings would be the iron and steel industry.

Table 28: Lost Rate Savings That Occurs From the Mid-System HydrologicSeparation Alternative

	Lost Rate Savings (Thousand $) by Commodity Group			
Commodity Group	**2010**	**2012**	**2017**	**2020**
Coal	$ 40,739	$ 33,010	$ 22,924	$ 22,924
Petroleum Fuels	$ 13,023	$ 12,847	$ 15,870	$ 15,879
Aggregates	$ 7,192	$ 17,373	$ 17,373	$ 17,373
Grains	$ 11,066	$ 13,759	$ 14,932	$ 15,684
Chemicals	$ 10,795	$ 10,535	$ 10,535	$ 10,535
Ore	$ 22,468	$ 26,787	$ 28,132	$ 26,712
Iron & Steel	$ 43,881	$ 62,478	$ 76,490	$ 86,364
All Others	$ 54,085	$ 60,452	$ 52,173	$ 55,643
Total Loss of Rate Savings	**$203,248**	**$237,241**	**$238,430**	**$251,115**

CAWS Buffer Zone/ Technology Alternatives

For the partial hydro-separation alternatives, all commodity movements affected by the barrier are assumed to move around the barrier. This assumption means that the complete transportation savings were not lost. However, it also means that the commodities must travel additional miles around the barrier, so the additional cost need to be calculated. These additional costs are in the form of additional fuel, labor, and other resources required to travel the extra miles. It should also be noted that re-routing of some movements resulted in the movement traveling a shorter more direct route. A number of reasons exist why a shipper would travel a slightly longer distance than necessary, but rather than speculate on the reasons, this analysis focused on net difference between the original route and the new route. Focusing on the net difference means that a switch to a shorter route resulted in negative costs.

(1) Hybrid Cal-Sag Open Alternative

Similar to Mid-System Hydrologic Separation Alternative, the Hybrid Cal-Sag Open Alternative places a barrier at Stickney, Illinois on the CSSC. However, the Hybrid Cal-Sag Open Alternative differs because the Cal-Sag Channel is left open to navigation. Leaving one navigable waterway open decreases the amount of affected tonnage. While Mid-System Hydrologic Separation Alternative would impact an average of approximately 9.7 million tons per year, the Hybrid Cal-Sag Open Alternative affects only an approximate average of 3.8 million tons per year. The two main commodity groups moving on this section on the CSSC are the coal group and the aggregates group. The noticeable trends shown in **Table 29** are the elimination of coal movements between 2012 and 2017, and the increase in aggregates between 2010 and 2012. The reduction in coal tonnage is due to the closure of the Crawford and Fisk power plants and the increase in aggregates is based on information gained when projecting tonnage for the CAWS.

Table 29: Tonnage Re-routed by the Hybrid Cal-Sag Open Alternative

	Thousand Tons by Commodity Group			
Commodity Group	**2010**	**2012**	**2017**	**2020**
Coal	2,433	1,415	0	0
Petroleum Fuels	335	345	351	348
Aggregates	958	2,492	2,492	2,492
Grains	3	34	37	39
Chemicals	50	49	49	49
Ore	0	0	0	0
Iron & Steel	193	287	351	396
All Others	76	89	77	82
Total Affected Tonnage	**4,047**	**4,712**	**3,358**	**3,408**

As shown in

Table 30, a barrier in Stickney, Illinois on the CSSC would increase costs by over $11.6 million for the first few years, but the elimination of the coal movements to Crawford and Fisk would reduce the additional costs to $7.3 million by 2017. Also noticeable in

Table 30 is the fact that the iron and steel commodity group, along with all other commodity group, experience reduction in cost. The commodity group that would experience the largest increase in cost from Hybrid Cal-Sag Open Alternative is the aggregate commodity group.

It should also be noted that re-routing of some movements resulted in the movement traveling a shorter more direct route. A number of reasons exist why a shipper would travel a slightly longer distance than necessary, but rather than speculate on the reasons, this analysis focused on net difference between the original route and the new route. Focusing on the net difference means that a switch to a shorter route resulted in negative costs.

Table 30: Additional Costs for Re-Routed Movements Affected by the Hybrid Cal-Sag Open Alternative

	Additional Costs (Thousand $) by Commodity Group			
Commodity Group	**2010**	**2012**	**2017**	**2020**
Coal	$ 8,429	$ 5,642	$ -	$ -
Petroleum Fuels	$ 518	$ 532	$ 543	$ 538
Aggregates	$ 2,586	$ 6,785	$ 6,785	$ 6,785
Grains	$ 2	$ (81)	$ (88)	$ (92)
Chemicals	$ 52	$ 50	$ 50	$ 50
Ore	$ -	$ -	$ -	$ -
Iron & Steel	$ (28)	$ (44)	$ (54)	$ (61)
All Others	$ 33	$ 36	$ 31	$ 33
Total Loss of Rate Savings	**$11,592**	**$12,920**	**$ 7,267**	**$ 7,253**

**negative numbers represent a gain in rate savings*

(2) Hybrid CSSC Open Alternative

The Hybrid CSSC Open Alternative places a hydrological barrier in Alsip, Illinois on the Cal-Sag Channel and leaves the CSSC open to navigation. However, any traffic re-routed from the Cal-Sag Channel to the CSSC may have to reduce the tow size because the CSSC offers a narrower channel. Therefore, the cost calculations for movements affected by Hybrid CSSC Open Alternative equaled the cost of the additional miles plus an additional $1.00 per ton charge for reduction in tow size. The $1.00 per ton charge was arrived upon based on conversations with the University of Tennessee, Center for Transportation Research (UTK-CTR).The additional costs for each commodity group are shown in *Commercial Cargo Report Appendix 1: Transportation Rate and Social Cost Analysis: Chicago Area Waterway System*. If the additional costs for a movement ended up being greater than the rate savings, then the movement was diverted off the water and the entire transportation rate savings was lost. The tonnage diverted off the CAWS because additional costs became greater than the rate savings is shown in **Table 31**. The sum of the tonnage in **Table 31** and **Table 32** equals the total tonnage affected by Hybrid CSSC Open Alternative. The total tonnage is presented in **Table 33**.

Table 31: Tonnage Re-Routed by the Hybrid CSSC Open Alternative

	Thousand Tons by Commodity Group for Re-Routed Movements			
Commodity Group	**2010**	**2012**	**2017**	**2020**
Coal	1,301	1,325	1,325	1,325
Petroleum Fuels	409	401	453	453
Aggregates	26	40	40	40
Grains	404	512	556	584
Chemicals	224	216	216	216
Ore	622	741	778	739
Iron & Steel	1,221	1,735	2,124	2,398
All Others	639	711	614	655
Total Affected Tonnage	**4,845**	**5,682**	**6,106**	**6,410**

Table 32: Tonnage Diverted off the CAWS by the Hybrid CSSC Open Alternative

	Thousand Tons by Commodity Group for Diverted Movements			
Commodity Group	**2010**	**2012**	**2017**	**2020**
Coal	40	41	41	41
Petroleum Fuels	NA	NA	NA	NA
Aggregates	NA	NA	NA	NA
Grains	5	6	6	6
Chemicals	NA	NA	NA	NA
Ore	NA	NA	NA	NA
Iron & Steel	37	53	65	73
All Others	74	83	71	76
Total Affected Tonnage	**156**	**182**	**183**	**196**

Table 33: Total Tonnage Affected by the Hybrid CSSC Open Alternative

	Thousand Tons by Commodity Group			
Commodity Group	2010	2012	2017	2020
Coal	1,341	1,365	1,365	1,365
Petroleum Fuels	409	401	453	453
Aggregates	26	40	40	40
Grains	409	518	562	590
Chemicals	224	216	216	216
Ore	622	741	778	739
Iron & Steel	1,259	1,788	2,189	2,472
All Others	713	794	685	731
Total Affected Tonnage	**5,002**	**5,864**	**6,289**	**6,606**

While **Table 34** shows the cost of the additional net miles plus an additional $1.00 per ton charge for reduction in tow size for all the re-routed movements, **Table 35** presents the loss in transportation rate savings for all movements that were diverted off the CAWS. Combining the values in **Table 34** and **Table 35** provides the total cost for the Hybrid CSSC Open Alternative that is shown in **Table 36**.

As seen in **Table 36**, the commodity groups that would experience the largest decrease in rate savings would be coal commodity group, ore commodity group, and the iron and steel commodity group. As with Hybrid Cal-Sag Open Alternative, the all other commodity group experience a reduction in costs.

Table 34: Additional Costs for Movements Re-Routed Around the Hybrid CSSC Open Alternative

	Additional Costs (Thousand $) by Commodity Group for Re-Routed Movements			
Commodity Group	2010	2012	2017	2020
Coal	$ 1,908	$ 1,943	$ 1,943	$ 1,943
Petroleum Fuels	$ 376	$ 369	$ 439	$ 439
Aggregates	$ 34	$ 53	$ 53	$ 53
Grains	$ 481	$ 533	$ 579	$ 608
Chemicals	$ 366	$ 354	$ 354	$ 354
Ore	$ 1,549	$ 1,847	$ 1,939	$ 1,842
Iron & Steel	$ 1,370	$ 1,947	$ 2,384	$ 2,691
All Others	$ 764	$ 850	$ 733	$ 782
Total Loss of Rate Savings	**$ 6,849**	**$ 7,896**	**$ 8,424**	**$ 8,712**

**negative numbers represent a gain in rate savings*

Table 35: Lost Rate Savings for Movements Diverted Off the CAWS by the Hybrid CSSC Open Alternative

	Lost Rate Savings (Thousand $) by Commodity Group for Diverted Movements			
Commodity Group	**2010**	**2012**	**2017**	**2020**
Coal	$ 7	$ 7	$ 7	$ 7
Petroleum Fuels	NA	NA	NA	NA
Aggregates	NA	NA	NA	NA
Grains	$ 3	$ 3	$ 4	$ 4
Chemicals	NA	NA	NA	NA
Ore	NA	NA	NA	NA
Iron & Steel	$ 21	$ 30	$ 37	$ 42
All Others	$ 24	$ 27	$ 24	$ 25
Total Loss of Rate Savings	**$ 55**	**$ 68**	**$ 71**	**$ 78**

**negative numbers represent a gain in rate savings*

Table 36: Total in Lost Rate Savings and Additional Costs for Movements Affected by the Hybrid CSSC Open Alternative

	Total in Additional Costs and Lost Rate Savings (Thousand $) by Commodity Group			
Commodity Group	**2010**	**2012**	**2017**	**2020**
Coal	$ 1,915	$ 1,950	$ 1,950	$ 1,950
Petroleum Fuels	$ 376	$ 369	$ 439	$ 439
Aggregates	$ 34	$ 53	$ 53	$ 53
Grains	$ 484	$ 536	$ 582	$ 611
Chemicals	$ 366	$ 354	$ 354	$ 354
Ore	$ 1,549	$ 1,847	$ 1,939	$ 1,842
Iron & Steel	$ 1,392	$ 1,977	$ 2,421	$ 2,733
All Others	$ 788	$ 877	$ 757	$ 807
Total Loss of Rate Savings	**$ 6,904**	**$ 7,963**	**$ 8,495**	**$ 8,789**

**negative numbers represent a gain in rate savings*

Comparison of Alternatives

The alternatives can be ranked by the tonnage affected as well as by the amount of lost rate savings. As expected, the alternatives recommending complete hydrological separation (Lakefront Hydrologic Separation and Mid-System Hydrologic Separation) have the greatest amount of affected tonnage and highest levels of lost rate savings. Since the new locks and lock modifications proposed in the Flow Bypass Alternative and CAWS Buffer Zone Alternative are in the same location as the complete hydrological separation alternative, then they will affect the same amount of tonnage as shown in **Table 37**. However, in **Table 38** the technology alternatives have the lowest increase in cost because the delay only increases operating costs rather than causing a complete loss of transportation rate savings. While the rate savings ranges between $9 per ton and $60 per ton, the operating cost for a vessel being processed by a lock processing is around $0.08 per ton.

Table 37: Ranking of Alternatives By Tonnage Affected in 2017

		Tonnage Affected (Thousand Tons)			
RANK	ALTERNATIVE	2010	2012	2017	2020
1	Mid System Hydrologic Separation	8,979	10,481	9,549	9,913
2	New Locks	8,979	10,481	9,549	9,913
3	Hybrid CSSC Open Alternative	5,002	5,864	6,289	6,606
4	CAWS Buffer Zone Alternative	4,912	5,842	6,278	6,596
5	Lakefront Complete Hydrologic	4,912	5,818	6,252	6,569
6	Hybrid Cal-Sag Open Alternative	4,047	4,712	3,358	3,408

Table 38: Ranking of Alternatives By Lost Transportation Rate Savings in 2017

		Lost Rate Savings (Thousand Dollars)			
RANK	ALTERNATIVE	2010	2012	2017	2020
1	Mid System Hydrologic Separation	$203,248	$237,241	$238,430	$251,115
2	Lakefront Complete Hydrologic	$159,629	$189,996	$199,914	$211,285
3	Hybrid CSSC Open Alternative	$ 6,904	$ 7,963	$ 8,495	$ 8,789
4	Hybrid Cal-Sag Open Alternative	$ 11,592	$ 12,920	$ 7,267	$ 7,253
5	Flow Bypass Alternative	$ 676	$ 789	$ 719	$ 747
6	CAWS Buffer Zone Alternative	$ 370	$ 440	$ 473	$ 497

Social Cost of Externalities

For the social cost of a closure of CAWS please review *Commercial Cargo Report Appendix 2: External Costs Due to an Unanticipated Closure of the Chicago Area Waterway System to Waterborne Commerce*.

Analysis of Potential Mitigation Measures

Since the complete hydrologic separation alternatives would prevent navigation on the CAWS, mitigation measures to potentially offset the impact to CAWS commercial cargo industry have been discussed. The two main suggested measures are a transloading facility and a multimodal facility.

Transloading Facility

(1) Definition of Transloading Facility

For this analysis, a transloading facility is defined as facility where the commodity remains on the waterway by having either the barge itself or the commodity within the barge being transferred across the barrier. A report prepared by HDR, Inc. for the Great Lakes Commission, *Evaluation of Physical Separation Alternative for the Great Lakes and Mississippi Basins in the Chicago Area Waterway System* offers conceptual drawings of two types of transloading facilities. One of these facilities would be placed on the South Branch Barrier while the other would be located at the Lake Calumet Port Terminal (see **Figure 10** and **Figure 11**).

Figure 10: Conceptual Rendering of South Branch Barrier

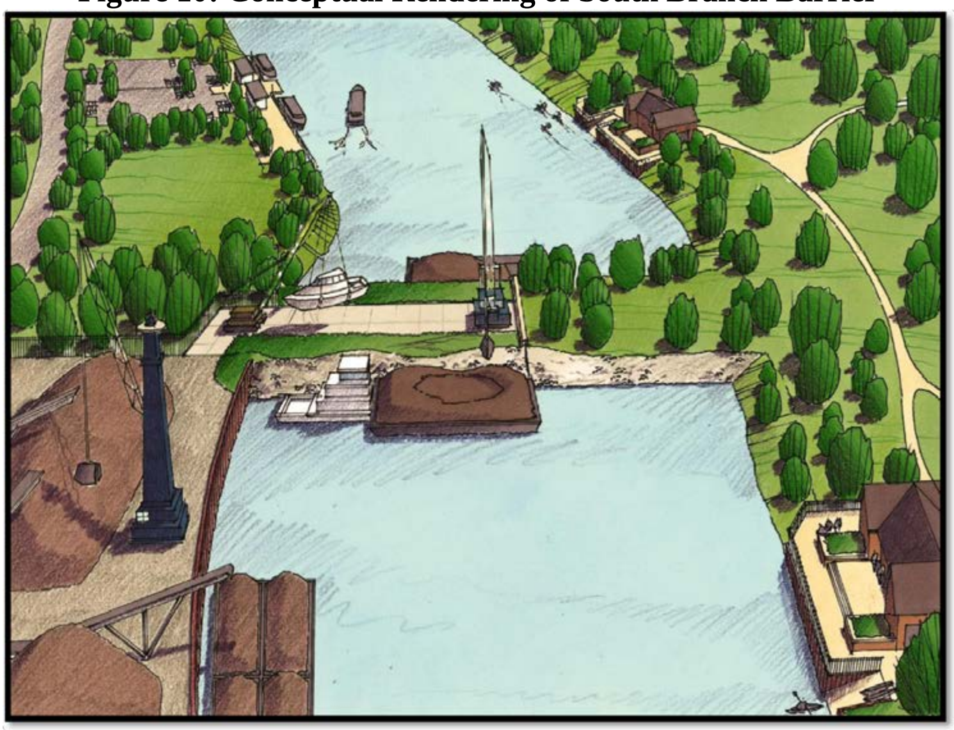
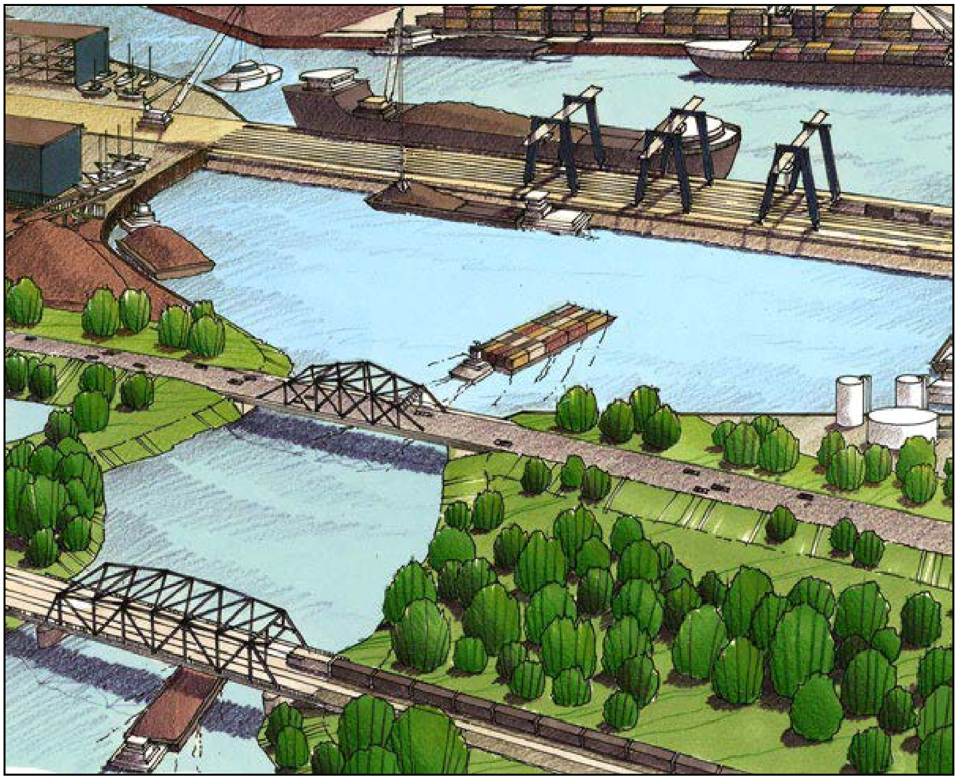


Figure 11: Conceptual Rendering of Lake Calumet Port Terminal



(2) Examples of Transloading Facility

(a) TVA Transshipment during Wheeler LD Closure

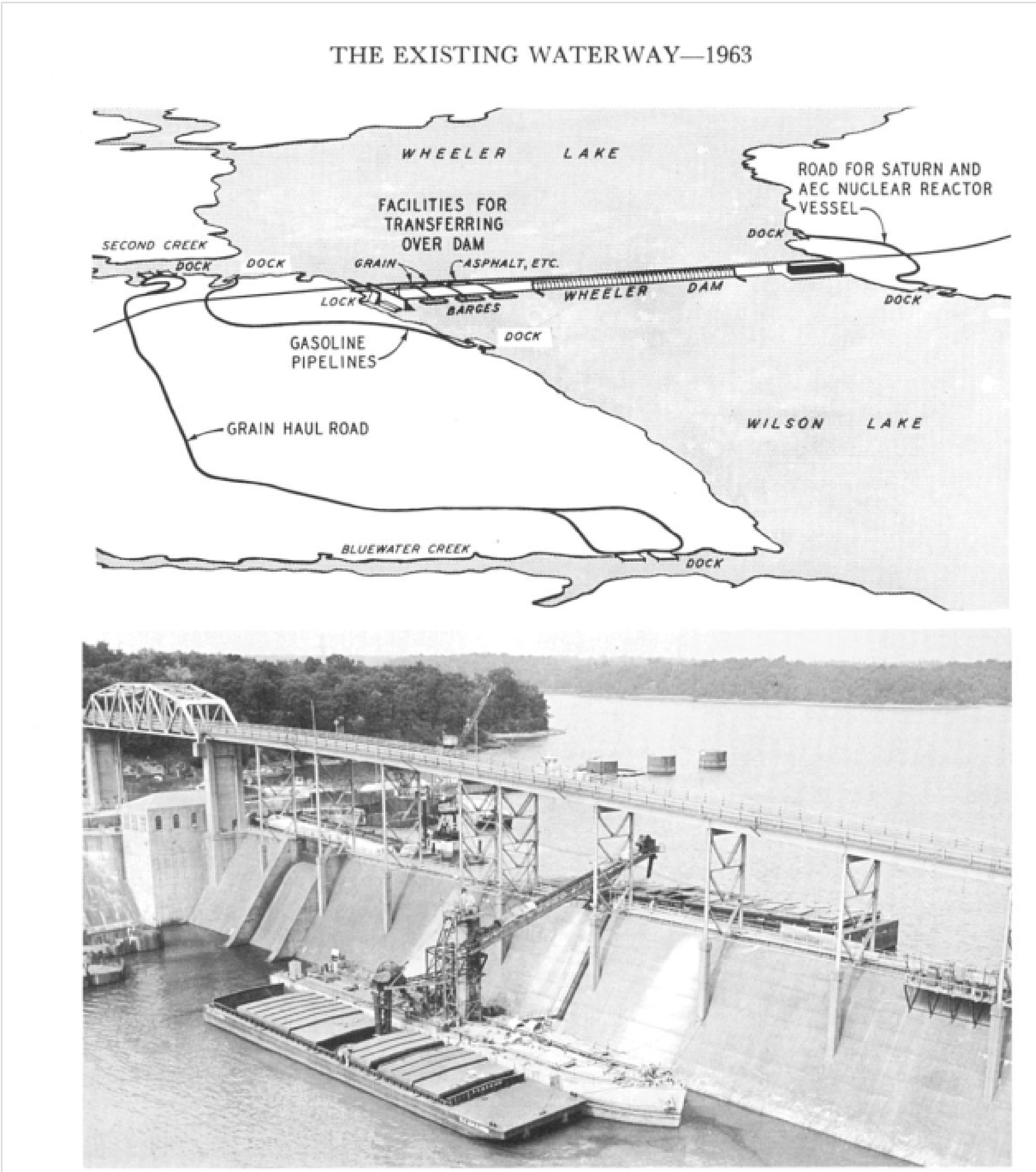
Alternatives utilizing conveyor systems for dry bulk commodities and pipelines for liquids might prove to be less costly and more efficient than the clam shell crane and pipeline/tank farm facility conceptualized by HDR. A failure of the lock chamber at Joseph A. Wheeler LD on the Tennessee River closed the project to barge traffic for 10.5 consecutive months in 1961/1962. The Tennessee Valley Authority (TVA) and affected towing companies took a number of measures to accomplish transshipment at the closed lock and dam (see **Figure 12**)[17]. Mooring cells and docks were installed at a number of locations above and below the dam. Haul roads were constructed to allow trucks to ferry grain around the dam, and pipelines were put in place to move petroleum fuels around the dam. In addition, elevating conveyors were used to carry grain over the dam, while pipelines crossed over the dam to carry asphalt, molasses, soybean oil, flour and chemicals. The tonnage transshipped by these means in 1961/1962 was roughly two thirds of the traffic that moved by barge during the same months of 1960/1961.

Transshipment alternatives like those employed by TVA and the towing companies during the Wheeler LD outage and proposed by HDR (the Down River and Midstream alternatives) require tow and barge fleets dedicated to working in the pools above these barriers. The Down River alternative requires operations similar to those in practice today - a specialized fleet operating

[17] See *The Tennessee River Navigation System, History, Development, and Operation*, Technical Report No.25, Tennessee Valley Authority, 1964.

above Lockport LD. The Midstream alternative would require two specialized fleets – one operating above Lockport and below the barriers and another operating above the barriers.

Figure 12: Transshipment measures employed during lock closure at Wheeler Lock and Dam



(b) TVA Transshipment during Wheeler LD Closure

The mechanical means for crossing dams or other water barriers are currently in use at a number of locations in North America, Europe, and Asia. Most, like the Falkirk wheel in Scotland and the Big Shute Marine Railway in Canada, are designed to handle recreational and smaller passenger vessels. Many are dry lift dams, like Canada's Big Shute Marine Railway, where no water is transferred with the vessel. In fact, the Big Shute Marine Railway lift was refurbished in favor of constructing a lock for recreation vessels as a means of preventing sea lampreys from entering Lake Simco by way of Ontario province's Trent-Severn Waterway.[18] Unlike these smaller boat lifts, those designed to handle the much larger commercial cargo vessels are wet lifts, meaning that water is transferred along with the vessel. Lifts designed to handle commercial cargo vessels, though, are small relative to typical commercial lock chambers. With dimensions of 110 meters in length or less and 11.4 meters in width or less, these wet boat lifts are capable of handling only one barge or one self-propelled vessel at a time with cargo capacity ranging from 1000 to 1350 metric tons. These lifts favor Europe's more prevalent self propelled vessels, which can process through the lift in one cycle versus two cycles for a tow and barge configuration, and 5 cycles for the typical 4 barge tows on the CAWS. Europe's commercial sized wet lifts are all located either on or at junctions with smaller-dimensioned, Class IV waterways.[19] A wet lift lock with a 3,000 ton capacity is under construction at China's Three Gorges Dam. All of these lifts are designed to move vessels from one elevation to another, basically up and down. In the case of barriers on the CAWS, vessels will need to be moved up, across, and then down to roughly the same water level. Wet lifts in use today, on European waterways and that are proposed in China do not perform this function.

Barge lifts were considered by the Tennessee Valley Authority (TVA) as an alternative to new lock construction at Chickamauga Lock and Dam on the Tennessee River. A barge lift at Krasnoyarsk on Siberia's Yenise River served as the model for a proposed Chickamauga LD lift. The design of this type of lift could potentially be altered to perform an up, across, and down type maneuver. As seen in **Figure 13**, a large metal caisson that functions much like a dry dock (except that water remains in the caisson) accepts a single loaded barge and moves it up and over the dam at Krasnoyarsk to the pool above.[20] Large pistons allow the caisson to remain level as the track moves from horizontal to inclined and back to a horizontal position. TVA concluded that keeping the massive hydraulic cylinders free of debris would be a chronic problem, raising

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[18] For more information on boat lifts, see Encyclopedia Britannica online for a discussion of locks, boat lifts and inclined planes at http://www.britannica.com/EBchecked/topic/92049/canals-and-inland-waterways/72507/Lock-gates, Canals and Waterways http://www.canals.com/lifts.htm and Wikipedia http://en.wikipedia.org/wiki/List_of_boat_lifts for lists of boat lifts.

[19] There are four lifts capable of handling vessels carrying 1000 – 1350 metric tons – two are located in Belgium (Canal du Centre lift No. 1 and Strepy-Thieu) and two are in Germany (Rothensee and Scharnebeck).See Inland Navigation Europe's website page for a map of canals and lift locations: http://www.inlandnavigation.eu/uploads/Maps/map_waterways_europe.jpg

[20] Research conducted by Dean Dabson, Great Lakes Commons, source Wikipedia. See the YouTube link for a video of the operation of this lift at http://youtu.be/DFfVmWjhE-s

serious reliability concerns, and the need to sand and paint the lift on a regular cycle presented environmental challenges.[21] Processing times will be lengthy due to the speed of the lift (3.8 feet of lift per minute at Krasnoyarsk, or 90 minutes to move from below to above the 341 foot dam), the weight restrictions of the lift, and the number of barges that can be carried in one operation (one at Krasnoyarsk). The larger the tow sizes, the longer the delay. Lockport LD averaged 3.9 barges per tow in 2010 and O'Brien LD average 3.3 barges per tow in 2010. An estimate of the time to process a tow is a key parameter in estimating the additional cost of using such a lift. Of course, such a wet lift would offer ANS a means of by-passing the permanent barrier unless a process for eliminating ANS in the caisson is used.[22]

Figure 13: Barge Wet Lift at Krasnoyarsk

(c) Challenges of a Transloading Facility

The conceptual transfer facilities offered by HDR can be constructed, but cost (particularly the Lake Calumet Port Terminal) and operational issues (the barge-to-barge transfer facilities of the Down River and Midstream alternatives) will need to be addressed. A more detailed design is required for both the Lake Port and barge-to-barge facilities. In any event, both facilities will add cost and time to the movement of cargo due to the additional handling each requires relative to rail or rail-truck. For the barge-to-barge facility, factors to be considered include location of the crane, the proper sizing, and the effect of the crane on the barrier's design and cost. In turn,

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[21] Interview with Mr. Chrisman Dager and Dr. Larry Bray, University of Tennessee, Center for Transportation Research.

[22] A dry lift does not offer the hydrostatic pressure of water to maintain the structural integrity of a loaded barge.

the height of the barrier will have a direct effect on the size and mast height required of a crane that must reach out and down to load and unload barges. It is not certain whether the technology depicted is the most efficient available today. The crane with clam shell as pictured in the HDR report is also relatively slow compared to the rigid-arm track hoes that are typically used to unload commodities such as coal. Further, the multitude of commodities that move on the CAWS will likely require equipment that is more flexible than a clam shell crane. Transferring liquid bulk commodities from barge to storage tanks as depicted by HDR presents a challenge. Surveys of CAWS shippers found that as many as 151 tanks are used by petroleum producers in formulating and segregating products for individual customers. It follows that the land area required for these types of operations could be extensive.

Multimodal Facility

(1) Introduction

Intermodal transportation is generally defined as a system of transport whereby two or more modes of transport are used to transport the same loading unit in an integrated manner. Multimodal is the continuous movement of goods by more than one means of transport. In other words, an intermodal facility usually refers to a facility that transfers containers from one transportation mode to another mode, while multimodal refers to facility that moves bulk commodities from one transportation mode to another. Mitigation for hydrological separation alternatives for the CAWS would require a multimodal facility.

Any multimodal facility built in the Chicago region would need the capability to handle both bulk and liquid commodities. For general and bulk commodities, the multimodal facility would likely need a crane for handling general cargo, a crane for handling bulk commodities, loading / unloading rail or truck facilities, bulk material covered storage area, docking barges, and other equipment. According to The University of Tennessee Center for Transportation Research (CTR), any multimodal facility handling liquids would require a separate pipeline for each impacted liquid commodity to avoid mixing of liquids. The IMTT (International Matex Tank Terminals) Joliet Facility can be used to give a frame of reference for the area that might be required to handle liquids moving on the CAWS. The IMTT Joliet facility is a liquid tank farm on the Illinois River which handles petroleum products, asphalt, and chemicals. In an area of approximately 74 acres, it has over 70 tanks as well as space for truck / rail loading / unloading spots. The CTR roughly estimates that 100 to 500 acres would be required for multi-modal facility in the Chicago Area depending on the location of the barrier. However, CTR suggested that further research would be required to generate a more defined estimate of area and facility requirements.

(2) Examples Multi-modal Facility

There are a few examples of multimodal facilities in other areas:

(a) South Point, Ohio Facility

A multimodal facility was been proposed for a 180 acre section along the Ohio River. The site would contain an overhead bridge crane for general cargo and containers, liquid loading containment areas, rail hopper car unloading / conveyor facilities, bulk material covered storage area, and docking for 6 barges deep[23]. Total costs for the construction and rehabilitation necessary for the facility are estimated to be $25.7 million.

(b) Boise, Idaho Facility

At study of a bulk commodity multimodal facility near Boise, Idaho determined a minimum-sized site of 40 acres would cost about $15.5 million while a 140-acre site that would provide the region "an attractive rail-based industrial park" would cost about $28 million.[24]

(c) St. James Parish, Louisiana Liquid Facility

Petroplex will build a storage and distribution terminal for crude oil, refined petroleum products, fuel oil, chemicals, agrichemicals, renewable fuels, and other commercial liquid commodities and will provide in-tank blending capabilities throughout the facility. The multi-modal bulk liquid terminal in St. James Parish, Louisiana will cost $600-million and is projected to have an initial storage capacity of 4-million to 6-million barrels. The initial phase of the project includes the design, engineering, development, and operation of a state-of-the-art storage terminal that is capable of receipt or delivery between a variety of intermodal systems, including trucks, railcars, marine barges and ocean-going vessels, and connections to the existing and future pipeline infrastructure systems.[25]

(3) Requirements for a Multimodal Facility on the CAWS

Each of the alternatives will have a different impact on the CAWS navigational traffic, each having different requirements.

(a) Requirements for the Lakefront Hydrologic Separation Alternative

This alternative includes a barrier at Chicago Lock and a barrier at RM 324.5 on the Cal-Sag Channel. An average (2007 to 2011) of 5.4 million tons will be impacted and approximately 62 percent of the tonnage is traveling towards the Great Lakes and 38 percent is traveling toward the Mississippi River. No dock to dock movements are within the Cal-Sag Channel.

The main commodity groups impacted are (1) iron and steel at 1.6 million tons and coal and coke at 1.5 million tons. These commodity groups account for 57 percent of traffic impacted that will be impacted by both barriers.

(b) Requirements for a Barrier at Chicago Lock

A barrier at Chicago Lock would impact a five year average of 53,400 tons. However, Chicago Lock saw 148 thousand tons in 2007 and 48 thousand tons in 2008. In 2010 and 2011, Chicago Lock only saw approximately 10 thousand tons and 34 thousand tons, respectively.

Thirteen commodity types would be impacted by a Chicago Lock barrier. Commodities are both liquids and solids and are the following:

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[23] Ohio Department of Transportation. 2010. *The Point Intermodal River Port Facility* http://www.dot.state.oh.us/news/TIGERIIGrantApplications/SouthPointIntermodalRiverPort.PDF

[24] Available at: http://www.capitalpress.com/content/SE-multimodal-051812

[25] Available at: http://www.reuters.com/article/2012/05/09/idUS231465+09-May-2012+BW20120509

- Petroleum products such as gas oils and other light oils
- Aggregates
- Grains such as maize and cotton seeds
- Chemicals such as urea fertilizers
- Iron and Steel products such as granules of pig iron, iron ore and concentrates, ferrous waste and scrap
- Others including specialized machinery

This list shows that any multi-modal facility near this location would require area for liquid tanks as well as small storage areas for the bulk commodities.

(c) Requirements for a Barrier at RM 324 on Cal-Sag Channel

The minimum impact point to navigation on the Cal-Sag Channel would occur between RM 325 and RM 327. A barrier at RM 324 on the Cal-Sag Channel would impact a five year average of 5.3 million tons. However, this point on the Cal-Sag Channel saw 4.9 million tons in 2010 and 5.9 million tons in 2011. Approximately 62 percent of the tonnage traveling past RM 324 on the Cal-Sag Channel is heading up-bound toward the Great Lakes and approximately 38 percent is heading downbound towards the Mississippi River.

The main commodity groups impacted are coal and iron and steel which account for 67 percent of the upbound traffic. There are 47 unique commodities moving passed this point in 2010 with an average of 101 thousand tons per commodity. They can be divided into the following groups:

- Coal and coke including pet coke (1.3 million tons in 2010)
- Petroleum products such as pitch and pitch coal, gas oils, and other light oils (330 thousand tons in 2010)
- Aggregates such as pebbles, gravel, and crushed stone (80 thousand tons in 2010)
- Grains such as wheat, soy beans, and maize
- Chemicals such as ethylene glycol, aluminum hydroxide, and urea fertilizers (192 thousand tons in 2010)
- Non-metallic ores such as salt and manganese ores (622 thousand tons in 2010)
- Iron and Steel products such as pig iron, iron ore and concentrates, ferrous waste and scrap, flat rolled iron and steel products (1.3 million tons in 2010)
- Others including specialized machinery (710 thousand tons in 2010)

Both petroleum products and chemicals move past this point, so liquid handling facilities would be required.

(d) Requirements for the Mid System Hydrologic Separation Alternative

This alternative includes a barrier in Stickney, Illinois on the CSSC and a barrier at Alsip, Illinois on the Cal-Sag Channel. An average (2007 to 2011) of 7.97 million tons will be impacted. Approximately 68 percent are traveling towards the Great Lakes and 32 percent is traveling towards the Mississippi River.

The main commodity groups impacted would be (1) iron and steel at 2 million tons, (2) aggregates at 1.7 million tons, and (3) coal and coke at 1.5 million tons.

(e) Requirements for a Barrier in Stickney, Illinois on the CSSC

The minimum impact point to navigation on the CSSC is RM 321 and it had a five year average of 1.7 million tons and was 919 thousand tons in 2010. A barrier in Stickney, Illinois would impact a five year average of 2.5 million tons. However, this point on the CSSC saw 1.6 million tons in 2010 and 1.62 million tons in 2011. This total has removed all coal movements to Crawford and Fisk power plants.

In 2010, sixteen commodity types would be impacted by a barrier in Stickney, Illinois on the CSSC. The types of commodities include both liquids and solids and are the following:

- Petroleum products such as asphalts (334 thousand tons in 2010)
- Aggregates such as pebbles, gravel, and crushed stone and sand (958 thousand tons in 2010)
- Grains such as bran and soy beans (3 thousand tons in 2010)
- Chemicals such as xylene, ethylene glycol, and fertilizer (50 thousand tons in 2010)
- Iron and Steel products such as ferrous waste and scrap (193 thousand tons in 2010)
- Others including cement (75,000 tons)

Any multi-modal facility near this location would require area for liquid tanks as well as small storage areas for the bulk commodities.

(f) Requirements for a Barrier in Alsip, Illinois on the Cal-Sag Channel

The minimum impact point to navigation on the Cal-Sag Channel would occur between RM 325 and RM 327. A barrier in Alsip, Illinois on Cal-Sag would impact a five year average of 5.4 million tons. However, this point on the CSSC saw 5.0 million tons in 2010 and 5.9 million tons in 2011. Of the 5.4 million tons, approximately 62 percent of the tonnage traveling past Alsip, Illinois on the Cal-Sag Channel is heading up-bound toward the Great Lakes and approximately 38 percent is heading downbound towards the Mississippi River.

The main commodity groups impacted would be (1) iron and steel at 2 million tons, (2) aggregates at 1.67 million tons, and (3) coal and coke at 1.5 million tons. There were 28 unique commodities that moved pass this point in 2010 with an average of 91 thousand tons per commodity. They can be divided into the following groups:

- Coal and Coke pet coke and coal (1.3 million tons)
- Petroleum products such as gas oils, asphalt, gasoline, other light oils, etc. (409 thousand tons in 2010)
- Aggregates such as pebbles, gravel, and crushed stone and sand (26 thousand tons in 2010)
- Grains such as wheat, soy beans, and maize (408 thousand tons in 2010)
- Chemicals such as ethylene glycol, aluminum hydroxide, urea fertilizers, and others (223.5 million tons)
- Non-metallic ores such as salt and manganese ores (622 thousand tons in 2010)
- Iron and Steel products such as pig iron, iron ore and concentrates, ferrous waste and scrap, flat rolled iron and steel products, etc. (1.2 million tons in 2010)
- Others including cement, iron and steel slag, specialized machinery, etc. (713 thousand tons)

Both petroleum products and chemicals moved pass this point, so liquid handling facilities would be required.

(4) Container Trade

In a report for the Great Lakes Commission, *Evaluation of Physical Separation Alternative for the Great Lakes and Mississippi Basins in the Chicago Area Waterway System*, HDR found that absent the container trade, the relatively small amount of bulk trade does not generate enough benefits to cover the investment costs; however, their alternatives included features that would accommodate container traffic. If the vision of these alternatives is realized, Chicago would become a Container-On-Barge (COB) hub, making transloading operations feasible at each of the permanent barrier sites.

A number of obstacles stand in the way of realizing Chicago as a COB hub. While Chicago can be considered a rail hub in the sense that many Class I lines converge in the Chicago area, these lines do not necessarily intersect one with the other, and few have terminals on the river – none with container transfer capability. The Chicago region is a major destination for containers. In testimony to this fact, railroads have focused on building inland terminals outside of Chicago, but within trucking distance (such as Centerpoint in Joliet, Illinois and Northwestern Terminal in North Baltimore, Ohio). Containers are transferred from rail to truck at these terminals for delivery to the ultimate destination in Chicago. Waterborne containers would be competing directly with rail for the linehaul portion of the trip between blue water deep draft ports to Chicago, or with truck for the final, short leg where truck has the competitive advantage in terms of time and ability to travel the last mile of a delivery.

Expansion of the Panama Canal is widely regarded as a boon to trade between eastern U.S. and Gulf Coast ports and northeast Asian markets, most notably China. Waterborne movements of containers into and out of Chicago could travel either by ocean vessel through the St. Lawrence Seaway or by barge between Chicago and the Gulf Coast. In the U.S., intermodal operations involving barges are very limited in nature, typically involving heavy commodities that would be overweight truck loads moving 200 miles or less. Successful operations are established on the Columbia-Snake River System, along the Gulf Intracoastal Waterway between Baytown and Houston, TX and between Stockton and Oakland, California. Weight limits and hours of operation for trucks are an example of public policy actions that can influence the viability of COB, as they do for the Stockton route. Another example is the direct subsidy paid by the Virginia Port Authority to support a COB service (Express 64) between Norfolk, Virginia and Richmond, VA on the James River, thereby lessening truck traffic on the heavily congested I-64 corridor.

The European experience with the movement of containers on inland waterways has been more successful. As can be seen in **Table 39** below, unlike the U.S., trucks dominate the movement of freight in Europe. Because truck traffic is seen as contributing to traffic congestion and air pollution, the European Union has an established transportation policy that specifically promotes shifting freight movements from truck to rail or inland waterways. Programs like the European Commission's Marco Polo II offer grants designed to jump-start inland waterway initiatives. The focus of these programs is on efficient vessel design, interconnected waterways, integrated communication systems, and improved logistics.

Table 39: Comparison of EU and US Freight Traffic

Domestic Freight by Mode

Percents based upon ton miles (US) or tonnes-kilometre (EU)

	Water	Truck	Rail
U.S. 1/	7%	47%	46%
European Union 2/	6%	77%	17%

1/ BTS 2007 Commodity Flow Survey
2/ Eurostat (https:\\epp.eurostat.ec.europa.eu) 2009
Note: U.S. figures include trips using two modes; ton miles were accounted for in both modes.

Individual countries, waterway associations and port authorities set policies and regulations to encourage water transport. One very important example is the 400 million ton per year Port of Rotterdam, which has set specific targets for the percentage of freight moving by the three major modes (truck - 47% in 2009 to 35% by 2035, inland water – 39% to 45%, and rail – 17% to 20% by 2035).

In the U.S., a relatively vibrant rail sector carries as great a share of the Nation's freight as trucks. Where Europe tends to subsidize and otherwise favor passenger rail, U.S. policy and preferences tend to favor highways and airlines for passenger movement, while relying on deregulation of railroads to improve their profitability by moving freight. At any rate, the case for shifting freight from truck to rail and inland waterways is much less compelling in the U.S. than in Europe, though the potential to alleviate congestion is undeniable. Absent strong policies and financial advocacy for COB over truck and rail, the viability of COB in Chicago appears very uncertain at the present time.

The other possible waterway avenue between Chicago and global markets is the Great Lakes-St. Lawrence Seaway system. The Seaway route is likely to be little affected owing to its physical limitations – it is incapable of transiting the current fleet of Canal-compatible Panamax deep draft vessels, not to mention the larger-dimensioned post Panamax fleet that will transit the expanded Canal. For the Seaway to benefit directly requires an entirely new means of container trade that would include ocean-based transfer hubs where very large container vessels' cargo is transferred to a fleet of smaller vessels capable of transiting the Seaway. Such opportunities for transfer to Seaway compatible vessels might present themselves at Montreal, Quebec, and Halifax, Nova Scotia where containers are currently transferred from ocean vessels of sizes too large for the Seaway to rail (primarily) or truck for final delivery. Other east coast ports may see more traffic, but rail and truck are the preferred options for reaching Chicago or other lake ports. Ports on the Gulf Coast are generally configured to handle exports of bulk commodities (especially grain). Imports of bulk commodities, like cement, alumina, and basic iron and steel products move by barge, while containers are primarily railed to final destination.

The potential for a container trade on the Great Lakes was investigated as part of the Great Lakes St. Lawrence Seaway Study, Fall 2007 prepared by an international agency team that included Transport Canada, the U.S. Army Corps of Engineers, the U.S. Department of Transportation (USDOT), The St. Lawrence Seaway Management Corporation, Saint Lawrence Seaway Development Corporation, Environment Canada, and U.S. Fish and Wildlife. The USDOT's Maritime Administration contracted with TEMS, Inc. and RAND Corporation to make this assessment. They found that congestion on road and rail (year 2005 data was available at the time of this analysis) and shortages of rail cars and crews were driving overland costs up, creating an opportunity for waterborne container movement. Routes between the eastern container ports like Montreal, Quebec City, and Halifax (referred to as H2O East) and between western container ports like Seattle and Portland by landbridge (rail) through Duluth-Superior (referred to as H2O West) to Great Lakes ports were envisioned. COB was found to lack the speed necessary to compete with truck and rail. Instead, a vessel fleet of small container vessels with roll-on, roll-off capability showed the greatest promise in the near term, especially in cross lake trade between eastern Wisconsin and Chicago and Lake Erie ports, with larger container vessels with lift-on, lift-off (Lo-Lo) capabilities being feasible in out years. The market envisioned is 0.6 million FEUs (Forty Foot Equivalent Units) under market conditions experienced in 2005, with a potential to reach 3.0 million FEU by 2050.

Due to the economic downturn in recent years, market conditions that existed in 2005 have yet to re-appear and railroads currently have excess capacity. Several caveats to this outlook were also offered by the study's authors: the need for a seasonal rail service to operate during annual winter closure of the Seaway and the Soo Locks, the need for investment in port facilities, the need for investments in container vessels, the response of railroads to competition from water, and the actualization of CREATE goals for improved rail infrastructure in Chicago, which would make the prospect for container vessels less compelling. While the HDR Near Lake alternative addresses one of the issues that stand in the way of realizing the Great Lakes container trade envisioned by the Great Lakes St. Lawrence Seaway Study, much depends on the behavior of the rail industry. CREATE is well advanced, and railroad investments in inland ports (rail-truck container transfer facilities) indicate an intention to hold their position on container service to the Great Lakes region.

The relative speed of rail and truck and their more expansive reach put COB at a disadvantage, as confirmed by both the 2007 Great Lakes St. Lawrence Seaway Study and the more recent Tioga report (June 2012). Adding the cost and time burden of an additional transfer across a barrier makes this market seem even less likely to materialize. It is more likely that COB carriage would extend to the point of the barrier where it would be off-loaded and transferred to truck for final delivery. Similarly, any outbound COB trade that might develop is more likely to be trucked to the point of the barrier and then loaded in a barge should such a trade develop. Barge-to-barge transfers add time and cost. Seaway compatible container vessels do show some promise, but if this service were to be established, it is more likely to be viable if containers are moved to and from the transfer facility by truck. As emphasized in the Great Lakes St. Lawrence Seaway Study, private-public partnerships are basic requirements for a container port to be realized. Without such a strong policy and financial partnership, it appears unlikely that deep draft container facility would result in a complementary COB service in Chicago and on the CAWS.

Challenges of Mitigation

(1) Ice on the Great Lakes

A few of the alternatives propose placing a single physical barrier on the Chicago Sanitary and Ship Canal (CSSC) or the Cal-Sag Channel rather than blocking both of the navigable waterways. Though commercial cargo navigation could continue on the CAWS, a partial hydrological separation would require some commodity movements to be re-routed onto Lake Michigan. However sometimes ice conditions have the potential for shutting down commercial traffic going through Chicago Harbor Lock. This means that if a partial hydrological alternative was enacted, barge traffic would be unable to travel on Lake Michigan between Calumet Harbor and Chicago Harbor.

Ice could impact the costs for any re-routed Lake Michigan traffic by causing damage to a vessel or delaying or preventing the movement. Ice could increase repair costs by damaging the hull or other equipment. If a movement is delayed, then the costs of additional fuel, labor, and other inputs reduce the movement rate savings. If the movement is prevented, then the entire rate savings is lost. An ice blockage that delays or prevents a movement could occur on either the open water of Lake Michigan between Calumet Harbor and Chicago Harbor or at locks. At Chicago Harbor, the City of Chicago operates a tug all winter to break up ice that gets frozen solid across the lock chamber. After the ice is broken up into smaller chunks, the lock gates are opened to allow the ice to flow into the generally ice free Chicago River. Some barrier options could increase the number of ice blockages that occur at the locks because the ice needs to be able to flow to open adjacent water.

Due to warm winters, the high salt runoff, and the presence of the City of Chicago tug to break the ice, both Chicago Lock and Thomas J. O'Brien Lock and Dam experienced few closures due to ice between 2000 and 2012. Chicago Lock was closed due to ice either around the lock or around the tow a total of 482 times or an average of 37 times per year (LPMS 2013). The stall-stoppages caused by ice occurred between December and April with 42 percent of the events happening in January and 26 percent happening in February. Though the maximum closure period for Chicago Lock was 190 minutes, the average closure period for each stall-stoppage was less than five minutes. Ice either around the lock or around the tow closed Thomas J O'Brien Lock and Dam a total of 1,869 times between 2000 and 2012. Unlike Chicago Lock, the ice induced stall stoppages occurred between November and March for Thomas J O'Brien Lock and Dam. However, 85 percent of these stall-stoppages occurred in January or February. In most months the average length of each stall-stoppage at O'Brien was under 15 minutes and the maximum is 119 minutes. However, in January the average length of a stall stoppage increases to 92 minutes and the maximum is approximately 14 hours.

(2) Shipper Response

In 2011, the University of Tennessee's Center for Transportation Research (CTR) was contracted by USACE to conduct a survey of the shippers, docks, and carriers that utilize the CAWS. CTR made on-site visits to the shippers and vessel operators to obtain the information necessary to complete the survey, with 132 of the 136 of the companies surveyed responding. The key questions put to these firms focused on how they would respond to waterway closures ranging from a one day closure to permanent hydrologic separation and how these disruptions would affect their operational, transportation, and/or logistics costs.

Shipper responses ranged from waiting out the closure, shifting modes to truck or rail, re-sourcing, or permanent closure of the dock. Furthermore, the shippers stated that the longer the closure the more likely they were to reduce future traffic, shift to the Great Lakes for shipping, or close the dock. Shippers and terminal operators were also asked if they would transfer around a temporary closure or permanent barrier by unloading from barge to truck or rail and then reloading to barge once past the point of disruption on the CAWS. Almost all docks and shippers (representing over 90% of the docks in the CAWS and 93% of all tonnage) responded they would not undertake this option. For many of the shippers, their margins are too slim for them to stay competitive with the additional cost of transloading. Most respondents replied that they would shift modes to either truck or rail. If the additional costs of trucking were too great and they did not have the capacity for rail, many companies replied they would either re-source, i.e. find new sources for production inputs, or shut down permanently.[26]

Conclusion

The effect of implementing technologies to prevent the spread of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River by aquatic pathways on Chicago Area Waterway System (CAWS) commercial cargo traffic was measured in terms of affected tonnage and transportation costs. In 2017, affected tonnage ranges from an average of 3.1 million tons to 9.55 million tons, and the impact to transportation costs (or lost transportation cost savings over the best alternative) ranges from an additional $0.47 million to $238 million[27]. As expected, the alternatives recommending complete hydrological separation affect the most tonnage and result in the highest cost to the commercial cargo industry. Other conclusions that may be drawn from this analysis are the following:

- The alternative with the least impact to CAWS commercial cargo navigation is the Technology Alternative With a Buffer Zone Alternative.
- The alternative with most impact to commercial cargo navigation is the Mid-System Hydrologic Separation which recommends complete hydrologic separation at Stickney, Illinois on the CSSC and Alsip, Illinois on the Cal-Sag Channel

[26] In order to take into account the effects of the 2008/2009 recession, a universal sample of 2,265 commodity movements was taken from Waterborne Commerce Statistics data for the years 2007-2009. The highest tonnage for individual shippers in those years was used in calculating tonnage impacts. Applying shippers' responses to the 2,265 commodity movements and highest tonnage in that three year period resulted in a population of 22.4 million tons, which was universally sampled. Of these 22.4 million tons, shippers accounting for 1.4 million tons, or 6.3%, indicated that they would transloaded if such a facility existed.

[27] This analysis focused on the costs to transportation rate savings and did not consider the potential benefits to waterway traffic. For example, the diversion of some waterway traffic to the next least expensive overland route would reduce delays on the waterway system. These benefits were not calculated due to difficulty in estimation.

Table 40: Ranking of Alternatives By Loss in Transportation Rate Savings in 2017

RANK	ALTERNATIVE	Lost Rate Savings (Thousand Dollars) 2010	2012	2017	2020
1	Mid System Hydrologic Separation	$203,248	$237,241	$238,430	$251,115
2	Lakefront Complete Hydrologic	$159,629	$189,996	$199,914	$211,285
3	Hybrid CSSC Open Alternative	$ 6,904	$ 7,963	$ 8,495	$ 8,789
4	Hybrid Cal-Sag Open Alternative	$ 11,592	$ 12,920	$ 7,267	$ 7,253
5	Flow Bypass Alternative	$ 676	$ 789	$ 719	$ 747
6	CAWS Buffer Zone Alternative	$ 370	$ 440	$ 473	$ 497

It should be noted that the cost of an alternative recommending complete separation equals the loss of all rate savings while the cost of the buffer zone / technology alternatives equals the costs from traveling the additional net miles and, if necessary, the costs of refleeting to move on Lake Michigan and Chicago River. Costs not completely reflected in this analysis include vessel and speed restrictions on the Chicago River, potential delays caused by increased traffic on a single waterway, and potential delays caused by ice on Lake Michigan, among others. However, these costs were deemed not to be significant and are unlikely to affect the relative rankings of the alternatives.

Ways to offset impacts to navigation from the implementation of ANS technologies have also been discussed in this analysis. The mitigation measures briefly reviewed include a transloading facility, an intermodal facility, and a multi-modal facility. Transloading refers to a facility where commodities would be transferred over a barrier. Intermodal describes a facility that transfers containers from one transportation mode to another and multimodal refers to a facility that moves bulk commodities from one transportation mode to another. The CAWS would require a multimodal facility that is capable of handling both liquid and bulk commodities. Due to the variety of commodities, The University of Tennessee Center for Transportation Research UT-(CTR) roughly estimates that 100 to 500 acres would be required for a multi-modal facility in the Chicago Area depending on the location of the barrier. It should also be noted that shippers and terminal operators were asked if they would transfer around a temporary closure or permanent barrier by unloading from barge to truck or rail and then reloading to barge once past the point of disruption on the CAWS. Almost all docks and shippers (representing over 90% of the docks in the CAWS and 93% of all tonnage) responded they would not undertake this option.

ABBREVIATIONS

1. ANS - Aquatic nuisance species
2. CSSC – Chicago Sanitary and Ship Canal
3. CAWS - Chicago Area Waterway System
4. FWOP - Future Without Project
5. FWP - Future With Project
6. LPMS - Lock Performance Monitoring System
7. NDC - National Data Center
8. RM - River Mile
9. WCSC - Waterborne Commerce Statistics Center

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Commercial Cargo Report Appendix 1:

Transportation Rate and Social Cost Analysis: Chicago Area Waterway System

August 2013

U.S. Army Corps
of Engineers
Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

Prepared for U.S. Army Corps of Engineers

Huntington District

by

The University of Tennessee

Center for Transportation Research

Knoxville, Tennessee

January 2013

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SUMMARY

Based on a 2,265 movement survey of barge shipping, users of the Chicago Area Waterway System are estimated to have saved, on average, more than $26.30 per ton in transportation and handling charges for the sample movements of 27 million tons of cargo when available barge costs are compared to the next-best, all-land transportation alternative. These savings are calculated across eight commodity groups including over 85 separate commodities and range between a high $60.90 per ton for Ore & Minerals and $9.34 per ton for Aggregates. In addition, the reduced shipper savings due to the unanticipated closure of the Chicago Area Waterway System (CAWS) are estimated to range from $6.23 per ton in the first year for a 15 day closure to $17.50 for a 180 day closure. A full reporting of all rate calculations is provided through a combination of spreadsheets and worksheets in Volume II.

INTRODUCTION

This study is conducted by the University of Tennessee Center for Transportation Research (UTK-CTR) under contracts with Marshall Research Corporation (MURC 2011-232) and the Huntington District of the U.S. Army Corps of Engineers (Corps) (W91237-11-C-0017) in order to facilitate the calculations of the National Economic Development (NED) and Regional Economic Development (RED) benefits attributable to CAWS navigation. Toward this objective, the study provides a full range of transportation rates and supplemental costs for a sampling of two thousand two hundred sixty five 2007, 2008, and 2009 waterborne commodity movements which, in total or in part, were routed in the Chicago Area Navigation System. The sampling technique utilized selected the highest annual tonnage observation by five digit commodity and by origin/destination dock for the three year time period. This sampling method was used to obtain the most diverse commodity and geographic representation of commodity flows in the CAWS region.

The first step in the study was to conduct interviews with the dock operators and shippers in the CAWS to ascertain physical operating conditions, specific commodity moves, modal choices during an unanticipated closure, and future operating changes. The interview responses have been recorded and summarized by commodity. In total 86 interviews were conducted in the field and four interviews by telephone representing 139 docks. Six docks declined to be interviewed or were out of business or closed, representing less than four percent of the total sample tonnage.

Freight rates for each sample movement are calculated based on the actual water-inclusive routing, as well as for competing all-land alternative and five closure periods (15, 30, 60, 90, and 180 day). All computations reflect those rates and fees which were in effect in the fourth quarter 2011. Results are documented on a movement-by-movement basis, including a separate worksheet for each observation. These dis-aggregated data are also integrated into individual spreadsheets for each of the eight commodity groupings. A full description of the study's scope and guidelines, UTK-CTR's methods of rate research and construction, and supporting assumptions is provided below.

STUDY PARAMETERS

A sample of 2,265 movements was identified for inclusion in this analysis. These movements either originated, terminated or passed through the CAWS (Defined as the river reach between Lockport Lock and Chicago River Lock or O'Brien Lock). Dock-to-dock tonnage over included origin destination pairs ranges between 15 tons and 1,614,000 tons annually, representing individual commodities. Reported rates for both the water movement and the all-land alternative are based on the actual location of shipment origins and destinations.

Water Routings

Because many of the sample movements have off-river origins and/or destinations, a full accounting of *all* transportation costs for waterborne movements also requires the calculation of railroad and/or motor carrier rates for movement to or from the nearest appropriate port facility. Additionally, all calculations reflect the loading and unloading costs at origin and destination, and all transfer costs to or from barge. Finally, when a fleeting point or closed dock was shown in the sample movement data as the origin or destination, the nearest dock to the named point that handled the commodity was used to construct the transportation rates or external costs.

Land Routes

With the exception of over-dimension shipments and intra-pool sand dredging, rail or truck rates are calculated for all movements (See Section VI for a discussion of exceptions.). For over dimension truck and intra-pool dredged materials, the land rate was estimated as compared to a specific modeled rate using identifiable data inputs. As in the case of the barge-inclusive routings, many all-land routes require the use of more than one transport mode. Therefore, when appropriate, calculations include all requisite transfer charges.

To facilitate the calculation of rates and external costs, the land miles by mode were developed. Here the rail route and rail miles or truck route and truck miles are shown. The source of the rail miles comes from a rail routing and mileage program developed by the Oak Ridge Nation Laboratory (ORNL). The UTK-CTR prepared the rail routes, and ORNL produced the practical miles. The truck route miles were developed from both MapQuest and Google Maps.

Seasonality and Market Anomalies

To accurately reflect NED benefits, it is necessary to develop rates which portray the normal market conditions which are anticipated over the project life. For this reason, every attempt was made to purge the data of anomalous or transitory influences. As a part of all shipper surveys and interviews, respondents were directed to ignore temporary market disruptions and provide information reflective of “normal” operating conditions. As a result of the commodity mix represented within the sample, we detected no need to adjust for seasonal fluctuations. Annual contract barge rates with a fuel escalation feature and five year average spot market grain rates provide an annual average barge rate that is comparable to the multi-year contract rail rates that remove seasonality. The result is consistent rate treatment for each mode.

The development of RED rates for unanticipated river closures is dependent upon the modal choice of the dock operators and shippers, given in response to questioning during interviews. The shipper modal choice for each observation and each closure period were recorded. The modal choice reflects equipment availability, enterprise cash flow needs, and inventory availability.

WORKSHEET EXPLANATION

Volume II contains the individual worksheets for each of the 2,265 movements. Each worksheet consists of 1 - 4 pages and catalogues basic shipment information including:

1) Assigned shipment reference number
2) Individual commodity description
3) Commodity group description
4) River origin
5) River origin waterway mile
6) Off-river origin (if applicable)
7) WCSC number
8) Shipment tonnage
9) River destination
10) River destination waterway mile
11) Off-river destination (if applicable)

Section I of the worksheet contains the analysis of the barge-inclusive routing from origin to destination via the Chicago Area Navigation System. Section II contains information describing the best available all land alternative. When multiple off river origins were observed, a supplemental page calculating a tonnage weighted average of the transportation rate is shown.

Authorities or sources for all calculations are reported in footnotes to the appropriate worksheet items. All rates and supplemental costs are expressed on a per net ton basis in fourth quarter 2011 U.S. dollars. When the river port town name and the railroad station name are different, the railroad station name is indicated as an off-river origin or destination with no cost to and/or from the river.

JUDGEMENTS AND ASSUMPTIONS

Based on information collected from shippers, receivers, carriers, river terminal operators, stevedores, federal agencies, and private trade associations, UTK-CTR was able to identify probable origins and destinations for the majority of those movements that originated or terminated at off-river locations. In the absence of specific shipper/receiver information, it is assumed that the river origin and destination are the respective originating and terminating points for both river and alternative modes of transportation. In every case, an attempt was made to gather information from all shipping ports. However, in some instances, 2007, 2008, and 2009 logistical data are not available from these ports. In other cases, port representatives declined to provide the requested information.

Specific commodity groups are discussed in more detail later in this section. However, for those movements that originate or terminate at a river port location, it is assumed that rail service could also be utilized by the shipper or receiver if that port is rail served. Exceptions to this assumption are noted on individual worksheets. When the shipper or receiver is served by truck only, the interviewer asked specifically if the shipper would trans-load to rail. Only those shippers responding in the affirmative were shown to do so. Further, only those shippers who ship more than 150,000 tons annually and who are adjacent to rail tracks would be assumed to undertake the significant capital expenditures necessary to acquire direct rail service. Mileage allowances made by carriers to shippers for the use of private equipment are also ignored as are rebates to shippers.

For short run unanticipated river closures, the modal choice decision assumed the shippers knowledge of equipment and carrier service availability coupled with loading and unloading capacity. It was assumed that no new capacity would be built unless specifically addressed by the shipper in the interview.

For the long run, in all cases, it is assumed that the alternative modes of transportation would have the physical capacity to accommodate the additional tonnage represented by each commodity movement (This is provided for in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G)). Commodity specific judgments and assumptions include:

Coal and Petroleum Coke

A number of assumptions are made for land haul rates on the movements of coal to utility destinations that are not rail served. Volumes to these utility destinations are, in many cases, substantial, so that long-haul truck transportation cannot be considered a viable option. In the absence of water transportation, receiving utilities would have to carefully evaluate those available options which might insure their ability to continue to receive large volumes of coal. These considerations might include the replacement cost of transfer and handling facilities, the construction cost of switch or main line rail track, the cost of new or improved highway access, the economies of buying or leasing rail equipment, the possibility of shifting origins to assure adequate coal supply, or utility plant closure. For their part, we may assume that rail carriers would be willing to construct additional track capacity if volumes are sufficient. However, these construction costs would most likely be passed on to the shipper via higher rates.

To accommodate those instances in which sample barge movements are to non-rail served utilities, we have incorporated the following judgments and assumptions.

> If the receiving utility is not rail served, rates are applied to the nearest trans-load facility, and trucking costs from the railhead to the destination are applied. If the shipping point is not rail served, a motor carrier charge is applied from the mine origin to the nearest trans-load. It is assumed that transfer facilities would be available at both origin and destination for transfer between rail and truck.
>
> If the receiving utility is rail served for supplies only, but not coal, the rail car unloading cost of the utility is inflated to accommodate a rail track expansion to the coal stockpile.
>
> In some instances, movements involve a truck haul from multiple origins to a concentration or preparation point for loading to rail. In these instances, where shipments originate at several mines within the same general area, a representative rail origin is selected as the transfer location.

Aggregates

Land haul rates on limestone and sand and gravel reflect the modes necessary to transport the shipments from actual origins to actual destinations. If origins or destinations are not rail served, a trucking charge is applied from the nearest rail station. For those movements where both rail and truck transportation are an option, the least cost land transportation option was selected. However if it was deemed impractical, in the absence of water transportation, to transport large volumes of these commodities for long distances by truck then rail would be considered. Limiting factors of truck transport include lower cargo carrying capacity, the inability to round-trip more than three times per day, and the absence of loaded back-haul opportunities.

With regard to waterway improvement materials, we assume that land movements would require a truck haul at the destination for delivery to river bank work locations. It should be noted that a significant amount of channel improvement and bank stabilization work is conducted off shore or at locations without highway access, making land transportation impractical.

Grain

The computation of rates for grain is based upon the survey responses of the shippers and receivers. Specifically, if a country elevator gathers grain then ships it to the river terminal, we assume a 20 mile truck haul from the farmer's field to the country elevator. If the grain moves for export, a multi car movement is considered due to shipper track capacity. For domestic shipments, the computation of rail rates is based on the track capacity of the country elevator or domestic receiver. We assume that the grain shipper would maximize the use of his facilities and utilize gathering rates to reach the track capacity of the receiver.

The rail rating of feed ingredients follows assumptions similar to those used for the rating of grain - namely rates constrained by track capacity. Rail and barge transit programs for meals (soybean, cottonseed, oilseed and fish) were not considered.

METHODS AND PROCEDURES

As a result of pricing flexibility and differential rates allowed by surface transportation deregulation, it is sometimes difficult to determine the exact rate charged by a carrier on shipments moving under contract. Barge rates are a matter of negotiation between shipper and barge line operator, and these rates are not published in current tariff form. Each carrier's rates are based on individual costs and specific market conditions, so that these rates will vary considerably between regions, across time, and from one barge line to another.

Contract rates are also common in rail and motor carrier transportation and, like barge rates, may be maintained in complete confidentiality. In other cases (particularly grain), tariff rates with an index are still applied. However, there is rarely any dependable means for determining whether a contract rate or a tariff rate should be used to price a particular movement. A further complication is the use of rebates and allowances as an incentive by carriers to shippers to induce higher traffic volumes.

Barge Rates

With the exception of grain and feed ingredients and average trade publication spot market rate quotes, unobservable barge rates are calculated through the application of a computerized barge costing model developed by the Tennessee Valley Authority. The TVA model (now maintained at the UTK-CTR) has been refined to include 2011 fixed and variable cost information obtained directly from the towing industry and from 2011 data published within the Corps' annual *Estimated Towboat and Barge Line-Haul Cost of Operating on the Mississippi River System (This is an update of data and equations using a 2000 report methodology)*. Additionally, 2010 data from the Waterbourne Commerce Statistical Center trip reports and 2011 data from the Lock Performance Monitoring System are incorporated into UTK-TRC BCM costing parameters.

The UTK-CTR model contains three costing modules: a one-way general towing service module, a round-trip dedicated towing service module, and a round-trip general towing service module. The one-way module calculates rates by simulating the use of general towing conditions between origin and destination, including the potential for a loaded return. The dedicated towing service module calculates costs based on a loaded outbound movement and the return movement of empty barges to the origin dock. The round-trip general towing service module is similar to the one-way, except that it provides for the return of empty barges to the point of origin. This module does not calculate costs for towboat standby time during the terminal process but does include barge ownership costs (maintenance, replacement cost, supplies, insurance, and administration) for both the terminal and fleeting functions. It does not require that the empty barges be returned with the use of the same towboat. Depending on the module in use inputs may include towboat class, barge type shipment tonnage, the interchange of barges between two or more carriers, switching or fleeting costs at interchange points or river junctions, and barge ownership costs accruing at origin and destination terminals, fuel taxes, barge investment costs, time contingency factors, return on investment, and applicable interest rates.

Barge rates on dry commodities are calculated with the use of the general towing service round-trip costing module. Inputs, based on information from carriers and the Corps' Performance Monitoring System (PMS) database were programmed into the module to simulate average towboat size (horsepower) and corresponding tow size (barges) for each segment of the Inland Waterway System. Other inputs include barge types, waterway speeds, horsepower ratios and empty return ratios. These inputs are documented.

An example of a typical shipment cost in this analysis would be a dry bulk commodity (iron ore intermediates or cement clinker) originating on the Mobile River at Mobile, Alabama and terminating on the Illinois Waterway at Chicago, IL. Based on the modeling process, this shipment would be assumed to move in an four barge tow from Mobile to the Mississippi River at New Orleans, a twenty-four barge tow from New Orleans to Cairo, a twenty barge tow from Cairo to St Louis, an 9 barge tow from St Louis to Lockport, and a two barge tow from Lockport to Chicago. At each interchange point, appropriate fleeting charges would be calculated. Empty return (back haul) factors would also be included for each segment of the movement.

With the exception of movements involving some Northbound and tributary rivers, barge rates for grain and dry feed ingredients are estimated on the basis of a percentage of base rates formerly published in Waterway Freight Bureau Tariff 7.[1] For movements with origins or destinations in the Illinois Waterway or Great Lakes barge served area, the five year average percent of base for the Lower Ohio, Mid Ohio, Upper Mississippi, Illinois, and Missouri Rivers is used. For movements on the Tennessee, Gulf Inter Coastal Waterway, and Arkansas, a Tariff Arbitrary charge is added to the New Orleans base rate where applicable. Rates for those movements that traversed the Tennessee -Tom Bigbee Waterway are calculated through the use of the TVA general towing service round-trip costing module.[2]

Barge rates for asphalt, heavy fuel oils, and light petroleum products are calculated through the use of the dedicated service round-trip costing module. Twenty hours standby time is allocated at origin and destination for towboat terminal functions. Finally, rates for sodium hydroxide, vegetable oils, lubricating oils, liquid chemicals, and molasses are calculated through the use of the general service round-trip costing module. As a result of comparable barge sizes, these commodities normally move in the same tow with dry commodities.

Barge rates calculated by the use of the UTK-CTR model reflect charges that would be assessed in an average annual period of typical demand for waterway service. It should be noted that the model does not explicitly consider market factors such as intra or inter modal competitive influences, favorable back haul conditions created by the traffic patterns of specific shippers, or the supply and demand factors which affect the availability of barge equipment. These and other factors can influence rate levels negotiated by waterway users. The model does, however, calculate rates based on the overall industry's fully allocated fixed and variable cost factors,

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[1] The expression of barge rates for agricultural commodities as a percentage of waterway Freight Bureau
Tariff 7 is consistent with industry standards.

[2] There is no basis for rates via the Tenn-Tom in the Waterway Freight Bureau Tariff.

including a reasonable rate of return on assets. The rate of return assigned to this project by the Huntington District of the Corps of Engineers is four percent. To offset abnormal market conditions a five percent charge is added to the rates for contingencies. It is UTK-CTR's judgment that the transportation rates (with the exception of the mandated low rate of return on investment) are representative of the industry and provide a reasonable basis for the calculation of NED benefits.

The spot market hopper barge rates were derived from the River Transport News published by the Criton Corporation of Silver Springs, Maryland. The average spot market rate for the second, third, and fourth quarters 2011 was utilized.

Railroad Rates

In 2007, rail shippers received rate relief from the Surface Transportation Board (STB) in the calculation of fuel surcharges. The result of the STB decision was a new calculation method for surcharges based upon mileage with the Class 1 rail carriers adopted the ALK practical mileage software program to estimate mileage. A further complication in rail rate calculation was the failure of Global Insight, Inc. to correct and update the Reebie Rail Costing Model that they purchased in 2004 when Global Insight acquired Reebie & Associates.

To resolve the above analytical issues, UTK-CTR developed a rail rate estimating technique using the attributes of rail shipping exhibited in the STB Waybill Sample. This technique was first employed in the Upper Mississippi and Illinois Rivers 2006 Transportation Rates Project for the Army Corps of Engineers, and was used in the Ohio River Transportation Rate Study 2010.

The UTK-CTR rail rate estimating method has six steps. First, UTK-CTR field or telephone interviews the dock operator to establish the off river origin and/or destination, the mode and carrier of transport to or from the dock, rail track capacity at the dock, and river dock handling capability. Second, a rail route is constructed from either the off river origin or the dock origin. Third, the STB Waybill Sample for 2009 was sorted by seven digit STCC number (or five digit if insufficient observations) by carrier, by single car-multi car-small unit train-large unit train, and by distance (less than 500 miles or greater than 500 miles). Fourth, the average revenue per mile was calculated. Fifth, the revenue per mile is indexed from 2009 to fourth quarter 2011 (8.4%) from the American Association of Railroads. Last, carrier mileage was multiplied by the adjusted revenue per mile, and the result was divided by the average weight per car to produce an estimate of the rail rate per short ton for the land move.

Railroad mileage was computed by a software package from the Oak Ridge National Laboratory (ORNL) and National Transportation Research Center in 2011. Specific rail routing was developed by UTK-CTR, and the practical rail mileage was prepared by ORNL. Specific routes and miles for each movement were developed.

Motor Carrier Rates

Truck rates for off-river movements were obtained from the shipper and dock surveys conducted by UTK-CTR for the Army Corps of Engineers. In addition, UTK-CTR maintains transportation trade publications that report various regional trucking rates and costs. Further, UTK-CTR reviewed the Security and Exchange Commission filings for 2011 for three truckload carriers (Prime Transportation, Knight Trucking, and Malone Trucking) to determine the revenue per mile received by the carriers for three different types of carrier services. In addition dock operators were queried about the rates paid for various types of service (local or long haul). The truck rate methods UTK-CTR uses consist of a rate per loaded mile for moves over 100 miles or a shuttle truck rate per hour for moves under 100 miles. Each rate is footnoted in the individual rate sheets. The truckload weight limit is one ton less than weight allowed by the individual state highway axel load and bridge formula for truckload and permitted load limits. Truck mileage was determined by Google Maps or Map Quest.

Handling Charges

Handling charges between modes of transportation are estimated on the basis of information obtained from shippers, receivers, stevedores, and terminal operators. Handling charges for the transfer of commodities from or to ocean-going vessels are on the basis of information obtained from ocean ports or stevedoring companies. For import or export movements that involved mid-stream transfer operations, handling costs to or from land modes at a competing port with rail access are applied.

Except as noted within individual worksheets, it is assumed that movements of bulk products (for example, grain or fertilizer) would be handled through elevators or storage facilities. It was also assumed that liquid commodities transferred between modes would require tank storage. Additional costs are incurred at both river and inland locations if shipments remain in storage past the free-time period allocated by the facilities involved. Storage charges are usually assessed on a monthly basis.

Loading and Unloading Costs

Because loading and unloading costs are not usually documented by shippers and receivers, they are particularly difficult to obtain.[3] Moreover, these costs can vary considerably across firms. In an attempt to provide the best possible estimates of these costs, we use available shipper and receiver information in combination with data from Corps studies performed by other researchers, as well as previous UTK-CTR studies. These data are revised to reflect 2011 conditions then averaged as required. In those cases where varying sources produced disparate estimates, we relied most heavily on shipper and receiver estimates.

Methodological Standards

Two points should be noted regarding the methodological standards applied within this study. First, the standards described above reflect essentially the same processes TVA and UTK-CTR have applied (or will apply) in developing transportation rates for other recent (or ongoing) Corps studies. Specifically, the outlined methodology was used in the 1996 and 2000 Ohio River Studies and the 1996 and 2006 Upper Mississippi Navigation Feasibility Study and was

[3] Loading and unloading costs are often considered a part of through-put or production costs.

applied in the Missouri River Master Manual Review process, the Soo Locks Study and Port Allen Cutoff assessment. Thus, inter-project comparison is facilitated by this uniform approach. More importantly, recent methodological improvements enable TVA and UTK-CTR to produce transportation rate/cost materials which are, simultaneously, more complete and more reliable than the transportation data TVA (or other agency) has produced for similar studies in the past. Each Rate study for each District of the USACOE is integrated into a series of data bases for quick accessibility and data manipulation.

SAVINGS TO USERS

Based on the fourth quarter 2011 cost levels, those users of the CAWS represented by the 2,265 sampled movements saved, on average, about $26.31 per ton over the best possible land routing. To facility the use of the shipper savings, the individual movement rate sheets were grouped by the Corps of Engineers Commodity Grouping. Two commodity group modifications were undertaken to maintain confidentiality and consistency. Coke from coal and petroleum coke were included in the Coal & Coke grouping. Also, lubricating oil was included in All Other grouping. Savings for each of the eight commodity groupings identified for this analysis are summarized below.[4]

Group	*Commodities*	*Total Dollars*	*Tons*	*Average Per-Ton NED Saving*
1	Aggregates	$34,096,116	3,650,102	$9.34
2	All Other	$104,890,950	4,024,432	$26.06
3	Chemicals	$90,612,498	2,698,821	$33.57
4	Coal & Coke	$103,518,057	6,448,111	$16.05
5	Grain	$20,914,927	764,577	$27.35
6	Iron & Steel	$176,061,118	5,229,270	$33.67
7	Ore & Minerals	$150,552,294	2,472,075	60.90
8	Petroleum Fuels	$46,970,742	2,369,105	19.83
AVERAGE ALL COMMODITIES		$727,620,491	27,656,493	26.31

In addition to the base case shipper savings with no navigation, separate rate sheets were prepared for each of the five short term disruption scenarios: 15, 30, 60, 60, 90, and 180 day. The shipper modal choice, waiting in demurrage, or ceasing operation are reflected in these rate sheets based upon the interview responses of the shippers and dock operators. Each entry in the rate sheet is footnoted to describe the source of the rate computation. These rate sheets were summarized by Corps of Engineers commodity groups.

During the preparation of this study, we observed that, in a few instances, the selection of barge transportation is more costly than the land alternative. There are any number of scenarios which work individually or in combination to explain this phenomenon. First, in some cases, the sample may occasionally captured a transitory use of barge which occurs when alternative modes lack capacity or when rail cars are in short supply. That is to say, for some particular shipper/receiver barge is only the mode of choice when other transportation markets are unusually active. Secondly, long term contracts and large capital investments may lead to discontinuities in the relationship between relative rates and modal choice. In many areas barge shippers and receivers are captive to the navigation mode because they lack the industrial footprint to build the infrastructure for a modal change. While this can be a short-run situation, it

[4] All rates and rate differentials are weighted average.

may, nonetheless help to explain what appears to be perverse behavior. Next, the analysis superimposes 2007, 2008, or 2009 transport market conditions on set of 2011 modal choice decisions. In the vast majority of cases, this dichotomy is of little import. However, in a few cases, transportation rates may have changed sufficiently, so that in 2011, barge would no longer have been the mode of choice. Finally, regulatory constraints on the new construction of coal and hazardous materials handling facilities may preclude the development of facilities necessary for some shippers to take advantage of changes in the vector of available transportation rates.

MODIFICATIONS EXTERNAL SOCIAL COSTS

The measurement of external social costs is based upon the decision of shippers or dock operators to shift mode or cease operation for each short term disruption scenario. The external social cost of using trucks to move cargo instead of barge are shown in . Now, we come to the point of adding to the external social cost for modal shifting by rail and/or subtracting external social cost for the reduced barge utilization.

While the truck mode analysis incorporated four elements, delay due congestion, accidents, emissions, and fuel; we are only measuring emissions for barge and rail since the other three elements are either incorporated in transportation rates or not measureable in the barge or rail modes.

The method used to arrive at the monetization of emissions was to first determine the added ton miles by rail and the reduced ton miles by barge. Next, the fuel efficiency of each mode was applied to the ton miles to arrive at the number of gallons of fuel. Here, the value of 453 ton miles per gallon for railroads was taken from the 2010 Annual Report of the American Associations Railroads. For the barge mode, the fuel efficiency of 640 ton miles per gallon for trips over 500 miles or 405 ton miles per gallon for trips under 500 miles. The mileage segregation for the barge mode was a reflection of the national average for longer trips and the Illinois Waterway fuel efficiency for shorter trips that would be dominated by travel on the Illinois Waterway. Once the annual gallons of fuel were determined, the gallons were apportioned by ratios of 15, 30, 60, 90, and 180 days to 365 days and then summed for each scenario.

The next step was to take the monetized truck emissions values and divide by the number of truck fuel gallons to arrive at a dollar per gallon value. The truck efficiency used for this computation was seven miles per gallon for ultra low sulfur diesel fuel. The total truck miles times the number of trips for each truck movement was divided by seven. This amount of fuel was then apportioned by the ratio of 15, 30, 60, 90, and 180 days to 365 days and summed to arrive at the gallons of truck fuel in each year (year 1-50 periods). The quantity of fuel was then divided into monetized truck emissions values to arrive at a dollar per gallon value.

The next step was to develop a ratio of truck emissions to rail and barge emissions. Here the source was the Environmental Protection Agency (EPA), January 6, 2013 Web Page, Standards for Marine, Railroad, and Truck Engine Emissions. The following table depicts the emissions permitted and the ratios used to standardize the nitrous oxide, hydrocarbons, and particulate matter to arrive at a modal emission ratio. The ratio for railroads is 156%, and the ratio for barge is 330%. The assumption is being made that each mode will be using ultra low sulfur diesel fuels. Further, it is assumed that the >3700 HP vessels are 33% of the fleet and <3700 HP vessels are 67% of the fleet in order to arrive at a weighted average emission standard. Also, the weighted average of the truck emissions is 60% for the Combo and 40% for the PM based upon the dollar contribution of the truck emissions values.

The last step was to take the monetized truck emissions value per gallon, multiply this value times the EPA regulatory allowable emissions ratio by mode, then multiply this amount times the number of modal gallons to arrive at a rail emissions total dollars to be added and a barge emissions total dollars to be subtracted from the monetized external social cost by scenario in Appendix 1.

A separate electronic disc is being provided that has the computations and resulting dollars per ton values for each scenario by year.

Table 1: EPA Engine Emission Standards

Mode	Year	NOX	HC	Combo	PM	Ratio Combo	PM Ratio	Total Ratio
Railroad	2015	1.30	0.14	1.44	0.03	36%	120%	156%
Truck	2007			2.40	0.01			
Barge(>3700HP)	2014	1.8	0.19	1.99	0.12			
Barge(<3700HP)	2014	1.8	0.19	1.99	0.04	50%	280%	330%

Source: Environmental Protection Agency, Web Page January 6, 2013

Regional Economic Value Model Inputs

The regional modeling of production and amenities cost changes requires two sets of values per ton as well as a traffic forecast for the five disruption periods. To this end, UTK-CTR developed values per ton for shipper production cost change and adjusted social cost change. These values are developed by rolling up the individual 2265 origin/destination sample movements into either commodity group or total annual values.

APPENDIX 1.1 – SAMPLE RATE WORKSHEET

TRANSPORTATION RATE ANALYSIS

Ref No.: 1 (Page 1)

Commodity	Wheat (Including Spelt) and Meslin, Unmilled		
WCSC Gp.	4100	Tonnage	1,686
River Origin	22888601	Riv. Dest	77625510
Origin Port Code	LOWER MISS RIVER MILE 888	Dest Port Code	BURNS WATERWAY HARBOR INDIANA
Origin WW Mile	MISSISSIPPI RIVER, MOUTH OF OHIO RIV	Dest WW Mile	LAKE MICHIGAN 0
Off-River Orig.	Farm Direct Radius 30 Miles	Off-River Dest	Export Vessel

WATER ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				0.77 a/
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river	Truck	20	1.7	5.78 b/
(5) Handling at river origin				1.79 c/
(6) Line haul charge	Barge	543	450.0	12.73 d/
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				2.00 e/
(10) Other				
Total		563		23.07

LAND ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				0.77 a/
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river	Truck	20	1.7	5.78 b/
(5) Handling at river origin				1.79 c/
(6) Line haul charge	Truck	422	8.0	50.32 f/
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				2.00 e/
(10) Other				
Total		442		60.66

SUMMARY

	Cost
(1) Water Route	23.07
(2) Land Route	60.66

AUTHORITIES FOR CHARGES AND EXPLANATION OF REFERENCE MARKS

a/ Kansas State University "Farm Machine Operation Cost Calculations" Agricultural Extension Service, Indexed 2011, Quarter Hour Transfer Time
b/ Private Truck Rate $85 per hour Based Upon Multiple Dock Interviews In September and October 2011 Average Distance 2/3 Radius
c/ Handling Rate Based Upon New Madrid Dock Interview for Upper Mississippi River Rate Study
d/ Waterborne Freight Tariff 7 with USDA Average Weekly Percent of Tariff 2007-2011 @ 214% Plus Vessel Operator Reported Switch Charge From/Or to Chicago
e/ Maximum Handling Rate for a Settlement Elevator Allowed by Chicago Board of Trade Regulations Six Cents per Bushel
f/ Truck Rate $3.10 Loaded Mile 26 Ton Minimum

TRANSPORTATION RATE ANALYSIS

Ref No.: 1 (Page 2)

Commodity	Wheat (Including Spelt) and Meslin, Unmilled		
WCSC Gp.	4100	Tonnage	1,686
River Origin	22888601	Riv. Dest	77625510
Origin Port Code	LOWER MISS RIVER MILE 888	Dest Port Code	BURNS WATERWAY HARBOR INDIANA
Origin WW Mile	MISSISSIPPI RIVER, MOUTH OF OHIO	Dest WW Mile	LAKE MICHIGAN 0
Off-River Orig.	Farm Direct Radius 30 Miles	Off-River Dest	Export Vessel

ALT1 ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				0.77 a/
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river	Truck	20	1.7	5.78 b/
(5) Handling at river origin				1.79 c/
(6) Line haul charge	Barge	543	450.0	12.73 d/
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				2.00 e/
(10) Other				1.20 f/
Total		563		24.27

ALT2 ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				0.77 a/
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river	Truck	20	1.7	5.78 b/
(5) Handling at river origin				1.79 c/
(6) Line haul charge	Barge	543	450.0	12.73 d/
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				2.00 e/
(10) Other				3.61 g/
Total		563		26.68

AUTHORITIES FOR CHARGES AND EXPLANATION OF REFERENCE MARKS

a/ Kansas State University "Farm Machine Operation Cost Calculations" Agricultural Extension Service, Indexed 2011, Quarter Hour Transfer Time

b/ Private Truck Rate $85 per hour Based Upon Multiple Dock Interviews In September and October 2011 Average Distance 2/3 Radius

c/ Handling Rate Based Upon New Madrid Dock Interview for Upper Mississippi River Rate Study

d/ Waterborne Freight Tariff 7 with USDA Average Weekly Percent of Tariff 2007-2011 @ 214% Plus Vessel Operator Reported Switch Charge From/Or to Chicago

e/ Maximum Handling Rate for a Settlement Elevator Allowed by Chicago Board of Trade Regulations Six Cents per Bushel

f/ Demurrage At Joliet, IL Average Seven Days @ $275 Per Day 1600 Tons

g/ Demurrage At Joliet, IL Average 21 Days @ $275 Per Day 1600 Tons

TRANSPORTATION RATE ANALYSIS

Ref No.: 1 (Page 3)

Commodity	Wheat (Including Spelt) and Meslin, Unmilled		
WCSC Gp.	4100	Tonnage	1,686
River Origin	22888601	Riv. Dest	77625510
Origin Port Code	LOWER MISS RIVER MILE 888	Dest Port Code	BURNS WATERWAY HARBOR INDIANA
Origin WW Mile	MISSISSIPPI RIVER, MOUTH OF OHIO	Dest WW Mile	LAKE MICHIGAN 0
Off-River Orig.	Farm Direct Radius 30 Miles	Off-River Dest	Export Vessel

ALT3 ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				0.77 a/
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river	Truck	20	1.7	5.78 b/
(5) Handling at river origin				1.79 c/
(6) Line haul charge	Truck	422	8.0	50.32 d/
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				2.00 e/
(10) Other				
Total		442		60.66

ALT4 ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				0.77 a/
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river	Truck	20	1.7	5.78 b/
(5) Handling at river origin				1.79 c/
(6) Line haul charge	Truck	422	8.0	50.32 d/
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				2.00 e/
(10) Other				
Total		442		60.66

AUTHORITIES FOR CHARGES AND EXPLANATION OF REFERENCE MARKS

a/ Kansas State University "Farm Machine Operation Cost Calculations" Agricultural Extension Service, Indexed 2011, Quarter Hour Transfer Time

b/ Private Truck Rate $85 per hour Based Upon Multiple Dock Interviews In September and October 2011 Average Distance 2/3 Radius

c/ Handling Rate Based Upon New Madrid Dock Interview for Upper Mississippi River Rate Study

d/ Truck Rate $3.10 Loaded Mile 26 Ton Minimum

e/ Maximum Handling Rate for a Settlement Elevator Allowed by Chicago Board of Trade Regulations Six Cents per Bushel

TRANSPORTATION RATE ANALYSIS

Ref No.: 1 (Page 4)

Commodity	Wheat (Including Spelt) and Meslin, Unmilled		
WCSC Gp.	4100	Tonnage	1,686
River Origin	22888601	Riv. Dest	77625510
Origin Port Code	LOWER MISS RIVER MILE 888	Dest Port Code	BURNS WATERWAY HARBOR INDIANA
Origin WW Mile	MISSISSIPPI RIVER, MOUTH OF OHIO	Dest WW Mile	LAKE MICHIGAN 0
Off-River Orig.	Farm Direct Radius 30 Miles	Off-River Dest	Export Vessel

ALT5 ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				0.77 a/
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river	Truck	20	1.7	5.78 b/
(5) Handling at river origin				1.79 c/
(6) Line haul charge	Truck	422	8.0	50.32 d/
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				2.00 e/
(10) Other				
Total		442		60.66

ALT6 ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river				
(5) Handling at river origin				
(6) Line haul charge				
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				
(10) Other				
Total		0		0.00

AUTHORITIES FOR CHARGES AND EXPLANATION OF REFERENCE MARKS

a/ Kansas State University "Farm Machine Operation Cost Calculations" Agricultural Extension Service, Indexed 2011, Quarter Hour Transfer Time

b/ Private Truck Rate $85 per hour Based Upon Multiple Dock Interviews In September and October 2011 Average Distance 2/3 Radius

c/ Handling Rate Based Upon New Madrid Dock Interview for Upper Mississippi River Rate Study

d/ Truck Rate $3.10 Loaded Mile 26 Ton Minimum

e/ Maximum Handling Rate for a Settlement Elevator Allowed by Chicago Board of Trade Regulations Six Cents per Bushel

APPENDIX 1.2 – EMPTY RETURN RATIOS, HORSEPOWER AND TOW SIZE BY RIVER SEGMENT

RIVNUM	RIVER	MTYUP	MTYDOWN
1	ALABAMA	0.06	0.99
2	ALLEGHENY	0.86	0.15
3	A/C/F/	1.00	1.00
4	ARKANSAS	0.22	0.31
5	ATCHAFALAYA, N	1.00	0.20
6	ATCHAFALAYA, S	0.97	0.44
7	BIG SANDY	1.00	1.00
8	BLACK/OUCHITA	0.74	0.25
9	BLACK-WARRIOR	0.09	0.87
10	CUMBERLAND	1.00	0.03
11	GIW(E) NOLA-MOBILE	0.50	0.32
12	GIW(E) MOBILE-ACF JCT	0.50	0.50
13	GIW(W) HARVEY LOCK-MORGAN CITY	0.71	0.24
14	GIW(W) MORGAN CITY-BROWNSVILLE	0.33	0.46
15	GREEN	0.26	0.43
16	HOU S/C	0.28	0.42
17	IHNC	0.51	0.36
18	ILL	0.31	0.42
19	KAN	0.07	0.80
2	LM 1-98	0.50	0.50
21	LM 99-229	0.25	0.50
22	LM 230-954	0.25	0.50

23	MO LOWR	0.10	0.25
24	MO MID	0.10	0.15
25	MO UPR	0.10	0.10
26	MOB RIV	0.13	0.88
27	MOB S/C	0.50	0.50
28	MON	0.27	0.57
29	MCPA	0.38	0.50
30	MRGO	1.00	1.00
31	OHIO	0.45	0.25
32	OLD	0.09	0.95
33	RED	0.96	0.01
34	TN LOWER	0.69	0.13
35	TN UPPER	0.77	0.12
36	TENN-TOM	0.13	0.93
37	TOMB	0.13	0.88
38	UM 0-185	0.09	0.48
39	UM 186-865	0.09	0.48
40	YAZOO	0.25	0.95
41	OTHER	0.34	0.46
42	ALGIERS CANAL	0.66	0.20
43	COLUMBIA	0.19	0.62
44	SNAKE	0.16	0.70

..

SEG_NO	RIVER	GTOW_HP	GTOW_CLS	GTOW_SIZ
1	ALABAMA	1200	1	4
2	ALLEGHENY	1450	2	3
3	A/C/F/	1600	3	2
4	ARKANSAS	3150	5	8
5	ATCHAFALAYA, NORTH	1550	2	2
6	ATCHAFALAYA, SOUTH	1450	2	2
7	BIG SANDY	1250	1	4
8	BLACK/OUCHITA	1500	2	2
9	BLACK-WARRIOR	1700	3	6
10	CUMBERLAND	2700	5	8
11	GIW(E) NOLA-MOBILE	1400	2	4
12	GIW(E) MOBILE-ACF JCT	1300	1	3
13	GIW(W) HARVEY LOCK-MORGAN CITY	1250	1	3
14	GIW(W) MORGAN CITY-BROWNSVILLE	1500	2	2
15	GREEN	1800	3	4
16	IHNC (NEW ORLEANS)	1200	1	4
17	ILLINOIS	3100	5	6
18	KANAWHA	2100	4	7
19	LOWER MISS	3000	5	25
20	MISS RIV-GULF OUTLET	950	0.9	2
21	MISSOURI KAN CITY-SOUTH	1500	2	4
22	MISSOURI KAN CITY-OMAHA	1600	3	2

23	MISSOURI OMAHA-S CITY	1800	3	2
24	MOBILE RIVER	1700	3	5
25	MONONGAHELA	1800	3	5
26	MOR CITY-PT ALLEN ROUTE	1800	3	4
27	OHIO	2800	5	11
28	OLD	1600	3	4
29	RED	1800	3	4
30	TENNESSEE, LOWER	2900	5	9
31	TENNESSEE, UPPER	2150	4	5
32	TENNESSEE-TOMBIGBEE	2200	4	6
33	TOMBIGBEE RIVER	1700	3	6
34	UPPER MISS CAIRO-ST LOUIS	4650	8	15
35	UPPER MISS ST LOUIS-MPLS	4150	7	11
36	YAZOO	2400	4	3
37	OTHER	2050	3	2
38	ILL RIV ABOVE MI 291(L'PORT)	3000	5	4
39	ALGIERS CANAL	1350	2	3
40	COLUMBIA	3100	5	3
41	SNAKE	3100	5	3

APPENDIX 1.3 – PERCENTAGE OF WATERWAY FREIGHT BUREAU TARIFF NO. 7 FOR THE MOVEMENT OF GRAIN

Waterway Segment	*2011 Percent of Tariff*	*2007-2011 Average Percent of Tariff*
Upper Mississippi River	515%	300%
Middle Mississippi River	467%	283%
Illinois River	461%	273%
Middle Mississippi River (0-243)	363%	228%
Upper Ohio River	432%	251%
Lower Ohio River	432%	251%
Lower Mississippi River (Memphis)	334%	214%
Lower Mississippi River (NOLA)	463%	287%

Source: U.S. Department of Agriculture

Commercial Cargo Report Appendix 2:

External Costs Due to an Unanticipated Closure of the Chicago Area Waterway System to Waterborne Commerce

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EXECUTIVE SUMMARY

Short-run or permanent disruptions of commercial barge transportation service on the Chicago Area Waterway System (CAWS) could be made necessary by plans for hydrologic separation of this waterway the from the Great Lakes. This separation is a potential solution to the problem of aquatic species (ANS) migration between the Great Lakes and the Mississippi River Basin. The current report documents the University of Tennessee's Center for Transportation Research (CTR) study of potential social costs of unanticipated 15, 30, 60, 90 and 180 day CAWS closures and the resultant water-to-overland truck diversions.

The traffic diversion study uses a modification of the models developed by CTR to study the impacts of traffic diversions in Pittsburgh to quantify the diversion costs in CAWS and non-CAWS areas. While certain non-critical parameters remained unchanged, highway traffic counts, speed limits, and the number of lanes were modified to reflect conditions in the study area.[1] Input data were derived from a variety of sources including Chicago area video logs, a highway field survey, and interviews with 133 firms concerning their response to a variety of possible planned and unplanned closures. On average, CTR interviewed 92 percent of the shipping docks identified in the data sample.

Inside the CAWS virtually every interstate waterway-inclusive movement is modeled using the modified traffic demand model. Eighty-two percent of the non-interstate CAWS movements are modeled. Costs for non-modeled segments were estimated on modeled results. In the case of CAWS traffic, a representative measure of social cost per mile is used. Total cost for the unmodeled segments in the CAWS are the product of miles traveled and the estimated cost ratio. For the non-CAWS unmodeled segments, an estimated free-flowing (no congestion) section of area interstate is used to develop the ratio of social cost to miles traveled. As with the traffic in the CAWS, social costs in the non-CAWS un-modeled segments are the product of miles traveled and the defined ratio of cost to miles traveled.

Waterway social closure costs for each year of a 50-year horizon are estimated for total closures of 15, 30, 60, 90, and 180 days. Costs are a composite of travel delay time, changed safety outcomes, air pollution and fuel consumed. These costs are not calculated for any specific time period in any given year but are calculated as annual values and then scaled to a period matching the scenario values. As Table 5 illustrates, the cost per ton mile value is essentially the same for all scenarios in years one and fifty ($0.030 and $0.037 respectively).

A major finding of the study is that calculated values for each scenario are scalar values one to another with differences that are dictated by changes in the number of trucks diverted into the resident traffic flow in each scenario. This linear relation is due to the several factors including: (1) the relatively small number of trucks (relative to resident CAWS vehicle volumes) that are diverted onto each highway in each closure scenario, (2) the low level of projected resident traffic growth, (3) the fact that diversions are made at night when traffic congestion is lower than

[1] Wegmann, Fred J. et. al., *Social Costs of Barge Cargo Modal Diversions Due to Unscheduled Closures at Emsworth, Dashields, and Montgomery Locks*, Center for Transportation Research and College of Engineering, University of Tennessee, August 2008.

in the daylight hours, and (4) the fact that many of the vehicle miles occur on free flowing interstates outside the Chicago area.

In summary, simulations demonstrate that highway capacity is adequate to support the traffic diversions both inside and outside the Chicago area at a one percent resident traffic growth rate. While not due to congestion induced by the traffic diversion, the societal costs reported in Table 5 are brought on by (1) differences in efficiency between the barge and truck transportation, (2) high base year traffic levels that produce congestion in resident CAWS traffic, and (3) a projected growth in resident traffic that exacerbates already-existing traffic levels especially in the Chicago area.

The results suggest that social costs are lowest in the 15 day diversion scenario. A one-time annual diversion in year one would cost \$2.0 million but grow to \$3.9 million if the diversion occurred in the 50th year. The 30 day diversion ranks second as costs would be \$6.0 million in the first year and grow to \$11.9 million in the 50th year. During the 60 day diversion, the annual cost in year one ranks third at \$12.2 million. In the 50th year the cost reaches \$25.2 million. The cost of a one-time diversion of 90 days is estimated to cost \$14.2 million in year one and rise to \$28.6 million in year 50. In the 180 day or closure scenario, the cost is estimated to be \$21.8 million in the first year and rise to \$44.2 million in the 50th year. Assuming that a closure occurs once annually in each scenario in years 1-50, the present values (calculated at a four percent interest rate) range from \$51.9 million in the 15 year period to \$566.8 million in the 180 day period.

INTRODCUTION

Short-run or permanent disruptions of commercial barge transportation service on the Chicago Area Waterway System (CAWS) could be necessary due to the implementation of plans for hydrologic separation of this waterway the from the Great Lakes. This separation is thought by some to be a solution to the problem of aquatic species (ANS) migrating between the Great Lakes and the Mississippi River Basin. The current report documents the University of Tennessee's Center for Transportation Research (CTR) study of potential social costs of unanticipated 15, 30, 60, 90 and 180 day closures due to the resultant water-to-overland truck diversions.

BACKGROUND

The proliferation of ANS is an ongoing concern in U.S. waterways, with the alarm centering on the prospect that Asian carp may cross into the Great Lakes through the CAWS, a key waterway link between the Great Lakes and Mississippi Basins. While the U.S. Army Corps of Engineers (Corps) has installed and maintains an electronic barrier on the Illinois River, many whose livelihoods depend on tourism and commercial fishing remain concerned by the prospect of an Asian carp invasion into the Great Lakes. Various solutions have been proposed for minimizing the risk of an Asian Carp migration, including complete hydrologic separation of the CAWS (at various locations) from the Great Lakes.

Any of the plans currently under consideration for addressing the ANS problem could potentially disrupt commercial cargo traffic on the CAWS, affecting both resident industry and the general public. Some of the commodities currently moving on barges would be diverted to truck or rail, depending on the nature of the disruption. The additional overland traffic would, in turn, result in a variety of adverse impacts, referred to as externalities. These impacts include delay due to traffic congestion and incidents, truck and rail-related accident damages, increased fuel consumption and air pollution emissions and morbidity and mortality effects of the increased emissions.

PRIMARY STUDY DATA

The primary study area is defined as the CAWS. For the purposes of this work, the area includes the parts of the Chicago Sanitary and Ship Canal above Lockport Lock, the North and South Branches of the Chicago River, the Chicago River itself, the Cal-Sag Waterway, the Little Calumet River, Lake Calumet and the Calumet River. The CAWS currently handles around 16 million tons of commodity traffic, 41 percent of which is inbound, 19 percent outbound, 28 percent internal and 12 percent through.

EXISTING METHODOLOGY

The traffic diversion model, in its present form developed for use in the Corp's Pittsburgh traffic diversion study, is used to analyze the effects on local traffic conditions given a planned or unplanned closure of the CAWS to commercial barge transportation[2]. In the base case of the current exercise, the analyst first estimates the social costs existing with current traffic levels. These data are then compared to social costs given a CAWS closure that requires waterway traffic diversions to overland routes.

In the Pittsburgh study, the model tracked hourly traffic volumes on the affect highway links over a 51 year period. The traffic model accepts a variety of user inputs for various infrastructure and traffic scenarios. These include base case traffic growth rates by major road type and new truck growth rates. In the Pittsburgh Study, the growth rate for new truck traffic mirrored the Corps forecast of river traffic on the upper Ohio River[3]. Other important user-supplied input parameters include the number of forecast years, number of days per year of new coal plus non-coal trucks, number of days per year of new coal-only trucks, constant dollar fuel price per gallon, value of travel time for auto and for truck, accident cost factors for auto and for truck, and emission cost factors for five pollutants.

Additional model inputs include highway link characteristics, base year average daily traffic levels (AADT) for all traffic and for trucks, number of new trucks owing to diversion (coal and non-coal by day and night), traffic distribution patterns (by functional class, direction, and hour), grams of pollutants per mile (truck and auto by 5mph speed bin and year), and new truck tonnage matrix by movement and link.

For a 51-year execution, the model outputs more than 75,000 values Resulting output tables include:

- Vehicle miles traveled (VMT) for auto and truck, by year and 5mph speed bin, base and 2 impact scenarios;
- Travel hours, VMT, fuel costs, pollutant costs for auto and truck, by link, base and 2 impact scenarios;
- Average speed by hour and direction by (user selected) link and year, base and 2 impact scenarios;
- Minimum speed occurring during year by link and year, base and 2 impact scenarios; and
- Kilogram emissions by year, base and 2 impact scenarios.

[2] The material below is taken from this study Wegmann et. al, *Social Costs of Barge Cargo Modal Diversions Due to Unscheduled Closures at Emsworth, Daschields, and Montgomery Locks*, University of Tennessee Center for Transportation Research, prepared for the Tennessee Valley Authority, 2007.

[3] A variety of forecasts were supplied by the U.S. Army Corps of Engineers, Huntington District via email on February 29, 2008.

The model calculates hourly traffic flows, based on specified distribution patterns, for each combination of base or diversion scenario (day and night), vehicle type (automobile or truck), and direction. If a diversion scenario is being considered, new truck traffic adds to base traffic volumes and the percent trucks for the specific hour and direction. The new traffic's share of total traffic enters into the capacity calculation routine affecting average speed. Along with the segment length, the average speed determines travel hours and fuel consumption per mile for autos and for trucks. Total vehicle miles traveled are determined by segment length and traffic volume.

Vehicle miles traveled by 5 mph ranges, by year for auto and for truck, are calculated in a subroutine that performs the necessary volume growth calculations, accumulates the quantities into the required average speed bins, and writes the output in separate worksheet.

HIGHWAY TRAFFIC PARAMETERS AND CALCULATIONS[4]

For each scenario, the model distributes ADT by hour and direction for each highway link based on the functional class of the link. Each link's traffic capacity is calculated based on road type, terrain, and the percentage that trucks are of total traffic. Capacity decreases as the percentage of trucks rises and speed decreases (and travel times increase) as the volume to capacity ratio rises. Capacity in one direction for one lane is given by:

Urban freeway, non-signalized, Sf = 55 mph

c=2300*PHF*Fp/(1+Pt(Et-1))
Assume PHF=0.9, and Fp=1.0

Rural freeway, non-signalized, Sf = 65 mph

c=2400*PHF*Fp/(1+Pt(Et-1))
Assume PHF = 0.80, Fp = 1.0

Non-freeway 2-lanes or 1-lane, non-signalized; Sf = 55 mph

c=1700*PHF*Fp*Fg/(1+Pt(Et-1))
Assume PHF = 0.85, Fp = 1.0

Signalized urban arterials, signal spacing <= 2 miles

c = 1900*PHF*(g/c)/(1+1.0*Pt)
Assume PHF = 0.90, g/c = 0.45

where PHF = peak hour factor (distribution of traffic in the peak hour)

Fp = adjustment for driver familiarity
Pt = proportion of heavy vehicles
Et = passenger car equivalents (varies by highway type and terrain)
Fg = grade adjustment factor
g/c = duration of green to cycle length

The results of NCHRP Report 387 were used to determine speed and travel time equations. These are summarized as follows:

For roads without signals – Posted speed limit > 50 mph

Sf = 0.88 * Sp + 14

[4] The equations are based on *HPMS Field Manual, Appendix N: Procedures for Estimating Highway Capacity*, U.S. Department of Transportation, Federal Highway Administration, and on suggestions by Dr. Arun Chatterjee, retired from the Civil Engineering Department of the University of Tennessee.

$S = Sf/ (1+0.15 * (v/c)^4)$[5]
T = 1/S. This is travel time.

For roads without signals – Posted speed limit <= 50 mph

$Sf = 0.79 * Sp + 12$
$S = Sf/(1 + 0.05(v/c)^{10})$

For roads with signals

$Smb = 0.79 * Sp + 12$
$D = Df * 0.5 * C * (1-.45)^2$
$Sf = L/(L/Smb + N' * (D/3600))$
$S = Sf/(1+0.05 * (v/c)^{10})$
$T=1/S$

Where:

Sp = posted speed limit in miles per hour (mph),
Sf = free flowing speed in mph,
S = average speed in mph,
V = traffic volume by direction by hour,
C = capacity in one direction in vehicles per hour,
T = travel time,
Smb = the mid-block free flowing speed in miles per hour,
Df = degree of coordination between signals (NHCRP Report 387 suggests that Df should equal one when fixed time signals are uncoordinated,
C = cycle length = 120 seconds,
D = delay in seconds per vehicle,
L = length of segment;
N' = the number of signalized intersections in each link.

Social Cost Assumptions

Once the model completes the traffic flow calculations, it estimates social costs by scenario, diversion social costs, and diversion unit (per ton) social costs. Outputs include these tables:

Total social cost by link by year, base and two impact scenarios
Diversion social costs per ton by link and year, two impact scenarios
Diversion social costs per mile by link, two impact scenarios
Social costs, total and four components for auto and truck, by year, base and two impact scenarios
Diversion social costs, total and four components for auto and truck, by year, two impact scenarios
Diversion social costs per ton by movement and year, two impact scenarios

[5] This speed equation has its origin in the Bureau of Public Roads. It is used for adjusting speeds for traffic assignment on a road network for the planning of roadways.

The next section discusses the components of social costs in more detail.

Social Cost Components

Non-Commercial Use

Increased travel time resulting from diversion of river traffic onto highways is a major component of user costs. Economists have studied the value of time and in particular how motorists value their time in traffic delays[6]. The value of time for the motorists depends on the opportunity cost of using their time in some other manner. Revealed preference studies, that is, studies of the value of time based on actual choices, allow values to depend on wage rates, incomes, and other factors Small and Winston (2005) examined the behavior of motorists in Los Angeles who may use express lanes but must first arrange to pay tolls and found that the average valuation in the value of time is quite high, thus suggesting that time is much more valuable than the revealed preference theoretical model might suggest.[7]

The USACE has also studied the value of time. David Hill and David Moser provided guidance for handling this problem in 1991 in the Institute for Water Resources Report, *Value of Time Saved for Use in Corps Planning Studies: A Review of the Literature and Recommendations.* The report focuses on the value of time related to personal vehicle use but gives no direction on value of time to commercial operators. The report cites a rich array of studies on the subject including the American Association of State Highway Officials (AASHO). Since the Corps report was published, AASHO (now AASHTO, the American Association of State Highway and Transportation Officials) has published further guidance to highway planners. The 2003 AASHTO Manual, commonly referred to as the Red Book, is used in the Pittsburgh study[8]. Recently, AASHTO has published a revised edition, *User and Non-User Benefit Analysis for Highways* (2010).

The Red Book document suggests that the value of time for personal vehicle use is 50 percent of the wage rate per person in each vehicle. The CTR follows the suggestion in the Red Book and uses the 50 percent factor, which seems conservative in view of the findings of Small and Winston. In 2005 the average wage rate per employee per year in the study area was $36 thousand or $17 per hour. The value of time for non-truck traffic is thus $8.50 per hour per person.

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[6] For example, Calfee, J. and C. Winston (1998). “The Value of Automobile Travel Time: Implications for Congestion Policy,” Journal of Public Economics, 69, pp. 699-707.

[7] Small, K.A. and C. Winston (1999), “The Demand for Transportation: Models and Applications,” in Gomez-Ibanez, W. Tye and C. Winston editors, Essays in Transportation Economics and Policy: A Handbook In Honor of John R. Meyer, Washington, DC: Brookings Institution Press.

[8] American Association of State Highway and Transportation Officials (AASHTO), User Benefit Analysis for Highways Manual, August 2003.

The Bureau of Transportation Statistics (BTS) reports that, for all personal vehicle trips in the nation, there are 1.63 persons per vehicle[9]. Vehicle occupancy by type of trip is shown in Table 1. Note that occupancy in work related trips is 1.14, which is the lowest value among the different types of trips.. The data suggest that in the study area 72.1and 83.8 percent of the commuters drive alone. In the remainder of the MSA, 83.8 percent drive alone. These data provide some evidence that, at least for commuters to work, it is appropriate to use the national data to reflect conditions in the Chicago area.

Table 1: National Vehicle Occupancy per Vehicle Mile by Daily Trip Purpose

Trip Purpose	Mean Value
All Person Vehicle Trips	1.63
Work	1.14
Work-related	1.22
Family-Personal	1.81
Church-school	1.76
Social-recreational	2.05
Other	2.02

Using BTS's mean value for all trips, the total estimated cost per hour is $13.86 ($8.50 x 1.63). The CTR methodology is easily compatible with the Hill and Moser document. For high time savings over 15 minutes, Hill and Moser suggest $8.33 dollars (1991 dollars) on a per vehicle-occupant basis. For other trips they suggest $9.98 on a per vehicle basis. For reference, the CPI calculator suggests an inflation adjustment from 1991 to 2005 of 1.43. Adjusting work trips for inflation and using the work-related vehicle occupancy rate suggested in the table above, the Hill and Moser work related savings would be ($8.33 x 1.43 x 1.14 = $13.58). The current value of the other trips category is $14.27 ($9.98 x 1.43). One other category suggested by Hill and Moser is social and recreational trips. The current value of time savings for this category is $13.28 ($9.29 x 1.43). Thus, whether suggested parameters come from the Red Book or from inflation adjusted data offered by Hill and Moser, an estimate of cost per hour per vehicle is approximately $14.00.

Commercial Highway Use

The opportunity cost of a commercial truck is equal to the benefit-loaded cost of hiring a new driver plus other operating expenses. The Tennessee Valley Authority (TVA) surveyed commercial highway users and found that the average cost of supplying a semi-tractor trailer driver is $65 per hour including fuel. Because this study groups all commercial vehicles together, the rate of $55 per hour is more reasonable since some of the deliveries would be made in smaller commercial vehicles that are less expensive to operate than the larger trucks[10]. However,

[9] Bureau of Transportation Statistics, daily trip file for 2001.
[10] The commercial data were supplied by TVA in an email dated March 4, 2008.

the cost of fuel must be netted out. TVA estimates that, of the $55 per hour estimate, $13.10 should be allocated to fuel consumption, leaving $41.90 as the net time value cost per hour.

Fuel Consumption

An important component of the current study involves the calculation of fuel required by the addition of new trucks into the traffic flow. When new trucks enter into the traffic flow, other vehicles will experience additional delays and longer driving times. Thus, these vehicles, both trucks and automobiles, consume more fuel per trip. This fuel consumption is an external effect. The new trucks also consume fuel as an element of doing business, and this consumption is an NED cost of doing business under normal operating conditions. This cost is included in the estimate of shipper savings, which does not incorporate delays induced by the trucks themselves. The additional fuel consumed by the new trucks, over and above that required to make deliveries under normal operating conditions, is an externality. CTR estimates the required fuel consumption for all vehicles in the base case and in the two scenarios, nets out the increase in fuel consumption, and values the cost of the net increase at a real cost of $4.00 per gallon[11].

Crash Costs

Additional truck traffic on the roads can degrade highway safety, increasing either or both the rate and severity of accidents. Increased rail traffic, however, should not affect the safety of highway transportation because virtually all rail crossing are not at grade.
Calculating accident costs can be very complicated, as accident frequency and accident unit costs must be computed. Total accident unit costs include all costs resulting from fatalities, injuries, and property damage. As discussed in the Red Book, "…accident unit costs are calculated net of insurance costs to avoid double counting that portion of costs that are already covered by insurance."[12] Insurance costs are a cost of doing business and are included in calculations of transportation rates.

The U.S. Department of Transportation provides accident cost data by category of accident for fatal accidents, non-fatal accidents, property damage, and for all accidents[13]. Table 2 presents these data for the year 2000; the values are converted to the initial year values for estimating the accident costs caused by the diversions to truck:

[11] It is possible that a small amount of double counting will occur as fuel costs for the diverted traffic also appears in the shipper savings calculations. However, this potential effect is thought to be too small to be of any consequence.
[12] Red Book, page 5-23.
[13] U.S. Department of Transportation, National Highway Traffic Safety Administration, *Traffic Safety Facts 200*0. U. S. Department of Transportation, Federal Highway Administration, *Highway Statistics 2000.*

Table 2: Motor Vehicle Accident Costs in Cents per Vehicle Mile Traveled (2000 dollars)

Category of Accidents	Passenger Cars	Large Trucks
Fatal Accidents	4.2	5.86
Injury (non-fatal Accidents)	11.16	3.66
Property Damage Only	0.61	0.38
All Accidents	15.97	9.90

CTR used 15.97 cents per VMT (in 2000 dollars) for the accident costs for personal vehicle travel and 9.9 cents per VMT for commercial trucks.

Air Quality – Vehicle Emissions

The model calculates air pollution emissions from on-road mobile sources by multiplying VMT for the various scenarios times an emission factor (in grams per vehicle mile). It computes VMT for two vehicle types: heavy-duty diesel vehicles class 8b (HDDV8b) and all other vehicles combined. HDDV8b vehicles are those with GVWR (gross vehicle weight ratings) of more than 65,000 pounds, equivalent to 18-wheeled tractor-trailer trucks. All other vehicles combined includes light-duty gasoline fueled automobiles, SUV's, pickup and delivery trucks, and light to moderate weight diesel vehicles (both cars and trucks).

Emission factors are obtained for each calendar year using the USEPA MOBILE6.2 emissions model, which determines emission factors for each pollutant, taking into account the model year, the national average age mix of each vehicle type, the average speed, fuel composition factors, and environmental conditions, such as ambient temperature and humidity. Emission factors calculated for this project are based on a minimum/maximum temperature of 56/80 F (average summer), the default humidity of 75 grains per pound of dry air, a gasoline RVP (Reid vapor pressure) of 7.8 psi, and a diesel sulfur content of 43 ppm until May 2010, and 11 ppm after June 2010 as required by USEPA nationwide. The most important factors are vehicle type, age, and speed. Newer vehicles of all types generally have lower emissions than older vehicles owing to USEPA's increasingly stringent emission standards for newer vehicles. The MOBILE6.2 model predicts that emission factors for all pollutants will decrease in future years (as they have done since the first emission standards in the 1970's) until about 2030 when all existing emission standards will be fully implemented. In fact, emissions from mobile sources will probably decrease even after 2030, but future emission standards are not currently known, so the model cannot account for these reductions.

HDDV8b vehicles have the highest emission factors for particulate matter (PM) and nitrogen oxide (NOx) emissions compared to other vehicles. Nitrogen oxide emissions from HDDV8b vehicles vary by vehicle speed. For this reason, emission factors are calculated for a range of speeds from 2.5 to 65 mph for different calendar years from 2006 to 2051 and for HDDV8b vehicles only and all other vehicles combined. The mix of all other vehicles combined follows USEPA's default national average values built into the MOBILE6.2 model. The effects of vehicle age, model year, and speed on emissions are all accounted for in the MOBILE6.2 model, so emission rates from on-road mobile sources can be estimated throughout the United States on a consistent basis. During the period in which the earlier studies were completed, the USEPA was recommending the use of the MOBILE6.2 model for calculating emissions from on-road mobile sources for transportation and air quality planning in all US states except California (California uses the CARB EMFAC model, very similar to MOBILE6.2).[14]

For the current study, the MOBILE6.2 model is used to calculate emission factors for particulate matter, nitrogen oxides, sulfur dioxide, VOC's (volatile organic compounds), and ammonia. Separate tables of results are prepared for each calendar year. In each table, emission factors for each pollutant, for HDDV8b, and all other vehicles combined are summarized for each speed ranging from 2.5 mph to 65 mph in 5 mph increments. After multiplying emission factors times the VMT for each diversion scenario, total tons/year or pounds/day of emissions are determined for each scenario.

Air Quality Benefits

Whenever USEPA proposes stricter emission standards for pollution sources they conduct a cost/benefit analysis to estimate the costs and benefits of the proposed regulations. The costs are primarily the costs of installing more efficient pollution controls while the benefits are largely health benefits resulting from reduced air pollution concentrations. USEPA has performed many health effects and epidemiological studies that quantify the health benefits of reducing air pollution.

In 2000 USEPA implemented new emission standards for trucks and buses (as well as sulfur limits in diesel fuel) that were expected to reduce emissions by 97 percent from these vehicles. EPA further concluded that diesel exhaust is likely to cause lung cancer in humans and that the new standards would prevent 8,300 premature deaths annually. The new standards were expected to prevent 5,500 cases of chronic bronchitis, 17,600 cases of acute bronchitis in children, 360,000 asthma attacks, and more than 386,000 cases of respiratory symptoms in asthmatic children annually (see EPA Fact Sheet at www.epa.gov/otaq/diesel.htm). The new emissions standards were expected to reduce nitrogen oxide emissions by 2.6 million tons per year and particulate matter emissions by 110,000 tons per year, once fully implemented. In order to estimate the costs and benefits of saving lives, EPA uses $6 million per life saved (8,300 lives per year), resulting in a potential $49.8 billion benefit per year. According to EPA "the benefits of the action outweigh costs by 16 to one".

The methods EPA uses to relate health effects to the change in ambient air pollution concentrations is beyond the scope of this report. These methods are based on epidemiological studies of the frequency of health effects in various cities with different air pollution concentrations. EPA developed a model called BenMAP (Environmental Benefits Mapping and Analysis Program) to estimate the benefits (dollars per ton of air pollution reduction) expected from the implementation of the new emission standards. This model was used by EPA in the RIA (Rule Impact Assessment) for the new truck and bus emission standards to provide

[14] More recently, EPA has made available the MOVES (Motor Vehicle Emissions Simulator) Model to estimate air pollution from on-road mobile sources.

"monetized benefit estimates of air quality improvements." BenMAP was run for different areas of the US to determine representative changes in air quality resulting from potential reductions in air pollutants and also to determine the health and cost benefit resulting from the emission reductions. The values obtained for a 25% reduction in mobile source emissions (the minimum considered) were $372,797 per ton of directly emitted particulate matter, $59,780 per ton of ammonia, $8,961 per ton of nitrogen oxides, $27,088 per ton of sulfur dioxide, and $695 per ton of VOC's. Because ammonia, nitrogen oxides, sulfur dioxide, and VOC emission reductions are due to their being precursors to particulate matter formed in the atmosphere, reducing these emissions also reduces particulate matter concentrations to which people are exposed. Note that while the cost benefit of reducing a ton of directly emitted particulate matter is much higher than for the other pollutants, nitrogen oxide emission reductions from trucks and buses are much greater than direct PM reductions, making the cost benefit of nitrogen oxide emission reductions comparable to the cost benefit from direct exhaust PM reductions.

For this study, the costs used to estimate each ton of emission reduction from mobile sources are the same values used by USEPA for the cost/benefit analysis in the RIA for the new emission standards for trucks and buses, based on the USEPA BenMAP model results. For each ton/year of emission change predicted by the traffic model, total incremental costs were calculated by multiplying the tons of emission reduction per year times the following cost per annual ton (as determined by USEPA for mobile sources):

- $ 372,797 per ton of directly emitted particulate matter
- $ 59,780 per ton of ammonia
- $ 8,961 per ton of nitrogen oxides
- $ 27,088 per ton of sulfur dioxide, and $ 695 per ton of VOC's.

Chicago-Specific Study Input Modifications

As suggested above, the basic methodology and many of the parameters used in the current work are the same as those used in earlier CTR work. There were, however, a number of updates and modifications. Additional data necessary to the Chicago area CTR social costing model were obtained from a variety of sources. Specifically many parameter values were obtained from field interviews of the affected firms in the CAWS area, a traffic field survey conducted by the CTR, DOT highway traffic counts and video logs posted on the internet, and traffic growth rates supplied by the Chicago Area Agency for Planning (CMAP) report *Travel Model Documentation Final Report 2010*.

Field Interviews

In the fall of 2011 a CTR staff member and contractor travelled twice to the Chicago area to interview 133 firms concerning their response to a variety of possible planned and unplanned closures of the CAWS. The interviews included questions regarding the probable user responses to unexpected closures of 15, 30, 60, 90 or 180 days. Some respondents suggested that their firm would continue to operate by shifting modes to either truck or rail transportation. Most firms indicated their affected tonnage and the routes that would most likely to taken in the event of a closure. Finally, many users concluded that due to traffic congestion in the Chicago area, the diverted truck trips would occur at night.

Traffic Growth Rates

Since the highway traffic model runs for a 50-year period, resident traffic by road (obtained from an internet search and field survey) must be forecast for this period. These data, developed by the CMAP organization are described below in Tables 3 and 4. Truck trip totals in the base year were estimated by reviewing vehicle registration files for the appropriate classes of trucks. "B" plate trucks are pickup trucks and vans with operating characteristics similar to automobiles. As shown in Table 3, the forecast annual compound growth rate is 0.008 regardless of the type of truck.

Table 3: Truck Trip totals by Vehicle Class and Growth Rates

Truck Type	Base Year 2000 Total	Year 2030	Compound Growth Rate
B Plate	1,530,000	1,989,000	0.00878
Light Trucks	430,000	559,000	0.00878
Medium Trucks	350,000	455,000	0.00878
Heavy Trucks	109,000	141,000	0.00862

Table 4: Total Point of Entry Productions and Growth Rates

Trip Type	Base Year 2000 Total	Year 2000	Compound Growth Rate
Auto External	306,000	398,000	0.00880
Truck External	131,000	170,000	0.00872
Air Traveler	61,000	79,000	0.00866

Point of entry trips represent travelers entering the region and, in the case of highway travelers, are based on traffic counts at locations around the region. Airplane counts are based on enplanements. Note that CMAP planners have forecast truck trip totals and entry productions at 0.008 percent regardless of the type of vehicle.

CTR Traffic Signal and Speed Limit Sign Survey

One of the drivers for the highway capacity model is the posted speed limit of each affected roadway. CTR staff drove to the Chicago area to collect this information for certain roads where speed limits were not visible in highway video logs due to the fact that the videos were taken at night. And during this visit, CTR staff also made ADT estimates to fill in gaps in the reported data.

Closure Costs

Background Data

The simulation results reported here are based on traffic diversions that would occur given an unanticipated closure of the CAWS to commercial barge transportation for a period of 15, 30, 90 or 180 days. To develop a rich set potentially affected shippers, CTR put together a set of shipment tons in the CAWS that for each commodity in the WCSC file are the highest movements in any single year during the period 2007-2009. This is the so-called “high three” movement file. Looking at river traffic in this manner helps achieve the goal of interviewing as many shippers in the CAWS as possible regarding their responses to closures of varying lengths. And on average CTR interviewed about 92% of the shipping docks identified in the high three sample.

Summary data for each closure period are shown in Table 5. Row one shows the number of origin-destination-commodity combinations for the first year, assuming one event per year. These range from 797 in the 15 day period to 907 in the 30 day period. The number falls in the 90 and 180 day period as many of the shippers choose to shut down or shift modes to rail transportation. The tons moved in each closure period rises through each closure period, but this increase is a function not only of business activity but also the number of days in each closure period. Standardizing for the number of days in each closure period, the average tons per day grows from the 15-day to the 30-day closure period and then declines to the low value of 25.3 thousand tons in the 180 day closure period. The average miles per trip rises from 18 days in the 15 day period to 25.8 days in the 60 day period, falling to 19.3 miles in the 180 day period. Those firms that remain open in a 90 or 180 day closure experience shorter driving times in the diversion process.

Table 5: Basic Truck Statistics for Carp Diversions

	15-Day	30-Day	60-Day	90-Day	180-Day
Number ODC Combinations	797	907	814	751	566
Tons Moved	403,694	993,858	1,893,502	2,687,267	4,562,210
Average Tons per Day	26,913	33,129	31,558	29,859	25,346
Average Miles per Trip	18.0	23.9	25.8	21.4	19.3

*ODC=origin, destination commodity

Inside the CAWS, virtually every interstate movement is modeled using the highway congestion model discussed above. Eighty-two percent of the non-interstate CAWS movements are modeled, with costs in the non-modeled segments being estimated based on patterns established in the modeled segments. In the case of CAWS movements, a representative measure of modeled social cost per mile is used. Total cost for the un-modeled segment is the product of miles traveled and the estimated ratio. For the non-CAWS un-modeled segments, a modeled free-flowing (no congestion) section of an area interstate is used to estimate the ratio of social cost to miles traveled. As with traffic in the CAWS, social costs in the non-CAWS un-modeled segments is the product of miles traveled and the defined ratio of cost to miles traveled.

SUMMARY OF FINDINGS

As noted, waterway social closure costs for years 1-50 are estimated for the periods totaling 15, 30, 60, 90, and 180 days. A summary of these costs, shown in Table 6, provides a composite of travel delay time, safety, air pollution and fuel consumed. These costs are not calculated for any specific time period in any given year but are calculated as annual values and then scaled to a period matching the scenario values, 15 days for example. As shown in Table 6, the cost per ton mile value is essentially the same for all scenarios in years one and fifty ($0.030 and $0.037 respectively). This most certainly implies that the calculated values for each scenario are scalar values one to the other and dictated by the number of trucks diverted into the resident traffic flow in each scenario. This linear relation is due to the relatively small number of trucks (relative to resident CAWS traffic levels) that are diverted onto each highway in each closure scenario, the low level of projected resident traffic growth, the fact that seventy percent of the diversions are made at night when traffic congestion is lower than in the daylight hours, and the fact that many of the vehicle miles occur on free flowing interstates outside the Chicago area. In summary, simulations demonstrate that highway capacity is adequate to support the traffic diversions both inside and outside the Chicago area at a one percent resident traffic growth rate.

Note that social costs are lowest in the 15 day diversion scenario. A onetime annual diversion in year one would cost $2.0 million but grow to $3.9 million if the diversion occurred in the 50th year. The 30 day diversion ranks second as costs would be $6.0 million in the first year and grow to $11.9 million in the 50th year. During the 60 day diversion, the annual cost in year one ranks third at $12.2 million. In the 50th year the cost reaches $25.2 million. The cost of a one-time diversion of 90 days is estimated to cost $14.2 million in year one and rise to $28.6 million in year 50. In the 180 day or closure scenario, the cost is estimated to be $21.8 million in the first year and rise to $44.2 million in the 50th year. Assuming that a closure occurs once annually in each scenario in years 1-50, the present values (calculated at a four percent interest rate) range from $51.2 million in the 15 year period to $566.8 million in the 180 day period.

Table 6: Summary Cost Data for Five Closure Scenarios at A One Percent Traffic Growth Rate ($000)

Closure Period	Cost in 1st Year	Cost in 50th Year	50 year Present Value	Cost/Ton Mile Year 1	Cost/Ton Mile Year 50
15 days	$1984.1	$3886.1	$51,193.8	$0.030	$0.037
30 days	6041.2	11,887.2	156,164.6	0.030	0.037
60 days	12,246.6	25,227.3	317,045.8	0.030	0.037
90 days	14,232.5	28,558.8	369,122.2	0.029	0.036
180 days	21,811.5	44,236.4	566,761.3	0.029	0.037

Disaggregated Results – 15, 30, 60, 90, and 180 Day Closures

The 15-day CAWS and non-CAWS 50-year highway impacts are shown in Table 7. The data are presented as annual calculated values for a 50-year period for the categories of drive time, accidents, fuel consumed, pollution effects, total value, and a present value that accumulates the annual totals for each year. As noted, the data are discounted at 4.0% rate per year, the rate requested by the Huntington District of the Corps.

In the initial year, the 15-day diversion cost is $1.984 million and rises to $3.886 million in the 50th year. The present value in year 50 is $51.20 million[15]. The initial year total is comprised of drive time (46.0%), accidents (6.4%), fuel (26.5%), and pollution cost (21.1%). But as the years advance in the simulation, pollution falls in the 50th year to 1.7% of total cost. This is due to the Environmental Protection Agency's assumptions regarding the penetration of clean burning vehicles into the resident vehicle fleet. In the 50th year of the simulation, the drive time variable rises to 57.7% of the total because congestion in the resident fleet of trucks and automobiles in the study area rises in response to the assumed one percent traffic growth rate. This growth rate is based on the CMAP assumed annual compound rate of 0.008%.

The 30-day CAWS and non-CAWS 50-year highway impacts are shown in Table 8. Like the 15-day closure results, the data are presented as annual calculated values for a 50-year period for the categories of drive time, accidents, fuel consumed, pollution effects, total value, and a present value that accumulates the annual totals for each year. The data are discounted at 4.0% rate per year as requested by the Huntington District of the Corps.

Table 7: 15-Day CAWS and non-CAWS Impacts in Current Dollars--One Percent Traffic Growth Rate Scenario

Year	Drive Time	Accident	Fuel	Pollution	Total	Per Ton-Mile	Present Value
1	$913,612	$125,924	$525,974	$418,579	$1,984,090	$0.031	$1,984,090
2	$928,538	$128,051	$534,465	$384,159	$1,975,213	$0.031	$3,883,333
3	$943,748	$130,217	$543,120	$344,214	$1,961,299	$0.030	$5,696,665
4	$959,250	$132,422	$551,945	$309,702	$1,953,320	$0.030	$7,433,159
5	$975,051	$134,668	$560,942	$273,434	$1,944,095	$0.029	$9,094,979
6	$991,159	$136,954	$570,114	$240,772	$1,938,999	$0.029	$10,688,695
7	$1,007,580	$139,282	$579,465	$211,174	$1,937,501	$0.029	$12,219,930

[15] This reflects an estimate of the gross navigation benefits attributable to keeping the diverted vehicle traffic on the CAWS waterway and not diverting due to possible closures. The net benefit would reduce the gross benefit by the cost of shipping via barge transportation. This latter number could be significant due to the fuel inefficiency of the small tows currently plying the CAWS.

8	$1,024,324	$141,653	$588,999	$186,426	$1,941,402	$0.028	$13,695,237
9	$1,041,399	$144,067	$598,722	$158,440	$1,942,628	$0.028	$15,114,696
10	$1,058,813	$146,525	$608,638	$137,628	$1,951,604	$0.028	$16,485,867
11	$1,076,576	$149,029	$618,753	$125,326	$1,969,685	$0.028	$17,816,516
12	$1,094,698	$151,578	$629,077	$112,307	$1,987,659	$0.028	$19,107,661
13	$1,113,188	$154,174	$639,616	$95,802	$2,002,780	$0.028	$20,358,592
14	$1,132,058	$156,817	$650,381	$87,678	$2,026,935	$0.028	$21,575,917
15	$1,151,318	$159,510	$661,385	$80,404	$2,052,617	$0.028	$22,761,252
16	$1,170,981	$162,251	$672,638	$74,646	$2,080,516	$0.028	$23,916,488
17	$1,191,058	$165,044	$684,157	$69,049	$2,109,306	$0.028	$25,042,664
18	$1,211,562	$167,887	$695,955	$64,003	$2,139,407	$0.028	$26,140,979
19	$1,232,509	$170,783	$708,051	$60,556	$2,171,898	$0.028	$27,213,089
20	$1,253,911	$173,733	$720,459	$57,654	$2,205,757	$0.029	$28,260,035
21	$1,275,786	$176,737	$733,198	$53,777	$2,239,498	$0.029	$29,282,113
22	$1,298,148	$179,796	$746,283	$51,422	$2,275,649	$0.029	$30,280,744
23	$1,321,017	$182,912	$759,730	$49,425	$2,313,084	$0.029	$31,256,762
24	$1,344,411	$186,086	$773,548	$48,566	$2,352,611	$0.029	$32,211,278
25	$1,368,349	$189,318	$787,748	$48,025	$2,393,439	$0.030	$33,145,010
26	$1,392,853	$192,610	$802,333	$44,737	$2,432,533	$0.030	$34,057,494
27	$1,417,946	$195,964	$817,304	$45,118	$2,476,332	$0.030	$34,950,681
28	$1,443,654	$199,379	$832,658	$45,506	$2,521,196	$0.030	$35,825,073
29	$1,470,001	$202,858	$848,387	$44,688	$2,565,933	$0.030	$36,680,754
30	$1,497,017	$206,402	$864,482	$45,520	$2,613,421	$0.031	$37,518,752
31	$1,524,733	$210,011	$880,934	$46,305	$2,661,984	$0.031	$38,339,491
32	$1,553,182	$213,688	$897,735	$47,085	$2,711,690	$0.031	$39,143,399
33	$1,582,400	$217,433	$914,879	$47,937	$2,762,649	$0.031	$39,930,914
34	$1,612,426	$221,248	$932,366	$48,725	$2,814,765	$0.032	$40,702,425
35	$1,643,301	$225,134	$950,204	$49,656	$2,868,295	$0.032	$41,458,370
36	$1,675,072	$229,092	$968,406	$50,577	$2,923,148	$0.032	$42,199,141
37	$1,707,790	$233,125	$986,993	$51,456	$2,979,364	$0.033	$42,925,119
38	$1,741,508	$237,232	$1,005,991	$52,383	$3,037,115	$0.033	$43,636,705
39	$1,776,286	$241,417	$1,025,435	$53,335	$3,096,473	$0.033	$44,334,295
40	$1,812,189	$245,680	$1,045,357	$54,371	$3,157,597	$0.034	$45,018,296
41	$1,849,288	$250,022	$1,065,791	$55,266	$3,220,368	$0.034	$45,689,063

42	$1,887,661	$254,446	$1,086,769	$56,160	$3,285,037	$0.034	$46,346,984
43	$1,927,393	$258,953	$1,108,316	$57,270	$3,351,933	$0.035	$46,992,482
44	$1,968,578	$263,544	$1,130,450	$58,507	$3,421,079	$0.035	$47,625,957
45	$2,011,317	$268,222	$1,153,180	$59,383	$3,492,103	$0.035	$48,247,713
46	$2,055,726	$272,987	$1,176,507	$60,383	$3,565,603	$0.036	$48,858,138
47	$2,101,926	$277,842	$1,200,426	$61,452	$3,641,647	$0.036	$49,457,604
48	$2,150,057	$282,788	$1,224,928	$62,518	$3,720,291	$0.036	$50,046,461
49	$2,200,268	$287,827	$1,250,000	$63,721	$3,801,816	$0.037	$50,625,078
50	$2,252,727	$292,961	$1,275,636	$64,807	$3,886,130	$0.037	$51,193,778

Table 8: 30-Day CAWS and non-CAWS Impacts in Current Dollars--One Percent Traffic Growth Rate Scenario

Year	Drive Time	Accident	Fuel	Pollution	Total	Per Ton-Mile	Present Value
1	$2,748,035	$391,838	$1,581,145	$1,320,192	$6,041,211	$0.030	$6,041,211
2	$2,794,582	$398,690	$1,607,662	$1,212,543	$6,013,477	$0.030	$11,823,401
3	$2,842,023	$405,669	$1,634,698	$1,087,202	$5,969,592	$0.030	$17,342,625
4	$2,890,381	$412,777	$1,662,263	$979,022	$5,944,443	$0.029	$22,627,213
5	$2,939,677	$420,019	$1,690,367	$865,056	$5,915,118	$0.029	$27,683,481
6	$2,989,933	$427,395	$1,719,021	$761,910	$5,898,258	$0.028	$32,531,419
7	$3,041,173	$434,909	$1,748,235	$668,860	$5,893,176	$0.028	$37,188,882
8	$3,093,421	$442,563	$1,778,022	$590,726	$5,904,731	$0.028	$41,675,992
9	$3,146,702	$450,360	$1,808,396	$502,423	$5,907,881	$0.028	$45,992,823
10	$3,201,043	$458,302	$1,839,372	$436,751	$5,935,469	$0.027	$50,163,005
11	$3,256,472	$466,394	$1,870,969	$397,763	$5,991,598	$0.027	$54,210,714
12	$3,313,016	$474,637	$1,903,207	$356,636	$6,047,496	$0.027	$58,139,052
13	$3,370,706	$483,034	$1,936,111	$304,541	$6,094,392	$0.027	$61,945,591
14	$3,429,573	$491,588	$1,969,706	$278,552	$6,169,419	$0.027	$65,650,784
15	$3,489,649	$500,303	$2,004,025	$255,771	$6,249,748	$0.027	$69,259,858
16	$3,550,970	$509,181	$2,039,100	$237,354	$6,336,605	$0.028	$72,778,349
17	$3,613,571	$518,226	$2,074,968	$219,607	$6,426,372	$0.028	$76,209,442
18	$3,677,489	$527,441	$2,111,671	$203,681	$6,520,282	$0.028	$79,556,781
19	$3,742,766	$536,830	$2,149,250	$192,682	$6,621,528	$0.028	$82,825,353

20	$3,809,444	$546,394	$2,187,749	$183,523	$6,727,110	$0.028	$86,018,325
21	$3,877,566	$556,139	$2,227,209	$171,187	$6,832,101	$0.028	$89,136,407
22	$3,947,181	$566,067	$2,267,670	$163,443	$6,944,362	$0.028	$92,183,826
23	$4,018,340	$576,183	$2,309,169	$157,314	$7,061,005	$0.029	$95,163,255
24	$4,091,094	$586,489	$2,351,734	$154,707	$7,184,023	$0.029	$98,078,003
25	$4,165,501	$596,989	$2,395,384	$152,959	$7,310,833	$0.029	$100,930,116
26	$4,241,621	$607,688	$2,440,133	$142,561	$7,432,002	$0.029	$103,717,985
27	$4,319,520	$618,588	$2,485,983	$143,814	$7,567,905	$0.029	$106,447,646
28	$4,399,267	$629,695	$2,532,930	$145,074	$7,706,965	$0.030	$109,120,550
29	$4,480,935	$641,011	$2,580,962	$142,493	$7,845,401	$0.030	$111,736,814
30	$4,564,606	$652,542	$2,630,067	$145,158	$7,992,373	$0.030	$114,299,580
31	$4,650,364	$664,291	$2,680,233	$147,762	$8,142,649	$0.030	$116,810,111
32	$4,738,302	$676,262	$2,731,454	$150,352	$8,296,370	$0.031	$119,269,655
33	$4,828,519	$688,460	$2,783,734	$153,207	$8,453,920	$0.031	$121,679,512
34	$4,921,124	$700,889	$2,837,087	$155,810	$8,614,910	$0.031	$124,040,808
35	$5,016,234	$713,554	$2,891,548	$158,789	$8,780,126	$0.032	$126,354,829
36	$5,113,975	$726,460	$2,947,161	$161,755	$8,949,351	$0.032	$128,622,733
37	$5,214,486	$739,610	$3,003,985	$164,670	$9,122,750	$0.032	$130,845,662
38	$5,317,915	$753,010	$3,062,089	$167,701	$9,300,715	$0.032	$133,024,790
39	$5,424,424	$766,665	$3,121,549	$170,754	$9,483,392	$0.033	$135,161,260
40	$5,534,194	$780,580	$3,182,443	$174,107	$9,671,324	$0.033	$137,256,268
41	$5,647,419	$794,759	$3,244,840	$177,068	$9,864,086	$0.033	$139,310,849
42	$5,764,308	$809,209	$3,308,797	$180,272	$10,062,586	$0.034	$141,326,163
43	$5,885,095	$823,933	$3,374,358	$183,654	$10,267,040	$0.034	$143,303,338
44	$6,010,036	$838,938	$3,441,550	$187,539	$10,478,064	$0.034	$145,243,542
45	$6,139,408	$854,229	$3,510,381	$190,626	$10,694,644	$0.035	$147,147,684
46	$6,273,521	$869,812	$3,580,848	$193,995	$10,918,176	$0.035	$149,016,859
47	$6,412,714	$885,692	$3,652,932	$197,602	$11,148,939	$0.036	$150,852,128
48	$6,557,355	$901,875	$3,726,613	$201,173	$11,387,016	$0.036	$152,654,494
49	$6,707,848	$918,367	$3,801,878	$205,033	$11,633,126	$0.036	$154,424,995
50	$6,864,656	$935,174	$3,878,726	$208,597	$11,887,154	$0.037	$156,164,575

In the initial year, the 30-day diversion cost is $5.735 million; in the 50th year the present value is $148.509 million[16]. The initial year total is comprised of drive time (45.1%), accidents (6.6%), fuel (26.1%), and pollution cost (22.3%). But as the years advance in the simulation, pollution falls in the 50th year to 1.8% of total cost. Again, this is due to the Environmental Protection Agency's assumptions regarding the penetration of clean burning vehicles into the resident vehicle fleet. In the 50th year of the simulation, the drive time variable rises to 57.5% of the total because congestion in the resident fleet of trucks and automobiles in the study area rises in response to the assumed one percent traffic growth rate.

The 60-day CAWS and non-CAWS 50-year highway impacts are shown in Table 9. Like the 15-day closure results, the data are presented as annual calculated values for a 50-year period for the categories of drive time, accidents, fuel consumed, pollution effects, total value, and a present value that accumulates the annual totals for each year. The data are discounted at 4.0% rate per year as requested by the Huntington District of the Corps.

In the initial year, the 60-day diversion cost is $12.246 million; in the 50th year the present value is $317.045 million[17]. Like the 15 and 30 day scenarios, the initial year total is comprised of drive time (45.3%), accidents (6.5%), fuel (26.1%), and pollution cost (22.3%). But as the years advance in the simulation, pollution falls in the 50th year to 1.8% of total cost.

The Ninety day closure data are shown in Table 10. The Total cost in year one is $14.2 million and grows to $28.6 million in year 50. The percentage distribution of total costs in each category is similar to that found in the fifteen day closure scenario discussed below.

The 180 day closure data are shown in Table 11.. The Total cost in year one is $21.82 million and grows to $44.2 million in year 50. The percentage distribution of total costs in each category is similar to that found in the fifteen day closure scenario discussed below.

Table 9; 60-Day CAWS and non-CAWS Impacts in Current Dollars--One Percent Traffic Growth Rate Scenario

Year	Drive Time	Accident	Fuel	Pollution	Total	Per Ton-Mile	Present Value
1	$5,549,978	$799,333	$3,196,796	$2,700,516	$12,246,622	$0.192	$12,246,622

[16] This reflects an estimate of the gross navigation benefits attributable to keeping the diverted vehicle traffic on the CAWS waterway and not diverting due to possible closures. The net benefit would reduce the gross benefit by the cost of shipping via barge transportation. This latter number could be significant due to the fuel inefficiency of the small tows currently plying the CAWS.

[17] This reflects an estimate of the gross navigation benefits attributable to keeping the diverted vehicle traffic on the CAWS waterway and not diverting due to possible closures. The net benefit would reduce the gross benefit by the cost of shipping via barge transportation. This latter number could be significant due to the fuel inefficiency of the small tows currently plying the CAWS.

2	$5,645,109	$813,452	$3,251,038	$2,481,150	$12,190,749	$0.189	$23,968,496
3	$5,742,081	$827,834	$3,306,346	$2,225,159	$12,101,420	$0.186	$35,156,939
4	$5,840,937	$842,486	$3,362,740	$2,004,206	$12,050,369	$0.183	$45,869,673
5	$5,941,720	$857,413	$3,420,241	$1,771,290	$11,990,664	$0.180	$56,119,343
6	$6,044,478	$872,619	$3,478,868	$1,560,450	$11,956,415	$0.178	$65,946,645
7	$6,149,259	$888,111	$3,538,643	$1,369,978	$11,945,991	$0.176	$75,387,735
8	$6,256,112	$903,894	$3,599,589	$1,210,120	$11,969,716	$0.175	$84,483,736
9	$6,365,091	$919,974	$3,661,733	$1,029,420	$11,976,218	$0.173	$93,234,641
10	$6,476,249	$936,355	$3,725,106	$894,856	$12,032,566	$0.172	$101,688,562
11	$6,589,642	$953,045	$3,789,742	$815,201	$12,147,630	$0.172	$109,895,066
12	$6,705,330	$970,049	$3,855,680	$731,287	$12,262,346	$0.172	$117,860,452
13	$6,823,375	$987,374	$3,922,968	$624,401	$12,358,117	$0.172	$125,579,295
14	$6,943,840	$1,005,024	$3,991,657	$571,089	$12,511,610	$0.172	$133,093,444
15	$7,066,795	$1,023,008	$4,061,808	$524,705	$12,676,316	$0.173	$140,413,701
16	$7,192,310	$1,041,331	$4,133,486	$486,736	$12,853,862	$0.173	$147,550,994
17	$7,320,459	$1,060,000	$4,206,765	$450,372	$13,037,596	$0.174	$154,511,873
18	$7,451,321	$1,079,021	$4,281,723	$417,778	$13,229,843	$0.175	$161,303,721
19	$7,584,981	$1,098,402	$4,358,442	$395,311	$13,437,136	$0.176	$167,936,669
20	$7,721,524	$1,118,149	$4,437,008	$376,500	$13,653,182	$0.177	$174,417,048
21	$7,861,044	$1,138,270	$4,517,501	$351,241	$13,868,056	$0.178	$180,746,248
22	$8,003,639	$1,158,772	$4,600,001	$335,399	$14,097,811	$0.179	$186,932,841
23	$8,149,415	$1,179,663	$4,684,575	$322,786	$14,336,439	$0.180	$192,982,179
24	$8,298,482	$1,200,949	$4,771,280	$317,498	$14,588,209	$0.182	$198,900,999

25	$8,450,958	$1,222,638	$4,860,155	$313,961	$14,847,713	$0.183	$204,693,411
26	$8,606,970	$1,244,740	$4,951,223	$292,613	$15,095,545	$0.184	$210,356,004
27	$8,766,654	$1,267,260	$5,044,491	$295,218	$15,373,623	$0.186	$215,901,104
28	$8,930,154	$1,290,209	$5,139,948	$297,841	$15,658,152	$0.187	$221,331,610
29	$9,097,626	$1,313,593	$5,237,572	$292,488	$15,941,279	$0.189	$226,647,668
30	$9,269,238	$1,337,422	$5,337,340	$298,059	$16,242,059	$0.191	$231,855,707
31	$9,445,170	$1,361,704	$5,439,231	$303,409	$16,549,513	$0.192	$236,958,231
32	$9,625,615	$1,386,448	$5,543,233	$308,776	$16,864,072	$0.194	$241,957,758
33	$9,810,782	$1,411,664	$5,649,357	$314,752	$17,186,555	$0.196	$246,856,922
34	$10,000,902	$1,437,359	$5,757,637	$320,177	$17,516,075	$0.198	$251,657,976
35	$10,196,218	$1,463,545	$5,868,139	$326,318	$17,854,219	$0.199	$256,363,493
36	$10,396,996	$1,490,229	$5,980,958	$332,410	$18,200,593	$0.201	$260,975,805
37	$10,603,534	$1,517,423	$6,096,216	$338,454	$18,555,626	$0.203	$265,497,230
38	$10,816,143	$1,545,135	$6,214,055	$344,730	$18,920,063	$0.205	$269,930,142
39	$11,035,167	$1,573,377	$6,334,630	$351,074	$19,294,247	$0.207	$274,276,854
40	$11,260,983	$1,602,158	$6,458,095	$358,008	$19,679,244	$0.209	$278,539,784
41	$11,494,008	$1,631,490	$6,584,592	$364,178	$20,074,268	$0.211	$282,721,035
42	$11,734,688	$1,661,382	$6,714,241	$370,775	$20,481,085	$0.213	$286,822,944
43	$11,983,517	$1,691,846	$6,847,130	$377,732	$20,900,225	$0.215	$290,847,803
44	$12,241,043	$1,722,893	$6,983,312	$385,745	$21,332,993	$0.218	$294,797,995
45	$12,507,852	$1,754,534	$7,122,807	$392,229	$21,777,422	$0.220	$298,675,386
46	$12,784,600	$1,786,782	$7,265,600	$399,210	$22,236,192	$0.223	$302,482,186
47	$13,072,016	$1,819,647	$7,411,662	$406,609	$22,709,934	$0.225	$306,220,556

48	$13,370,885	$1,853,143	$7,560,954	$414,061	$23,199,043	$0.228	$309,892,560
49	$13,682,073	$1,887,281	$7,713,445	$422,031	$23,704,830	$0.230	$313,500,311
50	$14,006,567	$1,922,074	$7,869,139	$429,481	$24,227,262	$0.233	$317,045,756

Table 10: 90-CAWS and non-CAWS Impacts in Current Dollars--One Percent Traffic Growth Rate Scenario

Year	Drive Time	Accident	Fuel	Pollution	Total
1	$6,459,062	$925,629	$3,730,487	$3,117,294	$14,232,473
2	$6,569,157	$941,849	$3,793,205	$2,863,571	$14,167,782
3	$6,681,401	$958,371	$3,857,162	$2,567,729	$14,064,663
4	$6,795,847	$975,201	$3,922,381	$2,312,310	$14,005,739
5	$6,912,552	$992,345	$3,988,885	$2,043,213	$13,936,994
6	$7,031,572	$1,009,808	$4,056,699	$1,800,039	$13,898,118
7	$7,152,969	$1,027,598	$4,125,848	$1,579,870	$13,886,284
8	$7,276,804	$1,045,721	$4,196,358	$1,395,381	$13,914,264
9	$7,403,146	$1,064,182	$4,268,259	$1,186,807	$13,922,394
10	$7,532,062	$1,082,989	$4,341,587	$1,031,499	$13,988,137
11	$7,663,626	$1,102,148	$4,416,381	$939,653	$14,121,809
12	$7,797,913	$1,121,666	$4,492,690	$842,500	$14,254,770
13	$7,935,005	$1,141,551	$4,570,567	$719,461	$14,366,583
14	$8,074,986	$1,161,808	$4,650,076	$658,008	$14,544,878
15	$8,217,945	$1,182,445	$4,731,291	$604,551	$14,736,233
16	$8,363,978	$1,203,470	$4,814,293	$560,857	$14,942,598
17	$8,513,185	$1,224,890	$4,899,171	$518,924	$15,156,171
18	$8,665,672	$1,246,714	$4,986,024	$481,300	$15,379,710
19	$8,821,554	$1,268,947	$5,074,955	$455,377	$15,620,834
20	$8,980,949	$1,291,600	$5,166,070	$433,668	$15,872,286
21	$9,143,988	$1,314,679	$5,259,471	$404,590	$16,122,728
22	$9,310,809	$1,338,193	$5,355,255	$386,209	$16,390,466
23	$9,481,560	$1,362,151	$5,453,509	$371,825	$16,669,045
24	$9,656,398	$1,386,561	$5,554,301	$365,597	$16,962,858
25	$9,835,494	$1,411,432	$5,657,678	$361,611	$17,266,216
26	$10,019,031	$1,436,773	$5,763,667	$336,975	$17,556,445
27	$10,207,208	$1,462,593	$5,872,269	$339,955	$17,882,025
28	$10,400,238	$1,488,901	$5,983,467	$343,055	$18,215,662
29	$10,598,352	$1,515,707	$6,097,228	$336,812	$18,548,100
30	$10,801,803	$1,543,021	$6,213,515	$343,196	$18,901,535
31	$11,010,862	$1,570,853	$6,332,292	$350,655	$19,264,661
32	$11,225,824	$1,599,211	$6,453,539	$355,405	$19,633,980

33	$11,447,010	$1,628,108	$6,577,262	$362,296	$20,014,677
34	$11,674,775	$1,657,553	$6,703,497	$368,414	$20,404,240
35	$11,909,499	$1,687,557	$6,832,323	$375,454	$20,804,834
36	$12,151,600	$1,718,131	$6,963,857	$382,494	$21,216,083
37	$12,401,544	$1,749,287	$7,098,251	$389,394	$21,638,476
38	$12,659,830	$1,781,034	$7,235,687	$396,580	$22,073,131
39	$12,927,005	$1,813,386	$7,376,362	$403,824	$22,520,578
40	$13,203,680	$1,846,353	$7,520,476	$411,810	$22,982,318
41	$13,490,520	$1,879,948	$7,668,212	$418,822	$23,457,503
42	$13,788,254	$1,914,184	$7,819,729	$426,306	$23,948,473
43	$14,097,694	$1,949,072	$7,975,144	$434,316	$24,456,226
44	$14,419,729	$1,984,625	$8,134,528	$443,657	$24,982,539
45	$14,755,333	$2,020,857	$8,297,906	$450,953	$25,525,049
46	$15,105,592	$2,057,780	$8,465,264	$458,889	$26,087,525
47	$15,471,709	$2,095,408	$8,636,559	$467,441	$26,671,118
48	$15,855,003	$2,133,756	$8,811,738	$475,846	$27,276,343
49	$16,256,923	$2,172,837	$8,990,754	$484,969	$27,905,482
50	$16,679,118	$2,212,665	$9,173,599	$493,456	$28,558,838

Table 11: One Hundred and Eighty Day Closure

Year	Drive Time	Accident	Fuel	Pollution	Total
1	$9,955,321	$1,406,303	$5,733,418	$4,716,441	$21,811,484
2	$10,123,252	$1,430,669	$5,828,788	$4,330,862	$21,713,570
3	$10,294,480	$1,455,484	$5,926,063	$3,882,764	$21,558,791
4	$10,469,093	$1,480,760	$6,025,281	$3,495,587	$21,470,720
5	$10,647,178	$1,506,503	$6,126,480	$3,087,975	$21,368,136
6	$10,828,830	$1,532,724	$6,229,698	$2,720,048	$21,311,299
7	$11,014,145	$1,559,431	$6,334,976	$2,386,651	$21,295,203
8	$11,203,226	$1,586,634	$6,442,357	$2,108,155	$21,340,372
9	$11,396,181	$1,614,342	$6,551,892	$1,792,161	$21,354,575
10	$11,593,122	$1,642,565	$6,663,636	$1,557,538	$21,456,861
11	$11,794,167	$1,671,314	$6,777,658	$1,418,495	$21,661,634
12	$11,999,444	$1,700,598	$6,894,035	$1,271,532	$21,865,609
13	$12,209,084	$1,730,427	$7,012,862	$1,085,492	$22,037,864
14	$12,423,226	$1,760,812	$7,134,247	$992,834	$22,311,118
15	$12,642,022	$1,791,764	$7,258,316	$911,726	$22,603,827
16	$12,865,627	$1,823,293	$7,385,210	$846,244	$22,920,375
17	$13,094,210	$1,855,412	$7,515,090	$782,760	$23,247,472
18	$13,327,950	$1,888,131	$7,648,127	$725,993	$23,590,202
19	$13,567,040	$1,921,462	$7,784,510	$686,914	$23,959,926
20	$13,811,682	$1,955,416	$7,924,427	$653,918	$24,345,443
21	$14,062,095	$1,990,006	$8,068,066	$610,207	$24,730,375
22	$14,318,514	$2,025,245	$8,215,603	$583,630	$25,142,992
23	$14,581,194	$2,061,144	$8,367,194	$560,853	$25,570,385
24	$14,850,406	$2,097,717	$8,522,960	$551,102	$26,022,184

25	$15,126,441	$2,134,976	$8,682,983	$545,274	$26,489,674
26	$15,409,618	$2,172,935	$8,847,301	$507,978	$26,937,832
27	$15,700,281	$2,211,607	$9,015,908	$512,438	$27,440,234
28	$15,998,801	$2,251,007	$9,188,752	$516,993	$27,955,552
29	$16,305,579	$2,291,148	$9,365,751	$507,752	$28,470,230
30	$16,621,060	$2,332,045	$9,546,814	$517,295	$29,017,213
31	$16,945,719	$2,373,712	$9,731,846	$526,440	$29,577,717
32	$17,280,076	$2,416,165	$9,920,782	$535,315	$30,152,339
33	$17,624,698	$2,459,419	$10,113,599	$545,805	$30,743,521
34	$17,980,210	$2,503,489	$10,310,339	$554,795	$31,348,832
35	$18,347,287	$2,548,391	$10,511,116	$565,347	$31,972,141
36	$18,726,674	$2,594,141	$10,716,124	$575,939	$32,612,877
37	$19,119,199	$2,640,756	$10,925,625	$586,199	$33,271,778
38	$19,525,751	$2,688,253	$11,139,938	$596,931	$33,950,872
39	$19,947,312	$2,736,649	$11,359,418	$608,079	$34,651,458
40	$20,384,973	$2,785,961	$11,584,424	$619,990	$35,375,348
41	$20,839,930	$2,836,207	$11,815,293	$630,435	$36,121,865
42	$21,313,490	$2,887,406	$12,052,308	$641,175	$36,894,378
43	$21,807,116	$2,939,576	$12,295,680	$653,651	$37,696,023
44	$22,322,410	$2,992,736	$12,545,530	$668,112	$38,528,788
45	$22,861,128	$3,046,905	$12,801,896	$678,214	$39,388,142
46	$23,425,235	$3,102,103	$13,064,727	$689,913	$40,281,978
47	$24,016,903	$3,158,350	$13,333,926	$702,762	$41,211,941
48	$24,638,523	$3,215,666	$13,609,371	$715,235	$42,178,796
49	$25,292,721	$3,274,073	$13,890,950	$728,756	$43,186,500
50	$25,982,485	$3,333,592	$14,178,620	$741,339	$44,236,036

Impact on Speed

An analysis of the impact of closure on highway speed indicates that resident highway traffic is not affected under any closure scenario. As noted, this finding is thought to result from the relatively small amount of tonnage diverted to overland transportation, the large number of roads onto which traffic is diverted, and the fact that most of the tonnage is projected to divert at night[18]. In this exercise, the highway congestion model is applied to a complete set of road segments inside and outside the CAWS; and highway speed values are calculated in a base case and in each diversion scenario.

These speed calculations are shown in Table 12 for each closure scenario and for eight modeled roadways in the CAWS study in the 50th year of the simulation. These roads are I-294, I-355, I-55, I-57, I-65, I-80, I-90/94, and I-94. From these data one can test the proposition that speeds calculated in the model would not change as additional CAWS traffic diverts into the highway

[18] CTR survey respondents indicated that most (70%) of traffic diversions would occur at night, with 30% occurring in the daylight hours.

network. Note that there is no appreciable change in speed on any of these roads as CAWS traffic of varying magnitude diverts on to the area interstate highways. A reasonable conclusion of this sample is that the traffic diversion is not of sufficient magnitude to negatively affect resident traffic. As noted, this phenomenon is partially because waterway traffic is projected to disperse on to many roads, thus minimizing the congestion impact on any single road. Additionally, congestion impacts are lessened because traffic is projected to divert at night when resident traffic is at its lowest level. Quite to the contrary, the societal costs reported in Table 5 are brought on by (1) differences in efficiency between the barge and truck transportation, (2) high base year traffic levels that produce congestion in resident CAWS traffic, and (3) a projected growth in resident traffic that exacerbates already-existing traffic levels especially in the Chicago area. Speed changes between the base case and other diversion scenarios generally produced the same results.

Table 12: Speed Calculations Estimated With and Without Diversions for Three Highways

Caws Roadways	15 day	30 Day	60 Day	90 Day	180 Day
I-294	50.1	50.4	50.4	50.4	49.7
I-355	55.7	55.7	55.7	55.7	55.7
I-55	39.3	39.3	39.3	39.3	39.3
I-57	47.7	48.0	48.0	48.0	48.0
I-65	47.5	47.5	47.5	47.5	47.5
I-80	44.1	44.2	44.2	44.2	44.2
I-90/94	15.7	15.1	15.3	15.3	15.3
I-94	38.5	38.7	38.5	37.3	37.3

SUMMARY AND CONCLUSIONS

Short-run or permanent disruptions of commercial barge transportation service on the Chicago Area Waterway System (CAWS) could be necessary due to the implementation of plans for hydrologic separation of this waterway the from the Great Lakes. This separation is thought by some to be a solution to the problem of aquatic species (ANS) migrating between the Great Lakes and the Mississippi River Basin. The current report documents the University of Tennessee Center for Transportation Research (CTR) study of potential social costs of unanticipated 15, 30, 60, 90 and 180 day closures due to the resultant water-to-overland truck diversions.

In this study, the CTR modified as appropriate the traffic diversion model developed for use in studying the impacts of traffic diversions in Pittsburgh. While certain non-critical parameters remained unchanged, highway traffic counts, speed limits, and the number of lanes are changed to reflect conditions in the study area. Input data are derived from a variety of sources including Chicago area video logs, highway field survey, and interviews with 133 firms concerning their response to a variety of possible planned and unplanned closures of the CAWS. On average, CTR interviewed about 92% of the shipping docks identified in the data sample.

Inside the CAWS, virtually every interstate movement is modeled using the traffic diversion model discussed above. Eighty-two percent of the non-interstate CAWS movements are modeled, with costs in the non-modeled segments being estimated with regularities established in the modeled segments. In the case of CAWS movements, a representative measure of modeled social cost per mile is used. Total cost for the un-modeled segment is the product of miles traveled and the estimated ratio. For the non-CAWS un-modeled segments, a modeled free-flowing (no congestion) section of an area interstate is used to estimate the ratio of social cost to miles traveled. As with the traffic in the CAWS, social costs in the non-CAWS un-modeled segments are the product of miles traveled and the defined ratio of cost to miles traveled.

As noted, waterway social closure costs for years 1-50 are estimated for the period totaling 15, 30, 60, 90, and 180 days. Costs are a composite of travel delay time, safety, air pollution and fuel consumed. These costs are not calculated for any specific time period in any given year but are calculated as annual values and then scaled back to a period matching the scenario values, 15 days for example. As shown in Table 5, the cost per ton mile value is essentially the same for all scenarios in years one and fifty ($0.030 and $0.037 respectively). A major finding of the study is that calculated values for each scenario are scalar values one to the other and dictated by the number of trucks diverted into the resident traffic flow in each scenario. This linear relation is due to the relatively small number of trucks (relative to resident CAWS traffic levels) that are diverted onto each highway in each closure scenario, the low level of projected resident traffic growth, the fact that diversions are made at night when traffic congestion is lower than in the daylight hours, and the fact that much of the vehicle miles occur on free flowing interstates outside the Chicago area. In summary, simulations demonstrate that highway capacity is adequate to support the traffic diversions both inside and outside the Chicago area at a one percent resident traffic growth rate. While not due to congestion induced by the traffic diversion, the societal costs reported in Table 5 in the text are brought on by (1) differences in efficiency between the barge and truck transportation, (2) high base year traffic levels that produce congestion in resident CAWS traffic, and (3) a projected growth in resident traffic that exacerbates already-existing traffic levels especially in the Chicago area.

Note that social costs are lowest in the 15 day diversion scenario. A onetime annual diversion in year one would cost $2.0 million but grow to $3.9 million if the diversion occurred in the 50th year. The 30 day diversion ranks second as costs would be $6.0 million in the first year and grow to $11.9 million in the 50th year. During the 60 day diversion, the annual cost in year one ranks third at $12.2 million. In the 50th year the cost reaches $25.2 million. The cost of a one-time diversion of 90 days is estimated to cost $14.2 million in year one and rise to $28.6 million in year 50. In the 180 day or closure scenario, the cost is estimated to be $21.8 million in the first year and rise to $44.2 million in the 50th year. Assuming that a closure occurs once annually in each scenario in years 1-50, the present values (calculated at a four percent interest rate) range from $51.2 million in the 15 year period to $566.8 million in the 180 day period.

SAVINGS TO USERS

Based on the fourth quarter 2011 cost levels, those users of the CAWS represented by the 2,265 sampled movements saved, on average, about $26.31 per ton over the best possible land routing. To facility the use of the shipper savings, the individual movement rate sheets were grouped by the Corps of Engineers Commodity Grouping. Two commodity group modifications were undertaken to maintain confidentiality and consistency. Coke from coal and petroleum coke were included in the Coal & Coke grouping. Also, lubricating oil was included in All Other grouping. Savings for each of the eight commodity groupings identified for this analysis are summarized below.[19]

Group	*Commodities*	*Total Dollars*	*Tons*	*Average Per-Ton NED Saving*
1	Aggregates	$34,096,116	3,650,102	$9.34
2	All Other	$104,890,950	4,024,432	$26.06
3	Chemicals	$90,612,498	2,698,821	$33.57
4	Coal & Coke	$103,518,057	6,448,111	$16.05
5	Grain	$20,914,927	764,577	$27.35
6	Iron & Steel	$176,061,118	5,229,270	$33.67
7	Ore & Minerals	$150,552,294	2,472,075	60.90
8	Petroleum Fuels	$46,970,742	2,369,105	19.83
AVERAGE ALL COMMODITIES		$727,620,491	27,656,493	26.31

In addition to the base case shipper savings with no navigation, separate rate sheets were prepared for each of the five short term disruption scenarios: 15, 30, 60, 60, 90, and 180 day. The shipper modal choice, waiting in demurrage, or ceasing operation are reflected in these rate sheets based upon the interview responses of the shippers and dock operators. Each entry in the rate sheet is footnoted to describe the source of the rate computation. These rate sheets were summarized by Corps of Engineers commodity groups.

During the preparation of this study, we observed that, in a few instances, the selection of barge transportation is more costly than the land alternative. There are any number of scenarios which work individually or in combination to explain this phenomenon. First, in some cases, the sample may occasionally captured a transitory use of barge which occurs when alternative modes lack capacity or when rail cars are in short supply. That is to say, for some particular shipper/receiver barge is only the mode of choice when other transportation markets are unusually active. Secondly, long term contracts and large capital investments may lead to discontinuities in the relationship between relative rates and modal choice. In many areas barge shippers and receivers are captive to the navigation mode because they lack the industrial footprint to build the infrastructure for a modal change. While this can be a short-run situation, it

[19] All rates and rate differentials are weighted average.

may, nonetheless help to explain what appears to be perverse behavior. Next, the analysis superimposes 2007, 2008, or 2009 transport market conditions on set of 2011 modal choice decisions. In the vast majority of cases, this dichotomy is of little import. However, in a few cases, transportation rates may have changed sufficiently, so that in 2011, barge would no longer have been the mode of choice. Finally, regulatory constraints on the new construction of coal and hazardous materials handling facilities may preclude the development of facilities necessary for some shippers to take advantage of changes in the vector of available transportation rates.

MODIFICATIONS EXTERNAL SOCIAL COSTS

The measurement of external social costs is based upon the decision of shippers or dock operators to shift mode or cease operation for each short term disruption scenario. The external social cost of using trucks to move cargo instead of barge are shown in . Now, we come to the point of adding to the external social cost for modal shifting by rail and/or subtracting external social cost for the reduced barge utilization.

While the truck mode analysis incorporated four elements, delay due congestion, accidents, emissions, and fuel; we are only measuring emissions for barge and rail since the other three elements are either incorporated in transportation rates or not measureable in the barge or rail modes.

The method used to arrive at the monetization of emissions was to first determine the added ton miles by rail and the reduced ton miles by barge. Next, the fuel efficiency of each mode was applied to the ton miles to arrive at the number of gallons of fuel. Here, the value of 453 ton miles per gallon for railroads was taken from the 2010 Annual Report of the American Associations Railroads. For the barge mode, the fuel efficiency of 640 ton miles per gallon for trips over 500 miles or 405 ton miles per gallon for trips under 500 miles. The mileage segregation for the barge mode was a reflection of the national average for longer trips and the Illinois Waterway fuel efficiency for shorter trips that would be dominated by travel on the Illinois Waterway. Once the annual gallons of fuel were determined, the gallons were apportioned by ratios of 15, 30, 60, 90, and 180 days to 365 days and then summed for each scenario.

The next step was to take the monetized truck emissions values and divide by the number of truck fuel gallons to arrive at a dollar per gallon value. The truck efficiency used for this computation was seven miles per gallon for ultra low sulfur diesel fuel. The total truck miles times the number of trips for each truck movement was divided by seven. This amount of fuel was then apportioned by the ratio of 15, 30, 60, 90, and 180 days to 365 days and summed to arrive at the gallons of truck fuel in each year (year 1-50 periods). The quantity of fuel was then divided into monetized truck emissions values to arrive at a dollar per gallon value.

The next step was to develop a ratio of truck emissions to rail and barge emissions. Here the source was the Environmental Protection Agency (EPA), January 6, 2013 Web Page, Standards for Marine, Railroad, and Truck Engine Emissions. The following table depicts the emissions permitted and the ratios used to standardize the nitrous oxide, hydrocarbons, and particulate matter to arrive at a modal emission ratio. The ratio for railroads is 156%, and the ratio for barge is 330%. The assumption is being made that each mode will be using ultra low sulfur diesel fuels. Further, it is assumed that the >3700 HP vessels are 33% of the fleet and <3700 HP vessels are 67% of the fleet in order to arrive at a weighted average emission standard. Also, the weighted average of the truck emissions is 60% for the Combo and 40% for the PM based upon the dollar contribution of the truck emissions values.

The last step was to take the monetized truck emissions value per gallon, multiply this value times the EPA regulatory allowable emissions ratio by mode, then multiply this amount times the number of modal gallons to arrive at a rail emissions total dollars to be added and a barge emissions total dollars to be subtracted from the monetized external social cost by scenario in Appendix 1.

A separate electronic disc is being provided that has the computations and resulting dollars per ton values for each scenario by year.

Table 13: EPA Engine Emission Standards

Mode	Year	NOX	HC	Combo	PM	Ratio Combo	PM Ratio	Total Ratio
Railroad	2015	1.30	0.14	1.44	0.03	36%	120%	156%
Truck	2007			2.40	0.01			
Barge(>3700HP)	2014	1.8	0.19	1.99	0.12			
Barge(<3700HP)	2014	1.8	0.19	1.99	0.04	50%	280%	330%

Source: Environmental Protection Agency, Web Page January 6, 2013

Regional Economic Value Model Inputs

The regional modeling of production and amenities cost changes requires two sets of values per ton as well as a traffic forecast for the five disruption periods. To this end, UTK-CTR developed values per ton for shipper production cost change and adjusted social cost change. These values are developed by rolling up the individual 2265 origin/destination sample movements into either commodity group or total annual values.

APPENDIX 2.1 – SAMPLE RATE WORKSHEET

TRANSPORTATION RATE ANALYSIS

Ref No.: 1 (Page 1)

Commodity	Wheat (Including Spelt) and Meslin, Unmilled		
WCSC Gp.	4100	Tonnage	1,686
River Origin	22888601	Riv. Dest	77625510
Origin Port Code	LOWER MISS RIVER MILE 888	Dest Port Code	BURNS WATERWAY HARBOR INDIANA
Origin WW Mile	MISSISSIPPI RIVER, MOUTH OF OHIO RIV	Dest WW Mile	LAKE MICHIGAN 0
Off-River Orig.	Farm Direct Radius 30 Miles	Off-River Dest	Export Vessel

WATER ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				0.77 a/
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river	Truck	20	1.7	5.78 b/
(5) Handling at river origin				1.79 c/
(6) Line haul charge	Barge	543	450.0	12.73 d/
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				2.00 e/
(10) Other				
Total		563		23.07

LAND ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				0.77 a/
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river	Truck	20	1.7	5.78 b/
(5) Handling at river origin				1.79 c/
(6) Line haul charge	Truck	422	8.0	50.32 f/
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				2.00 e/
(10) Other				
Total		442		60.66

SUMMARY

	Cost
(1) Water Route	23.07
(2) Land Route	60.66

AUTHORITIES FOR CHARGES AND EXPLANATION OF REFERENCE MARKS

a/ Kansas State University "Farm Machine Operation Cost Calculations" Agricultural Extension Service, Indexed 2011, Quarter Hour Transfer Time

b/ Private Truck Rate $85 per hour Based Upon Multiple Dock Interviews In September and October 2011 Average Distance 2/3 Radius

c/ Handling Rate Based Upon New Madrid Dock Interview for Upper Mississippi River Rate Study

d/ Waterborne Freight Tariff 7 with USDA Average Weekly Percent of Tariff 2007-2011 @ 214% Plus Vessel Operator Reported Switch Charge From/Or to Chicago

e/ Maximum Handling Rate for a Settlement Elevator Allowed by Chicago Board of Trade Regulations Six Cents per Bushel

f/ Truck Rate $3.10 Loaded Mile 26 Ton Minimum

TRANSPORTATION RATE ANALYSIS

Ref No.: 1 (Page 2)

Commodity	Wheat (Including Spelt) and Meslin, Unmilled		
WCSC Gp.	4100	Tonnage	1,686
River Origin	22888601	Riv. Dest	77625510
Origin Port Code	LOWER MISS RIVER MILE 888	Dest Port Code	BURNS WATERWAY HARBOR INDIANA
Origin WW Mile	MISSISSIPPI RIVER, MOUTH OF OHIO	Dest WW Mile	LAKE MICHIGAN 0
Off-River Orig.	Farm Direct Radius 30 Miles	Off-River Dest	Export Vessel

ALT1 ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				0.77 a/
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river	Truck	20	1.7	5.78 b/
(5) Handling at river origin				1.79 c/
(6) Line haul charge	Barge	543	450.0	12.73 d/
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				2.00 e/
(10) Other				1.20 f/
Total		563		24.27

ALT2 ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				0.77 a/
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river	Truck	20	1.7	5.78 b/
(5) Handling at river origin				1.79 c/
(6) Line haul charge	Barge	543	450.0	12.73 d/
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				2.00 e/
(10) Other				3.61 g/
Total		563		26.68

AUTHORITIES FOR CHARGES AND EXPLANATION OF REFERENCE MARKS

a/ Kansas State University "Farm Machine Operation Cost Calculations" Agricultural Extension Service, Indexed 2011, Quarter Hour Transfer Time

b/ Private Truck Rate $85 per hour Based Upon Multiple Dock Interviews In September and October 2011 Average Distance 2/3 Radius

c/ Handling Rate Based Upon New Madrid Dock Interview for Upper Mississippi River Rate Study

d/ Waterborne Freight Tariff 7 with USDA Average Weekly Percent of Tariff 2007-2011 @ 214% Plus Vessel Operator Reported Switch Charge From/Or to Chicago

e/ Maximum Handling Rate for a Settlement Elevator Allowed by Chicago Board of Trade Regulations Six Cents per Bushel

f/ Demurrage At Joliet, IL Average Seven Days @ $275 Per Day 1600 Tons

g/ Demurrage At Joliet, IL Average 21 Days @ $275 Per Day 1600 Tons

TRANSPORTATION RATE ANALYSIS

Ref No.: 1 (Page 3)

Commodity	Wheat (Including Spelt) and Meslin, Unmilled		
WCSC Gp.	4100	Tonnage	1,686
River Origin	22888601	Riv. Dest	77625510
Origin Port Code	LOWER MISS RIVER MILE 888	Dest Port Code	BURNS WATERWAY HARBOR INDIANA
Origin WW Mile	MISSISSIPPI RIVER, MOUTH OF OHIO	Dest WW Mile	LAKE MICHIGAN 0
Off-River Orig.	Farm Direct Radius 30 Miles	Off-River Dest	Export Vessel

ALT3 ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				0.77 a/
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river	Truck	20	1.7	5.78 b/
(5) Handling at river origin				1.79 c/
(6) Line haul charge	Truck	422	8.0	50.32 d/
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				2.00 e/
(10) Other				
Total		442		60.66

ALT4 ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				0.77 a/
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river	Truck	20	1.7	5.78 b/
(5) Handling at river origin				1.79 c/
(6) Line haul charge	Truck	422	8.0	50.32 d/
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				2.00 e/
(10) Other				
Total		442		60.66

AUTHORITIES FOR CHARGES AND EXPLANATION OF REFERENCE MARKS

a/ Kansas State University "Farm Machine Operation Cost Calculations" Agricultural Extension Service, Indexed 2011, Quarter Hour Transfer Time

b/ Private Truck Rate $85 per hour Based Upon Multiple Dock Interviews In September and October 2011 Average Distance 2/3 Radius

c/ Handling Rate Based Upon New Madrid Dock Interview for Upper Mississippi River Rate Study

d/ Truck Rate $3.10 Loaded Mile 26 Ton Minimum

e/ Maximum Handling Rate for a Settlement Elevator Allowed by Chicago Board of Trade Regulations Six Cents per Bushel

TRANSPORTATION RATE ANALYSIS

Ref No.: 1 (Page 4)

Commodity	Wheat (Including Spelt) and Meslin, Unmilled		
WCSC Gp.	4100	Tonnage	1,686
River Origin	22888601	Riv. Dest	77625510
Origin Port Code	LOWER MISS RIVER MILE 888	Dest Port Code	BURNS WATERWAY HARBOR INDIANA
Origin WW Mile	MISSISSIPPI RIVER, MOUTH OF OHIO	Dest WW Mile	LAKE MICHIGAN 0
Off-River Orig.	Farm Direct Radius 30 Miles	Off-River Dest	Export Vessel

ALT5 ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				0.77 a/
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river	Truck	20	1.7	5.78 b/
(5) Handling at river origin				1.79 c/
(6) Line haul charge	Truck	422	8.0	50.32 d/
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				2.00 e/
(10) Other				
Total		442		60.66

ALT6 ROUTE

	Mode	Miles	Time	Cost
(1) Loading at origin				
(2) Charge to transfer point				
(3) Transfer charge				
(4) Charge to river				
(5) Handling at river origin				
(6) Line haul charge				
(7) Handling at river destination				
(8) Charge ex river				
(9) Unloading at destination				
(10) Other				
Total		0		0.00

AUTHORITIES FOR CHARGES AND EXPLANATION OF REFERENCE MARKS

a/ Kansas State University "Farm Machine Operation Cost Calculations" Agricultural Extension Service, Indexed 2011, Quarter Hour Transfer Time

b/ Private Truck Rate $85 per hour Based Upon Multiple Dock Interviews In September and October 2011 Average Distance 2/3 Radius

c/ Handling Rate Based Upon New Madrid Dock Interview for Upper Mississippi River Rate Study

d/ Truck Rate $3.10 Loaded Mile 26 Ton Minimum

e/ Maximum Handling Rate for a Settlement Elevator Allowed by Chicago Board of Trade Regulations Six Cents per Bushel

APPENDIX 2.2 – EMPTY RETURN RATIOS, HORSEPOWER AND TOW SIZE BY RIVER SEGMENT

RIVNUM	RIVER	MTYUP	MTYDOWN
1	ALABAMA	0.06	0.99
2	ALLEGHENY	0.86	0.15
3	A/C/F/	1.00	1.00
4	ARKANSAS	0.22	0.31
5	ATCHAFALAYA, N	1.00	0.20
6	ATCHAFALAYA, S	0.97	0.44
7	BIG SANDY	1.00	1.00
8	BLACK/OUCHITA	0.74	0.25
9	BLACK-WARRIOR	0.09	0.87
10	CUMBERLAND	1.00	0.03
11	GIW(E) NOLA-MOBILE	0.50	0.32
12	GIW(E) MOBILE-ACF JCT	0.50	0.50
13	GIW(W) HARVEY LOCK-MORGAN CITY	0.71	0.24
14	GIW(W) MORGAN CITY-BROWNSVILLE	0.33	0.46
15	GREEN	0.26	0.43
16	HOU S/C	0.28	0.42
17	IHNC	0.51	0.36
18	ILL	0.31	0.42
19	KAN	0.07	0.80
2	LM 1-98	0.50	0.50
21	LM 99-229	0.25	0.50
22	LM 230-954	0.25	0.50

23	MO LOWR	0.10	0.25
24	MO MID	0.10	0.15
25	MO UPR	0.10	0.10
26	MOB RIV	0.13	0.88
27	MOB S/C	0.50	0.50
28	MON	0.27	0.57
29	MCPA	0.38	0.50
30	MRGO	1.00	1.00
31	OHIO	0.45	0.25
32	OLD	0.09	0.95
33	RED	0.96	0.01
34	TN LOWER	0.69	0.13
35	TN UPPER	0.77	0.12
36	TENN-TOM	0.13	0.93
37	TOMB	0.13	0.88
38	UM 0-185	0.09	0.48
39	UM 186-865	0.09	0.48
40	YAZOO	0.25	0.95
41	OTHER	0.34	0.46
42	ALGIERS CANAL	0.66	0.20
43	COLUMBIA	0.19	0.62
44	SNAKE	0.16	0.70

..

SEG_NO	RIVER	GTOW_HP	GTOW_CLS	GTOW_SIZ
1	ALABAMA	1200	1	4
2	ALLEGHENY	1450	2	3
3	A/C/F/	1600	3	2
4	ARKANSAS	3150	5	8
5	ATCHAFALAYA, NORTH	1550	2	2
6	ATCHAFALAYA, SOUTH	1450	2	2
7	BIG SANDY	1250	1	4
8	BLACK/OUCHITA	1500	2	2
9	BLACK-WARRIOR	1700	3	6
10	CUMBERLAND	2700	5	8
11	GIW(E) NOLA-MOBILE	1400	2	4
12	GIW(E) MOBILE-ACF JCT	1300	1	3
13	GIW(W) HARVEY LOCK-MORGAN CITY	1250	1	3
14	GIW(W) MORGAN CITY-BROWNSVILLE	1500	2	2
15	GREEN	1800	3	4
16	IHNC (NEW ORLEANS)	1200	1	4
17	ILLINOIS	3100	5	6
18	KANAWHA	2100	4	7
19	LOWER MISS	3000	5	25
20	MISS RIV-GULF OUTLET	950	0.9	2
21	MISSOURI KAN CITY-SOUTH	1500	2	4
22	MISSOURI KAN CITY-OMAHA	1600	3	2

23	MISSOURI OMAHA-S CITY	1800	3	2
24	MOBILE RIVER	1700	3	5
25	MONONGAHELA	1800	3	5
26	MOR CITY-PT ALLEN ROUTE	1800	3	4
27	OHIO	2800	5	11
28	OLD	1600	3	4
29	RED	1800	3	4
30	TENNESSEE, LOWER	2900	5	9
31	TENNESSEE, UPPER	2150	4	5
32	TENNESSEE-TOMBIGBEE	2200	4	6
33	TOMBIGBEE RIVER	1700	3	6
34	UPPER MISS CAIRO-ST LOUIS	4650	8	15
35	UPPER MISS ST LOUIS-MPLS	4150	7	11
36	YAZOO	2400	4	3
37	OTHER	2050	3	2
38	ILL RIV ABOVE MI 291(L'PORT)	3000	5	4
39	ALGIERS CANAL	1350	2	3
40	COLUMBIA	3100	5	3
41	SNAKE	3100	5	3

APPENDIX 2.3 – PERCENTAGE OF WATERWAY FREIGHT BUREAU TARIFF NO. 7 FOR THE MOVEMENT OF GRAIN

Waterway Segment	*2011 Percent of Tariff*	*2007-2011 Average Percent of Tariff*
Upper Mississippi River	515%	300%
Middle Mississippi River	467%	283%
Illinois River	461%	273%
Middle Mississippi River (0-243)	363%	228%
Upper Ohio River	432%	251%
Lower Ohio River	432%	251%
Lower Mississippi River (Memphis)	334%	214%
Lower Mississippi River (NOLA)	463%	287%

Source: U.S. Department of Agriculture

ATTACHMENT 7

NON-CARGO NAVIGATION

Baseline Assessment of Non-Cargo CAWS Traffic

November 2011

Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

GREAT LAKES MISSISSIPPI RIVER INTERBASIN STUDY (GLMRIS)
BASELINE ASSESSMENT OF NON-CARGO CAWS TRAFFIC

Contents

FIGURES

TABLES

I. **GLMRIS STUDY INFORMATION**

This document is intended to serve as a baseline assessment of lock traffic by commercial passenger, recreation, and governmental vessels. The assessment includes an appraisal of historical traffic through the locks and a description of the lock operations. This assessment includes non-cargo-related traffic only as cargo-related traffic will be identified under a separate endeavor. This effort serves as the basis from which to compare possible changes as a result of aquatic nuisance species transfers to and from the Great Lakes system.

A. Introduction

An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (2010).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River by aquatic pathways. In this context, the term "prevent" includes the reduction of risk to the maximum extent possible, because it may not be technologically feasible to achieve an absolute solution. As part of this study, USACE will conduct a detailed analysis of various ANS controls, including hydrologic separation.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;

- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

B. GLMRIS Study Area

The GLMRIS study area includes portions of the Great Lakes and Mississippi River basins that fall within the United States.

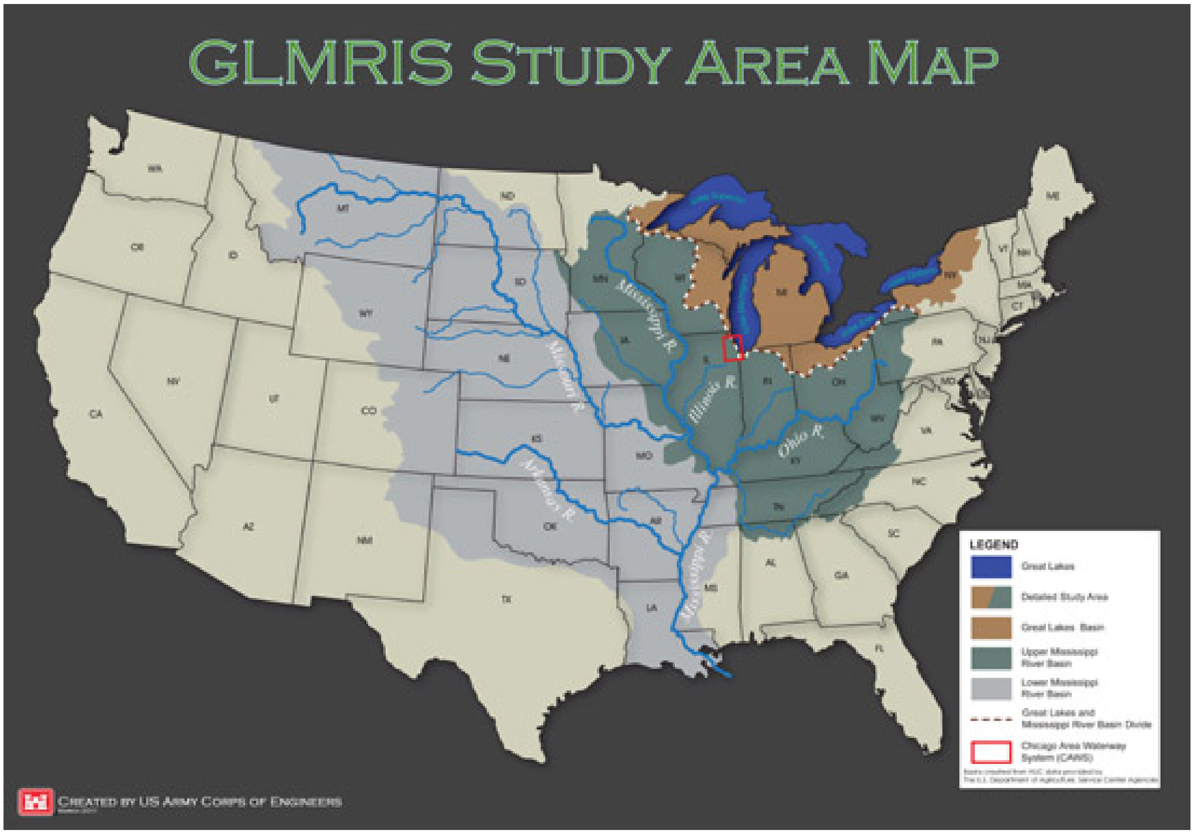

Figure 1. GLMRIS Study Area Map

Potential aquatic pathways between the Great Lakes and Mississippi River basins exist along the basins' shared boundary (illustrated as "▬ ▬ ▬" in Figure 1). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi Basin ( ) and the Great Lakes Basin ( ). See Figure 1.

Future ANS may transfer beyond the *Detailed Study Area*; this pattern was observed by the spread of zebra mussels, which originated in the Great Lakes and spread throughout the Mississippi River Basin. Therefore, the *General Study Area* encompasses the lower Mississippi River Basin ( ). While the majority of GLMRIS tasks will be completed within the *Detailed Study Area*, USACE will consider specific ANS impacts in the larger *General Study Area*.

a. GLMRIS Focus Areas

The U.S. Army Corps of Engineers is conducting GLMRIS along two concurrent tracks: Focus Area I, the Chicago Area Waterway System (CAWS), and Focus Area II, Other Pathways.

(1) Chicago Area Waterway System (CAWS)

Focus Area I, the Chicago Area Waterway System, as shown in the map below, is the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins and, therefore, poses the greatest potential risk of aquatic nuisance species (ANS) transfer between the basins, via an aquatic pathway.

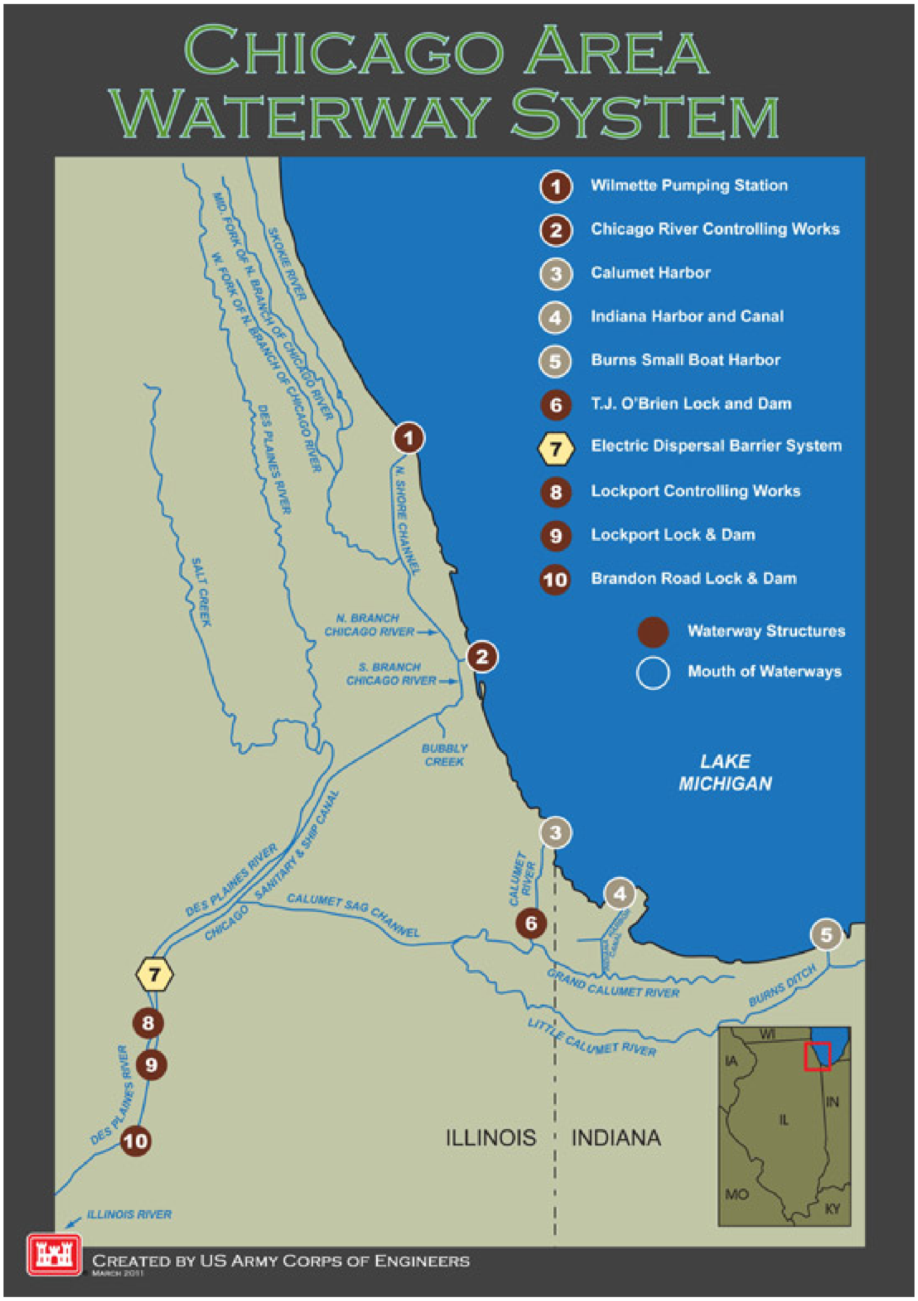

Figure 2. Chicago Area Waterway System

(2) Other Pathways

Focus Area II addresses remaining aquatic pathways. For this focus area, the U.S. Army Corps of Engineers completed a document entitled *Other Pathways Preliminary Risk Characterization Report* that identified other potential aquatic pathways outside of the Chicago Area Waterway System, as well as included a screening-level assessment of potential ANS that may transfer via these connections.

As shown on the *Other Pathways* map below, 18 potential aquatic pathways have suggested that there is significant uncertainty about the relative risks of ANS transfer. Eagle Marsh, located in Fort Wayne, Indiana was identified as having the highest potential risk of ANS transfer. The Indiana Department of Natural Resources has implemented interim measures to mitigate this risk, and USACE is further studying this pathway to determine whether a long-term ANS control should be implemented. For the remaining 17 sites, USACE is coordinating further study to finalize the risk characterization and determine whether ANS controls are recommended.

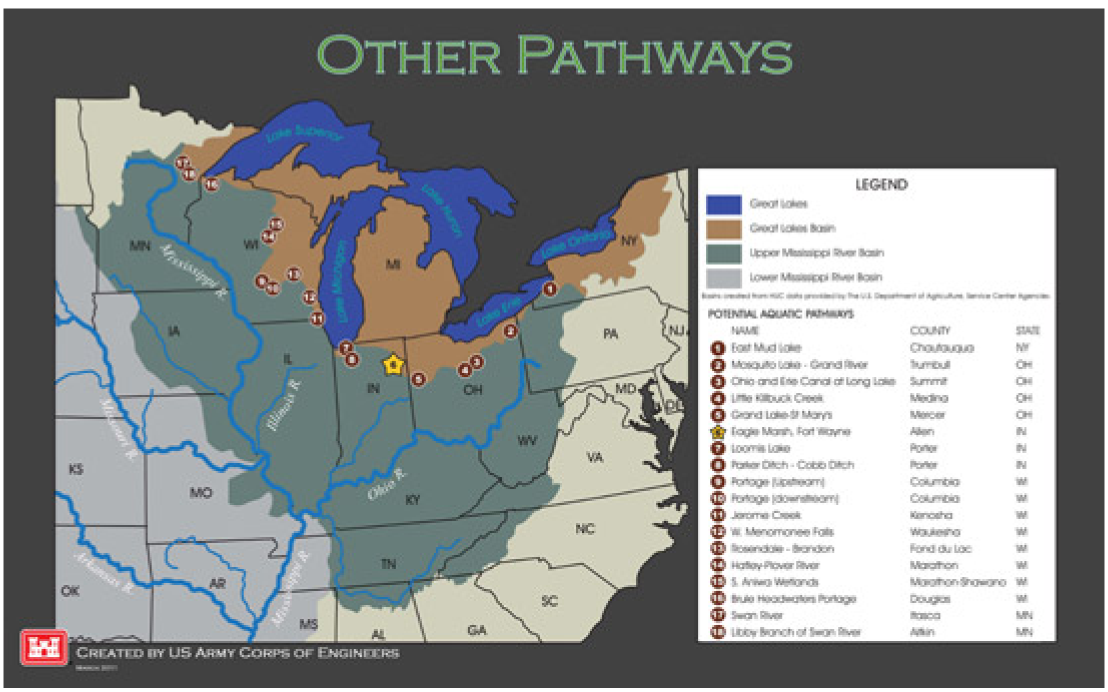

Figure 3. Other Pathways Map

II. DESCRIPTION OF CAWS INFRASTRUCTURE

Direct water diversions occur at multiple locations - the Chicago River Controlling Works (CRCW), the O'Brien Lock and Dam, Lockport Lock and Dam, Brandon Lock and Dam, and the Wilmette Pumping Station. Diversion at these locations consists of four components; lockage, leakage, discretionary flow, and navigation makeup flow. The lockage component is the flow used in locking vessels to and from the lake. The leakage component is water estimated to pass, in an uncontrolled way, through or around the lakefront structures. The purpose of the discretionary diversion is to dilute effluent from sewage discharges and improve water quality in the canal system.

Water levels in Lake Michigan are typically higher than water levels in the channels, however during high rain events this is not always the case. The fourth component of water diversion is navigation makeup water. When large storms are forecast, the canal is drawn down before the storm to prevent flooding, and navigation makeup water is used during this draw down period to maintain navigation depths. If the runoff is not enough to refill the canal, additional navigation makeup water is allowed to pass from Lake Michigan to return the canal system to its normal operating stages.[1]

A. Chicago River Controlling Works Lock

The Chicago River Controlling Works Lock (also known as the Chicago Lock and Chicago Harbor Lock) is located in the City of Chicago adjacent to Navy Pier, and it separates the waters of the Lake Michigan basin from the waters of the Chicago River. The lock was originally designed and built between 1936 and 1938 by the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC).

The lock was constructed as a component of the historic engineering project that reversed the flow of the Chicago River to prevent river water containing sewage from flowing into the lake and contaminating the city's drinking water. Today, the Chicago River is much cleaner but the lock continues to perform the environmental function of separating Chicago River storm water from Lake Michigan. MWRDGC operated and maintained the lock until 1984, when responsibility for operation and maintenance was transferred to the U.S. Army Corps of

[1] USACE Chicago District, Lake Michigan Diversion Accounting Water Year 2003 Annual Report

Engineers.[2] It takes about 15 minutes to cycle though the lock, and on a busy day 50-100 vessels can be locked at once.[3]

Table 1. Chicago River Controlling Works Lock Characteristics

River/ Lock	Chamber	River/ Mile	Year Open	Length	Width	Lift	Status	Owner/Operator	Gatetype
Chicago	Main	327.2	1938	600	80	4	Operational	Corps/Contractor	Sector

Source: http://www.ndc.iwr.usace.army.mil/lpms/pdf/lkgenrl.pdf

Figure 4. Chicago River Controlling Works Lock
Source: U.S. Army Corps of Engineers/Jessica Vandrick

B. T.J. O'Brien Lock & Dam

T. J. O'Brien Lock and Controlling Works were placed into operation in 1960. The project is located at the entrance to Lake Michigan (River Mile 326.0), in Chicago, Illinois. The facility is a unit of the Inland Waterway Navigation System and is one of nine such facilities between Chicago, Illinois, and La Grange, Illinois.

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[2] USACE Press Release Dated September 29, 2010. http://www.lrc.usace.army.mil/chicagolock/press_release9-29-10.pdf
[3] Personal Interview with Al Polus (PM) and Steve Hungness – Chicago Lock Operators, March 2011

O'Brien Lock is a low lift sector gate lock. It provides a maximum lift of 5.0 feet for traffic passing from Lake Michigan to the Little Calumet River. The lock chamber is 1000 feet long by 110 feet wide. The adjacent dam is 257 feet in length and comprised of two sections. The fixed section is 204 feet of steel sheet pile cellular construction. The controlling segment, a reinforced concrete structure with four slide gate sections, is 53 feet in length. It takes approximately 15 minutes to cycle through the lock.[4]

Table 2. T.J. O'Brien Lock Characteristics

River/ Lock	Chamber	River/ Mile	Year Open	Length	Width	Lift	Status	Owner/Operator	Gatetype
Thomas J O'Brien	Main	326.5	1960	1000	110	4	Operational	Corps/Corps	Tainter

Source: http://www.ndc.iwr.usace.army.mil/lpms/pdf/lkgenrl.pdf

Figure 5. T.J. O'Brien Lock & Dam
Source: U.S. Army Corps of Engineers Digital Visual Library

C. Lockport Lock & Dam

Lockport Lock and Dam is located 291 miles above the confluence of the Illinois River with the Mississippi River at Grafton, Illinois. The complex is two miles southwest of the city of Lockport, Illinois.

[4] Personal Interview with Bob Balamut, Lockmaster, O'Brien Lock, March 2011

The lock is 110 feet wide by 600 feet long. Maximum vertical lift is 42.0 feet, with an average lift of 39 feet. It averages 22.5 minutes to fill the lock chamber; 15 minutes to empty.[5]

Table 3. Lockport Lock Characteristics

River/ Lock	Chamber	River/ Mile	Year Open	Length	Width	Lift	Status	Owner/Operator	Gatetype
Lockport	Main	291.1	1933	600	110	39	Operational	Corps/Corps	Miter

Source: http://www.ndc.iwr.usace.army.mil/lpms/pdf/lkgenrl.pdf

Figure 6. Lockport Lock & Dam
Source: U.S. Army Corps of Engineers Digital Visual Library

D. Brandon Road Lock & Dam

Brandon Road Lock and Dam (also known as Brandon Road Pool and Brandon Lock) is a gravity dam. The core is homogeneous, earth, concrete, and metal with a rock foundation. Though originally completed in 1933, the structure was modified in 1985.[6]

Table 4. Brandon Road Lock Characteristics

River/	Chamber	River/	Year	Length	Width	Lift	Status	Owner/Operator	Gatetype

[5] Waterways Council, Inc. http://www.waterwayscouncil.org/WWSystem/Fact%20Sheets/lockport.pdf

[6] http://findlakes.com/brandon_road_lock_and_dam_illinois~il00001.htm

Lock		Mile	Open						
Brandon	Main	286	1933	600	110	34	Operational	Corps/Corps	Miter

Source: http://www.ndc.iwr.usace.army.mil/lpms/pdf/lkgenrl.pdf

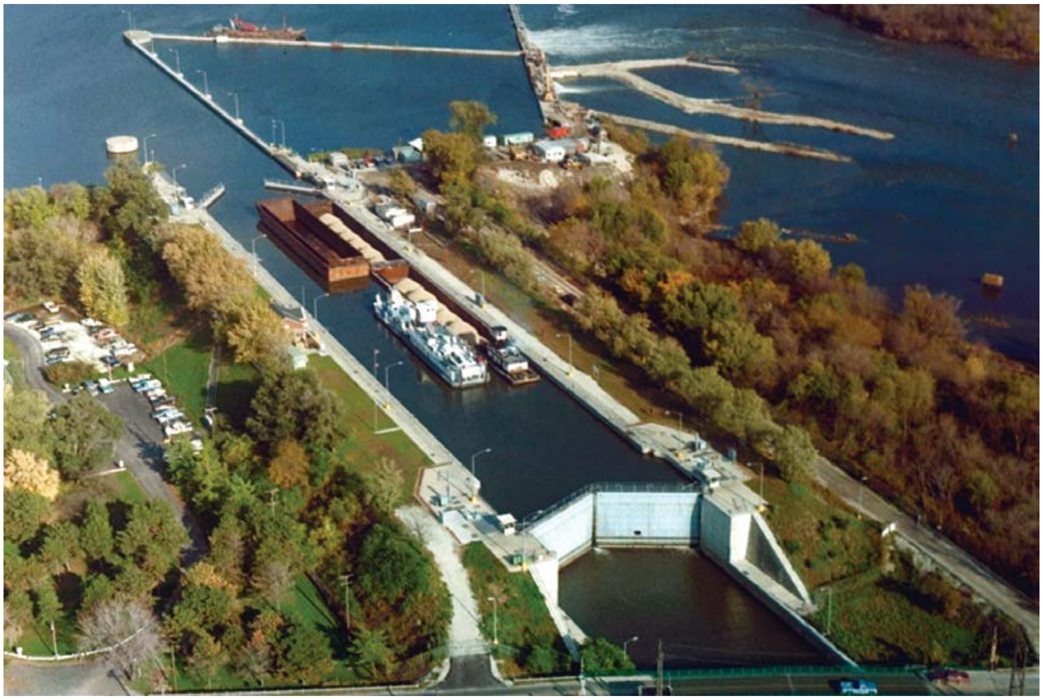

Figure 7. Brandon Road Lock & Dam
Source: U.S. Army Corps of Engineers

E. Wilmette Pumping Station

Between 1907 and 1910, the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) constructed a canal called the North Shore Channel. It extended from Lake Michigan at Wilmette in a southerly direction 6.14 miles to the north branch of the Chicago River. The Wilmette Pumping Station, also known as the Wilmette Controlling Works, regulates the amount of Lake Michigan flow allowed down the North Shore Channel through the use of one vertical lift gate. The four abandoned 250 cfs pumps have not been used for diversion since the 1970's.[7] The sluice gate is a means by which excess storm water is reversed to Lake Michigan.

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[7] USACE Chicago District, Lake Michigan Diversion Accounting Water Year 2003 Annual Report

The Wilmette Pumping Station is the gateway between the North Shore Channel and Lake Michigan. The pumping station and the bridge are a single integral structure. In addition to going over the pumping station, the bridge features two spans that pass over the access roads and open paved space that provides access to the pumping station facility.

This bridge is historically significant as an unusual bridge that was designed as a part of a building, and also for its association as an unaltered part of the canal that plays an important role in regulating the flow of the Chicago River.[8]

MWRDGC, not the US Army Corps of Engineers, owns and operates the Wilmette Pumping Station.

Figure 8. Wilmette Pumping Station
Source: Public Domain, http://commons.wikimedia.org/wiki/File:Wilmette_Pumping_Station2.JPG

[8] www.historicbridges.org

III. NON-CARGO CAWS USERS

Multiple groups utilize the Chicago Area Waterway System. Some of these user groups include: passenger boats and ferries, non federal government vessels, commercial fishing vessels, federal government vessels, and recreation vessels. A brief description of some of the major user categories are below. Traffic data for each of the CAWS lock user groups is in Section IV: Non-Cargo CAWS Traffic.

A. Passenger Vessels

Passenger boats primarily serve the tourist industry, an element of Chicago's economy.

Newly constructed passenger vessels that are added to the existing fleet are frequently transported through the lock system to reach their home port. Passenger vessel access for both daily operations and fleet expansion would be directly affected in the event of a lock closure.

1. Tour Boats and Ferries

Tour boat operators provide lectures on architecture, history, natural history, and on the city's unique collection of moveable bridges.[9] Tour passengers also indicate that cutting through the Chicago Lock is one of the highlights of a combined lake/river tour; and brief discussions of the history of the lock, its construction, and operation are frequently conducted by tour operators. Chicago area passenger boats and ferries provide services for hundreds of thousands of passengers every year.[10]

Product offerings include:

- water taxi services (in the CAWS, seven-day a week water transportation for thousands of commuters and tourists)
- sunset cruises (from Lake Michigan, viewing sunset and Chicago city lights)
- fireworks tours (through Chicago Lock to Lake Michigan, viewing of fireworks show from the Lake)
- skyline tours (from Lake Michigan, viewing Chicago from the lake)
- architecture tours (in the CAWS, river tour through the heart of Chicago with narrated education of Chicago architecture)

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[9] The Electronic Encyclopedia of Chicago © 2005 Chicago Historical Society. http://www.encyclopedia.chicagohistory.org/pages/300014.html

[10] Personal Communication. Michael Borgstrom, President, Wendella Tours. March 2011.

- combined lake/river tours (includes Lake Michigan and access to CAWS through Chicago Lock, for viewing Chicago skyline and architecture)
- specialty cruises (multiple options including Wine Tasting, Pet Friendly Tours, Supernatural/Haunted Attractions, etc)
- charter services (for weddings, corporate events, or other private parties).

2. Cruise Ships

While large, ocean going cruise ships are not commonly seen in the Chicago area, smaller vessels do have itineraries featuring Chicago as a port of call.

The 100-passenger M/V Grande Caribe, M/V Grande Mariner, and M/V Niagara Prince, operated by the Great Lakes Cruise Company of Ann Arbor, Michigan, departs Chicago on a variety of tours including a 15-day tour that takes passengers to Warren, Rhode Island by way of lakes Michigan, Huron, Erie, and Ontario, the Oswego and Erie canals, and the Hudson River.[11]

MV Columbus, also operated by Great Lakes Cruise Company, was designed specifically to accommodate the locks of the Great Lakes. The ship contains 134 outside cabins, 63 inside cabins and 8 outside suites. Itineraries include voyages from Chicago to Toronto.[12]

B. Non-Federal Government Vessels

1. Chicago Police

Chicago Police Marine Operations personnel are responsible for all bodies of water within the City of Chicago. This includes 80 square miles of Lake Michigan, 27 miles of Lake Michigan shore line, 38 miles of Chicago River system, Wolf Lake, Lake Calumet and various ponds and lagoons throughout the City.

To complete their mission, Marine Operations personnel use seven patrol/rescue boats and a state of the art dive response truck for land based assignments. Marine Operations personnel (all of whom are public safety divers) are the first responders to any maritime incident. Marine Operations personnel have three areas of responsibility. They are Search/Rescue/ Recovery Operations, Law Enforcement, and Homeland Security. Incidents requiring marine response include everything from person(s) in the water to commercial airline crashes. Law Enforcement personnel assigned to Marine Operations are responsible for enforcing state statutes, City ordinances, and Chicago Park District ordinances. Marine Operations personnel

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[11] http://www.greatlakescruising.com/

[12] http://www.greatlakescruising.com/

spend a large portion of their tour conducting homeland security checks and patrols. Several of the highest threat assessed targets within the City are on, or surrounded by, water.[13]

The Chicago Police utilize the locks in their daily operations for patrol and emergency response. The department currently houses two vessels on each side of the Chicago lock to reduce response time. When an emergency response requires vessels to utilize the lock, the lock operators have the ability to open both sets of lock gaits to allow expeditious access for the vessels.[14]

2. Illinois Department of Natural Resources

The Illinois Department of Natural Resources promotes the safe use and enjoyment of the waters of Illinois. Their mission is to manage, protect, and sustain Illinois's natural and cultural resources; further the public's understanding and appreciation of those resources; and promote the education, science, and public safety of our natural resources for present and future generations.[15]

C. Fishing Vessels

1. Commercial Boats

Commercial fishing has been part of the Chicago region since the 1830s. Through much of the nineteenth century, commercial fisherman mostly caught whitefish. By the 1890s trout had become the most valuable catch. Invasions of non-native fish, especially rainbow smelts and lampreys, decimated the lake trout population, and reduced commercial fishing.[16]

Commercial fishing continued, focused on perch, until a 1996 Illinois statute ended that fishery as well. There are limited small commercial fisheries in Lake Michigan. Commercial fishing boats typically no longer use the Chicago area locks. There are a number of commercial fishing endeavors on the river system but these boats typically do not use the Chicago area locks either.

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[13] Chicago Police. https://portal.chicagopolice.org/portal/page/portal/ClearPath/About%20CPD/Specialized%20Units/Marine%20and%20Helecopter%20Unit

[14] Personal Communication. Sgt Mazzola and Officer Doane, Chicago Police. March 2011.

[15] http://www.dnr.state.il.us/home.htm

[16] Please see the GLMRIS white paper "Non-Native Species of Concern and Dispersal Risk for the Great Lakes and Mississippi River Interbasin Study" for a further discussion on invasive species and transport mechanisms.

2. Sport Fishing

While commercial fishing has declined significantly over time, sport fishing on Chicago's rivers and lakes remains popular. The Illinois Department of Natural Resources stocks trout, salmon, and other fish (as do its counterparts in neighboring states).[17]

D. Federal Government Vessels (With and Without Barges)

Multiple federal agencies utilize the Chicago Area Waterway System including the U.S. Coast Guard and the U.S. Army Corps of Engineers, among others. These agencies are discussed below.

1. U.S. Coast Guard

Marine Safety Unit (MSU) Chicago is responsible for executing the Coast Guard's Port Safety and Security, Marine Environmental Protection, and Commercial Vessel Safety missions under the auspices of the Department of Homeland Security. These missions ensure a safe, secure, and environmentally sound maritime domain that continues to promote recreation and the free flow of commerce on Southern Lake Michigan, as well as the Chicago Area Waterway System and the Illinois River Watershed.

MSU Chicago serves an active network of domestic and international maritime interests covering the Lake Michigan shorelines of Illinois and Indiana, as well as 177 miles of the Illinois River System segmented by seven locks and over 250 bridges. The MSU Chicago area of responsibility includes nine Lake Michigan ports, a fleet of 235 inspected vessels, 101 regulated waterfront facilities, and eight permanent security zones. They also oversee the safety and security of more than 25 million passengers that frequent riverboat casinos and passenger vessels annually.

The unit's 53 active duty, reserve and civilian personnel perform a variety of tasks each day, ranging from conducting armed port security patrols, inspecting commercial vessels, conducting pollution and marine casualty investigations, enforcing safety zones and conducting waterfront facility exams for compliance with federal regulations.[18]

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[17] The Electronic Encyclopedia of Chicago © 2005 Chicago Historical Society. http://www.encyclopedia.chicagohistory.org/pages/300036.html

[18] U.S. Coast Guard, http://www.uscg.mil/d9/msuchicago/

2. U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers utilizes the Chicago Area Waterway System to achieve its missions of flood control, environmental protection, shoreline protection, navigation, and emergency management. Vessels within the U.S. Army Corps of Engineers fleet include debris collectors, tenders, dredge vessels, research vessels, survey and patrol vessels, towboats, and multiple types of barges.[19]

E. Recreational Vessels

The Chicago Park District has nine lakefront harbors that stretch from Lincoln Park in the northern part of the city to Jackson Park in the south. With accommodations for more than 5,000 boats, the Chicago Park District Harbors constitute the nation's largest municipal harbor system and feature state-of-the-art floating docks, moorings, star docks, fuel facilities and other amenities for Chicago boaters and their guests. The harbors are very popular with area boaters and have enjoyed occupancies in excess of 98 percent for the past several years.[20]

Many recreational boaters that utilize these harbors travel through the locks to access recreational areas further inland, to avoid severe weather of the Great Lakes, or to reach dry storage for off-season storing of their vessels. Off-season vessel storage is available from multiple companies, including several of the Chicago area harbors. Storage options include inside and outside dry storage.

1. Chicago Park District Harbors

From north to south, below is a description of the Chicago Park District Harbor facilities. The description below should not be considered an exhaustive list of marine facilities in Chicago. Boaters utilizing harbors outside the immediate Chicago area also utilize the CAWS for marine service and boat storage operations.

[19] USACE Vessel factsheets. http://www.nap.usace.army.mil/mdc/factsheets.htm

[20] http://www.chicagoharbors.info/

a. Montrose Harbor

Figure 9. Montrose Harbor
Source: http://www.chicagoharbors.info

Montrose Harbor is located on the northern edge of Lincoln Park, a short walk from Montrose Beach. There are 630 docks, mooring cans,[21] and star docks.[22] Transient docking is available. Waste pump-out equipment is provided on a no charge basis. Montrose Harbor is the home harbor of the Chicago Corinthian Yacht Club.[23]

b. Belmont Harbor

Belmont Harbor is located in Lincoln Park. There are 730 docks, mooring cans and star docks. Transient docking is available. Belmont Harbor has a fuel dock facility, with gas and diesel fuels.

The Ship's Store, located in the Harbor Building, offers refreshments, apparel and boating supplies. Additionally, there is a mast stepping/unstepping capability at the Harbor Building. Waste pump-out equipment is available on a no charge basis. Chicago Yacht Club (Belmont Station) and the Belmont Yacht Club are located at Belmont Harbor. [24]

[21] Mooring cans are attached to anchors in the harbor – the owners must row out to their boats for access.

[22] Star docks are a circular configuration similar to the mooring cans but able to accommodate more than one boat – the owners must row out to their boats for access.

[23] Ibid

[24] Ibid

Figure 10. Belmont Harbor
Source: http://www.chicagoharbors.info

c. Diversey Harbor

Figure 11. Diversey Harbor
Source: http://www.chicagoharbors.info

Diversey Harbor is located in the heart of Lincoln Park. Within walking distance is the Lincoln Park Zoo and the Peggy Notebaert Nature Museum, Diversey Harbor has 714 docks and star docks. Transient docking is available.

There is a fuel facility at Diversey Harbor located at the Diversey Yacht Club. This facility dispenses gas and diesel fuels. Additionally, there is a public launch ramp with parking for approximately 67 vehicles with trailers. Waste pump-out equipment is provided on a no charge basis. [25]

d. DuSable Harbor

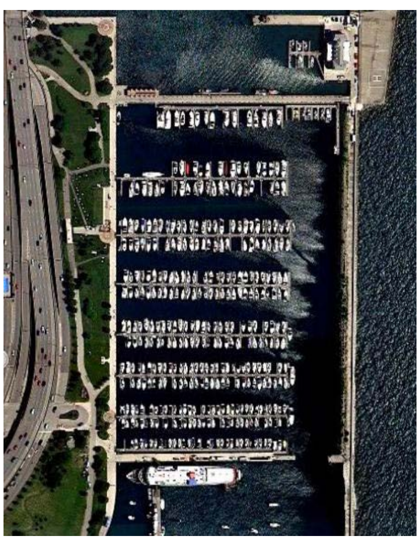

Figure 12. DuSable Harbor
Source: Google Earth

DuSable Harbor is located in the heart of downtown Chicago at the foot of Randolph Street. Entrance to the harbor is through the Monroe Harbor entrance with a turn to the north along the eastern breakwater, past the stern of the Columbia Yacht Club and into the harbor. There are 420 docks in DuSable Harbor. Transient docking is available. Waste pump-out equipment is provided on a no-charge basis.

The Ship's Store, located in the harbor building, offers refreshments, apparel and limited boating supplies.[26]

[25] Ibid

[26] Ibid

e. Monroe Harbor

Monroe Harbor is located in the heart of downtown Chicago. There are approximately 1,000 mooring cans in the harbor. Transient mooring is available. Monroe Harbor has a tender service, which provides delivery and pickup to boats in the harbor. Additionally, there is Waste pump-out equipment, which is provided on a no charge basis.

Monroe Harbor is home to the Chicago Yacht Club and the Columbia Yacht Club. [27]

Figure 13. Monroe Harbor
Source: Google Earth

f. Burnham Harbor

Burnham Harbor is located within walking distance of the Chicago downtown area and is situated on the Museum Campus. The Museum Campus is home to the Field Museum, the Shedd Aquarium and the Adler Planetarium. Soldier Field is on the west side of Burnham Harbor and McCormick Place is to the south. There are 1120 docks, mooring cans and star docks. Transient docking is available.

Burnham Harbor has a fuel dock facility which dispenses gas and diesel fuels. The Ship's Store, located in the harbor building, offers refreshments, apparel and boating supplies and there is a laundry facility in the building. Waste pump-out equipment is available at no charge. There is a launch ramp at the harbor with parking for approximately 43 vehicles with trailers. There is a mast stepping/unstepping capability at the

[27] Ibid

Burnham Park Yacht Club, located on the east side of Burnham Harbor. [28]

Figure 14. Burnham Harbor
Source: Google Earth

g. 31st Street Harbor

The Chicago Park District's newest harbor is now under construction and is scheduled to open in May 2012 with 1000 new slips. It will feature a parking garage, fuel dock, harbor store, launch ramps and winter storage. The harbor is located just one mile south of Burnham Harbor and has a beach and playground.[29]

Figure 15. 31st Street Harbor Conceptual Rendering
Source: http://www.chicagoharbors.info

h. 59th Street Harbor

59th Street Harbor is located in Jackson Park, a very short walk to the Museum of Science and Industry and the 63rd Street Beach. There are 125 docks located in the harbor. Transient docking is available. Waste pump-out equipment is provided on a no-charge basis. 59th Street Harbor is the home harbor of the Museum Shores Yacht Club. [30]

[28] Ibid

[29] Ibid

[30] Ibid

Figure 16. 59th Street Harbor
Source: http://www.chicagoharbors.info

i. Jackson Park Inner Harbor

Jackson Park Inner Harbor is located in the heart of Jackson Park. There are 165 docks and star docks. Transient docking is available. Waste pump-out equipment is available on a no charge basis. There is also a launch ramp on the east side of the harbor with parking for 40 vehicles with trailers.

Jackson Park Inner Harbor is the home to the Southern Shore Yacht Club. [31]

Figure 17. Jackson Park Inner Harbor
Source: Google Earth

j. Jackson Park Outer Harbor

Jackson Park Outer Harbor is located in the heart of Jackson Park of 63rd Street Beach. There are 169 docks, mooring cans and star docks. Transient docking is available.

Jackson Park Outer Harbor has a fuel dock facility, which dispenses gas and diesel fuels. The Ship's Store, located in the Harbor building, offers refreshments, apparel and boating supplies. There is a privately operated restaurant at the south end of the building. Waste pump-out equipment is available on a no charge basis.

The Jackson Park Yacht Club is located in the harbor; the club offers a mast stepping/unstepping capability.[32]

Figure 18. Jackson Park Outer Harbor
Source: Google Earth

[31] Ibid

[32] Ibid

2. Chicago Area Marine Events

Yacht clubs in the Chicago area host over 125 races during a season, including the Race to Mackinac, the Sailing World Chicago National Offshore One Design Regatta, and the Chicago Yacht Club Verve Regattas. Other racing events include the the North American Challenge Cup for Disabled Sailors, One Design Seasonal Championship Racing, Wednesday night "Beer Can" racing, and "Frostbiting" in both the spring and fall.

Fishing tournaments, fireworks displays, and other marine events sponsored by a variety of organizations also draw local boaters and visitors to the area.

IV. NON-CARGO CAWS TRAFFIC

Lock data was obtained from the US Army Corps of Engineers Institute of Water Resources Navigation Data Center for the years shown. This data is included to show the magnitude and distribution of non-cargo lock usage in the CAWS area. Some of these passengers and vessels are likely to be making a round trip through the lock during the calendar year. All data should be considered preliminary and is subject to updates.

A. Chicago River Controlling Works Lock

The Chicago River Controlling Works Lock is heavily utilized. The lock sees an average of 711,902 commercial passenger one-way trips and 41,071 non-cargo vessel one-way trips (based on averaging 2000 through 2010 data). See Table 5 and Table 6 for further information.

Table 5. Chicago River Controlling Works Lock Usage, Calendar Year 2000-2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Cuts (#)	12,261	11,288	11,504	10,514	11,028	12,623	12,030	12,442	11,599	11,334	11,699

Source: USACE NDC, LPMS
Note: Preliminary Data, Subject to Updates
Includes Non-Vessel Lockages

Table 6. Chicago River Controlling Works Lock Non-Cargo Traffic, Calendar Year 2000-2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Passenger Boat or Ferry	11,967	9,582	10,521	9,665	9,835	11,069	10,832	10,893	10,195	9,934	11,306
Non-Federal Govt Vessel	1,461	1,193	1,078	1,024	2,162	2,297	1,434	1,569	1,399	1,135	921
Commercial Fishing Vessel	93	-	-	-	-	-	-	-	-	-	-
Federal Govt Vessel (no barge)	137	220	194	335	354	529	701	552	606	472	442
Federal Govt Vessel (w/barge)	1	11	16	11	11	-	1	1	2	-	4
Recreation Vessel	38,418	35,898	37,126	30,676	27,699	26,189	22,486	26,661	23,886	23,298	23,284
Total Non-Cargo Vessels	**52,077**	**46,904**	**48,935**	**41,711**	**40,061**	**40,084**	**35,454**	**39,676**	**36,088**	**34,839**	**35,957**
Commercial Passengers	821,840	678,108	694,323	616,254	606,263	728,591	687,567	774,950	732,438	685,012	805,575

Source: USACE IWR, WCSC
Note: Preliminary Data, Subject to Updates.
Does not include vessels listed in the "Other" category as it is unknown whether or not those vessels would be considered cargo or non-cargo vessels.

B. T.J. O'Brien Lock & Dam

The T.J. O'Brien Lock sees an average of 479 commercial passenger one-way trips and 19,274 non-cargo vessel one-way trips (based on averaging 2000 through 2010 data). See Table 7 and Table 8 for further information.

Table 7. T.J. O'Brien Lock Usage, Calendar Year 2000-2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Cuts (#)	9,133	8,680	8,379	8,353	7,800	7,893	7,274	7,352	6,310	5,898	5,796

Source: USACE NDC, LPMS
Note: Preliminary Data, Subject to Updates
Includes Non-Vessel Lockages

Table 8. T.J. O'Brien Lock Non-Cargo Traffic, Calendar Year 2000-2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Passenger Boat or Ferry	9	12	20	19	22	16	14	19	20	29	21
Non-Federal Govt Vessel	7	43	25	23	3	19	33	27	11	21	16
Federal Govt Vessel (no barge)	42	49	104	180	172	149	168	160	65	86	48
Federal Govt Vessel (w/barge)	1	2	6	7	2	-	-	2	-	1	1
Recreation Vessel	26,467	23,543	24,344	21,038	18,699	20,354	16,267	18,381	15,184	13,923	12,142
Total Non-Cargo Vessels	**26,526**	**23,649**	**24,499**	**21,267**	**18,898**	**20,538**	**16,482**	**18,589**	**15,280**	**14,060**	**12,228**
Commercial Passengers	341	744	677	845	719	442	292	314	220	423	254

Source: USACE IWR, WCSC
Note: Preliminary Data, Subject to Updates
Does not include vessels listed in the "Other" category as it is unknown whether or not those vessels would be considered cargo or non-cargo vessels.

C. Lockport Lock & Dam

The Lockport Lock sees an average of 164 commercial passenger one-way trips and 1,021 non-cargo vessel one-way trips (based on averaging 2000 through 2010 data). See Table 9 and Table 10 for further information.

Table 9. Lockport Lock Usage, Calendar Year 2000-2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Cuts (#)	4,207	4,161	4,254	4,039	4,138	4,116	4,207	3,719	3,379	3,239	3,176

Source: USACE NDC, LPMS
Note: Preliminary Data, Subject to Updates
Includes Non-Vessel Lockages

Table 10. Lockport Lock Non-Cargo Traffic, Calendar Year 2000-2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Passenger Boat or Ferry	5	8	14	10	13	4	4	3	-	2	5
Non-Federal Govt Vessel	-	-	-	6	2	3	2	1	3	1	1
Federal Govt Vessel (no barge)	16	5	2	27	93	16	2	13	6	29	7
Federal Govt Vessel (w/barge)	12	10	11	3	14	11	8	2	6	4	5
Recreation Vessel	1,172	1,212	1,227	1,189	1,081	1,112	912	896	721	720	602
Total Non-Cargo Vessels	**1,205**	**1,235**	**1,254**	**1,235**	**1,203**	**1,146**	**928**	**915**	**736**	**756**	**620**
Commercial Passengers	82	213	459	235	286	58	78	2	-	111	284

Source: USACE IWR, WCSC
Note: Preliminary Data, Subject to Updates
Does not include vessels listed in the “Other” category as it is unknown whether or not those vessels would be considered cargo or non-cargo vessels.

D. Brandon Road Lock & Dam

The Brandon Road Lock sees an average of 148 commercial passenger one-way trips and 1,242 non-cargo vessel one-way trips (based on averaging 2000 through 2010 data). See Table 11 and Table 12 for further information.

Table 11. Brandon Road Lock Usage, Calendar Year 2000-2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Cuts (#)	4,453	4,438	4,405	4,257	4,307	4,312	4,400	3,848	3,464	3,417	3,297

Source: USACE NDC, LPMS
Note: Preliminary Data, Subject to Updates
Includes Non-Vessel Lockages

Table 12. Brandon Road Lock Non-Cargo Traffic, Calendar Year 2000-2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Passenger Boat or Ferry	10	15	12	8	9	3	2	2	-	2	3
Non-Federal Govt Vessel	-	-	-	2	2	4	2	2	5	6	2
Federal Govt Vessel (no barge)	8	20	9	40	82	7	4	19	6	28	12
Federal Govt Vessel (w/barge)	36	11	19	17	36	45	19	43	14	14	12
Recreation Vessel	1,556	1,480	1,621	1,488	1,323	1,289	1,018	1,013	755	808	718
Total Non-Cargo Vessels	**1,610**	**1,526**	**1,661**	**1,555**	**1,452**	**1,348**	**1,045**	**1,079**	**780**	**858**	**747**
Commercial Passengers	187	226	211	242	298	97	119	2	-	111	137

Source: USACE IWR, WCSC
Note: Preliminary Data, Subject to Updates
Does not include vessels listed in the "Other" category as it is unknown whether or not those vessels would be considered cargo or non-cargo vessels.

E. Wilmette Pumping Station

The Wilmette Pumping Station is the gateway between the North Shore Channel and Lake Michigan. While water does pass through this location, vessel traffic does not. Therefore a non-cargo vessel traffic analysis was not conducted at this location.

V. **ADDITIONAL INFORMATION**

The data for this report was derived from a variety of sources as noted in footnote references. The primary source of the data was taken from the Lock Performance and Monitoring System (LPMS) and the Waterborne Commerce Statistics Center (WCSC). LPMS tracks vessels and barges locked; type and dates of cuts; durations of, and causes for, periods of lock unavailability; barge type, size, and commodity type; and tonnages carried. WCSC tracks vessel operating companies that transport waterborne commerce. Domestic and foreign vessel trips and tonnages by commodity for ports and waterways are tracked. All data should be considered preliminary and is subject to updates. Movement data acquired by the Center is primarily for the use of the Corps and other government agencies; however, summary statistics, which do not disclose movements of individual companies, are also released to private companies and to the general public.

Additional information and analysis will be included in a subsequent deliverable entitled "Economic Evaluation of Non-Cargo CAWS Traffic." This document will include an economic evaluation of expected increases in costs to businesses and services from basin separation alternatives as well as the degradation in value associated with the recreational experience. The evaluation will summarize survey and personal interview information gathered from lock users. Final deliverable is expected in the first quarter of 2012.

Information is also available on the Great Lakes Mississippi River Interbasin Study Web Site located at: http://glmris.anl.gov/

Future Without-Project Condition Assessment of Non-Cargo CAWS Traffic

October 2013

Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

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I. GLMRIS STUDY INFORMATION

This document follows from the *Baseline Assessment of Non-Cargo CAWS Traffic* (November 2011) which described existing conditions for commercial passenger, recreation, and governmental vessels. While the previous report established the baseline, the purpose of this assessment is to quantify the future conditions for the Non-Cargo Chicago Area Waterway System (CAWS) users if no further action is taken to prevent the transfer of aquatic nuisance species. The study period of analysis covers 50 years.

The without-project condition is based on various assumptions, and in some cases, professional judgment. Assumptions include:

- the electrical barrier currently in place on the Des Plaines River continues to function in preventing the transfer of invasive species. The electric barrier is designed to repel carp from entering Lake Michigan
- similar water conditions to those present today (i.e. rainfall events, occurrence of high water and poor water quality events are similar)
- similar growth in the passenger vessel industry is assumed to occur, based on population forecasts, tourism projections, and recent history
- any future exchange of aquatic nuisance species between basins is not likely to have a significant adverse economic impact on Chicago Area waterway non-cargo users during the study period

This assessment includes non-cargo-related traffic only, as cargo-related traffic is evaluated under a separate endeavor. This effort serves to quantify the economic activity associated with the CAWS that is subject to damage as a result of measures that address the risk reduction of aquatic nuisance species. The without-project conditions will later be compared to conditions with a project. The differences between the without-project conditions and conditions under the potential alternatives will be the benefits (i.e. avoided damages) or costs (i.e. incurred losses). These differences determine which National Economic Development (NED) or National Ecosystem Restoration (NER) plan will be selected for consideration by Congress.

A. Introduction

An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (2010).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Water quality has improved, and these canals allow the transfer of species between the basins.

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River by aquatic pathways. In this context, the term "prevent" includes the reduction of risk to the maximum extent possible, because it may not be technologically feasible to achieve an absolute solution. As part of this study, USACE will conduct a detailed analysis of various ANS controls, including hydrologic separation.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and

- Statutory and legal responsibilities relative to the lakes and waterways.

B. GLMRIS Study Area

The GLMRIS study area includes portions of the Great Lakes and Mississippi River basins that fall within the United States.[1]

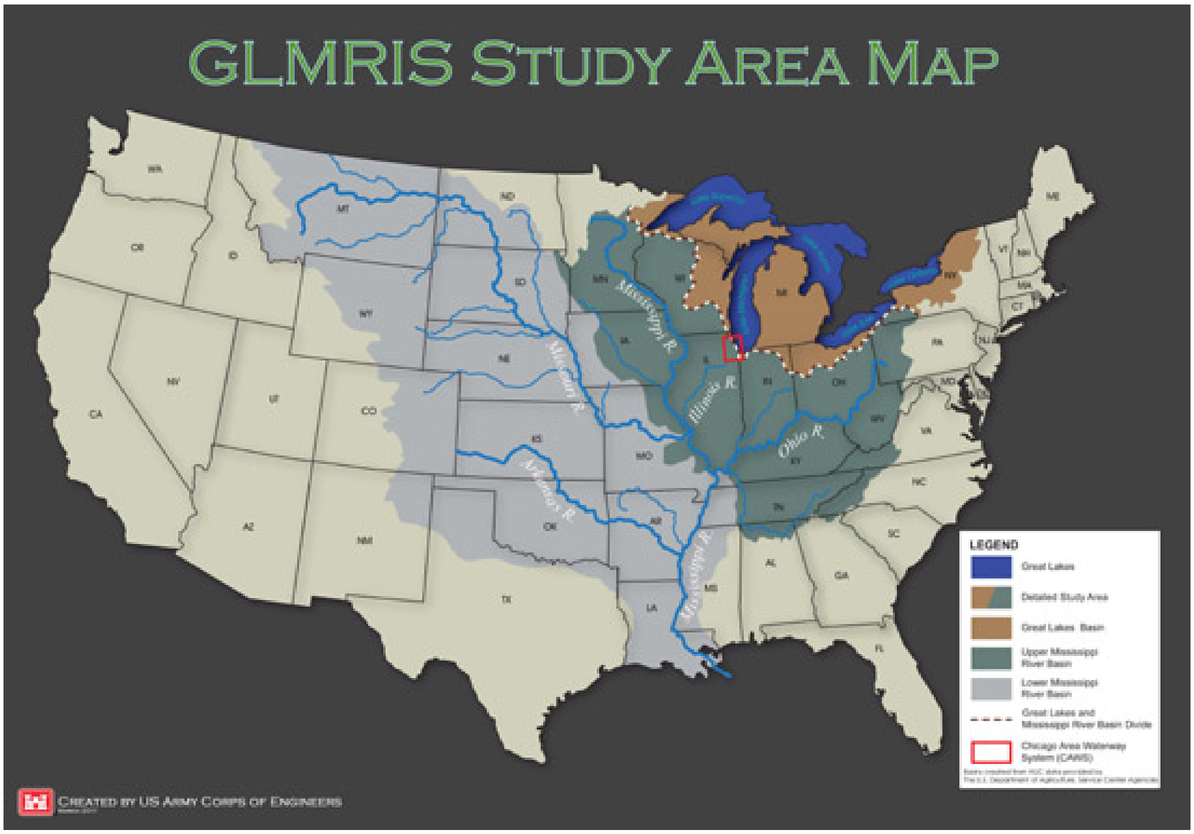

Figure 1. GLMRIS Study Area Map

Potential aquatic pathways between the Great Lakes and Mississippi River basins exist along the basins' shared boundary (illustrated as "▬ ▬ ▬" in Figure 1). This shared boundary is the primary concentration of the study.

[1] The GLMRIS team recognizes that the transfer of ANS between the Great Lakes, Upper Mississippi River, and Ohio River Basins may potentially impact fisheries in the U.S. and Canadian waters of the Great Lakes. The Team is also aware of ongoing practices to manage the Great Lakes fisheries as a bi-national effort. The GLMRIS team will continue to remain cognizant of potential environmental, economic, and social impacts of ANS transfer to Canadian interests.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi Basin ( ) and the Great Lakes Basin ( ). See Figure 1.

Future ANS may transfer beyond the *Detailed Study Area*; this pattern was observed by the spread of zebra mussels, which originated in the Great Lakes and spread throughout the Mississippi River Basin. Therefore, the *General Study Area* encompasses the lower Mississippi River Basin ( ). While the majority of GLMRIS tasks will be completed within the *Detailed Study Area*, USACE will consider specific ANS impacts in the larger *General Study Area*.

a. GLMRIS Focus Areas

The U.S. Army Corps of Engineers is conducting GLMRIS along two concurrent tracks: Focus Area I, the Chicago Area Waterway System (CAWS), and Focus Area II, Other Pathways.

(1) Chicago Area Waterway System (CAWS)

Focus Area I, the Chicago Area Waterway System, as shown in the map below, is the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins and, therefore, poses the greatest potential risk of aquatic nuisance species (ANS) transfer between the basins via an aquatic pathway.

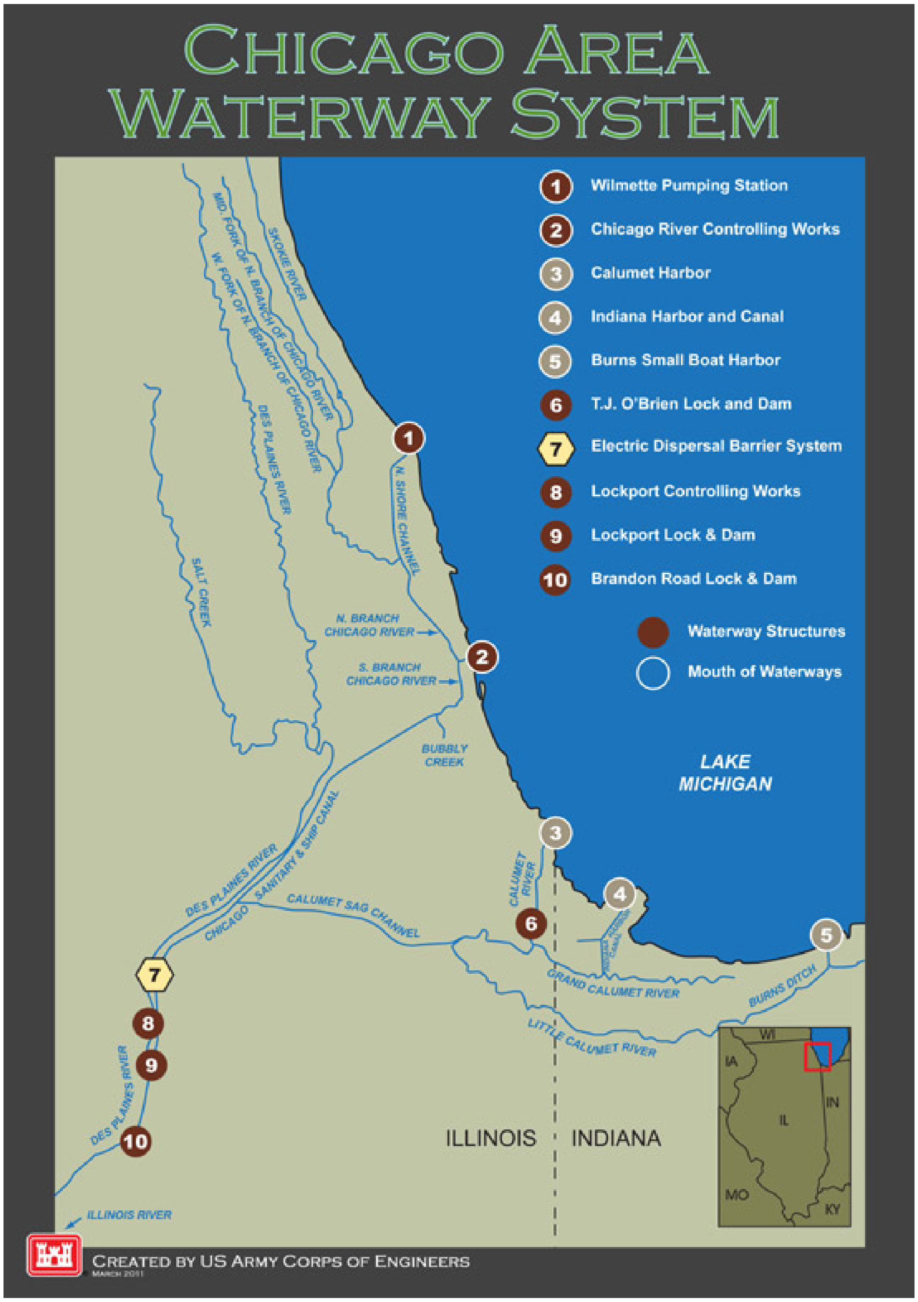

Figure 2. Chicago Area Waterway System

(2) Other Pathways

Focus Area II addresses remaining aquatic pathways. For this focus area, the U.S. Army Corps of Engineers completed a document entitled *Other Pathways Preliminary Risk Characterization Report* that identified other potential aquatic pathways outside of the Chicago Area Waterway System, as well as included a screening-level assessment of potential ANS that may transfer via these connections.

As shown on the *Other Pathways* map below, 18 potential aquatic pathways have suggested that there is significant uncertainty about the relative risks of ANS transfer. Eagle Marsh, located in Fort Wayne, Indiana was identified as having the highest potential risk of ANS transfer. The Indiana Department of Natural Resources has implemented interim measures to mitigate this risk, and USACE is further studying this pathway to determine whether a long-term ANS control should be implemented. For the remaining 17 sites, USACE is coordinating further study to finalize the risk characterization and determine whether ANS controls are recommended.

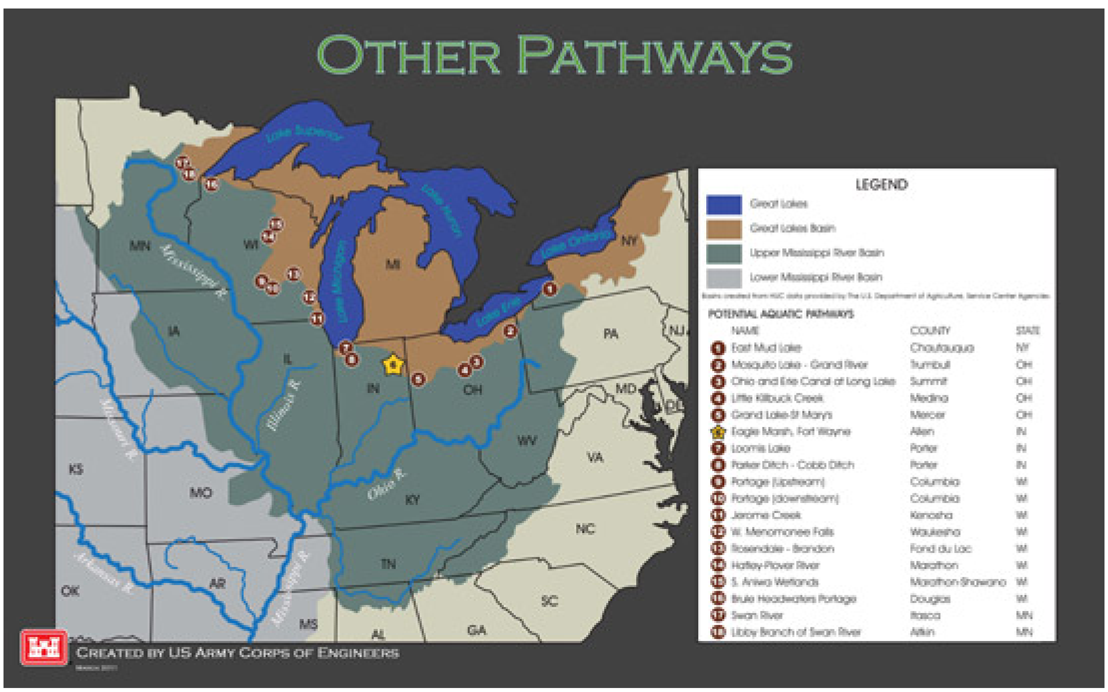

Figure 3. Other Pathways Map

II. METHOD OF ANALYSIS

The without-project condition is a forecast of what is expected to happen at a site if no project was to be implemented. For GLMRIS, the base year is 2017 with a study period of 50 years going from 2017 to 2067. Non-cargo lock users include the local population, tourists to the region and transient users passing through Chicago waterways in route to their final destination. These users own recreational vessels, ride commercial passenger vessels, and require the services of police and fire responders on occasion. The forecast for population and tourism forms the basis for future non-cargo usage of the CAWS.

In order to determine population and tourism forecasts, multiple agencies were contacted to gather accurate and reliable data. Those agencies contacted are as follows: the Chicago Metropolitan Agency for Planning (CMAP), the Chicago Office of Tourism & Culture (Explore Chicago), the Illinois Office of Tourism (Enjoy Illinois), the Chicago Convention and Visitors Bureau (Choose Chicago), the US Census Bureau, and the US Department of Commerce, Economics and Statistics Administration.

The earliest available tourism data is the year 1999, and none of the agencies are developing tourism forecasts given the instability inherent in the industry. The tourism data set runs from the 1999 to 2011 (with the country experiencing a recession midway through the data set). Due to the limited duration of historical data, and the recession that occurred during the time period when data is available, this data set was not considered appropriate to use as a base for forecasting tourism over the 50 year study period. For the purposes of this analysis, tourism is assumed to remain constant over the 50-year study period. Therefore a flat trend for tourism dependant industries (such as commercial passenger vessels) is also assumed for the 50 year study period.

Population data was gathered from the US Census in order to provide the most accurate forecast of population possible. This information was collected/forecasted as follows:

1) Decennial Census Data was collected for the years from 1900 to 2010.[2]

2) Census Annual Estimates of Population were collected for the years 2001 through 2011.[3]

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[2] Decennial Census: 1900 to 1990, http://www.census.gov/population/cencounts/il190090.txt; Census Data for 2000 http://www.census.gov/census2000/states/il.html and American Fact Finder for 2010 http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_DP_DPDP1

[3] Annual Estimates of Population produced by the Census Bureau's Population Estimates Program (PEP). Collected data includes Annual Estimates for Resident Population for Counties). http://www.census.gov/popest/data/counties/totals/2009/CO-EST2009-01.html and http://www.census.gov/popest/data/counties/totals/2011/index.html

3) Census Population Projections were collected for the years of 2015, 2020, 2025, and 2030.[4]

4) Averages between periods of data were calculated due to collected data being at varying intervals.

5) Forecast was created for the period 2031 to 2067 using a trend line from 1980-2030 data (previous 50 years). Only 50 years of data (including both historic and forecasted census data) was utilized because it provided a more conservative estimate of population growth compared to using the previous 100 years data.

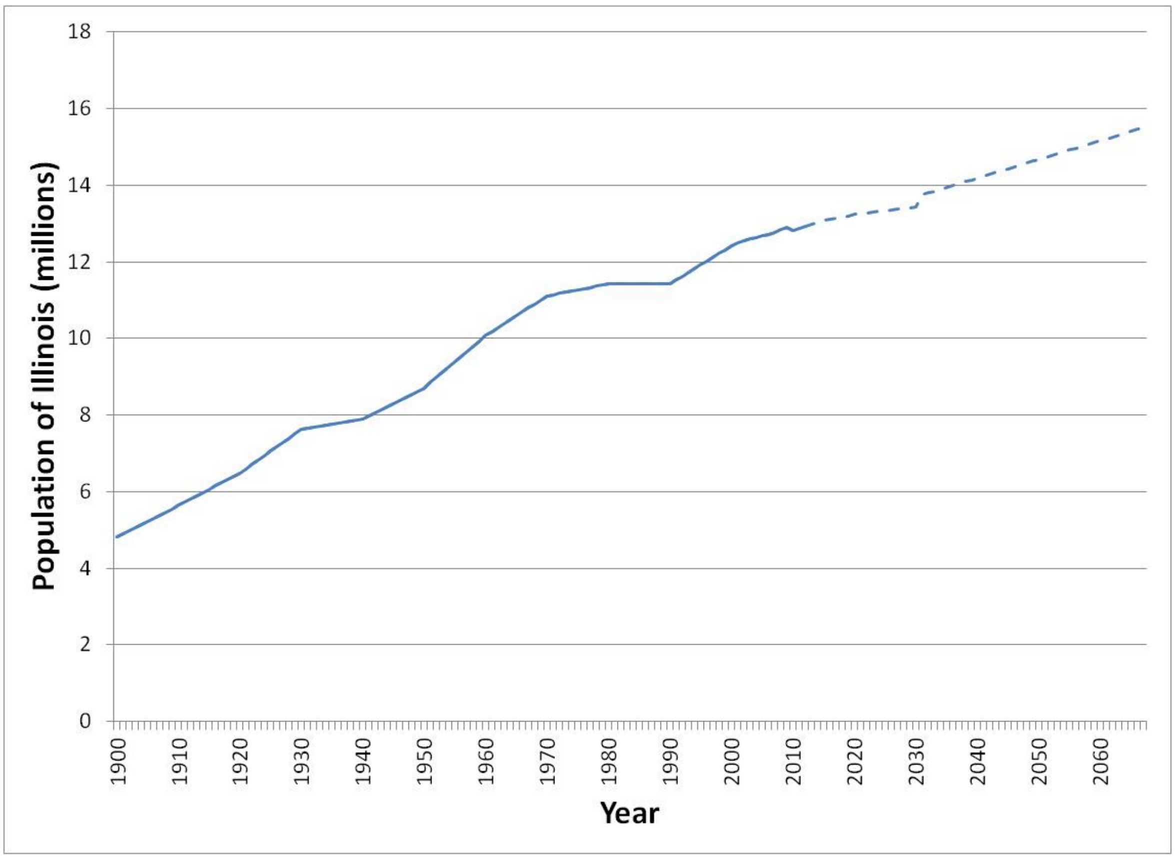

Figure 4. Illinois Population (including forecast)

[4] State Interim Population Projections based on Census 2000 and were released in 2005. Produced by the Census Population Division.
http://www.census.gov/population/www/projections/projectionsagesex.html

III. COMMERCIAL PASSENGER VESSEL NAVIGATION IMPACTS

A. CAWS Passenger Vessel Operations

Passenger vessel companies operating in the Chicago area were interviewed for the purpose of determining passenger vessel businesses current operations, likely future operations under a without-project condition, and how the companies anticipate their operations may change as a result of any basin separation measures being considered.

1. Passenger Vessel Company Interviews

The study team interviewed multiple passenger vessel and water taxi companies.[5] A summary of non-confidential information gathered during those interviews is included below.

Mercury Chicago's Skyline Cruiseline offers many boat tours including city tours, fireworks cruises, Lake Michigan cruises, pirate cruises featuring Buccaneer Bob, and Chicago's only Canine Cruise. More than a third of their business is dependent on use of the Chicago Lock. According to Captain Bob Agra, "lock closure would force us to close Mercury Cruiselines and reduce the size of Chicago's First Lady Cruises."[6] Their season runs from May 1 through Thanksgiving, seven days a week.

Wendella Sightseeing Co. Inc. offers tours and water taxi services. Tours focus on the history and architecture of the city and include a combined lake and river tour, a Chicago architecture tour on the river, and a sunset tour. In 1962, Wendella started a rush-hour commuter service known as Chicago Water Taxi which operates between Michigan Avenue and the Northwestern Railroad Station. This service enhances transportation options for the city's thousands of commuters by utilizing the resources of the Chicago River. The Chicago Water Taxi operates from the end of May through November.

Seventy percent (70%) of Wendella's total business relies on movement through the lock. Normal maintenance on vessels occurs annually and also relies on passage through the locks.

Shoreline Sightseeing offers cruises and tours along with water taxi services. Shoreline's water taxi service makes stops at major sites in the city as well as Union Station. Taxis run at least every twenty minutes from 10:00 a.m. to 6:00 p.m. during the main season of Memorial Day through Labor Day. Water Taxis may also run outside the main season in the spring and fall, weather permitting.

Cruises and tours include an architecture tour, sunset tour, and lake tours along with regularly scheduled fireworks tours.

[5] The economics study team conducted these interviews the week of August 8 – 12, 2011.
[6] Personal communication on August 16, 2011.

Shoreline generally limits their use of the lock to chartered tours, so annual passenger counts through the locks are low. Passengers change boats (one inside lock, one outside lock) so Shoreline can avoid using the locks for most day-to-day operations.

During the off season they move boats to the Calumet River and Chicago dry docks, while periodically going to Sturgeon Bay, Wisconsin for repairs. Repairs and maintenance are conducted from December through February. Shoreline currently has over 20 vessels, including 6 new vessels purchased in the last 10 years. They would not relocate in the event of a lock closure.

Chicago Line Cruises (Chicago from the Lake) offers daily architectural and historical cruises along with private charters and fireworks cruises. The company is in the process of building a new vessel, “Ceres”, which is a “green” vessel that operates on battery power at times. The battery banks will be recharged via electricity generated by land-based wind turbines.

The company operates from March 17th through the second week of December annually. Terrence Johnson, a company representative, indicates that Europeans make up a large component of the tourists visiting the city for the architecture tours. In their opinion, it’s the combination water tours that make Chicago unique and is a huge draw for tourists to come to the area.

Chicago Line Cruises dry dock their vessels riverside. Hull inspections are conducted at the Chicago Dry Dock. When asked what the company would do in the event of lock closure, the response was: “closure of the lock is a radical solution, drastic remedy, and not worth considering.”

Chicago Cruises and Great Lakes Development offers cruises for private parties, wedding celebrations, and corporate outings. Their primary business during the week is corporate events and weekend business is generally weddings and other parties. The season runs from April through September and the vessel stays in the river all year long.

Chicago Cruises revealed that they have experienced water quality issues, causing changes in route plans to avoid poor quality water. Additionally, Chicago Cruises noted that the water within the river was black when the locks were closed for upgrade during the winter of 2010/2011.

Entertainment Cruises (Seadog) has two distinct offerings: large vessels offering customizable cruises, and high-powered speed-boat rides. The company’s large vessels are moored on the lakeside of Lake Michigan and rarely use the Chicago area locks. Their large vessels are also on a 5-year inspection schedule and typically go to Sturgeon Bay, Wisconsin. The Seadog vessels (high-powered boats) are smaller and use the locks for transport of passengers from the river to the lake.

Company representatives indicated that they have a large number of international visitors.

In the event of lock closure, the Seadog business offering would be damaged. Seadog opens the 2nd week of April and closes on Halloween each year.

2. Vessel Operations

The passenger vessel companies interviewed indicated their vessels are on a five-year mandatory dry-dock rotation for Coast Guard inspections. In addition to the Coast Guard inspections, many of the vessels travel through the locks at the beginning and end of the season for repair and maintenance or winter storage. There is no heavy equipment, welding, or crane at the Navy Pier.

Typically, Chicago area boats are specifically designed and engineered to operate in the Chicago Area Waterway System. Therefore passenger boat operators would not be able to move their vessels to another location without significant modifications to the boats.

3. Passengers

The number of one-way trip passengers reported through the locks from 2000 through 2010 remained fairly consistent. Variances over these eleven years have never been more than 15 percent with average annual one-way trips of 712,000 passengers. One noted anomaly was 2010 when the passenger count was 13 percent higher than the average even though the locks were closed down starting in November for maintenance and repair.

The U.S. Department of Commerce International Trade Administration cited Chicago as one of the "most visited by overseas travelers in 2010."[7] Illinois ranked 8th among the states and territories while Chicago ranked 10th among the cities represented in the report. In total, Chicago saw 43.6 million visitors in 2011 (including domestic and overseas, leisure and business travel).[8] If the visitor industry were to experience a significant shift, then passenger vessel companies both on the river and on the lake would likely be impacted.

[7] U.S. Department of Commerce International Trade Administration Office of Travel and Tourism Industries – *Overseas Visitation Estimates for U.S. States, Cities, and Census Regions: 2010.*

[8] Chicago Office of Tourism and Culture

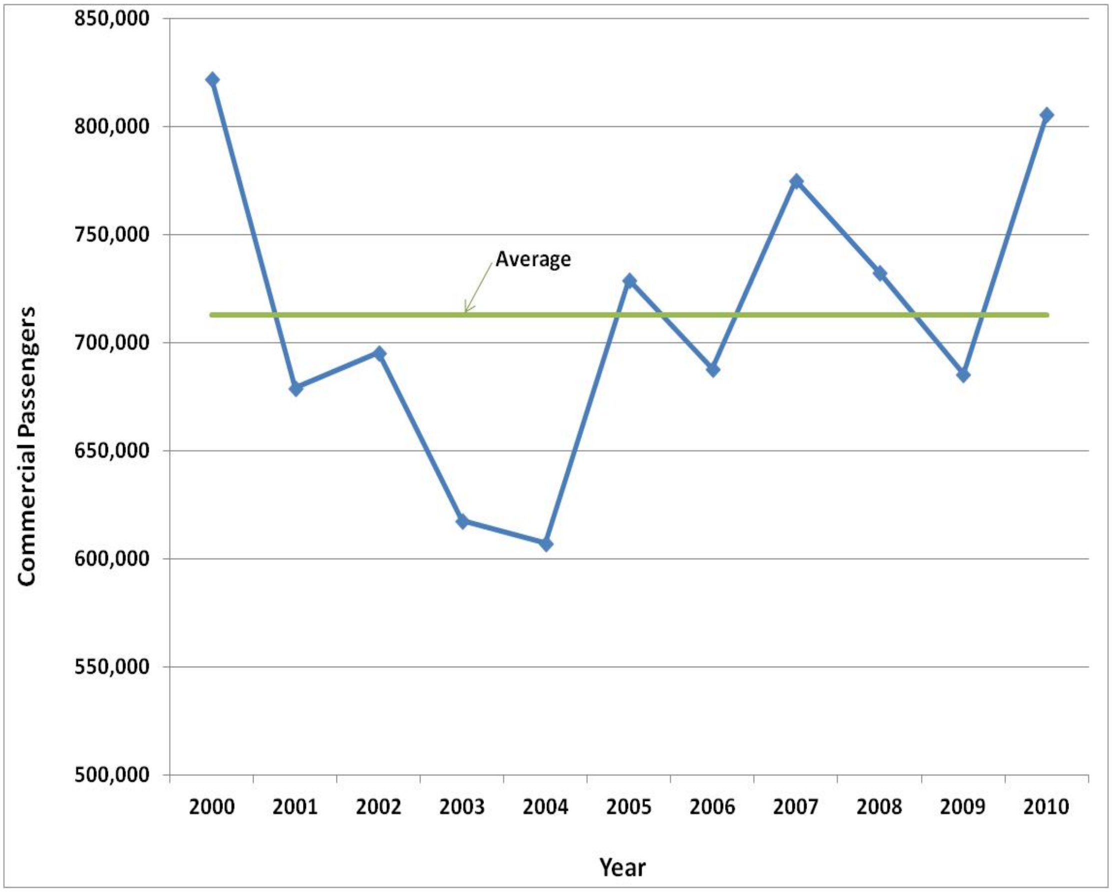

Figure 5. Commercial Passenger One Way Trips through the Chicago Lock, 2000-2010

Source: USACE IWR, WCSC
Note: Preliminary Data, Subject to Updates.

4. Employment

There were almost 1,100 workers employed in 2010 by those passenger vessels companies interviewed. Almost half of these workers operate from the lakeside of Lake Michigan and are not expected to be heavily impacted by a lock closure alternative.

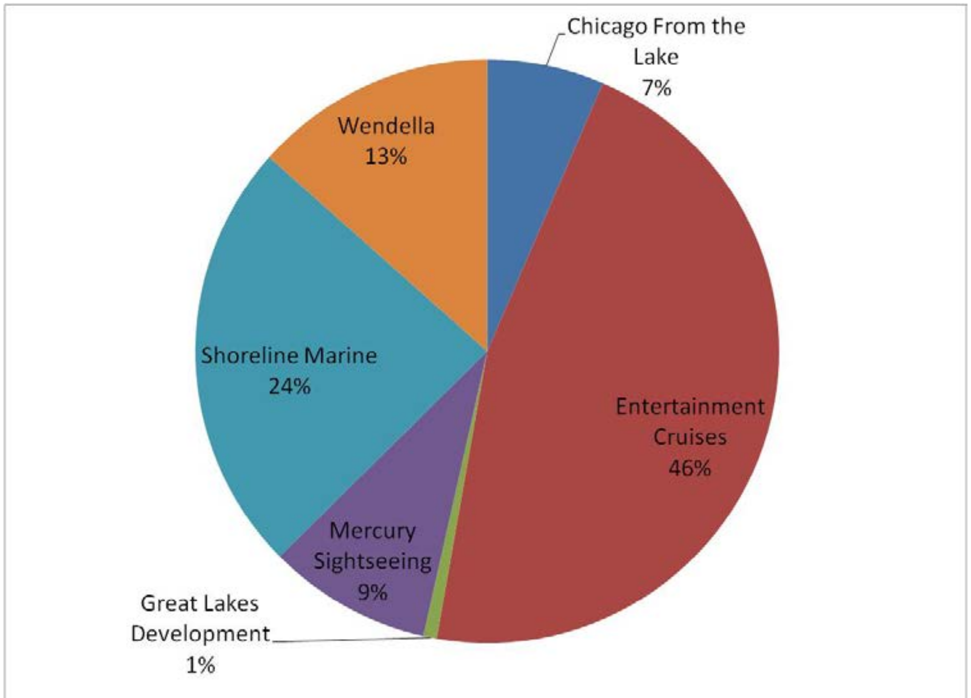

Figure 6. Passenger Vessel Company Employment Levels by Percentage of Total, 2010

Source: Interviews with Passenger Vessel/Water Taxi Companies

B. High Water Event Impact on Passenger Vessel Industry Operations under Without-Project Conditions

Passenger vessel companies indicated that their larger vessels need an air draft of 17 feet when navigating the CAWS. Boat captains prefer 1 ½ to 2 feet of under bridge clearance. Some boat captains have marked the bridges to make sure they have sufficient clearance when operating their vessels. High water levels generally impact operations once or twice a year, although several companies indicated that high water events seem to be increasing. One company lost three days during 2010 due to high water events. This company also indicated the docks were underwater this past year. They have a 30-inch delta for usage of their docks – any change in water level beyond that makes their dock unusable. It is appropriate to assume that the passenger vessel industry is being impacted by high water events that cause a temporary delay or closure of normal business operations.

The impact to the passenger vessel industry of high water events is difficult to quantify. Passengers who are unable to book a tour on any given day due to a high water event may behave in several different ways with varying impacts to the passenger vessel industry. The customer might a) rebook their tour at a later date with the same company, b) rebook with another company that is not impacted by the high water event, c) cancel their plans to take a passenger vessel, or d) choose some other alternative behavior. Depending on the behavior of the customer in response to the high water event, impacts to the passenger vessel industry would vary.

C. Passenger Vessel Revenues and Costs under Without-Project Conditions

Interviews with passenger vessel companies provided information regarding levels of revenues and expenses under current conditions. These revenues and expenses provide a picture of the health of the industry, and assuming conditions remain flat for the 50 year period of analysis the following tables contain an overview of revenues and expenses for Chicago area passenger vessel companies over the 50 year period of analysis.

Table 1. Base Year - Commercial Passenger Annual Business Revenues and Expenses

Alternative	Revenues (Dollars)	Expenses (Dollars)
Without-Project	$ 36,100,000	$ 30,000,000

Source: Interviews with Passenger Vessel/Water Taxi Companies
Note: Totals rounded to the nearest hundred thousand.

Table 2. Without-Project Condition - Commercial Passenger Business Revenues and Expenses

Alternative	Total Present Value*
Without-Project Revenues	$776,200,000
Without-Project Expenses	$643,900,000

Note: *Present Value is calculated utilizing the FY13 discount rate of 3.75%. Income and expenses are forecasted to remain flat. Totals rounded to the nearest hundred thousand.

The present value of revenues for commercial passenger businesses utilizing the Chicago Locks over the 50-year period of analysis is $776.2 million with an average annual value of $36.1 million.

The present value of expenses for commercial passenger businesses utilizing the Chicago Locks over the 50-year period of analysis is $643.9 million with an average annual value of $30 million.

D. Unit Day Value of Tour Boat Passengers under Without-Project Condition

To estimate the economic value of recreation use, the unit day value method (UDV) is used as described in Corps Economic Guidance Memorandum (EGM-12-03) for fiscal year 2012. The EGM provides guidelines for assigning point values to general recreation activities that are suitable for use to estimate the value for passenger vessel customers and provides a table showing the range of daily values that correspond to point value scores. Points are awarded based on five criteria that address the quality of the site, the number and types of activities enjoyed at the site, and the availability of substitutes for the site. Using the UDV method we can then assign points to determine day values for recreation.

A panel of ten experts was convened during a meeting in Chicago the week of January 23, 2012 to assign point values to each of the five criteria for the passenger vessel recreation experience analysis. Email communication and a conference call followed the week after. Each expert was familiar with the Chicago Area Waterway System based on both personal use and familiarity with issues related to the area. Each expert received the selection criteria for review and was requested to complete their responses by assigning values to each of the five criteria on an individual basis. Responses were accepted as-is, and were averaged to obtain a single point score for the without-project conditions.

Respondents were instructed to rank the without-project condition based on five key areas: recreation experience; availability of opportunity; carrying capacity; accessibility; and environment. Results are included in the discussion below.

Rankings for "Recreation Experience" are based on 30 total points possible. Minimum points were awarded if the respondent believed the without-project condition offered few general activities, while maximum points were awarded if the experience offers numerous high quality value activities along with some additional general activities. Points awarded between the two extremes depended upon the number of available activities and their quality. Responses for recreation experience ranged from a minimum of 16 points to a maximum of 30 points awarded, with an average of 23.

"Availability of Opportunity" refers to the travel distance required to reach other recreational options and rankings are based on 18 total points possible. Minimum points were awarded if the respondent believed the without-project condition had several alternative recreation opportunities within one hour travel time, and a few additional opportunities within only thirty minutes travel time. Maximum points were awarded if the respondent believed that no alternative recreation opportunities were within two hours travel time. Points awarded between the two extremes depended upon the number of available alternative recreation opportunities and their distance from the site. Responses for availability of opportunity ranged from a minimum of zero points awarded to a maximum of 18 points, with an average of 4 points.

Rankings for "Carrying Capacity" are based on the facilities available to users at the site under the without-project condition and are based on 14 total points possible. Minimum points were awarded if the respondent believed the without-project condition had only minimum facilities available, while maximum points were awarded if the respondent believed that the ultimate facilities were available. Points awarded between the two extremes depended upon the availability of facilities. Carrying capacity ranged from a minimum of 5 points awarded to a maximum of 14 points, with an average of 10 points.

"Accessibility" refers to the quantity and quality of access to the site under without-project conditions and rankings are based on 18 total points possible. Minimum points were awarded if the respondent believed there was only limited access by any means to the site or within the site, maximum points were awarded if the respondent believed there was good access to and within the site. Points awarded between the two extremes depended upon the availability and quality of access to and within the site. Accessibility responses ranged from a minimum of 10 points to a maximum of 18 points, with an average of 14 points awarded.

Rankings for "Environmental" are based on the esthetic quality of the without-project condition of the site and are based on 20 total points possible. Minimum points were awarded if the respondent believed that there was low esthetic factors that significantly lowered quality, maximum points were awarded if the respondent believed that the without-project condition of the site had outstanding esthetic quality with no factors in existence that lowered quality. Points awarded between the two extremes depended upon the esthetic quality and the number of factors that lowers quality. Environment ranged from a minimum of 5 points to a maximum of 15 points, with an average of 11 points awarded.

The average of responses provided by the panel of experts is shown in Table 3.

Table 3. Commercial Passenger Unit Day Value Categories for Without-Project Condition

Category	Points Possible	Without Project Condition Points Awarded (Average)
Recreation Experience	0-30	23
Availability of Opportunity	0-18	4
Carrying Capacity	0-14	10
Accessibility	0-18	14
Environment	0-20	11
Total UDV Points	100	62

Source: Expert elicitation held January 2012.

According to USACE Guidance (EGM 12-03), points awarded are then assigned a dollar value (which is provided within the guidance). The dollar value assigned to each activity is multiplied by the number of recreation days for that activity to estimate the total dollar value of annual recreation. Utilizing this method it is estimated that the average annual value for commercial passenger recreation experience is approximately $3.2 million.

Table 4. Base Year - Commercial Passenger Unit Day Value

Alternative	Dollar Recreational Value (as provided in EGM 12-03)	Average Annual Visitation*	Average Annual Value of Recreation Experience
Without-Project	$8.70	355,951	$3,200,000

Note: *Average Annual Visitation obtained from "Baseline Assessment of Non-Cargo CAWS Traffic" by USACE, November 2011. An average of 711,902 commercial passenger one-way trips through the Chicago Lock was experienced between the years 2000 and 2010. This number was divided by two to account for round trip experiences. This number should be considered a conservative estimate as it would undervalue one-way trip recreational experiences. Total rounded to the nearest hundred thousand.

Table 5. Without-Project Condition - Commercial Passenger Unit Day Value

Alternative	Total Present Value*
Without-Project	$69,500,000

Note: *Present Value is calculated utilizing the FY13 discount rate of 3.75%. Average annual visitation is forecasted to remain flat." Totals rounded to the nearest hundred thousand.

The present value of commercial passenger Unit Day Value for those passengers utilizing the Chicago Locks over the 50-year period of analysis is $69.5 million with an average annual value of $3.2 million.

IV. RECREATIONAL NAVIGATION IMPACTS

A. Non-Commercial Small Craft Owner CAWS Users under Without-Project Condition

1. Recreational User Unit Day Value under Without-Project Condition

Unit Day Value calculations are utilized (as similarly utilized in Section III.D, Unit Day Value of Tour Boat Passengers) to tabulate the economic value of small craft CAWS recreation users. A Lock User Survey was conducted from November of 2011 through January 2012 (see Attachment I. Great Lakes Mississippi River Interbasin Study Chicago Area Waterway System Non-Cargo Lock User Survey Results). Results of this survey effort and lock data obtained from USACE Institute for Water Resources, Waterborne Commerce Statistics Center were utilized as inputs for calculating the UDV of small craft CAWS users recreation use.

According to the survey results, 86 percent of the trips made through the Chicago lock by recreational boaters (including trips that originated from both the lakeside and riverside) were for recreational purposes. Other trip purposes indicated were: seeking refuge from bad weather, for use of dry dock/ramp to remove boat from water, for wet storage, dry storage, boat repair services, etc. Utilizing lock data for the years 2000 through 2010, an average of 28,693 trips were made through the Chicago Lock by recreational boats per year.[9] Assuming a round trip this provides an estimate of 14,346 recreational boat trips through the lock annually, or 12,302 boat trips through the lock for recreational purposes (14,346 multiplied by 86 percent).

Lock User Survey responses also indicated an average of 5.27 passengers per boat trip (including the captain). Therefore, the average number of passengers annually transiting the Chicago Lock for recreational purposes can be estimated at 64,795 annually for the 2000 through 2010 period (5.27 passengers multiplied by 12,302 boats).

Utilizing the population of Illinois as a proxy, we can calculate that .5 percent of the population of Illinois utilized the Chicago Lock through recreational boating each year between 2000 and 2010. Our forecast for population growth in Illinois provides the ability to estimate growth in the number of recreational boaters using of the Chicago Lock over the 50 year study period.

Utilizing unit day value (see Section III.D. Unit Day Value of Tour Boat Passengers), it is estimated that the average annual value for small craft passenger recreation is approximately $645,000.

[9] See "Baseline Assessment of Non-Cargo CAWS Traffic" dated November 2011.

Table 6. Base Year – Small Craft Recreation Value

Alternative	Dollar Recreational Value (as provided in EGM 12-03)	Average Annual Value of Recreation Experience
Without-Project	$8.70	$645,000

Note: *Total rounded to the nearest thousand.

Table 7. Without-Project Condition – Small Craft Recreation Value

Alternative	Total Present Value*
Without-Project	$13,800,000

Note: *Present Value is calculated utilizing the FY13 discount rate of 3.75%. Average annual visitation is forecasted as a percentage of Illinois estimated population during the study period. Total rounded to the nearest hundred thousand.

The present value of UDV small craft recreation for those passengers utilizing the Chicago Locks over the 50-year period of analysis is $13.8 million with an average annual value of $645,000.

2. Recreational User Willingness to Pay to Keep the Locks Open

NED benefits from recreation opportunities created by a project are measured in terms of willingness to pay. Benefits for projects that alter willingness to pay for recreational facilities are measured as the with- and without-project willingness to pay.[10] For the without-project condition, willingness to pay is measured as what recreational lock users are willing to pay annually to keep the locks open.

According to the GLMRIS Baseline Assessment of Non-Cargo CAWS Traffic dated November 2011, the Chicago Park District has nine lakefront harbors with accommodations for more than 5,000 boats. The harbors are very popular with area boaters and have enjoyed occupancies in excess of 98 percent for the past several years.[11]

Based on this data, we can assume that the number of recreational vessels moored in the Chicago area is approximately 4,900 (5,000 slips available multiplied by a 98 percent occupancy rate). This could be underestimated as trailered vessels, along with vessels moored

[10] ER 1105-2-100, page 3-30

[11] See USACE "Baseline assessment of Non-Cargo CAWS Traffic" dated November 2011.

at harbors not located within the Chicago Park District, are not included in this estimate (such as those vessels that use riverside moorage). However, it could also be overestimated if there are a significant number of non-recreational boats utilizing the harbor system (such as commercial charter vessels, water taxi vessels, etc). If there are a significant number of non-recreational vessels mooring in the harbors then the number of recreational vessels could be overestimated. As there are no known harbor expansions at this time, the number of recreational boats using the locks in the Chicago area is assumed to remain stable for the project period of analysis (50 years).

According to GLMRIS Chicago Area Waterway System Non-Cargo Lock User Survey Results (included at the end of this report), 72 percent of respondents were mostly or fully against permanent lock closure. Therefore, we can assume that approximately 3,552 boat owners are against lock closure (4,900 boats multiplied by 72 percent).

According to survey results, the willingness to pay of boat owners to keep the locks open (the without-project condition) ranged from zero dollars annually to $80,000 to $100,000 annually (ranges were incorporated into potential responses for the survey question). Responses were heavily centered on values ranging from zero dollars to $2,499 per year, with a few responses on the extreme high end.[12] Additionally, 23 percent of respondents indicated "it's worth more to me to keep the locks open, but it's all I can afford to pay".

Those responses on the extreme high end were substantiated by an additional survey question regarding household income levels and therefore were not eliminated as outliers. Additional analysis revealed that those who use their boat most often (greater than 150 days per year) were willing to pay the highest dollar amount to keep the locks open. However, the sample size for those in this category (n=8) was too small to provide meaningful results.

Dollar values from a low of $0 to a high of $100,000 annually were broken into smaller ranges and provided as potential responses to the survey question. It is likely that respondents selecting any given range were distributed between the upper and lower bounds of that range. Therefore, lower and upper bounds of each category were analyzed to provide a low and high value to represent annual willingness to pay.

Using this method, the lower bound average willingness to pay was $1,591 per boater, and the upper bound was $2,127 per boater. Using a 50-year project period of analysis, and the FY13 discount rate of 3.75 percent, average annual willingness to pay for the estimated 3,552 boat owners that moor in the Chicago area ranged from $5.9 million to $7.9 million. Total present value ranged from $127 million to $169 million.

The present value of Willingness to Pay to keep the locks open for recreational boaters utilizing the Chicago Lock over the 50-year period of analysis ranged from $127 million to $169 million with an annual value of $5.9 million to $7.9 million.

[12] See the appendix attached to this report entitled "Great Lakes Mississippi River Interbasin Study Chicago Area Waterway System Non-Cargo Lock User Survey Results"

3. Recreational User Transportation Cost (Seasonal Mobilization)

Recreational boaters in the Chicago area who transport their vessel between a winter storage location and summer moorage incur a transportation cost for the seasonal mobilization of their vessels. For the without-project condition, the storage and moorage locations utilized by recreational boaters are based on GLMRIS Chicago Area Waterway System Non-Cargo Lock User Survey (results included at the end of this report). A with-project condition analysis will later be conducted to determine how seasonal mobilization costs could change under various project alternatives.

Based on the analysis conducted in a previous section of this report (Willingness to Pay), we can assume that the number of recreational vessels in the Chicago area is approximately 4,900 and is assumed to remain stable for the project period of analysis. According to survey results, 69 percent of recreational boaters use the Chicago area locks in a typical year. Therefore, it is assumed that approximately 3,359 recreational boats use the waterways for seasonal mobilization of their vessels (69 percent multiplied by 4,900). This could be overestimated as there could be a portion of lock users who do not use the locks for seasonal mobilization of their vessels, but rather use the locks exclusively during recreation.

Survey respondents were asked where they typically store their boat in the summer, and also where they typically store their boat in the winter. Respondents were able to choose from the following responses to both questions 1) lakeside Chicago Lock, 2) riverside Chicago Lock, 3) Calumet River side of O'Brien Lock, 4) Cal-Sag side of O'Brien Lock, and 5) other. Distances between these points were estimated. Those respondents who indicated that they were traveling from or to an "other" destination were eliminated due to a lack of data. Also eliminated were those respondents who only answered one of the questions (providing a response to either summer moorage or winter moorage, but not answering both questions). It is assumed that those respondents who indicated that both their summer and winter moorage locations were the same do not incur any seasonal mobilization costs (however, this could be underestimated because seasonal mobilization costs could still be incurred depending upon the moorage/storage choices of the boater). Using this data, it was estimated that 7,303 hours are spent by the recreational boating fleet for seasonal mobilization occurring twice per year in the spring and fall (14,605 hours per year).

It is assumed that vessels travel at four nautical miles per hour (allowing time for delays experienced by recreational boaters traveling the CAWS[13]). Cost per hour for operation of a recreational vessel is highly variable and can differ depending on multiple factors including: the kind of vessel, number and type of engines, hull type and length, how the vessel is operated, going with or against the wind and currents. However, cost for hourly operation of

[13] Delays can include waiting for lockage, bridge clearance concerns, etc.

recreational vessels was estimated using costs for operation of charter vessels as determined in the Great Lakes Charter Fishing Industry in 2011 report by F. Lichtkoppler (et al.) of the Sea Grant Great Lakes Network. Costs specifically associated with running a charter business were removed from the estimates in order to account for the differences in costs experienced between the charter and recreational groups.[14] Using this method, a low end estimate for hourly operation cost of $42 was determined for recreational vessels. However, costs could be estimated to go as high as $75 per hour. This equates to annual cost for seasonal mobilization for the recreational boat fleet that use the locks from a low of $609,000 to a high of $1.1 million.

Table 8. Seasonal Mobilization Cost, Low and High Estimates

			Trip Duration in Hours	# of Boats based off Survey and Fleet Data	Annual Hours for Seasonal Mob (Spring and Fall)	Annual Cost for Seasonal Mob, Low Estimate ($42 per hour)	Annual Cost for Seasonal Mob, High Estimate ($75 per hour)
Lakeside Chicago Lock	to/from	Riverside of Chicago Lock	1.25	1,013	2,533	105,600	189,900
Lakeside Chicago Lock	to/from	Calumet River side of O'Brien Lock	10	253	5,060	210,900	379,500
Lakeside Chicago Lock	to/from	Cal-Sag side of O'Brien Lock	10	321	6,420	267,600	481,500
Riverside of Chicago Lock	to/from	Calumet River side of O'Brien Lock	10	-	-	-	-
Riverside of Chicago Lock	to/from	Cal-Sag side of O'Brien Lock	10	17	340	14,200	25,500
Calumet River side of O'Brien Lock	to/from	Cal-Sag side of O'Brien Lock	1.25	101	253	10,500	18,900
Other, Unknown, or Same	to/from	Other, Unknown, or Same	-	1,654	-	-	-
				3,359	**14,605**	**608,800**	**1,095,300**

Note: Columns may not sum due to rounding.
Source: GLMRIS Chicago Area Waterway System Non-Cargo Lock User Survey, Great Lakes Charter Fishing Industry in 2011 report by F. Lichtkoppler (et al.) of the Sea Grant Great Lakes Network.

Using a 50-year project period of analysis, and the FY13 discount rate of 3.75 percent, average annual cost for seasonal mobilization for the estimated 3,359 boat owners ranged from $609,000 to $1.1 million. Total present value ranged from $13.7 million to $24.6 million.

[14] In order to estimate the cost for recreational boating, categories removed from the annual operating costs for charters included: advertizing, office & communications, hired labor, license fees, drug testing and professional dues.

The present value of seasonal mobilization for the recreational boaters utilizing the Chicago Locks over the 50-year period of analysis is estimated between $13.7 million and $24.6 million with an average annual value from $636,000 to $1.1 million.

V. OTHER NON-CARGO NAVIGATION

Multiple federal, state, and local government agencies utilize the Chicago Area Waterway System. Some of these agencies are discussed below.

1. U.S. Coast Guard

The Coast Guard's Marine Safety Unit (MSU) Chicago is located in the Southwest Suburbs of Chicago in Burr Ridge, Illinois, 40 minutes from Downtown Chicago.[15] MSU Chicago is responsible for executing the Coast Guard's Port Safety and Security, Marine Environmental Protection, and Commercial Vessel Safety missions under the auspices of the Department of Homeland Security. These missions ensure a safe, secure, and environmentally sound maritime domain that continues to promote recreation and the free flow of commerce on Southern Lake Michigan, as well as the Chicago Area Waterway System and the Illinois River Watershed.[16] Marine Safety Unit Chicago's area of responsibility covers Lake Michigan south from the Illinois/Wisconsin border running east to the Indiana/Michigan border, including 186 miles of the Illinois Waterway System and tributaries which connect the Great Lakes to the Mississippi River.[17]

MSU Chicago serves an active network of domestic and international maritime interests. The MSU Chicago area of responsibility includes nine Lake Michigan ports, a fleet of 235 inspected vessels, 101 regulated waterfront facilities, and 8 permanent security zones. They also oversee the safety and security of more than 25 million passengers that frequent riverboat casinos and passenger vessels annually.[18, 19]

The unit's 53 active duty, reserve and civilian personnel perform a variety of tasks each day, ranging from conducting armed port security patrols, inspecting commercial vessels, conducting pollution and marine casualty investigations, enforcing safety zones, and conducting waterfront facility exams for compliance with federal regulations. In the past year, unit members have dedicated their time to numerous port security and harbor patrols, conducted 707 vessel inspections, completed 185 investigations, and oversaw regulatory compliance at 101 waterfront facilities.[20,21]

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[15] U.S. Coast Guard web site, http://www.uscg.mil/d9/msuChicago/
[16] USACE, Baseline Assessment of Non-Cargo CAWS Traffic, November 2011.
[17] http://www.uscg.mil/d9/sectlakemichigan/MSUChicagoUO.pdf
[18] USACE, Baseline Assessment of Non-Cargo CAWS Traffic, November 2011.
[19] U.S. Coast Guard web site, http://www.uscg.mil/d9/msuChicago/
[20] U.S. Coast Guard, http://www.uscg.mil/d9/msuchicago/

In addition to the active duty Coast Guard personnel at MSU Chicago, the U.S. Coast Guard Reserve and U.S. Coast Guard Auxiliary are members of Team Coast Guard in the greater Chicagoland area.[22]

a. Chicago Marine Safety Station

Station Chicago is a sub-unit of Station Calumet Harbor. It is a seasonal station open from May 1st until October 31st each year and manned by one boat crew from Calumet Harbor. The Station is housed in the Old Chicago Life Saving Station just south of Navy Pier adjacent to the Chicago River Locks. See Figure 7. Station Chicago is commonly known as the Chicago Marine Safety Station as it is a joint facility shared with the Chicago Police Marine and Helicopter Division, and the Illinois Conservation Police.[23]

Figure 7. Chicago Marine Safety Station

Source: http://www.uscg.mil/d9/sectlakemichigan/STAChicago.asp

Unit resources are rotated from Station Calumet Harbor. Normally two Response Boats – Small (RB-S's) are kept at Chicago Marine Safety Station during the boating season. One on the river side of the Chicago Locks and one on the lake side for quicker response.[24] See Figure 8.

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[21] U.S. Coast Guard web site, last modified date of May 10, 2012, http://www.uscg.mil/d9/msuChicago/
[22] U.S. Coast Guard web site, http://www.uscg.mil/d9/msuChicago/TeamCoastGuard.asp
[23] U.S. Coast Guard web site, http://www.uscg.mil/d9/sectlakemichigan/STAChicago.asp
[24] http://www.uscg.mil/d9/sectlakemichigan/STAChicagoUO.pdf

Figure 8. Example of Response Boat – Small (RB-S's)

Source: http://www.uscg.mil/acquisition/rbs/

2. Chicago Fire Department

The Chicago Fire Department (CFD) is the largest fire department in the Midwest, and one of the largest departments throughout the United States.[25] The fire department is also an integral part of the city's Emergency Preparedness and Disaster Plan known as the Office of Emergency Management.[26]

The Bureau of Operations is the CFD's largest bureau, with uniformed firefighters and paramedics, many of whom are "cross-trained" in the use of nearly 250 pieces of equipment and apparatus, including fire engines, fire trucks, ambulances, squads, helicopters and marine equipment. The Bureau of Operations consists of four divisions: Fire Suppression and Rescue, Emergency Medical Services (EMS), Special Operations and the Office of Fire Investigations (OFI). The Special Operation Division is the "special rescue" branch of the CFD that is

[25] City of Chicago Fire Department Web Site, http://www.cityofchicago.org/city/en/depts/cfd.html

[26] http://www.cityofchicago.org/content/dam/city/depts/cfd/general/PDFs/HistoryOfTheChicagoFireDepartment_1.pdf

intricately involved in homeland security activities. It currently includes the Hazardous Materials Unit, the Air Sea Rescue Unit and the Technical Rescue Unit.[27]

The CFD has acquired a new NFPA Type III Fireboat,[28] the Christopher Wheatley (Engine 2), to replace their 60 year old Fireboat, the Victor L. Schlaeger. The boat was designed and built to operate year-round in Lake Michigan, the Chicago River, and surrounding harbors.[29, 30] The Christopher Wheatley is a heavy-duty fireboat designed to break up to 12 inches of ice so it can operate year-round.[31]

The Wheatley is used to respond to firefighting; rescue; Chemical, Biological, Radiological, Nuclear and Explosive incidents (CBRNE); Hazmat decontamination; dive operations; and other waterway related response needs.[32] The new fireboat can also be used with scuba divers, for firefighting with foam or water, and as a pumping station to supplement the city's fire-main supply of water. It can be run with a crew of five or up to 10 when fighting a fire. It has a kitchen, washroom and crew accommodations below decks. One of the four monitor nozzles sits on a platform that can be elevated 30 feet.[33]

To be able to pass underneath low bridges, the Wheatley was built so the mast comes down and sits no more than 16 feet out of the water. It has four engines, two for the water pumps and two 1,500 horsepower propulsion engines to drive the boat. It can travel at 12 knots or at three knots through ice. The Christopher Wheatley is 90 feet long, 300 tons, and valued at $8.5 million.[34]

The Christopher Wheatley is stored at the Chicago Marine Safety Station. The boat has a crew of five (one officer, two engineers, one firefighters, and one marine pilot) and is operated 24/7, so it is estimated that a total of 15 full time employees are required to support the fire

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[27] City of Chicago Fire Department Web Site, http://www.cityofchicago.org/city/en/depts/cfd.html
[28] A Type III vessel must have a minimum pumping capacity of 4,500 gpm through two pumps and carry sufficient fuel to remain on-station for at least eight hours.
[29] https://www.chicagofireboat.com/Default.asp
[30] Personal Interview, March/April of 2011 with Al Polus (PM) and Steve Hungness – Chicago Lock Operators
[31] http://www.suntimes.com/news/metro/4859994-418/hope-floats-on-new-fireboat.html
[32] https://www.chicagofireboat.com/Default.asp
[33] http://www.suntimes.com/news/metro/4859994-418/hope-floats-on-new-fireboat.html
[34] http://www.suntimes.com/news/metro/4859994-418/hope-floats-on-new-fireboat.html

boat. During 2011, the Wheatley responded to 157 emergencies.[35] If the Chicago lock were closed, the City would potentially need two fireboats – one on either side of the lock.[36]

Figure 9. Chicago Fire Department Fire Boat "Christopher Wheatley"

Source: http://www.chicagofd.org/cfdairsearescue.html

The Victor L. Schlaeger (Engine 58) is the City of Chicago's previous fireboat. Built in 1949 the steel 92 foot vessel has been around for nearly 60 years. The Schlaeger is capable of pumping over 14,000 gallons per minute of water, and in the winter, breaking ice 8 to 12 inches thick. [37] Docked at the Chicago Marine Safety Station, the Schlager is in reserve status and is used if the Wheatley is down for repairs.[38]

[35] Personal Communication, Michael Fox, Assistance Deputy Fire Commissioner of Special Operations for the Chicago Fire Department, May 14, 2012.
[36] Personal Interview, March/April of 2011 with Sgt. Mazzola and Police Officer Doane from the Chicago Police
[37] https://www.chicagofireboat.com/Default.asp
[38] Personal Communication, Michael Fox, Assistance Deputy Fire Commissioner of Special Operations for the Chicago Fire Department, May 14, 2012.

Figure 10. Chicago Fire Department Fire Boat "Schlaeger"

Source: http://www.cityofchicago.org/city/en/depts/cfd.html

The Chicago Fire Department's single 6-8-8 rescue boat has a crew of four (one officer, one engineer, and two firefighters). All are trained SCUBA divers. The 6-8-8 is only utilized from May 1st through November 1st and moors at the Chicago Marine Safety Station. During 2011 the 6-8-8 responded to 133 emergencies.[39]

[39] Personal Communication, Michael Fox, Assistance Deputy Fire Commissioner of Special Operations for the Chicago Fire Department, May 14, 2012.

Figure 11. Chicago Fire Department Fire Boat, Fast Attack Rescue Boat 688

Source: http://www.chicagofd.org/cfdairsearescue.html

3. Chicago Police Department

Chicago has the nation's second largest police department, led by the superintendent of police who is appointed by the mayor. [40]

The Chicago Police has four to six response boats available, depending upon maintenance schedules and other factors.[41] The CPD frequently keeps two vessels on either side of the Chicago lock. They utilize the lock both during the course of their normal patrol and in response to emergencies. Lock operators can open both gates during emergencies so responders can cross the lock quickly. Flooding issues, suicide attempts, high traffic volume

[40] Chicago Police Department 2010 Annual Report, https://portal.chicagopolice.org/portal/page/portal/ClearPath/News/Statistical%20Reports/Annual%20Reports/10AR.pdf

[41] Telephone Interview, March 2012 with Officer Sullivan of the Public Information Office.

due to fireworks displays or other events all contribute to safety concerns and frequently require CPD vessel response. The Locks, Navy Pier, and some downtown locations are also considered targets for terrorists as identified by Homeland Security.[42]

Chances of life-safety issues would likely increase if the locks are closed. Each Police Officer has about 100 pounds of gear on each boat and if locks closed, gear would have to be transferred overland to the boat on the desired side of the lock.[43]

a. Marine Operations Unit

The Marine & Helicopter Unit of the Chicago Police Department is a group of highly motivated and technically trained personnel. The unit utilizes many types of specialized equipment to complete their required tasks. The Unit is broken into two distinct operations: Marine Operations and Helicopter Operations. Marine Operations personnel are responsible for all bodies of water within the City of Chicago. This includes 80 square miles of Lake Michigan, 27 miles of Lake Michigan shore line, 38 miles of Chicago River system, Wolf Lake, Lake Calumet and various ponds and lagoons throughout the City.[44]

To complete their mission Marine Operations personnel use patrol/rescue boats and a state of the art dive response truck for land based assignments. Marine Operations personnel (all of whom are public safety divers) are the first responders to any maritime incident. Marine Operations personnel have three areas of responsibility: Search, Rescue, Recovery Operations; Law Enforcement; and Homeland Security. These incidents include everything from person(s) in the water to commercial airline crashes. Law Enforcement personnel assigned to Marine Operations are responsible for enforcing state statutes, City ordinances and Chicago Park District ordinances. Marine Operations personnel spend a large portion of their tour conducting homeland security checks and patrols. Several of the highest threat assessed targets within the City are on or surrounded by water. Lake Michigan is home to several major events each year including the Air & Water Show, July 3rd fireworks and Venetian night. These events draw millions of spectators to the lakefront each year. Marine Operations personnel are trained as divers, in heavy weapon usage, Stingray remote

[42] Personal Interview, March/April of 2011 with Sgt. Mazzola and Police Officer Doane from the Chicago Police

[43] Personal Interview, March/April of 2011 with Sgt. Mazzola and Police Officer Doane from the Chicago Police

[44] https://portal.chicagopolice.org/portal/page/portal/ClearPath/About%20CPD/Specialized%20Units/Marine%20and%20Helecopter%20Unit

Operations, Stedi-eye night vision systems, AED & first aid skills as well as other very technical skills.[45]

4. Illinois Department of Natural Resources

The Illinois Department of Natural Resources (DNR) have Conservation Police Officers (CPO's) that have full police authority in the enforcement of Illinois Compiled Statutes, focusing on those laws and activities associated with natural resource protection and recreational safety. These duties can include enforcing criminal laws in the State Parks; patrolling on Illinois lakes and rivers to check boating safety equipment and watercraft registration; enforcing fish and wildlife laws, timber laws, endangered species laws, etc. CPO's also assist other law enforcement agencies and help in certain emergency/rescue situations.[46]

Illinois DNR has 9 officers and a 3-county territory to cover, and do not run a 24-hour operation. Historically they have had 16 officers, and they believe that if they could get 20 officers they would be able to maintain 80-percent coverage.[47]

In order to assist them with their mission, DNR has a 27-foot boat that they keep on the lake side. They also have two 36-foot Boston Whalers, one 27-foot Boston Whaler, some 22-foot and 19-foot boats, and canoes. They keep one boat near the Wisconsin border. DNR has 44 miles of coast to monitor. CPO's patrol the lakefront and the river, including regulating all the fish houses. Illinois DNR responsibilities include boat accidents - the Coast Guard enforces Federal regulations and DNR enforces state regulations.[48]

If locks closed, there would be diminished ability to respond to drug enforcement and they would require more equipment and perhaps additional personnel. DNR keeps operations on both lake and river side's and there would be tremendous delays if the locks were closed (given current staffing and equipment levels). If lock closure becomes a reality, DNR would have to come up with a contingency plan for operations. The plan would likely include additional boats near the boat launch ramps and stationing of boats elsewhere in the region.[49]

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https://portal.chicagopolice.org/portal/page/portal/ClearPath/About%20CPD/Specialized%20Units/Marine%20and%20Helecopter%20Unit

46 http://dnr.state.il.us/Law3/olepage.htm
47 Personal Interview, March/April of 2011 with Bill Shannon from the Department of Conservation, Division of Illinois Department of Natural Resources
48 Personal Interview, March/April of 2011 with Bill Shannon from the Department of Conservation, Division of Illinois Department of Natural Resources
49 Personal Interview, March/April of 2011 with Bill Shannon from the Department of Conservation, Division of Illinois Department of Natural Resources

5. Future Without-Project Condition for Other Non-Cargo Navigation

The future without-project condition for other non-cargo navigation users of the CAWS including (among others) the U.S. Coast Guard, Chicago Marine Safety Station, Chicago Fire Department, Chicago Police Department, and the Illinois Department of Natural Resources are likely to be unchanged from the baseline conditions except for normal fluctuations in responses, funding levels, and equipment (for example, the retiring and/or installation of new equipment including boats during the study period is likely and could include an increase or reduction in quantity). An annual cost for operation of the portion of these entities that is specifically tied to the use of the locks is difficult to quantify.

VI. ADDITIONAL INFORMATION

This effort serves to quantify the economic activity associated with the CAWS that is subject to damage as a result of aquatic nuisance species. This assessment includes non-cargo-related traffic only, as cargo-related traffic is evaluated under a separate endeavor. The study period of analysis covers 50 years. Data for this report was derived from a variety of sources as noted in footnote references. A summary table including the total present value for each category is shown below.

Table 9. Without-Project Condition Summary

Without-Project Condition	Total Present Value*
Commercial Passenger Business Revenues	$776,200,000
Commercial Passenger Business Expenses	$643,900,000
Commercial Passenger Unit Day Value	$69,500,000
Recreational User Unit Day Value	$13,800,000
Recreational User Willingness To Pay to Keep Locks Open	$127 million to $169 million
Recreational User Transportation Cost (Seasonal Mobilization)	$13.7 million to $24.6 million

Note: *Present Value is calculated utilizing the FY13 discount rate of 3.75%. Totals rounded to the nearest hundred thousand.

These without-project conditions will later be compared to conditions with a project. The differences between the without-project conditions and the alternatives formulated will be the benefits (i.e. avoided damages) or costs (i.e. incurred losses). These differences determine which National Economic Development (NED) or National Ecosystem Restoration (NER) plan will be selected for consideration by Congress.

A survey of non-cargo lock users was conducted between November 2011 and January 2012, the results of which were utilized to help determine the future conditions of non-cargo users. Details of the survey instrument, and an analysis of the results, are included in Attachment I. Great Lakes Mississippi River Interbasin Study Chicago Area Waterway System Non-Cargo Lock User Survey Results.

More information about GLMRIS and previously published reports are available on the Great Lakes Mississippi River Interbasin Study Web Site located at: http://glmris.anl.gov/

ATTACHMENT I. GREAT LAKES MISSISSIPPI RIVER INTERBASIN STUDY CHICAGO AREA WATERWAY SYSTEM NON-CARGO LOCK USER SURVEY RESULTS

Great Lakes Mississippi River Interbasin Study Chicago Area Waterway System Non-Cargo Lock User Survey Results

Introduction

Following is a summary of the non-cargo lock user survey conducted from November 2011 through January 2012. In conjunction with the US Army Corps of Engineers (USACE), ARGONNE National Labs emailed survey links to 924 current Chicago Area Waterway System (CAWS) area boaters. Email addresses were obtained by three different means:

1. a pre-survey conducted at the locks in May 2011
2. supplied by Westrec Marinas (Chicago area harbor management), and
3. through a "request survey" mechanism on the website where individuals could voluntarily request to receive a link.

Of the 924 surveys sent, 301 individuals responded to survey questions (258 surveys were fully completed) for a response rate of 32.6 percent. At a 95 percent confidence level, the margin of error for questions asked of all survey respondents is within plus/minus 4.35 percent. The margin of error for individual questions will vary.

ARGONNE National Labs conducted the survey electronically and provided results to USACE via an Excel database. Each participant was provided a unique survey link in order to track survey completion and verify that a representative sample had been achieved. Survey responses were completed by individuals using the Chicago Lock, the Lockport Lock, and the T.J. O'Brien Lock, all part of the Chicago Area Waterway System.

The following discussion summarizes responses to each question in the order in which they were asked. A copy of the survey instrument follows this summary.

Responses

Survey Question 1.

The first survey question asked respondents the primary purpose of their vessel. The majority of respondents indicated that their vessel purpose was for personal recreational use. Of those respondents who indicated "other", it was noted that their vessels were primarily rental or charter vessels.

Table 1. Vessel Primary Purpose

(n = 291)

Vessel Primary Purpose	Number of Respondents	Percent of Respondents
Personal Recreational Use (general boating, sport fishing, etc)	283	97
Other	8	3

Survey Question 2.

Respondents were asked the length of their vessel in feet. Responses ranged from a minimum of 10 feet to a maximum of 75 feet, with an average of almost 33 feet in length. Nearly 2/3 of the vessels were 34-foot or less.

Table 2. Length of Vessel (feet)

(n = 299)

Length overall (ft)	0-28	>28-34	>34-37	>37-45	>45-54	>54-60	>60 +
Number of Respondents (#)	88	96	42	56	10	3	4
Percent of Respondents (%)	29	32	14	19	3	1	1

Survey Question 3.

Respondents were asked how many people, including themselves, were on a typical boat trip. The number of people per trip ranged from a minimum of 1 to a maximum of 40, with an average of about 5 people per trip.

Table 3. Number of People per Trip

(n = 296)

Number of People per Trip	0-2	>2-4	>4-6	>6-8	>8-10	>10-12	>12 +
Number of Respondents (#)	29	132	84	28	11	3	9
Percent of Respondents (%)	10	45	28	9	4	1	3

Survey Question 4.

The next question asked respondents how many years they had been a Chicago area boater. The number of years respondents boated in the Chicago area ranged from 1 to 65 years, with an average of just over 19 years.

Table 4. Number of Years Boating in Chicago

(n = 298)

Number of Years	**0-5**	**>5-10**	**>10-15**	**>15-20**	**>20-25**	**>25-30**	**>30 +**
Number of Respondents (#)	53	53	43	39	25	30	55
Percent of Respondents (%)	18	18	14	13	8	10	18

Survey Question 5.

Respondents were asked whether or not they use Chicago Area locks in a typical year.

Table 5. Use of Chicago Area Locks

(n = 299)

Use Chicago Area Locks?	**Number of Respondents**	**Percent of Respondents**
Yes	205	69
No	94	31
Total	**299**	

Survey Question 6.

If respondents indicated that they use Chicago Area locks in a typical year (Table 5), they were further asked which Chicago Area locks they use. Respondents were directed to check all options that applied. Most, 80 percent, used the Chicago Lock starting from the lakeside of the lock.

Table 6. Chicago Area Locks Used

(n = 205)

Use Chicago Area Locks?	**Number of Respondents**	**Percent of Respondents***
Chicago Lock starting from lakeside (skip to 6A)	164	80
Chicago Lock starting from riverside (skip to 6B)	110	54
O'Brien Lock starting from Calumet River (skip to 6C)	79	39
O'Brien Lock starting from Cal-Sag (skip to 6D)	73	36
Lockport Lock from above (skip to 6E)	11	5
Lockport Lock from below (skip to 6F)	11	5

Note: *Percentage calculated based on the number of responses to usage of a lock divided by the total number of respondents (i.e. 205).

[Survey Question 6A]

Respondents who indicated that they used "Chicago Lock starting from lakeside" (Table 6) were also asked: In a typical year, indicate the number of boat trips you take from the lakeside of the Chicago Lock toward Chicago based on your **primary** trip purpose (respondents were asked to enter the number of one-way trips for all that apply).

Table 7. Number of Trips through Chicago Lock Starting from Lakeside Based on Primary Trip Purpose

(n = 162)

Primary Trip Purpose	Number of Respondents	Average Number of Trips Taken	Percent of Respondents
For river day trip(s)	104	8	64
For river "loops" to destinations farther south	26	7	16
For river "loops" through another lock and back to lake	29	6	18
For river architecture viewing	103	8	64
To seek refuge from bad weather	19	6	12
For dry dock/ramp or to remove boat from water	78	2	48
For wet storage on river side	11	2	7
To riverside restaurants/stores	68	7	42
For boat repair services	36	2	22
For other purpose	8	14	5

[Survey Question 6B]

Respondents who indicated that they used "Chicago Lock starting from riverside" (Table 6) were also asked: In a typical year, indicate the number of boat trips you take from the riverside of the Chicago Lock to the lake based on your **primary** trip purpose (respondents were asked to enter the number of one-way trips for all that apply).

Table 8. Number of Trips through Chicago Lock Starting from Riverside Based on Primary Trip Purpose

(n = 86)

Primary Trip Purpose	Number of Respondents	Average Number of Trips Taken	Percent of Respondents
For Lake Michigan day trip	40	27	47
To lakeside restaurant/store	19	13	22
For lakeside city/fireworks viewing	29	14	34
To dry storage	30	2	35
To wet storage on lake side	35	3	41
For boat repair services	11	2	13
For other purpose	5	6	6

[Survey Question 6C]

Respondents who indicated that they used "O'Brien Lock starting from Calumet River" (Table 6) were also asked: In a typical year, indicate the number of boat trips you take from the Calumet river side of the T.J. O'Brien Lock toward Cal-Sag based on your **primary** trip purpose (respondents were asked to enter the number of one-way trips for all that apply).

Table 9. Number of Trips through O'Brien Lock Starting from Calumet River Based on Primary Trip Purpose

(n = 73)

Primary Trip Purpose	Number of Respondents	Average Number of Trips Taken	Percent of Respondents
For river day trip(s)	28	8	38
For river "loops" to destinations farther south	15	5	21
For river "loops" through another lock and back to lake	14	3	19
To seek refuge from bad weather	6	4	8
For dry dock/ramp or to remove boat from water	48	2	66
For wet storage on river side	4	2	5
To riverside restaurants/stores	14	7	19
For boat repair services	17	2	23
For other purpose	2	8	3

[Survey Question 6D]

Respondents who indicated that they used "O'Brien Lock starting from Cal-Sag" (Table 6) were also asked: In a typical year, indicate the number of boat trips you take from Cal-Sag side of the T.J. O'Brien Lock to Calumet River based on your **primary** trip purpose (respondents were asked to enter the number of one-way trips for all that apply).

Table 10. Number of Trips through O'Brien Lock Starting from Cal-Sag Based on Primary Trip Purpose

(n = 59)

Primary Trip Purpose	Number of Respondents	Average Number of Trips Taken	Percent of Respondents
For Lake Michigan day trip	21	9	36
To lakeside restaurant/store	7	8	12
To dry storage on lake side	15	2	25
To wet storage on lake side	20	1	34
For boat repair services	12	2	20
For other purpose	4	6	7

[Survey Question 6E]

Respondents who indicated that they used "Lockport Lock from above" (Table 6) were also asked: In a typical year, indicate the number of boat trips you take from above the Lockport Lock based on your **primary** trip purpose (respondents were asked to enter the number of one-way trips for all that apply).

Table 11. Number of Trips through Lockport Lock Starting from Above Based on Primary Trip Purpose

(n = 10)

Primary Trip Purpose	Number of Respondents	Average Number of Trips Taken	Percent of Respondents
For river day trip(s)	6	2	60
For river "loops" to destinations farther south	5	1	50
For river "loops" through another lock and back to lake	3	1	30
For dry dock/ramp or to remove boat from water	1	1	10
For wet storage on river side	3	1	30
To riverside restaurants/stores	3	1	30
For boat repair services	2	1	20
For other purpose	0	0	0

[Survey Question 6F]

Respondents who indicated that they used "Lockport Lock from below" (Table 6) were asked: In a typical year, indicate the number of boat trips you take from below Lockport Lock based on your **primary** trip purpose (respondents were asked to enter the number of one-way trips for all that apply).

Table 12. Number of Trips through Lockport Lock Starting from Below Based on Primary Trip Purpose

(n = 7)

Primary Trip Purpose	Number of Respondents	Average Number of Trips Taken	Percent of Respondents
For Lake Michigan day trip	4	2	57
For river day trip	5	2	71
To riverside restaurant/store	2	7	29
To lakeside restaurant/store	1	2	14
To dry storage	2	1	29
For wet storage on river side	1	1	14
For wet storage on lake side	1	1	14
For boat repair services	1	1	14
For other purpose	1	1	14

Survey Question 7.

Respondents were asked where they typically store their boat in the **summer**. *Of those who indicated "other", 19 respondents provided specific harbor locations within the Chicago Harbor system (for example, "Belmont Harbor"). When those 19 responses are added to the 137 who indicated "Lakeside Chicago Lock", the total becomes 156 respondents or 79 percent.

A minority of those who indicated "other" noted that they store their boat at their residence, out of state, or at another location.

Table 13. Summer Boat Storage
(n = 198)

Summer Boat Storage Location	Number of Respondents	Percent of Respondents
Lakeside Chicago Lock	137	69
Riverside of Chicago Lock	8	4
Calumet River side of O'Brien Lock	8	4
Cal-Sag side of O'Brien Lock	11	6
Other	34*	17

* See note in discussion above.

Survey Question 8.

Respondents were asked where they typically store their boat in the **winter**. Of those who indicated "other", the majority indicated that they stored their trailored vessel at their residence or at another dry storage location. A minority of those who indicated "other" noted that they store their boat out of state.

Table 14. Winter Boat Storage
(n = 198)

Winter Boat Storage Location	Number of Respondents	Percent of Respondents
Lakeside Chicago Lock	16	8
Riverside of Chicago Lock	67	34
Calumet River side of O'Brien Lock	25	13
Cal-Sag side of O'Brien Lock	39	20
Other	51	26

Survey Question 9.

Respondents were asked, "Other than relocating your boat for moorage, please indicate the following boat trips in which you participate that are dependent on the availability of the CAWS locks (respondents were asked to check all that apply.)

Table 15. Trips Dependent on Availability of CAWS Locks

(n = 164)

Trip Purpose	Number of Respondents	Percent of Respondents
Fishing	27	16
Sightseeing	131	80
Water skiing (kneeboarding, inflatable towables, wake surfing, etc)	18	11
Pleasure sailing	24	15
Competitive sailing	6	4
Day cruising	109	66
Overnight / multi-day cruise	29	18
Obtain boat service / repair	66	40
Day trip to private or transient dock	42	26
Swimming / Sun bathing / Picnicking	35	21
Visit Friends / Family	37	23
Camping in primitive areas	2	1
Take out business associates / customers	61	37
Wildlife observation and/or photography	25	15
Other	9	5

Survey Question 10.

Participants were asked to indicate whether they strongly disagreed, disagreed, neither agreed nor disagreed, agreed, or strongly agreed with the following sentences.

Table 16. Importance of CAWS

(n = 266)

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
	# of respondents				
The CAWS has no particular importance to me personally	127	58	36	23	22
The CAWS is important to me because of its prominence in history and culture	18	16	78	95	59
The CAWS is important to me for its uniqueness	16	12	80	93	61
The CAWS is important to me because it allows for the safe transportation of commodities on water that would otherwise be adding to our congested land transportation routes.	20	9	63	90	82
The CAWS is important to me because it offers many types of recreation	14	23	47	78	103
The CAWS is important to me because it allows the transport of storm waters away from the city	15	13	51	108	78
The CAWS is important to me because it allows the transport of treated sewage away from the city	14	16	62	91	81
The CAWS ambience and aesthetics are important to me	7	15	63	95	81
It is important to take care of the CAWS so that it is available to future generations	11	5	22	82	143
The CAWS is important to me because of its value to commerce and industry including tourism	10	13	41	80	119
The CAWS is important because it provides an important transportation link between the Great Lakes and the Mississippi River.	14	7	46	87	111

Survey Question 11.

Respondents were asked, "Of the following CAWS concerns, which one do you think should be the **highest** priority?"

Table 17. CAWS Priority

(n = 269)

Category	Number of Respondents	Percent of Respondents
Reduce risk of transfer of invasive species between the Great Lakes and Mississippi River Basins	75	28
Maximize Chicago area water quality	59	22
Reduce the Chicago area flood risk	11	4
Maintain open water access between lake and river systems to commercial, recreational, and government watercraft	117	43
Don't have an opinion	7	3

Survey Question 12.

Respondents were asked to indicate what best described their opinion about permanent closure of the CAWS locks as an alternative to prevent transfer of aquatic nuisance species. Of those who responded, 28 percent indicated fully or partially supporting permanent lock closure, while 72 percent indicated they were mostly or fully against permanent lock closure.

Table 18. Opinion on Permanent Closure of CAWS Locks

(n = 269)

Category	Number of Respondents	Percent of Respondents
I fully support permanent lock closure (go to 12A)	30	11
I partially support permanent lock closure (go to 12A)	44	16
I am mostly against permanent lock closure (go to 12C)	68	25
I am fully against permanent lock closure (to 12C)	127	47

[Survey Question 12A]

Respondents who indicated that they supported lock closure (Table 18) were asked: "The intent of lock closure is to lower the risk of invasive species transfer, but there would be other adverse impacts to the area. If it was necessary to impose a fee to support CAWS lock closure, what is the most you would be willing to pay **annually** to keep the locks closed?"

Table 19. Willingness to Pay to Keep Locks Closed

(n = 68)

Willingness to Pay	Number of Respondents	Percent of Respondents
\$80,000 to \$100,000	3	4
\$60,000 to \$79,999	0	0
\$40,000 to \$59,999	0	0
\$30,000 to \$39,999	0	0
\$20,000 to \$29,999	0	0
\$15,000 to \$19,999	0	0
\$10,000 to \$14,999	0	0
\$7,500 to \$9,999	0	0
\$5,000 to \$7,499	0	0
\$2,500 to \$4,999	0	0
\$1,000 to \$2,499	1	1
\$750 to \$999	0	0
\$500 to \$749	0	0
\$250 to \$499	1	1
\$100 to \$249	5	7
\$50 to \$99	6	9
\$1 to \$49	23	34
\$0	29	43

[Survey Question 12B]

Respondents who indicated that they supported lock closure (Table 18) were further asked to choose the one response that best described the reason for their willingness to pay in the previous answer (Table 19).

Table 20. Reason for Willingness to Pay to Keep Locks Closed

(n = 72)

Category	Number of Respondents	Percent of Respondents
I didn't want to place a dollar value	7	10
I object to paying to keep the locks closed	16	22
That's what it is worth to me	8	11
Not enough information is provided	25	35
It's worth more to me to keep the locks closed, but it's all I can afford to pay	9	13
Other reason	7	10

[Survey Question 12C]

Respondents who indicated that they were against lock closure (Table 18) were asked: The Chicago Area Locks provide a public service without charge to the user. Operation of the locks is supported by government dollars. If you could prevent the closure of the CAWS locks; what is the most you would be willing to pay **annually** to keep the locks open?

Table 21. Willingness to Pay to Keep Locks Open

(n = 186)

Willingness to Pay	Number of Respondents	Percent of Respondents
$80,000 to $100,000	3	2
$60,000 to $79,999	0	0
$40,000 to $59,999	1	1
$30,000 to $39,999	0	0
$20,000 to $29,999	0	0
$15,000 to $19,999	0	0
$10,000 to $14,999	0	0
$7,500 to $9,999	0	0
$5,000 to $7,499	0	0
$2,500 to $4,999	0	0
$1,000 to $2,499	6	3
$750 to $999	3	2
$500 to $749	3	2
$250 to $499	7	4
$100 to $249	27	15
$50 to $99	33	18
$1 to $49	38	20
$0	65	35

[Survey Question 12D]

Respondents who indicated that they were against lock closure (Table 18) were further asked to choose the one response that best describes their reason for their willingness to pay in the previous answer (Table 21).

Table 22. Reason for Willingness to Pay to Keep Locks Open

(n = 191)

Reason	Number of Respondents	Percent of Respondents
I didn't want to place a dollar value	27	14
I object to paying to keep the locks open	37	19
That's what it is worth to me	33	17
Not enough information is provided	25	13
It's worth more to me to keep the locks open, but it's all I can afford to pay	44	23
Other reason	25	13

Survey Question 13.

Respondents were asked which statement best describes what they would do with their vessel if the locks were permanently closed in order to prevent the transfer of invasive species.

Table 23. Vessel Use if Locks Closed

(n = 263)

Vessel Use Category	Number of Respondents	Percent of Respondents
I would keep and use my vessel below the Lockport Lock	1	0
I would keep and use my vessel on the river between the Lockport and Chicago locks	2	1
I would keep and use my vessel on the river between the Lockport and O'Brien locks	0	0
I would keep and use my vessel on the river between the Lockport and Chicago and O'Brien locks	2	1
I would keep and use my vessel on Lake Michigan	189	72
I would keep and use my vessel on some other water body	13	5
I would sell my vessel	35	13
Other	21	8

Survey Question 14.

Respondents were told: "If a physical barrier were erected elsewhere on the waterway, there would be the following adverse effects:

(1) During high flow or flood conditions, storm water and/or treated sewage which currently flow toward the Mississippi River would remain lakeward of the barrier, deteriorating water quality and odors.

(2) More frequent high water levels in the river would reduce bridge height clearances.

(3) Traffic between Lake Michigan and Lockport Lock would be reduced or eliminated."

Then respondents were asked to select a survey response that best describes how they feel about a basin separation measure that would reduce the risk of transfer of ANS but have the possibility of adverse impacts.

Table 24. Opinions on Basin Separation with Adverse Effects

(n = 253)

Selection	Number of Respondents	Percent of Respondents
I am in support of this type of basin separation measure even though there would be the adverse impacts described. (*go to 14A*)	84	33
I am opposed to this type of basin separation measure with the adverse impacts as described even though it would reduce the risk of transfer of ANS between the basins. (*go to 14C*)	169	67

[Survey Question 14A]

If respondents indicated that they were in support of a basin separation measure despite adverse impacts (Table 24), they were then asked "If it was necessary to impose a fee to support a basin separation measure that does not affect Chicago and T.J. O'Brien Locks for local use, what is the most you would be willing to pay **annually** to ensure that the basin separation measure is implemented and maintained?"

Table 25. Willingness to Pay for Basin Separation Not Affecting Chicago and O'Brien Locks

(n = 80)

Willingness to Pay	Number of Respondents	Percent of Respondents
$80,000 to $100,000	2	3
$60,000 to $79,999	0	0
$40,000 to $59,999	0	0
$30,000 to $39,999	0	0
$20,000 to $29,999	0	0
$15,000 to $19,999	0	0
$10,000 to $14,999	0	0
$7,500 to $9,999	0	0
$5,000 to $7,499	0	0
$2,500 to $4,999	0	0
$1,000 to $2,499	1	1
$750 to $999	0	0
$500 to $749	1	1
$250 to $499	5	6
$100 to $249	9	11
$50 to $99	12	15
$1 to $49	20	25
$0	30	38

[Survey Question 14B]

Respondents who indicated that they were in support of a basin separation measure despite adverse impacts (Table 24) were asked to choose the one response that best describes the reason for their willingness to pay for a basin separation measure that wouldn't affect the Chicago and O'Brien Locks (Table 25).

Table 26. Reason for Willingness to Pay Basin Separation Not Affecting Chicago and O'Brien Locks

(n = 82)

Reason	Number of Respondents	Percent of Respondents
I didn't want to place a dollar value	12	15
I object to paying for a basin separation	8	10
That's what it is worth to me	19	23
Not enough information is provided	17	21
It's worth more to me to keep the locks open, but it's all I can afford to pay	16	20
Other reason	10	12

[Survey Question 14C]

If respondents indicated that they were against a basin separation measure despite the risk of ANS (Table 24), they were then asked "If a basin separation as described was planned for implementation and if you could prevent this basin separation from occurring, what is the most you would be willing to pay **annually** to prevent basin separation along with preventing the adverse impacts as described from happening?"

Table 27. Willingness to Pay to Prevent Basin Separation and Adverse Impacts

(n = 156)

Willingness to Pay	Number of Respondents	Percent of Respondents
$80,000 to $100,000	2	1
$60,000 to $79,999	0	0
$40,000 to $59,999	0	0
$30,000 to $39,999	0	0
$20,000 to $29,999	0	0
$15,000 to $19,999	0	0
$10,000 to $14,999	0	0
$7,500 to $9,999	0	0
$5,000 to $7,499	0	0
$2,500 to $4,999	0	0
$1,000 to $2,499	5	3
$750 to $999	3	2
$500 to $749	0	0
$250 to $499	2	1
$100 to $249	15	10
$50 to $99	16	10
$1 to $49	29	19
$0	84	54

[Survey Question 14D]

Respondents who indicated they were against a basin separation measure despite the risk of ANS (Table 24) were asked to choose the one response that best describes their reason for their willingness to pay to avoid a basin separation measure and the associated adverse impacts (Table 27).

Table 28. Reason for Willingness to Pay to Prevent Basin Separation and Adverse Impacts

(n = 162)

Reason	Number of Respondents	Percent of Respondents
I didn't want to place a dollar value	25	15
I object to paying keep the separation from occurring	41	25
That's what it is worth to me	16	10
Not enough information is provided	37	23
It's worth more to me to keep the locks open, but it's all I can afford to pay	31	19
Other	12	7

Survey Question 15.

Respondents were asked how many days they use their vessel in a typical year. The average number of days for vessel use per year was just over 54. The minimum number of days was 5, and the maximum was 210.

Table 29. Vessel Use per Year in Days

(n = 217)

Number of Days	0-10	>10-25	>25-50	>50-100	>100-150	>150-300	>300 +
Number of Respondents	3	45	95	56	10	8	0
Percent of Respondents	1	21	44	26	5	4	0

Survey Question 16.

Respondents were asked, "If lake or river water quality were to deteriorate as a result of basin separation, please indicate how or if your boat usage would change?"

Table 30. Vessel Usage with Water Quality Deterioration

(n = 256)

Alternative	Number of Respondents	Percent of Respondents
Boat usage would probably stay the same	145	57
Boat usage would drop by ____ number of days	56	22
Discontinue boat usage	55	21

The following table represents responses from those who indicated that their boat usage would drop by an estimated number of days. The average number of days that respondents indicated their usage would decrease was just under 21 days, with a minimum decrease of 2 days and a maximum decrease of 100 days.

Table 31. Number of Days of Decreased Usage with Water Quality Deterioration

(n = 55)

Number of Days	0-5	>5-15	>15-25	>25-50	>50-100	>100 +
Number of Respondents	9	20	13	10	3	0
Percent of Respondents	4	8	5	4	1	0

The following information was requested to assist research staff in analyzing the results of the study.

Survey Question 17.

Respondents were asked about the highest level of education that they completed.

Table 32. Highest Level of Completed Education

(n = 259)

Education Level	Number of Respondents	Percent of Respondents
Grade school (K - 8)	1	0
High school	14	5
Associate's Degree (2 yr college) or Trade School	23	9
Bachelor's Degree (4 year college)	114	44
Master's Degree	76	29
Doctorate Degree	31	12

Survey Question 18.

Respondents were asked, "Including yourself, how many people live in your household?" The average number of people per household was 2.78, with the most frequently occurring answer being two people.

Table 33. Number of People in Household

(n = 242)

Number of People	0-1	2	3	4	5	6	7	>7 +
Number of Respondents	32	97	44	44	14	8	2	1
Percent of Respondents	13	40	18	18	6	3	1	0

Survey Question 19.

Respondents were asked to indicate their age bracket.

Table 34. Age of Respondents

(n = 258)

Age	Number of Respondents	Percent of Respondents
Under 20	0	0
20 – 29	12	5
30 - 39	35	14
40 - 49	65	25
50 - 59	83	32
60 – 69	53	21
70 – 79	9	3
80 & over	1	0

Survey Question 20.

Respondents were asked to indicate their combined annual income before taxes for their household during 2010.

Table 35. Household Income for 2010

(n = 253)

Income Level	Number of Respondents	Percent of Respondents
Under $ 15,000	1	0
$15,000 - $24,999	0	0
$25,000 - $49,999	7	3
$50,000 - $74,999	15	6
$75,000 - $99,999	21	8
$100,000 - $149,999	47	19
$150,000 - $199,999	39	15
$200,000 or more	73	29
I prefer not to answer	50	20

Survey Question 21.

Respondents were asked to provide any additional comments regarding their lock experiences as it pertains to the threat of invasive species. While summarizing comments is difficult due to their complexity and diversity, the following table includes some of the themes that were most frequent in comments provided by survey respondents.

Table 36. Additional Comments by Topic

(n = 93)

Summary of Comment Theme	Number of Respondents
Is there another alternative to closing the locks?	14
Keep the locks open	13
Keep the carp out of Lake Michigan	12
Concerned about water quality	7
Concerned about other avenues for ANS invasion	5
Would like to see evidence that there will actually be a problem generated by the carp	5
Chicago needs to treat its waste water	4
Concerned about biased survey	4
Costs for a solution need to be shared with all those who benefit, not just the boaters	3
Would like to see evidence that the carp are close by before acting	3
Government should provide the funds for the solution	2
Not concerned about invasive species - the ecosystem will adjust	2

Lock user survey

U.S Army Corps of Engineers Agency Disclosure Notice OMB Number 0710-0001

The public report burden for this data collection effort is estimated at 20 minutes per survey, including the time for reviewing instructions, searching existing data sources, gathering and maintaining data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this data collection, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Executive Services Directorate, Information Management Division, 1155 Defense Pentagon, Washington DC, 20301-1155 and the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC 20503, Attn: Desk Officer for US Army Corps of Engineers. Respondents should be aware that notwithstanding any other provision of law, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

PLEASE DO NOT RETURN YOUR RESPONSE TO THE ABOVE ADDRESS.

Statement of Purpose: The United States Army Corps of Engineers (USACE), in consultation with other agencies, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). USACE will evaluate a range of options and technologies designed to prevent the spread of aquatic nuisance species (ANS) between the Great Lakes (GL) and Mississippi River (MR) basins. GLMRIS will analyze the potential effects of each alternative plan on the current uses of the aquatic pathways. The goal of the study is to identify potential solutions to reduce the risk of the transfer of invasive species.

Participation in this survey is completely voluntary and all the information you provide will be kept strictly **confidential**. Your responses to the following questions will be aggregated with other responses to help us determine the impacts from alternatives that address the spread of aquatic nuisance species. All responses and comments provided will be shared only with the project delivery team. The information collected will be managed in accordance with AR 25-400-2 records retention requirements.

If you have any questions about the Great Lakes Mississippi River Interbasin Study, please contact the Project Manager, David Wethington at (312) 846-5522. For questions about the non-cargo lock user survey, please contact the Project Lead Economist, Jonathan Brown, at (716) 879-4430.

Your answers to the following questions will assist the study team in the analysis. We appreciate your willingness to participate in this important survey effort.

Survey Question 1. What is the primary usage of your vessel? (*please check the one that best applies*)

_____ Personal recreational use (i.e. general boating, sport fishing, etc.)

____ Other (please describe) ____

Survey Question 2. What is the length of your vessel? _____ (feet)

Survey Question 3. How many people, including you are on your typical boat trip?

_____Number of people (*include yourself*)

Survey Question 4. How long have you been a Chicago area boater? _______ years

Survey Question 5. Do you use the Chicago Area locks in a typical year?

____ Yes

____ No (skip to question 10)

Survey Question 6. Check below the Chicago Area locks that you use during a typical year. (*Please check all that apply*.)

____ Chicago Lock starting from lakeside (skip to 6A)

____ Chicago Lock starting from riverside (skip to 6B)

____ O'Brien Lock starting from Calumet River (skip to 6C)

____ O'Brien Lock starting from Cal-Sag (skip to 6D)

____ Lockport Lock from above (skip to 6E)

____ Lockport Lock from below (skip to 6F)

[6A] In a typical year, indicate the number of boat trips you take from the lakeside of the Chicago Lock toward Chicago based on your **primary** trip purpose (*enter number of one-way trips for all that apply*). I take the following number of trips:

i. ______ for river day trip(s)

ii. ______ for river "loops" to destinations farther south

iii. ______ for river "loops" through another lock and back to lake

iv. ______ for river architecture viewing

v. ______ to seek refuge from bad weather

vi. ______ for dry dock/ramp or to remove boat from water

vii. ______ for wet storage on river side

viii. ______ to riverside restaurants/stores

ix. ______ for boat repair services

x. ______ for other purpose:____

(go to next box checked on 6 until done, then *go to question 7)*

[6B] In a typical year, indicate the number of boat trips you take from the riverside of the Chicago Lock to the lake based on your **primary** trip purpose (*enter number of one-way trips for all that apply*). I take the following number of trips:

i. ______ for Lake Michigan day trip
ii. ______ to lakeside restaurant/store
iii. ______ for lakeside city/fireworks viewing
iv. ______ to dry storage
v. ______ to wet storage on lake side
vi. ______ for boat repair services
vii. ______for other purpose: ____

(go to next box checked on 6 until done, then *go to question 7)*

[6C] In a typical year, indicate the number of boat trips you take from the Calumet river side of the T.J. O'Brien Lock toward Cal-Sag based on your **primary** trip purpose (*enter number of one-way trips for all that apply*). I take the following number of trips:

i. ______ for river day trip
ii. ______ for river "loops" to destinations farther south
iii. ______ for river "loops" through another lock and back to lake
iv. ______ to seek refuge from bad weather
v. ______ for dry dock/ramp or to remove boat from water
vi. ______ for wet storage on river side
vii. ______ to riverside restaurant/store
viii. ______ for boat repair services
ix. ______ for other purpose:____

(go to next box checked on 6 until done, then go to question 7)

[6D] In a typical year, indicate the number of boat trips you take from Cal-Sag side of the T.J. O'Brien Lock to Calumet River based on your **primary** trip purpose (*enter number of one-way trips for all that apply*). I take the following number of trips:

i. ______ for Lake Michigan day trip
ii. ______ to lakeside restaurant/store
iii. ______ to dry storage on lake side
iv. ______ for wet storage on lake side
v. ______ for boat repair services
vi. ______ for other purpose:____

(go to next box checked on 6 until done, then *go to question 7)*

[6E] In a typical year, indicate the number of boat trips you take from above the Lockport Lock based on your **primary** trip purpose (*enter number of one-way trips for all that apply)*. I take the following number of trips:

i. ______ for river day trip

ii. ______ for river "loops" to destinations farther south
iii. ______ for river "loops" through another lock and back to lake
iv. ______ to dry dock/ramp or to remove boat from water
v. ______ for wet storage on river side
vi. ______ to riverside restaurant/store
vii. ______ for boat repair services
viii. ______ for other purpose:____

(go to next box checked on 6 until done, then *go to question 7)*

[6F] In a typical year, indicate the number of boat trips you take from below Lockport Lock based on your **primary** trip purpose (*enter number of one-way trips for all that apply*). I take the following number of trips:

i. ______ for Lake Michigan day trip
ii. ______ for river day trip
iii. ______ to riverside restaurant/store
iv. ______ to lakeside restaurant/store
v. ______ to dry storage
vi. ______ for wet storage on river side
vii. ______ for wet storage on lake side
viii. ______ for boat repair services
ix. ______ for other purpose:____

(go to next box checked on 6 until done, then *go to question 7)*

Survey Question 7. Typically, where do you store your boat in the **summer**?

_____ Lakeside Chicago Lock
_____ Riverside of Chicago Lock
_____ Calumet River side of O'Brien Lock
_____ Cal-Sag side of O'Brien Lock
_____ Other (*please explain*) ________________________________

Survey Question 8. Typically, where do you store your boat in the **winter**?

_____ Lakeside Chicago Lock
_____ Riverside of Chicago Lock
_____ Calumet River side of O'Brien Lock
_____ Cal-Sag side of O'Brien Lock
_____Other (*please explain*) ________________________________

Survey Question 9. Other than relocating your boat for moorage, please indicate the following boat trips in which you participate that are dependent on the availability of the CAWS locks. (*please check all that apply*.)

a. _____ Fishing
b. _____ Sightseeing
c. _____ Water skiing (kneeboarding, inflatable towables, wake surfing, etc)
d. _____ Pleasure sailing
e. _____ Competitive sailing
f. _____ Day cruising
g. _____ Overnight / multi-day cruise
h. _____ Obtain boat service / repair
i. _____ Day trip to private or transient dock
j. _____ Swimming / Sun bathing / Picnicking
k. _____ Visit Friends / Family

l. _____ Camping in primitive areas
m. _____ Take out business associates / customers
n. _____ Wildlife observation and/or photography
o. _____ Other:____________________

Survey Question 10. Please indicate how important the following are to you:

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
The CAWS has no particular importance to me personally					
The CAWS is important to me because of its prominence in history and culture					
The CAWS is important to me for its uniqueness					
The CAWS is important to me because it allows for the safe transportation of commodities on water that would otherwise be adding to our congested land transportation routes.					
The CAWS is important to me because it offers many types of recreation					
The CAWS is important to me because it allows the transport of storm waters away from the city					
The CAWS is important to me because it allows the transport of treated sewage away from the city					
The CAWS ambience and aesthetics are important to me					
It is important to take care of the CAWS so that it is available to future generations					
The CAWS is important to me because of its value to commerce and industry including tourism					
The CAWS is important because					

it provides an important transportation link between the Great Lakes and the Mississippi River.					

Survey Question 11. Of the following CAWS concerns, which one do you think should be the **highest** priority:
___Reduce risk of transfer of invasive species between the Great Lakes and Mississippi River Basins
___Maximize Chicago area water quality
___Reduce the Chicago area flood risk
___Maintain open water access between lake and river systems to commercial, recreational, and government watercraft
___Don't have an opinion

Survey Question 12. <u>**Permanent closure**</u> of the CAWS locks is being considered to prevent transfer of aquatic nuisance species.
Please indicate what best describes your opinion about this.

_____ I fully support permanent lock closure (**go to 12A**)
_____ I partially support permanent lock closure (**go to 12A**)
_____ I am mostly against permanent lock closure (**go to 12C**)
_____ I am fully against permanent lock closure (**to 12C**)

[12A] The intent of lock closure is to lower the risk of invasive species transfer, but there would be other adverse impacts to the area. If it was necessary to impose a fee to support CAWS lock closure, what is the most you would be willing to pay **annually** to keep the locks closed? (Please *select the value from the list below that represents the maximum amount you would be willing and able to pay annually.*)

_____$80,000 to $100,000	_____$60,000 to $79,999	_____$40,000 to $59,999
_____$30,000 to $39,999	_____$20,000 to $29,999	_____$15,000 to $19,999
_____$10,000 to $14,999	_____$7,500 to $9,999	_____$5,000 to $7,499
_____$2,500 to $4,999	_____$1,000 to $2,499	_____$750 to $999
_____$500 to $749	_____$250 to $499	_____$100 to $249
_____$50 to $99	_____$1 to $49	_____$0

(go to question 12B)

[12B] Please choose the response that best describes your reason for the previous answer (*select **only one** response*):
_____ I didn't want to place a dollar value.
_____ I object to paying to keep the locks closed.
_____ That's what it is worth to me.
_____ Not enough information is provided.
_____ It's worth more to me to keep the locks closed, but it's all I can afford to pay
_____ Other reason: ____
(go to question 13)

[12C] The Chicago Area Locks provide a public service without charge to the user. Operation of the locks is supported by government dollars. If you could prevent the closure of the CAWS locks; what is the most you would be willing to pay **annually** to keep the locks open? (Please *select the value from the list below that represents the maximum amount you would be willing and able to pay annually*)

_____$80,000 to $100,000	_____$60,000 to $79,999	_____$40,000 to $59,999
_____$30,000 to $39,999	_____$20,000 to $29,999	_____$15,000 to $19,999
_____$10,000 to $14,999	_____$7,500 to $9,999	_____$5,000 to $7,499
_____$2,500 to $4,999	_____$1,000 to $2,499	_____$750 to $999
_____$500 to $749	_____$250 to $499	_____$100 to $249
_____$50 to $99	_____$1 to $49	_____$0

(go to question 12D)

[12D] Please choose the response that best describes your reason for the previous answer (*select **only one** response*):

_____ I didn't want to place a dollar value.
_____ I object to paying to keep the locks open.
_____ That's what it is worth to me.
_____ Not enough information is provided.
_____ It's worth more to me to keep the locks open, but it's all I can afford to pay.
_____ Other reason: ____

(go to question 13)

Survey Question 13. If the locks were permanently closed in order to prevent the transfer of invasive species, which statement best describes what you would do with your vessel? (*Select most likely choice.*)

a. _____ I would keep and use my vessel below the Lockport Lock
b. _____ I would keep and use my vessel on the river between the Lockport and Chicago locks.
c. _____ I would keep and use my vessel on the river between the Lockport and O'Brien locks.
d. _____ I would keep and use my vessel on the river between the Lockport and Chicago and O'Brien locks.
e. _____ I would keep and use my vessel on Lake Michigan.
f. _____ I would keep and use my vessel on some other water body.
g. _____ I would sell my vessel.
h. _____ Other: ____

Survey Question 14. Previously we asked your willingness to pay to (1. keep the locks open or 2. permanently close the locks). If a physical barrier were erected elsewhere on the waterway, there would be the following adverse effects:

(4) During high flow or flood conditions, storm water and/or treated sewage which currently flow toward the Mississippi River would remain lakeward of the barrier, deteriorating water quality and odors.
(5) More frequent high water levels in the river would reduce bridge height clearances.
(6) Traffic between Lake Michigan and Lockport Lock would be reduced or eliminated.

Please choose the response that best describes how you feel about a basin separation measure that would reduce the risk of transfer of ANS but have the possibility of adverse impacts.

_____ I am in support of this type of basin separation measure even though there would be the adverse impacts described. (***go to 14A***)
_____ I am opposed to this type of basin separation measure with the adverse impacts as described even though it would reduce the risk of transfer of ANS between the basins. (***go to 14C***)

[14A] If it was necessary to impose a fee to support a basin separation measure that does not affect Chicago and T.J. O'Brien Locks for local use, what is the most you would be willing to pay **annually** to ensure that the basin separation measure is implemented and maintained? (Please *select the value from the list below that represents the maximum amount you would be willing and able to pay annually to keep Chicago and T.J. O'Brien Locks open in spite of the adverse effects.*)

_____$80,000 to $100,000	_____$60,000 to $79,999	_____$40,000 to $59,999
_____$30,000 to $39,999	_____$20,000 to $29,999	_____$15,000 to $19,999
_____$10,000 to $14,999	_____$7,500 to $9,999	_____$5,000 to $7,499
_____$2,500 to $4,999	_____$1,000 to $2,499	_____$750 to $999
_____$500 to $749	_____$250 to $499	_____$100 to $249
_____$50 to $99	_____$1 to $49	_____$0

(go to question 14B)

[14B] Please choose the response that best describes your reason for the previous answer (*select* ***only one*** *response*):

_____ I didn't want to place a dollar value.
_____ I object to paying for a basin separation.
_____ That's what it is worth to me.
_____ Not enough information is provided.
_____ It's worth more to me to keep the locks open, but it's all I can afford to pay.
_____ Other reason: ____

(go to question 15)

[14C] If a basin separation as described was planned for implementation and if you could prevent this basin separation from occurring, what is the most you would be willing to pay **annually** to prevent basin separation along with preventing the adverse impacts as described from happening? (Please *select the value from the list below that represents the maximum amount you would be willing and able to pay annually.*)

_____$80,000 to $100,000	_____$60,000 to $79,999	_____$40,000 to $59,999
_____$30,000 to $39,999	_____$20,000 to $29,999	_____$15,000 to $19,999
_____$10,000 to $14,999	_____$7,500 to $9,999	_____$5,000 to $7,499
_____$2,500 to $4,999	_____$1,000 to $2,499	_____$750 to $999
_____$500 to $749	_____$250 to $499	_____$100 to $249
_____$50 to $99	_____$1 to $49	_____$0

(go to question 14D)

[14D] Please choose the response that best describes your reason for the previous answer (*select* ***only one*** *response*):

_____ I didn't want to place a dollar value.
_____ I object to paying to keep the separation from occurring.
_____ That's what it is worth to me.
_____ Not enough information is provided.
_____ It's worth more to me to keep the locks open, but it's all I can afford to pay.
_____ Other reason: ____

(go to question 15)

Survey Question 15. How many days do you use your vessel in a typical year? _______ number of days

Survey Question 16. If lake or river water quality were to deteriorate as a result of basin separation, please indicate how or if your boat usage would change?

_____ boat usage would probably stay the same
_____ boat usage would drop by ____ number of days

_____discontinue boat usage

The following information will help our research staff analyze the results of the study properly.

Survey Question 17. What was the highest level of education that you completed?

[___] Grade school (K - 8)

[___] Bachelor's Degree (4 year college)

[___] High school

[___] Master's Degree

[___] Associate's Degree (2 yr college) Or Trade School

[___] Doctorate Degree

Survey Question 18. Including yourself, how many people live in your household? ________ Number of people

Survey Question 19. Please mark the bracket that contains your age.

[ ] Under 20 [ ] 20 – 29 [ ] 30 - 39

[ ] 40 - 49 [ ] 50 - 59 [ ] 60 – 69

[ ] 70 – 79 [ ] 80 & over

Survey Question 20. Here is a list of income categories. Mark the category that best describes the combined annual income before taxes that you and all other members of your household earned from all sources during 2010.

[ ] Under $ 15,000 [ ] $75,000 - $99,999

[ ] $15,000 - $24,999 [ ] $100,000 - $149,999

[ ] $25,000 - $49,999 [ ] $150,000 - $199,999

[ ] $50,000 - $74,999 [ ] $200,000 or more [ ] I prefer not to answer.

Survey Question 21. Please provide any additional comments you would like to pass on to the study team regarding your lock experiences as it pertains to the threat of invasive species.______________________

____
____
____

THANK YOU FOR YOUR PARTICIPATION.

Results of this survey effort will be available around April 2012. Respondents will be notified when the final document is posted to the GLMRIS website.

Future With-Project Assessment of Non-Cargo Chicago Area Waterway System (CAWS) Traffic

October 2013

Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

GREAT LAKES MISSISSIPPI RIVER INTERBASIN STUDY (GLMRIS)
FUTURE WITH-PROJECT ASSESSMENT OF NON-CARGO CAWS TRAFFIC

Contents

I. GREAT LAKES AND MISSISSIPPI RIVER INTERBASIN STUDY (GLMRIS)

This document is intended for use in conjunction with the baseline assessment and the future without-project assessment of lock traffic by commercial passenger, recreation, and governmental vessels.[1] This effort compares the future without-project assessment to the alternatives developed to prevent the transfer of aquatic nuisance species transfer between the Great Lakes and Mississippi River Basins. Typically, economic assessments for Corps' projects would identify (and quantify) benefits to users as a result of project implementation. For GLMRIS however, not all waterway users will be made better off from a project implementation as this document will show. The first part of this assessment is the background for the study, followed by a summary of the final array of alternatives, and then the predicted impacts to the non-cargo users as a result of implementation of the proposed alternatives. This is a qualitative assessment.

Introduction

An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (2010).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE evaluated a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River by aquatic pathways. In this context, the term "prevent" includes the reduction of risk to the maximum extent possible, because it may not be technologically feasible to achieve an absolute solution. USACE conducted a detailed analysis of various ANS controls, including hydrologic separation.

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[1] *Baseline Assessment of Non-Cargo CAWS Traffic* published by the GLMRIS project delivery team November 2011 and *Without-Project Condition Assessment of Non-Cargo CAWS Traffic* published by the GLMRIS project delivery team December 2012.

GLMRIS Study Area

The GLMRIS study area includes portions of the Great Lakes and Mississippi River basins that fall within the United States.

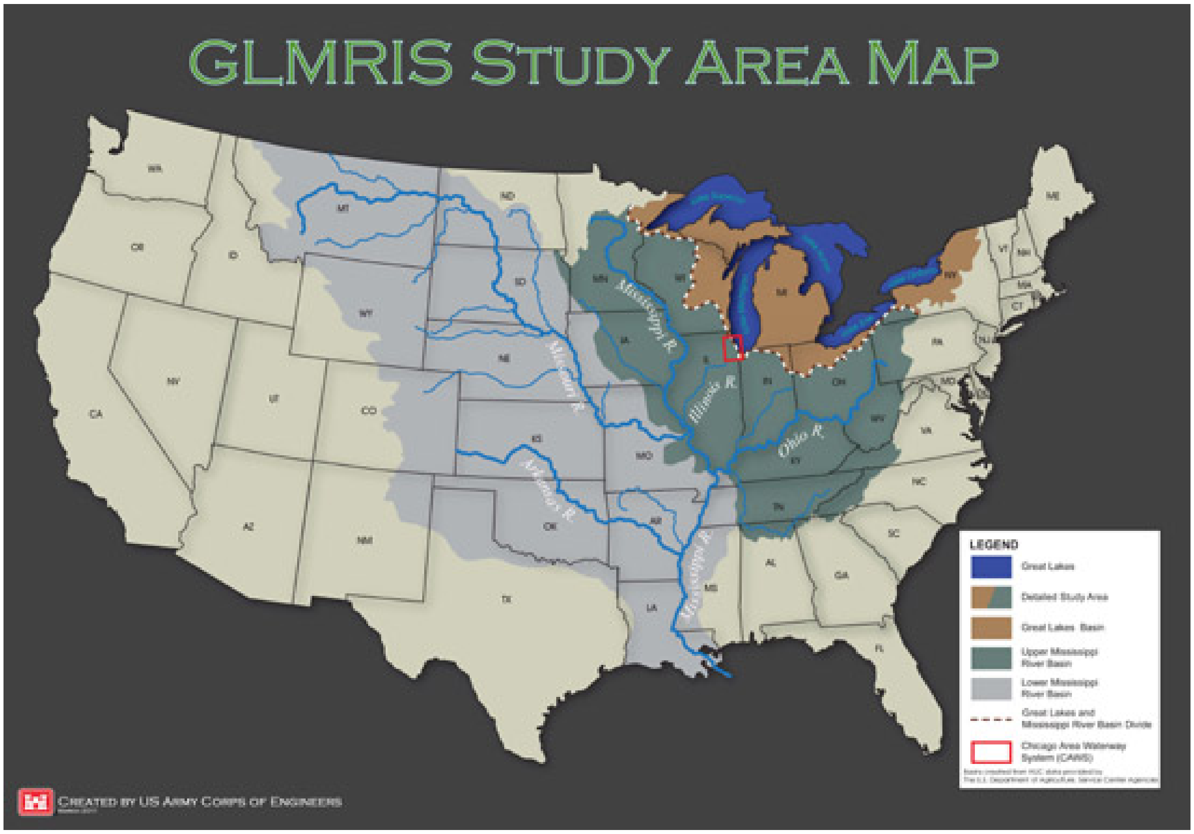

Figure 1. GLMRIS Study Area Map

Potential aquatic pathways between the Great Lakes and Mississippi River basins exist along the basins' shared boundary (illustrated as "▬ ▬ ▬" in Figure 1). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi Basin ( ) and the Great Lakes Basin ( ). See Figure 1.

Future ANS may transfer beyond the *Detailed Study Area*; this pattern was observed by the spread of zebra mussels, which originated in the Great Lakes and spread throughout the Mississippi River Basin. Therefore, the *General Study Area* encompasses the lower Mississippi River Basin ( ).

a. GLMRIS Focus Areas

The GLMRIS follows two concurrent tracks: Focus Area I, the Chicago Area Waterway System (CAWS), and Focus Area II, Other Pathways.

(1) Chicago Area Waterway System (CAWS)

Focus Area I, the CAWS, as shown in the map below, is the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins. Therefore, it poses the greatest potential risk of ANS transferring between the basins via an aquatic pathway.

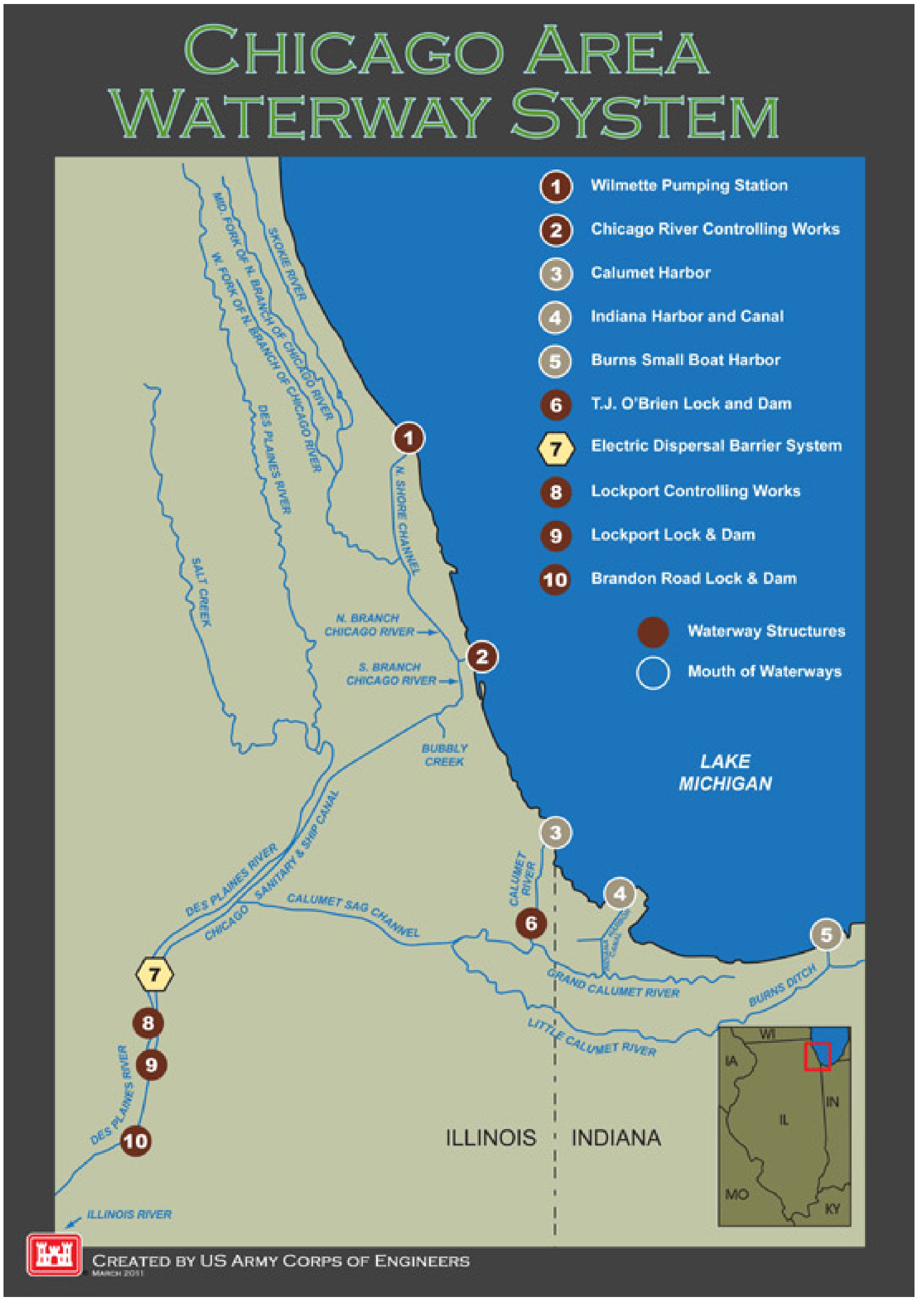

Figure 2. Chicago Area Waterway System

(2) Other Pathways

Focus Area II addresses the remaining aquatic pathways. For this focus area, the U.S. Army Corps of Engineers completed a document entitled, "*Other Pathways Preliminary Risk Characterization Report*" that identifies other potential aquatic pathways outside of the CAWS, as well as includes a screening-level assessment of potential ANS that may transfer via these connections.

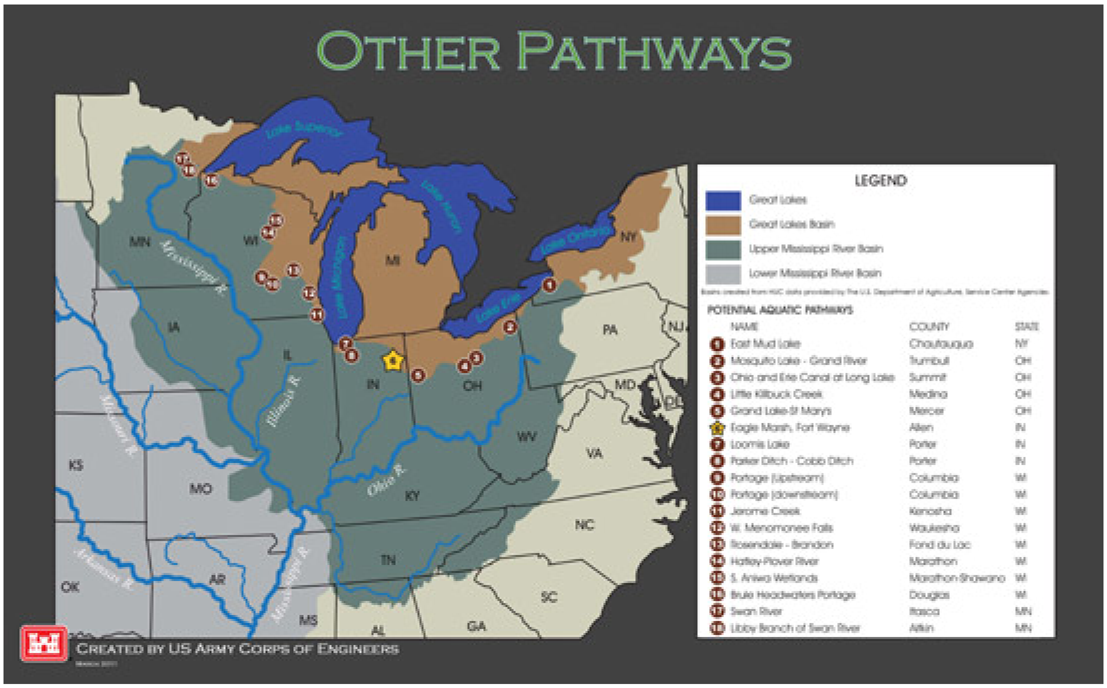

Figure 3. Other Pathways Map

This assessment of non-cargo lock users addresses only Focus Area I.

II. FINAL ARRAY OF ALTERNATIVES

The GLMRIS Project Delivery Team (PDT) developed an array of alternatives to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins. These alternatives were evaluated, and after a thorough screening process, were narrowed down to eight which are described briefly below:

No New Federal Action – This forms the basis of comparison for the alternatives considered.

Non-Structural Control Technologies - Features of this alternative include:

- laws and regulations that restrict site access and use,
- mandatory watercraft inspection and decontamination,
- prohibition of sale, cultivation, transport, release/planting,
- live bait restrictions,
- laws that prohibit sale, ownership, transport, release, and
- education, regulations, and the application of biocides.

Mid-System Control Technologies without a Buffer Zone (Flow Bypass Alternative) - Features of this alternative include:

- basin-wide non-structural control technologies,
- a GLMRIS lock, treatment plant for ANS-free water in the lockage, and a 950-foot electric barrier on the downstream and upstream sides at Mile 316 of the Chicago Sanitary and Ship Canal (CSSC) (Stickney, IL),
- a GLMRIS lock, treatment plant for ANS-free water in the lockage, and a 950-foot electric barrier on the downstream and upstream sides at Mile 315 of the Calumet-Sag Channel (Alsip, IL).

Technology Alternative with a Buffer Zone (CAWS Buffer Zone Alternative) - Features of this alternative include:

- basin-wide non-structural measures,
- rehabilitation of control structure to prevent lake from mixing with North Shore Channel at Wilmette (IL),
- deep and shallow GLMRIS lock with sluice structure, ANS Treatment Plant that provides ANS-free water for lockages, an electric barrier in a 950-foot engineered approach channel, and breakwater with rip-rap and shoreline improvements near the current Chicago Lock and Controlling Works (IL),
- ANS Treatment Plant that provides ANS-free water for lockages, GLMRIS lock with sluice structure, and an electric barrier in a 950-foot engineered approach channel at T J O'Brien Lock and Dam on the Calumet River (IL),
- a physical barrier on the Grand Calumet River (IL/IN state line) consisting of a concrete dam that spans bank to bank,
- a physical barrier on the Little Calumet River (Hammond, IN) consisting of a concrete dam that spans bank to bank, and
- a lock with exchange at the Brandon Road Lock and Dam – Des Plaines River (Brandon Road, IL) along with an electric barrier in a 2,300-foot engineered approach channel.

Lakefront Hydrologic Separation – Features of this alternative include:

- basin-wide non-structural measures,
- a physical barrier consisting of a concrete dam that spans bank to bank while the pump station stays in place with the current operators at Wilmette Pumping Station (IL),
- a physical barrier at Michigan Avenue bridge (Chicago, IL) on the CAWS consisting of a concrete dam that spans bank to bank while the Chicago Lock and Controlling Works would remain in place and continue with USACE operators,
- a physical barrier at Bishop Ford (IL) consisting of a concrete dam that spans bank to bank while T J O'Brien Lock would remain in place and continue with USACE operators, and
- a physical barrier at Hammond (IL) consisting of a concrete dam that would span bank to bank.

Mid-System Hydrologic Separation – Features of this alternative include:

- basin-wide non-structural measures,
- a physical barrier at River Mile 316 (Stickney, IL) of the Chicago Ship and Sanitary Canal (CSSC) consisting of a concrete dam that spans bank to bank while the Wilmette Pumping Station and the Chicago Lock and Controlling Works remain in place under the current operators to protect the CAWS from the effects of high lake levels,
- a physical barrier at the Calumet-Sag Channel (Alsip, IL) consisting of a concrete dam that spans bank to bank while T J O'Brien Lock would remain in place under current operation to protect the CAWS from the effects of high lake levels.

Mid-System Separation Cal-Sag Open Control Technologies with a Buffer Zone (Hybrid Cal-Sag Open Alternative) – Features of this alternative include:

- basin-wide non-structural measures,
- a physical barrier at River Mile 316 on the CSSC (Stickney, IL) consisting of a concrete dam that spans bank to bank,
- a GLMRIS lock with sluice structure at the T J O'Brien Lock and Dam (IL) that includes ANS Treatment Plant that provides ANS free water for lockages along with an electric barrier in a 950-foot engineered approach channel,
- a physical barrier on the Grand Calumet River (IL/IN state line) consisting of a concrete dam that spans bank to bank,
- a physical barrier on the Little Calumet River (Hammond, IN) consisting of a concrete dam that spans bank to bank, and
- a GLMRIS lock with exchange at the Brandon Road Lock and Dam – Des Plaines River (Brandon Road, IL) along with an electric barrier in a 2,300-foot engineered approach channel.

Mid-System Separation CSSC Open Control Technologies with a Buffer Zone (Hybrid CSSC Open Alternative) - Features of this alternative include:

- basin-wide non-structural measures,
- rehabilitation of control structure to prevent lake from mixing with North Shore Channel at Wilmette (IL),
- deep and shallow GLMRIS lock with sluice structure, ANS Treatment Plant that provides ANS-free water for lockages, an electric barrier in a 950-foot engineered approach channel, and breakwater with rip-rap and shoreline improvements near the current Chicago Lock and Controlling Works (IL),
- a physical barrier consisting of a concrete dam that will span bank to bank at Alsip, IL that will prevent Cal-Sag from flowing downstream
- a GLMRIS lock with exchange at the Brandon Road Lock and Dam – Des Plaines River (Brandon Road, IL) along with an electric barrier in a 2,300-foot engineered approach channel.

III. IMPACTS TO NON-CARGO CAWS USERS FROM ALTERNATIVES

Basin separation and electric barrier measures will affect non-cargo vessels using the CAWS. Vessels currently accessing Lake Michigan from the CAWS will have to modify their behavior in order to continue their customary use. The degree of impact and the timing will vary by individual.

The Chicago Park District has nine lakefront harbors with accommodations for more than 5,000 boats. However, these 5,000 moorages spaces should not be considered an exhaustive list of moorage space within the CAWS. Between 2000 and 2010 there was an average of 50,000 recreation vessels using the Chicago River Controlling Works, the T J O'Brien, the Lockport, and the Brandon Road locks and dams. Based on the boater survey conducted by Argonne National Labs and USACE, recreation boats generally have between 1 and 6 passengers. We also know that between 600,000 and 800,000 passengers go through the locks annually via one of the Passenger Vessel Association tour boat vessels. Government vessels (police, fire, rescue, and research vessels) made more than 2,000 trips through the locks during this same time. (See *Baseline Assessment of Non-Cargo CAWS Traffic* for the complete data summaries.)

Most of these vessels pass through the Chicago River Controlling Works Lock. As discussed in the Baseline Assessment report, the number of vessels passing through the T J O'Brien, Lockport, and Brandon locks is much smaller, but the impacts are no less significant to those vessels that must modify their behavior for the alternatives under consideration.

These basic assumptions are used to determine the impacts from each of the alternatives:

1. Historical vessel traffic forms the basis for future traffic.
2. Concrete dams will be impassable for non-cargo vessels.
3. Electric barrier measures are consistent with existing operations and include the following regulations:
    a. Vessels that are 20-feet or less in length may not pass through the electric barriers.
    b. Kayaks may not pass through the electric barriers.
    c. Yachts and sailboats of sufficient length may pass through the electric barriers provided other operating criteria are met.
4. Treatment plants will be effective in addressing potential ANS transfer via aquatic pathways.
5. Non-structural measures currently under consideration will not interfere with vessel operations.
6. The number of people wanting to use the CAWS and Lake Michigan for recreation will not diminish as a result of implementation of any of these alternatives.

Non-cargo CAWS users are broken down into groups which are described in more detail in the *Baseline Assessment of Non-Cargo CAWS Traffic* published in November 2011. Impacts to each of the user groups by alternative are listed below:

No New Federal Action

- Non-cargo vessels are expected to continue current operations.

Non-Structural Alternative

- Passenger Vessels (tour boats, ferries, and cruiseships) –
  - New laws and regulations will impact operations for these vessels and perhaps affect profitability.
- Non-Federal Government Vessels (Chicago Police, Illinois Department of Natural Resources) –
  - Not enough known about this alternative to determine impacts to non-Federal government vessels.
- Fishing vessels (commercial boats, sport fishing) –
  - New laws and regulations may impact those fishing in the GLMRIS area. For example, changes to bait and tackle regulations could affect the ability to harvest targeted species.
- Federal Government Vessels (U.S. Coast Guard, U.S. Army Corps of Engineers) –
  - Not enough known about this alternative to determine impacts to Federal government vessels.
- Recreational vessels (Chicago Park District harbors) –
  - New laws and regulations will impact operations of these vessels.
  - The cost of continuing current practices may go up which would decrease the net value of the experience for the recreational boaters.

Mid-System Control Technologies without a Buffer Zone (Flow Bypass Alternative)

- Passenger Vessels (tour boats, ferries, and cruiseships):
  - May be impacted more frequently by high water events.
  - Will experience delays and increased costs for any trip through the new locks.
- Non-Federal Government Vessels (Chicago Police, Illinois Department of Natural Resources):
  - Will experience delays and additional costs for any trip through the new locks.
- Fishing vessels (commercial boats, sport fishing):
  - Will experience delays and additional costs for any trip through the new locks,
  - Would not be allowed in the electric barrier region at Stickney or Alsip if the vessels are under 20-feet.
- Federal Government Vessels (U.S. Coast Guard, U.S. Army Corps of Engineers):
  - Will experience delays and additional costs for any trip through the new locks
- Recreational vessels (Chicago Park District harbors):
  - Will experience delays and additional costs for any trip through the new locks
  - Would not be allowed in the electric barrier region at Stickney or Alsip if the vessels are under 20-feet. According to the survey responses, about 30 percent of all recreation vessels in the Chicago area are less than 28-feet.

Technology Alternative with a Buffer Zone (CAWS Buffer Zone Alternative)

- Passenger Vessels (tour boats, ferries, and cruiseships):
    - May be impacted more frequently by high water events once the physical barriers are constructed. High water events make the CAWS impassable for some vessels needing larger clearances under bridges.
- Non-Federal Government Vessels (Chicago Police, Illinois Department of Natural Resources):
    - May have to offer duplicate services if their jurisdictions extend beyond the concrete barriers,
    - Will experience delays and additional costs for any trip through the new locks
    - May be restricted by high water events on the CAWS more often due to physical barriers,
    - May have to offer duplicate services if their missions encompass areas on both sides of the new concrete dams.
- Fishing vessels (commercial boats, sport fishing):
    - Will experience delays and additional costs for any trip through the new locks. For example, vessels would have to find alternate means to reach their destination or seek alternate repair services or places to fish.
- Federal Government Vessels (U.S. Coast Guard, U.S. Army Corps of Engineers):
    - Will experience delays and additional costs for any trip through the new locks,
    - May have to provide duplicate services if their jurisdiction extends beyond the concrete barrier locations,
    - May be restricted by high water events on the CAWS more often due to physical barriers.
- Recreational vessels (Chicago Park District harbors):
    - Vessels attempting to do the "loop" will be unable to do so,
    - Vessels less than 20-feet would not be allowed in the electric barrier region on the CAWS or the Des Plaines River near Brandon Lock. According to the survey responses, about 30 percent of all recreation vessels in the Chicago area are less than 28-feet.

Lakefront Hydrologic Separation

- Passenger Vessels (tour boats, ferries, and cruiseships):
    - Almost half (47%) of the Passenger Vessel Association businesses will shut down as a result of basin separation. It is estimated that the passenger vessel annual revenues are approximately $36 million. (See *Without-Project Condition Assessment of Non-Cargo CAWS Traffic* dated December 2012.) Cruiseship operators would have to constrain their operations to one side of the Michigan Avenue Bridge. This means that sunset cruises, fireworks tours, and skyline tours would all take place from the lakeside of Michigan Avenue Bridge. Cruiseship operators originating on the river side of Michigan Avenue Bridge would be limited to architecture tours and special events.
    - This alternative could also affect water-taxi service as well since the service is supplemented by the tour boat operations. Water taxi service will require a

subsidy from the Chicago city government or a significant increase in fares in order to stay viable.

  - Architecture tours would all take place on the riverside of the Michigan Avenue Bridge and combination tours would be eliminated.
  - Charter services for weddings or other events would be limited by the Michigan Avenue Bridge concrete dam.
  - Passenger vessels may face increased repair and maintenance expenses as their now-typical travel through the locks to reach facilities on Lake Michigan will be eliminated. There is no heavy equipment, welding equipment, or cranes at the Navy Pier.
  - Passenger vessels operating on the CAWS are of specific design to accommodate the many bridges along the waterway and are not well-suited to other water bodies. So in the event of shrinkage in this industry, the salvage value for Chicago tour boats would be minimal as the vessels would need additional modifications to serve in other markets.
  - The value of the recreation experience for passengers of these vessels will decrease (see discussion of Unit Day Value of Tour Boat Passengers in the *Without Project Condition Assessment of Non-Cargo CAWS Traffic*). The estimated annual value of recreation experience for commercial passengers is estimated at $3.2 million in the without-project condition.
  - The 1,100 employees (2010 estimate) of the passenger vessel companies may be impacted by changes in service. Especially, the almost half who would be working on the lakeside of the barriers.
- Non-Federal Government Vessels (Chicago Police, Illinois Department of Natural Resources):
  - Chicago police, fire, and rescue boats will need to change operations in order to maintain the same level of service. This could entail having duplicate services (i.e. boats, divers, equipment) on both sides of the four concrete dams.
  - The Illinois Dept. of Natural Resources would need to modify and/or enhance their current management, protection, and sustainability program to account for the separation of the water bodies.
- Fishing vessels (commercial boats, sport fishing):
  - Commercial fishing vessels primarily use the lock system to get to winter storage or to reach boat repair / certification centers. These vessels operators would experience increase costs since they would be required to either identify alternate means of reaching the repair/ certification centers or go to alternate companies that offer the needed services.
  - Sixteen percent of the recreational boat owners using the locks indicated their purpose as fishing (see survey responses which follow this report). All of these vessels would have to find alternate means of accessing either the lake or the river in the event of separation.
  - Many states stock the lakes and rivers in their jurisdiction so Department of Natural Resources in each of the states may need to revisit their stocking programs for impacts from separation measures.
  - The value of recreation experience for recreational fishermen may decrease.
- Federal Government Vessels (U.S. Coast Guard, U.S. Army Corps of Engineers)

- The Marine Safety Unit Chicago has 53 active duty, reserve, and civilian personnel conducting armed port security patrols, inspecting commercial vessels, conducting pollution and marine casualty investigations, enforcing safety zones, conducting waterfront facility exams for regulatory compliance, and other Homeland Security missions. Marine Safety Unit Chicago would have to modify their operations in order to maintain the same level of service in this basin separation alternative.
- U.S. Army Corps of Engineers vessels include debris collectors, tenders, dredge vessels, research vessels, survey and patrol vessels, towboats, and multiple types of barges. USACE would also have to modify its operations in order to maintain the same level of service.

- Recreational vessels (Chicago Park District harbors):
    - According to the survey results, 72 percent of recreational boaters using the CAWS locks were mostly or fully against permanent lock closure. When asked what vessel owners would do in the event of lock closure, 72 percent indicated they would keep and use the vessel on Lake Michigan, 5 percent would keep and use the vessel on some other water body, 13 percent would sell the vessel, and 10 percent indicated other alternatives. When asked what boat owners would be willing to pay to keep the locks open, the average response was $1,850 annually. While the question asked was about lock closure, a basin separation would ultimately have the same effect on recreational boaters. While individual responses to basin separation may differ, the overall effect will be that boat owners will need to modify their current practices and probably incur additional expenses in order to maintain the level of recreation activity they currently enjoy.
    - Boat owners who must transport their vessels by road to Lake Michigan due to basin separation will increase congestion on the adjoining roadways.
    - The value of the recreation experience for recreational boaters may decrease (see discussion of Recreational User Unit Day Value in the *Without Project Condition Assessment of Non-Cargo CAWS Traffic*). The estimated annual value of recreation experience for recreational boaters is estimated at $645,000 in the without project condition.

Mid-System Hydrologic Separation

- Passenger Vessels (tour boats, ferries, and cruiseships):
    - May be impacted more frequently by high water events once the dams are constructed. High water events make the CAWS impassable for some vessels needing larger clearances under bridges.
- Non-Federal Government Vessels (Chicago Police, Illinois Department of Natural Resources):
    - May have to offer duplicate services if their jurisdictions extend beyond the concrete barriers.
    - May be restricted by high water events on the CAWS more often due to physical barriers.
- Fishing vessels (commercial boats, sport fishing):

- Will experience an increase in costs for any trips through the new concrete barrier areas. Vessels would have to find alternate means to reach their destination or seek alternate repair services or places to fish.
- Federal Government Vessels (U.S. Coast Guard, U.S. Army Corps of Engineers):
  - May have to provide duplicate services if their jurisdiction extends beyond the concrete barrier locations.
  - May be restricted by high water events on the CAWS more often due to physical barriers..
- Recreational vessels (Chicago Park District harbors):
  - Vessels attempting to do the "loop" will be unable to do so.
  - The net value of the recreational experience for boaters may decrease.

Mid-System Separation Cal-Sag Open Control Technologies with a Buffer Zone (Hybrid Cal-Sag Open Alternative)

- Passenger Vessels (tour boats, ferries, and cruiseships):
  - May be impacted more frequently by high water events once the physical barriers are constructed. High water events make the CAWS impassable for some vessels needing larger clearances under bridges.
- Non-Federal Government Vessels (Chicago Police, Illinois Department of Natural Resources):
  - May have to offer duplicate services if their jurisdictions extend beyond the concrete barriers.
  - May be restricted by high water events on the CAWS more often due to physical barriers.
- Fishing vessels (commercial boats, sport fishing):
  - Will experience an increase in costs for any trips through the concrete barrier locations. Vessels would have to find alternate means to reach their destination or seek alternate repair services or places to fish.
- Federal Government Vessels (U.S. Coast Guard, U.S. Army Corps of Engineers):
  - May have to provide duplicate services if their jurisdiction extends beyond the concrete barrier locations.
  - May be restricted by high water events on the CAWS more often due to physical barriers.
- Recreational vessels (Chicago Park District harbors):
  - Vessels attempting to do the "loop" will be unable to do so.
  - Vessels less than 20-feet would not be allowed in the electric barrier region on the CAWS or the Des Plaines River near Brandon Lock. According to the survey responses, about 30 percent of all recreation vessels in the Chicago area are less than 28-feet.

Mid-System Separation CSSC Open Control Technologies with a Buffer Zone (Hybrid CSSC Open Alternative)

- Passenger Vessels (tour boats, ferries, and cruiseships):

    - May be impacted more frequently by high water events once the physical barriers are constructed. High water events make the CAWS impassable for some vessels needing larger clearances under bridges.
- Non-Federal Government Vessels (Chicago Police, Illinois Department of Natural Resources):
    - May have to offer duplicate services if their jurisdictions extend beyond the concrete barriers.
    - May also be subject to restrictions with high water events on the CAWS.
- Fishing vessels (commercial boats, sport fishing):
    - Will experience an increase in costs for any trips through the concrete barrier locations. Vessels would have to find alternate means to reach their destination or seek alternate repair services or places to fish.
- Federal Government Vessels (U.S. Coast Guard, U.S. Army Corps of Engineers):
    - May have to provide duplicate services if their jurisdiction extends beyond the concrete barrier locations.
    - May be restricted by high water events on the CAWS more often due to physical barriers.
- Recreational vessels (Chicago Park District harbors):
    - Vessels attempting to do the “loop” will be unable to do so.
    - Vessels less than 20-feet would not be allowed in the electric barrier region on the CAWS or the Des Plaines River near Brandon Lock. According to the survey responses, about 30 percent of all recreation vessels in the Chicago area are less than 28-feet.

IV. SUMMARY

Alternatives	Impacts	Notes
No New Federal Action	None	Non-cargo vessels would continue current operations.
Non-Structural Control Technologies	Low	• Could require additional time/special license to operate in these environments. • May impact ability to harvest targeted fish species. • May be additional costs associated with the measures. • The net value of the recreational experience for tour boat passengers, recreational fishermen, and recreational boaters may decrease.
Mid-System Control Technologies without a Buffer Zone – "Flow Bypass Alternative"	Low	• Two new locks and two electronic barriers. • The new locks will require additional time for vessels attempting the "loop". • Passenger and government vessels will experience additional costs and delay when taking a trip through the location of the new locks. • Vessels under 20-feet will not be able to pass through the electronic barriers.
Technology Alternatives with a Buffer Zone – "CAWS Buffer Zone Alternative"	Medium	• Two new physical barriers and three electronic barriers are added. • Police/fire/other government vessels will need to incur additional expense in order to maintain the same level of service. The potential impact to emergency response vessels represents a safety issue. • Additional effects to vessels that must travel through electric barriers. • There will be additional cost to non-cargo lock users as they attempt to maintain previous usage, find alternate means of reaching their destination, and/or find alternate destinations for boat repairs, fishing, or other recreation activity. • The physical barriers may increase the frequency of high water events on the CAWS. • The value of the recreation experience for tour boat passengers, recreational fishermen, and recreational boaters may decrease. Vessels under 20-feet will not be able to pass through the electronic barriers.

Alternatives	Impacts	Notes
Lakefront Hydrologic Separation	High	• Four physical barriers are added. • High impacts to all lock users. • Passenger/non-cargo vessels currently utilizing the locks would be severely impacted. • Police/fire/other government vessels will need to incur additional expense in order to maintain the same level of service. Emergency response vessels will be impacted which is a safety issue. • There will be additional cost to non-cargo lock users as they attempt to maintain previous usage, find alternate means of reaching their destination, and/or find alternate destinations for boat repairs, fishing, or other recreation activity. • The physical barriers may increase the frequency of high water events on the CAWS. • The value of the recreation experience for tour boat passengers, recreational fishermen, and recreational boaters may decrease.
Mid-System Hydrologic Separation	Medium	• Two new physical barriers. • Impacts vessels attempting to do the "loop". • Some government agencies may have to duplicate some services if their jurisdictions extend beyond the barriers. • Also passenger vessels and government vessels may be affected by additional high water events.
Hybrid Mid-System Separation Cal-Sag Open Control Technologies with a Buffer Zone – "Hybrid Cal-Sag Open Alternative"	Medium	• Three physical barriers and two electronic barriers. • Impacts vessels attempting to do the "loop. • Additional effects to vessels that must travel through electric barriers. • Some government agencies may have to duplicate services if their jurisdictions extend beyond the barriers. • Also passenger vessels and government vessels may be affected by additional high water events. • Vessels under 20-feet will not be able to pass through the electronic barriers.

Alternatives	Impacts	Notes
Hybrid Mid-System Separation CSSC Open Control Technologies with a Buffer Zone – “Hybrid CSSC Open Alternative”	Medium	• One physical barrier and two electronic barriers. • Impacts vessels attempting to do the “loop. • Additional effects to vessels that must travel through electric barriers. • Some government agencies may have to duplicate services if their jurisdictions extend beyond the barriers. • Also passenger vessels and government vessels may be affected by additional high water events. • Vessels under 20-feet will not be able to pass through the electronic barriers.

Note: High, medium, and low impacts are based on professional judgment and the relative number of non-cargo lock users who might be impacted.

ATTACHMENT 8

FLOOD RISK MANAGEMENT

Flood Risk Management Economic Study:

Baseline and Future Conditions

September 2013

U.S. Army Corps
of Engineers
Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

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EXECUTIVE SUMMARY:

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) authorizes the Secretary to evaluate a range of options and technologies to prevent the transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River basins by aquatic pathways. In order to accomplish this task, the GLMRIS Project Delivery Team developed an array of alternatives that can be assembled into two categories: (1) the future without-project (FWOP) condition – the case where no new Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins, and (2) the future with-project (FWP) condition – the case where new Federal action is taken to prevent the transfer of ANS between the basins.

In order to fully describe the impacts associated with the implementation of a GLMRIS project, a flood risk management economic assessment was completed. This assessment addresses the impacts of the various alternatives considered in GLMRIS on flooding in the Chicagoland area. The area of interest (AOI) encompasses over 200 square miles of the Chicago metropolitan area, including the Chicago River, the Chicago Sanitary and Ship Canal (CSSC), the Calumet-Saganashkee (Cal-Sag) Channel, the Calumet River, and portions of the Grand and Little Calumet Rivers. The area also includes sewer basins with outlets to the Chicago area waterways that could be impacted by a hydrologic separation alternative. This study analyzes physical damages to buildings and their contents, as well as other types of infrastructure such as rail yards, power equipment, etc.

The flood damages associated with the potential implementation of each GLMRIS alternative plan, measured via expected annual damage (EAD), is summarized in Table 1. An estimate of EAD was calculated for the base year (2017 – when McCook Reservoir, phase one, is expected to become operational), and the future year (2029 – when stage two of the McCook Reservoir is expected to become operational). The EAD in the base year is the amount of damage that is expected to occur on an annual basis between the years 2017 and 2029. EAD in the future year is the amount of damage expected to occur on an annual basis between the years 2029 and 2067 (the final year of the 50-year project evaluation period). Table 1 exhibits the mean EAD associated with each alternative plan considered in GLMRIS, to include both the FWOP (i.e., the no new Federal action alternative plan) and the FWP conditions.

Table 1: Summary of Key Findings

GLMRIS Alternative Plan	Mean Expected Annual Damage (EAD) ($1,000s)	
	Equivalent Annual	Equiv. Net[1] Change
No New Federal Action	$232,200	$0
Non-Structural	$232,200	$0
Control Technology Without a Buffer Zone – Flow Bypass	$233,300	$1,100
Control Technology With a Buffer Zone	$232,770	$570
Lakefront Hydrologic Separation	$298,100	$65,900
Mid-System Hydrologic Separation	$233,300	$1,100
Hybrid – Mid System Separation Cal-Sag Open[2]	$260,200	$28,000
Hybrid – Mid System Separation CSSC Open[3]	$205,800	-$26,400

1. This column displays the equivalent expected annual damages (EEAD) associated with the implementation of each GLMRIS alternative plan. In the without-project conditions, damages are expected to occur to various structures. However, the implementation of a GLMRIS plan will either increase the total damages in the Chicago area (represented as positive values in this column) or decrease total damages in the Chicago area (negative value). Specifically, the values presented represent the difference (i.e., net change) between the without-project condition (EEAD of $232.2 million) and the with-project conditions. *Positive values represent induced damages in the Chicago area. Negative values represent a reduction in overall damages in the Chicago area.
2. Cal-Sag: Calumet Saganashkee Channel
3. CSSC: Chicago Sanitary and Ship Canal

GLMRIS BACKGROUND INFORMATION:

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River basins by aquatic pathways. An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (FY13). As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and

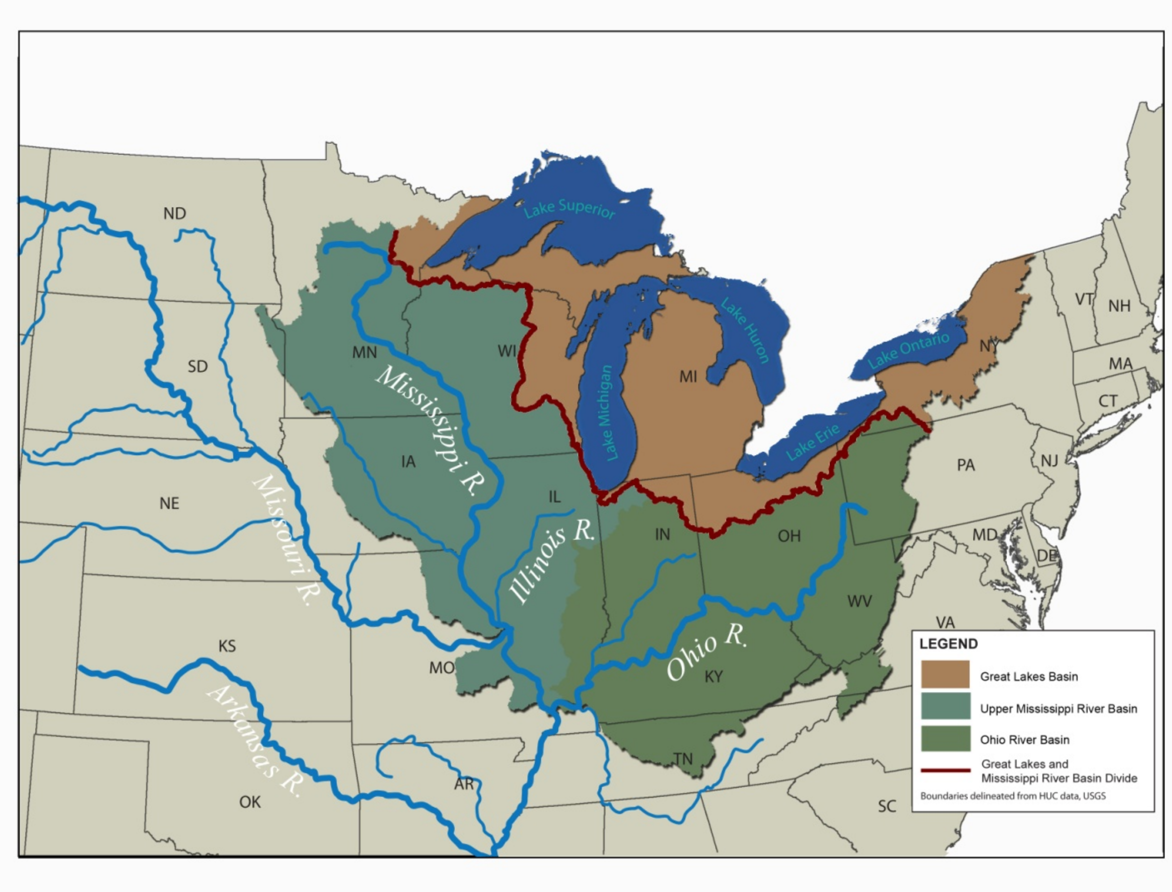
Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

GLMRIS STUDY AREA

The GLMRIS study area includes portions of the Great Lakes, Mississippi River, and Ohio River Basins that fall within the United States.

Figure 1: GLMRIS Study Area Map

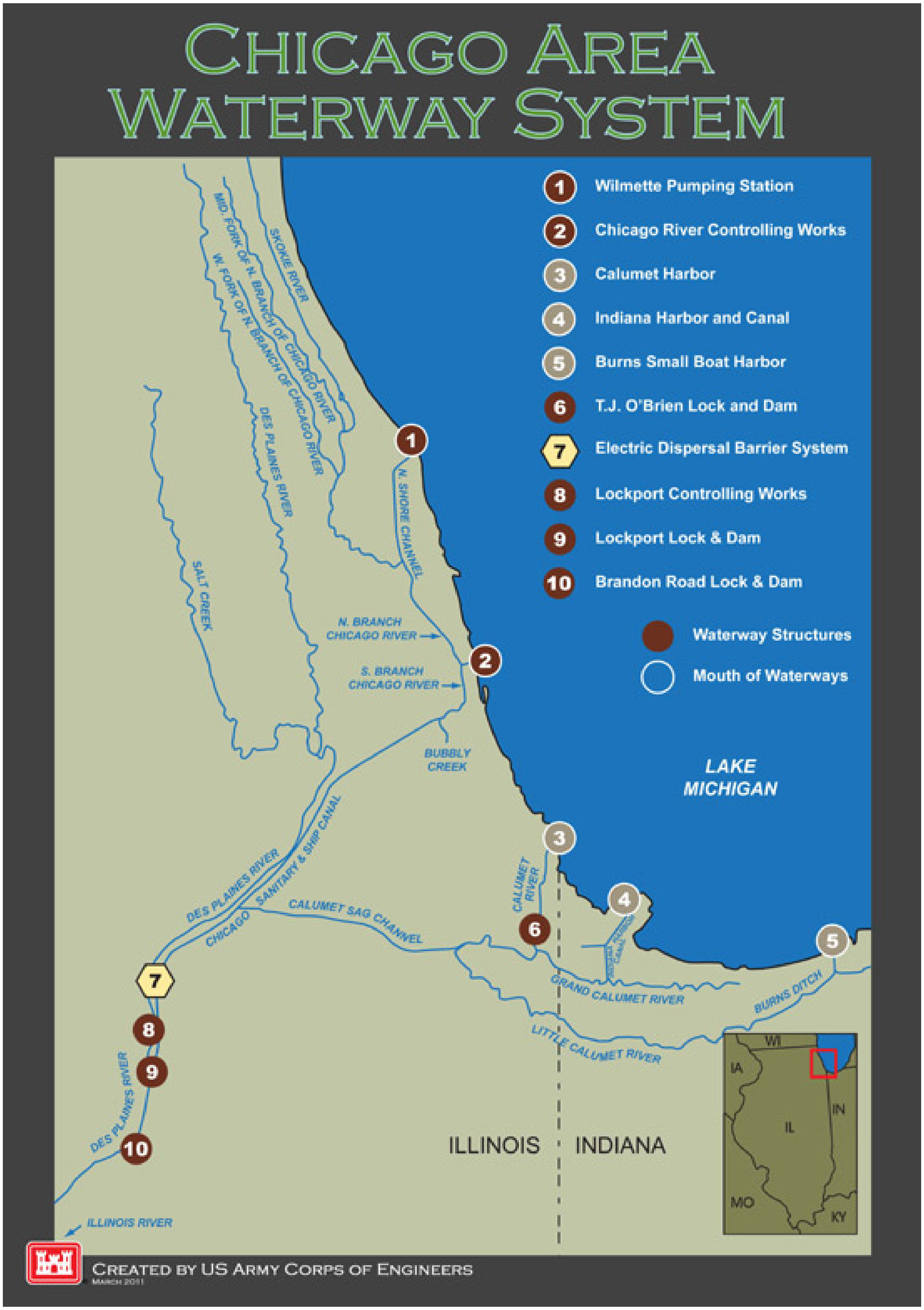


Potential aquatic pathways between the Great Lakes, Mississippi River, and Ohio River Basins exist along the basins' shared boundary (illustrated in *Figure 1: GLMRIS Study Area Map*). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi and Ohio River Basins (green shaded areas) and the Great Lakes Basin (brown shaded area).

Focus Area I, the Chicago Area Waterway System (CAWS), as shown in Figure 2, is the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins and, therefore, poses the greatest potential risk of aquatic nuisance species (ANS) transfer between the basins, via an aquatic pathway.

Figure 2: Chicago Area Waterway System (CAWS)



NAVIGATION AND ECONOMICS PRODUCT DELIVERY TEAM:

In support of GLMRIS, the Navigation and Economics Product Delivery Team (PDT) was formed. The PDT was tasked with assessing the current value of economic activities within the GLRMIS detailed study area that *could* change with the implementation (FWP condition) or lack of implementation (FWOP condition) of a GLMRIS project. The PDT is comprised of several sub-teams, each of which focuses on a specific economic activity within the GLRMIS study area. These categories include:

Navigation Related Economic Categories

- Commercial Cargo
- Non-Cargo Related Navigation

Other Related Economic Categories

- Flood Risk Management
- Hydropower
- Commercial and Recreational Fishery
- Water Quality
- Water Supply
- Regional Economics

Flood Risk Management Team:

In support of the Navigation and Economics PDT, the Flood Risk Management (FRM) Team was formed. The purpose of this FRM economic study is to characterize flood risk impacts associated with the implementation of the range of alternative plans considered in GLMRIS. Additional flood risk will be characterized by the increase in damages for different flood events using risk and uncertainty, as well as in terms of expected annual damage (EAD). This analysis followed Engineering Regulation (ER) 1105-2-100 and other appropriate guidelines for analyzing National Economic Development (NED) benefits and costs. However, this FRM analysis differs from typical USACE FRM feasibility studies in that it was not an effort to develop benefit-to-cost ratios (BCRs).

INTRODUCTION

GLMRIS authorizes the Secretary to evaluate a range of ANS controls to prevent the transfer of ANS between the Great Lakes and Mississippi River basins via aquatic pathways. As part of this study, USACE is conducting a detailed analysis of various ANS controls, including hydrologic separation (preventing water from flowing between the two basins).

In the case of hydrologic separation, the City of Chicago would be expected to see higher flood stages during rain events. Under normal conditions, water flows from Lake Michigan through the CAWS and into the Des Plaines River. Occasionally, large rainfall events require the Chicago Controlling Works and Lock (Chicago Lock), the T.J. O'Brien Lock and Dam, and the Wilmette Pumping Station to be opened to allow water to flow from the CAWS into Lake Michigan, at the same time it is flowing out to the Des Plaines River. A hydrologic separation would prevent water from flowing out to Lake Michigan or towards the Des Plaines River, depending on the location of the separation, and would thereby increase flood stages. This potential for increased flood stages required further investigation to quantify the impacts of any possible induced flooding, resulting from hydrologic separation.

This *Flood Risk Management Economic Analysis – Baseline and Future Conditions* report provides information on the methods, details, and results of the flood damage analysis conducted in support of GLMRIS.

Study Area of Interest

The FRM area of interest (AOI) for this analysis is the portion of the Chicago metropolitan area that would be adversely impacted by the implementation of a hydrologic separation measure. Since modeling of separation alternatives was not complete at the outset of this study, it was necessary to estimate the area of interest boundaries. In order to ensure that enough data was collected, the AOI boundaries were drawn larger than would be necessary for a typical study. The AOI is divided into two mutually exclusive areas, the Overland AOI (the area at risk of direct flooding from a river or channel) and the Sewer AOI (the area at risk of flooding from sewer backups caused by overland flooding).

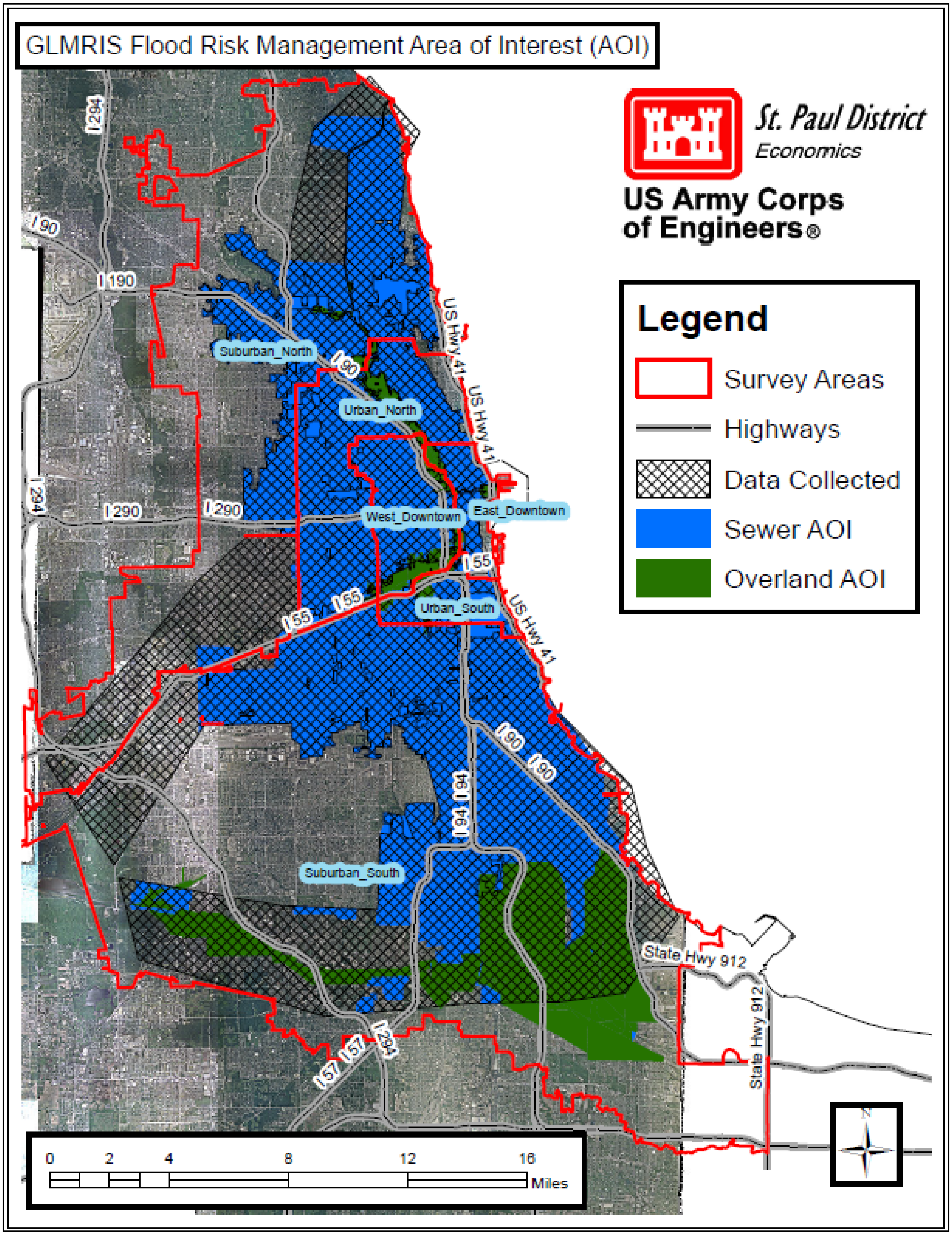
The Overland AOI was delineated using a flood model developed by the USACE – Chicago District. The 0.2% (500 year) chance exceedence flood event was analyzed with barriers placed at the Chicago Lock and at T.J. O'Brien Lock and Dam in order to simulate hydrologic separation scenarios. The outline of the 0.2% flood with separation at Chicago Lock and T.J. O'Brien was thought to be the maximum area that would be adversely impacted by a separation alternative. Data was collected at a high level of detail for the Overland AOI due to the high damages associated with overland flooding and the relatively small size of this area.

The Sewer AOI is the area that is not directly flooded by surface runoff, but may be subject to sewer backup flooding. The sanitary and storm sewer system in the Chicago Metro normally drains to treatment facilities, but during large rainfall events (usually larger than a 20%, or 5 year storm) both the sanitary and storm sewers discharge directly into the CAWS. Therefore, a stage increase on the CAWS has a tendency to backup the sewer system.

In order to delineate the Sewer AOI, an existing sewer runoff model was obtained from the City of Chicago. The 500 year rainfall event was analyzed using the sewer runoff model for two sets of downstream conditions on the CAWS, first for normal lock operations (existing conditions), and second for separation at Chicago and T.J. O'Brien (same conditions as the Overland AOI). If a sewer basin saw an increase in stage of more than 0.05 ft due to the separation, that basin was counted as part of the Sewer AOI. Since not all sewer basins were accounted for in the sewer runoff model, the boundaries of the Sewer AOI were extended considerably to accommodate any future changes to the sewer runoff model. Due to the size of the Sewer AOI, and the fact that flooding was for the most part limited to basements, data was collected at a lower level of detail in this area.

Figure 3 displays the Sewer and Overland AOIs. The overall AOI comprises the entire city of Chicago, and several outlying communities, including the northern part of Wilmette, the southern portion of Calumet, and the western portion of Lockport.

Figure 3: Area of Interest



ECONOMIC ANALYSIS OF FLOOD RISK MANAGEMENT

Measuring Flood Risk – Key Terminology

When evaluating the effects of a civil works project, it is important to consider the long term impact, as well as the immediate consequences. This study pertains to the damages associated with flooding, not only for the present conditions, but for conditions that are expected to occur in the foreseeable future. The period of analysis for this study is 50 years (per ER 1105-2-100). Given the length of time being analyzed, it is important to compare dollar amounts on a consistent basis. Therefore, dollars are presented as real dollars, at the October 2012 price level. In order to account for the time value of money (this is distinct from the concept of price level), values of future dollars are discounted to a common point in time (the "base year"). The base year of the period of analysis is the first year that any of the alternatives considered for federal action would have an effect; for GLMRIS, 2017 represents the base year (this is the earliest date any GLMRIS alternative could be implemented). Since damages can change from one time period to the next, it is helpful to express them as annual values, rather than one lump sum. Some definitions of key measures of flood risk are presented below.

<u>Average Annual Damage (AAD)</u>

When evaluating flood damages, it is useful to relate the amount of damage to the water surface elevation in the river. Therefore, each water surface elevation is related to a certain amount flow, and each flow is related to a frequency of exceedance. Therefore, each level of damage can be associated with a frequency, resulting in a damage-frequency curve. Average annual damage (AAD) is defined as the area under the damage-frequency curve.

Typically, AAD does not incorporate uncertainty in flows, water surface elevations, or damages; however, the term is often confused with expected annual damages. For the purposes of this report, AAD will represent the deterministic area under the damage-frequency curve (with no uncertainty).

AAD represents the average amount of damage that would occur in *any given year*, if *that year* were repeated infinitely many times. The average value is based on the frequency of recurrence for each flood event. No other probabilistic variables are factored into the calculation of AAD.
AAD can vary by year, depending on changes in hydraulic, hydrologic, and economic conditions.

<u>Expected Annual Damage (EAD)</u>

Expected annual damage (EAD) takes into account uncertainties in stage-damage, stage-flow, and flow-frequency relationships. EAD is the mean value of AAD, given the uncertainty associated with each damage, stage, and flow relationship. AAD and EAD are often confused, due to the similarity in the terms "average" and "expected." For the purposes of this report, expected annual damages refers to the probabilistic definition offered above. EAD is typically computed using HEC-FDA version 1.2.5a, which utilizes the Monte Carlo method for evaluating mean values.

Expected annual damage represents the mean amount of damage that would occur in *any given year*, if *that year* were repeated infinitely many times over. The mean value is based on the frequency of recurrence for each flood event, as well as the uncertainties in stage-damage, stage-flow, and flow-frequency relationships.

Equivalent Expected Annual Damage (EEAD)

Throughout the period of analysis, EAD can vary if there are changes in hydraulic, hydrologic, or economic conditions. If each year is taken in sequence from the beginning of the period of analysis to the end, the result is a series or "stream" of EAD values. Equivalent Expected Annual Damage (EEAD) is the equivalent annual value of the EAD stream. It is computed by amortizing the net present value of the EAD stream. Equivalent values are not necessarily probabilistic values, and depend only on the discount rate, the number of years in the period of analysis, and the stream of values. The only uncertainties accounted for in EEAD are those already accounted for in EAD.

EEAD values do not vary by year, and serve as a means of comparing damages incurred at different time periods in a consistent manner. Based on time value of money, the EEAD value is "equivalent" to the "stream" of EAD values that occur at different times throughout the period of analysis. From an investment perspective, someone paying out an annuity equal to the EEAD value through the 50 year period of analysis would be no better and no worse off if he or she paid the EAD stream instead.

Overview of Method of Analysis

Eight alternative plans – including the future without-project (FWOP) and future with-project (FWP) conditions – were developed for GLMRIS, which consist of the following:

1. No New Federal Action (FWOP Condition)
2. Non-Structural
3. Control Technology Without a Buffer Zone – Flow Bypass
4. Control Technology With a Buffer Zone
5. Lakefront Hydrologic Separation
6. Mid-System Hydrologic Separation
7. Hybrid – Mid System Separation Cal-Sag Open
8. Hybrid – Mid System Separation CSSC Open

Each of these alternative plans has implications for flood damages in the Chicagoland area, and for some of the alternative plans, the northwestern portion of Indiana.

During the GLMRIS flood risk management economic study, only two of the FWP condition alternative plans were developed – the Lakefront and Mid-System Hydrologic Separation plans. Estimates of EEAD were developed for these alternative plans, as well the No New Federal

Action plan (FWOP condition). As displayed in the upcoming portions of this document, a combination of overland and sewer flood surveys, hydrology and hydraulics modeling, and the utilization of the Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) computer program, yielded estimates of EEAD for these three alternative plans for the Chicagoland area.

The remaining five FWP condition alternative plans were still in the process of being developed. Therefore, the associated EEAD for these alternative plans were estimated based on delineating certain regions of the remaining plans that would exhibit similar damages in the Chicagoland area as either the Lakefront or Mid-System Hydrologic Separation plans.

A physical barrier would be constructed on the Little Calumet River (LCR) in 3 of the alternative plans considered in GLMRIS, to include the: (1) Control Technology With a Buffer Zone, (2) Lakefront Hydrologic Separation, and (3) Hybrid – Mid System Separation Cal-Sag Open plans. Since the original HEC-FDA model, utilized to estimate the flooding impacts within the Chicagoland area of the alternative plans considered in GLMRIS, did not include the portion of the LCR that lies east of Hart Ditch within Indiana, additional methods were employed to estimate equivalent average annual damages (EEAD) to this area.

A HEC-FDA model was developed in Fiscal Year 2011 (FY11) for the LCR Limited Reevaluation Report (LRR). This served as the model to estimate damages in Indiana associated with the three aforementioned GLMRIS alternative plans.

The summation of EEAD for the Chicagoland area and northwest portion of Indiana yielded the total EEAD estimate for each GLMRIS alternative plan.

Methods for Estimating EEAD

Without-Project Condition

Existing and Future Hydraulic and Hydrologic Conditions

The watershed divide runs through the study area, between the Des Plaines River and Lake Michigan, and through the Chicago Metropolitan area. The Lake Michigan drainage area (which is a part of the Saint Lawrence River Basin) sits on the North and East side of this divide, while the Des Plaines River drainage area (part of the Mississippi River Basin) is to the South and West of the divide. However, the study area is situated at a saddle point along the divide, which facilitated the construction of man-made channels between the Lake and the Des Plaines River. These channels, most notably the Chicago Sanitary and Shipping Canal (CSSC) and the Calumet-Saganashkee (Cal-Sag) Channel, along with portions of the Chicago River, the Calumet River, and the Des Plaines River are collectively referred to as the Chicago Area Waterway System (CAWS). These channels allow barge and boat traffic to pass from the Great Lakes to the Mississippi River, and also serve as an integral part of the City of Chicago sewer system.

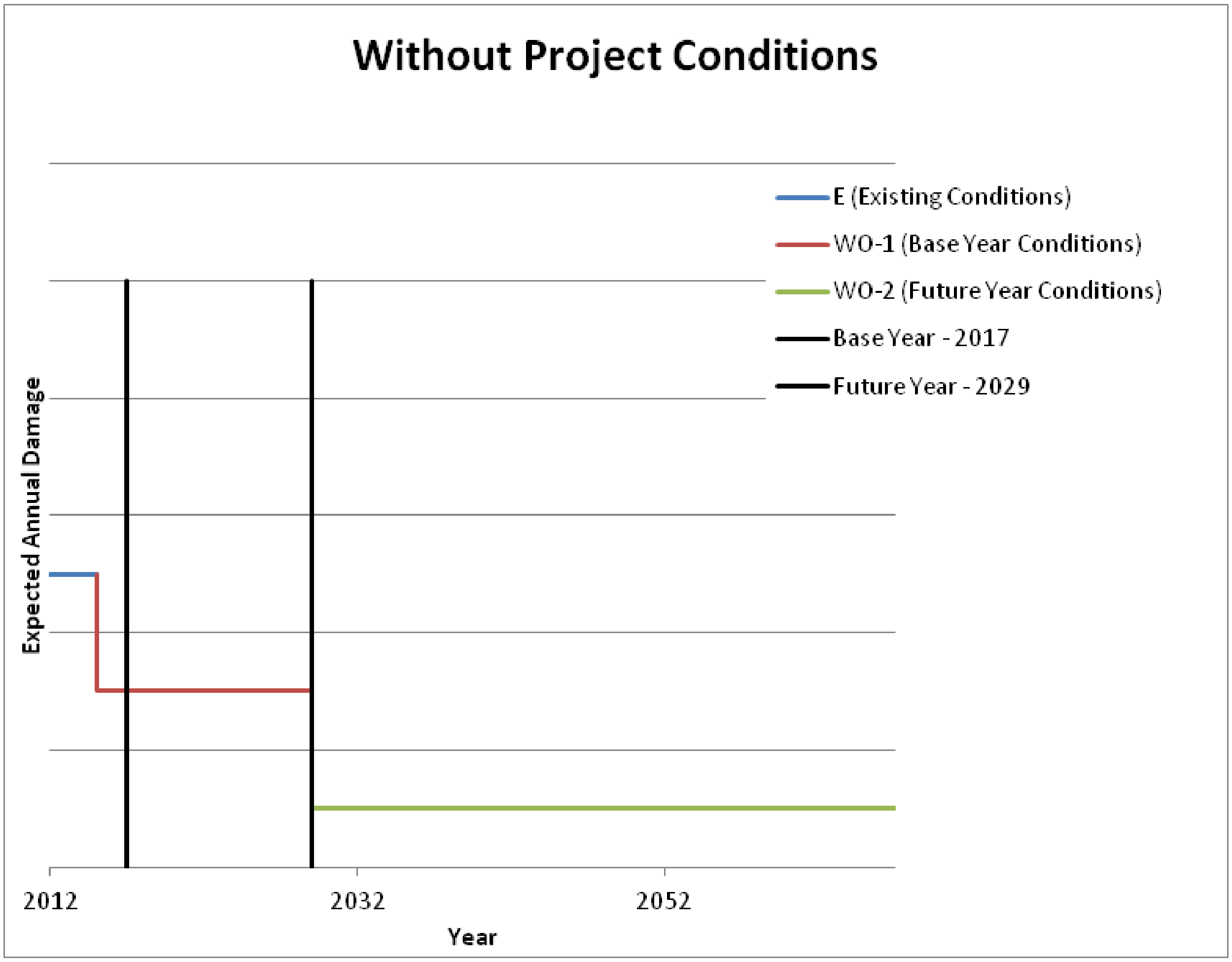
Under normal conditions, water flows at a minimal rate from Lake Michigan, through the CAWS, and into the Des Plaines River (a tributary of the Illinois River). The flow of water is controlled by a set of structures at or near the lakefront, including the Chicago Lock located in Downtown Chicago, the T.J O’Brien Lock and Dam on the Calumet River, and the Wilmette

Pumping Station in Wilmette. The Lockport Lock and Dam in Lockport, IL is also an important structure in the regulation of flow in the CAWS. The water surface elevation in the CAWS is normally very flat throughout, with a slight drop in elevation from Chicago Controlling Works to Lockport. During heavy rainfall events the various locks and pumps on the CAWS can be operated so that water flows out either side of the CAWS and discharges into the Lake and the Des Plaines River. This alleviates flooding in the system and facilitates drainage of the sanitary and storm sewer system.

The City of Chicago, along with the Metropolitan Water Reclamation District (MWRD) and the U.S. Army Corps of Engineers, is in the process of constructing the Tunnel and Reservoir Plan (TARP) to reduce flood risk in the Metro. The plan consists of a series of large tunnels over three hundred feet below the city's surface that carry storm and sewer water to two primary reservoirs, Thornton and McCook. The Thornton and McCook reservoirs are large open quarries that are being converted to reservoirs in phases, as mining operations continue. The subsurface tunnel system has largely been completed, and it is expected that the Thornton and part of the McCook (stage I) reservoir will be operational by the year 2015. The remainder of the McCook reservoir (stage II) is expected to be operational by 2029.

The study area will see reductions in flood risk as each phase of TARP is completed. The GLMRIS Project Delivery Team (PDT) will evaluate flood risk at key points in time in order to obtain an estimate of flood risk throughout the period of analysis (years 2017 through 2066). The base year for GLMRIS is 2017, after Thornton and McCook stage I reservoirs are complete. The last year in the period of analysis is 2066 (50 years). The analysis will need to reflect a change in flood risk for the completion of McCook stage II reservoir, in 2029. Figure 4 below depicts how flood risk (as measured by expected annual damage) is expected to change throughout the study period. The base year conditions include the Thornton and McCook stage I reservoirs, while the future year conditions include the Thornton, McCook stage I and McCook stage II reservoirs. The existing conditions do not include any reservoirs, but do include the tunnel system (TARP), which when complete will have the capacity to store 17.5 billion gallons of water. The graph is intended to show the general slope and direction of change, but not the magnitude of flood risk.

Figure 4 Without Project Conditions at a Glance



The Hydrology and Hydraulics (H&H) Appendix describes the Chicago Areas Waterway System (CAWS), H&H conditions, and H&H models prepared for this effort in more detail.

(1) Structure Inventory Methodology

The structure inventory was created using the Cook County Assessor's parcel information as the base. The assessor provided USACE with a Geographic Information System (GIS) shapefile with the spatial location of all parcels within the project area. The data included parcel number, improvement value, and improvement class. The improvement class is a description of the use of the parcel, and if applicable, the type of building on the parcel. It also categorizes parcels into groups that are appraised and taxed similarly. The residential classes included more detailed data about the building on the parcel, including type of home, square footage, basement square footage and level of finish, number of bathrooms and number of fixtures. A list of the improvement classes and their descriptions can be found in Exhibit A.

While the assessor information was a reliable source of information; it was complex, as some buildings were prorated over many parcels and some parcels contained numerous buildings.

Additionally, there was no information on exempt properties (properties that are not subject to county property taxes), and nothing to indicate whether a building still existed or not. Pre-processing was required prior to utilizing the data.

First, the parcel outlines were converted to points. All properties were reviewed using aerial imagery and topography obtained from LiDAR (Light Detection and Ranging), and the point was placed directly on top of the structure. Additional points were added where necessary. The improvement values for each parcel were converted to the appraised market value, using the factors associated with each improvement class (Exhibit B). The market values were distributed to each point in the structure database to adjust for cases where a parcel contained numerous buildings, or where a building was prorated over many parcels. Table 2 summarizes the resulting structure database for the combined Sewer and Overland AOI's. The initial set of structures for the combined AOI's included 503,501 structures with a total assessed value of over $194 billion.

Table 2 Initial Structure Inventory

Property Type	Total Assessed Value	Number of Structures	Average Structure Value
Exempt	$1,855,636,732	11,127	$166,768.83
Residential	$61,110,764,098	280,157	$218,130.42
Multi	$80,997,228,404	180,721	$448,189.35
Commercial	$41,513,165,925	21,880	$1,897,311.06
Industrial	$8,601,616,104	9,616	$894,510.83
Total	**$194,078,411,261**	**503,501**	**$385,457.85**

Further, assessor data did not include the following data: information pertaining to ground elevation, foundation height, susceptibility to flood damage (depth-damage functions), and depreciated replacement value.

The assessor's data contained enough information about structure type and basement finish to fit all residential structures and most multi-family structures to a depth-damage function from EGM 04-01. Non-residential depth-damage functions were obtained from the U.S. Army Corps of Engineers Institute for Water Resources' (IWR) *Draft Report Expert Opinion Elicitation for the Development of Nonresidential Depth-Damage Functions*. Most of the project area is not expected to see much flooding above ground. Rather, flooding is expected in basements. The assessor's data did not contain information about basements for non-residential structures, and the IWR depth-damage curves do not include damages to basements. Extensive field work was completed in order to obtain the necessary depth damage, depreciated replacement value, and elevation information.

For the overland flooding area of interest (AOI), which consisted of 11,000 structures tightly grouped along the CAWS, a windshield survey was completed for 100% of structures, flagging unique structures for depth-damage interviews. The Overland AOI was later expanded as additional hydraulic modeling became available to include over 32,000 structures. The information collected (for the initial 11,000 structures) included a visual estimation of foundation height, construction type and material, number of stories, structure condition, and the presence of a basement.

The Sewer AOI consists of nearly 500,000 structures covering most of the Chicagoland area. Since flooding for this area is caused by sewer backup and largely limited to basements, it was determined that the most critical data needed was the susceptibility to damage for non-residential structures. Being such a large area, a sampling technique was deemed the best method. A random sample was used to identify interview candidates. The random sample was augmented to make the best use of time and resources. Specifically, if a structure was sampled randomly, the interviewer would also try to find other willing candidates within walking range. This introduced a bias towards structures in dense areas, however the results were broken out by density (downtown, outside downtown) to account for this bias. The interviews in the sewer AOI were focused on the commercial, industrial, and exempt structures, while interviews in the overland AOI were focused on unique structures.

Detailed methodologies and results of the data collection efforts are summarized in the following sections.

(2) Depth-Damage Relationships with Uncertainty

A depth-damage relationship defines how much damage occurs at a given building for each depth of flooding. The deeper the flooding is, the higher the damage will be. These relationships are usually expressed as a percent of total structure value, which makes it easy to use one damage curve for many structures, as long as they fall within the same basic category. Table 3 through Table 6 display the depth-damage functions used for GLMRIS. Some of these were developed specifically for this study.

Table 3 Depth-Damage Functions for GLMRIS from EGM

Damage Function	Description	Category
Oreswbsmt	One Story, With Basement	Residential
Oreswoutbsmt	One Story, No Basement	Residential
Splitwbsmt	Split Level, With Basement	Residential
Splitwoutbsmt	Split Level, No Basement	Residential
Treswbsmt	Two Or More Stories, With Basement	Residential
Treswoutbsmt	Two Or More Stories, No Basement	Residential

Table 4 Depth-Damage Functions for GLMRIS from Fargo-Moorhead Study

Damage Function	Description	Category
Bilevel	Bilevel home	Residential
COM-ANTIQ	Antique store	Commercial
COM-BAKE	Bakeries, quick shop (?)	Commercial
COM-BARB	Barber and beauty shops	Commercial
COM-BOWL	Bowling alley	Commercial
COM-DEAL	Auto dealer	Commercial
COM-FLOR	Florist	Commercial
COM-FUNE	Funeral home	Commercial
COM-HALL	Community hall - VFW, Legion, etc.	Commercial
COM-HDWR	Hardware, paint, sporting goods, auto parts stores	Commercial
COM-JEWEL	Jewelry store	Commercial
COM-LAUND	Laundromat, cleaners	Commercial
COM-LIQUO	Liquor store, tavern	Commercial
COM-MALL	Department stores - Sears, Penney's, etc.	Commercial
COM-NEWS	Newspaper office	Commercial
COM-THEAT	Small theater	Commercial
IND-AGSTOR	Agricultural storage buildings	Industrial
IND-SHED	Machine Shed - Unsulated Pole Building or quonset	Industrial

Table 5 Depth-Damage Functions for GLMRIS from IWR Draft Non-Residential Paper

Damage Function	Description	Category
COM-APT	Apartment building	Commercial
COM-CLOTH	Store, clothing retail	Commercial
COM-CONV	Store, convenience	Commercial
COM-ELEC	Store, electronic retail	Commercial
COM-FFR	Restaurant, fast food	Commercial
COM-FURN	Store, furniture	Commercial
COM-GROC	Store, grocery /supermarket	Commercial
COM-HOSP	Hospital	Commercial
COM-HTL	Hotel/motels	Commercial
COM-MED	Medical, dental office	Commercial
COM-OFF	Office building	Commercial
COM-REST	Restaurant, traditional sit-down	Commercial
COM-SERV	Service related establishment, contractor/auto repair	Commercial
IND-LT	Light industrial/fabrication shop	Industrial
IND-WH	Warehouse, non-refrigerated	Industrial
IND-WHR	Warehouse, refrigerated	Industrial
PUB-CF	Correctional facility/jail	Public
PUB-PS	Protective services – fire/rescue services	Public
PUB-REC	Recreation, fitness center	Public
PUB-RF	Religious facility	Public
PUB-SCH	School	Public

Table 6 Depth-Damage Functions for GLMRIS from Data Collection

Damage Function	Description	Category
COM-APT-ED5	Apartment building , with basement, 5 stories or less, downtown	Commercial
COM-APT-OD5	Apartment building , with basement, 5 stories or less, suburban	Commercial
COM-APT-Plus18	Apartment building , with basement, more than 18 stories	Commercial
COM-APT-Sixto18	Apartment building , with basement, 6 to 18 stories	Commercial
COM-ELEC-ED5	Store, electronic retail , with basement, 5 stories or less, downtown	Commercial
COM-ELEC-OD5	Store, electronic retail , with basement, 5 stories or less, suburban	Commercial
COM-ELEC-Plus18	Store, electronic retail , with basement, more than 18 stories	Commercial
COM-ELEC-Sixto18	Store, electronic retail , with basement, 6 to 18 stories	Commercial
COM-HTL-ED5	Hotel/motels , with basement, 5 stories or less, downtown	Commercial
COM-HTL-OD5	Hotel/motels , with basement, 5 stories or less, suburban	Commercial
COM-HTL-Plus18	Hotel/motels , with basement, more than 18 stories	Commercial
COM-HTL-Sixto18	Hotel/motels , with basement, 6 to 18 stories	Commercial
COM-OFF-ED5	Office building , with basement, 5 stories or less, downtown	Commercial
COM-OFF-OD5	Office building , with basement, 5 stories or less, suburban	Commercial
COM-OFF-Plus18	Office building , with basement, more than 18 stories	Commercial
COM-OFF-Sixto18	Office building , with basement, 6 to 18 stories	Commercial
IND-WH-ED5	Warehouse, non-refrigerated , with basement, 5 stories or less, downtown	Industrial
IND-WH-OD5	Warehouse, non-refrigerated , with basement, 5 stories or less, suburban	Industrial
IND-WH-Plus18	Warehouse, non-refrigerated , with basement, more than 18 stories	Industrial
IND-WH-Sixto18	Warehouse, non-refrigerated , with basement, 6 to 18 stories	Industrial
PUB-PS-ED5	Protective services – fire/rescue services , with basement, 5 stories or less, downtown	Public
PUB-PS-OD5	Protective services – fire/rescue services , with basement, 5 stories or less, suburban	Public
PUB-PS-Plus18	Protective services – fire/rescue services , with basement, more than 18 stories	Public
PUB-PS-Sixto18	Protective services – fire/rescue services , with basement, 6 to 18 stories	Public

Of the nearly 500,000 structures in the Sewer AOI, over 450,000 are residential or multi-family structures. These structures were assigned depth damage functions from Economic Guidance Memorandum 04-01 according to the data available through the County Assessor. Table 7 shows how the assessor data was translated to depth damage functions (occupancy types).

Table 7 Residential Assessor Class to Depth-Damage Function

Residential - Existing Generic Curves

Class Code	Basement	No Basement	Class Desc.	Class Code	Basement	No Basement	Class Desc.
236	Oreswbsmt	Oreswoutbsmt	Any residence located on a parcel used primarily forcommercial or industrial	208	Treswbsmt	Treswoutbsmt	Two or more story residence, up to 62 years of age, 3,801to 4,999 square
295	Treswbsmt	Treswoutbsmt	Individually owned townhome or row house up to 62 yearsof age	207	Treswbsmt	Treswoutbsmt	Two or more story residence, up to 62 years of age, up to2,000 square feet
210	Treswbsmt	Treswoutbsmt	Old style row house (town home), over 62 years of age	913	Treswbsmt	Treswoutbsmt	Two or three story apartment building, seven or
203	Oreswbsmt	Oreswoutbsmt	One Story Residence, any age, 1,000 to 1,800 square	313	Treswbsmt	Treswoutbsmt	Two or three story building seven or more units
204	Oreswbsmt	Oreswoutbsmt	One Story Residence, any age, 1,801 square feet and over	314	Treswbsmt	Treswoutbsmt	Two or three story non-fireproof building with corridorapartment or California type apartments,
202	Oreswbsmt	Oreswoutbsmt	One Story Residence, any age, up to 999 square feet	315	Treswbsmt	Treswoutbsmt	Two or three story non-fireproof corridor apartments orCalifornia type
225	Oreswbsmt	Oreswoutbsmt	Single room occupancy rental building	915	Treswbsmt	Treswoutbsmt	Two or three story non-fireproof corridor apartments, orCalifornia
234	Splitwbsmt	Splitwoutbsmt	Split level residence with a lower level below grade(ground level) all ages, all sizes	914	Treswbsmt	Treswoutbsmt	Two or three story non-fireproof court and corridorapartments or California type apartments,
209	Treswbsmt	Treswoutbsmt	Two or more story residence, any age, 5,000	211	Treswbsmt	Treswoutbsmt	Apartment building with 2 to 6 units, any age
205	Treswbsmt	Treswoutbsmt	Two or more story residence, over 62 years of age up to2,200 square feet	396	Treswbsmt	Treswoutbsmt	Rented modern row houses, seven or more units in a singledevelopment or one or more contiguous parcels in commonownership
206	Treswbsmt	Treswoutbsmt	Two or more story residence, over 62 years of age, 2,201 to 4,999 square feet	996	Treswbsmt	Treswoutbsmt	Rented modern row houses, seven or more units in a singledevelopment or one or more contiguous parcels in commonownership
278	Treswbsmt	Treswoutbsmt	Two or more story residence, up to 62 years of age, 2,001to 3,800 square	496	Treswbsmt	Treswoutbsmt	Not for profit rented modern row houses, seven or moreunits in a single

Since each structure in the overland AOI was surveyed in person, these were fitted directly to a depth-damage function in the field.

(3) Interviews for Sewer AOI

Since the focus of the flood damage analysis in the Sewer AOI was on damages from sewer backup, the presence of a basement was of particular importance. The Assessor's database contained sufficient information on residential structures to classify them as having a basement or not. There was no electronic data pertaining to basements for the 42,000 commercial, public and industrial (CIP) structures in the Sewer AOI. Furthermore, there are few depth-damage functions used by USACE that include basement damages for CIP occupancy types. This necessitated two data collection efforts for the sewer AOI: first, to determine which CIP structures have basements; and second, to determine the depth-damage relationship for CIP basements. As much as possible, these efforts were overlapped to minimize the amount of fieldwork necessary. There were three data collection tools utilized to obtain the information for basements:

- Windshield Surveys (916 surveyed)
- Phone Call Interviews (582 interviews)
- In-Person Interviews (212 interviews)

For windshield surveys and in-person interviews, the Sewer AOI was divided into grids. Each grid was assigned a number using a random number generator. Approximately 20 to 30 grids were selected from each survey area, based on the lowest random number seed. Field personnel were deployed to each selected grid, where they began to assess the targeted structures. If a structure did not have a basement, the field crew noted it and moved on. If a target structure had a basement and the owner was willing, an interview was obtained.

Exhibit E displays the standard interview form used for the survey. Most interviewees were not able to provide actual flood costs, since few facilities had been flooded in the past. This limitation is inherent to the study, since the alternatives being considered may induce flooding where it has not occurred before.

The interviews focused on determining physical damages to structures and contents, however some consideration was given to non-physical damages. Costs incurred from flooding were included in the damage estimate if they were a part of restoring the building to pre-flood conditions. Thus, if a component were upgraded as a result of a hypothetical flood, only the value of the pre-flood component was included. Table 8 exhibits the depth-damage portion of the interview form. The GLMRIS flood risk management economic study does not account for costs related to displacement of businesses and residents during flooding and cleanup. Depending on the level of flooding, some buildings may be unusable for many weeks or months. Costs associated with displacement include forgone business, temporary lodging or relocation of business, disruption of supply chain, and disruption to secondary businesses that rely on the affected business. Although these costs can be quite burdensome, quantifying these costs is impractical and beyond the scope of the flood risk management study.

Table 8 Sewer Interview Table

	Structure Damage ($)			Content Damage ($)			Emergency Preparation and Cleanup ($)		
Flood Depth/ Elevation (ft)	Low	Most Likely	High	Low	Most Likely	High	Low	Most Likely	High

The interview form was designed with the goal of ascertaining the level of uncertainty about flood damages. This was particularly important, since so few buildings have experienced flooding. The uncertainty was captured by asking for a high, medium (most likely), and low level of damage. The interviewee identified key depths where new damages would occur if the water got deeper. The cumulative damage associated with each depth was recorded for each level (high, medium, low). Taken together, the different levels of damage and the ascending depths are referred to as a trace. A trace is one possible depth-damage relationship that could occur in the building. Each column (structure high, structure low, etc.) represents one trace. Thus for 212 interviews, there are 1,908 traces (9 traces for each interview).

The water entry point for each structure was also discussed in each interview. Sewer water can back up into structures through the sewer connection, or at the first floor if sewage is flowing over the street level. Additional entry points were also investigated, such as coal shafts, etc. The point where the interviewee thought water was most likely to enter first was recorded as the beginning damage depth on the interview form. If the entry point was the building's sewer outlet, special consideration was given to back flow preventers, overhead rises, sloped sewer pipes, or any measure that would prevent sewer water from entering the structure.

The respondent was instructed to take a brief inventory of the basement and determine the cost of repair for each item that might get damaged. Most of the variation was determined by looking at each component, whether the respondent thought it would be damaged, and if so if it needed to be rebuilt or replaced. A flooded component could be rebuilt, replaced entirely, or not damaged. Most respondents stated that the depth of flooding did not change the rebuild or replacement costs, but rather the likelihood of whether it would need to be rebuilt or replaced. Once the appropriate high, medium and low level damage estimate was obtained for each component, the total damage was then summed across each depth for each trace.

Additional sources of uncertainty were found where floor and wall finishes or inventories were estimated on a square foot basis. In these cases the respondent was asked for a reasonable estimate of the square foot costs. For interviews where the respondent was not knowledgeable about costs, or where they were reluctant to give specific estimates, the interviewer would rely on component costs developed from building cost estimating software (Marshall, Swift & Boeck Commercial Estimator 7, 2012 Cost Index). The interviewer then applied a high and a low estimate to each component and reconstructed the interview based on this additional source of uncertainty, relying heavily on their first hand knowledge of the basement.

For the most part, the interviewee was familiar with the building's layout and the costs of repairing or replacing components. For those less familiar with the structure, the interviewer usually obtained this information by isolating components and asking for reasonable estimates. Every interview relied on both the professional judgment of the respondent and the interviewer. In cases where the respondent was not able to provide definitive answers, the interviewer was able to rely on their own experience and a visual inspection of the basement in order to complete the form.

Upon completion of the interview, each structure was assessed for a depreciated replacement value using Marshal Swift & Boeck software. The software output consists of a value based on the square footage, type of construction, construction materials, quality of construction, condition and use of structure.

A thorough quality control (QC) of each interview was conducted. This QC included the following steps:

- Ensure that flood depth ordinates are referenced to the first floor of structure.
- Review all depreciated replacement cost estimates a second time
- Investigate the source for any depreciated replacement costs per square foot less than \$100 or greater than \$400.
- Ensure that all traces start at the lowest basement floor and end at the first floor
- Ensure that lowest depth ordinate for each trace is associated with zero damages
- Ensure that damages are ascending or flat as depth increases for each trace
- Ensure that all depth ordinates are zero or less
- Review all traces where damage exceeds 100% of depreciated replacement value. In some cases this was appropriate, since content damage was considered, and the depreciated replacement cost estimates were run for the first floor and above only (basement finishes were not part of the Marshall & Swift analysis).
- Interpolate damages for missing depth ordinates for all traces. The interview obtained the "tripping" points where damages would increase. The interpolation ensured that each trace had an ordinate for every integer from the basement floor to zero ft.

(4) Regression Analysis

Once quality control for all data was complete, the traces were organized into different groups to generate a generic depth damage function that could be applied to the tens of thousands of structures that were not sampled. It was found that some inconsistency existed in the categorization of damage types. For instance, some facility managers included clean up costs in their estimates of structural repair, or were unable to provide a detailed breakdown. Therefore it was decided that the traces should be consolidated by summing the damage types across depths for each level (high, medium, low), resulting in a set of *total* damage traces (with a high, medium, and low for each depth). This provided greater consistency for all interviews. Figure 5 shows data points for all total damage traces. The highest depth ordinate for each trace was zero feet, while the lowest depth varied greatly. In order to protect the confidentially of the interviewee, only depths above -12 feet are shown.

Figure 5 Sample Data Plot - Sewer Interviews

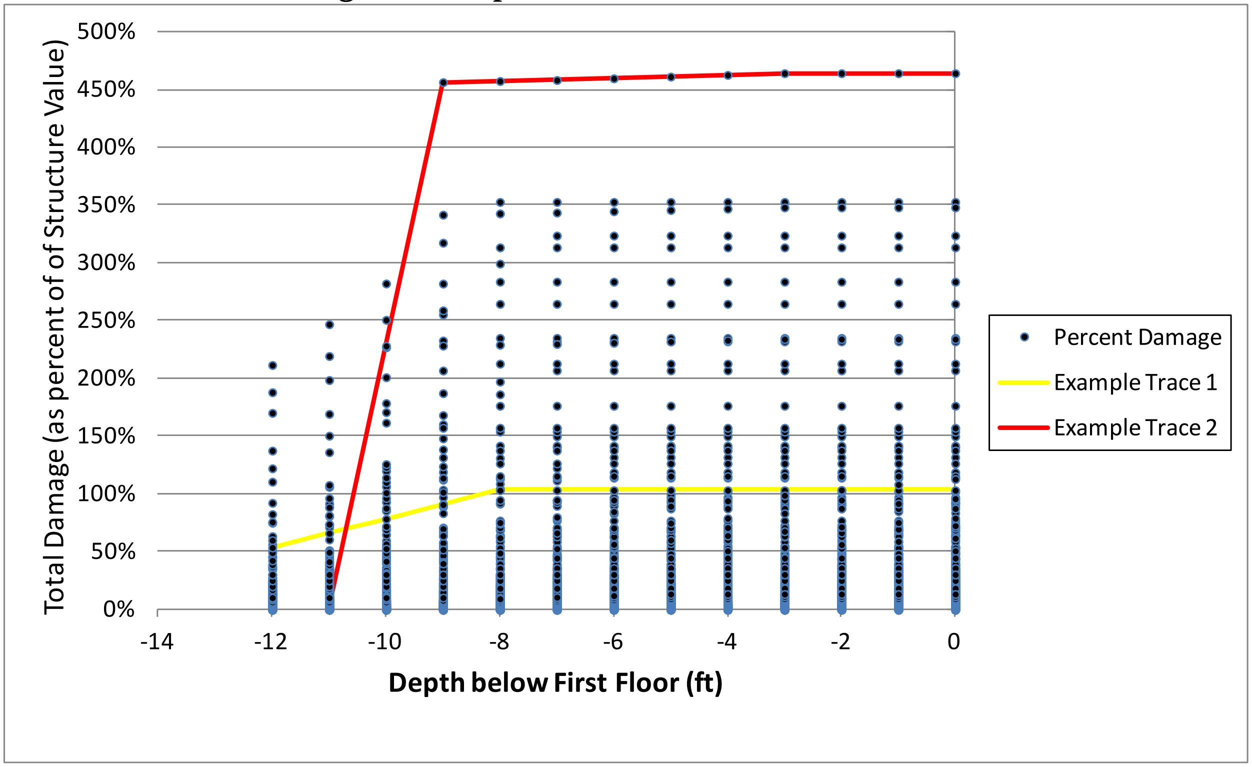
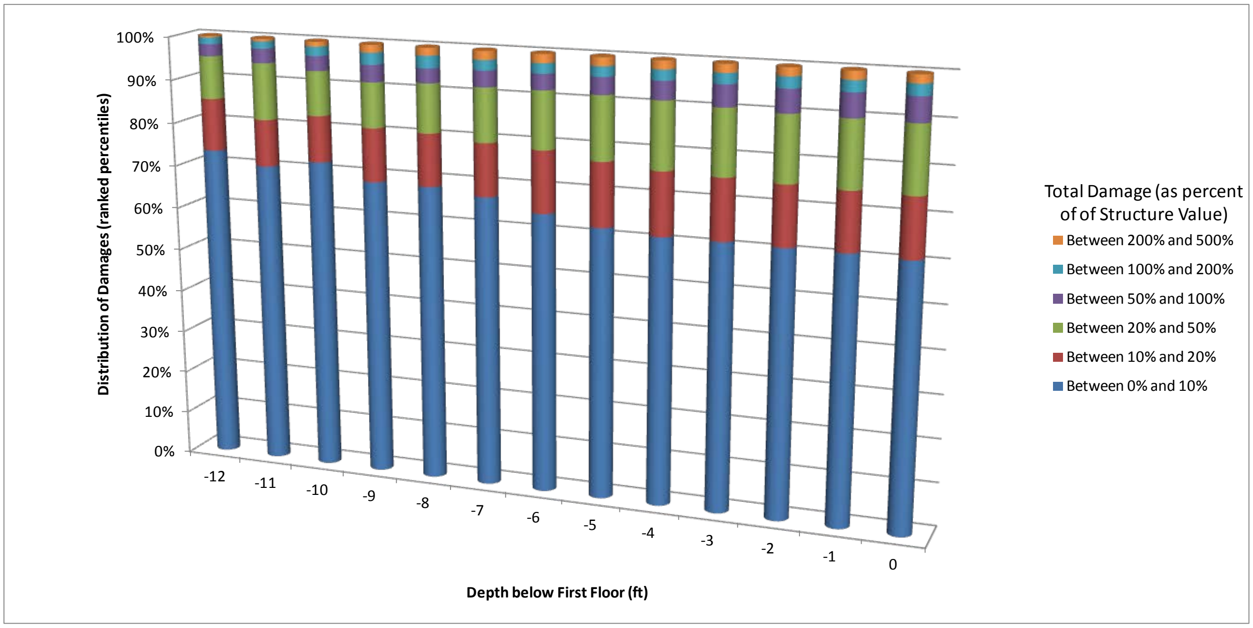


Figure 5 displays that many of the data points are concentrated at a lower percent-damage. The higher points are visible because they are alone, and therefore outliers. Figure 6 shows the distribution of percent-damages by flood depth.

Figure 6 Distribution of Percent Damage by Depth



For every depth of flooding, the 85th percentile of damages is 20% or less of total structure value. Figure 6 also shows that although the distribution of damages is fairly large, it is consistent across flood depths.

The broad distribution of damages can be attributed to a natural variation in the use of basements. For many facilities, there is a critical depth of flooding that triggers a large amount of damage. Damage will increase from that point on, but the margin is usually small. This is due to the fact that many of the damageable components of a structure are stored at the same height, often inches or feet above the basement floor. This is evident from the example traces in Figure 5 above. There is also a great deal of variation in the height of the basement itself.

The set of traces was organized in different categories to try to explain some of the natural variation. Organizing them by parcel improvement class or number of stories of the structure did not provide further explanation. The most dramatic change was seen by geographic area. Structures in the downtown region were more likely to have higher percent damages than structures outside of downtown.

The percent damage estimates were adjusted to reflect only the value of the first floor of the structure. Although this broadens the distribution of damages, it provides a straightforward method for blending the basement depth damage relationships with existing IWR curves (to estimate damages above the basement ceiling). The damage estimates were adjusted by dividing the total structure value by the number of stories to get a per-floor value, and then taking the total damage as a percent of that per-floor value.

After reviewing a number of possible categories, four separate categories of regressions were run:

- 1 - East Downtown Structures five stories or less

- 2 - Structures outside of Downtown five stories or less
- 3 - All structures six to 18 stories
- 4 - All structures greater than 18 stories

In each case the dependent variable was total damage as a percent of first floor value, and the independent variable was flood depth. Although the different categories account for different number of stories, each category includes the damage *as a percent of the first floor value only*. The regression equations are presented below, along with the standard error of each coefficient, and the coefficient of determination (R^2). The F test was used to test the hypothesis that each regression was not significant. In each case the probability that depth was not a significant variable was less than 2.5%. By this test each regression was determined to be significant.

Equation 1 Downtown Structures - Five Stories or Less

Percent Damage = 0.6339 + 0.0136 x Depth
(0.03601) (0.00587) R^2 =0.2%

Equation 2 Structures outside Downtown - Five Stories or Less

Percent Damage = 0.2652 + 0.0124 x Depth
(0.01651) (0.00270) R^2 =1.3%

Equation 3 All Structures - Six to 18 Stories

Percent Damage = 2.0238 + 0.0721 x Depth
(0.07848) (0.01155) R^2 =2.4%

Equation 4 All Structures - Greater than 18 Stories

Percent Damage = 1.9244 + 0.043 x Depth
(0.09811) (0.01398) R^2 =0.7%

The regression equations yielded appropriate results - a line with a positive, but relatively flat slope, with statistical significance. Each predicted value from -12 feet to 0 feet was reasonable. The R^2 would be higher without employing the high, medium, and low approach. However the driving factor in the performance of the regression is due to a natural variation in basement use. Some buildings have utilities in the basement, and others have them on the roof. They could also be located anywhere in between. Many buildings store inventory in the basement while others leave it empty. There are few indicators that would help predict how a basement is utilized. Given the inevitable variation in basement damage, the flood risk management economics sub-team focused on creating an appropriate distribution from which to sample.

Upon review of the confidence limits of the equations (the standard error of each coefficient), it appeared that the error bounds were too small to match the data. This was attributable to two key factors:

- *Issue 1:* Damages were interpolated at each whole number depth that was *not* recorded on the interview form. The interview obtained the “tripping” points where there was a change in the slope of the curve. The interpolation ensured that each trace had an ordinate for every integer from the basement floor to zero ft. This was done to ensure that the interviews with numerous "tripping points" did not receive undue weight in determining the regression coefficients. The result was that there were many more coordinates than initially observed, which tended to increase the regression degrees of freedom without dramatically changing the variation. This yielded narrow confidence limits around the predicted regression line.

- *Issue 2:* The slope of each individual trace was almost always extremely flat. By definition, the slope cannot be negative (since the damages are cumulative from the basement floor). However, the incremental change with respect to depth is usually small compared with the beginning damage estimate. This left very little room for variation in the regression slope.

Issue 2 appears to be the appropriate result based on the evidence from the interviews. However, it was decided that an adjustment needed to be made to compensate for Issue 1. Each sample dataset included ordered pairs of depth and percent-damage coordinates from a number of interviews. Each interview contained 3 traces, a high, low and medium (the structure, content and emergency damages were summed by depth), with as many as 7 to 13 depth/percent-damage coordinates, some of which were interpolated. This meant that the regression sample size appeared very large, having 21 to 39 observations per interview. It was decided that the analysis of variance should reflect the total number of interviews in each category, rather than the total number of observations. After making this adjustment, the confidence limits of each regression were widened to a reasonable level (this was accomplished by changing the degrees of freedom from *#observations minus 2* to *#interviews minus 2*). Another alternative was also considered, calculating the degrees of freedom as the *number of traces minus 2* (there are 3 traces per interview). These three methods have the same predicted damages, but different confidence limits. Each method is defined as follows, with successively wider confidence limits.

- Method 1: *degrees of freedom = # observations minus 2*
- Method 2: *degrees of freedom = # traces minus 2*
- Method 3: *degrees of freedom = # interviews minus 2*

Equation 5 is an example of how the standard error was calculated for any of these scenarios.

Equation 5 Example AnOVa - All Structures - Greater than 18 Stories

- Coefficient of Depth (C) = 0.043
- Intercept (I) = 1.9244
- Sum of Squared Residuals (SSR) = 4,666
- Mean of Squared Residuals (MSR) = SSR/(N_a - 2) = 145.82
- Xi = ith value of depth
- Xbar = mean value of depth = -5.95
- # Observations (N_o) = 1,314
- # Interviews (N_a) = 34
- SE of Regression (SEr) = Square Root [SSR/(N_a-2)] = 12.08
- SE of Intercept = SEr*Square Root[$Xbar^2/\sum(Xi - Xbar)^2 + 1/N_a$] = 2.0912
- SE of Coefficient = Square Root [MSR/ $\sum(Xi - Xbar)^2$] = .0487
- Predicted damage at depth of -2ft = I + C*(-2) = 183.8%
- Standard Error of Damage at -2ft = [$(I+SE_I + (C+SE_c)*(-2))/(I+C*(-2)) - 1$] = 108.7%

The revised regression results, along with the final depth-damage tables are present in Table 9 through Table 12. The revision to the sample size caused the regression coefficients to be less significant; however these results are more accurate and will generate more meaningful results for the structures that were not sampled. By definition, the relationship between depth and damage must be positive. The T test for statistical significance is based on the hypothesis that the regression coefficient is zero or less. Since this is logically impossible, the T test does not imply that the independent variable is not significant in explaining the dependent variable. The most powerful aspect of the standard error of each coefficient is that they assist in defining the range of possible damages for a sampled depth.

Since the flood risk analysis is done iteratively, the same depth may be sampled thousands of times, and yield a different damage each time. Since negative values of damages are outside the realm of possibility, the sampling range is truncated at zero. By widening the confidence limits of the regression, values below zero are more likely to be sampled. Since negative values are replaced by zero, the mean of all iterations will tend to be higher than the predicted damage from the regression (since the extreme high values won't be offset by the extreme low values, but by zero instead). This is a common issue with depth-damage relationships and makes it important to consider the overall distribution of damages, rather than only looking at the mean.

Each regression is plotted in Figure 7 through Figure 10 along with the observed data points. It is important to note that the depth-damage relationships reflect *only the value of the first floor*, and include structure and content damage. This means that the percentage can exceed 100% of the structure value, and that the structure value of all structures fitted to these categories need to reflect only the first floor. The content value of structures is not relevant for damages below the first floor, since they are already included in the estimate. The standard error associated with each depth is used in FDA, and the distribution is defined as a normal distribution. In cases where the standard error extends below zero, FDA returns a value of zero (FDA does not sample negative damage values).

Table 9 Downtown Structures - Five Stories or Less

Downtown Structures - Five Stories or Less
Adjusted for Sample Size

Line Equation----
Percent Damage = 0.6339 + 0.0136 x Depth

		Standard Error	t Stat	P-value
Method 1 (# Observations)	Intercept	0.0360	17.60	0.00
	Depth	0.0059	2.32	0.02
Method 2 (# traces)	Intercept	0.2365	2.68	0.01
	Depth	0.0193	0.71	0.48
Method 3 (# interviews)	Intercept	0.6490	0.98	0.33
	Depth	0.0330	0.41	0.68

		Method 1	Method 2	Method 3
Sample Size		2534	237	82
Standard Error of Regression		1.01	3.31	5.68
Depth	Predicted Damage	Sandard Error	Sandard Error	Sandard Error
0.00	63.4%	5.7%	37.3%	102.4%
-1.00	62.0%	4.9%	35.0%	99.3%
-2.00	60.7%	4.0%	32.6%	96.1%
-3.00	59.3%	3.1%	30.1%	92.7%
-4.00	58.0%	2.2%	27.5%	89.2%
-5.00	56.6%	1.2%	24.8%	85.5%
-6.00	55.2%	0.1%	21.9%	81.6%
-7.00	53.9%	0.0%	18.9%	77.6%
-8.00	52.5%	0.0%	15.7%	73.3%
-9.00	51.2%	0.0%	12.3%	68.8%
-10.00	49.8%	0.0%	8.8%	64.1%
-11.00	48.4%	0.0%	5.1%	59.0%
-12.00	47.1%	0.0%	1.1%	53.7%

Table 10 Structures outside Downtown - Five Stories or Less

Structures outside Downtown - Five Stories or Less
Adjusted for Sample Size

Line Equation----
Percent Damage = 0.2652 + 0.0124 x Depth

		Standard Error	t Stat	P-value
Method 1 (# Observations)	Intercept	0.0165	16.06	0.00
	Depth	0.0027	4.60	0.00
Method 2 (# traces)	Intercept	0.1040	2.55	0.01
	Depth	0.0058	2.13	0.04
Method 3 (# interviews)	Intercept	0.3075	0.86	0.39
	Depth	0.0103	1.21	0.23

		Method 1	Method 2	Method 3
Sample Size		1592	147	49
Standard Error of Regression		0.36	1.21	2.12
Depth	Predicted Damage	Sandard Error	Sandard Error	Sandard Error
0.00	26.5%	6.2%	39.2%	116.0%
-1.00	25.3%	5.5%	38.8%	117.6%
-2.00	24.0%	4.6%	38.4%	119.4%
-3.00	22.8%	3.7%	37.9%	121.4%
-4.00	21.6%	2.7%	37.4%	123.6%
-5.00	20.3%	1.5%	36.8%	126.2%
-6.00	19.1%	0.2%	36.1%	129.0%
-7.00	17.8%	0.0%	35.4%	132.2%
-8.00	16.6%	0.0%	34.5%	135.9%
-9.00	15.3%	0.0%	33.5%	140.2%
-10.00	14.1%	0.0%	32.3%	145.3%
-11.00	12.9%	0.0%	30.9%	151.4%
-12.00	11.6%	0.0%	29.1%	158.7%

Table 11 All Structures - Six to 18 Stories

All Structures - Six to 18 Stories
Adjusted for Sample Size

Line Equation----
Percent Damage = 2.0238 + 0.0721 x Depth

		Standard Error	t Stat	P-value
Method 1 (# Observations)	Intercept	0.0785	25.79	0.00
	Depth	0.0115	6.24	0.00
Method 2 (# traces)	Intercept	0.5436	3.72	0.00
	Depth	0.0260	2.77	0.01
Method 3 (# interviews)	Intercept	1.6153	1.25	0.22
	Depth	0.0457	1.58	0.12

		Method 1	Method 2	Method 3
Sample Size		1587	129	43
Standard Error of Regression		1.68	5.94	10.45
Depth	Predicted Damage	Sandard Error	Sandard Error	Sandard Error
0.00	202.4%	3.9%	26.9%	79.8%
-1.00	195.2%	3.4%	26.5%	80.4%
-2.00	188.0%	2.9%	26.2%	81.1%
-3.00	180.8%	2.4%	25.8%	81.8%
-4.00	173.6%	1.9%	25.3%	82.5%
-5.00	166.4%	1.2%	24.9%	83.4%
-6.00	159.1%	0.6%	24.4%	84.3%
-7.00	151.9%	0.0%	23.8%	85.3%
-8.00	144.7%	0.0%	23.2%	86.3%
-9.00	137.5%	0.0%	22.5%	87.5%
-10.00	130.3%	0.0%	21.8%	88.9%
-11.00	123.1%	0.0%	20.9%	90.4%
-12.00	115.9%	0.0%	20.0%	92.0%

Table 12 All Structures - Greater than 18 Stories

All Structures - Greater than 18 Stories
Adjusted for Sample Size

Line Equation----
Percent Damage = 1.9244 + 0.043 x Depth

		Standard Error	t Stat	P-value
Method 1 (# Observations)	Intercept	0.0981	19.61	0.00
	Depth	0.0140	3.07	0.00
Method 2 (# traces)	Intercept	0.6960	2.77	0.01
	Depth	0.0276	1.56	0.12
Method 3 (# interviews)	Intercept	2.0912	0.92	0.36
	Depth	0.0487	0.88	0.38

		Method 1	Method 2	Method 3
Sample Size		1314	102	34
Standard Error of Regression		1.89	6.83	12.08
Depth	Predicted Damage	Sandard Error	Sandard Error	Sandard Error
0.00	192.4%	5.1%	36.2%	108.7%
-1.00	188.1%	4.5%	35.5%	108.6%
-2.00	183.8%	3.8%	34.9%	108.4%
-3.00	179.5%	3.1%	34.2%	108.3%
-4.00	175.2%	2.4%	33.4%	108.2%
-5.00	170.9%	1.7%	32.6%	108.1%
-6.00	166.7%	0.9%	31.8%	107.9%
-7.00	162.4%	0.0%	31.0%	107.8%
-8.00	158.1%	0.0%	30.1%	107.6%
-9.00	153.8%	0.0%	29.1%	107.5%
-10.00	149.5%	0.0%	28.1%	107.3%
-11.00	145.2%	0.0%	27.1%	107.1%
-12.00	140.9%	0.0%	25.9%	106.9%

Figure 7 Plot Downtown Structures - Five Stories or Less – Method 3

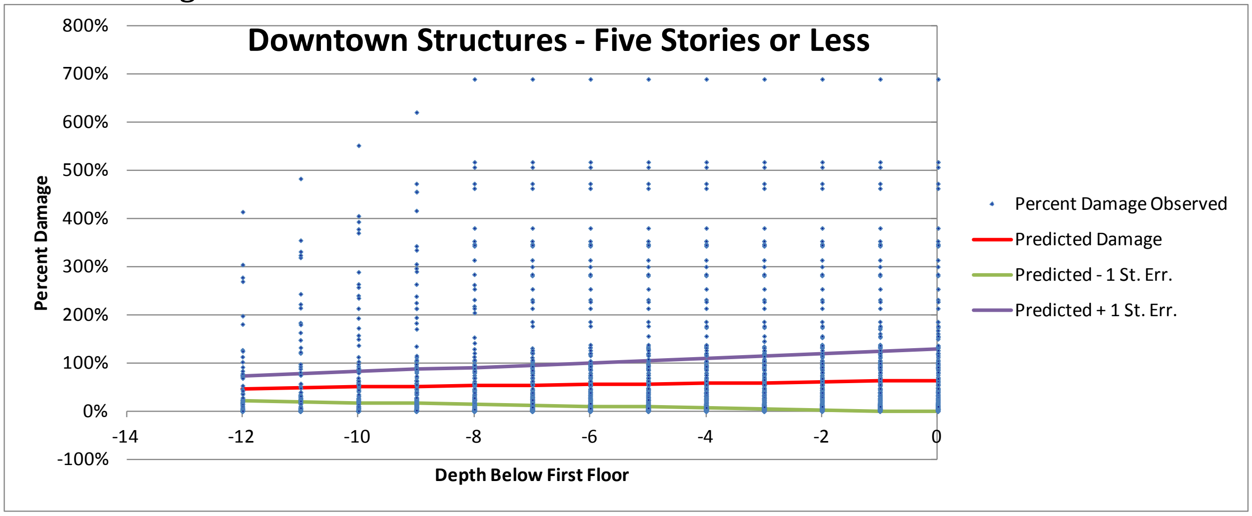


Figure 8 Plot Structures outside Downtown - Five Stories or Less – Method 3

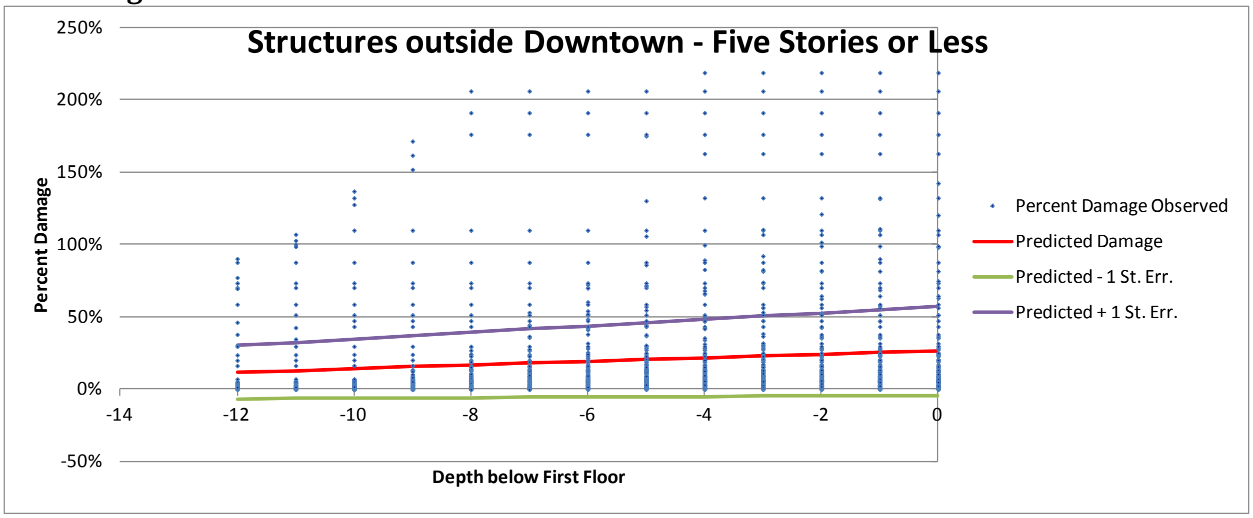


Figure 9 Plot All Structures - Six to 18 Stories – Method 3

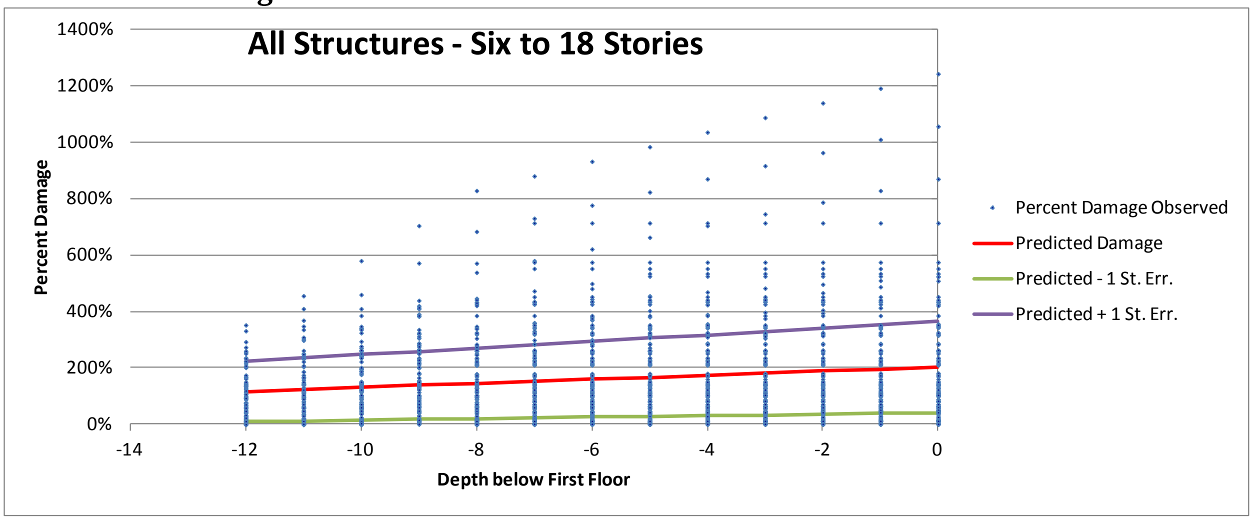
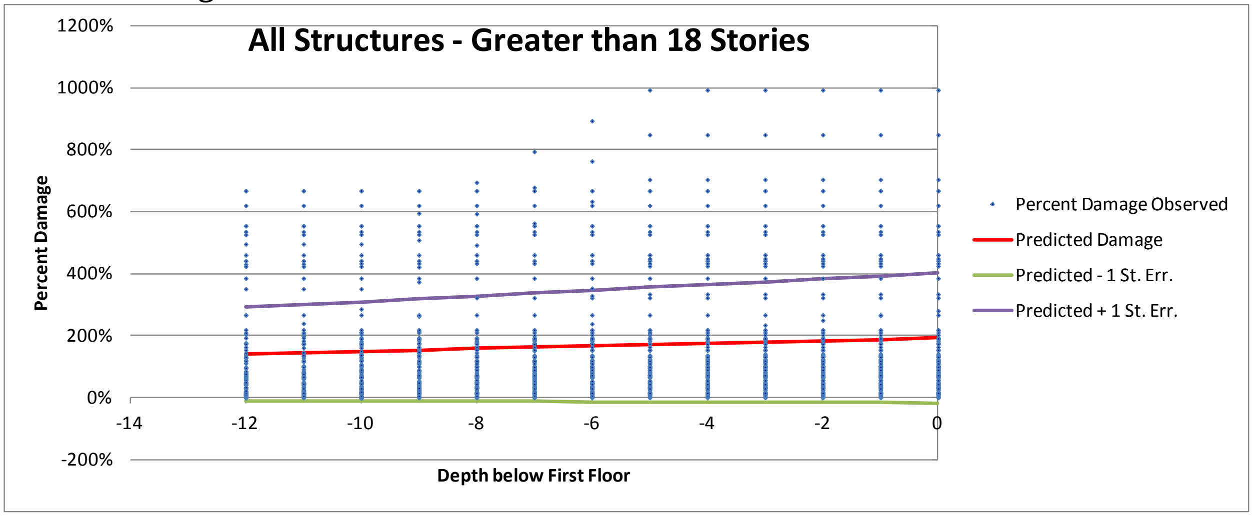


Figure 10 Plot All Structures - Greater than 18 Stories – Method 3



(5) Structure Values with Uncertainty

Sampling and regression analyses were combined to estimate structure values within the project area. For each structure category (residential, exempt, commercial, and industrial) Marshall & Swift (M&S) estimates were used to determine the depreciated replacement values (DRV) for a small sample. These DRVs were then analyzed using one other independent variable. While using more than one independent variable would likely have led to a more exact estimation, there were not very many categories where multiple inputs were available for the whole structure population. The regression results were applied to residential structures, however were not satisfactory for commercial, industrial and exempt structures. Where the DRV regression was not applied, the fair market value (FMV) from the county assessor was used instead.

(a) Residential Structures

A random sample of 100 residential structures was selected from the overland population. Twelve structures were excluded because of incomplete information, leaving 88 structures in the sample. For each of these structures, the DRV was calculated based on a combination of field observations and assessor data. The M&S Residential Estimator was used for the DRV estimates. After these values were obtained for each structure in the sample, a regression was run with the assessor's FMV as the independent variable and the DRV as the dependent variable. This regression resulted in the following equation:

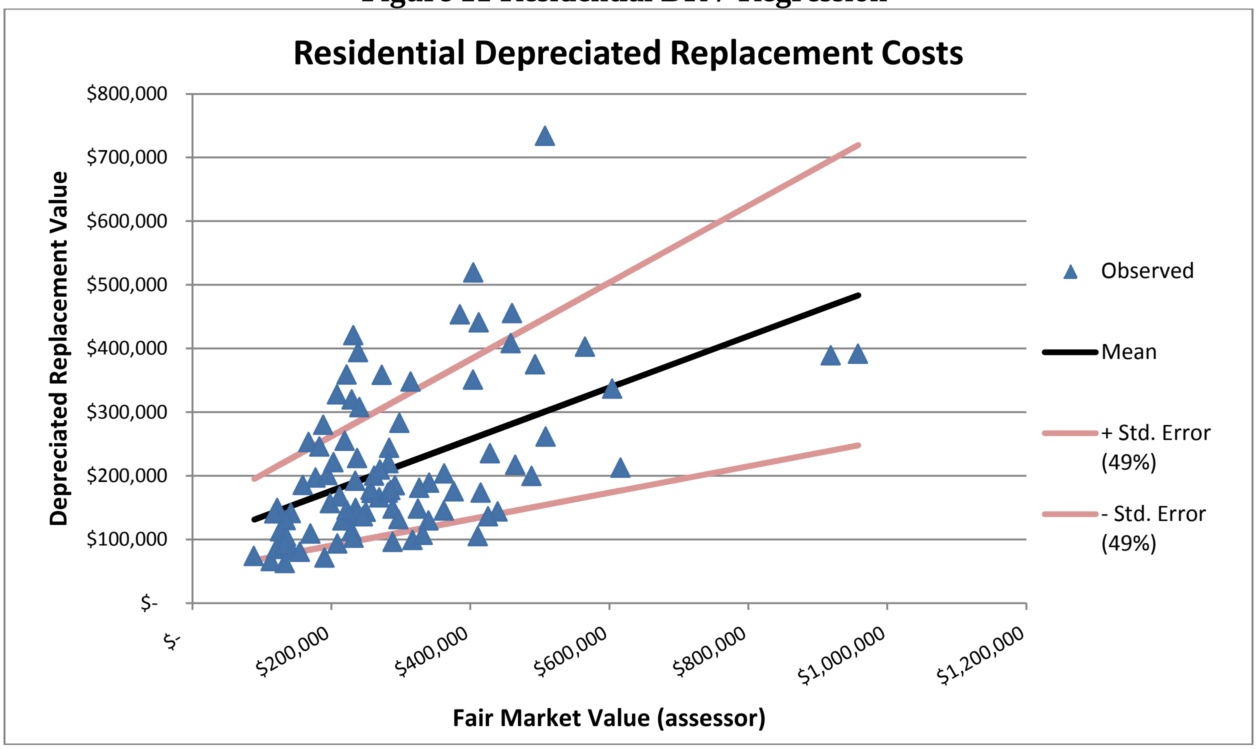
Equation 6 Residential DRV = $138,772.94 + $0.4152(FMV)
R^2 = 26%, std. error of intercept = 95,119.55 (p-value = 0.0002), std. error of coefficient = 0.07 (p-value = .0000)

When applied, this equation forces a minimum value of $139,000. Since this is not a reasonable minimum value, using DRV = FMV was considered as an alternative to the regression. Using DRV = FMV provides a more realistic estimate of DRV for lower values, but overestimates DRV for higher values. In order to obtain better estimates of DRV for both high and low values, a piecewise equation was chosen to convert FMV's to DRV's:

Equation 7 if FMV < 237,299.8, Residential DRV = FMV;
if FMV > 237,299.8, Residential DRV = \$138,772.94 + \$0.4152(FMV)

The threshold of \$237,299.8 was calculated as the solution to the two sets of lines (the two equations intersect at this value). This threshold was used in the piecewise function in order to create a continuous function for the entire domain. This equation was then applied to each individual residential structure within the total population to determine the DRV. The standard error for residential structure values is 49%. The regression results are displayed below in Figure 11 as well as the error bounds.

Figure 11 Residential DRV Regression



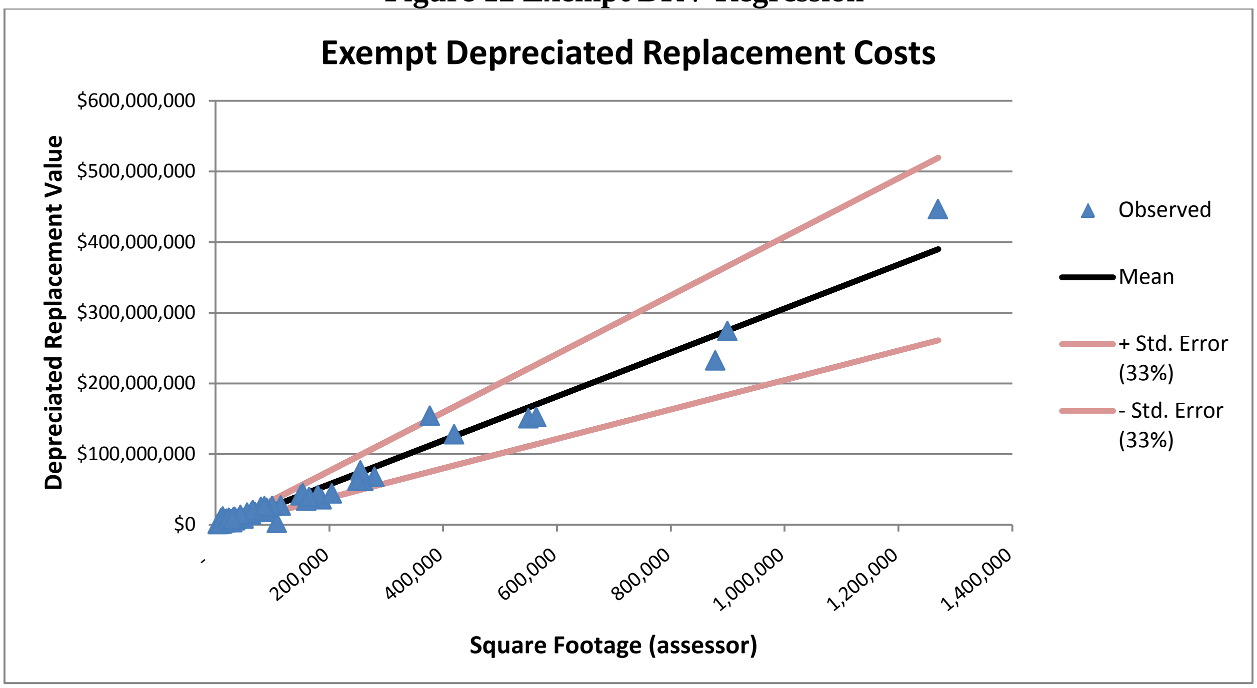
(b) Exempt Structures

From the sample (discussed in the Sewer AOI section), 67 structures were categorized as exempt. Using the M&S Commercial and Agricultural Estimator, a DRV was calculated for each of these structures. Since the assessor does not calculate a FMV for exempt buildings, the regression was run using Total Square Footage as the independent variable. This information was provided by the assessor. To determine the value of each exempt structure within the project area, the following regression equation was used:

Equation 8 Exempt DRV = -$4,968,411.90 + $311.2195 (Total Square Footage)
R2 = 97%, standard error of intercept = 1,848,756.42 (p-value = 0.0091), standard error of coefficient = 6.87 (p-value = .0000)

Although this equation provides a method for calculating a DRV, the square footage estimates are lacking for the entire inventory of exempt properties. Therefore, this equation was not applied. The assessor provides some values for exempt properties, however most of the 11,000 exempt structures in the inventory do not have values. A dummy value of $31,415.9 (pi x 10^4) was used to identify which exempt structures would be damaged and set a minimum structure value for each. The standard error for exempt structure values is 33%. The regression results are displayed below in Figure 12, as well as the error bounds.

Figure 12 Exempt DRV Regression



(c) Commercial Structures (3 or Fewer Stories)

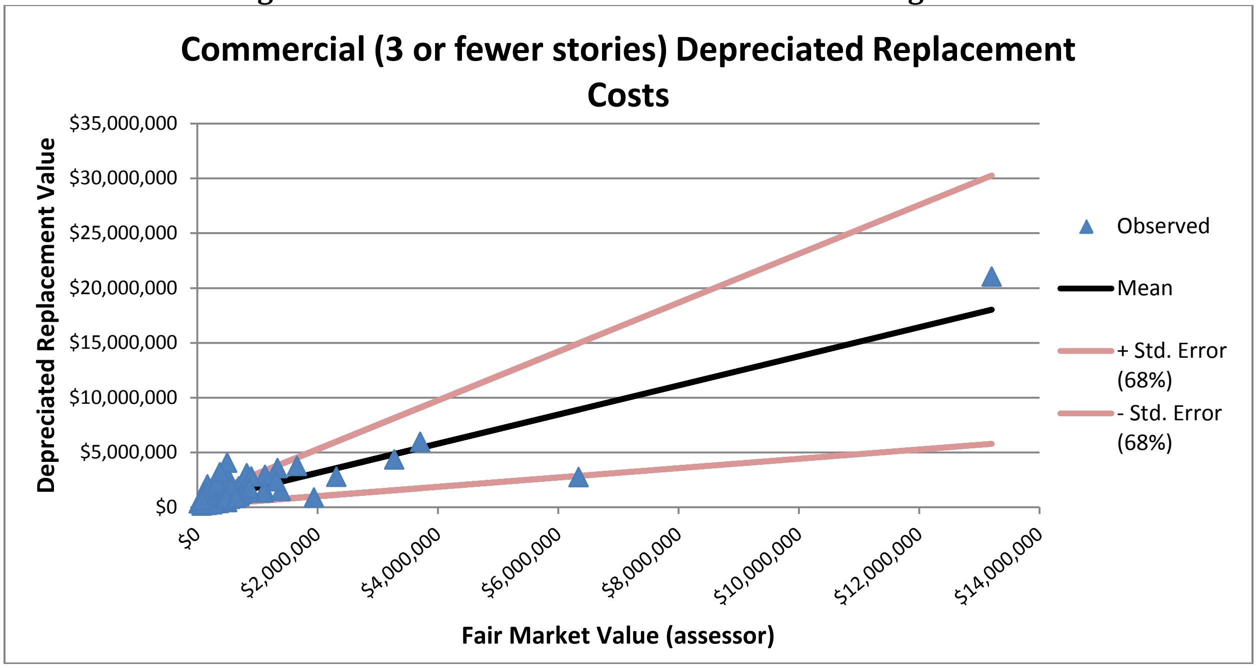
Based on the number of stories, the commercial structures were broken up into three groups: commercial structures with 3 or fewer stories, commercial structures with 4 to 10 stories, and commercial structures with 11 or more stories. From the sample, 66 structures were categorized as commercial structures with 3 or fewer stories. Using the M&S Commercial and Agricultural Estimator, a DRV was calculated for each of these structures. The FMV was used as the independent variable and this regression resulted in the following equation:

Equation 9 Commercial (3 or fewer stories) DRV = $501,944.97 + $1.3265(FMV)

R^2 = 81%, std. error of intercept = 161,953.64 (p-value = 0.0029), std. error of coefficient = 0.08 (p-value = .0000)

Since this equation forces a minimum value of $501,945 for each structure in this group, the equation was not applied. The assessor's FMV was instead used to estimate the DRV. The standard error for commercial structure values (3 stories or less) is 68%. The regression results are displayed below in Figure 13 as well as the error bounds.

Figure 13 Commercial 3 or fewer Stories DRV Regression



(d) Commercial Structures (4-10 Stories)

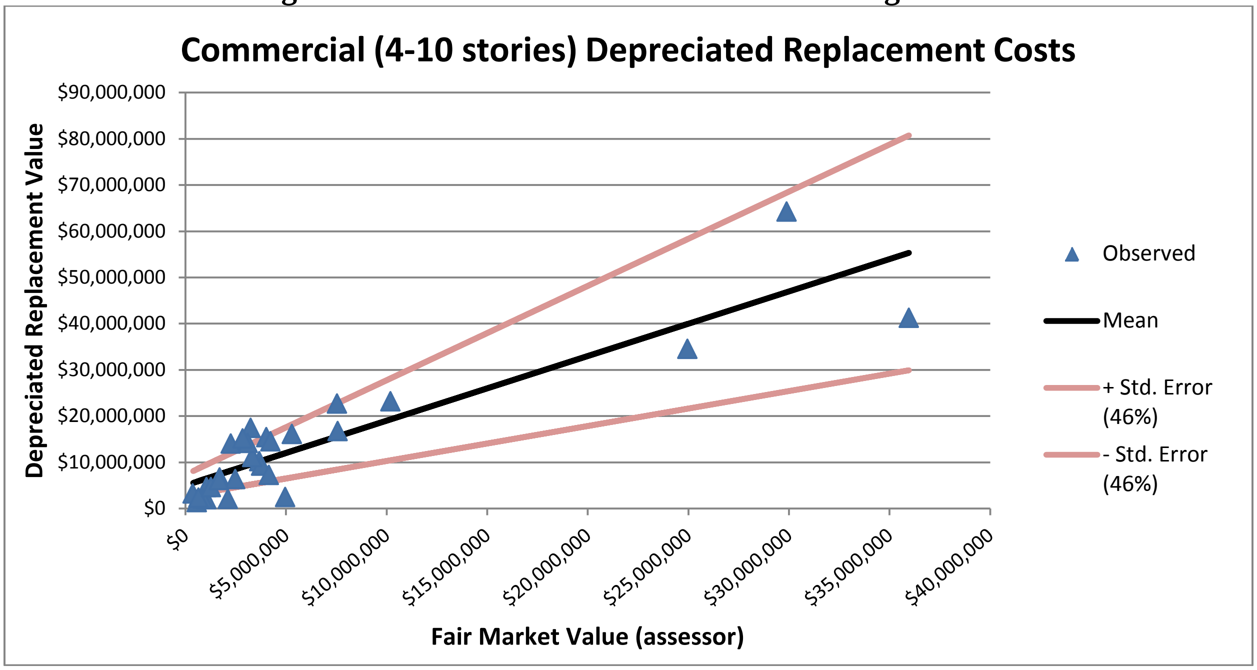
From the sample, 35 structures were categorized as commercial structures with 4 to 10 stories. Of the 35 structures, 6 were identified as outliers and were left out of the regression analysis. Using the M&S Commercial and Agricultural Estimator, a DRV was calculated for each of these structures. The FMV was used as the independent variable and this regression resulted in the following equation:

Equation 10 Commercial (4-10 stories) DRV = $5,041,331.10 + $1.3984(FMV)

R^2 = 80%, std. error of intercept = 1,402,663.41 (p-value = 0.0013), std. error of coefficient = 0.13 (p-value = .0000)

Since this equation forces a minimum value of $5,041,331 for each structure in this group, the equation was not applied. The assessor's FMV was instead used to estimate the DRV. The standard error for commercial structure values (4 to 10 stories) is 46%. The regression results are displayed below in Figure 14 as well as the error bounds.

Figure 14 Commercial 4 to 10 Stories DRV Regression



(e) Commercial Structures (11 or More Stories)

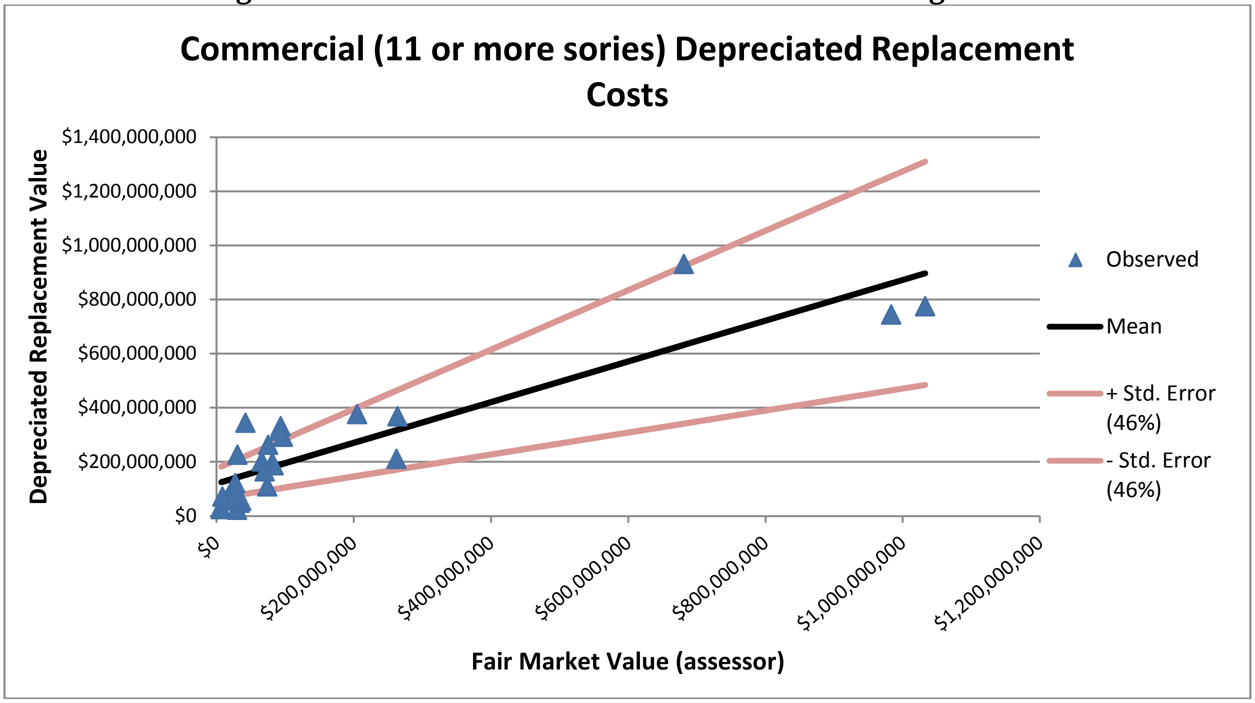
From the sample, 35 structures were categorized as commercial structures with 4 to 10 stories. Of the 35 structures, 8 were identified as outliers and were left out of the regression analysis. Using the M&S Commercial and Agricultural Estimator, a DRV was calculated for each of these structures. The FMV was used as the independent variable and this regression resulted in the following equation:

Equation 11 Commercial (11 or more stories) DRV = $119,934,396.58 + $0.7524(FMV)

R^2 = 77%, std. error of intercept = 25,239,541.12 (p-value = 0.0001), std. error of coefficient = 0.08 (p-value = .0000)

Since this equation forces a minimum value of $119,934,397 for each structure in this group, the equation was not applied. The assessor's FMV was instead used to estimate the DRV. The standard error for commercial structure values (11 or more stories) is 46%. The regression results are displayed below in Figure 15, as well as the error bounds.

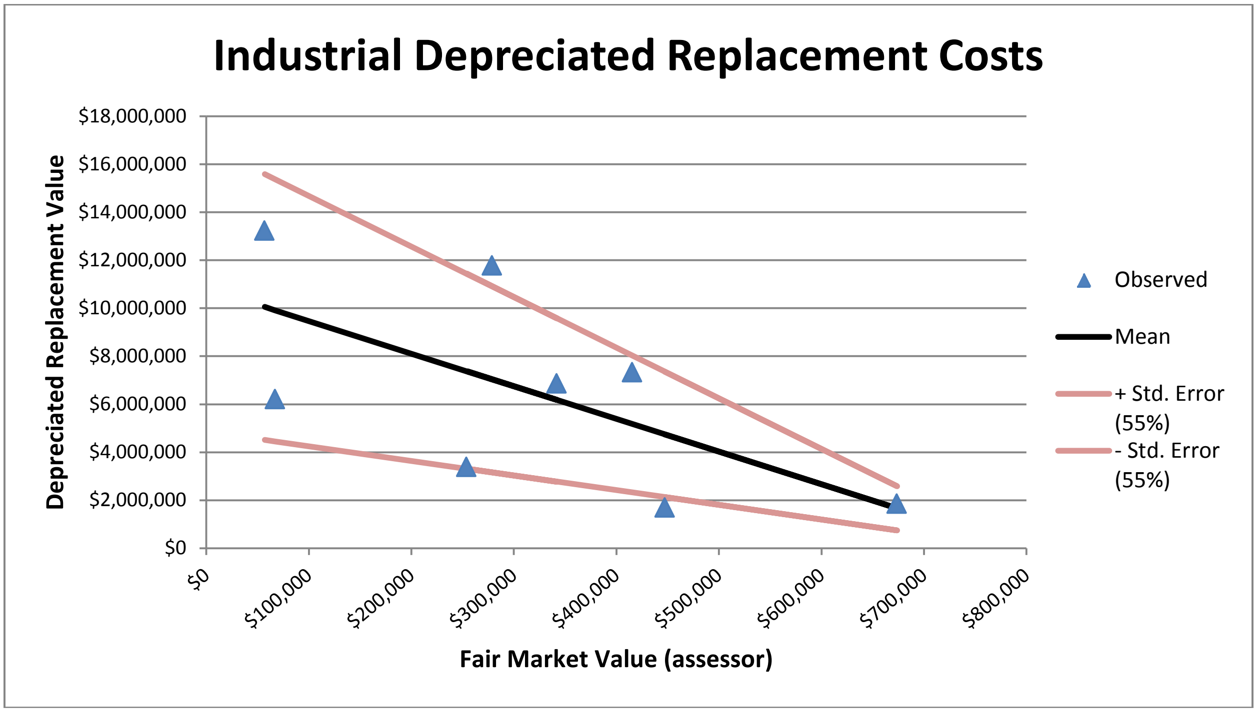
Figure 15 Commercial more than 11 Stories DRV Regression



(f) Industrial Structures

The regression analysis of the industrial structures within the sample was deemed unreliable. The inverse relationship, shown below, meant structures with high assessed values had low depreciated replacement values. For these structures, the FMV from the assessor will be used instead of an estimated DRV. Overall, the impact on the total value of the inventory will be small since industrial structures make up less than 2% of the total population.

Figure 16 Industrial DRV Regression



(6) Structure Elevations with Uncertainty

The first floor elevation (FFE) of a structure is vital to predicting flood damage, since it is directly compared to the water surface elevation of a flood event. The FFE is the sum of the lowest-adjacent-grade (LAG) to the structure and the structure's foundation height. The most efficient way to estimate LAGs is using digital elevation models (DEM's), where available. The spatially referenced points for each structure are related to the DEM using a variety of geo-processing tools. The DEM used for this study was a terrain model (DTM) built using the Cook County LiDAR dataset collected between November 2008 and April 2009.

Foundation heights are generally more difficult to estimate, due to the sheer number of structures typically involved in flood studies. A 100% survey of foundation heights is impossible for the more than 500,000 structures in the initial dataset. Instead, the team focused on collecting foundation heights in the Overland AOI. A windshield survey method was the most expedient way of collecting foundation heights. Approximately 6,650 structures were surveyed, including 5,520 residential structures and 1,130 commercial, industrial, and public structures. The survey crew would drive past each structure and visually estimate the foundation height. Steps leading to the structure entrance were often employed as a visual benchmark to gain perspective.

Occasionally, spot checks were used with a measuring tape. The survey crew attempted to estimate the foundation height based on where the DTM would likely be picked up in the geo-processing results.

The foundation heights were summarized by occupancy type and the averages for each were used to estimate the foundation heights for un-sampled structures. The results are presented in Table 13. The averages were rounded to the nearest half number for use in the flood risk analysis.

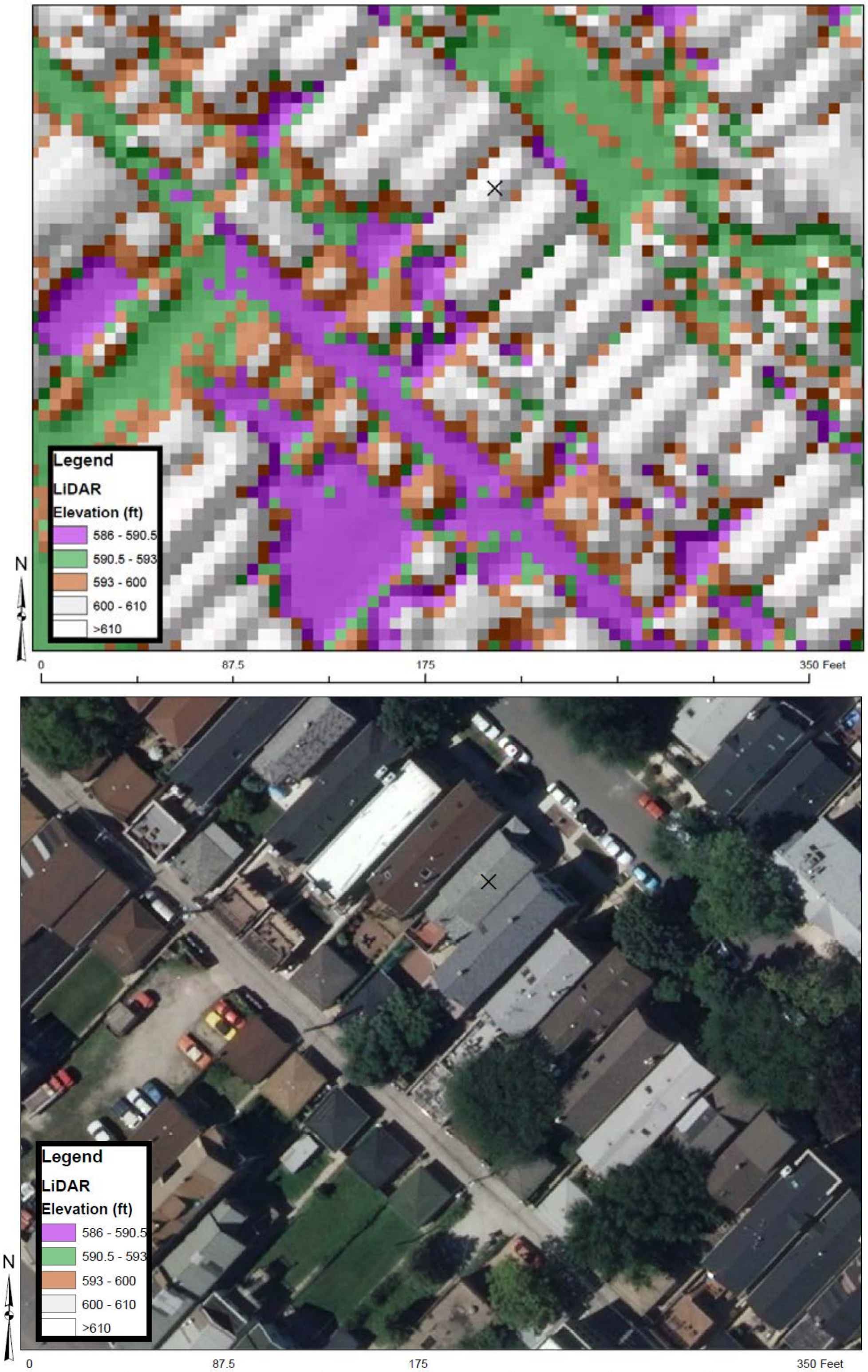
Table 13 Foundation Heights by Occupancy Type (ft)

	Occupancy Name	**Foundation Height used in Analysis**	Avg. of Foundation	Min. of Foundation	Max. of Foundation	Number of Structures Surveyed
Commercial, Industrial, Public	all	**1.5**	1.46	-10	45	1127
Residential	Bilevel	**5**	NA	NA	NA	NA
Residential	all except Bilevel	**4.5**	4.43	-3	10	5520

The greatest variation in foundation heights usually occurs in structures adjacent to a river channel or steep grade, or areas where unusual road and drainage systems were present. Close attention was paid to such areas to ensure that the foundation heights were not underestimated. Near rivers or ponds, buildings tend to have walk-out basements or exposed foundations that are not apparent from the roadside. The LAG assignment method will typically pick up the grade at the back, so the foundation height needs to reflect that. Additionally, certain areas of the Chicago Metro tend to produce above average foundation heights, due to the construction of the road system. In Figure 17 below, the city's surface is shown for a select neighborhood. The purple shaded area is the back alley area, while the green on the northeast side of the map is the street level. The white areas are house rooftops. The FFE's of houses in these areas are usually 4-5 feet above the road, however the LAG in the backyard is often 2-4 feet lower than the road.

Therefore, applying the average foundation heights from the Overland windshield survey is not appropriate for these areas. The geospatial team searched for structures that might be located along rivers, ponds, or in areas with recessions and adjusted the foundation heights accordingly.

Figure 17 Recessed Backyards in some Neighborhoods



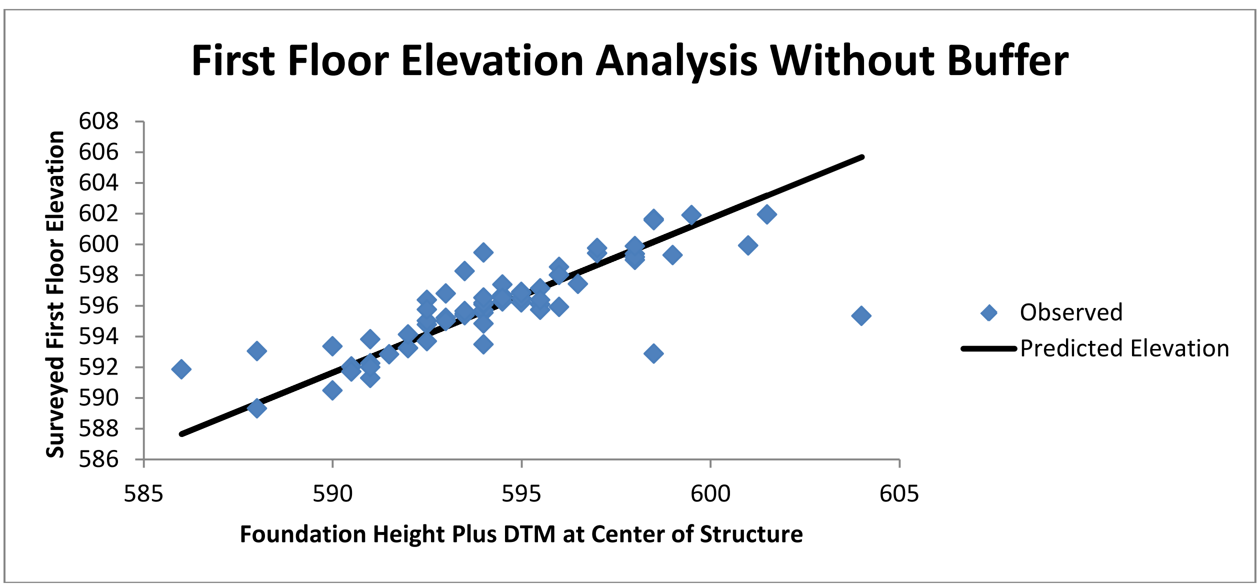
To determine the elevation uncertainty associated with the field elevation estimates, a random sample of structures was identified. A structure elevation sample was selected by identifying the nearest benchmark to each structure and was limited to structures located within eight-hundred feet of a benchmark. This reduced the sampling population to 1,109 structures. A sample of 70 structures was taken from this population. Each of these 70 structure elevations was determined rigorously using survey equipment. The surveyed elevations were then compared to geospatially assigned elevations from three separate methods:

1- LAG = The DTM value at a point in the center of the structure
2- LAG = minimum of DTM within 30 foot buffer of the center of the structure
3- LAG = mean of DTM within 30 foot buffer of the center of the structure

The foundation heights were added to the LAG for each geospatial method to make them directly comparable to the surveyed elevations. A regression tool was implemented to conduct an analysis of variance between the surveyed elevations and the geospatially assigned elevations. The purpose of the regression was to determine the standard error in FFE. For each method there is a 1 to 1 relationship between the surveyed elevations and the geospatially assigned elevations.

The residual error is smallest when a 30 foot buffer is applied; however methods that involve buffers are also the most time consuming and data intensive. The standard error in FFE without using a buffer is approximately 2 ft (Equation 12), whereas the standard error with a 30 foot buffer is 1.9 ft (Equation 14). It was determined that the increased precision (standard error of 2 ft versus 1.9 ft) was not worth the extra time and effort involved with buffering all structures and computing statistics. Therefore, method 1 was chosen to assign FFE's to un-sampled structures (using the DTM value at a point in the center of the structure), and the standard error in FFE was 2 ft.

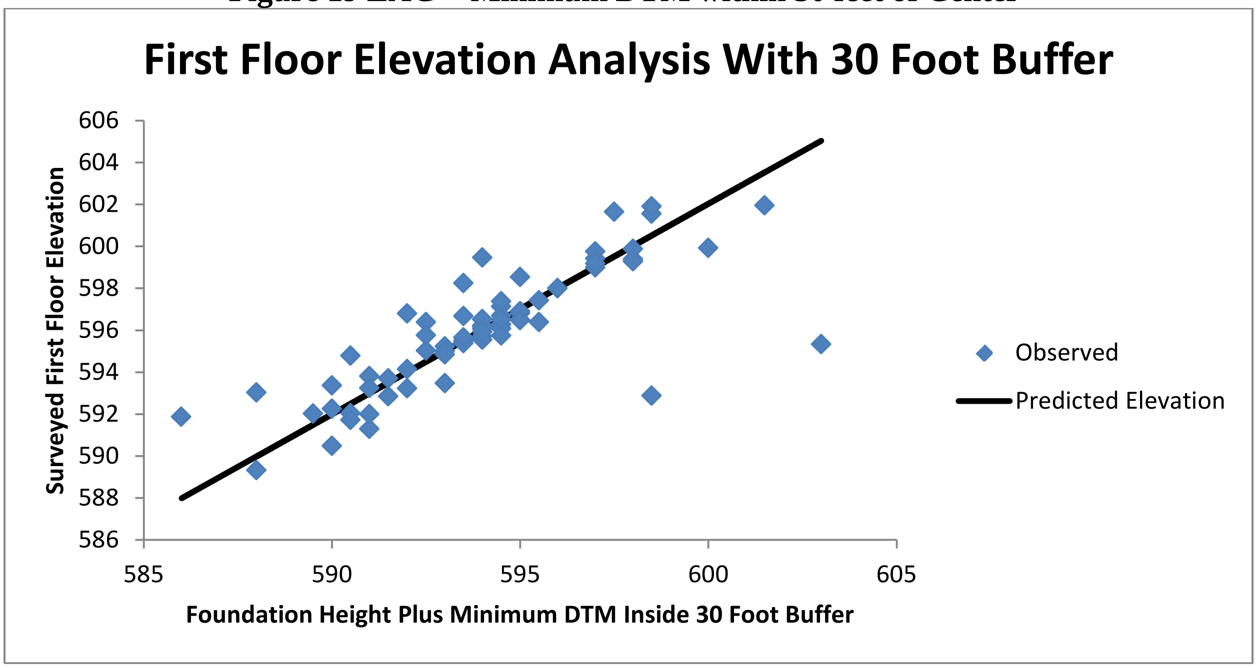
Figure 18 LAG = DTM at Center



Equation 12 Surveyed Elevation = 0 + 1.002778*(Geospatial Elevation)

Regression Statistics	
R Square	0.999989
Standard Error	1.99
Observations	70

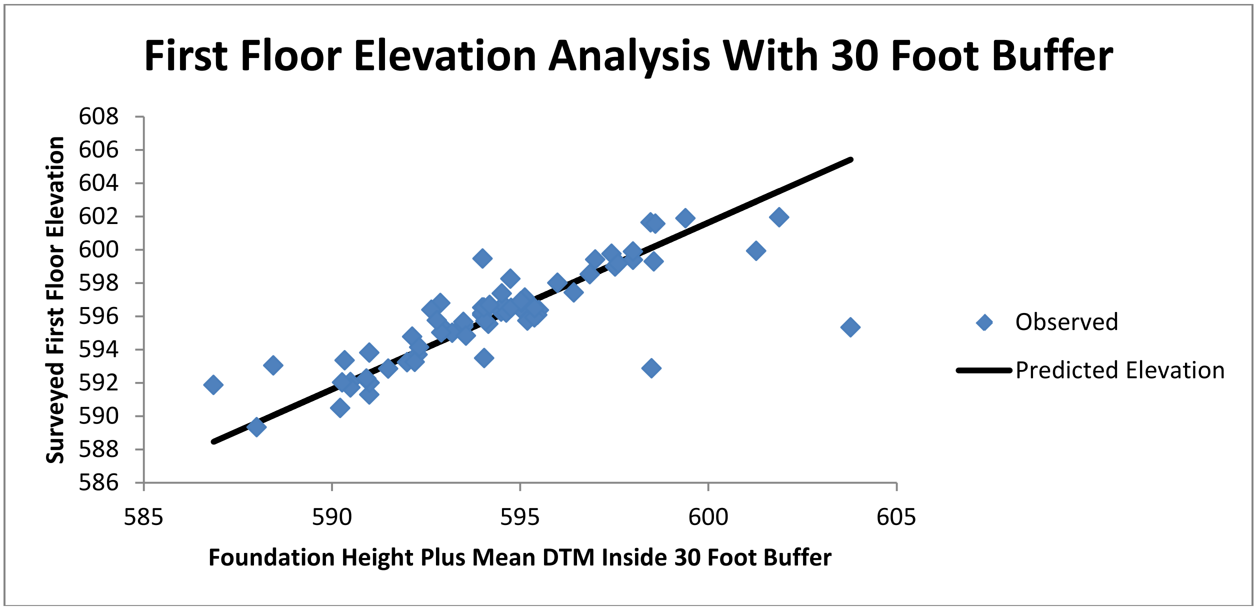
Figure 19 LAG = Minimum DTM within 30 feet of Center



Equation 13 : Surveyed Elevation = 0 + 1.003382*(Geospatial Elevation)

Regression Statistics	
R Square	0.99999
Standard Error	1.92
Observations	70

Figure 20 LAG = Mean DTM within 30 feet of Center



Equation 14 : Surveyed Elevation = 0 + 1.002713*(Geospatial Elevation)

Regression Statistics	
R Square	0.99999
Standard Error	1.90
Observations	70

With and Without-Project Condition Damages

Once all structure data was gathered, HEC-FDA version 1.2.5a was used to calculate expected annual flood damages (EAD). This model is certified in accordance with USACE Engineering Circular Number 1105-2-407, May 2005. The HEC-FDA program calculates EAD in the study area utilizing water surface elevation information, structure elevations, structure values, and depth-damage functions. EAD was calculated for both the base year (2017) and the future year when stage two of the McCook reservoir comes online (2029).

Exhibit F displays the EAD results for each year, and Exhibit G shows the total number of structures damaged by flood event. For the without project conditions in the base year (2017) the total mean expected annual damage for the Overland AOI is $26.5 million, and for the Sewer AOI is $227.3 million, for a total of $253.8 million. In the future year (2029), the total EAD is $20.7 million for the Overland AOI and $193.9 million for the Sewer AOI, for a total of $214.6 million.

Table 14 displays the total mean and most likely EAD for each without and with project condition for Commercial, Industrial, Public (CIP), and Residential structures.

Table 14 Expected Annual Damage - Entire Study Area

Mean EAD ($1,000's)

Category	CIP	Residential	Total
Without Project Base Year	$144,135	$109,690	$253,824
Without Project Future Year	$122,361	$92,225	$214,586
Lakeside Base Year	$251,403	$137,340	$388,743
Lakeside Project Future Year	$132,712	$95,989	$228,702
Midsystem Project Base Year	$145,233	$112,841	$258,074
Midsystem Project Future Year	$121,778	$91,670	$213,449

Most Likely* EAD ($1,000's)

Category	CIP	Residential	Total
Without Project Base Year	$37,387	$73,522	$110,909
Without Project Future Year	$29,360	$61,650	$91,010
Lakeside Base Year	$77,544	$90,891	$168,435
Lakeside Project Future Year	$33,292	$63,595	$96,887
Midsystem Project Base Year	$34,618	$76,170	$110,788
Midsystem Project Future Year	$29,561	$61,642	$91,203

With Project Change in Mean EAD ($1,000's)

Category	CIP	Residential	Total
Lakeside Base Year	*$107,268*	*$27,650*	*$134,918*
Lakeside Project Future Year	*$10,351*	*$3,765*	*$14,116*
Midsystem Project Base Year	*$1,098*	*$3,151*	*$4,250*
Midsystem Project Future Year	*-$583*	*-$554*	*-$1,137*

With Project Change in Most Likely* EAD ($1,000's)

Category	CIP	Residential	Total
Lakeside Base Year	*$40,157*	*$17,369*	*$57,526*
Lakeside Project Future Year	*$3,932*	*$1,946*	*$5,877*
Midsystem Project Base Year	*-$2,769*	*$2,648*	*-$121*
Midsystem Project Future Year	*$200*	*-$8*	*$193*

*The most likely value is the Average Annual Damage calculated without uncertainty. The mean value is the Expected Annual Damage calculated with uncertainty. The mean value incorporates the risks associated with errors in water surface elevations, structure values, structure elevations, etc. The most likely value is so called because it is based on the one-off estimates of these variables and is assumed to have the highest incremental probability.

There were three methods for estimating uncertainty in the depth-damage relationships for CIP structures with basements. The distributed results for each of these methods are presented in

Table 15. Method 3 is the prefered method, since it provides the widest condidence limits and is therefore more likely to contain the mean EAD. The best estimate for EAD is the Most Likely estimate provided in Table 14, which is estimated without any uncertainty.

Table 15 Distributed EAD

Without Project Distributed EAD ($1,000's) Base Year (2017)

			Probability EAD does not Exceed Indicated Value		
	Mean	Most Likely*	25%	50%	75%
Method 1	$185,521	$110,909	$118,154	$162,415	$236,527
Method 2	$202,995	$110,909	$130,184	$178,449	$258,980
Method 3	$253,825	$110,909	$163,897	$224,252	$323,757

Without Project Distributed EAD ($1,000's) Future Year (2029)

			Probability EAD does not Exceed Indicated Value		
	Mean	Most Likely*	25%	50%	75%
Method 1	$155,151	$91,010	$101,758	$136,759	$196,134
Method 2	$170,302	$91,010	$112,220	$150,507	$215,278
Method 3	$214,585	$91,010	$141,988	$190,483	$270,952

*The most likely value is the Average Annual Damage calculated without uncertainty. The mean value is the Expected Annual Damage calculated with uncertainty. The mean value incorporates the risks associated with errors in water surface elevations, structure values, structure elevations, etc.
The most likely value is so called because it is based on the one-off estimates of these variables and is assumed to have the highest incremental probability.

As stated in the "Overview of Method of Analysis" section, a physical barrier would be constructed on the Little Calumet River (LCR) in 3 of the alternative plans considered in GLMRIS. The GLMRIS HEC-FDA model, utilized to estimate the flooding impacts of the alternative plans considered in GLMRIS, did not include the portion of the LCR that lies east of Hart Ditch within Indiana. A corresponding analysis was utilized to estimate EEAD to this area.

A HEC-FDA model was developed in FY11 for the LCR Limited Reevaluation Report. This served as the model to estimate damages in Indiana associated with the three aforementioned GLMRIS alternative plans. The following process was utilized to estimate damages associated with the implementation of a barrier on the LCR.

1. The Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) detailed watershed plan (DWP) model was utilized by the USACE Chicago District (LRC) to estimate stage impacts ranging from 0.5 to 2.0 feet.
2. Without-project condition water surface profiles (with levees in place) within the HEC-FDA model were then adjusted by these stage increases, which also required River Mile (RM) stationing adjustments.
3. Exceedance probability functions were developed using Graphical Water Surface Profiles (WSP) and a 10-year equivalent record.
4. HEC-FDA simulations comparing the damages of the without-project condition (levees in place) and with-project condition (levees with GLMRIS barrier) were completed.

Sources of Uncertainty

The sources of uncertainty in the distributed EAD are discussed throughout the report. These uncertainties are summarized in Table 16 below, ranked in order of significance.

Table 16 Summary of Uncertainties

Parameter	Estimate of error	How it is Addressed in Analysis	Effect on EAD	Comments
Depth Damage Functions	St Error up to 160% of most likely value	Analysis captures full uncertainty	Significantly widens EAD confidence limits and inflates mean	This was analyzed in detail through interviews and regression analysis for CIP structures with basements. The effects are discussed extensively in report. Residential structures and CIP structures without basements contain a lesser degree of uncertainty
Beginning Damage Elevations	not directly estimated, accounted for in First Floor Elevations	Analysis does not fully address uncertainty	not analyzed	Most beginnning damage depths range from 0 to 4 feet below grade at structure. It is very difficult to determine where beginning damages will occur, even during an interview, due to the many unknown variables (performance of backflow preventers, potential for seepage through ground and foundation, etc.).
Water Surface Elevations	St Error up to 2ft. Estimated as normal distr. with 10 year period of record	Analysis captures full uncertainty	Widens EAD confidence limits	
First Floor Elevations	St Error of 2ft. Estimated by direct survey method	Analysis captures full uncertainty	Widens EAD confidence limits	This was analyzed in detail through surveys and regression analysis. A large source of uncertainty, however the exact impact on EAD distribution was estimated
Structure Values	St Error up to 68% of most likely value	Analysis captures full uncertainty	Widens EAD confidence limits	This was analyzed in detail through surveys and regression analysis. A large source of uncertainty, however the exact impact on EAD distribution was estimated
Content Values	St Error up to 10% of most likely value	Analysis does not fully address uncertainty	not analyzed	Content Values were estimated as a percentage of the structure value. With the exeption of CIP structures with basements, extensive detail was not collected pertaining to content values. Past studies were primary source of estimates
Location & Number of Structures	not directly estimated	Analysis does not fully address uncertainty	likely not a significant source of uncertainty	Extensive GIS processing lead to accurate spatial inventory. The shear size of Study Area does not allow for a minority of structures to dominate analysis

Estimating Flood Damages Associated With GLMRIS Alternative Plans

The purpose of this economic study is to characterize flood risk impacts from the potential implementation of the various alternative plans considered in GLMRIS. The AOI encompasses over 200 square miles of the Chicago metropolitan area – to include the: Chicago River, CSSC, the Cal-Sag Canal, the Calumet River, and portions of the Grand and Little Calumet Rivers. The area also includes sewer basins with outlets to the Chicago area waterways that could be impacted by a hydrologic separation alternative – to include the northwest portion of Indiana. This study analyzes physical damages to buildings and their contents, as well as other types of infrastructure such as rail yards, power equipment, etc.

Eight alternative plans are considered in GLMRIS – to include:

1. No New Federal Action
2. Non-Structural
3. Control Technology Without a Buffer Zone – Flow Bypass
4. Control Technology With a Buffer Zone
5. Lakefront Hydrologic Separation
6. Mid-System Hydrologic Separation
7. Hybrid – Mid-System Separation Cal-Sag Open
8. Hybrid – Mid-System Separation CSSC Open

Estimates of EAD were developed for each alternative plan.

Without-Project Condition: No New Federal Action

The HEC-FDA model was utilized to estimate EAD for the base (2017) and future year (2029) for the without-project condition. The estimates of EAD contain a great deal of uncertainty, due to the myriad of unknowns in water surface elevations, values of infrastructure, elevations of homes and businesses, and susceptibility of infrastructure to flood damage. Therefore, EAD is presented as a distributed variable with confidence limits.

For the base year, the mean value of EAD is $254 million with a 75% chance that EAD is greater than $118 million, a 50% chance that it is greater than $178 million, and a 25% chance that it is greater than $324 million. The most likely value of EAD is $110 million.

For the future year, the mean value of EAD is $215 million, with a 75% chance that EAD is greater than $102 million, a 50% chance that it is greater than $151 million, and a 25% chance that it is greater than $271 million. The most likely value of EAD is $91 million.

With-Project Condition: Lakefront and Mid-System Hydrologic Separation

The completion of the without-project condition estimates EAD for the base and future years allowed for their comparison with the with-project conditions. The HEC-FDA model was utilized to estimate the most like and mean values of EAD associated with the Lakefront and

Mid-System Separation alternative plans (as the remaining alternatives considered in GLMRIS had not been fully developed at the time of the FRM economic study).
The Lakeside alternative increases EAD by 53% in the base year (2017), and 6.6% in the future year (2029). The Mid-System alternative increases EAD in the base year by 1.7%, and decreases EAD in the future year by less than 1%. The table below provides a summary of the mean and most likely estimates of the impacts of these alternatives.

An estimated $570,000 of induced damages to the Indiana AOI would be expected. Impacts to interior drainage were not estimated, but since the majority of the levied sections are drained by pumping, it is assumed that interior drainage would be minimally impacted by increases in river stages.

Estimates of induced damages to the Grand Calumet River (GCR) were not produced since current damage estimates were not available at the time of the GLMRIS study. However, it is assumed that impacts would be minimal since the river does not currently induce substantial overbank flooding.

Table 17 Summary of Most Likely and Mean EADs

Base Year	Mean ($1,000s)
Without-Project EAD	$254,800
Lakeside Separation *Change in EAD*	$135,400
Mid-System Separation *Change in EAD*	$4,200
Future Year	**Mean ($1,000s)**
Without-Project EAD	$215,500
Lakeside Separation *Change in EAD*	$14,700
Mid-System Separation *Change in EAD*	-$1,100

With-Project Condition: Structural, Technology, and Hybrid Separation Alternatives

In order to estimate the EAD values for the five remaining GLMRIS alterative plans, the Mid-System and Lakeside Separation data was utilized. The additional alternatives include:

- Non-Structural
- Control Technology without a Buffer Zone - Flow Bypass
- Control Technology with a Buffer Zone
- Hybrid – Mid-System Separation Cal-Sag Open
- Hybrid – Mid-System Separation CSSC Open

Estimates of EAD for the five remaining alternatives were determined by segmenting the AOI into various regions. For each alternative, the applicable regions that are expected to be impacted by an alternative plan were included in the estimate of EAD, while the remaining AOI was excluded. For instance, if one alternative would be expected to induce damages in the northern part of the AOI, and not the southern portion, then EAD estimates for the northern part of

Chicago were utilized as a proxy for flood impacts in that alternative. Estimates of EAD for the five alternatives were generated by applying the following assumptions.

- *Non-Structural*: This alternative is expected to have the same level of flood risk as the without project condition (No New Federal Action plan) since it does not include any physical separation measures.
- *Control Technology without a Buffer Zone - Flow Bypass*: This alternative has a similar level of flood risk as the Mid-System alternative across the study area.
- *Control Technology with a Buffer Zone*: This alternative has a similar level of flood risk in the study area as without-project conditions, but an increased level of flood risk in the Indiana area.
- *Hybrid - Mid System Separation Cal-Sag Open*: This alternative has a similar level of flood risk as without project conditions in the Suburban South and Calumet River areas, and a similar level of flood risk as the Mid-System alternative in the Downtown East, Downtown West, Urban North, Urban South, and Suburban North, and Chicago River areas.
- *Hybrid - Mid System Separation CSSC Open*: This alternative has a similar level of flood risk as without project conditions in the Downtown East, Downtown West, Urban North, Urban South, and Suburban North, and Chicago River areas, and a similar level of flood risk as the Mid-System alternative in the Suburban South and Calumet River areas.

The EAD and EEAD (EEAD was calculated at a discount rate of 3.75 percent) for each alternative are presented in Table 18.

Table 18: Summary of Key Findings

GLMRIS Alternative Plan	Mean Expected Annual Damage (EAD) ($1,000s)

	Equivalent Annual	Equiv. Net[1] Change

No New Federal Action	$232,200	$0

Non-Structural	$232,200	$0

Control Technology Without a Buffer Zone – Flow Bypass	$233,300	$1,100

Control Technology With a Buffer Zone	$232,800	$600

Lakefront Hydrologic Separation	$298,100	$65,900
Mid-System Hydrologic Separation	$233,300	$1,100
Hybrid – Mid System Separation Cal-Sag Open	$260,200	$28,000
Hybrid – Mid System Separation CSSC Open	$205,800	-$26,400
1. This column displays the equivalent expected annual damages (EEAD) associated with the implementation of each GLMRIS alternative plan. In the without-project conditions, damages are expected to occur to various structures. However, the implementation of a GLMRIS plan will either increase the total damages in the Chicago area (represented as positive values in this column) or decrease total damages in the Chicago area (negative value). Specifically, the values presented represent the difference (i.e., net change) between the without-project condition (EEAD of $232.2 million) and the with-project conditions. *Positive values represent induced damages in the study area. Negative values represent a reduction in overall damages in the study area.		

CONCLUSION

The goal of the Navigation and Economics PDT is to establish the implications of the alternative plans presented in the GLRMIS Report. The FRM team was tasked with addressing potential flood damages associated with the implementation of these plans. By utilizing two HEC-FDA models (to account for EAD values in Illinois and Indiana), estimates of induced flood damages were developed. The difference between the with-project and without-project conditions yielded the net change in EAD associated with each alternative plan. It was determined that several of the alternatives considered in GLMRIS would induce flooding in the Chicagoland area as well as the northwest portion of Indiana. This FRM economic analysis displays important information regarding the implications of the various plans considered in GLMRIS.

Flood Risk Management Economic Analysis

Great Lakes and Mississippi River Interbasin Study (GLMRIS)

Exhibit A - Cook County Class Codes

DEFINITIONS FOR THE CODES FOR CLASSIFICATION OF REAL PROPERTY

Major Class 0 Exempt and Railroad

EX	Exempt Property
RR	Railroad Property

Major Class 1 Vacant *(10% level of assessment)*

1-00	Vacant Land
1-90	Minor Improvement on Vacant Land

Major Class 2 Residential *(10% level of assessment)*

Regression Classes

2-00	Residential Land
2-02	One Story Residence, any age, up to 999 square feet
2-03	One Story Residence, any age, 1,000 to 1,800 square feet
2-04	One Story Residence, any age, 1,801 square feet and over
2-05	Two or more story residence, over 62 years of age up to 2,200 square feet
2-06	Two or more story residence, over 62 years of age, 2,201 to 4,999 square feet
2-07	Two or more story residence, up to 62 years of age, up to 2,000 square feet
2-08	Two or more story residence, up to 62 years of age, 3,801 to 4,999 square feet
2-09	Two or more story residence, any age, 5,000 square feet and over
2-10	Old style row house (town home), over 62 years of age

2-11 Apartment building with 2 to 6 units, any age

2-12 Mixed use commercial/residential building with apartment and commercial area totaling 6 units or less with a square foot area less than 20,00 square feet, any age

2-34 Split level residence with a lower level below grade (ground level) all ages, all sizes

2-78 Two or more story residence, up to 62 years of age, 2,001 to 3,800 square feet

2-95 Individually owned townhome or row house up to 62 years of age

Non-Regression Classes

2-00 Residential land

2-39 Non-equalized land under agricultural use, valued at farm pricing

2-40 First time agricultural use of land valued at market price

2-41 Vacant land under common ownership with adjacent residence

2-01 Residential garage

2-13 Cooperative

2-24 Farm Building

2-25 Single room occupancy rental building

2-36 Any residence located on a parcel used primarily for commercial or industrial purposes

2-88 Home improvement exemption

2-90 Minor improvement

2-97 Special residential improvements (May apply to condo building in first year of construction before division into individual units.)

2-99 Residential condominium

Major Class 3 Multi Family

16% - 2009
13% - 2010
10% - 2011

3-00	Land used in conjunction with rental apartments
3-01	Garage used in conjunction with rental apartments
3-13	Two or three story building seven or more units
3-14	Two or three story non-fireproof building with corridor apartment or California type apartments, no corridors exterior entrance
3-15	Two or three story non-fireproof corridor apartments or California type apartments, interior entrance
3-18	Mixed use commercial/residential building with apartments and commercial area totaling seven units or more with a square foot area of over 20,000 square feet
3-90	Other minor improvement related to rental use
3-91	Apartment building over three stories, seven or more units
3-96	Rented modern row houses, seven or more units in a single development or one or more contiguous parcels in common ownership
3-97	Special rental structure
3-99	Rental condominium

Major Class 4 Not For Profit *(25% level of assessment)*

4-00	Not for profit land
4-01	Not for profit garage
4-17	Not for profit one story commercial building
4-18	Not for profit two or three story mixed use commercial/residential building
4-22	Not for profit one story non-fireproof public garage
4-23	Not for profit gasoline station
4-26	Not for profit commercial greenhouse
4-27	Not for profit theatre
4-28	Not for profit bank building
4-29	Not for profit motel

4-30	Not for profit supermarket
4-31	Not for profit shopping center
4-32	Not for profit bowling alley
4-33	Not for profit quonset hut or butler type building
4-35	Not for profit golf course improvement
4-80	Not for profit industrial minor improvement
4-81	Not for profit garage used in conjunction with industrial improvement
4-83	Not for profit industrial quonset hut or butler type building
4-87	Not for profit special industrial improvement
4-89	Not for profit industrial condominium
4-90	Not for profit commercial minor improvement
4-91	Not for profit improvement over three stories
4-92	Not for profit two or three story building containing part or all retail and/or commercial space
4-93	Not for profit industrial building
4-96	Not for profit rented modern row houses, seven or more units in a single development
4-97	Not for profit special structure
4-99	Not for profit condominium

Major Class 5A Commercial *(25% level of assessment)*

5-00	Commercial land
5-35	Golf course land
5-01	Garage used in conjunction with commercial improvements
5-16	Non-fireproof hotel or rooming house (apartment hotel)
5-17	One story commercial building
5-22	One story non-fireproof public garage
5-23	Gasoline station
5-26	Commercial greenhouse
5-27	Theatre
5-28	Bank building
5-29	Motel
5-30	Supermarket

5-31	Shopping center
5-32	Bowling alley
5-33	Quonset hut or butler type building
5-35	Golf course improvement
5-90	Commercial minor improvement
5-91	Commercial building over three stories
5-92	Two or three story building containing part or all retail and/or commercial space
5-97	Special commercial structure
5-99	Commercial condominium unit

Major Class 5B Industrial *(25% level of assessment)*

5-50	Industrial land
5-80	Industrial minor improvement
5-81	Garage used in conjunction with industrial improvement
5-83	Industrial quonset hut or butler type building
5-87	Special industrial improvement
5-89	Industrial condominium unit
5-93	Industrial building

Major Class 6A Industrial Incentive

A. Industrial Incentive Classes (6A)

6-50	Industrial land
6-80	Industrial minor improvement
6-81	Garage used in conjunction with industrial incentive improvement
6-83	Industrial quonset hut or butler type building
6-87	Special industrial improvement
6-89	Industrial condominium unit
6-93	Industrial building

B. Industrial Incentive Classes (6B)

6-51	Industrial land
6-63	Industrial building
6-70	Industrial minor improvement
6-71	Garage used in conjunction with industrial incentive improvement
6-73	Industrial quonset hut or butler type building
6-77	Special industrial improvement
6-79	Industrial condominium unit

Major Class 6C Industrial Brownfield Incentive

6-37	Industrial Brownfield land
6-38	Industrial Brownfield
6-54	Other industrial Brownfield minor improvements
6-55	Garage used in conjunction with industrial Brownfield incentive improvement
6-66	Industrial Brownfield quonset hut or butler type building
6-68	Special industrial Brownfield improvement
6-69	Industrial Brownfield condominium unit

Major Class 7 Commercial Incentive

A. Commercial Incentive Classes

7-00	Commercial Incentive Land
7-35	Golf Course Land
7-01	Garage used in conjunction with Commercial Incentive improvement
7-16	Non-Fireproof hotel or rooming house (Apartment hotel)
7-17	One story commercial use building
7-22	Garage, service station
7-23	Gasoline station, with /without bays, store
7-26	Commercial greenhouse
7-27	Theatre

7-28	Bank building
7-29	Motel
7-30	Supermarket
7-31	Shopping center
7-32	Bowling alley
7-33	Quonset hut or butler type building
7-35	Golf course improvement
7-90	Other minor commercial improvement
7-91	Office building (One story, low, rise, mid rise, high rise)
7-92	Two or three story building containing part or all retail and/or commercial space
7-97	Special commercial structure
7-99	Commercial/Industrial-Condominium unit/garage

B. Commercial Incentive Classes

7-42	Commercial incentive land
7-45	Golf course land
7-43	Garage used in conjunction with commercial incentive improvement
7-45	Golf course improvement
7-46	Non-Fireproof hotel or rooming house (Apartment hotel)
7-47	One story commercial building
7-48	Motel
7-52	Garage, service station
7-53	Gasoline station, with/without bays, store
7-56	Commercial greenhouse
7-57	Theatre
7-58	Bank building
7-60	Supermarket
7-61	Shopping center (Regional, community, neighborhood, promotional, specialty)
7-62	Bowling alley
7-64	Quonset hut or butler type building
7-65	Other minor commercial improvements
7-67	Special commercial structure

7-72	Two or three story building containing part or all retail and/or commercial space
7-74	Office building
7-98	Commercial/Industrial-condominium units/garage

Major Class 8 Commercial/Industrial Incentive

8-00	Commercial incentive land
8-35	Golf course land
8-50	Industrial incentive land
8-01	Garage used in conjunction with commercial incentive improvement
8-16	Non-fireproof hotel or rooming house (apartment hotel)
8-17	One story commercial building
8-22	Garage, service station
8-23	Gasoline station with/without bay, store
8-26	Commercial greenhouse
8-27	Theatre
8-28	Bank building
8-29	Motel
8-30	Supermarket
8-31	Shopping center (Regional, community, neighborhood, promotional, specialty)
8-32	Bowling alley
8-33	Quonset hut or butler type building
8-35	Golf course improvement
8-80	Industrial minor improvement
8-81	Garage used in conjunction with industrial incentive improvement
8-83	Quonset hut or butler type building
8-87	Special industrial improvement
8-89	Industrial condominium unit
8-90	Minor industrial improvement
8-91	Office building
8-92	Two or three story building containing part or all retail and/or commercial space

8-93	Industrial building
8-97	Special commercial structure
8-99	Commercial/Industrial condominium unit/garage

Major Class 9 Multi Family Incentive

9-00	Land used in conjunction with incentive rental apartments
9-01	Garage used in conjunction with incentive rental apartment
9-13	Two or three story apartment building, seven or more units
9-14	Two or three story non-fireproof court and corridor apartments or California type apartments, no corridors, exterior entrance
9-15	Two or three story non-fireproof corridor apartments, or California type apartments, interior entrance
9-18	Mixed use commercial/residential building with apartments and commercial area where the commercial area is granted an incentive use
9-59	Rental condominium unit
9-90	Other minor improvements
9-91	Apartment buildings over three stories
9-96	Rented modern row houses, seven or more units in a single development or one or more contiguous parcels in common ownership
9-97	Special rental structure

Valid Major Class 6 to 9 and “C”, “L”, “S” Major Classes Incentive CDU’s

CDU represents the area on the Assessor’s Office record where the incentive type is stored. The CDU is shown on AINQ and the facesheet under the heading “CDU”.

Major Class 6A

CDU = Blank	Industrial; 2009 ordinance; 8 years at 20%

Major Class 6B

CDU = ‘PB’	Industrial; 2009 ordinance; 10% for the first 10 years and any subsequent 10 year renewal period; if not renewed, 15% in the 11th year, 20% in the 12th year

Major Class 6C

CDU = ‘BF’	2009 ordinance; 3 years at 10%

Major Class 7A

CDU = ‘SA’	Industrial; 2009 ordinance; 10% for the first 10 years, 15% in the 11th year, 20% in the 12th year, eligible for renewable terms, it not renewed, returns to 25% in year 13.
CDU = “CM”	Commercial: 2009 ordinance; 10% for first 10 years,15% in the 11th year, 20% in 12th year, not eligible for renewal.

Major Class 7B

CDU = ‘CB’	Commercial; 2009 ordinance; 10% for first 10 years,15% in the 11th year, 20% in 12th year, not eligible for renewal.
CDU = ‘SB’	Industrial; 2009 ordinance; 10% for first 10 years,15% in the 11th year, 20% in 12th year, not eligible for renewal.

Major Class 8

CDU = ‘RE’	Industrial; 2009 ordinance; 10% for the first 10 years and any subsequent renew period; if not renewed, 15% in the 11th year, 20% in the 12th year, 25% in the 13th and subsequent years;
CDU = ‘RC’	Industrial; 2009 ordinance; 10% for the first 10 years and any subsequent renew period; if not renewed, 15% in the 11th year, 20% in the 12th year, 25% in the 13th and subsequent years, not eligible for renewal.

Major Class 9

CDU = 'AP'	Apartments; 2009 ordinance; 10 years at 10%

Major Class "C" *(Reflected in Major Class 6)*

CDU = 'CL'	Industrial; 2009 ordinance; 10% for the first 10 years and for any subsequent 10 year renewal period; if not renewed, 15% in the 11th year, 20% in the 12th year.
CDU = 'CC'	Commercial; 2009 ordinance; 10% in the first 10 years, 15% in the 11th year, 20% in the 12th year, not eligible for renewal.

Major Class "L" *(Reflected in Major Class 3, 4, 5 and 6 (Landmark))*

CDU = 'LI'	Industrial landmark; 2009 ordinance; 10% for 8 years, 15% in the 9th year, 20% in the 10th year
CDU = 'LL'	Commercial landmark; 2009 ordinance; 10% for 8 years, 15% in the 9th year, 20% in the 10th year, not eligible for renewal.
CDU = 'LM'	Multifamily Class 3 landmark; 2009 ordinance 10% for 10 years and for any subsequent renewal periods; if not renewed, 15% in year 11 and 20% in year 12.
CDU = 'LP'	Not-for-Profit landmark 2009 ordinance 10% for 10 years and for any subsequent renewal periods; if not renewed 15% in year 11 and 20% in year 12.
CDU = 'LD'	Industrial landmark 2009 ordinance 10% for 10 years and for any subsequent renewal periods, if not renewed 15% in year 11 and 20% in year 12.
CDU = 'LC'	Commercial landmark 2009 ordinance 10% for 10 years, 15% in year 11 and 20% in year 12, not eligible for renewal.

Major Class "S" *(Reflected in Major Class 3)*

CDU = 'S'	Multifamily class 3; 2009 ordinance 10% for the term (at least 5 years) of the section 8 contract renewal under the mark up to the market option and then any additional terms of renewal under that contract.

Flood Risk Management Economic Analysis

Great Lakes and Mississippi River Interbasin Study (GLMRIS)

Exhibit B - Fair Market Value Conversions

ImpClass	ImpDesc	Assessment Level	Fair Market Value Factor	MajClass
0	Exempt Property	10%	10	Major Class 0 Exempt and Railroad
202	One Story Residence, any age, up to 999 square feet	10%	10	Major Class 2 Residential (10% level of assessment)
203	One Story Residence, any age, 1,000 to 1,800 square feet	10%	10	Major Class 2 Residential (10% level of assessment)
204	One Story Residence, any age, 1,801 square feet and over	10%	10	Major Class 2 Residential (10% level of assessment)
205	Two or more story residence, over 62 years of age up to2,200 square feet	10%	10	Major Class 2 Residential (10% level of assessment)
206	Two or more story residence, over 62 years of age, 2,201 to 4,999 square feet	10%	10	Major Class 2 Residential (10% level of assessment)
207	Two or more story residence, up to 62 years of age, up to2,000 square feet	10%	10	Major Class 2 Residential (10% level of assessment)
208	Two or more story residence, up to 62 years of age, 3,801to 4,999 square feet	10%	10	Major Class 2 Residential (10% level of assessment)
209	Two or more story residence, any age, 5,000 square feetandover	10%	10	Major Class 2 Residential (10% level of assessment)
210	Old style row house (town home), over 62 years of age	10%	10	Major Class 2 Residential (10% level of assessment)
211	Apartment building with 2 to 6 units, any age	10%	10	Major Class 2 Residential (10% level of assessment)
212	Mixed use commercial/residential building with apartmentandcommercial area totaling 6 units or less with a squarefootarea less than 20,00 square feet, any age	10%	10	Major Class 2 Residential (10% level of assessment)
213	Cooperative	10%	10	Major Class 2 Residential (10% level of assessment)
224	Farm Building	10%	10	Major Class 2 Residential (10% level of assessment)
225	Single room occupancy rental building	10%	10	Major Class 2 Residential (10% level of assessment)
234	Split level residence with a lower level below grade(ground level) all ages, all sizes	10%	10	Major Class 2 Residential (10% level of assessment)
236	Any residence located on a parcel used primarily forcommercial or industrial purposes	10%	10	Major Class 2 Residential (10% level of assessment)
278	Two or more story residence, up to 62 years of age, 2,001to 3,800 square feet	10%	10	Major Class 2 Residential (10% level of assessment)
295	Individually owned townhome or row house up to 62 yearsof age	10%	10	Major Class 2 Residential (10% level of assessment)
297	Special residential improvements (May apply to condobuilding in first year of construction before division intoindividual units.)	10%	10	Major Class 2 Residential (10% level of assessment)
299	Residential condominium	16%	6.25	Major Class 2 Residential (10% level of assessment)
313	Two or three story building seven or more units	16%	6.25	Major Class 3 Multi Family
314	Two or three story non-fireproof building with corridorapartment or California type apartments, no corridorsexterior entrance	16%	6.25	Major Class 3 Multi Family
315	Two or three story non-fireproof corridor apartments orCalifornia type apartments, interior entrance	16%	6.25	Major Class 3 Multi Family
318	Mixed use commercial/residential building with apartmentsandcommercial area totaling seven units or more with asquare foot area of over 20,000 square feet	16%	6.25	Major Class 3 Multi Family
391	Apartment building over three stories, seven or more units	16%	6.25	Major Class 3 Multi Family
396	Rented modern row houses, seven or more units in a singledevelopment or one or more contiguous parcels in commonownership	16%	6.25	Major Class 3 Multi Family
397	Special rental structure	16%	6.25	Major Class 3 Multi Family
399	Rental condominium	16%	6.25	Major Class 3 Multi Family
401	Not for profit garage	25%	4	Major Class 4 Not For Profit (25% level of assessment)
417	Not for profit one story commercial building	25%	4	Major Class 4 Not For Profit (25% level of assessment)
418	Not for profit two or three story mixed usecommercial/residential building	25%	4	Major Class 4 Not For Profit (25% level of assessment)
422	Not for profit one story non-fireproof public garage	25%	4	Major Class 4 Not For Profit (25% level of assessment)
423	Not for profit gasoline station	25%	4	Major Class 4 Not For Profit (25% level of assessment)
426	Not for profit commercial greenhouse	25%	4	Major Class 4 Not For Profit (25% level of assessment)
427	Not for profit theatre	25%	4	Major Class 4 Not For Profit (25% level of assessment)
428	Not for profit bank building	25%	4	Major Class 4 Not For Profit (25% level of assessment)
429	Not for profit motel	25%	4	Major Class 4 Not For Profit (25% level of assessment)
430	Not for profit supermarket	25%	4	Major Class 4 Not For Profit (25% level of assessment)
431	Not for profit shopping center	25%	4	Major Class 4 Not For Profit (25% level of assessment)
432	Not for profit bowling alley	25%	4	Major Class 4 Not For Profit (25% level of assessment)
433	Not for profit quonset hut or butler type building	25%	4	Major Class 4 Not For Profit (25% level of assessment)
435	Not for profit golf course improvement	25%	4	Major Class 4 Not For Profit (25% level of assessment)
481	Not for profit garage used in conjunction with industrialimprovement	25%	4	Major Class 4 Not For Profit (25% level of assessment)
483	Not for profit industrial quonset hut or butler type building	25%	4	Major Class 4 Not For Profit (25% level of assessment)
487	Not for profit special industrial improvement	25%	4	Major Class 4 Not For Profit (25% level of assessment)
489	Not for profit industrial condominium	25%	4	Major Class 4 Not For Profit (25% level of assessment)

ImpClass	ImpDesc	Assessment Level	Fair Market Value Factor	MajClass
491	Not for profit improvement over three stories	25%	4	Major Class 4 Not For Profit (25% level of assessment)
492	Not for profit two or three story building containing part orallretail and/or commercial space	25%	4	Major Class 4 Not For Profit (25% level of assessment)
493	Not for profit industrial building	25%	4	Major Class 4 Not For Profit (25% level of assessment)
496	Not for profit rented modern row houses, seven or moreunits in a single development	25%	4	Major Class 4 Not For Profit (25% level of assessment)
497	Not for profit special structure	25%	4	Major Class 4 Not For Profit (25% level of assessment)
499	Not for profit condominium	25%	4	Major Class 4 Not For Profit (25% level of assessment)
516	Non-fireproof hotel or rooming house (apartment hotel)	25%	4	Major Class 5A Commercial (25% level of assessment)
517	One story commercial building	25%	4	Major Class 5A Commercial (25% level of assessment)
522	One story non-fireproof public garage	25%	4	Major Class 5A Commercial (25% level of assessment)
523	Gasoline station	25%	4	Major Class 5A Commercial (25% level of assessment)
526	Commercial greenhouse	25%	4	Major Class 5A Commercial (25% level of assessment)
527	Theatre	25%	4	Major Class 5A Commercial (25% level of assessment)
528	Bank building	25%	4	Major Class 5A Commercial (25% level of assessment)
529	Motel	25%	4	Major Class 5A Commercial (25% level of assessment)
530	Supermarket	25%	4	Major Class 5A Commercial (25% level of assessment)
531	Shopping center	25%	4	Major Class 5A Commercial (25% level of assessment)
532	Bowling alley	25%	4	Major Class 5A Commercial (25% level of assessment)
533	Quonset hut or butler type building	25%	4	Major Class 5A Commercial (25% level of assessment)
535	Golf course improvement	25%	4	Major Class 5A Commercial (25% level of assessment)
583	Industrial quonset hut or butler type building	25%	4	Major Class 5B Industrial (25% level of assessment)
587	Special industrial improvement	25%	4	Major Class 5B Industrial (25% level of assessment)
589	Industrial condominium unit	25%	4	Major Class 5B Industrial (25% level of assessment)
591	Commercial building over three stories	25%	4	Major Class 5A Commercial (25% level of assessment)
592	Two or three story building containing part or all retailand/or commercial space	25%	4	Major Class 5A Commercial (25% level of assessment)
593	Industrial building	25%	4	Major Class 5B Industrial (25% level of assessment)
597	Special commercial structure	25%	4	Major Class 5A Commercial (25% level of assessment)
599	Commercial condominium unit	25%	4	Major Class 5A Commercial (25% level of assessment)
638	Industrial Brownfield	10%	10	Major Class 6C Industrial Brownfield Incentive
655	Garage used in conjunction with industrial Brownfieldincentive improvement	10%	10	Major Class 6C Industrial Brownfield Incentive
663	Industrial building	20%	5	Major Class 6A Industrial Incentive
666	Industrial Brownfield quonset hut or butler type building	10%	10	Major Class 6C Industrial Brownfield Incentive
668	Special industrial Brownfield improvement	10%	10	Major Class 6C Industrial Brownfield Incentive
669	Industrial Brownfield condominium unit	10%	10	Major Class 6C Industrial Brownfield Incentive
673	Industrial quonset hut or butler type building	20%	5	Major Class 6A Industrial Incentive
677	Special industrial improvement	20%	5	Major Class 6A Industrial Incentive
679	Industrial condominium unit	20%	5	Major Class 6A Industrial Incentive
681	Garage used in conjunction with industrial incentiveimprovement	20%	5	Major Class 6A Industrial Incentive
683	Industrial quonset hut or butler type building	20%	5	Major Class 6A Industrial Incentive
687	Special industrial improvement	20%	5	Major Class 6A Industrial Incentive
689	Industrial condominium unit	20%	5	Major Class 6A Industrial Incentive
693	Industrial building	20%	5	Major Class 6A Industrial Incentive
701	Garage used in conjunction with Commercial Incentiveimprovement	10%	10	Major Class 7 Commercial Incentive
716	Non-Fireproof hotel or rooming house (Apartment hotel)	10%	10	Major Class 7 Commercial Incentive
717	One story commercial use building	10%	10	Major Class 7 Commercial Incentive
722	Garage, service station	10%	10	Major Class 7 Commercial Incentive
723	Gasoline station, with /without bays, store	10%	10	Major Class 7 Commercial Incentive
726	Commercial greenhouse	10%	10	Major Class 7 Commercial Incentive
727	Theatre	10%	10	Major Class 7 Commercial Incentive
728	Bank building	10%	10	Major Class 7 Commercial Incentive
729	Motel	10%	10	Major Class 7 Commercial Incentive
730	Supermarket	10%	10	Major Class 7 Commercial Incentive
731	Shopping center	10%	10	Major Class 7 Commercial Incentive
732	Bowling alley	10%	10	Major Class 7 Commercial Incentive
733	Quonset hut or butler type building	10%	10	Major Class 7 Commercial Incentive
735	Golf course improvement	10%	10	Major Class 7 Commercial Incentive
743	Garage used in conjunction with commercial incentiveimprovement	10%	10	Major Class 7 Commercial Incentive
745	Golf course improvement	10%	10	Major Class 7 Commercial Incentive
746	Non-Fireproof hotel or rooming house (Apartment hotel)	10%	10	Major Class 7 Commercial Incentive
747	One story commercial building	10%	10	Major Class 7 Commercial Incentive
748	Motel	10%	10	Major Class 7 Commercial Incentive
752	Garage, service station	10%	10	Major Class 7 Commercial Incentive
753	Gasoline station, with/without bays, store	10%	10	Major Class 7 Commercial Incentive

ImpClass	ImpDesc	Assessment Level	Fair Market Value Factor	MajClass
756	Commercial greenhouse	10%	10	Major Class 7 Commercial Incentive
757	Theatre	10%	10	Major Class 7 Commercial Incentive
758	Bank building	10%	10	Major Class 7 Commercial Incentive
760	Supermarket	10%	10	Major Class 7 Commercial Incentive
761	Shopping center (Regional, community, neighborhood,promotional, specialty)	10%	10	Major Class 7 Commercial Incentive
762	Bowling alley	10%	10	Major Class 7 Commercial Incentive
764	Quonset hut or butler type building	10%	10	Major Class 7 Commercial Incentive
767	Special commercial structure	10%	10	Major Class 7 Commercial Incentive
772	Two or three story building containing part or all retailand/or commercial space	10%	10	Major Class 7 Commercial Incentive
774	Office building	10%	10	Major Class 7 Commercial Incentive
791	Office building (One story, low, rise, mid rise, high rise)	10%	10	Major Class 7 Commercial Incentive
792	Two or three story building containing part or all retailand/or commercial space	10%	10	Major Class 7 Commercial Incentive
797	Special commercial structure	10%	10	Major Class 7 Commercial Incentive
798	Commercial/Industrial-condominium units/garage	10%	10	Major Class 7 Commercial Incentive
799	Commercial/Industrial-Condominium unit/garage	10%	10	Major Class 7 Commercial Incentive
801	Garage used in conjunction with commercial incentiveimprovement	10%	10	Major Class 8 Commercial/Industrial Incentive
816	Non-fireproof hotel or rooming house (apartment hotel)	10%	10	Major Class 8 Commercial/Industrial Incentive
817	One story commercial building	10%	10	Major Class 8 Commercial/Industrial Incentive
822	Garage, service station	10%	10	Major Class 8 Commercial/Industrial Incentive
823	Gasoline station with/without bay, store	10%	10	Major Class 8 Commercial/Industrial Incentive
826	Commercial greenhouse	10%	10	Major Class 8 Commercial/Industrial Incentive
827	Theatre	10%	10	Major Class 8 Commercial/Industrial Incentive
828	Bank building	10%	10	Major Class 8 Commercial/Industrial Incentive
829	Motel	10%	10	Major Class 8 Commercial/Industrial Incentive
830	Supermarket	10%	10	Major Class 8 Commercial/Industrial Incentive
831	Shopping center (Regional, community, neighborhood,promotional, specialty)	10%	10	Major Class 8 Commercial/Industrial Incentive
832	Bowling alley	10%	10	Major Class 8 Commercial/Industrial Incentive
833	Quonset hut or butler type building	10%	10	Major Class 8 Commercial/Industrial Incentive
881	Garage used in conjunction with industrial incentiveimprovement	10%	10	Major Class 8 Commercial/Industrial Incentive
883	Quonset hut or butler type building	10%	10	Major Class 8 Commercial/Industrial Incentive
887	Special industrial improvement	10%	10	Major Class 8 Commercial/Industrial Incentive
889	Industrial condominium unit	10%	10	Major Class 8 Commercial/Industrial Incentive
891	Office building	10%	10	Major Class 8 Commercial/Industrial Incentive
892	Two or three story building containing part or all retailand/or commercial space	10%	10	Major Class 8 Commercial/Industrial Incentive
893	Industrial building	10%	10	Major Class 8 Commercial/Industrial Incentive
897	Special commercial structure	10%	10	Major Class 8 Commercial/Industrial Incentive
899	Commercial/Industrial condominium unit/garage	10%	10	Major Class 8 Commercial/Industrial Incentive
913	Two or three story apartment building, seven or more units	10%	10	Major Class 9 Multi Family Incentive
914	Two or three story non-fireproof court and corridorapartments or California type apartments, no corridors,exterior entrance	10%	10	Major Class 9 Multi Family Incentive
915	Two or three story non-fireproof corridor apartments, orCalifornia type apartments, interior entrance	10%	10	Major Class 9 Multi Family Incentive
918	Mixed use commercial/residential building with apartmentsandcommercial area where the commercial area is grantedan incentive use	10%	10	Major Class 9 Multi Family Incentive
959	Rental condominium unit	10%	10	Major Class 9 Multi Family Incentive
991	Apartment buildings over three stories	10%	10	Major Class 9 Multi Family Incentive
996	Rented modern row houses, seven or more units in a singledevelopment or one or more contiguous parcels in commonownership	10%	10	Major Class 9 Multi Family Incentive
997	Special rental structure	10%	10	Major Class 9 Multi Family Incentive

Flood Risk Management Economic Analysis

Great Lakes and Mississippi River Interbasin Study (GLMRIS)

Exhibit C - Correspondence

-----Original Message-----
From: Awsumb, Lance G MVP
Sent: Friday, December 07, 2012 11:13 AM
To: Carl, Robert D IWR-HEC
Cc: Carr, John P MVR; Hatch, Kathryn MVP @ MVR; Linkowski, Daniel MVS@MVP
Subject: FDA and Sewer Flooding Hydraulic Model (UNCLASSIFIED)
Classification: UNCLASSIFIED
Caveats: NONE
Bob,

I am soliciting your opinion on a study we (CCed) are working on in the Chicago Metro. The study is the Great Lakes and Mississippi River Interbasin Study (GLMRIS). The major part of the study area is affected by sewer flooding, as opposed to surface runoff. We have conducted interviews to determine the sewer water entry points and the depth-damages at structures. The hydraulic team is utilizing a model called Infoworks (similar to XPSWMM) to analyze storm and sewer water for eight rainfall events (frequencies up to 500 year). We will get the maximum sewer water surface elevation for these events for each sewer basin in the study area. Our current plan is to run FDA for the flood risk analysis:

1 - assign each structure in our inventory a number that relates it to a particular sewer basin
2 - Import the water surface elevations for each sewer basin, but instead of a river mile, use a unique number as the station (that number gets assigned to structures)
3 - Aggregate stage-damage functions to an index location
4 - Analyze EAD using an elevation-frequency function at the index locations

The biggest concern is with the aggregation. I believe that as long as there is no interpolation of elevation (structures are assigned exactly to a sewer basin), and the water surface elevations for each basin are increasing or flat by frequency, the results should be valid. By valid I mean that the aggregated stage-damage functions are representative of the individual stage damages at each structure. We want the damage at the 1% stage at each structure to be summed, and then have that sum related to the 1% stage at the index location... same for the 2% etc. I realize that the Monte Carlo engine will aggregate damage using a sampling method, but the thought process is the same. We obviously do not want to force FDA to do something that might provide erroneous results, so we would be grateful for any comments you might have on our plan. A couple afterthoughts: we have about 550,000 structures, about 9,000 sewer basins (most of which cover less than 10 acres). We will probably do about 5 FDA models, just to keep the number of structures in each down.

Thanks,

Lance
Lance Awsumb
U.S. Army Corps of Engineers
St Paul District
651 290 5379

-----Original Message-----
From: Carl, Robert D IWR-HEC
Sent: Friday, December 07, 2012 3:38 PM
To: Awsumb, Lance G MVP
Cc: Carr, John P MVR; Hatch, Kathryn MVP @ MVR; Linkowski, Daniel MVS@MVP
Subject: RE: FDA and Sewer Flooding Hydraulic Model (UNCLASSIFIED)
Classification: UNCLASSIFIED
Caveats: NONE

Lance,

This should be doable.

I presume that you won't have one damage reach for each sewer basin. If you did, then breaking it out into five models would still mean that you have a lot of damage reaches and calculating the EAD would be slow since the speed of computations is related to the number of cross-sections.

To aggregate damage, you do need profiles even if they are flat and even if you assign the structures to have the exact stream station and the sewer basin identifiers. How will you bring the stage-probability data in? Will they be imported as ASCII tab delimited profiles? If so, then the numbering system for the cross-sections would be important. Normally, FDA expects cross-section identifiers/numbers to start low and increase in value and it will interpolate stages between cross-sections based on the structure's stream station and the cross-section stream stations. To do this interpolation, FDA searches the cross-section identifiers, finds one that exceeds that of the structure, then does the interpolation. That means, for your scheme to work, the cross-section identifiers/numbers must increase in value even though you set a structure stream station to exactly equal that of a particular sewer basin. For example, you might set the sewer basin numbers ("cross-section identifiers) to be 101, 102, 103, 104, 105, etc. In your profile data, they would have to appear in that order, they couldn't be something like 101, 105, 102, 103, 104. I'm assuming that the sewer basins are pseudo cross-sections. I think that this is the biggest caveat in performing your study.

The Sacramento District does something similar to this when dealing with two dimensional flow data. The grid cells are treated like cross-sections and the structures are assigned the exact identifier for the grid.

The Louisville District did a similar study to yours with the Louisville sewer system a number of years ago. I don't know much about it and a lot of it was done by a consultant, but they were dealing with some of the same problems that you are dealing with (thousands of sewer basins, stage-probability profiles and functions, etc.).

Bob
Robert Carl
robert.carl@usace.army.mil
(530) 756-1104

-----Original Message-----
From: Staley, George C MVR
Sent: Tuesday, April 10, 2012 1:09 PM
To: Carl, Robert D IWR-HEC
Cc: Hanna-Holloway, Nathaniel L MVR; Hatch, Kathryn E MVR
Subject: period of record for HEC-FDA (UNCLASSIFIED)
Classification: UNCLASSIFIED
Caveats: NONE

Bob,
About five years ago we had a discussion concerning the smallest period of record to use in generating a discharge frequency relationship within HEC-FDA. I believe you told me the period should be larger than 20 years. Did I remember this correctly? I have been asked to comment on an study plan that plans to use a period of record of 10 years for FDA.
George Staley
Rock Island District EC-HH
309.794.5318

-----Original Message-----
From: Carl, Robert D IWR-HEC
Sent: Tuesday, April 10, 2012 3:56 PM
To: Staley, George C MVR
Cc: Hanna-Holloway, Nathaniel L MVR; Hatch, Kathryn E MVR
Subject: RE: period of record for HEC-FDA (UNCLASSIFIED)
Classification: UNCLASSIFIED
Caveats: NONE

George,
The EM 1619 says you can go down to 10 years but I've always been hesitant to set it that low because it gives high uncertainty and such a short record that I'm concerned about the uncertainty calculations. You really can't define much of the curve with that short of record. However, for some test cases I've done, using 10 years seems to give acceptable results. For now, without seeing your data, I would guess that using 10 years is OK but it does make me nervous.

When version 1.4 of FDA comes out, it will have a different algorithm for calculating uncertainty about graphical curves and I will have more faith in it to give reasonable, consistent results for all equivalent record lengths.

I probably mislead you a little. At the time, I had become very aware of the shortcomings of the current uncertainty calculation method and very concerned about calculating uncertainty for such a short record length. We also run into consistency problems if you run an array of equivalent length of records and compare results. Hence, the proposed change in calculating uncertainty.

Bob
Robert Carl
robert.carl@usace.army.mil (530) 756-1104

-----Original Message-----
From: Hatch, Kathryn MVP @ MVR
Sent: Tuesday, November 13, 2012 1:16 PM
To: Maestri, Brian T MVN
Cc: Awsumb, Lance G MVP; Linkowski, Daniel MVS@MVP; Carr, John P MVR
Subject: FW: GLMRIS question (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Good Afternoon Brian,

Lance, Dan, and I have been working on Great Lakes and Mississippi River Interbasin Study (GLMRIS) FRM impact analysis for Mark in Chicago District. We've collected structure inventory for overland flooded area and basement area and are now processing data in Marshall and Swift estimator for depreciated replacement value. Our comparison of M&S DRV to Chicago assessor's value is giving us some concern and want to discuss with you as RTS (and our ATR reviewer) to ask for any suggestions/ideas.

Could you join us on a 1 hour webmeeting/conf call on any of these dates: Friday Nov 16 & Tuesday Nov 20? We want to informally introduce our study efforts and discuss structure values. I believe the Chicago district PM is scheduling an official kick-off meeting for reviewers, but I'm not sure how soon and we need to move forward as FWOP damages need to be modeled this month or early next to meet GLMRIS timeline.

After you get back to me with a good date and time, then I'll send an invite out for a teleconference.

Thanks,
Katie Hatch
Economist, Regional Planning and Environment Division North
US Army Engineer District
Clock Tower Building, PO Box 2004, Rock Island, IL 61204-2004
309-794-5827

-----Original Message-----
From: Maestri, Brian T MVN
Sent: Monday, November 19, 2012 5:26 PM
To: Hatch, Kathryn MVP @ MVR; Kramer, Mark J LRC; Awsumb, Lance G MVP; Linkowski, Daniel MVS@MVP; Carr, John P MVR
Cc: Manguno, Richard J MVN
Subject: RE: Notes from GLMRIS FRM ATR conf call today (UNCLASSIFIED)
Classification: UNCLASSIFIED
Caveats: NONE

Hi Katie, Lance, Dan, and Mark,
I appreciate the team discussing the GLMRIS evaluation with me on Friday. Rich Manguno and I had the chance to discuss the GLMRIS evaluation and specifically the FRM aspects and the approach being taken by the PDT. The following is a summary of our discussion relative to the evaluation:
Rich agreed that a fair amount of effort has already been put into the FRM aspects of the evaluation. Rich viewed the FRM impacts as similar to "induced damages" for a large number of residential and non-residential structures in a major metropolitan area. If viewed in such a manner, then the precision of the exact dollar amount may not be as important as using the information that you collected to let reviewers know it is going to be a significant impact. I also appreciate your concern about not having depth-damage relationships available that show the amount of damage that can occur below first floor for non-residential structures. I am not aware of any Corps Districts that have developed depth-damage curves for non-residential structures that include damage to basements. You are left to showing through sampling that these damages will occur to the basements of non-residential structures.
In terms of structure value and sampling, Rich agreed that segmenting the sample into some type of classifications such as "depressed value" areas versus "over-valued" or "balanced" market areas would be a way to reduce the error term for the regression equation. However, you will need to determine within your sample which sampled values fit into a classification and the a criteria for applying a segmented sample to a geographic area. The boundaries of the areas may not be straight forward as there will be varying degrees of areas between "depressed" and "overvalued". You would probably have to use zip codes or census designations to define boundary areas and beyond the technical aspects, you will need to create classifications and try to avoid political type issues, i.e. "good" vs "bad". We did think that the HAZUS non-residential values, even though by census block and not shown for individual structures, would be an additional source of information that should be more closely related to M&S values. Segmenting the sample is worth pursuing if it is determined that this can be accomplished without a lot of effort (create small test area) and that it will significantly reduce the error in the regression equations.
We discussed the use of HEC-FIA model and while a good tool to show FRM impacts, it is not a Corps certified model, it can only be used for a single flood event per model execution, and does not incorporate risk analysis.
As on most aspects of Corps evaluations, it is a matter of making judgments about schedule and resource allocation cost relative to the cost of collecting the information and the importance of the information to the final answer. Rich and I would both be available to further discuss the

evaluation with the team and any ideas or techniques that you may want to employ as you move forward on the evaluation. Thanks again, Brian

Brian T. Maestri
Regional Economist
USACE-MVN
504 862-1915

Flood Risk Management Economic Analysis

Great Lakes and Mississippi River Interbasin Study (GLMRIS)

Exhibit D - Overland Survey

COMMERCIAL AND INDUSTRIAL FLOOD DAMAGE SURVEY

(Personal Interview)

OMB Control Number: 0710-0001

The public report burden for this information collection is estimated to average 60 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this data collection, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Executive Services Directorate, Information Management Division, and the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, D.C. 20503, Attn.: Desk Officer for U.S. Army Corps of Engineers. Respondents should be aware that notwithstanding any other provision of law, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Please DO NOT RETURN your completed form to either of these offices.

***Be sure to notify each person to be interviewed that responding to questions is voluntary.**

Statement of Purpose

The U.S. Army Corps of Engineers (USACE), Chicago District is conducting a survey of selected businesses in Chicago, IL and surrounding areas. The purpose of this survey is to collect information that will help us better determine potential economic losses from future flood events. The increased understanding of flood losses that we get from this survey will help us more accurately quantify the impacts of potential flood risk management projects for this area. You have been selected to participate in this survey because of your facility characteristics and we want to ensure that these characteristics are reflected in our analysis.

Participation in this survey is completely voluntary. Should you choose to provide your name, title, and e-mail address, this information will be used only to contact you regarding your input; otherwise, responses will be anonymous. Comments provided will only be shared with the planning staff at the USACE during the evaluation of the overall study. Reports generated with these evaluations will show impacts only as aggregated by broad categories (such as commercial, industrial, public, and residential), no information will be released that can be used to identify you or your facility. The information collected will be managed in accordance with AR 25-400-2 records retention requirements. The point of contact for the survey is Mr. Mark Kramer (312 846 5448) of the U.S. Army Corps of Engineers, Chicago District Planning and Economic Analysis Branch.

COMMERCIAL AND INDUSTRIAL FLOOD DAMAGE SURVEY OMB#: 0710-0001

PRIMARY SURVEY FORM

Attach Business Card Here

Firm Name: ____

This survey is focused on damages that could occur to the structures and contents of buildings at your facility in the event of future flooding. Structure is defined as the components associated with a basic structure (shell), plus any improvements (tenant build-out) made to the basic shell to make it usable for a certain type of business. Contents are defined as items that would be relocated in the event that the facility moves to another location, such as furniture, equipment, products, and raw materials. For this survey, contents were divided in three categories:

- **Equipment**: Physical items that are used for the production process or the operation of the facility (e.g., generators, machinery, production tables, paint booths, robotics, racks, conveyors, floor scrubbers, computers/servers, etc.). These items would most likely be removed if the business relocates to another facility.
- **Furniture**: Physical items necessary for the conduct of business or delivery of a product (e.g., desks, chairs, bookcases, artwork, etc.). As with equipment, this category is focused on free-standing and attached furniture that would be removed in the event of relocation.
- **Inventory/Products**: Items that are used in the production process or result from the production process, or consumables used as part of the business activities. Items include raw materials, finished products, replacement parts, medical consumables, cleaning products, food, pharmaceuticals, software, building materials, office supplies, etc.

Business Information

Address____

Contact Name ____

Contact's Title ____________________________________ Telephone # ___________________

Interviewer________________________________ Date_____________ Time ______________

1. Type of business ____

2. Total number of buildings on site _____

3. Number of years business has been at this location _____

Flood History and Mitigation

4. Has your facility been flooded in the past? Yes No

If "Yes," please complete Questions 5 and 6. If "No," skip to Question 7.

5. Please estimate the damages to your business from past flooding events. Please give a single set of combined damages for all floors in all buildings.

Date of the flooding event:		Date of the flooding event:	
Water depth above first floor:		Water depth above first floor:	
Contents damage estimate ($):		Contents damage estimate ($):	
Structure damage estimate ($):		Structure damage estimate ($):	
Number of lost business days:		Number of lost business days:	
Amount of lost net income ($):		Amount of lost net income ($):	
Cost of cleanup ($):		Cost of cleanup ($):	

6. Briefly describe any permanent flood mitigation measures that have been implemented to reduce potential flood damage. ____
____
____
____
____

Building Information

*(Questions 7-17 are to be answered for your **primary building only**. If there are multiple buildings at the facility, a supplemental sheet is provided that asks for similar information.)*

7. Building #: ___________

8. Brief description of function of the building and its contents: ___________________________
____
____
____

9. Year building was constructed: ________

10. Building Construction Type (e.g. brick): __________________

11. What is the 1st floor elevation of the building (express as either actual elevation or height above adjacent grade):_________ft actual/adjacent grade

12. Number of floors (including basement, if any): _____________

13. Building footprint: __________ feet by __________ feet = ____________square feet

14. Does the building have a basement? Yes No
If yes: _______ square feet finished area _______ square feet unfinished area

15. What is the value of the building (not including contents): $_________

16. Is there a seasonal variation in the value of inventory in this building? Yes No

What is the average value of your inventory during the following time periods:

January – March	$_______________	April – June	$________________
July – September	$_______________	October – December	$________________

17. Relative to the 1st floor elevation of the building, what is the value of the contents and where are they located vertically?

Height (ft)	Equipment ($)	Furniture ($)	Inventory/products ($)
0.0 ft			
1.0 ft			
3.0 ft			
6.0 ft +			
Total			

Notes to interviewer:

- Shaded areas are for buildings with a subterranean level only. Please fill in appropriate values for the depth (e.g., -1.0 ft, -3.0 ft, -6.0 ft). Leave shaded areas blank if no subterranean level exists.
- The values in the columns should be a cumulative total, starting from the lowest level of the structure, for all contents located at or below the specified height.

Susceptibility to Flood Damage

The amount of damage due to flooding can vary considerably depending on conditions (e.g., quality of water, duration of flood). When completing the following section, you will be asked to provide a range for potential damages. In addition to the most likely damage amount due to flooding, you will also be asked to provide a low and high estimate. Please use the following definitions:

- *"Most Likely" – reasonable amount of damage expected to occur during an average flood.*
- *"Low" – reasonable low estimate of damages assuming that the flood conditions are less than a typical flood (e.g., short duration, relatively clean floodwaters) or the contents were less impacted than typically estimated (e.g., motors were sealed well).*
- *"High" – reasonable high estimate of damages assuming that the flood conditions are worse than a typical flood (e.g., long duration, highly contaminated floodwaters) or the contents were more impacted than typically estimated (e.g., motors need total replacement).*

18. At what elevation, relative to the 1st floor of the building, does flood damage to **contents** begin? (+ or – ; will only be negative if there is a subterranean level) ____________ feet

19. Please estimate damage to contents corresponding with water depths above/below the building's 1st floor elevation. (Express damage in either **$ or % of total value**.)

Flood Depth	**Equipment**			**Furniture**			**Inventory/products**		
	Low	Most Likely	High	Low	Most Likely	High	Low	Most Likely	High
0.0 ft									
0.5 ft									
1.0 ft									
3.0 ft									
6.0 ft									

Notes to interviewer:

- Shaded areas are for buildings with a subterranean level only. Please fill in appropriate values for the depth (e.g., -1.0 ft, -3.0 ft, -6.0 ft). Leave shaded areas blank if no subterranean level exists.
- The values in the columns should be a cumulative total, starting from the lowest level of the structure, for all contents located at or below the specified height.

20. Please estimate damage to the structure of the building corresponding with water depths above/below the building's 1st floor elevation. (Express damage in either **$ or % of total structure value**.)

Flood Depth	**Structure**		
	Low	Most Likely	High
0.0 ft			
0.5 ft			
1.0 ft			
3.0 ft			
6.0 ft			

Notes to interviewer:

- Shaded areas are for buildings with a subterranean level only. Please fill in appropriate values for the depth (e.g., -1.0 ft, -3.0 ft, -6.0 ft). Leave shaded areas blank if no subterranean level exists.
- The values in the columns should be a cumulative total, starting from the lowest level of the structure.

Other Information

21. Other than the principal structures, are there any other valuable items on your property that flood waters could damage?

- Movable (cars, trucks, trailers, etc.)

Type	Current Value ($)

- Not readily movable (landscaping, electrical equipment, pipes, trailers on blocks, etc.)

Type	Current Value ($)	Height Above Ground (ft.)

22. Emergency Measures/Plans:

a. What emergency measures/plans, if any, would you take to reduce damage if flooding was imminent? ____
____
____
____

b. What is the estimated cost to implement these emergency measures? $________________

c. How much time is required to implement these emergency measures? ___________ Hours

23. What would be the estimated cost (in dollars) to clean up hazardous material following a flood event? For example, chemicals, batteries, paint etc. $_______________

COMMERCIAL AND INDUSTRIAL FLOOD DAMAGE SURVEY OMB#: 0710-0001

SUPPLIMENTAL SURVEY FORM

Firm Name: ____

This supplemental survey form is to be used for each additional building at your facility. Information for each building is needed to estimate damages that could occur to the contents of all structures at your facility in the event of future flooding.

7. Building #: ___________
8. Brief description of function of the building and its contents: __________________________
   ____
   ____
9. Year building was constructed: ________
10. Building Construction Type (e.g. brick): __________________
11. What is the 1st floor elevation of the building (express as either actual elevation of height above adjacent grade):_________ft actual/adjacent grade

12. Number of floors (including basement, if any): _____________
13. Building footprint: __________ feet by __________ feet = ____________square feet

14. Does the building have a basement? Yes No
    If yes: _______ square feet finished area _______ square feet unfinished area

15. What is the value of the building (not including contents): $_________

16. Is there a seasonal variation in the value of inventory in this building? Yes No
    What is the average value of your inventory during the following time periods:
    January – March $_______________ April – June $________________
    July – September $_______________ October – December $________________

17. Relative to the 1st floor elevation of the building, what is the value of the contents and where are they located vertically?

Height (ft)	**Equipment ($)**	**Furniture ($)**	**Inventory/products ($)**
0.0 ft			
1.0 ft			
3.0 ft			
6.0 ft +			
Total			

Notes to interviewer:
- Shaded areas are for buildings with a subterranean level only. Please fill in appropriate values for the depth (e.g., -1.0 ft, -3.0 ft, -6.0 ft). Leave shaded areas blank if no subterranean level exists.
- The values in the columns should be a cumulative total, starting from the lowest level of the structure, for all contents located at or below the specified height.

Susceptibility to Flood Damage

18. At what elevation, relative to the 1st floor of the building, does flood damage to **contents** begin? (+ or – ; will only be negative if there is a subterranean level) ____________ feet

19. Please estimate damage to contents corresponding with water depths above/below the building's 1st floor elevation. (Express damage in either **$ or % of total value**.)

Flood Depth	**Equipment**			**Furniture**			**Inventory/products**		
	Low	Most Likely	High	Low	Most Likely	High	Low	Most Likely	High
0.0 ft									
0.5 ft									
1.0 ft									
3.0 ft									
6.0 ft									

Notes to interviewer:

- Shaded areas are for buildings with a subterranean level only. Please fill in appropriate values for the depth (e.g., -1.0 ft, -3.0 ft, -6.0 ft). Leave shaded areas blank if no subterranean level exists.
- The values in the columns should be a cumulative total, starting from the lowest level of the structure, for all contents located at or below the specified height.

20. Please estimate damage to the structure of the building corresponding with water depths above/below the building's 1st floor elevation. (Express damage in either **$ or % of total structure value**.)

Flood Depth	**Structure**		
	Low	Most Likely	High
0.0 ft			
0.5 ft			
1.0 ft			
3.0 ft			
6.0 ft			

Notes to interviewer:

- Shaded areas are for buildings with a subterranean level only. Please fill in appropriate values for the depth (e.g., -1.0 ft, -3.0 ft, -6.0 ft). Leave shaded areas blank if no subterranean level exists.
- The values in the columns should be a cumulative total, starting from the lowest level of the structure.

Flood Risk Management Economic Analysis

Great Lakes and Mississippi River Interbasin Study (GLMRIS)

Exhibit E - Sewer Survey

COMMERCIAL AND INDUSTRIAL BASEMENT FLOOD DAMAGE SURVEY

(Personal Interview)

OMB Control Number: 0710-0001

The public report burden for this information collection is estimated to average 60 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this data collection, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Executive Services Directorate, Information Management Division, and the Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, D.C. 20503, Attn.: Desk Officer for U.S. Army Corps of Engineers. Respondents should be aware that notwithstanding any other provision of law, an agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. Please DO NOT RETURN your completed form to either of these offices.

***Be sure to notify each person to be interviewed that responding to questions is voluntary.**

Statement of Purpose

The U.S. Army Corps of Engineers (USACE), Chicago District is conducting a survey of selected businesses in Chicago, IL and surrounding areas. The purpose of this survey is to collect information that will help us better determine potential economic losses from future flood events. The increased understanding of flood losses that we get from this survey will help us more accurately quantify the impacts of potential flood risk management projects for this area. You have been selected to participate in this survey because of your facility characteristics and we want to ensure that these characteristics are reflected in our analysis.

Participation in this survey is completely voluntary. Should you choose to provide your name, title, and e-mail address, this information will be used only to contact you regarding your input; otherwise, responses will be anonymous. Comments provided will only be shared with the planning staff at the USACE during the evaluation of the overall study. Reports generated with these evaluations will show impacts only as aggregated by broad categories (such as commercial, industrial, public, and residential), no information will be released that can be used to identify you or your facility. The information collected will be managed in accordance with AR 25-400-2 records retention requirements. The point of contact for the survey is Mr. Mark Kramer (312 846 5448) of the U.S. Army Corps of Engineers, Chicago District Planning and Economic Analysis Branch.

COMMERCIAL AND INDUSTRIAL BASEMENT FLOOD DAMAGE SURVEY

OMB#: 0710-0001

PRIMARY SURVEY FORM

Attach Business Card Here

Firm Name: ____

This survey is focused on damages that could occur to the structures and contents of buildings at your facility in the event of future flooding. Structure is defined as the components associated with a basic structure (shell), plus any improvements (tenant build-out) made to the basic shell to make it usable for a certain type of business. Contents are defined as items that would be relocated in the event that the facility moves to another location, such as furniture, equipment, products, and raw materials.

Business Information

Address____

Contact Name ____

Contact's Title ___________________________________ Telephone # ___________________

Interviewer________________________________ Date_____________ Time ______________

1.Type of business ____
2. Business Name____

Flood History and Mitigation

3. Has your facility been flooded in the past? Yes No

If "Yes," please complete Question 4. If "No," skip to Question 5.

4. Please estimate the damages to your business from past flooding events. Please list damages for subterranean level only.

Date of the flooding event:		Date of the flooding event:	
Water depth above (or below) first floor:		Water depth above (or below) first floor:	
Contents damage estimate ($):		Contents damage estimate ($):	
Structure damage estimate ($):		Structure damage estimate ($):	
Number of lost business days:		Number of lost business days:	
Amount of lost net income ($):		Amount of lost net income ($):	
Cost of cleanup ($):		Cost of cleanup ($):	

5. Briefly describe any permanent flood mitigation measures that have been implemented to reduce potential flood damage. ____
____
____

Building Information
(Questions 6-15 are to be answered for your ***primary building only****. If there are multiple buildings at the facility, a supplemental sheet is provided that asks for similar information.)*

6. Building #: ____________

7. Brief description of function of the building and its contents: ____________________________
____
____

8. What is the elevation of:
Ground ___________ First Floor ___________ Basement Floor ___________

9. Number of subterranean floors: _______________
9(a) What is the primary use of each subterranean level?
____
____
____

9(b) What is the square footage of each subterranean level?
____
____
____

10. What is the square footage of the building? ______________ft

11. What is the age of the building? ____________ years

12. What is the market value of the building (not including contents): $__________

13. What is the replacement value of the building (not including contents): $__________

14. What is the content value?
Furniture____________ Equipment_____________ Inventory_____________

15. Expansion Plans? ____
____
____

16. Please estimate damage to structure and contents corresponding with water depths above the building's basement floor elevation. The values in the columns should be a cumulative total, starting from the lowest level of the structure, for all contents located at or below the specified height.

	Structure Damage ($)			**Content Damage ($)**			**Emergency Preparation and Cleanup ($)**		
Flood Depth/ Elevation (ft)	Low	Most Likely	High	Low	Most Likely	High	Low	Most Likely	High

The amount of damage due to flooding can vary considerably depending on conditions (e.g., quality of water, duration of flood). When completing the following section, you will be asked to provide a range for potential damages. In addition to the most likely damage amount due to flooding, you will also be asked to provide a low and high estimate. Please use the following definitions:

- *"Most Likely" – reasonable amount of damage expected to occur during an average flood.*
- *"Low" – reasonable low estimate of damages assuming that the flood conditions are less than a typical flood (e.g., short duration, relatively clean floodwaters) or the contents were less impacted than typically estimated (e.g., motors were sealed well).*
- *"High" – reasonable high estimate of damages assuming that the flood conditions are worse than a typical flood (e.g., long duration, highly contaminated floodwaters) or the contents were more impacted than typically estimated (e.g., motors need total replacement).*

COMMERCIAL AND INDUSTRIAL FLOOD DAMAGE SURVEY OMB#: 0710-0001
SUPPLIMENTAL SURVEY FORM

Firm Name: ____

This supplemental survey form is to be used for each additional building at your facility. Information for each building is needed to estimate damages that could occur to the contents of all structures at your facility in the event of future flooding.

6. Building #: ___________

7. Brief description of function of the building and its contents: __________________________
____
____

8. What is the elevation of the:
Ground __________ First Floor __________ Basement Floor __________

9. Number of subterranean floors: ______________
9(a) What is the primary use of each subterranean level?
____
____
____

9(b) What is the square footage of each subterranean level?
____
____
____

10. What is the square footage of the building? _____________ft

11. What is the age of the building? ___________ years

12. What is the market value of the building (not including contents): $_________

13. What is the replacement value of the building (not including contents): $_________

14. What is the content value?
Furniture___________ Equipment____________ Inventory____________

15. Expansion Plans? ____
____
____

16. Please estimate damage to structure and contents corresponding with water depths above the building's basement floor elevation. The values in the columns should be a cumulative total, starting from the lowest level of the structure, for all contents located at or below the specified height.

	Structure Damage ($)			**Content Damage ($)**			**Emergency Preparation and Cleanup ($)**		
Flood Depth/ Elevation (ft)	Low	Most Likely	High	Low	Most Likely	High	Low	Most Likely	High

The amount of damage due to flooding can vary considerably depending on conditions (e.g., quality of water, duration of flood). When completing the following section, you will be asked to provide a range for potential damages. In addition to the most likely damage amount due to flooding, you will also be asked to provide a low and high estimate. Please use the following definitions:

- *"Most Likely" – reasonable amount of damage expected to occur during an average flood.*
- *"Low" – reasonable low estimate of damages assuming that the flood conditions are less than a typical flood (e.g., short duration, relatively clean floodwaters) or the contents were less impacted than typically estimated (e.g., motors were sealed well).*
- *"High" – reasonable high estimate of damages assuming that the flood conditions are worse than a typical flood (e.g., long duration, highly contaminated floodwaters) or the contents were more impacted than typically estimated (e.g., motors need total replacement).*

Flood Risk Management Economic Analysis

Great Lakes and Mississippi River Interbasin Study (GLMRIS)

Exhibit F – Expected Annual Damage

Without Project Mean EAD ($1,000's) for Base Year (2017)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$4,247	$279	$119	$3,535	$8,181
Downtown West	$2,607	$171	$73	$2,170	$5,022
Urban North	$18,166	$1,194	$509	$15,121	$34,990
Urban South	$665	$44	$19	$553	$1,280
Suburban North	$32,446	$2,133	$909	$27,007	$62,495
Suburban South	$59,871	$3,936	$1,677	$49,835	$115,319
Total Sewer AOI	$118,002	$7,758	$3,306	$98,222	$227,288
Chicago River	$13,739	$903	$385	$11,436	$26,463
Calumet River	$38	$3	$1	$32	$74
Total Overland AOI	$13,777	$906	$386	$11,468	$26,537
Total	$131,779	$8,663	$3,692	$109,690	$253,825

Lakeside Mean EAD ($1,000's) for Base Year (2017)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$31,207	$1,567	$744	$18,311	$51,830
Downtown West	$11,336	$569	$270	$6,652	$18,828
Urban North	$31,673	$1,590	$756	$18,585	$52,604
Urban South	$2,660	$134	$63	$1,561	$4,418
Suburban North	$47,664	$2,394	$1,137	$27,967	$79,162
Suburban South	$78,661	$3,950	$1,876	$46,155	$130,643
Total Sewer AOI	$203,203	$10,204	$4,847	$119,231	$337,484
Chicago River	$48,249	$2,423	$1,151	$28,310	$80,133
Calumet River	$464	$23	$11	$272	$770
Total Overland AOI	$48,712	$2,446	$1,162	$28,582	$80,903
Total	$251,915	$12,650	$6,009	$147,813	$388,743

Midsystem Mean EAD ($1,000's) for Base Year (2017)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$5,373	$371	$159	$4,586	$10,488
Downtown West	$3,611	$249	$107	$3,082	$7,049
Urban North	$18,726	$1,291	$554	$15,983	$36,555
Urban South	$989	$68	$29	$844	$1,930
Suburban North	$31,968	$2,205	$946	$27,286	$62,404
Suburban South	$60,305	$4,159	$1,784	$51,472	$117,720
Total Sewer AOI	$120,972	$8,343	$3,578	$103,253	$236,146
Chicago River	$11,132	$768	$329	$9,502	$21,731
Calumet River	$101	$7	$3	$86	$197
Total Overland AOI	$11,233	$775	$332	$9,588	$21,928
Total	$132,205	$9,118	$3,910	$112,841	$258,074

Lakeside Mean Change in EAD ($1,000's) for Base Year (2017)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$26,960	$1,288	$625	$14,776	$43,649
Downtown West	$8,729	$398	$197	$4,481	$13,806
Urban North	$13,507	$396	$247	$3,464	$17,613
Urban South	$1,995	$90	$45	$1,008	$3,138
Suburban North	$15,218	$260	$228	$960	$16,667
Suburban South	$18,791	$14	$199	-$3,680	$15,324
Total Sewer AOI	$85,201	$2,446	$1,541	$21,009	$110,196
Chicago River	$34,510	$1,520	$766	$16,874	$53,670
Calumet River	$425	$21	$10	$240	$696
Total Overland AOI	$34,935	$1,540	$776	$17,114	$54,366
Total	$120,136	$3,987	$2,317	$38,123	$134,918

Midsystem Mean Change in EAD ($1,000's) for Base Year (2017)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$1,125	$91	$40	$1,050	$2,306
Downtown West	$1,004	$78	$34	$912	$2,027
Urban North	$560	$97	$45	$862	$1,564
Urban South	$324	$25	$11	$291	$650
Suburban North	-$478	$72	$36	$278	-$91
Suburban South	$435	$223	$106	$1,637	$2,401
Total Sewer AOI	$2,970	$585	$272	$5,031	$8,858
Chicago River	-$2,607	-$135	-$56	-$1,934	-$4,732
Calumet River	$62	$4	$2	$54	$123
Total Overland AOI	-$2,544	-$131	-$54	-$1,880	-$4,609
Total	$426	$454	$218	$3,151	$4,249

Without Project Mean EAD ($1,000's) for Future Year (2029)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$3,245	$208	$89	$2,670	$6,213
Downtown West	$1,511	$97	$41	$1,243	$2,892
Urban North	$15,444	$991	$423	$12,706	$29,564
Urban South	$407	$26	$11	$335	$779
Suburban North	$31,842	$2,044	$872	$26,198	$60,956
Suburban South	$48,856	$3,137	$1,338	$40,196	$93,526
Total Sewer AOI	$101,304	$6,504	$2,775	$83,348	$193,930
Chicago River	$10,607	$681	$291	$8,727	$20,306
Calumet River	$182	$12	$5	$150	$349
Total Overland AOI	$10,790	$693	$296	$8,877	$20,655
Total	$112,094	$7,197	$3,070	$92,225	$214,585

Lakeside Mean EAD ($1,000's) for Future Year (2029)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$4,188	$262	$115	$3,302	$7,867
Downtown West	$1,773	$111	$49	$1,397	$3,329
Urban North	$16,490	$1,031	$451	$12,999	$30,972
Urban South	$476	$30	$13	$375	$894
Suburban North	$35,183	$2,200	$963	$27,736	$66,083
Suburban South	$50,824	$3,179	$1,391	$40,066	$95,461
Total Sewer AOI	$108,934	$6,813	$2,982	$85,876	$204,605
Chicago River	$12,574	$786	$344	$9,913	$23,618
Calumet River	$255	$16	$7	$201	$479
Total Overland AOI	$12,830	$802	$351	$10,114	$24,097
Total	$121,764	$7,615	$3,333	$95,989	$228,702

Midsystem Mean EAD ($1,000's) for Future Year (2029)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$3,452	$221	$94	$2,836	$6,604
Downtown West	$413	$26	$11	$339	$789
Urban North	$4	$0	$0	$3	$8
Urban South	$31,596	$2,026	$864	$25,960	$60,447
Suburban North	$49,581	$3,180	$1,356	$40,737	$94,853
Suburban South	$15,731	$1,009	$430	$12,925	$30,095
Total Sewer AOI	$100,776	$6,463	$2,756	$82,801	$192,796
Chicago River	$2,371	$152	$65	$1,948	$4,537
Calumet River	$8,424	$540	$230	$6,921	$16,116
Total Overland AOI	$10,795	$692	$295	$8,870	$20,653
Total	$111,571	$7,156	$3,051	$91,670	$213,448

Lakeside Mean Change in EAD ($1,000's) for Future Year (2029)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$943	$54	$26	$632	$1,654
Downtown West	$262	$14	$7	$154	$437
Urban North	$1,046	$40	$28	$293	$1,408
Urban South	$69	$4	$2	$41	$115
Suburban North	$3,341	$156	$91	$1,538	$5,127
Suburban South	$1,969	$42	$53	-$130	$1,934
Total Sewer AOI	$7,630	$309	$207	$2,528	$10,675
Chicago River	$1,967	$105	$54	$1,185	$3,312
Calumet River	$73	$4	$2	$51	$130
Total Overland AOI	$2,040	$110	$56	$1,237	$3,442
Total	$9,670	$419	$263	$3,765	$14,117

Midsystem Mean Change in EAD ($1,000's) for Future Year (2029)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$206	$13	$6	$166	$391
Downtown West	-$1,098	-$71	-$30	-$904	-$2,103
Urban North	-$15,440	-$991	-$423	-$12,703	-$29,557
Urban South	$31,189	$2,000	$853	$25,626	$59,668
Suburban North	$17,739	$1,136	$484	$14,539	$33,897
Suburban South	-$33,125	-$2,128	-$908	-$27,271	-$63,431
Total Sewer AOI	-$528	-$41	-$19	-$547	-$1,134
Chicago River	-$8,236	-$529	-$226	-$6,779	-$15,769
Calumet River	$8,241	$529	$225	$6,771	$15,767
Total Overland AOI	$5	$0	$0	-$8	-$3
Total	-$523	-$41	-$19	-$554	-$1,137

Without Project Most Likely EAD ($1,000's) for Base Year (2017)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$3,627	$5	$64	$113	$3,809
Downtown West	$664	$54	$44	$1,576	$2,338
Urban North	$2,116	$237	$78	$13,862	$16,292
Urban South	$38	$5	$11	$541	$596
Suburban North	$15,909	$302	$190	$12,699	$29,099
Suburban South	$8,040	$878	$289	$44,488	$53,695
Total Sewer AOI	$30,395	$1,481	$675	$73,279	$105,830
Chicago River	$4,835	$0	$0	$230	$5,065
Calumet River	$1	$0	$0	$14	$14
Total Overland AOI	$4,836	$0	$0	$243	$5,080
Total	$35,231	$1,481	$675	$73,522	$110,909

Lakeside Most Likely EAD ($1,000's) for Base Year (2017)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$21,234	$50	$655	$517	$22,457
Downtown West	$3,360	$187	$143	$4,467	$8,158
Urban North	$3,099	$642	$111	$18,940	$22,792
Urban South	$253	$22	$48	$1,591	$1,914
Suburban North	$16,903	$336	$217	$16,844	$34,299
Suburban South	$8,377	$953	$302	$46,974	$56,605
Total Sewer AOI	$53,227	$2,190	$1,475	$89,333	$146,225
Chicago River	$20,384	$152	$7	$1,455	$21,998
Calumet River	$56	$37	$16	$102	$211
Total Overland AOI	$20,440	$189	$23	$1,557	$22,209
Total	$73,666	$2,380	$1,498	$90,891	$168,435

Midsystem Most Likely EAD ($1,000's) for Base Year (2017)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$4,604	$8	$144	$145	$4,900
Downtown West	$1,076	$64	$59	$2,094	$3,294
Urban North	$2,217	$250	$84	$14,529	$17,080
Urban South	$98	$7	$12	$786	$902
Suburban North	$15,916	$303	$190	$12,748	$29,157
Suburban South	$8,170	$904	$294	$45,636	$55,003
Total Sewer AOI	$32,081	$1,536	$783	$75,937	$110,336
Chicago River	$219	$0	$0	$229	$448
Calumet River	$0	$0	$0	$4	$4
Total Overland AOI	$219	$0	$0	$233	$452
Total	$32,300	$1,536	$783	$76,170	$110,788

Lakeside Most Likely Change in EAD ($1,000's) for Base Year (2017)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$17,607	$46	$591	$404	$18,647
Downtown West	$2,696	$133	$98	$2,892	$5,819
Urban North	$983	$405	$33	$5,078	$6,500
Urban South	$215	$17	$37	$1,049	$1,318
Suburban North	$994	$34	$27	$4,145	$5,200
Suburban South	$336	$75	$13	$2,486	$2,910
Total Sewer AOI	$22,832	$709	$800	$16,055	$40,396
Chicago River	$15,548	$152	$7	$1,225	$16,933
Calumet River	$55	$37	$16	$89	$197
Total Overland AOI	$15,604	$189	$23	$1,314	$17,130
Total	$38,436	$899	$823	$17,369	$57,526

Midsystem Most Likely Change in EAD ($1,000's) for Base Year (2017)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$977	$3	$80	$32	$1,091
Downtown West	$412	$10	$15	$518	$955
Urban North	$101	$14	$6	$667	$788
Urban South	$60	$1	$1	$244	$306
Suburban North	$7	$2	$1	$49	$58
Suburban South	$130	$25	$5	$1,148	$1,308
Total Sewer AOI	$1,686	$55	$107	$2,658	$4,507
Chicago River	-$4,617	$0	$0	-$1	-$4,618
Calumet River	$0	$0	$0	-$10	-$10
Total Overland AOI	-$4,617	$0	$0	-$10	-$4,628
Total	-$2,931	$55	$107	$2,648	-$121

Without Project Most Likely EAD ($1,000's) for Future Year (2029)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$2,808	$1	$12	$80	$2,902
Downtown West	$380	$36	$14	$920	$1,351
Urban North	$1,836	$205	$64	$11,703	$13,808
Urban South	$21	$2	$5	$336	$364
Suburban North	$15,692	$276	$186	$12,315	$28,469
Suburban South	$6,598	$789	$234	$36,060	$43,680
Total Sewer AOI	$27,335	$1,308	$515	$61,414	$90,572
Chicago River	$202	$0	$0	$228	$430
Calumet River	$0	$0	$0	$7	$7
Total Overland AOI	$202	$0	$0	$235	$438
Total	$27,537	$1,308	$515	$61,650	$91,010

Lakeside Most Likely EAD ($1,000's) for Future Year (2029)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$3,453	$2	$65	$90	$3,610
Downtown West	$473	$36	$16	$1,002	$1,528
Urban North	$1,896	$211	$65	$12,042	$14,214
Urban South	$39	$4	$5	$362	$410
Suburban North	$16,270	$284	$200	$13,574	$30,328
Suburban South	$6,613	$790	$234	$36,173	$43,810
Total Sewer AOI	$28,744	$1,328	$584	$63,244	$93,901
Chicago River	$2,597	$6	$0	$324	$2,927
Calumet River	$8	$18	$7	$27	$59
Total Overland AOI	$2,605	$24	$7	$351	$2,987
Total	$31,349	$1,352	$591	$63,595	$96,887

Midsystem Most Likely EAD ($1,000's) for Future Year (2029)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$2,978	$1	$11	$77	$3,068
Downtown West	$139	$0	$0	$228	$367
Urban North	$0	$0	$0	$3	$4
Urban South	$15,715	$272	$186	$11,911	$28,083
Suburban North	$6,697	$790	$238	$36,342	$44,069
Suburban South	$1,865	$207	$64	$11,846	$13,982
Total Sewer AOI	$27,395	$1,270	$500	$60,408	$89,572
Chicago River	$21	$2	$8	$327	$358
Calumet River	$318	$36	$12	$907	$1,272
Total Overland AOI	$339	$37	$20	$1,234	$1,631
Total	$27,734	$1,307	$520	$61,642	$91,203

Lakeside Most Likely Change in EAD ($1,000's) for Future Year (2029)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$646	$1	$52	$10	$709
Downtown West	$92	$1	$2	$82	$177
Urban North	$60	$6	$1	$339	$407
Urban South	$18	$2	$0	$26	$47
Suburban North	$578	$8	$13	$1,259	$1,859
Suburban South	$15	$1	$0	$113	$130
Total Sewer AOI	$1,409	$20	$69	$1,830	$3,328
Chicago River	$2,395	$6	$0	$96	$2,497
Calumet River	$8	$18	$7	$20	$52
Total Overland AOI	$2,402	$24	$7	$116	$2,549
Total	$3,812	$44	$76	$1,946	$5,877

Midsystem Most Likely Change in EAD ($1,000's) for Future Year (2029)

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$171	$0	-$1	-$3	$166
Downtown West	-$242	-$36	-$14	-$693	-$984
Urban North	-$1,836	-$205	-$64	-$11,699	-$13,804
Urban South	$15,694	$270	$181	$11,575	$27,720
Suburban North	-$8,994	$515	$52	$24,028	$15,600
Suburban South	-$4,733	-$582	-$170	-$24,214	-$29,698
Total Sewer AOI	$60	-$38	-$15	-$1,007	-$1,000
Chicago River	-$181	$2	$8	$99	-$72
Calumet River	$318	$36	$12	$899	$1,265
Total Overland AOI	$137	$37	$20	$999	$1,193
Total	$196	-$1	$5	-$8	$193

Flood Risk Management Economic Analysis

Great Lakes and Mississippi River Interbasin Study (GLMRIS)

Exhibit G –Consequences

Without Project Base Year (2017) Damages at 10% (10 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$0	$0	$0	$0	$0
Downtown West	$0	$0	$0	$20	$20
Urban North	$2,004	$0	$2	$7,034	$9,040
Urban South	$0	$0	$0	$0	$0
Suburban North	$56	$3	$2	$77	$139
Suburban South	$757	$176	$30	$3,466	$4,429
Total Sewer AOI	$2,818	$180	$34	$10,597	$13,628
Chicago River	$18,878	$0	$0	$0	$18,878
Calumet River	$0	$0	$0	$35	$35
Total Overland AOI	$18,878	$0	$0	$35	$18,913
Total	$21,696	$180	$34	$10,631	$32,541

Without Project Base Year (2017) Number of Structures Damaged at 10% (10 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	0	0	0	0	0
Downtown West	0	0	0	5	5
Urban North	111	0	1	319	431
Urban South	0	0	0	0	0
Suburban North	2	1	1	4	8
Suburban South	42	6	14	476	538
Total Sewer AOI	155	7	16	804	982
Chicago River	4	0	0	0	4
Calumet River	0	0	0	2	2
Total Overland AOI	4	0	0	2	6
Total	159	7	16	806	988

Without Project Future Year (2029) Damages at 10% (10 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$0	$0	$0	$0	$0
Downtown West	$0	$0	$0	$20	$20
Urban North	$2,004	$0	$2	$7,029	$9,035
Urban South	$0	$0	$0	$0	$0
Suburban North	$56	$3	$2	$7	$69
Suburban South	$757	$176	$30	$3,466	$4,430
Total Sewer AOI	$2,818	$180	$34	$10,522	$13,554
Chicago River	$0	$0	$0	$0	$0
Calumet River	$0	$0	$0	$0	$0
Total Overland AOI	$0	$0	$0	$0	$0
Total	$2,818	$180	$34	$10,522	$13,554

Without Project Future Year (2029) Number of Structures Damaged at 10% (10 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	0	0	0	0	0
Downtown West	0	0	0	5	5
Urban North	111	0	1	319	431
Urban South	0	0	0	0	0
Suburban North	2	1	1	1	5
Suburban South	42	6	14	476	538
Total Sewer AOI	155	7	16	801	979
Chicago River	0	0	0	0	0
Calumet River	0	0	0	0	0
Total Overland AOI	0	0	0	0	0
Total	155	7	16	801	979

Without Project Base Year (2017) Damages at 4% (25 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$4,284	$0	$18	$29	$4,332
Downtown West	$80	$10	$12	$946	$1,048
Urban North	$4,393	$102	$191	$34,131	$38,818
Urban South	$0	$0	$0	$189	$189
Suburban North	$187,217	$854	$1,666	$69,132	$258,868
Suburban South	$57,728	$4,628	$2,330	$339,398	$404,084
Total Sewer AOI	$253,702	$5,594	$4,217	$443,826	$707,339
Chicago River	$19,887	$0	$0	$922	$20,809
Calumet River	$0	$0	$0	$62	$62
Total Overland AOI	$19,887	$0	$0	$984	$20,870
Total	$273,589	$5,594	$4,217	$444,809	$728,210

Without Project Base Year (2017) Number of Structures Damaged at 4% (25 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	1	0	2	1	4
Downtown West	33	2	7	206	248
Urban North	284	25	55	3,264	3,628
Urban South	0	0	0	71	71
Suburban North	1,284	88	226	3,883	5,481
Suburban South	2,193	170	656	31,920	34,939
Total Sewer AOI	3,795	285	946	39,345	44,371
Chicago River	4	0	0	27	31
Calumet River	0	0	0	3	3
Total Overland AOI	4	0	0	30	34
Total	3,799	285	946	39,375	44,405

Without Project Future Year (2029) Damages at 4% (25 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$4,196	$0	$0	$0	$4,196
Downtown West	$1	$0	$0	$63	$64
Urban North	$3,533	$41	$100	$21,974	$25,648
Urban South	$0	$0	$0	$75	$75
Suburban North	$186,939	$565	$1,623	$66,245	$255,373
Suburban South	$39,065	$3,871	$1,539	$234,906	$279,381
Total Sewer AOI	$233,734	$4,477	$3,263	$323,264	$564,738
Chicago River	$0	$0	$0	$922	$922
Calumet River	$0	$0	$0	$29	$29
Total Overland AOI	$0	$0	$0	$950	$950
Total	$233,734	$4,477	$3,263	$324,214	$565,688

Without Project Future Year (2029) Number of Structures Damaged at 4% (25 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	1	0	0	0	1
Downtown West	1	0	0	16	17
Urban North	188	6	22	1,580	1,796
Urban South	0	0	0	46	46
Suburban North	1,236	58	206	3,433	4,933
Suburban South	1,671	106	520	27,848	30,145
Total Sewer AOI	3,097	170	748	32,923	36,938
Chicago River	0	0	0	27	27
Calumet River	0	0	0	1	1
Total Overland AOI	0	0	0	28	28
Total	3,097	170	748	32,951	36,966

Without Project Base Year (2017) Damages at 2% (50 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$71,394	$0	$46	$783	$72,223
Downtown West	$1,240	$175	$40	$7,592	$9,047
Urban North	$36,621	$4,983	$1,595	$269,893	$313,092
Urban South	$31	$0	$4	$1,946	$1,981
Suburban North	$234,739	$4,993	$3,311	$201,695	$444,738
Suburban South	$155,427	$17,005	$5,355	$825,632	$1,003,420
Total Sewer AOI	$499,452	$27,157	$10,350	$1,307,541	$1,844,501
Chicago River	$19,935	$0	$0	$3,114	$23,049
Calumet River	$0	$0	$0	$178	$178
Total Overland AOI	$19,935	$0	$0	$3,292	$23,227
Total	$519,387	$27,157	$10,350	$1,310,833	$1,867,728

Without Project Base Year (2017) Number of Structures Damaged at 2% (50 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	18	0	5	17	40
Downtown West	162	28	21	1,027	1,238
Urban North	2,289	550	546	17,229	20,614
Urban South	8	0	2	336	346
Suburban North	2,003	332	450	9,663	12,448
Suburban South	4,314	591	1,309	63,000	69,214
Total Sewer AOI	8,794	1,501	2,333	91,272	103,900
Chicago River	4	0	0	89	93
Calumet River	0	0	0	5	5
Total Overland AOI	4	0	0	94	98
Total	8,798	1,501	2,333	91,366	103,998

Without Project Future Year (2029) Damages at 2% (50 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$43,876	$0	$19	$177	$44,072
Downtown West	$385	$3	$10	$498	$897
Urban North	$32,198	$4,333	$1,286	$218,565	$256,382
Urban South	$10	$0	$2	$907	$918
Suburban North	$233,003	$4,280	$3,274	$189,398	$429,956
Suburban South	$133,442	$15,080	$4,523	$683,314	$836,359
Total Sewer AOI	$442,915	$23,697	$9,113	$1,092,860	$1,568,584
Chicago River	$0	$0	$0	$3,085	$3,085
Calumet River	$0	$0	$0	$122	$122
Total Overland AOI	$0	$0	$0	$3,207	$3,207
Total	$442,915	$23,697	$9,113	$1,096,067	$1,571,791

Without Project Future Year (2029) Number of Structures Damaged at 2% (50 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	11	0	2	7	20
Downtown West	20	2	5	125	152
Urban North	1,898	506	445	14,637	17,486
Urban South	3	0	1	184	188
Suburban North	1,944	316	441	9,378	12,079
Suburban South	3,641	443	1,059	55,072	60,215
Total Sewer AOI	7,517	1,267	1,953	79,403	90,140
Chicago River	0	0	0	88	88
Calumet River	0	0	0	4	4
Total Overland AOI	0	0	0	92	92
Total	7,517	1,267	1,953	79,495	90,232

Without Project Base Year (2017) Damages at 1% (100 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$107,127	$0	$75	$2,949	$110,152
Downtown West	$24,923	$3,019	$886	$67,803	$96,632
Urban North	$65,774	$8,714	$2,700	$465,558	$542,747
Urban South	$388	$109	$684	$17,664	$18,845
Suburban North	$299,941	$10,573	$4,303	$368,571	$683,389
Suburban South	$208,134	$25,335	$6,884	$1,114,594	$1,354,946
Total Sewer AOI	$706,288	$47,751	$15,532	$2,037,140	$2,806,711
Chicago River	$19,959	$0	$0	$6,059	$26,018
Calumet River	$0	$0	$0	$243	$243
Total Overland AOI	$19,959	$0	$0	$6,302	$26,261
Total	$726,246	$47,751	$15,532	$2,043,442	$2,832,971

Without Project Base Year (2017) Number of Structures Damaged at 1% (100 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	40	0	8	54	102
Downtown West	1,356	345	231	4,858	6,790
Urban North	3,600	965	892	24,003	29,460
Urban South	80	24	37	1,815	1,956
Suburban North	2,458	460	594	16,310	19,822
Suburban South	5,386	752	1,568	73,262	80,968
Total Sewer AOI	12,920	2,546	3,330	120,302	139,098
Chicago River	4	2	0	158	164
Calumet River	0	0	0	7	7
Total Overland AOI	4	2	0	165	171
Total	12,924	2,548	3,330	120,467	139,269

Without Project Future Year (2029) Damages at 1% (100 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$95,209	$0	$229	$2,205	$97,644
Downtown West	$7,461	$1,603	$227	$29,652	$38,943
Urban North	$51,044	$7,546	$2,282	$401,893	$462,765
Urban South	$152	$38	$14	$8,508	$8,713
Suburban North	$282,225	$10,257	$4,236	$363,061	$659,779
Suburban South	$181,112	$23,517	$6,266	$982,652	$1,193,547
Total Sewer AOI	$617,204	$42,961	$13,254	$1,787,971	$2,461,389
Chicago River	$8,776	$0	$0	$5,989	$14,765
Calumet River	$0	$0	$0	$193	$193
Total Overland AOI	$8,776	$0	$0	$6,183	$14,959
Total	$625,980	$42,961	$13,254	$1,794,153	$2,476,348

Without Project Future Year (2029) Number of Structures Damaged at 1% (100 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	32	0	7	38	77
Downtown West	578	196	83	2,754	3,611
Urban North	2,982	819	733	21,472	26,006
Urban South	32	14	7	1,056	1,109
Suburban North	2,468	473	590	16,494	20,025
Suburban South	4,778	674	1,459	67,370	74,281
Total Sewer AOI	10,870	2,176	2,879	109,184	125,109
Chicago River	3	2	0	156	161
Calumet River	0	0	0	5	5
Total Overland AOI	3	2	0	161	166
Total	10,873	2,178	2,879	109,345	125,275

Without Project Base Year (2017) Damages at .2% (500 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$236,821	$788	$10,323	$12,287	$260,218
Downtown West	$69,678	$4,023	$5,841	$135,368	$214,909
Urban North	$106,442	$13,207	$3,636	$615,915	$739,201
Urban South	$5,655	$751	$829	$57,618	$64,853
Suburban North	$365,900	$16,188	$5,724	$597,457	$985,269
Suburban South	$244,326	$32,658	$8,467	$1,369,780	$1,655,231
Total Sewer AOI	$1,028,822	$67,615	$34,818	$2,788,426	$3,919,682
Chicago River	$22,568	$5	$17	$15,274	$37,864
Calumet River	$86	$0	$0	$592	$678
Total Overland AOI	$22,654	$5	$17	$15,866	$38,542
Total	$1,051,476	$67,621	$34,836	$2,804,292	$3,958,224

Without Project Base Year (2017) Number of Structures Damaged at .2% (500 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	214	20	57	279	570
Downtown West	2,607	490	519	6,782	10,398
Urban North	4,367	1,175	1,081	27,796	34,419
Urban South	337	83	88	4,013	4,521
Suburban North	3,050	570	749	25,223	29,592
Suburban South	6,194	944	1,804	82,881	91,823
Total Sewer AOI	16,769	3,282	4,298	146,974	171,323
Chicago River	10	4	7	281	302
Calumet River	5	0	0	12	17
Total Overland AOI	15	4	7	293	319
Total	16,784	3,286	4,305	147,267	171,642

Without Project Future Year (2029) Damages at .2% (500 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$187,458	$210	$1,657	$9,654	$198,979
Downtown West	$51,229	$3,557	$1,953	$107,007	$163,746
Urban North	$98,709	$11,731	$3,301	$560,963	$674,704
Urban South	$3,283	$215	$754	$40,488	$44,740
Suburban North	$362,444	$16,062	$5,656	$592,666	$976,828
Suburban South	$223,829	$30,351	$7,567	$1,215,474	$1,477,221
Total Sewer AOI	$926,951	$62,127	$20,888	$2,526,253	$3,536,218
Chicago River	$20,538	$5	$17	$15,168	$35,728
Calumet River	$18	$0	$0	$430	$448
Total Overland AOI	$20,556	$5	$17	$15,598	$36,176
Total	$947,508	$62,131	$20,905	$2,541,850	$3,572,394

Without Project Future Year (2029) Number of Structures Damaged at .2% (500 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	126	10	37	191	364
Downtown West	2,209	426	421	6,115	9,171
Urban North	4,066	1,097	1,021	26,161	32,345
Urban South	186	53	55	3,086	3,380
Suburban North	3,077	588	737	24,871	29,273
Suburban South	5,607	831	1,673	75,628	83,739
Total Sewer AOI	15,271	3,005	3,944	136,052	158,272
Chicago River	9	3	7	279	298
Calumet River	1	0	0	9	10
Total Overland AOI	10	3	7	288	308
Total	15,281	3,008	3,951	136,340	158,580

Lakeside Base Year (2017) Damages at 10% (10 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$0	$0	$9	$0	$9
Downtown West	$0	$0	$0	$28	$28
Urban North	$2,004	$0	$26	$7,035	$9,065
Urban South	$0	$0	$0	$0	$0
Suburban North	$779	$4	$4	$4,412	$5,199
Suburban South	$757	$176	$30	$3,465	$4,429
Total Sewer AOI	$3,540	$180	$70	$14,940	$18,731
Chicago River	$22,011	$1	$0	$29	$22,041
Calumet River	$0	$0	$0	$58	$58
Total Overland AOI	$22,011	$1	$0	$87	$22,099
Total	$25,551	$181	$70	$15,027	$40,829

Lakeside Base Year (2017) Number of Structures Damaged at 10% (10 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	0	0	1	0	1
Downtown West	0	0	0	7	7
Urban North	111	0	2	319	432
Urban South	0	0	0	0	0
Suburban North	14	1	2	221	238
Suburban South	42	6	14	476	538
Total Sewer AOI	167	7	19	1,023	1,216
Chicago River	5	1	0	1	7
Calumet River	0	0	0	3	3
Total Overland AOI	5	1	0	4	10
Total	172	8	19	1,027	1,226

Lakeside Future Year (2029) Damages at 10% (10 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$0	$0	$0	$0	$0
Downtown West	$0	$0	$0	$20	$20
Urban North	$2,004	$0	$2	$7,029	$9,035
Urban South	$0	$0	$0	$0	$0
Suburban North	$56	$3	$2	$7	$69
Suburban South	$757	$176	$30	$3,466	$4,430
Total Sewer AOI	$2,818	$180	$34	$10,522	$13,554
Chicago River	$0	$0	$0	$0	$0
Calumet River	$0	$0	$0	$0	$0
Total Overland AOI	$0	$0	$0	$0	$0
Total	$2,818	$180	$34	$10,522	$13,554

Lakeside Future Year (2029) Number of Structures Damaged at 10% (10 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	0	0	0	0	0
Downtown West	0	0	0	5	5
Urban North	111	0	1	319	431
Urban South	0	0	0	0	0
Suburban North	2	1	1	1	5
Suburban South	42	6	14	476	538
Total Sewer AOI	155	7	16	801	979
Chicago River	0	0	0	0	0
Calumet River	0	0	0	0	0
Total Overland AOI	0	0	0	0	0
Total	155	7	16	801	979

Lakeside Base Year (2017) Damages at 4% (25 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$27,156	$0	$28	$169	$27,353
Downtown West	$127	$10	$14	$1,544	$1,695
Urban North	$4,584	$125	$265	$38,616	$43,590
Urban South	$0	$0	$0	$281	$281
Suburban North	$189,012	$861	$1,758	$77,581	$269,213
Suburban South	$58,163	$4,636	$2,347	$344,275	$409,421
Total Sewer AOI	$279,042	$5,633	$4,412	$462,465	$751,552
Chicago River	$104,744	$3	$0	$993	$105,740
Calumet River	$0	$0	$0	$183	$183
Total Overland AOI	$104,744	$3	$0	$1,176	$105,923
Total	$383,786	$5,636	$4,412	$463,641	$857,475

Lakeside Base Year (2017) Number of Structures Damaged at 4% (25 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	5	0	3	6	14
Downtown West	49	2	8	298	357
Urban North	310	31	64	3,773	4,178
Urban South	0	0	0	86	86
Suburban North	1,329	92	241	4,172	5,834
Suburban South	2,208	172	662	32,117	35,159
Total Sewer AOI	3,901	297	978	40,452	45,628
Chicago River	8	2	0	29	39
Calumet River	0	0	0	5	5
Total Overland AOI	8	2	0	34	44
Total	3,909	299	978	40,486	45,672

Lakeside Future Year (2029) Damages at 4% (25 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$4,196	$0	$0	$0	$4,196
Downtown West	$1	$0	$0	$63	$64
Urban North	$3,533	$41	$100	$22,007	$25,681
Urban South	$0	$0	$0	$75	$75
Suburban North	$188,235	$565	$1,644	$71,454	$261,898
Suburban South	$39,111	$3,872	$1,540	$235,695	$280,217
Total Sewer AOI	$235,076	$4,477	$3,284	$329,294	$572,132
Chicago River	$0	$0	$0	$922	$922
Calumet River	$0	$0	$0	$32	$32
Total Overland AOI	$0	$0	$0	$954	$954
Total	$235,076	$4,477	$3,284	$330,248	$573,086

Lakeside Future Year (2029) Number of Structures Damaged at 4% (25 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	1	0	0	0	1
Downtown West	1	0	0	16	17
Urban North	188	6	22	1,585	1,801
Urban South	0	0	0	46	46
Suburban North	1,276	58	215	3,583	5,132
Suburban South	1,676	106	520	27,872	30,174
Total Sewer AOI	3,142	170	757	33,102	37,171
Chicago River	0	0	0	27	27
Calumet River	0	0	0	2	2
Total Overland AOI	0	0	0	29	29
Total	3,142	170	757	33,131	37,200

Lakeside Base Year (2017) Damages at 2% (50 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$136,942	$76	$8,629	$3,561	$149,208
Downtown West	$26,523	$2,697	$919	$68,449	$98,589
Urban North	$53,147	$6,261	$2,249	$392,639	$454,295
Urban South	$3,142	$74	$79	$16,742	$20,037
Suburban North	$246,207	$5,450	$3,534	$245,066	$500,257
Suburban South	$164,347	$18,431	$5,647	$880,091	$1,068,516
Total Sewer AOI	$630,308	$32,988	$21,058	$1,606,548	$2,290,902
Chicago River	$299,713	$153	$0	$4,144	$304,011
Calumet River	$88	$0	$31	$599	$718
Total Overland AOI	$299,801	$153	$31	$4,744	$304,728
Total	$930,109	$33,141	$21,088	$1,611,292	$2,595,630

Lakeside Base Year (2017) Number of Structures Damaged at 2% (50 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	74	3	28	78	183
Downtown West	1,261	284	176	4,861	6,582
Urban North	3,281	794	771	22,649	27,495
Urban South	77	17	12	1,988	2,094
Suburban North	2,132	347	494	11,544	14,517
Suburban South	4,671	674	1,405	66,298	73,048
Total Sewer AOI	11,496	2,119	2,886	107,418	123,919
Chicago River	24	6	0	153	183
Calumet River	5	0	13	12	30
Total Overland AOI	29	6	13	165	213
Total	11,525	2,125	2,899	107,583	124,132

Lakeside Future Year (2029) Damages at 2% (50 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$43,880	$0	$19	$177	$44,076
Downtown West	$385	$3	$10	$511	$909
Urban North	$32,631	$4,469	$1,298	$225,521	$263,918
Urban South	$10	$0	$2	$907	$918
Suburban North	$235,872	$4,351	$3,450	$207,731	$451,404
Suburban South	$133,515	$15,083	$4,524	$683,974	$837,095
Total Sewer AOI	$446,293	$23,905	$9,302	$1,118,821	$1,598,321
Chicago River	$4	$0	$0	$3,085	$3,088
Calumet River	$0	$0	$0	$170	$170
Total Overland AOI	$4	$0	$0	$3,255	$3,259
Total	$446,297	$23,905	$9,302	$1,122,076	$1,601,580

Lakeside Future Year (2029) Number of Structures Damaged at 2% (50 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	11	0	2	7	20
Downtown West	20	2	5	128	155
Urban North	1,950	517	450	15,040	17,957
Urban South	3	0	1	184	188
Suburban North	1,995	323	469	9,713	12,500
Suburban South	3,642	442	1,059	55,083	60,226
Total Sewer AOI	7,621	1,284	1,986	80,155	91,046
Chicago River	2	0	0	88	90
Calumet River	0	0	0	5	5
Total Overland AOI	2	0	0	93	95
Total	7,623	1,284	1,986	80,248	91,141

Lakeside Base Year (2017) Damages at 1% (100 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$521,274	$1,074	$11,415	$17,138	$550,902
Downtown West	$111,961	$6,789	$6,782	$178,067	$303,599
Urban North	$105,980	$11,297	$3,633	$621,447	$742,358
Urban South	$8,097	$776	$822	$63,470	$73,165
Suburban North	$338,835	$12,048	$5,492	$503,433	$859,808
Suburban South	$217,428	$27,553	$7,233	$1,192,709	$1,444,923
Total Sewer AOI	$1,303,576	$59,537	$35,378	$2,576,264	$3,974,755
Chicago River	$404,721	$1,360	$7	$22,085	$428,173
Calumet River	$403	$119	$319	$1,205	$2,045
Total Overland AOI	$405,123	$1,479	$326	$23,290	$430,218
Total	$1,708,699	$61,016	$35,704	$2,599,554	$4,404,973

Lakeside Base Year (2017) Number of Structures Damaged at 1% (100 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	410	33	120	381	944
Downtown West	3,018	646	622	7,902	12,188
Urban North	4,621	1,179	1,086	28,505	35,391
Urban South	397	89	87	4,558	5,131
Suburban North	3,179	518	751	23,492	27,940
Suburban South	5,851	864	1,645	76,622	84,982
Total Sewer AOI	17,476	3,329	4,311	141,460	166,576
Chicago River	66	27	3	779	875
Calumet River	13	4	106	26	149
Total Overland AOI	79	31	109	805	1,024
Total	17,555	3,360	4,420	142,265	167,600

Lakeside Future Year (2029) Damages at 1% (100 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$95,248	$0	$230	$2,218	$97,696
Downtown West	$7,687	$1,605	$242	$31,332	$40,866
Urban North	$54,495	$7,690	$2,290	$411,369	$475,844
Urban South	$152	$38	$14	$8,626	$8,831
Suburban North	$316,979	$10,593	$4,876	$391,190	$723,637
Suburban South	$181,321	$23,499	$6,266	$983,007	$1,194,094
Total Sewer AOI	$655,882	$43,425	$13,919	$1,827,742	$2,540,968
Chicago River	$19,135	$0	$0	$6,109	$25,245
Calumet River	$18	$0	$14	$375	$406
Total Overland AOI	$19,153	$0	$14	$6,484	$25,651
Total	$675,035	$43,425	$13,933	$1,834,226	$2,566,619

Lakeside Future Year (2029) Number of Structures Damaged at 1% (100 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	32	0	7	38	77
Downtown West	600	202	90	2,867	3,759
Urban North	3,030	834	734	21,710	26,308
Urban South	32	14	7	1,072	1,125
Suburban North	2,508	459	627	17,519	21,113
Suburban South	4,782	675	1,459	67,415	74,331
Total Sewer AOI	10,984	2,184	2,924	110,621	126,713
Chicago River	4	2	0	159	165
Calumet River	1	0	6	9	16
Total Overland AOI	5	2	6	168	181
Total	10,989	2,186	2,930	110,789	126,894

Lakeside Base Year (2017) Damages at .2% (500 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$2,233,754	$6,611	$70,174	$50,413	$2,360,953
Downtown West	$324,977	$14,211	$11,200	$295,693	$646,081
Urban North	$167,444	$73,536	$5,359	$891,620	$1,137,959
Urban South	$22,176	$2,369	$6,545	$126,214	$157,304
Suburban North	$422,887	$18,490	$7,181	$862,316	$1,310,873
Suburban South	$261,248	$38,134	$9,272	$1,498,340	$1,806,994
Total Sewer AOI	$3,432,485	$153,350	$109,733	$3,724,596	$7,420,164
Chicago River	$660,360	$22,924	$1,137	$191,997	$876,418
Calumet River	$8,493	$5,990	$2,104	$10,939	$27,526
Total Overland AOI	$668,853	$28,915	$3,241	$202,936	$903,944
Total	$4,101,338	$182,265	$112,973	$3,927,532	$8,324,108

Lakeside Base Year (2017) Number of Structures Damaged at .2% (500 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	1,970	129	309	777	3,185
Downtown West	4,800	1,262	897	9,862	16,821
Urban North	5,993	1,403	1,286	34,661	43,343
Urban South	901	168	152	6,287	7,508
Suburban North	4,592	691	1,085	36,173	42,541
Suburban South	6,778	1,087	1,968	87,607	97,440
Total Sewer AOI	25,034	4,740	5,697	175,367	210,838
Chicago River	414	202	47	4,863	5,526
Calumet River	110	26	345	591	1,072
Total Overland AOI	524	228	392	5,454	6,598
Total	25,558	4,968	6,089	180,821	217,436

Lakeside Future Year (2029) Damages at .2% (500 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$295,028	$337	$10,365	$11,270	$317,000
Downtown West	$66,278	$3,664	$2,322	$118,123	$190,387
Urban North	$102,457	$12,245	$3,397	$585,677	$703,776
Urban South	$6,275	$608	$765	$44,694	$52,342
Suburban North	$390,881	$16,786	$6,345	$679,749	$1,093,761
Suburban South	$225,502	$30,600	$7,627	$1,226,935	$1,490,664
Total Sewer AOI	$1,086,421	$64,240	$30,821	$2,666,447	$3,847,929
Chicago River	$404,123	$1,018	$27	$30,997	$436,165
Calumet River	$1,250	$2,925	$1,172	$3,306	$8,654
Total Overland AOI	$405,373	$3,944	$1,199	$34,303	$444,819
Total	$1,491,793	$68,184	$32,020	$2,700,750	$4,292,748

Lakeside Future Year (2029) Number of Structures Damaged at .2% (500 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	191	15	73	234	513
Downtown West	2,409	439	460	6,427	9,735
Urban North	4,215	1,117	1,035	27,022	33,389
Urban South	220	58	60	3,529	3,867
Suburban North	3,615	598	893	28,649	33,755
Suburban South	5,605	843	1,685	76,046	84,179
Total Sewer AOI	16,255	3,070	4,206	141,907	165,438
Chicago River	70	27	11	906	1,014
Calumet River	24	19	282	200	525
Total Overland AOI	94	46	293	1,106	1,539
Total	16,349	3,116	4,499	143,013	166,977

Midsystem Base Year (2017) Damages at 10% (10 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$0	$0	$0	$0	$0
Downtown West	$0	$0	$0	$20	$20
Urban North	$2,004	$0	$2	$7,033	$9,040
Urban South	$0	$0	$0	$0	$0
Suburban North	$56	$3	$2	$142	$204
Suburban South	$757	$176	$30	$3,441	$4,405
Total Sewer AOI	$2,818	$180	$34	$10,636	$13,668
Chicago River	$2	$0	$0	$0	$2
Calumet River	$0	$0	$0	$0	$0
Total Overland AOI	$2	$0	$0	$0	$2
Total	$2,820	$180	$34	$10,636	$13,670

Midsystem Base Year (2017) Number of Structures Damaged at 10% (10 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	0	0	0	0	0
Downtown West	0	0	0	5	5
Urban North	111	0	1	319	431
Urban South	0	0	0	0	0
Suburban North	2	1	1	8	12
Suburban South	42	6	14	474	536
Total Sewer AOI	155	7	16	806	984
Chicago River	2	0	0	0	2
Calumet River	0	0	0	0	0
Total Overland AOI	2	0	0	0	2
Total	157	7	16	806	986

Midsystem Future Year (2029) Damages at 10% (10 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$0	$0	$0	$0	$0
Downtown West	$0	$0	$0	$20	$20
Urban North	$2,004	$0	$2	$7,030	$9,036
Urban South	$0	$0	$0	$0	$0
Suburban North	$56	$3	$2	$7	$69
Suburban South	$757	$176	$30	$3,466	$4,430
Total Sewer AOI	$2,818	$180	$34	$10,523	$13,554
Chicago River	$2	$0	$0	$0	$2
Calumet River	$0	$0	$0	$0	$0
Total Overland AOI	$2	$0	$0	$0	$2
Total	$2,820	$180	$34	$10,523	$13,556

Midsystem Future Year (2029) Number of Structures Damaged at 10% (10 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	0	0	0	0	0
Downtown West	0	0	0	5	5
Urban North	111	0	1	319	431
Urban South	0	0	0	0	0
Suburban North	2	1	1	1	5
Suburban South	42	6	14	476	538
Total Sewer AOI	155	7	16	801	979
Chicago River	2	0	0	0	2
Calumet River	0	0	0	0	0
Total Overland AOI	2	0	0	0	2
Total	157	7	16	801	981

Midsystem Base Year (2017) Damages at 4% (25 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$4,248	$0	$0	$26	$4,275
Downtown West	$52	$10	$12	$842	$916
Urban North	$4,293	$108	$185	$32,294	$36,881
Urban South	$0	$0	$0	$166	$166
Suburban North	$186,926	$839	$1,661	$67,305	$256,731
Suburban South	$58,178	$4,651	$2,359	$346,722	$411,910
Total Sewer AOI	$253,698	$5,608	$4,218	$447,356	$710,880
Chicago River	$2	$0	$0	$922	$924
Calumet River	$0	$0	$0	$0	$0
Total Overland AOI	$2	$0	$0	$922	$924
Total	$253,700	$5,608	$4,218	$448,277	$711,804

Midsystem Base Year (2017) Number of Structures Damaged at 4% (25 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	1	0	0	1	2
Downtown West	31	2	7	198	238
Urban North	283	25	52	3,075	3,435
Urban South	0	0	0	66	66
Suburban North	1,274	85	224	3,807	5,390
Suburban South	2,213	175	670	33,436	36,494
Total Sewer AOI	3,802	287	953	40,583	45,625
Chicago River	2	0	0	27	29
Calumet River	0	0	0	0	0
Total Overland AOI	2	0	0	27	29
Total	3,804	287	953	40,610	45,654

Midsystem Future Year (2029) Damages at 4% (25 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$4,203	$0	$0	$0	$4,203
Downtown West	$1	$0	$0	$63	$64
Urban North	$3,540	$43	$100	$22,405	$26,088
Urban South	$0	$0	$0	$75	$75
Suburban North	$186,484	$571	$1,626	$63,733	$252,414
Suburban South	$39,349	$3,871	$1,603	$238,857	$283,681
Total Sewer AOI	$233,578	$4,484	$3,329	$325,134	$566,525
Chicago River	$2	$0	$0	$922	$924
Calumet River	$0	$0	$0	$0	$0
Total Overland AOI	$2	$0	$0	$922	$924
Total	$233,580	$4,484	$3,329	$326,056	$567,449

Midsystem Future Year (2029) Number of Structures Damaged at 4% (25 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	1	0	0	0	1
Downtown West	1	0	0	16	17
Urban North	190	7	22	1,637	1,856
Urban South	0	0	0	46	46
Suburban North	1,224	59	207	3,333	4,823
Suburban South	1,693	106	524	27,959	30,282
Total Sewer AOI	3,109	172	753	32,991	37,025
Chicago River	2	0	0	27	29
Calumet River	0	0	0	0	0
Total Overland AOI	2	0	0	27	29
Total	3,111	172	753	33,018	37,054

Midsystem Base Year (2017) Damages at 2% (50 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$74,747	$0	$55	$895	$75,698
Downtown West	$4,133	$294	$65	$14,175	$18,668
Urban North	$38,136	$5,078	$1,733	$285,921	$330,867
Urban South	$48	$0	$4	$4,260	$4,312
Suburban North	$234,778	$5,040	$3,313	$202,213	$445,345
Suburban South	$157,703	$17,524	$5,474	$852,100	$1,032,801
Total Sewer AOI	$509,546	$27,936	$10,644	$1,359,564	$1,907,691
Chicago River	$4	$0	$0	$3,085	$3,089
Calumet River	$0	$0	$0	$27	$27
Total Overland AOI	$4	$0	$0	$3,111	$3,116
Total	$509,551	$27,936	$10,644	$1,362,676	$1,910,807

Midsystem Base Year (2017) Number of Structures Damaged at 2% (50 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	19	0	6	19	44
Downtown West	276	49	34	1,613	1,972
Urban North	2,394	565	581	18,190	21,730
Urban South	14	0	2	636	652
Suburban North	2,005	335	450	9,671	12,461
Suburban South	4,482	628	1,363	64,463	70,936
Total Sewer AOI	9,190	1,577	2,436	94,592	107,795
Chicago River	2	0	0	88	90
Calumet River	0	0	0	1	1
Total Overland AOI	2	0	0	89	91
Total	9,192	1,577	2,436	94,681	107,886

Midsystem Future Year (2029) Damages at 2% (50 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$61,571	$0	$19	$489	$62,079
Downtown West	$475	$13	$13	$855	$1,356
Urban North	$32,657	$4,442	$1,321	$225,901	$264,321
Urban South	$10	$0	$2	$965	$976
Suburban North	$233,223	$4,303	$3,280	$190,672	$431,478
Suburban South	$137,849	$15,110	$4,619	$690,995	$848,573
Total Sewer AOI	$465,785	$23,868	$9,254	$1,109,877	$1,608,783
Chicago River	$4	$0	$0	$3,085	$3,089
Calumet River	$0	$0	$0	$27	$27
Total Overland AOI	$4	$0	$0	$3,111	$3,116
Total	$465,790	$23,868	$9,254	$1,112,988	$1,611,899

Midsystem Future Year (2029) Number of Structures Damaged at 2% (50 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	13	0	2	12	27
Downtown West	32	3	7	194	236
Urban North	1,946	513	461	15,064	17,984
Urban South	3	0	1	191	195
Suburban North	1,952	319	443	9,416	12,130
Suburban South	3,666	446	1,073	55,364	60,549
Total Sewer AOI	7,612	1,281	1,987	80,241	91,121
Chicago River	2	0	0	88	90
Calumet River	0	0	0	1	1
Total Overland AOI	2	0	0	89	91
Total	7,614	1,281	1,987	80,330	91,212

Midsystem Base Year (2017) Damages at 1% (100 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$126,799	$93	$8,539	$3,672	$139,103
Downtown West	$47,101	$3,400	$1,957	$93,779	$146,236
Urban North	$70,887	$9,642	$2,970	$494,963	$578,461
Urban South	$818	$147	$717	$30,013	$31,696
Suburban North	$300,346	$10,633	$4,320	$371,715	$687,014
Suburban South	$212,910	$26,396	$6,967	$1,144,876	$1,391,149
Total Sewer AOI	$758,860	$50,311	$25,471	$2,139,019	$2,973,660
Chicago River	$7,416	$0	$0	$5,989	$13,406
Calumet River	$0	$0	$0	$51	$51
Total Overland AOI	$7,416	$0	$0	$6,041	$13,457
Total	$766,276	$50,311	$25,471	$2,145,059	$2,987,117

Midsystem Base Year (2017) Number of Structures Damaged at 1% (100 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	50	3	13	70	136
Downtown West	1,909	408	372	5,841	8,530
Urban North	3,847	1,049	971	25,042	30,909
Urban South	162	37	45	2,762	3,006
Suburban North	2,467	460	599	16,463	19,989
Suburban South	5,588	811	1,595	74,686	82,680
Total Sewer AOI	14,023	2,768	3,595	124,864	145,250
Chicago River	3	3	0	156	162
Calumet River	0	0	0	3	3
Total Overland AOI	3	3	0	159	165
Total	14,026	2,771	3,595	125,023	145,415

Midsystem Future Year (2029) Damages at 1% (100 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$95,927	$0	$230	$2,330	$98,487
Downtown West	$9,514	$1,659	$428	$34,467	$46,069
Urban North	$54,252	$7,647	$2,314	$408,690	$472,902
Urban South	$166	$38	$415	$9,512	$10,132
Suburban North	$288,281	$10,011	$4,217	$347,211	$649,719
Suburban South	$184,085	$23,720	$6,355	$987,544	$1,201,705
Total Sewer AOI	$632,225	$43,076	$13,960	$1,789,755	$2,479,015
Chicago River	$7,376	$0	$0	$5,989	$13,365
Calumet River	$0	$0	$0	$52	$52
Total Overland AOI	$7,376	$0	$0	$6,041	$13,417
Total	$639,601	$43,076	$13,960	$1,795,796	$2,492,432

Midsystem Future Year (2029) Number of Structures Damaged at 1% (100 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	33	0	7	43	83
Downtown West	689	221	106	3,095	4,111
Urban North	3,031	833	746	21,859	26,469
Urban South	34	14	19	1,161	1,228
Suburban North	2,400	450	580	15,539	18,969
Suburban South	4,822	687	1,474	67,854	74,837
Total Sewer AOI	11,009	2,205	2,932	109,551	125,697
Chicago River	3	2	0	156	161
Calumet River	0	0	0	3	3
Total Overland AOI	3	2	0	159	164
Total	11,012	2,207	2,932	109,710	125,861

Midsystem Base Year (2017) Damages at .2% (500 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$361,946	$1,115	$11,012	$16,226	$390,298
Downtown West	$98,048	$4,807	$6,716	$166,987	$276,558
Urban North	$112,434	$13,812	$3,967	$655,159	$785,372
Urban South	$14,949	$903	$872	$74,152	$90,877
Suburban North	$368,245	$16,367	$5,822	$611,003	$1,001,437
Suburban South	$250,173	$33,863	$8,656	$1,401,014	$1,693,705
Total Sewer AOI	$1,205,794	$70,867	$37,045	$2,924,540	$4,238,247
Chicago River	$25,047	$9	$17	$15,328	$40,401
Calumet River	$18	$0	$0	$514	$533
Total Overland AOI	$25,065	$9	$17	$15,842	$40,934
Total	$1,230,860	$70,876	$37,063	$2,940,382	$4,279,181

Midsystem Base Year (2017) Number of Structures Damaged at .2% (500 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	357	35	87	352	831
Downtown West	2,905	635	634	7,667	11,841
Urban North	4,613	1,221	1,126	29,057	36,017
Urban South	472	105	105	4,598	5,280
Suburban North	3,154	575	763	26,092	30,584
Suburban South	6,386	982	1,847	83,721	92,936
Total Sewer AOI	17,887	3,553	4,562	151,487	177,489
Chicago River	11	5	7	289	312
Calumet River	1	0	0	11	12
Total Overland AOI	12	5	7	300	324
Total	17,899	3,558	4,569	151,787	177,813

Midsystem Future Year (2029) Damages at .2% (500 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$170,571	$166	$1,507	$8,149	$180,392
Downtown West	$37,548	$3,437	$1,296	$96,599	$138,880
Urban North	$97,541	$11,590	$3,200	$553,488	$665,818
Urban South	$3,204	$202	$748	$37,400	$41,554
Suburban North	$359,674	$15,678	$5,604	$562,648	$943,604
Suburban South	$223,071	$30,218	$7,540	$1,209,671	$1,470,501
Total Sewer AOI	$891,610	$61,290	$19,895	$2,467,955	$3,440,749
Chicago River	$11,792	$5	$17	$15,128	$26,943
Calumet River	$18	$0	$0	$430	$448
Total Overland AOI	$11,811	$5	$17	$15,558	$27,390
Total	$903,420	$61,294	$19,912	$2,483,513	$3,468,140

Midsystem Future Year (2029) Number of Structures Damaged at .2% (500 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	98	9	27	148	282
Downtown West	2,032	414	367	5,761	8,574
Urban North	4,014	1,081	1,004	25,965	32,064
Urban South	171	48	53	2,862	3,134
Suburban North	2,908	554	713	23,364	27,539
Suburban South	5,570	824	1,666	75,356	83,416
Total Sewer AOI	14,793	2,930	3,830	133,456	155,009
Chicago River	8	3	7	278	296
Calumet River	1	0	0	9	10
Total Overland AOI	9	3	7	287	306
Total	14,802	2,933	3,837	133,743	155,315

Lakeside Base Year (2017) change in Damages at 10% (10 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$0	$0	$9	$0	$9
Downtown West	$0	$0	$0	$8	$8
Urban North	$0	$0	$24	$1	$25
Urban South	$0	$0	$0	$0	$0
Suburban North	$723	$0	$2	$4,335	$5,060
Suburban South	$0	$0	$0	$0	-$1
Total Sewer AOI	$723	$0	$36	$4,344	$5,102
Chicago River	$3,132	$1	$0	$29	$3,163
Calumet River	$0	$0	$0	$23	$23
Total Overland AOI	$3,132	$1	$0	$52	$3,186
Total	$3,855	$1	$36	$4,396	$8,288

Lakeside Base Year (2017) change in Number of Structures Damaged at 10% (10 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	0	0	1	0	1
Downtown West	0	0	0	2	2
Urban North	0	0	1	0	1
Urban South	0	0	0	0	0
Suburban North	12	0	1	217	230
Suburban South	0	0	0	0	0
Total Sewer AOI	12	0	3	219	234
Chicago River	1	1	0	1	3
Calumet River	0	0	0	1	1
Total Overland AOI	1	1	0	2	4
Total	13	1	3	221	238

Lakeside Future Year (2029) change in Damages at 10% (10 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$0	$0	$0	$0	$0
Downtown West	$0	$0	$0	$0	$0
Urban North	$0	$0	$0	$0	$0
Urban South	$0	$0	$0	$0	$0
Suburban North	$0	$0	$0	$0	$0
Suburban South	$0	$0	$0	$0	$0
Total Sewer AOI	$0	$0	$0	$0	$0
Chicago River	$0	$0	$0	$0	$0
Calumet River	$0	$0	$0	$0	$0
Total Overland AOI	$0	$0	$0	$0	$0
Total	$0	$0	$0	$0	$0

Lakeside Future Year (2029) change in Number of Structures Damaged at 10% (10 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	0	0	0	0	0
Downtown West	0	0	0	0	0
Urban North	0	0	0	0	0
Urban South	0	0	0	0	0
Suburban North	0	0	0	0	0
Suburban South	0	0	0	0	0
Total Sewer AOI	0	0	0	0	0
Chicago River	0	0	0	0	0
Calumet River	0	0	0	0	0
Total Overland AOI	0	0	0	0	0
Total	0	0	0	0	0

Lakeside Base Year (2017) change in Damages at 4% (25 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$22,872	$0	$9	$140	$23,021
Downtown West	$48	$0	$2	$597	$647
Urban North	$191	$23	$74	$4,485	$4,772
Urban South	$0	$0	$0	$92	$92
Suburban North	$1,795	$8	$93	$8,449	$10,345
Suburban South	$435	$8	$17	$4,876	$5,336
Total Sewer AOI	$25,340	$38	$195	$18,640	$44,213
Chicago River	$84,857	$3	$0	$71	$84,931
Calumet River	$0	$0	$0	$121	$121
Total Overland AOI	$84,857	$3	$0	$192	$85,052
Total	$110,197	$42	$195	$18,832	$129,266

Lakeside Base Year (2017) change in Number of Structures Damaged at 4% (25 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	4	0	1	5	10
Downtown West	16	0	1	92	109
Urban North	26	6	9	509	550
Urban South	0	0	0	15	15
Suburban North	45	4	15	289	353
Suburban South	15	2	6	197	220
Total Sewer AOI	106	12	32	1,107	1,257
Chicago River	4	2	0	2	8
Calumet River	0	0	0	2	2
Total Overland AOI	4	2	0	4	10
Total	110	14	32	1,111	1,267

Lakeside Future Year (2029) change in Damages at 4% (25 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$0	$0	$0	$0	$0
Downtown West	$0	$0	$0	$0	$0
Urban North	$0	$0	$0	$33	$33
Urban South	$0	$0	$0	$0	$0
Suburban North	$1,296	$0	$21	$5,209	$6,525
Suburban South	$46	$0	$0	$789	$836
Total Sewer AOI	$1,342	$1	$21	$6,030	$7,394
Chicago River	$0	$0	$0	$0	$0
Calumet River	$0	$0	$0	$4	$4
Total Overland AOI	$0	$0	$0	$4	$4
Total	$1,342	$1	$21	$6,034	$7,398

Lakeside Future Year (2029) change in Number of Structures Damaged at 4% (25 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	0	0	0	0	0
Downtown West	0	0	0	0	0
Urban North	0	0	0	5	5
Urban South	0	0	0	0	0
Suburban North	40	0	9	150	199
Suburban South	5	0	0	24	29
Total Sewer AOI	45	0	9	179	233
Chicago River	0	0	0	0	0
Calumet River	0	0	0	1	1
Total Overland AOI	0	0	0	1	1
Total	45	0	9	180	234

Lakeside Base Year (2017) change in Damages at 2% (50 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$65,548	$76	$8,583	$2,777	$76,985
Downtown West	$25,283	$2,522	$880	$60,858	$89,542
Urban North	$16,526	$1,278	$654	$122,746	$141,204
Urban South	$3,111	$74	$75	$14,795	$18,056
Suburban North	$11,468	$457	$224	$43,371	$55,519
Suburban South	$8,920	$1,425	$292	$54,459	$65,096
Total Sewer AOI	$130,856	$5,831	$10,707	$299,007	$446,401
Chicago River	$279,779	$153	$0	$1,031	$280,962
Calumet River	$88	$0	$31	$421	$539
Total Overland AOI	$279,867	$153	$31	$1,452	$281,501
Total	$410,722	$5,984	$10,738	$300,458	$727,903

Lakeside Base Year (2017) change in Number of Structures Damaged at 2% (50 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	56	3	23	61	143
Downtown West	1,099	256	155	3,834	5,344
Urban North	992	244	225	5,420	6,881
Urban South	69	17	10	1,652	1,748
Suburban North	129	15	44	1,881	2,069
Suburban South	357	83	96	3,298	3,834
Total Sewer AOI	2,702	618	553	16,146	20,019
Chicago River	20	6	0	64	90
Calumet River	5	0	13	7	25
Total Overland AOI	25	6	13	71	115
Total	2,727	624	566	16,217	20,134

Lakeside Future Year (2029) change in Damages at 2% (50 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$4	$0	$0	$0	$4
Downtown West	$0	$0	$0	$13	$13
Urban North	$433	$136	$12	$6,956	$7,536
Urban South	$0	$0	$0	$0	$0
Suburban North	$2,869	$71	$176	$18,333	$21,448
Suburban South	$73	$2	$1	$659	$736
Total Sewer AOI	$3,379	$209	$189	$25,961	$29,737
Chicago River	$4	$0	$0	$0	$4
Calumet River	$0	$0	$0	$48	$48
Total Overland AOI	$4	$0	$0	$48	$52
Total	$3,382	$209	$189	$26,009	$29,789

Lakeside Future Year (2029) change in Number of Structures Damaged at 2% (50 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	0	0	0	0	0
Downtown West	0	0	0	3	3
Urban North	52	11	5	403	471
Urban South	0	0	0	0	0
Suburban North	51	7	28	335	421
Suburban South	1	-1	0	11	11
Total Sewer AOI	104	17	33	752	906
Chicago River	2	0	0	0	2
Calumet River	0	0	0	1	1
Total Overland AOI	2	0	0	1	3
Total	106	17	33	753	909

Lakeside Base Year (2017) change in Damages at 1% (100 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$414,147	$1,074	$11,340	$14,189	$440,750
Downtown West	$87,038	$3,770	$5,896	$110,263	$206,968
Urban North	$40,206	$2,583	$934	$155,889	$199,612
Urban South	$7,709	$667	$138	$45,806	$54,320
Suburban North	$38,893	$1,475	$1,189	$134,862	$176,419
Suburban South	$9,294	$2,218	$350	$78,115	$89,976
Total Sewer AOI	$597,288	$11,786	$19,846	$539,124	$1,168,044
Chicago River	$384,762	$1,360	$7	$16,027	$402,155
Calumet River	$403	$119	$319	$962	$1,802
Total Overland AOI	$385,165	$1,479	$326	$16,988	$403,958
Total	$982,452	$13,265	$20,172	$556,112	$1,572,002

Lakeside Base Year (2017) change in Number of Structures Damaged at 1% (100 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	370	33	112	327	842
Downtown West	1,662	301	391	3,044	5,398
Urban North	1,021	214	194	4,502	5,931
Urban South	317	65	50	2,743	3,175
Suburban North	721	58	157	7,182	8,118
Suburban South	465	112	77	3,360	4,014
Total Sewer AOI	4,556	783	981	21,158	27,478
Chicago River	62	25	3	621	711
Calumet River	13	4	106	19	142
Total Overland AOI	75	29	109	640	853
Total	4,631	812	1,090	21,798	28,331

Lakeside Future Year (2029) change in Damages at 1% (100 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$39	$0	$1	$13	$53
Downtown West	$225	$2	$15	$1,680	$1,923
Urban North	$3,451	$144	$9	$9,476	$13,079
Urban South	$0	$0	$0	$118	$118
Suburban North	$34,754	$335	$640	$28,129	$63,858
Suburban South	$209	-$17	$0	$355	$547
Total Sewer AOI	$38,679	$464	$665	$39,771	$79,579
Chicago River	$10,359	$0	$0	$120	$10,479
Calumet River	$18	$0	$14	$181	$213
Total Overland AOI	$10,377	$0	$14	$301	$10,692
Total	$49,056	$464	$679	$40,073	$90,271

Lakeside Future Year (2029) change in Number of Structures Damaged at 1% (100 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	0	0	0	0	0
Downtown West	22	6	7	113	148
Urban North	48	15	1	238	302
Urban South	0	0	0	16	16
Suburban North	40	-14	37	1,025	1,088
Suburban South	4	1	0	45	50
Total Sewer AOI	114	8	45	1,437	1,604
Chicago River	1	0	0	3	4
Calumet River	1	0	6	4	11
Total Overland AOI	2	0	6	7	15
Total	116	8	51	1,444	1,619

Lakeside Base Year (2017) change in Damages at .2% (500 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$1,996,933	$5,824	$59,852	$38,126	$2,100,735
Downtown West	$255,299	$10,187	$5,360	$160,325	$431,172
Urban North	$61,001	$60,329	$1,724	$275,704	$398,758
Urban South	$16,521	$1,618	$5,716	$68,597	$92,452
Suburban North	$56,987	$2,301	$1,457	$264,858	$325,604
Suburban South	$16,922	$5,476	$805	$128,560	$151,762
Total Sewer AOI	$2,403,663	$85,734	$74,914	$936,170	$3,500,482
Chicago River	$637,792	$22,919	$1,120	$176,723	$838,554
Calumet River	$8,407	$5,990	$2,104	$10,347	$26,848
Total Overland AOI	$646,199	$28,910	$3,224	$187,070	$865,402
Total	$3,049,862	$114,644	$78,138	$1,123,240	$4,365,884

Lakeside Base Year (2017) change in Number of Structures Damaged at .2% (500 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	1,756	109	252	498	2,615
Downtown West	2,193	772	378	3,080	6,423
Urban North	1,626	228	205	6,865	8,924
Urban South	564	85	64	2,274	2,987
Suburban North	1,542	121	336	10,950	12,949
Suburban South	584	143	164	4,726	5,617
Total Sewer AOI	8,265	1,458	1,399	28,393	39,515
Chicago River	404	198	40	4,582	5,224
Calumet River	105	26	345	579	1,055
Total Overland AOI	509	224	385	5,161	6,279
Total	8,774	1,682	1,784	33,554	45,794

Lakeside Future Year (2029) change in Damages at .2% (500 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$107,570	$127	$8,708	$1,615	$118,021
Downtown West	$15,049	$107	$369	$11,116	$26,641
Urban North	$3,748	$513	$96	$24,714	$29,072
Urban South	$2,992	$393	$11	$4,206	$7,602
Suburban North	$28,437	$724	$689	$87,083	$116,933
Suburban South	$1,673	$249	$61	$11,461	$13,443
Total Sewer AOI	$159,470	$2,113	$9,934	$140,194	$311,711
Chicago River	$383,585	$1,014	$9	$15,829	$400,437
Calumet River	$1,232	$2,925	$1,172	$2,876	$8,206
Total Overland AOI	$384,816	$3,939	$1,182	$18,706	$408,642
Total	$544,286	$6,052	$11,115	$158,900	$720,353

Lakeside Future Year (2029) change in Number of Structures Damaged at .2% (500 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	65	5	36	43	149
Downtown West	200	13	39	312	564
Urban North	149	20	14	861	1,044
Urban South	34	5	5	443	487
Suburban North	538	10	156	3,778	4,482
Suburban South	-2	12	12	418	440
Total Sewer AOI	984	65	262	5,855	7,166
Chicago River	61	24	4	627	716
Calumet River	23	19	282	191	515
Total Overland AOI	84	43	286	818	1,231
Total	1,068	108	548	6,673	8,397

Midsystem Base Year (2017) change in Damages at 10% (10 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$0	$0	$0	$0	$0
Downtown West	$0	$0	$0	$0	$0
Urban North	$0	$0	$0	-$1	-$1
Urban South	$0	$0	$0	$0	$0
Suburban North	$0	$0	$0	$65	$65
Suburban South	$0	$0	$0	-$25	-$25
Total Sewer AOI	$0	$0	$0	$39	$39
Chicago River	-$18,876	$0	$0	$0	-$18,876
Calumet River	$0	$0	$0	-$35	-$35
Total Overland AOI	-$18,876	$0	$0	-$35	-$18,911
Total	-$18,876	$0	$0	$5	-$18,872

Midsystem Base Year (2017) change in Number of Structures Damaged at 10% (10 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	0	0	0	0	0
Downtown West	0	0	0	0	0
Urban North	0	0	0	0	0
Urban South	0	0	0	0	0
Suburban North	0	0	0	4	4
Suburban South	0	0	0	-2	-2
Total Sewer AOI	0	0	0	2	2
Chicago River	-2	0	0	0	-2
Calumet River	0	0	0	-2	-2
Total Overland AOI	-2	0	0	-2	-4
Total	-2	0	0	0	-2

Midsystem Future Year (2029) change in Damages at 10% (10 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$0	$0	$0	$0	$0
Downtown West	$0	$0	$0	$0	$0
Urban North	$0	$0	$0	$1	$1
Urban South	$0	$0	$0	$0	$0
Suburban North	$0	$0	$0	$0	$0
Suburban South	$0	$0	$0	$0	$0
Total Sewer AOI	$0	$0	$0	$1	$1
Chicago River	$2	$0	$0	$0	$2
Calumet River	$0	$0	$0	$0	$0
Total Overland AOI	$2	$0	$0	$0	$2
Total	$2	$0	$0	$1	$2

Midsystem Future Year (2029) change in Number of Structures Damaged at 10% (10 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	0	0	0	0	0
Downtown West	0	0	0	0	0
Urban North	0	0	0	0	0
Urban South	0	0	0	0	0
Suburban North	0	0	0	0	0
Suburban South	0	0	0	0	0
Total Sewer AOI	0	0	0	0	0
Chicago River	2	0	0	0	2
Calumet River	0	0	0	0	0
Total Overland AOI	2	0	0	0	2
Total	2	0	0	0	2

Midsystem Base Year (2017) change in Damages at 4% (25 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	-$36	$0	-$18	-$3	-$57
Downtown West	-$28	$0	$0	-$105	-$132
Urban North	-$100	$6	-$6	-$1,836	-$1,936
Urban South	$0	$0	$0	-$23	-$23
Suburban North	-$290	-$15	-$5	-$1,827	-$2,137
Suburban South	$450	$23	$30	$7,324	$7,826
Total Sewer AOI	-$4	$14	$1	$3,530	$3,541
Chicago River	-$19,885	$0	$0	$0	-$19,885
Calumet River	$0	$0	$0	-$62	-$62
Total Overland AOI	-$19,885	$0	$0	-$62	-$19,946
Total	-$19,889	$14	$1	$3,468	-$16,406

Midsystem Base Year (2017) change in Number of Structures Damaged at 4% (25 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	0	0	-2	0	-2
Downtown West	-2	0	0	-8	-10
Urban North	-1	0	-3	-189	-193
Urban South	0	0	0	-5	-5
Suburban North	-10	-3	-2	-76	-91
Suburban South	20	5	14	1,516	1,555
Total Sewer AOI	7	2	7	1,238	1,254
Chicago River	-2	0	0	0	-2
Calumet River	0	0	0	-3	-3
Total Overland AOI	-2	0	0	-3	-5
Total	5	2	7	1,235	1,249

Midsystem Future Year (2029) change in Damages at 4% (25 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$7	$0	$0	$0	$7
Downtown West	$0	$0	$0	$0	$0
Urban North	$7	$2	$0	$431	$440
Urban South	$0	$0	$0	$0	$0
Suburban North	-$455	$6	$2	-$2,512	-$2,959
Suburban South	$284	$0	$64	$3,951	$4,299
Total Sewer AOI	-$156	$7	$66	$1,870	$1,787
Chicago River	$2	$0	$0	$0	$2
Calumet River	$0	$0	$0	-$29	-$29
Total Overland AOI	$2	$0	$0	-$29	-$26
Total	-$154	$7	$66	$1,841	$1,761

Midsystem Future Year (2029) change in Number of Structures Damaged at 4% (25 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	0	0	0	0	0
Downtown West	0	0	0	0	0
Urban North	2	1	0	57	60
Urban South	0	0	0	0	0
Suburban North	-12	1	1	-100	-110
Suburban South	22	0	4	111	137
Total Sewer AOI	12	2	5	68	87
Chicago River	2	0	0	0	2
Calumet River	0	0	0	-1	-1
Total Overland AOI	2	0	0	-1	1
Total	14	2	5	67	88

Midsystem Base Year (2017) change in Damages at 2% (50 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$3,353	$0	$9	$112	$3,475
Downtown West	$2,893	$119	$26	$6,583	$9,621
Urban North	$1,515	$95	$138	$16,027	$17,775
Urban South	$17	$0	$0	$2,314	$2,331
Suburban North	$39	$47	$3	$518	$607
Suburban South	$2,276	$518	$118	$26,469	$29,381
Total Sewer AOI	$10,094	$779	$294	$52,023	$63,190
Chicago River	-$19,930	$0	$0	-$29	-$19,960
Calumet River	$0	$0	$0	-$151	-$151
Total Overland AOI	-$19,930	$0	$0	-$181	-$20,111
Total	-$9,836	$779	$294	$51,842	$43,079

Midsystem Base Year (2017) change in Number of Structures Damaged at 2% (50 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	1	0	1	2	4
Downtown West	114	21	13	586	734
Urban North	105	15	35	961	1,116
Urban South	6	0	0	300	306
Suburban North	2	3	0	8	13
Suburban South	168	37	54	1,463	1,722
Total Sewer AOI	396	76	103	3,320	3,895
Chicago River	-2	0	0	-1	-3
Calumet River	0	0	0	-4	-4
Total Overland AOI	-2	0	0	-5	-7
Total	394	76	103	3,315	3,888

Midsystem Future Year (2029) change in Damages at 2% (50 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$17,695	$0	$0	$312	$18,007
Downtown West	$90	$10	$3	$357	$459
Urban North	$459	$110	$35	$7,336	$7,939
Urban South	$0	$0	$0	$58	$58
Suburban North	$220	$23	$6	$1,274	$1,522
Suburban South	$4,407	$29	$97	$7,681	$12,214
Total Sewer AOI	$22,871	$171	$141	$17,016	$40,199
Chicago River	$4	$0	$0	$0	$4
Calumet River	$0	$0	$0	-$95	-$95
Total Overland AOI	$4	$0	$0	-$95	-$91
Total	$22,875	$171	$141	$16,921	$40,108

Midsystem Future Year (2029) change in Number of Structures Damaged at 2% (50 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	2	0	0	5	7
Downtown West	12	1	2	69	84
Urban North	48	7	16	427	498
Urban South	0	0	0	7	7
Suburban North	8	3	2	38	51
Suburban South	25	3	14	292	334
Total Sewer AOI	95	14	34	838	981
Chicago River	2	0	0	0	2
Calumet River	0	0	0	-3	-3
Total Overland AOI	2	0	0	-3	-1
Total	97	14	34	835	980

Midsystem Base Year (2017) change in Damages at 1% (100 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$19,672	$93	$8,464	$723	$28,951
Downtown West	$22,178	$381	$1,071	$25,976	$49,605
Urban North	$5,112	$927	$270	$29,405	$35,714
Urban South	$430	$38	$33	$12,349	$12,851
Suburban North	$404	$60	$17	$3,144	$3,625
Suburban South	$4,777	$1,061	$83	$30,282	$36,202
Total Sewer AOI	$52,572	$2,560	$9,938	$101,879	$166,950
Chicago River	-$12,543	$0	$0	-$69	-$12,612
Calumet River	$0	$0	$0	-$192	-$192
Total Overland AOI	-$12,543	$0	$0	-$261	-$12,804
Total	$40,030	$2,560	$9,938	$101,618	$154,146

Midsystem Base Year (2017) change in Number of Structures Damaged at 1% (100 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	10	3	5	16	34
Downtown West	553	63	141	983	1,740
Urban North	247	84	79	1,039	1,449
Urban South	82	13	8	947	1,050
Suburban North	9	0	5	153	167
Suburban South	202	59	27	1,424	1,712
Total Sewer AOI	1,103	222	265	4,562	6,152
Chicago River	-1	1	0	-2	-2
Calumet River	0	0	0	-4	-4
Total Overland AOI	-1	1	0	-6	-6
Total	1,102	223	265	4,556	6,146

Midsystem Future Year (2029) change in Damages at 1% (100 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$718	$0	$1	$125	$844
Downtown West	$2,052	$57	$201	$4,816	$7,126
Urban North	$3,208	$101	$32	$6,797	$10,137
Urban South	$14	$0	$401	$1,004	$1,420
Suburban North	$6,056	-$247	-$19	-$15,850	-$10,059
Suburban South	$2,973	$204	$89	$4,892	$8,159
Total Sewer AOI	$15,021	$115	$706	$1,784	$17,626
Chicago River	-$1,400	$0	$0	$0	-$1,400
Calumet River	$0	$0	$0	-$142	-$142
Total Overland AOI	-$1,400	$0	$0	-$142	-$1,542
Total	$13,621	$115	$706	$1,643	$16,084

Midsystem Future Year (2029) change in Number of Structures Damaged at 1% (100 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	1	0	0	5	6
Downtown West	111	25	23	341	500
Urban North	49	14	13	387	463
Urban South	2	0	12	105	119
Suburban North	-68	-23	-10	-955	-1,056
Suburban South	44	13	15	484	556
Total Sewer AOI	139	29	53	367	588
Chicago River	0	0	0	0	0
Calumet River	0	0	0	-2	-2
Total Overland AOI	0	0	0	-2	-2
Total	139	29	53	365	586

Midsystem Base Year (2017) change in Damages at .2% (500 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	$125,124	$327	$689	$3,939	$130,080
Downtown West	$28,370	$784	$876	$31,619	$61,648
Urban North	$5,991	$605	$332	$39,244	$46,172
Urban South	$9,294	$153	$43	$16,534	$26,024
Suburban North	$2,345	$178	$98	$13,546	$16,168
Suburban South	$5,847	$1,205	$189	$31,233	$38,474
Total Sewer AOI	$176,972	$3,252	$2,227	$136,114	$318,565
Chicago River	$2,480	$4	$0	$54	$2,537
Calumet River	-$68	$0	$0	-$78	-$146
Total Overland AOI	$2,412	$4	$0	-$24	$2,391
Total	$179,384	$3,255	$2,227	$136,090	$320,957

Midsystem Base Year (2017) change in Number of Structures Damaged at .2% (500 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	143	15	30	73	261
Downtown West	298	145	115	885	1,443
Urban North	246	46	45	1,261	1,598
Urban South	135	22	17	585	759
Suburban North	104	5	14	869	992
Suburban South	192	38	43	840	1,113
Total Sewer AOI	1,118	271	264	4,513	6,166
Chicago River	1	1	0	8	10
Calumet River	-4	0	0	-1	-5
Total Overland AOI	-3	1	0	7	5
Total	1,115	272	264	4,520	6,171

Midsystem Future Year (2029) change in Damages at .2% (500 year) Flood - $1,000's

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	-$16,887	-$45	-$150	-$1,505	-$18,587
Downtown West	-$13,681	-$120	-$657	-$10,408	-$24,865
Urban North	-$1,168	-$142	-$101	-$7,475	-$8,886
Urban South	-$79	-$13	-$5	-$3,089	-$3,186
Suburban North	-$2,769	-$384	-$53	-$30,018	-$33,225
Suburban South	-$758	-$133	-$26	-$5,803	-$6,720
Total Sewer AOI	-$35,341	-$837	-$993	-$58,298	-$95,469
Chicago River	-$8,746	$0	$0	-$40	-$8,785
Calumet River	$0	$0	$0	$0	$0
Total Overland AOI	-$8,746	$0	$0	-$40	-$8,786
Total	-$44,087	-$837	-$993	-$58,338	-$104,255

Midsystem Future Year (2029) change in Number of Structures Damaged at .2% (500 year) Flood

Category	Commercial	Industrial	Public	Residential	Total
Downtown East	-28	-1	-10	-43	-82
Downtown West	-177	-12	-54	-354	-597
Urban North	-52	-16	-17	-196	-281
Urban South	-15	-5	-2	-224	-246
Suburban North	-169	-34	-24	-1,507	-1,734
Suburban South	-37	-7	-7	-272	-323
Total Sewer AOI	-478	-75	-114	-2,596	-3,263
Chicago River	-1	0	0	-1	-2
Calumet River	0	0	0	0	0
Total Overland AOI	-1	0	0	-1	-2
Total	-479	-75	-114	-2,597	-3,265

ATTACHMENT 9

WATER QUALITY

Baseline Assessment of Water Quality -

Chicago Area Waterway System

August 2013

U.S. Army Corps
of Engineers
Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

GREAT LAKES MISSISSIPPI RIVER INTERBASIN STUDY (GLMRIS)
BASELINE ASSESSMENT OF WATER QUALITY IN THE
CHICAGO AREA WATERWAY SYSTEM

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FIGURES

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I. EXECUTIVE SUMMARY

In support of the Great Lakes and Mississippi River Interbasin Study (GLMRIS), several alternative plans were developed which seek to prevent the transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River Basins. As a result of implementation of a GLMRIS project (i.e., the future with-project condition) or lack thereof (i.e., the future without-project condition), water quality discharge standards within the Chicago Area Waterway System (CAWS) may change. In order to address these potential changes, this baseline assessment of entities that either use water from or discharge water into CAWS was developed.

Changes in water quality, and or water quality discharge standards, due to implementation of an ANS control, could lead to increased costs for entities that either withdraw water from, and or discharge water into, the CAWS. Identification of the number of existing users (withdrawers and dischargers), and their geographical location, is the first step that must be accomplished in order to accurately reflect the number of users that could be affected under future without and with-project conditions. This evaluation concentrates on the current number of existing users, and an estimate of their current costs associated with either withdrawing water from the CAWS for usage in the services they provide, or discharging water into the CAWS.

There are three main discharger groups that use the waterway for different purposes. The waste water reclamation plants use it as the final destination for their effluent. The power generation plants use it for cooling purposes. The industrial users use it for non contact cooling purposes. The last two dischargers do not change the quality of the water when using it in their production process since the water is primarily utilized for cooling purposes. It is assumed that, under existing conditions, the last two user groups do not change the quality of the water when using it in their production processes.

However, the three waste water reclamation plants within the CAWS, (to include the: Northside, Calumet, and Stickney Water Reclamation Plants) have to treat their effluent so that it will meet water quality discharge standards associated with discharging water into the CAWS. Under future without and future with project conditions, there may be additional water treatment costs associated with meeting discharge water quality standards. Change in water treatment costs may occur due to more stringent water quality standards being imposed for discharges into the CAWS under future without-project (FWOP) conditions. Also, water treatment costs may increase under future with-project (FWP) conditions if the final destination of the water must meet Lake Michigan water quality standards, which is more stringent than current CAWS water quality standards.

Existing condition discharger operating costs were developed for the three waste water reclamation plants. Development of these wastewater annual operation and maintenance costs capture the large majority of water treatment costs that could be potentially impacted under FWOP and FWP conditions. These operation and maintenance costs are displayed in Table 1.

Table 1. Annual Operation and Maintenance Costs: Northside, Calumet and Stickney Water Reclamation Plants.

Activity	Northside	Calumet	Stickney
Collection and Treatment	$19,244,201	$25,876,415	$52,763,401
Solids Processing	$4,939,114	$6,641,302	$23,141,587
Solids Utilization	$1,556,127	$2,092,422	$8,499,823
Flood and Pollution Control	$1,083,478	$1,456,881	$758,965
General Support	$273,794	$368,153	$2,384,024
	---------------------------	----------------------------	-----------------------------
	$27,096,713	**$36,435,174**	**$87,547,800**
Source: "*2012 Budget, Metropolitan Reclamation District Of Greater Chicago,*" adopted December 8, 2011, and amended December 15, 2011.			

II. GLMRIS STUDY INFORMATION

A. Introduction

An aquatic nuisance species (ANS) is a non-indigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (2010).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and non-indigenous invasive species.

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River by aquatic pathways. In this context, the term "prevent" includes the reduction of risk to the maximum extent possible, because it may not be technologically feasible to achieve an absolute solution. As part of this study, USACE will conduct a detailed analysis of various ANS controls, including hydrologic separation.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;

- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

B. GLMRIS Study Area

The GLMRIS study area includes portions of the Great Lakes and Mississippi River basins that fall within the United States.

Potential aquatic pathways between the Great Lakes and Mississippi River basins exist along the basins' shared boundary (illustrated as “” in Figure 1). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi Basin () and the Great Lakes Basin (). See Figre 1.

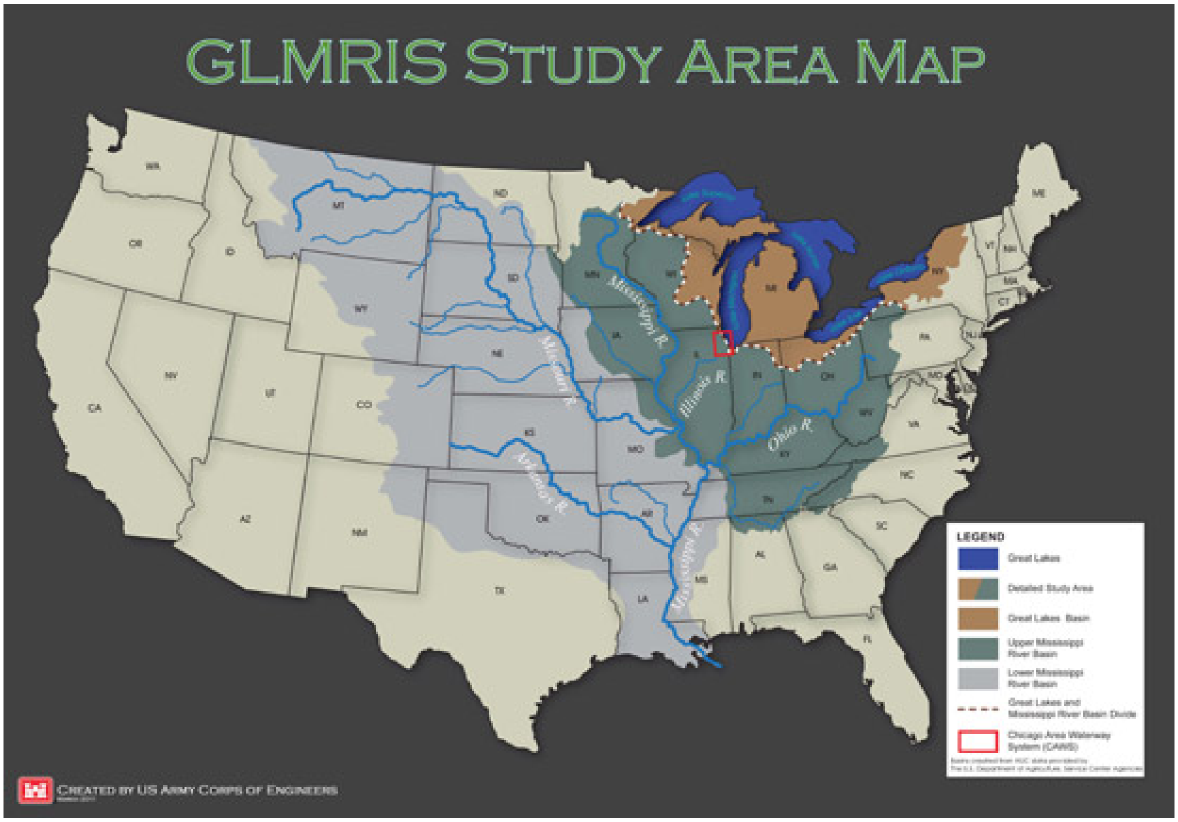

Figure 1. GLMRIS Study Area Map

Future ANS may transfer beyond the *Detailed Study Area*; this pattern was observed by the spread of zebra mussels, which originated in the Great Lakes and spread throughout the Mississippi River Basin. Therefore, the *General Study Area* encompasses the lower Mississippi River Basin ( ). While the majority of GLMRIS tasks will be completed within the *Detailed Study Area*, USACE will consider specific ANS impacts in the larger *General Study Area*.

a. GLMRIS Focus Areas

The U.S. Army Corps of Engineers is conducting GLMRIS along two concurrent tracks: Focus Area I, the Chicago Area Waterway System (CAWS), and Focus Area II, Other Pathways.

(1) Chicago Area Waterway System (CAWS)

The Chicago Area Waterway system (**Figure 2**) consists of a number of rivers, locks and canals that connect Lake Michigan with the Mississippi River system via the Illinois River. Focus Area I, the Chicago Area Waterway System, as shown in Figure 2, is the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins. It, therefore, poses the greatest potential risk of aquatic nuisance species (ANS) transfer between the basins, via an aquatic pathway.

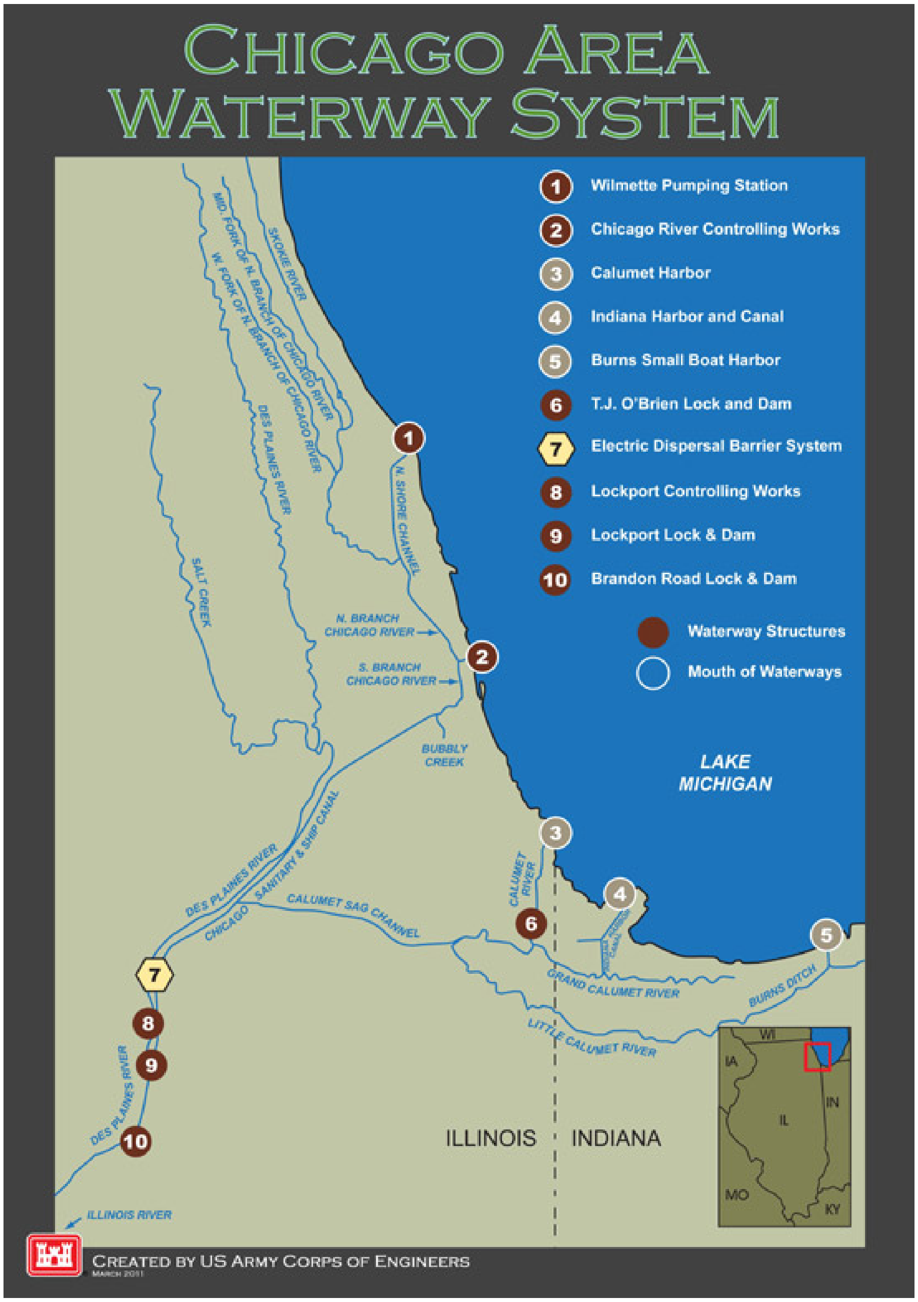

Figure 2. Chicago Area Waterway System

(2) Other Pathways

Focus Area II addresses remaining aquatic pathways. For this focus area, the U.S. Army Corps of Engineers completed a document entitled *Other Pathways Preliminary Risk Characterization Report* that identified other potential aquatic pathways outside of the Chicago Area Waterway System, as well as included a screening-level assessment of potential ANS that may transfer via these connections.

As shown on the *Other Pathways* map (**Figure 3**), 18 potential aquatic pathways have suggested that there is significant uncertainty about the relative risks of ANS transfer. Eagle Marsh, located in Fort Wayne, Indiana was identified as having the highest potential risk of ANS transfer. The Indiana Department of Natural Resources has implemented interim measures to mitigate this risk, and USACE is further studying this pathway to determine whether a long-term ANS control should be implemented. For the remaining 17 sites, USACE is coordinating further study to finalize the risk characterization and determine whether ANS controls are recommended.

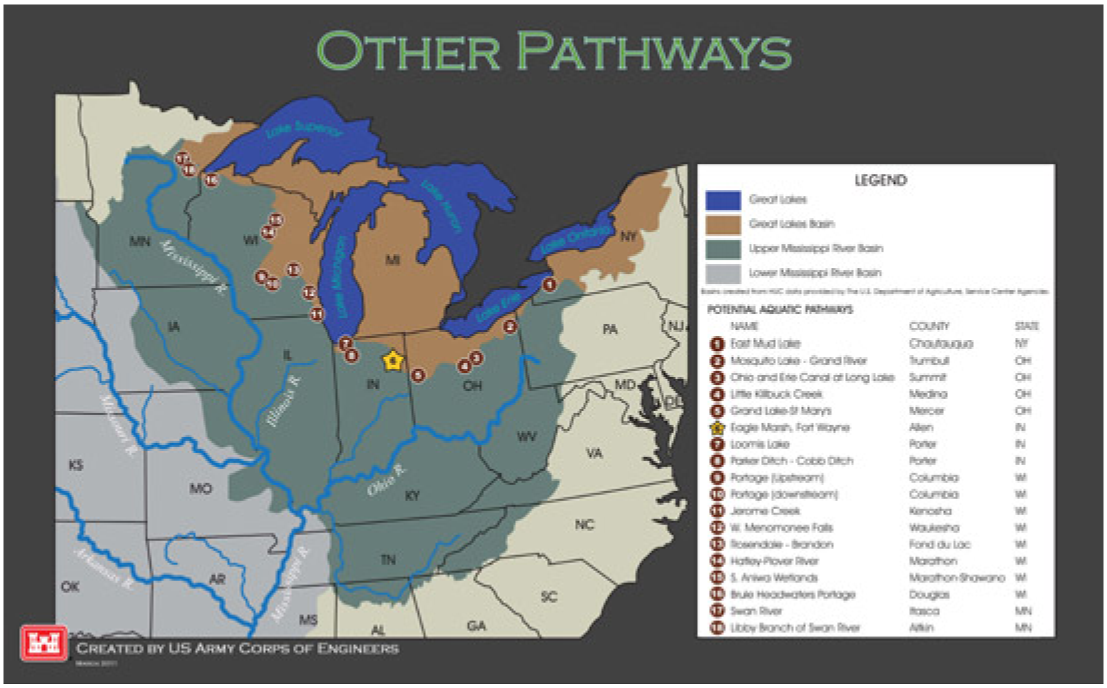

Figure 3. Other Pathways Map

C. GLMRIS Navigation and Economics Product Delivery Team

In support of the Great Lakes and Mississippi River Interbasin Study, the Navigation and Economics Product Delivery Team (PDT) was formed. The PDT was tasked with assessing the current value of *economic* activities within the GLRMIS detailed study area that *could* change with the implementation (FWP condition) or lack of implementation (FWOP condition) of a GLMRIS project. The PDT is comprised of several sub-teams, each of which focuses on a specific economic activity within the GLRMIS study area. These categories include:

Navigation Related Economic Categories

- Commercial Cargo
- Non-Cargo Related Navigation

Other Related Economic Categories

- Flood Risk Management
- Hydropower
- Commercial and Recreational Fishery
- Water Quality

- Water Supply
- Regional Economics

1. Water Quality Team:

In support of the Navigation and Economics PDT, the Water Quality Team was formed. The water quality in the CAWS, as well as the water quality discharge standards thereof, could be impacted by the implementation of various Aquatic Nuisance Species (ANS) controls developed to prevent the spread of ANS between the Great Lakes and Mississippi River by aquatic pathways. Therefore, this team was tasked with identifying the current entities that either use water from or discharge water into, the CAWS since changes in water quality, and or water quality discharge standards, due to implementation of an ANS control, could lead to increased costs for entities that either withdraw water from, and or discharge water into, the CAWS.

III. DESCRIPTION OF CAWS INFRASTRUCTURE

The CAWS consists of a series of rivers, locks and canals. The system is used as a water transport mode by a number of vessel user groups: commercial cargo movers, and non-cargo vessels (passenger vessels, non federal government vessels, fishing vessels, federal government vessels, etc.). The water in the CAWS is also used by a number of public and private entities and businesses located adjacent to the CAWS. These users either withdraw water from the CAWS, or discharge water into the CAWS. Plans developed to address the spread of ANS could have impacts on these users.

To help accommodate vessel movements there are a number of direct water diversions that take place, primarily at locks. There is also augmentation of water flow into the system from three waste water reclamation plants.

Direct water diversions occur at multiple locations - the Chicago River Controlling Works (CRCW), the O'Brien Lock and Dam, Lockport Lock and Dam, Brandon Lock and Dam, and the Wilmette Pumping Station. Diversion at these locations consists of four components; lockage, leakage, discretionary flow, and navigation makeup flow. The lockage component is the flow used in locking vessels to and from Lake Michigan. The leakage component is water estimated to pass, in an uncontrolled way, through or around the lakefront structures. The purpose of the discretionary diversion is to dilute effluent from sewage discharges and improve water quality in the canal system.

Water levels in Lake Michigan are typically higher than water levels in the channels, however during high rain events this is not always the case. The fourth component of water diversion is navigation makeup water. When large storms are forecast, the canal is drawn down before the storm to prevent flooding, and navigation makeup water is used during this draw down period to maintain navigation depths. If the runoff is not enough to refill the canal, additional navigation makeup water is allowed to pass from Lake Michigan to return the canal system to its normal operating stages.[1]

A. Chicago River Controlling Works Lock

The Chicago River Controlling Works Lock (also known as the Chicago Lock and Chicago Harbor Lock) is located in the City of Chicago adjacent to Navy Pier, and it separates the waters of the Lake Michigan basin from the waters of the Chicago River. The lock was originally designed and built between 1936 and 1938 by the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC).

[1] USACE Chicago District, Lake Michigan Diversion Accounting Water Year 2003 Annual Report

The lock was constructed as a component of the historic engineering project that reversed the flow of the Chicago River to prevent river water containing sewage from flowing into the lake and contaminating the city's drinking water. Today, the Chicago River is much cleaner but the lock continues to perform the environmental function of separating Chicago River storm water from Lake Michigan. MWRDGC operated and maintained the lock until 1984, when responsibility for operation and maintenance was transferred to the U.S. Army Corps of Engineers.[2] It takes about 15 minutes to cycle though the lock, and on a busy day 50-100 vessels can be locked at once.[3]

Table 2. Chicago River Controlling Works Lock Characteristics

River/ Lock	Chamber	River/ Mile	Year Open	Length	Width	Lift	Status	Owner/Operator	Gatetype
Chicago	Main	327.2	1938	600	80	4	Operational	Corps/Contractor	Sector

Source: http://www.ndc.iwr.usace.army.mil/lpms/pdf/lkgenrl.pdf

Figure 4. Chicago River Controlling Works Lock

Source: U.S. Army Corps of Engineers/Jessica Vandrick

B. T.J. O'Brien Lock & Dam

T. J. O'Brien Lock and Controlling Works were placed into operation in 1960. The project is located at the entrance to Lake Michigan (River Mile 326.0), in Chicago, Illinois. The facility is

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[2] USACE Press Release Dated September 29, 2010. http://www.lrc.usace.army.mil/chicagolock/press_release9-29-10.pdf

[3] Personal Interview with Al Polus (PM) and Steve Hungness – Chicago Lock Operators, March 2011

a unit of the Inland Waterway Navigation System and is one of nine such facilities between Chicago, Illinois, and La Grange, Illinois.

O'Brien Lock is a low lift sector gate lock. It provides a maximum lift of 5.0 feet for traffic passing from Lake Michigan to the Little Calumet River. The lock chamber is 1000 feet long by 110 feet wide. The adjacent dam is 257 feet in length and comprised of two sections. The fixed section is 204 feet of steel sheet pile cellular construction. The controlling segment, a reinforced concrete structure with four slide gate sections, is 53 feet in length. It takes approximately 15 minutes to cycle through the lock.[4]

Table 3. T.J. O’Brien Lock Characteristics

River/ Lock	Chamber	River/ Mile	Year Open	Length	Width	Lift	Status	Owner/Operator	Gatetype
Thomas J O’Brien	Main	326.5	1960	1000	110	4	Operational	Corps/Corps	Tainter

Source: http://www.ndc.iwr.usace.army.mil/lpms/pdf/lkgenrl.pdf

Figure 5. T.J. O’Brien Lock & Dam

Source: U.S. Army Corps of Engineers Digital Visual Library

C. Lockport Lock & Dam

Lockport Lock and Dam is located 291 miles above the confluence of the Illinois River with the Mississippi River at Grafton, Illinois. The complex is two miles southwest of the city of Lockport, Illinois.

[4] Personal Interview with Bob Balamut, Lockmaster, O’Brien Lock, March 2011

The lock is 110 feet wide by 600 feet long. Maximum vertical lift is 42.0 feet, with an average lift of 39 feet. It averages 22.5 minutes to fill the lock chamber; 15 minutes to empty.[5]

Table 4. Lockport Lock Characteristics

River/ Lock	Chamber	River/ Mile	Year Open	Length	Width	Lift	Status	Owner/Operator	Gatetype
Lockport	Main	291.1	1933	600	110	39	Operational	Corps/Corps	Miter

Source: http://www.ndc.iwr.usace.army.mil/lpms/pdf/lkgenrl.pdf

Figure 6. Lockport Lock & Dam

Source: U.S. Army Corps of Engineers Digital Visual Library

D. Brandon Road Lock & Dam

Brandon Road Lock and Dam (also known as Brandon Road Pool and Brandon Lock) is a gravity dam. The core is homogeneous, earth, concrete, and metal with a rock foundation. Though originally completed in 1933, the structure was modified in 1985.[6]

Table 5. Brandon Road Lock Characteristics

River/	Chamber	River/	Year	Length	Width	Lift	Status	Owner/Operator	Gatetype

[5] Waterways Council, Inc. http://www.waterwayscouncil.org/WWSystem/Fact%20Sheets/lockport.pdf

[6] http://findlakes.com/brandon_road_lock_and_dam_illinois~il00001.htm

Lock		Mile	Open						
Brandon	Main	286	1933	600	110	34	Operational	Corps/Corps	Miter

Source: http://www.ndc.iwr.usace.army.mil/lpms/pdf/lkgenrl.pdf

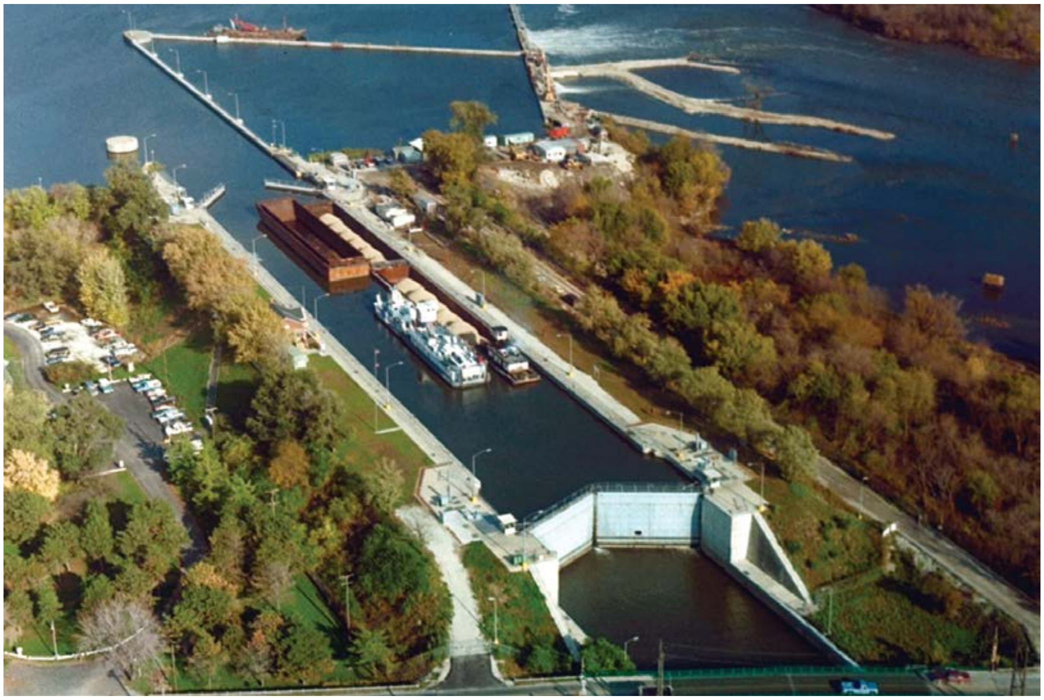


Figure 7. Brandon Road Lock & Dam
***Source*: U.S. Army Corps of Engineers**

E. Wilmette Pumping Station

Between 1907 and 1910, the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) constructed a canal called the North Shore Channel. It extended from Lake Michigan at Wilmette in a southerly direction 6.14 miles to the north branch of the Chicago River. The Wilmette Pumping Station, also known as the Wilmette Controlling Works, regulates the amount of Lake Michigan flow allowed down the North Shore Channel through the use of one vertical lift gate. The four 250 cfs pumps have not been used for diversion since the 1970's.[7] The sluice gate is a means by which excess storm water is reversed to Lake Michigan.

The Wilmette Pumping Station is the gateway between the North Shore Channel and Lake Michigan. The pumping station and the bridge are a single integral structure. In addition to going over the pumping station, the bridge features two spans that pass over the access roads and open paved space that provides access to the pumping station facility.

[7] USACE Chicago District, Lake Michigan Diversion Accounting Water Year 2003 Annual Report

This bridge is historically significant as an unusual bridge that was designed as a part of a building, and also for its association as an unaltered part of the canal that plays an important role in regulating the flow of the Chicago River.[8]

MWRDGC, not the US Army Corps of Engineers, owns and operates the Wilmette Pumping Station.

Figure 8. Wilmette Pumping Station

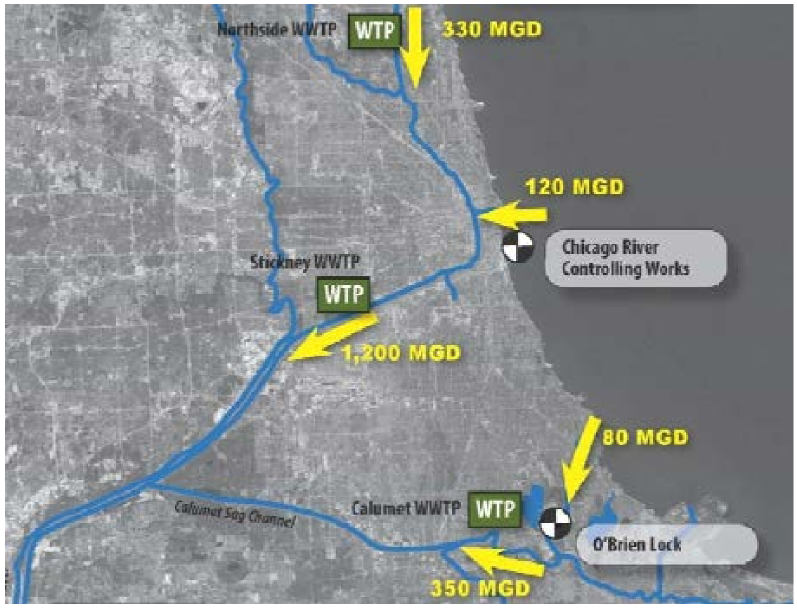
Source: Public Domain, http://commons.wikimedia.org/wiki/File:Wilmette_Pumping_Station2.JPG

F. Waste Water Treatment Plants

The MWRDGC operates seven wastewater treatments plants and 23 pumping stations in the Chicago Metropolitan area. The seven MWRDGC plants service an 883 square mile area and treat 1.5b gallons of wastewater per day. There are three waste water treatment facilities that discharge water into the CAWS: the North Side, Calumet and Stickney plants **(Figure 9**). Plant characteristics are provided in **Table 5.** A brief description of the three plants follows.

[8] www.historicbridges.org

Figure 9. Waste Water Treatment Plants



Source:"*Evaluation of Physical Separation Alternatives for the Great Lakes and Mississippi River Basins In the Chicago Area, Waterway System, Appendix A 4, Wastewater Improvements Technical Memo*", study performed for the Great Lakes Commission.

Table 6. CAWS Sewage Plant Characteristics

Parameter	North Side WWTP	Calumet WWTP	Stickney WWTP
Design Average Flow (MGD)	330	350	1,200
Daily Maximum Flow (MGD)	450	430	1,440
Liquid Treatment Process	☐ Preliminary: Screening and grit removal ☐ Primary: Settling using primary clarifiers ☐ Secondary: Activated sludge process with nitrification and final clarifiers	☐ Preliminary: Screening and grit removal ☐ Primary: Settling using primary clarifiers ☐ Secondary: Activated sludge process with nitrification and final clarifiers	☐ Preliminary: Screening and grit removal ☐ Primary: Settling using Imhoff tanks and primary clarifiers ☐ S Activated sludge process with nitrification and final clarifiers
Solids Treatment Process	None; pumped to Stickney	☐ Thickening, anaerobic digestion, lagoon storage, air drying ☐ Various land application options	☐ Thickening, anaerobic digestion, lagoon storage, air drying ☐ Various land application options

Source:"*Evaluation of Physical Separation Alternatives for the Great Lakes and Mississippi River Basins In the Chicago Area Waterway System, Appendix A 4, Wastewater Improvements Technical Memo*", study performed for the Great Lakes Commission.

1. North Side Water Reclamation Plant

The North Side Water Reclamation Plant (**Figure 10**) is located at Howard Street and McCormick Boulevard. The plant serves 1.3m people located in 141 square miles, including the city of Chicago north of Fullerton Avenue. It has a design capacity of 330m gallons per day.

Figure 10. North Side Water Reclamation Plant

Source: Bing Maps

2. Calumet Waste Water Reclamation Plant

The Calumet plant (**Figure 11**) is located at 400 East 130th Street. This plant is the oldest of the seven plants the MWRDGC operates. The plant services a 300 square mile area including parts of the city of Chicago south of 87th Street and its southern suburbs. It has primary and secondary treatment of effluents. The plant has a design capacity of 350m gallons per day. The TARP pumping station is located adjacent to the water treatment plant.

3. Stickney Waste Water Reclamation Plan

The Stickney Plant (**Figure 12**) is located at 6001 West Pershing Road, near Lombard Road, in Cicero Illinois. This is the largest waste water treatment plant in the world. The 570 acre plant services 2.38m people over 260 square miles which includes 43 suburban communities and the central part of Chicago. This is a three phase treatment plant. The Phase 1 screening process removes debris and settling tanks allow heaver solids to sink to the bottom and lighter waste to float to the top. Skimmers collect material at the bottom and top of the tanks for disposal. Stage 2 uses microorganisms to convert remaining wastes to forms that can be removed. The third phase further filters the water and adds ammonia. The plant has a design capacity of 1,200m gallons per day.

Figure 11. Calumet Waste Water Reclamation Plant

Source: Bing Maps

Figure 12. Stickney Waste Water Reclamation Plant

Source: Bing Maps

4. NPDES Discharge Standards and Plant Performance

All three waste water reclamation plants must meet certain effluent discharge standards. Currently these plants discharge their effluent into the CAWS. The water then travels via various connecting channels to eventually flow into the Missouri and Mississippi River. Therefore, effluent currently discharged into the CAWS must meet effluent standards of the rivers the waters eventually flow into (Missouri River). A description of these current water quality standards are provided in Table 6, as well as how well these plants performed in 2010 with respect to these standards.

Table 7. NPDES Discharge Standards and Plant Performance

WWTP – Permit Number	Monthly Average	Weekly Average	Daily Maximum	2010 Effluent [a]		
Parameter				Mean	Maximum	Minimum
North Side – Permit IL0028088						
CBOD [b] (mg/L)	10	12		<2	11	<2
TSS [c] (mg/L)	12	18		5	18	2
Ammonia – N (mg/L)						
Apr–Oct	2.5		5	<0.3 [d]	2.2 [d]	<0.1 [d]
Nov–Mar	4		8			
Total – P (mg/L)	No Limit			1.4	2.3	0.4
NO_2 – N (mg/L)	No Limit			<0.2	1.3	<0
NO_3 – N (mg/L)	No Limit			8.9	11.7	3.7
Fecal Coliform (count/100 mL)	No Limit			GM [e]: 7,986	80,000	2,700
Calumet – Permit IL0028061						
CBOD (mg/L)	10	20		<3	8	<2
TSS (mg/L)	15	25		6	13	2
Ammonia – N (mg/L)						
Apr–Oct	2.5		5	<0.3	2.4	<0.2
Nov–Mar	4.0		8			
Cyanide (mg/L)	0.15		0.3	<0.006	<0.005	0.014
Total - P	No Limit			3.8	9.7	1.0
NO_2 + NO_3 – N (mg/L)	No Limit			8.3	17.0	3.3
Fecal Coliform (count/100 mL)	No Limit			GM: 6,304	24,000	1,600
Stickney – Permit IL0028053						
CBOD (mg/L)	10	15		<3	10	<2
TSS (mg/L)	12	20		<5	12	<4
Ammonia – N (mg/L)						
Apr–Oct	2.4		5	<0.6	3.6	<0.1
Nov–Mar	4.0		8			
DO [f], Minimum (mg/L)			6 (minimum)	8.3	10.3	6.4
Total – P (mg/L)	No Limit			1.3	3.4	0.2
NO_2 – N (mg/L)	No Limit			<0.3	2.1	<0
NO_3 – N (mg/L)	No Limit			8.6	16.3	3.3
Fecal Coliform (count/100 mL)	No Limit			GM: 7,363	86,000	1,400

Notes:

[a] Based on daily average data published by MWRDGC. See link below for data.
www.mwrd.org/irj/portal/anonymous?NavigationTarget=navurl://14d6b38927bee2ff03c32994983903f0

[b] Carbonaceous biochemical oxygen demand

[c] Total suspended solids

[d] Annual ammonia data from plant effluent are not seasonal. Typical of all ammonia plant effluent data in this table.

[e] Geometric mean

[f] Dissolved oxygen

IV. CAWS CHARACTERISTICS

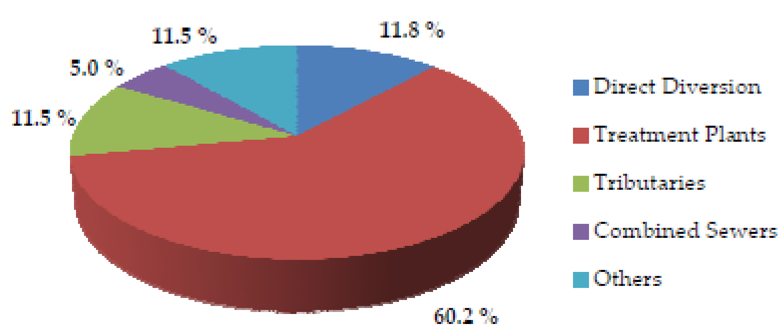
Multiple groups utilize the Chicago Area Waterway System. It is used as a waterway for vessel movements. Some of these user groups include: passenger boats and ferries, non federal government vessels, commercial fishing vessels, federal government vessels, and recreation vessels. The CAWS is also used by a number of public and private businesses located adjacent to the CAWS. These users discharge water into the CAWS. Plans developed to address the spread of aquatic nuisance species could have impacts on all of these users.

In order for the CAWS to function as a waterway for vessel movements, and as a source of water for various public and private entities, or as a location to discharge water into, the operational characteristics of the CAWS need to be known with respect to water inflow and outflow. Such characteristics as mean annual flow, and major dischargers will now be discussed.

A. CAWS Mean Annual Flow

The U.S. geological Survey has estimated the mean annual flow of water from the CAWS at 3,130 cfs. There are five sources of this flow: 1- waste water treatment plants (60%), direct diversion (12%), others (12%), tributaries (11%), and combined sewers (5%). Approximately 75% of the water in the CAWS comes from Lake Michigan as Waste Water Treatment Plant effluent or as diversions.

Figure 13. CAWS Water Sources



Source: Evaluation of Physical Separation Alternatives- Technical Report Appendix- CAWS Ecological Integrity Baseline Conditions- Technical Memorandum

B. CAWS Dischargers

An inventory of existing dischargers to the CAWS was developed by accessing National Pollutant Discharge Elimination System (NPDES) Permit Program records. There were 58 permits for discharging to the CAWS. These dischargers could be grouped into the following three user categories: water treatment plants, power generation plants and industrial processes. The permits total 5,110.2 mgd. Table 7 summarizes discharge amounts for the main users in the three user categories.

Table 8. Major Dischargers /Daily Average Flow in Millions of Gallons per Day

Water Treatment Plants				
MWRDGC STICKNEY WRP	Water Reclamation Plant Discharge		1,200	37%
MWRDGC CALUMET WRP	Water Reclamation Plant Discharge		354	
MWRDGC NORTHSIDE WRP	Water Reclamation Plant Discharge		333	

			1,887	
Power Generation Plants				59%
MIDWEST GENERATION,LLC-WILL CO	CONDENSER COOLING;HSE SERV WTR		741	
MIDWEST GENERATION,LLC-CRAWFRD	CONDENSER COOLING WTR&HSE SER		466	
MIDWEST GENERATION,LLC-FISK	CONDENSER COOLING WTR & HOUSE		312	
MIDWEST GENERATION,LLC-JOLIET	CONDENSER COOLING WTR.,HSE SER		1,073	
MIDWEST GENERATION,LLC-JOLIET9	CONDENSER COOLING AND HSE SERV		399	

			2,991	
Industrial Processes				4%
MDE THERMAL TECHNOLOGIES INC	NON-CONTACT COOLING WATER		82	
CORN PRODUCTS INTERNATL-ARGO	NON-CONTACT COOLING WATER		48	
MDE THERMAL TECHNOLOGIES-PL #5	NON-CONTACT COOLING WATER		38	
CHICAGO COKE COMPANY	Non-contact cooling water, sw, groundwater		20	
INTERNATIONAL STEEL-RIVERDALE	NCCW BASIC OXYGEN furnace; SW		12	
DORCHESTER CORPORATION-CHICAGO	NON CONTACT COOLING WATER		10	

			209	
Total Removal/Discharges			5,110	

V. EXISTING CONDITION DISCHARGER OPERATING COSTS

Examination of the main dischargers as presented in Table 7 show that the three main discharger groups use the waterway for different purposes. The waste water reclamation plants use it as the final destination for their effluent. The power generation plants use it for cooling purposes. The industrial users use it for non contact cooling purposes. The last two dischargers do not change the quality of the water when using it in their production process. The water is basically used for cooling purposes. It is assumed that, under existing conditions, the last two user groups do not change the quality of the water when using it in their production processes.

However, the three waste water reclamation plants have to treat their effluent so that it will meet water quality discharge standards associated with discharging water into the CAWS. Under future without and future with project conditions, there may be additional water treatment costs associated with meeting discharge water quality standards. Change in water treatment costs may happen due to more stringent water quality standards being imposed for discharges into the CAWS under future without project conditions. Also, water treatment costs may increase under with project conditions if the final destination of the water must now meet Lake Michigan water quality standards, which is more stringent than current CAWS water quality standards.

Note: the three waste water reclamation plants account for about 60 percent of the mean annual flow in the CAWS. Direct diversions of water from the locks into the CAWS account for another 12 percent. Since the locks use Lake Michigan water, there will be no water treatment costs associated with lock discharges under future WOP and Future WP conditions to meet existing or new water quality standards. However, if water quality standards change under future WOP and or future WP conditions, the waste water reclamation plants will incur additional treatment costs in order to comply with these new water quality standards. Consequently, a "baseline" annual maintenance and operation cost would be a starting point for developing economic impacts to water dischargers under future WOP and future WP conditions. Existing condition discharger operating costs will be developed for the three waste water reclamation plants. Development of these wastewater annual operation and maintenance costs will capture the large majority of water treatment costs that could be potentially impacted under future WOP and WP conditions.

A. 2012 Operation and Maintenance Costs

Annual operation and maintenance costs for the Northside, Calumet and Stickney waste water reclamation plants were obtained from the 2012 budget of the Metropolitan Water Reclamation District Of Greater Chicago. The report provided requested 2012 annual costs for all the various water treatment plants the District operates. The annual cost data was broken down into eight categories: construction and design (32.9%), bond redemption and interest fund (17.9%), plant operation and maintenance (17.7%), staff services (12%), retirement fund (6.2%), claims and judgments (5.9%), storm water management (4.9%), and monitoring and research (2.5%).

Maintenance and operation costs were provided by service area: the North Service area ($40,859,300), the Calumet service area ($36,671,900) and the Stickney service area (87,547,800.) The operation and maintenance costs had 5 cost categories: collection and treatment, solids' processing, solids utilization, flood and pollution control and general support. Operation and maintenance costs associated with the Northside, Calumet and Stickney plants were developed from this data. For the Stickney plant, it is the only plant in the Stickney service area. Thus all operation and maintenance costs associated with the Stickney service area was for the Stickney plant itself. The Northside and Calumet service areas have more treatment plants in them than just the Northside and Calumet plants. Thus operation and maintenance costs associated with the Northside and Calumet plants were developed from service area operation and maintenance costs. Operation and maintenance costs were allocated to each treatment plant based on its percentage of total service area design flow. Table 8 shows the results of this analysis.

Based on Table 8, existing (2012) annual operation and maintenance costs for the Northside, Calumet and Stickney plants are placed at: $27,096,700, $36,435,200, and $87,547,800 respectively. All data should be considered preliminary and is subject to updates.

Table 9. Annual Operation and Maintenance Costs: Northside, Calumet and Stickney Water Reclamation Plants.

Activity		Northside	Calumet	Stickney
Collection And Treatment		$ 19,244,201	$25,876,415	$ 52,763,401
Solids Processing		$ 4,939,114	$ 6,641,302	$ 23,141,587
Solids Utilization		$ 1,556,127	$ 2,092,422	$ 8,499,823
Flood And Pollution Control		$ 1,083,478	$ 1,456,881	$ 758,965
General Support		$ 273,794	$ 368,153	$ 2,384,024
		------------------	------------------	------------------
		$ 27,096,713	$36,435,174	$ 87,547,800

Source:"*2012 Budget, Metropolitan Reclamation District Of Greater Chicago*", adopted December 8, 2011, and amended December 15,2011.

VI. ADDITIONAL INFORMATION

This report developed an estimate of operation and maintenance costs under existing conditions, for the three waste water reclamation plants: Northside, Calumet and Stickney. Existing condition annual operation and maintenance costs reflect operation and maintenance costs that are expected to be incurred in 2012. Data for this report was derived from a variety of sources. A summary table of existing condition annual operation and maintenance costs, by waste water reclamation plant was provided in Table 8.

Additional information and analysis will be included in future reports that will evaluate expected increases in waste water reclamation operation and maintenance costs from various basin separation alternatives. These evaluations will develop operation and maintenance costs under future without project and future with project conditions. Existing operation and maintenance costs are the starting point of these future evaluations.

A brief listing of the major sources of material provided in this report follows.

North Side Water Reclamation Plant

http://www.google.com/imgres?hl=en&sa=X&tbo=d&biw=1132&bih=764&tbm=isch&tbnid=17V9xBfw3R9hnM:&imgrefurl=http://www.waterandwastewater.com/plant_directory/Detailed/431.html&docid=X6QIKAJhq5n_dM&imgurl=http://www.waterandwastewater.com/plant_directory/images/plants/2/1082-medium_northsideIL_WRP.JPG&w=300&h=126&ei=GHXcUK6hI42k8QSVz4DoAw&zoom=1&iact=hc&vpx=93&vpy=439&dur=3416&hovh=100&hovw=240&tx=155&ty=73&sig=112519885159019781491&page=1&tbnh=100&tbnw=228&start=0&ndsp=31&ved=1t:429,r:12,s:0,i:125

Calumet Waste Water Reclamation Plant

http://www.mwrd.org/pv_obj_cache/pv_obj_id_1280442C124912FF4E4EE10FC03DAD14601A1900/filename/CWRP%20full%20document.pdf

Stickney Waste Water Reclamation Plant

http://www.mwrd.org/pv_obj_cache/pv_obj_id_E52F7E1A7E8A2B3F9FA1A36D2BB7073431054B00/filename/SWRP%20full%20document.pdf

http://www.mwrd.org/irj/portal/anonymous/stickney

http://gizmodo.com/5844925/chicagos-stickney-wastewater-treatment-plant-is-the-crappiest-place-on-earth

http://www.waterandwastewater.com/plant_directory/Detailed/432.html

Baseline Assessment of Water Quality – Lake Michigan Beaches

August 2013

Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

GREAT LAKES MISSISSIPPI RIVER INTERBASIN STUDY (GLMRIS)
BASELINE ASSESSMENT OF WATER QUALITY IMPACTS ON
LAKE MICHIGAN

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FIGURES

I. **EXECUTIVE SUMMARY**

In support of the Great Lakes and Mississippi River Interbasin Study (GLMRIS), several alternative plans were developed which seek to prevent the transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River Basins. As a result of implementation of a GLMRIS project (i.e., the future with-project condition) or lack thereof (i.e., the future without-project condition), water quality in the Chicago area may change.

This document is intended to serve as a baseline assessment of the number of public beaches that are along the city of Chicago's Lake Michigan shoreline. The water quality along these public beaches could be impacted by the implementation of various ANS controls. Changes in water quality (algae growth, turbidity, E. Coli), due to implementation of an ANS control measure could lead to changes in beach usage beach swimming advisories, beach closings, etc). Identification of the number of existing public beaches is the first step in developing the number of beaches that could be affected under without and with project conditions.

This evaluation used secondary sources to identify the location and number of public beaches in the Chicago area that are located on Lake Michigan. There are 77 communities in the Chicago area. This document highlights key aspects of the number of public beaches that were located in the 16 shoreline communities of the city of Chicago: Rogers Park, Edgewater, Uptown, Lakeview, Lincoln Park, Near North Side, Chicago Loop, Near South Side, Douglas, Oakland, Kenwood, Hyde Park, Woodlawn, South Shore, South Chicago, and East Side.

II. GLMRIS STUDY INFORMATION

A. Introduction

An aquatic nuisance species (ANS) is a non-indigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (2010).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and non-indigenous invasive species.

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River by aquatic pathways. In this context, the term "prevent" includes the reduction of risk to the maximum extent possible, because it may not be technologically feasible to achieve an absolute solution. As part of this study, USACE will conduct a detailed analysis of various ANS controls, including hydrologic separation.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

B. GLMRIS Study Area

The GLMRIS study area includes portions of the Great Lakes and Mississippi River basins that fall within the United States.

Potential aquatic pathways between the Great Lakes and Mississippi River basins exist along the basins' shared boundary (illustrated as “▬ ▬ ▬” in Figure 1). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi Basin ( ) and the Great Lakes Basin ( ). See Figure 1.

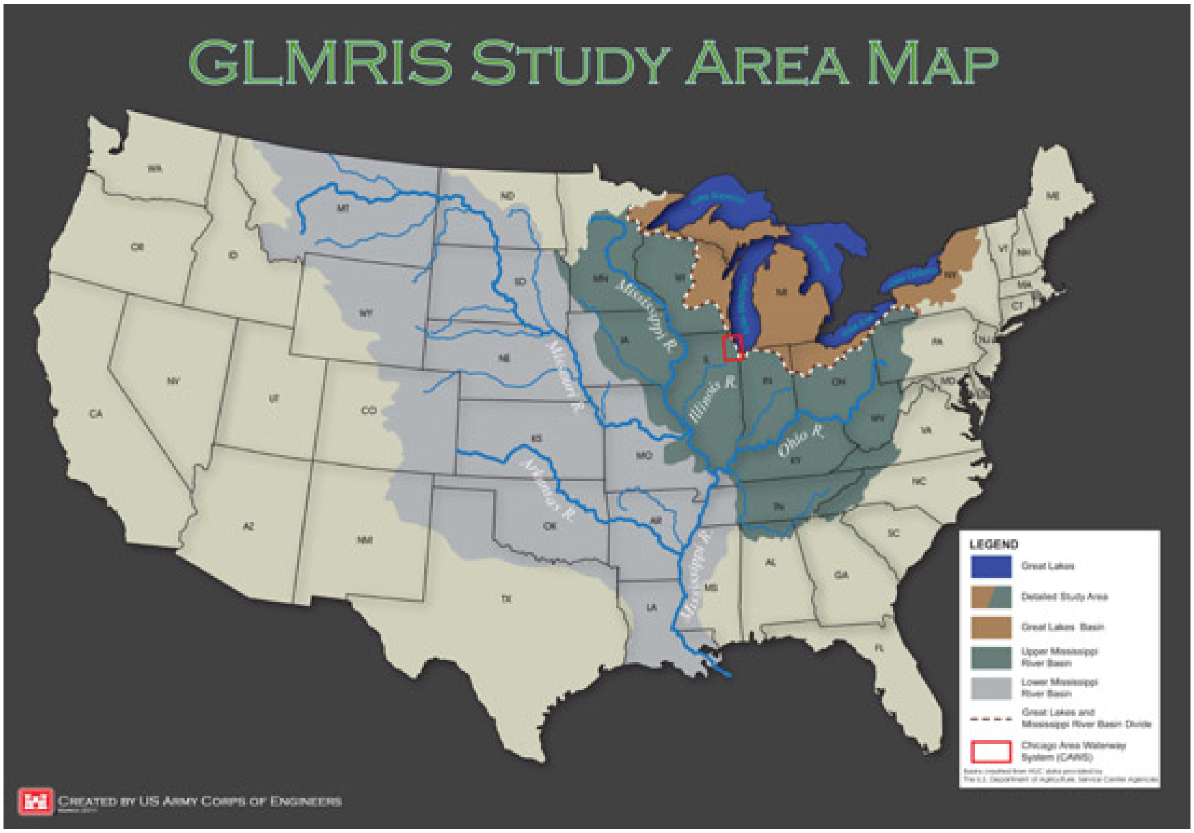


Figure 1. GLMRIS Study Area Map

Future ANS may transfer beyond the *Detailed Study Area.* This pattern was observed by the spread of zebra mussels, which originated in the Great Lakes and spread throughout the Mississippi River Basin. Therefore, the *General Study Area* encompasses the lower Mississippi River Basin ( ). While the majority of GLMRIS tasks will be completed within the *Detailed Study Area*, USACE will consider specific ANS impacts in the larger *General Study Area*.

a. GLMRIS Focus Areas

The U.S. Army Corps of Engineers is conducting GLMRIS along two concurrent tracks: Focus Area I, the Chicago Area Waterway System (CAWS), and Focus Area II, Other Pathways.

(1) Chicago Area Waterway System (CAWS)

Focus Area I, the Chicago Area Waterway System, as shown in Figure 2, is the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins and, therefore, poses the greatest potential risk of aquatic nuisance species (ANS) transfer between the basins, via an aquatic pathway.

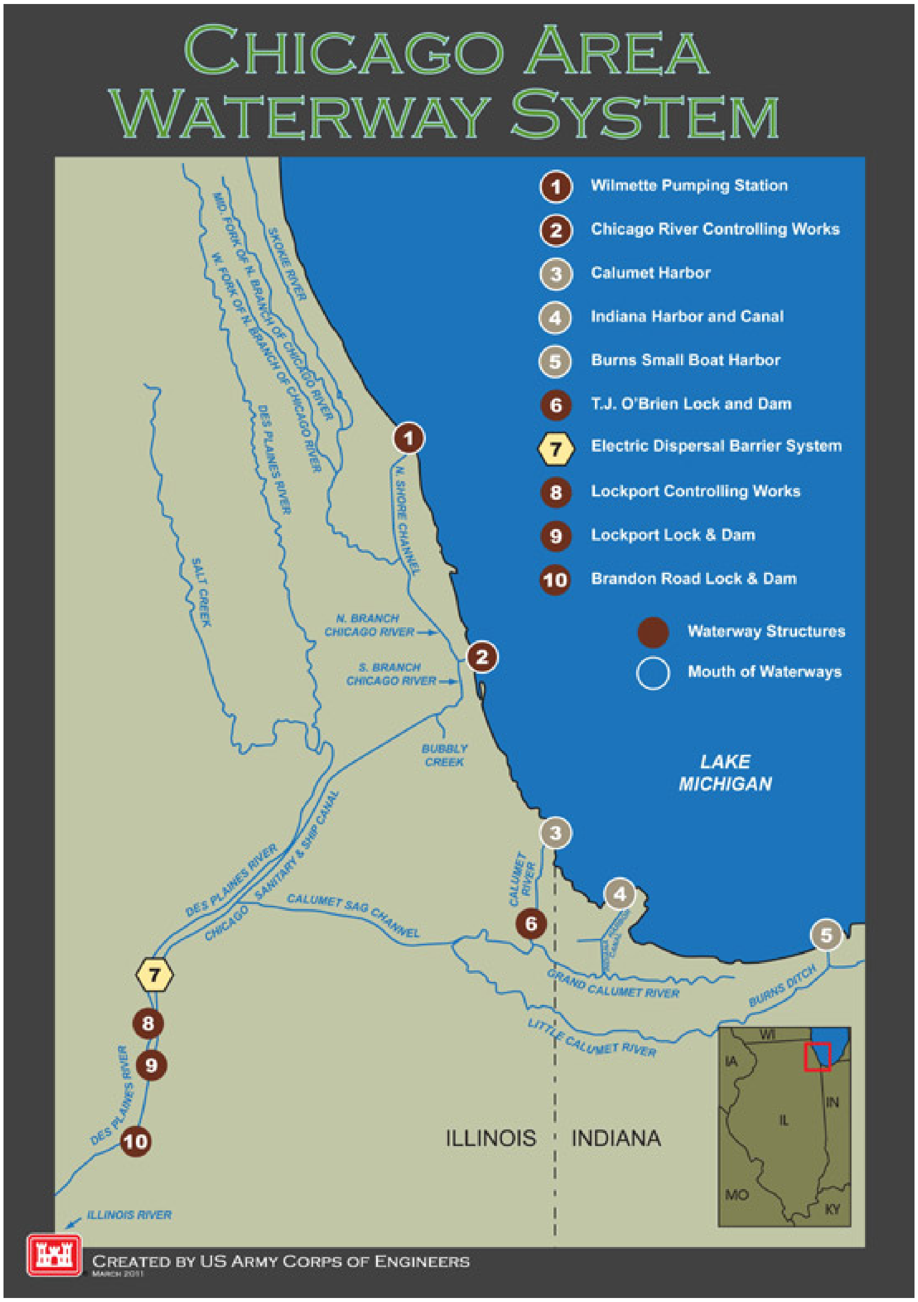


Figure 2. Chicago Area Waterway System

(2) Other Pathways

Focus Area II addresses remaining aquatic pathways. For this focus area, the U.S. Army Corps of Engineers completed a document entitled *Other Pathways Preliminary Risk Characterization Report* that identified other potential aquatic pathways outside of the Chicago Area Waterway System, as well as included a screening-level assessment of potential ANS that may transfer via these connections.

As shown on the *Other Pathways* map (Figure 3), 18 potential aquatic pathways have suggested that there is significant uncertainty about the relative risks of ANS transfer. Eagle Marsh, located in Fort Wayne, Indiana was identified as having the highest potential risk of ANS transfer. The Indiana Department of Natural Resources has implemented interim measures to mitigate this risk, and USACE is further studying this pathway to determine whether a long-term ANS control should be implemented. For the remaining 17 sites, USACE is coordinating further study to finalize the risk characterization and determine whether ANS controls are recommended.

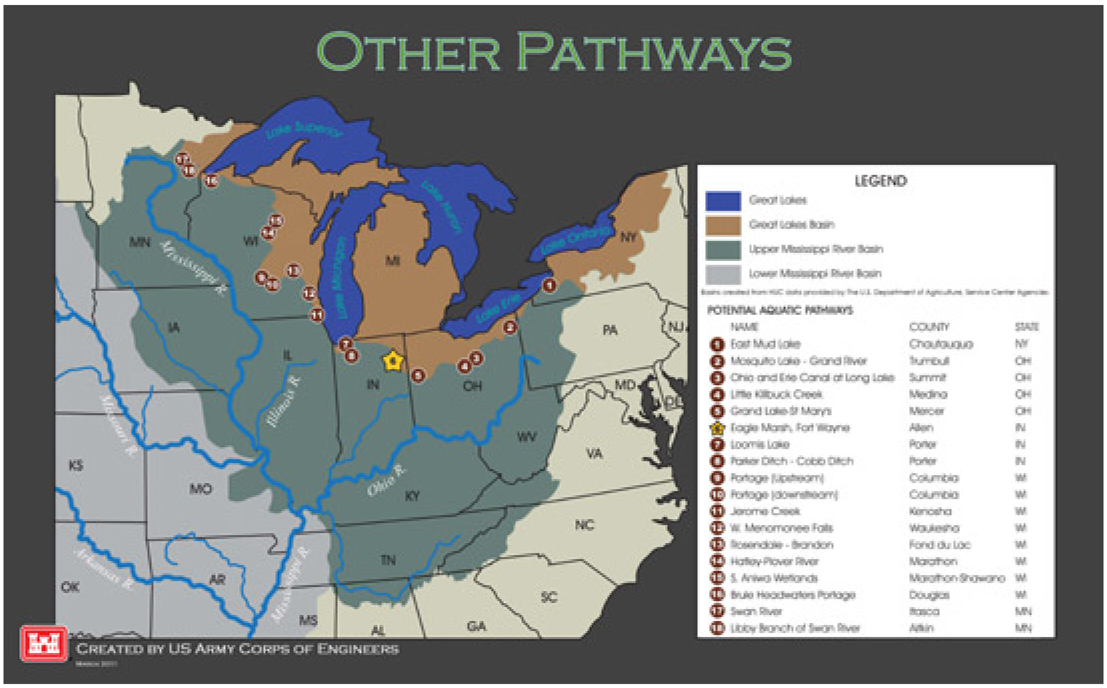


Figure 3. Other Pathways Map

III. DESCRIPTION OF CHICAGO PUBLIC BEACHES ON LAKE MICHIGAN

Public beaches in Chicago are maintained by the Chicago Park District. Private entities such as private clubs and hotels developed the first beaches. The first public beach was located in Lincoln Park, and opened in 1895. An overall plan for the development of the city of Chicago was presented in the 1909 study *Plan of Chicago* (the Burnham Plan). One of the six major topics was improvement of the lakefront. The report emphasized reclaiming the lakefront for the public. It recommended expanding the parks along the lakefront by filling in the existing shoreline. The report acted as a guide to city planners into the 20th century. Today, Chicago's 28 miles of shoreline is completely manmade, its main use is as parkland, and is open to the public for free. There are 33 beaches in Chicago. The beaches are generally located in a park, and the parks typically take the name of the east-west Street at each beach's location.

This evaluation used secondary sources to identify the location and number of public beaches in the Chicago area that are located on Lake Michigan. There are 77 communities in the Chicago area. The evaluation was restricted to the number of public beaches that were located in the 16 shoreline communities of the city of Chicago: Rogers Park, Edgewater, Uptown, Lakeview, Lincoln Park, Near North Side, Chicago Loop, Near South Side, Douglas, Oakland, Kenwood, Hyde Park, Woodlawn, South Shore, South Chicago, and East Side. Figure 4 is a map of the various Chicago Shoreline Communities. A brief description of existing Chicago public beaches, by community, follows.

A. Rogers Park Beaches

Rogers Park is on the north side of Chicago. It is bounded basically by West Howard Street on the north, North Ridge Boulevard on the west and East Devon Avenue on the south (Figure 5). Rogers Park was incorporated as a village in 1878. The community has 10 end street beaches.

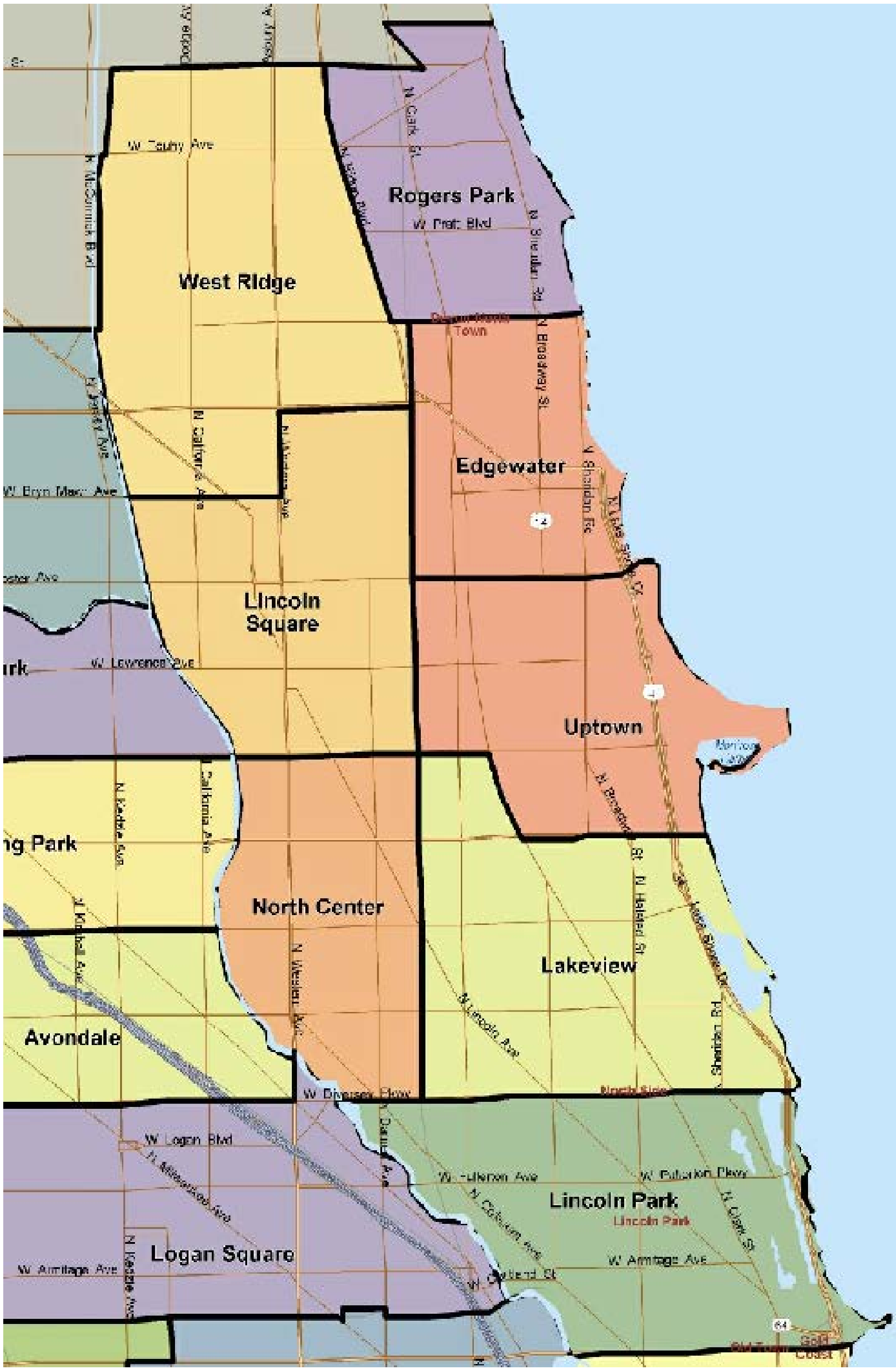
1. Juneway Terrace Beach

Juneway Terrace Beach is located in Rogers Park at 7800 North and Lake Michigan (Figure 6). Its southern border is formed by riprap which protects three apartment buildings. South of Juneway Terrace beach is Rogers Beach.

2. Rogers Beach

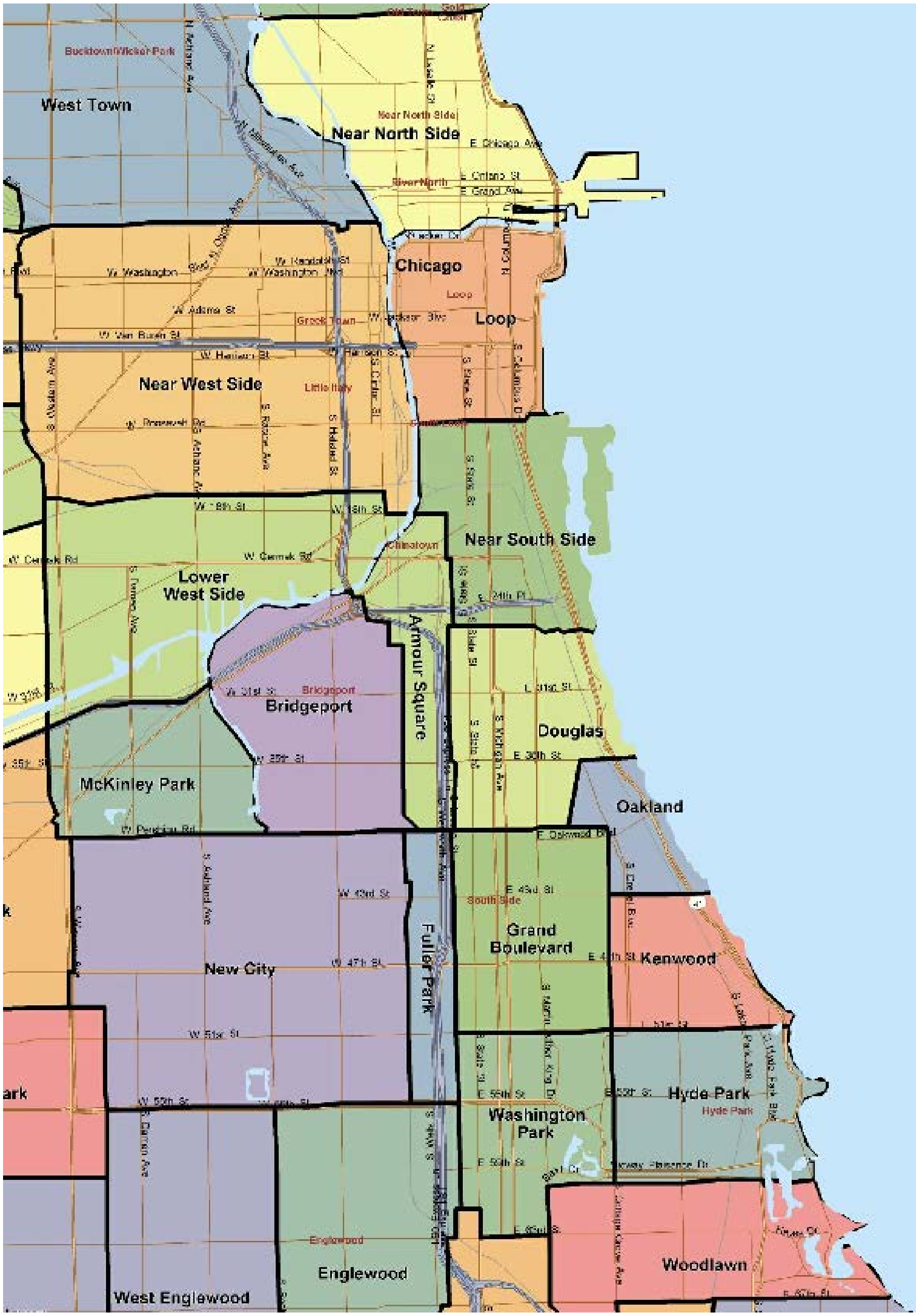
This beach is located at 7705 N Eastlake Terrace. The beach is one block long and has tennis courts. To the north is Juneway Terrace Beach, which is also in Rogers Avenue Beach and park. It is separated from Rogers's beach by riprap, which is protecting four homes

Figure 4. Chicago Area Communities



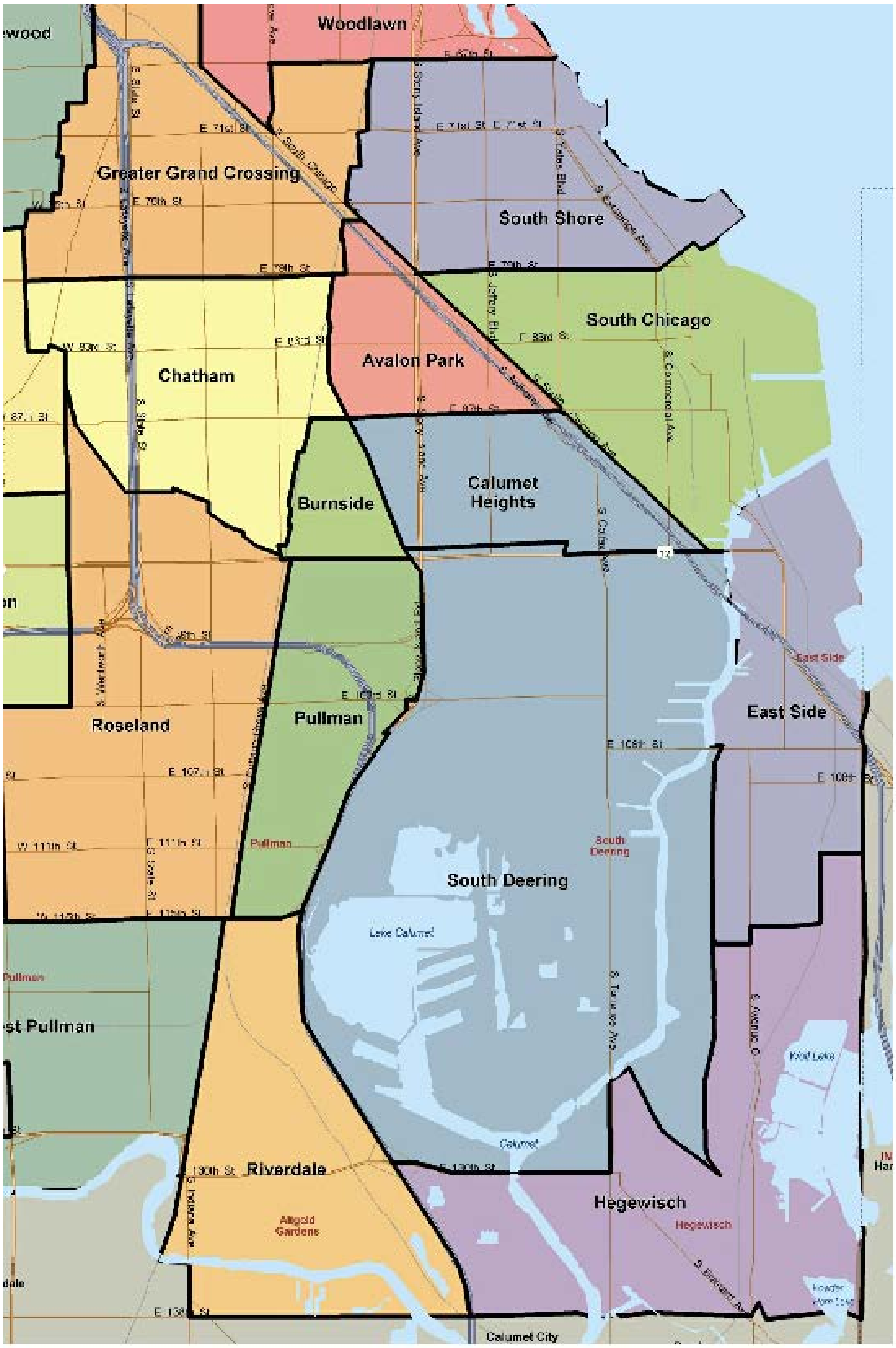
Source:Lucid Realty http://lucidrealty.com/images/Chicago_Neighborhoods.jpg

Figure 4 Chicago Area Communities- Continued



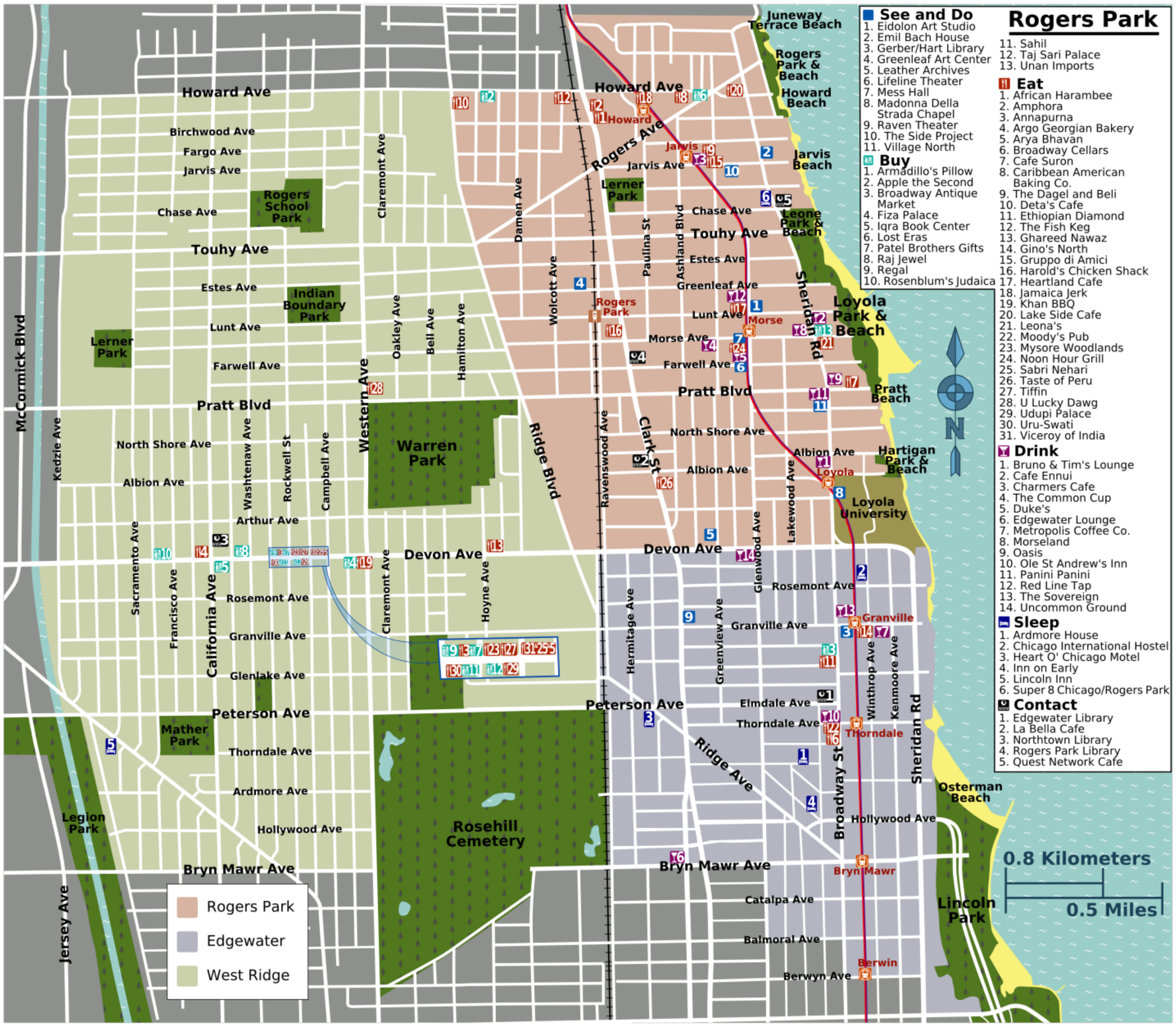
Source:Lucid Realty http://lucidrealty.com/images/Chicago_Neighborhoods.jpg

Figure 4 Chicago Area Communities- Continued



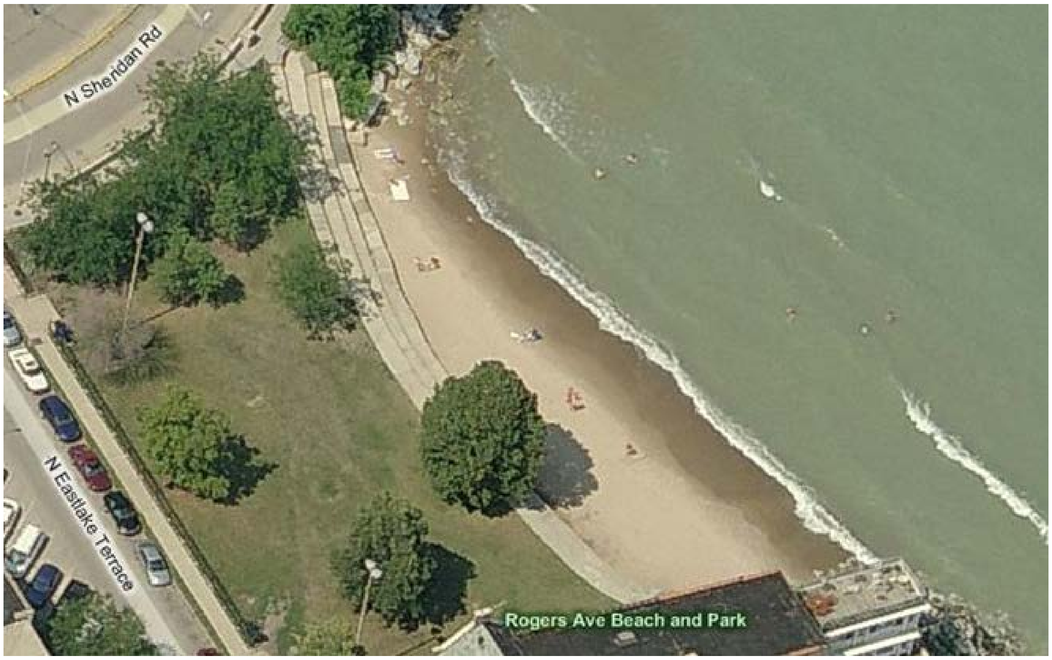
Source:Lucid Realty http://lucidrealty.com/images/Chicago_Neighborhoods.jpg

Figure 5. Rogers Park Community Map



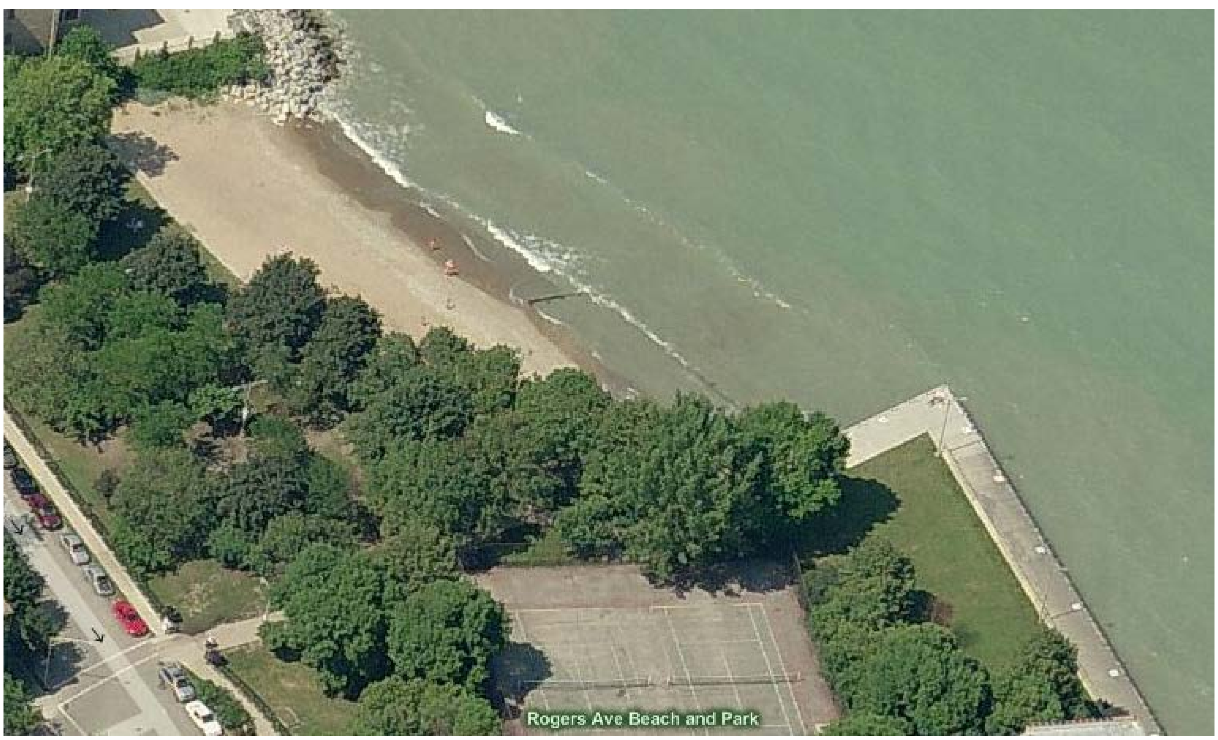
Source : WIKI Travel   http://wikitravel.org/en/Chicago/Rogers_Park

Figure 6. Juneway Terrace Beach



Source: Bing Maps

Figure 7. Rogers Beach



Source: Bing Maps

3. Howard Beach

Howard Beach is in Howard St Park at 7519 North Eastlake Terrace (Figure 8). The street and beach are named after Howard Ure, a pioneer Rogers Park family. The Park offers off-street parking, a tree shaded park and a children's playground. The beach is separated from the park by a concrete ledge.

4. Jarvis Beach/Fargo Beach

Jarvis Beach is located in Jarvis Beach Park at 1208 West Jarvis Avenue (Figure 9). The street is named after R.J Jarvis, a friend of the Rogers and Touhy families. Fargo beach is located just north of Jarvis beach (1300 West Fargo Avenue). The beach and street is named after an active north side real estate developer in the late 1900's: James C. Fargo. Two stone groins offer wave protection and foster sand accumulation. There is off street parking but no restrooms or changing facilities.

5. Loyola/Leone Beach

This eight-block long beach is actually in two parks: Leone Park and Loyola Park (Figure 10). The beach stretches from W. Touhy Avenue on the north, to Pratt Avenue on the south. Leone Beach extends from W.Touhy Ave to W. Greenleaf Avenue and includes a field house/converted water pumping station. Loyola Beach Park is 21.5 acres of land located next to Loyola University, and extends from W. Greenleaf Avenue south to W. Pratt Boulevard. Leone Beach is a training beach for lifeguards. This is one of the largest beach complexes in Chicago. The combined parks offer off street parking, softball diamonds, basketball courts, a wooden playground, tennis courts, sand volleyball courts, picnic grounds, a concession stand and a fishing pier.

6. Pratt Beach

Pratt Beach is located in Pratt Park, at 1050 W. Pratt Boulevard. It is located just south of Loyola Beach (Figure 11).

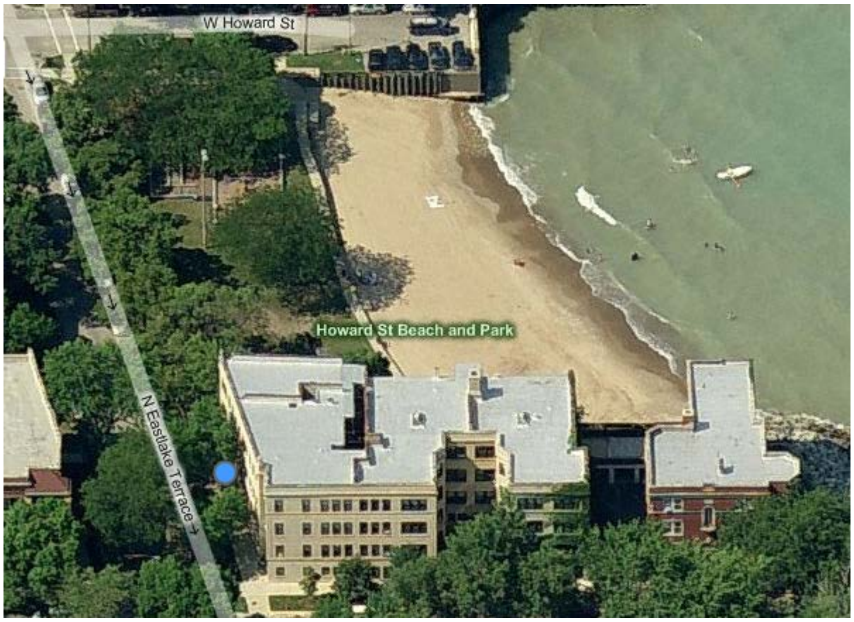
7. Columbia Beach

Columbia Beach is located in Columbia Park, at 1041West Columbia Avenue, just south of Pratt Beach (Figure 12).

8. Hartigan Beach

Hartigan Beach is located at 1050 W. Pratt Boulevard. Prior to 1965 it was known as Albion Beach and Park. The park has a playground and offers distance swimming parallel to the shore at Farwell pier Figure 13).

Figure 8. Howard Beach



Source: Bing Maps

Figure 9. Jarvis Beach

Source: Bing Maps

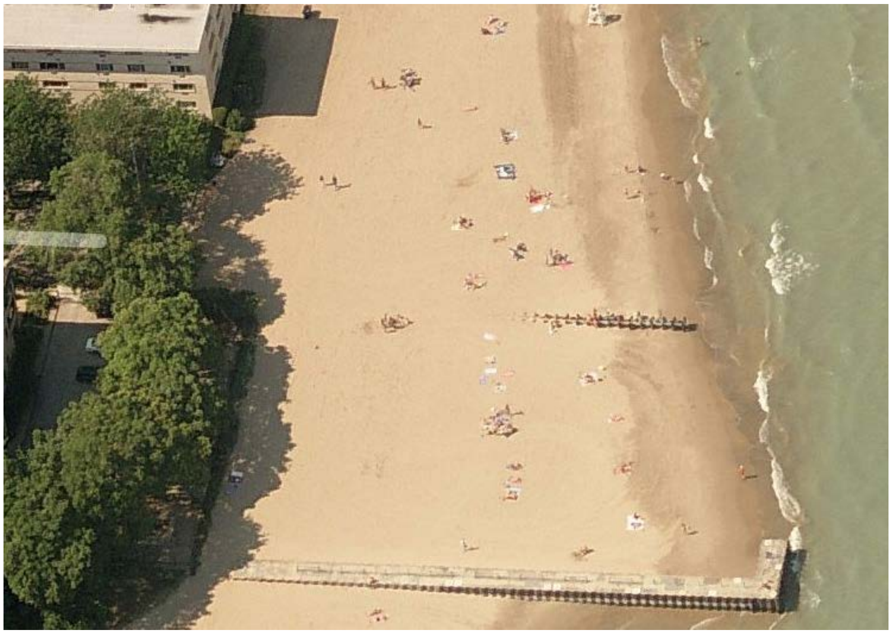
Figure 10. Loyola/Leone Beach

Source: Bing Maps

Figure 11. Pratt Beach

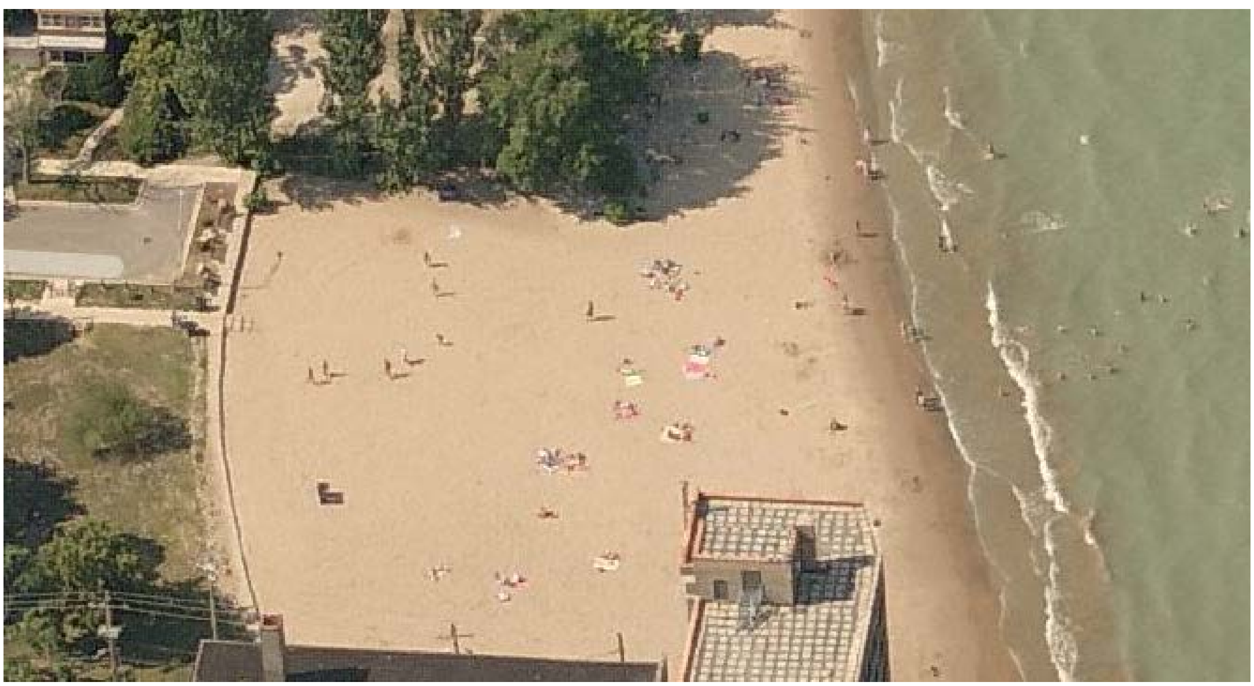
Source: Bing Maps

Figure 12. Columbia Beach



Source: Bing Maps

Figure 13. Hardigan Beach

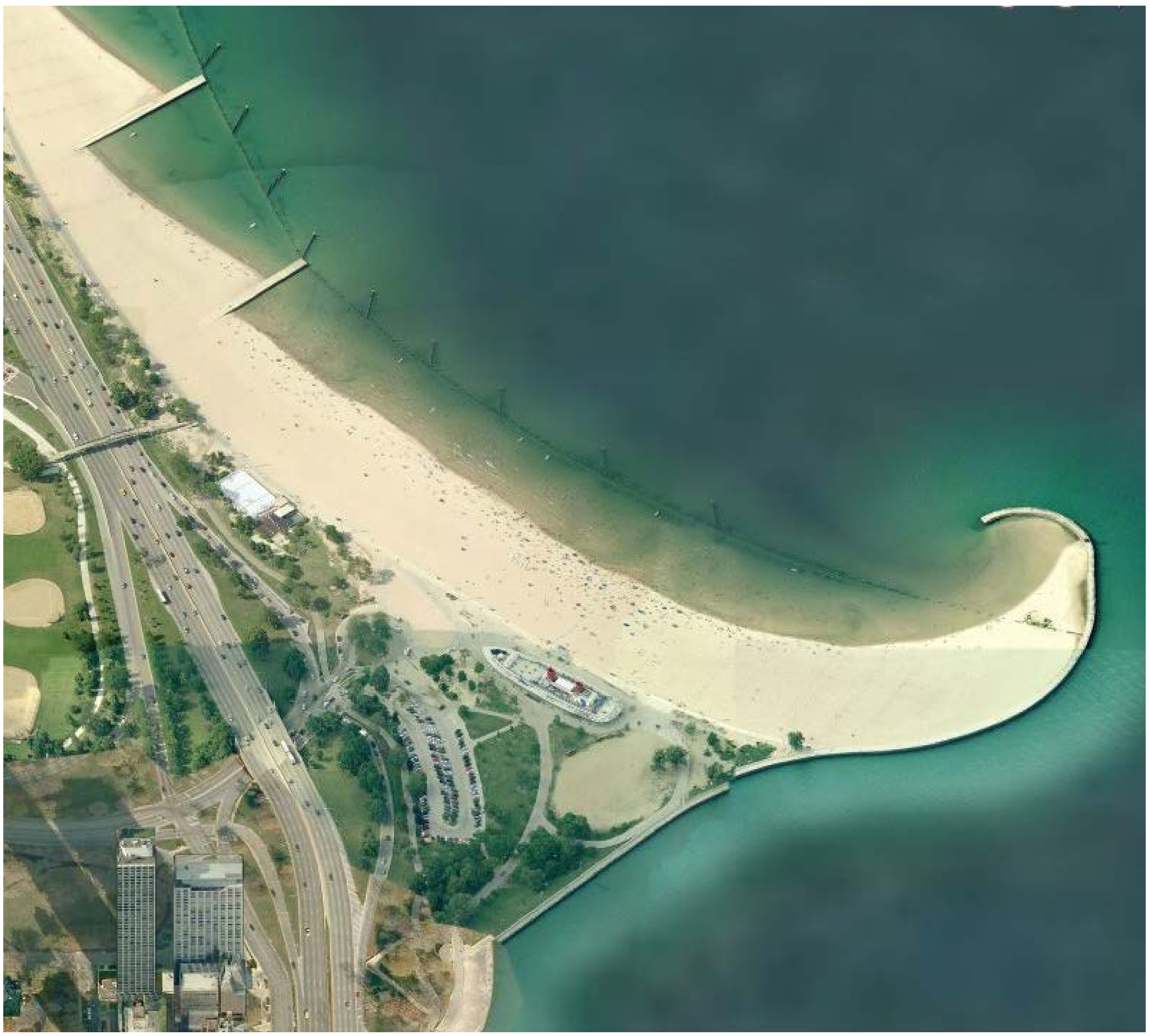


Source: Bing Maps

9. North Shore Beach

The North Shore Beach (North Avenue Beach) is located in Lincoln Park at 6700 North Lake Shore Drive and Shore Avenue. The park offers volleyball, biking, kayaking, paddle board and wake board rentals. The beach offers food concessions, restrooms and an ADA accessible beach walk. There is distance swimming at beaches 3 and 4, north of the boathouse. The North Avenue Beach House was opened in May 2000. The blue and white ocean liner inspired building houses the concessions and has an upper deck for viewing.

Figure 14. North Shore Beach

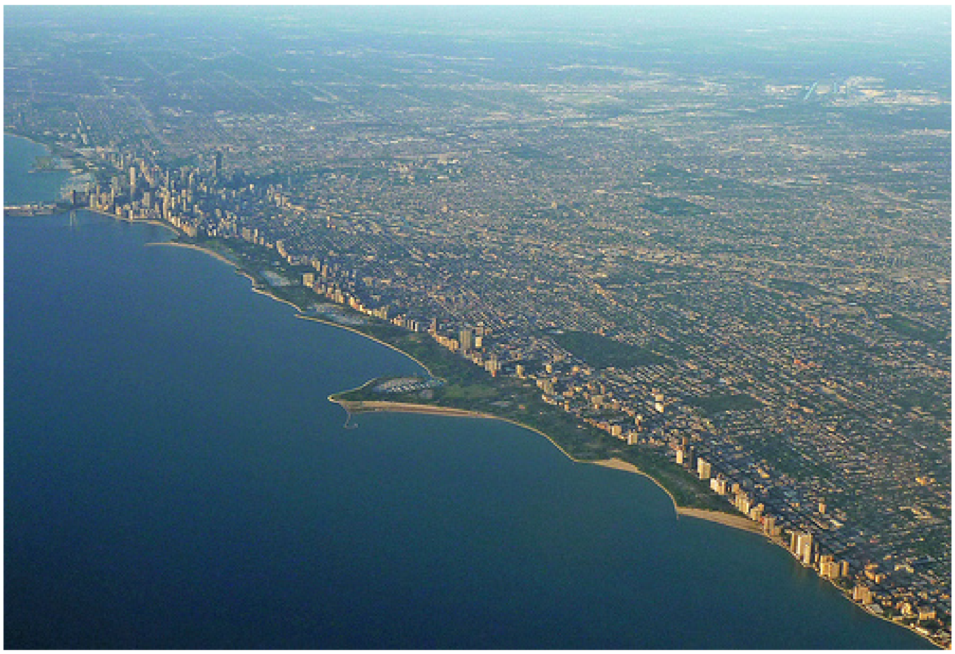


Source: Bing Maps

B. Lincoln Park Beaches

Lincoln Park is Chicago's largest public park at 1,208 acres. The park is seven miles long and is located between Ohio Street on its south border and Ardmore Avenue on its north border (Figure 15). The Park is located in the communities of Edgewater, Uptown and Lakeview. The park has a number of boating facilities; a zoo; the Lincoln Park Conservatory; the Chicago History Museum; numerous baseball, basketball, softball, soccer, tennis and volleyball facilities; and seven public beaches. The park has approximately 20m visitors per year.

Figure 15. Lincoln Park



Source: Wikimedia Commons http://www.flickr.com/photos/paytonc/3785616575/

1. George A. Lane Beach

The George A. Lane Beach (Thorndale Beach) is located in George Lane Park, in the Community of Edgewater, at 5934 North Sheridan Road, at the end of Thorndale Avenue. The beach (Figure 16) has a boardwalk ramp which allows wheelchair access. The beach is connected to the Kathy Osterman Beach (Hollywood Beach) to the south.

Figure 16. George A. Lane Beach

2. Kathy Osterman Beach

The Kathy Osterman Beach (Figure 17) is a crescent shaped beach located in Edgewater, at the 5800 north block, where Lake Shore Drive feeds into Sheridan Road. There is a beach house and concession stand, but no nearby parking lot. The northern half of the beach has shallow water, a long boardwalk ramp that allows shoreline access for strollers and wheelchairs.

3. Foster Avenue Beach

Foster Avenue Beach, located at 5200 North Lake Shore Drive in Edgewater, is actually a landfill extension of Lincoln Park. The work started in 1947 and concluded in 1958. The beach has a beach house with amenities such as showers, restrooms, etc (Figure 18).

4. Montrose Avenue Beach

Montrose Beach (Figure 19) is located in Uptown, at 4400 North Lakeshore Drive, at Montrose Drive. It is Chicago's largest beach, with ample parking, and allows launching of non-motorized watercraft, as well as offering a dog beach in its northern section. Its beach house, which looks like a lake steamer, has a full service restaurant, patio deck, restrooms, showers, an ADA accessible beach walk and distance swimming from Tower 4. Montrose small boat harbor is located south of the beach.

Figure 17. Kathy Osterman Beach

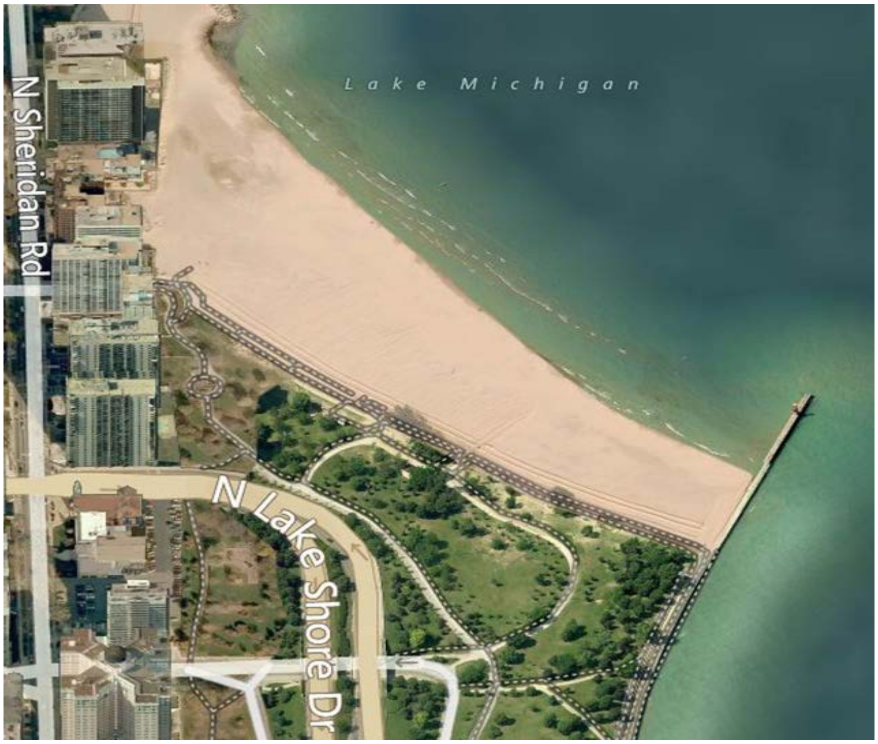
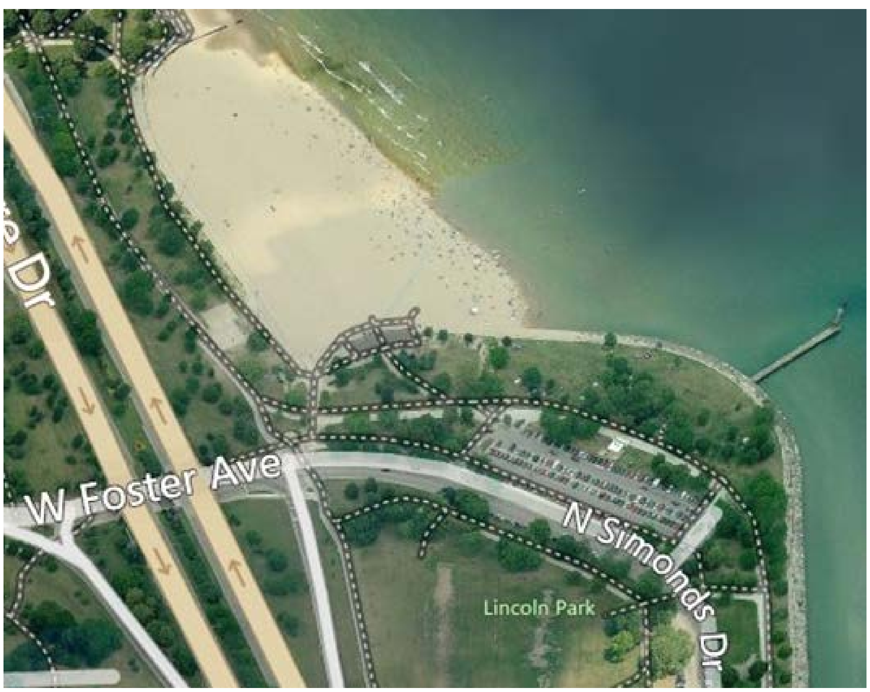
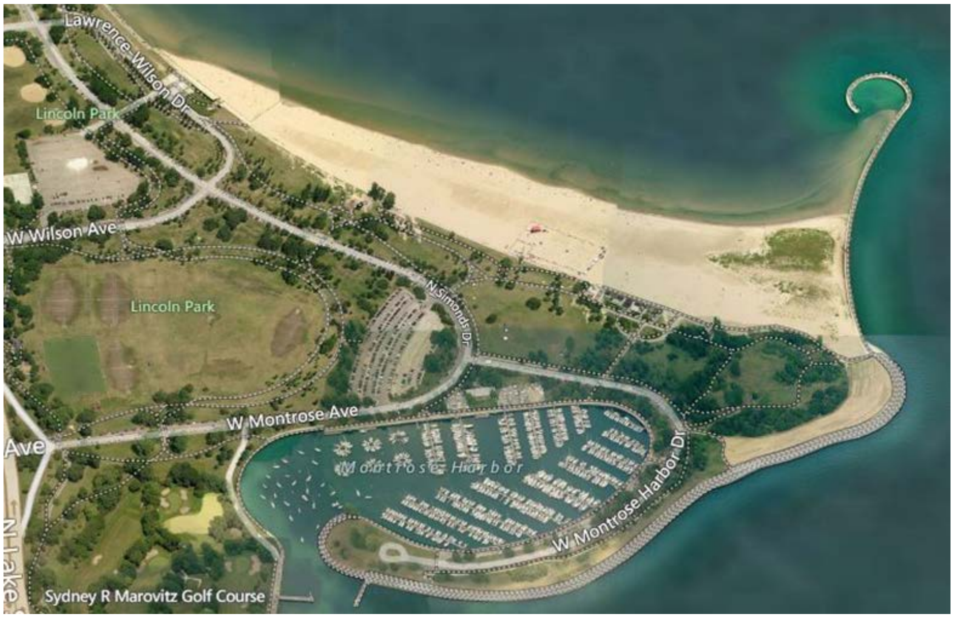


Figure 18. Foster Avenue Beach



Source: Bing Maps

Figure 19. Montrose Avenue Beach



Source: Bing Maps

5. North Avenue Beach

North Avenue Beach (Figure 20) is located at 1600 North Avenue, in the Lincoln Park neighborhood. The beach has a scalloped shoreline, formed by its sand holding piers. International volleyball tournaments are held here, and the beach is a prime viewing location for the Chicago Air and Water show. The beach's beach house, which looks like an ocean liner, offers a bar and restaurant, a concession stand, restrooms and rentals of bikes and sports equipment.

6. Oak Street Beach

Oak Street Beach (Figure 21) is located at 1000 North Lake Shore Drive. The beach extends from 1550 to 500 North Lake Shore Drive, is 1.5 miles long, and has about a half mile of deep water swimming, which is used by SCUBA divers. The park offers an outdoor restaurant and a chess pavilion.

7. Ohio Street Beach

Ohio Street Beach (Figure 22) is just north of Ohio Street and borders the Jane Adams Memorial Park and Olive Park. The beach is unique in that it faces north, and is formed in a bay made by the Jardine Water Purification plant. The north oriented seawall provides a half mile of open lake swimming in relatively shallow water.

Figure 20. North Avenue Beach

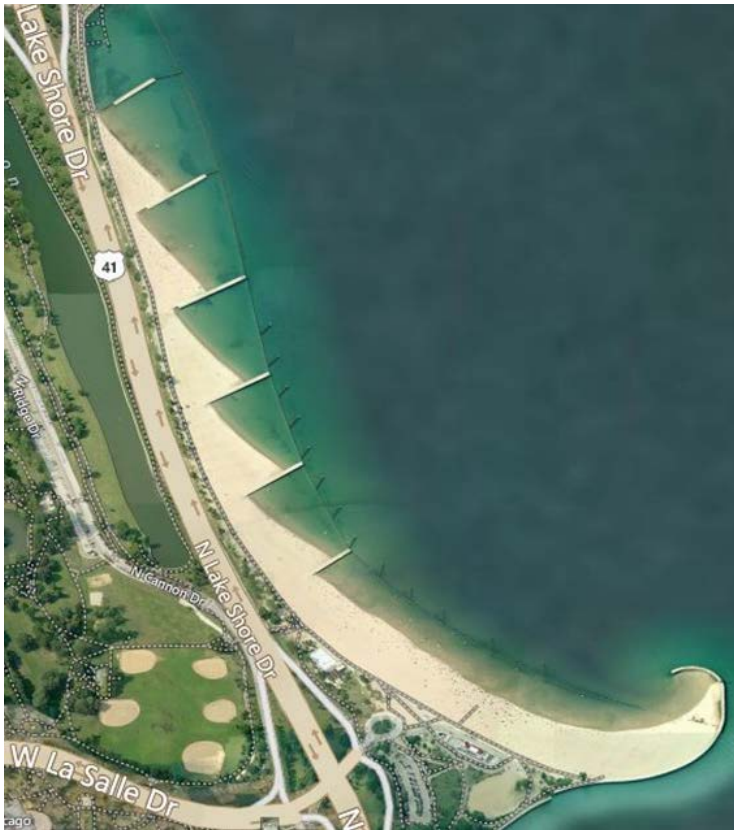
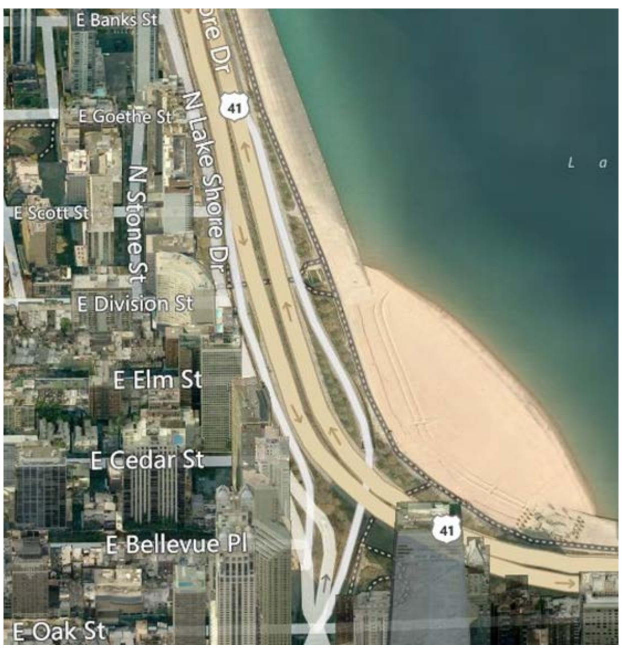
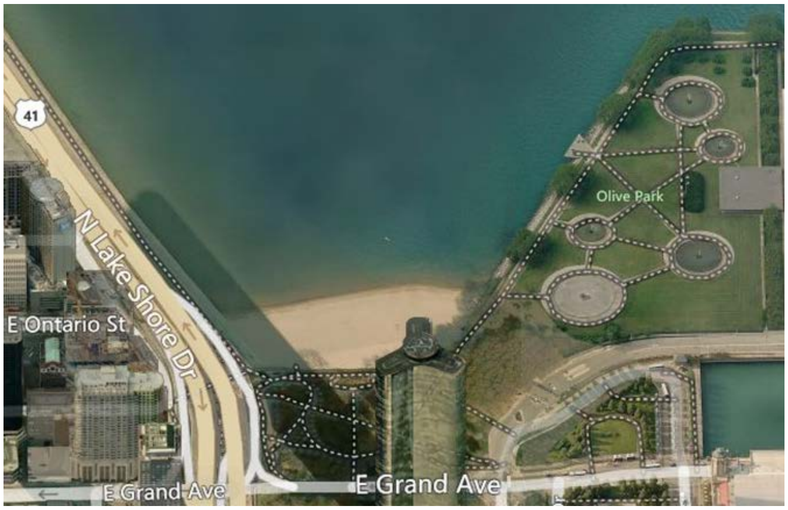


Figure 21. Oak Street Beach



Source: Bing Maps

Figure 22. Ohio Street Beach



Source: Bing Maps

C. Burnham Park Beaches

Burnham Park is 598 acres in size and runs from Jackson Park in the south to Grant Park in the north. The Park is six miles long and is located in the communities of Near South, Douglas, Oakland, Kenwood and Hyde Park (See Figure 4). The Park is named after Daniel M. Burnham, the architect who developed the park plan for Chicago's lakefront land. The park contains Soldier Field, McCormack Place convention center, an all concrete skate park, two harbors (Burnham Harbor and 31st Harbor) which offer over 2,100 slips, and seven beaches.

1. 12th Street Beach

The 12th Street Beach (Figure 23) is located at 1200 South Linn White Drive, on Northerly Island. The beach offers concessions, a beach house with restrooms, an accessible beach walk, a non-motorized boat launch, and distance swimming located parallel to the shoreline.

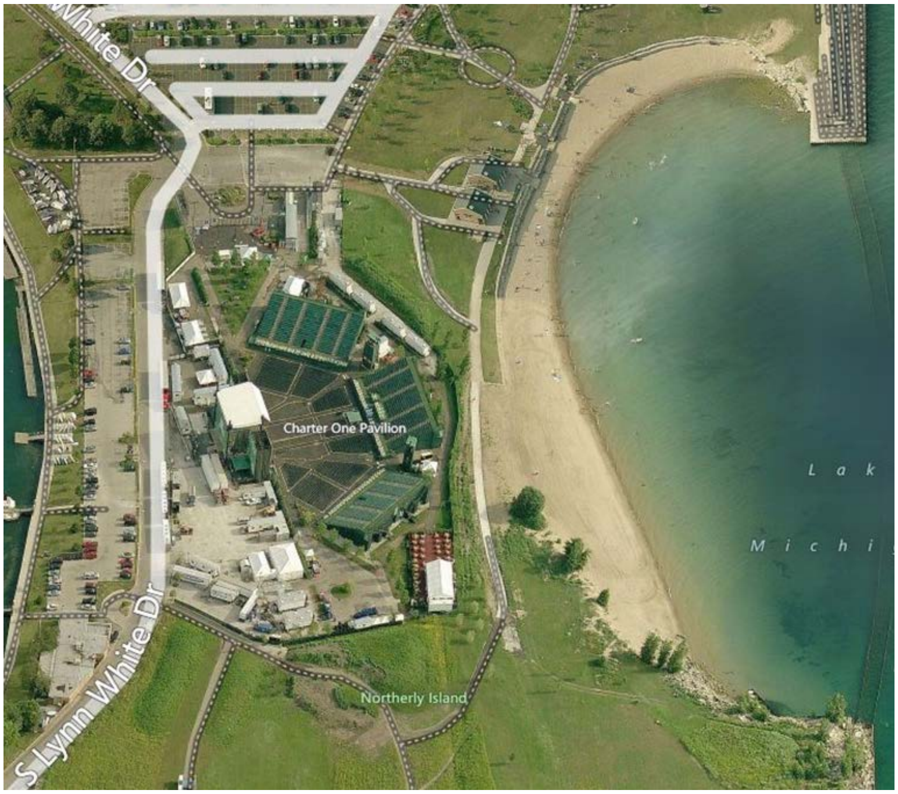
2. 31st Street Beach

The 31st Street Beach (Figure 24) is located at 3100 South Lakeshore Drive, in Burnham Park. The beach house has food and restrooms, an accessible beach walk, and distance swimming from the pier to the tower.

3. Oakwood/41St. Beach

This beach is located at 4100 South Lake Shore Drive (Figure 25). The beach opened in 2010 and offers food concessions, restrooms and an ADA accessible beach walk. Distance swimming is available parallel to the shoreline.

Figure 23. 12th Street Beach



Source: Bing Maps

Figure 24. 31st Street Beach

Source: Bing Maps

Figure 25. Oakwood/41st Street Beach

Source: Bing Maps

4. 49th Street Beach

The 49th Street Beach (Figure 26) is a small stone beach with no swimming, located at **4900** South Lakeshore Drive.

5. 57th Street Beach

The 57th Street Beach (Figure 27) is located at 5700 South Lakeshore Drive in Jackson Park, in the Hyde Park community. The beach has food concessions, restrooms, an ADA accessible beach walk and distance swimming parallel to the shore. Limited street parking is available.

D. East 63rd St. Beach

The E. 63rd Street Beach (Figure 28) is located at 6300 South Lakeshore Drive in the Jackson Park community. The beach includes a historic beach house with restrooms, showers, food concessions and meeting rooms. There are bike rentals and a non-motorized boat launch. There is an ADA accessible beach walk and long distance open lake swimming between buoys one and three.

Figure 26. 49th Street Beach

Source: Bing Maps

Figure 27.   57th Street Beach

Source: Bing Maps

Figure 28. 63rd Street Beach

Source: Bing Maps

E. South Shore Beaches

The South Shore community stretches from E. 67th to E. 79th Street. This community has much shoreline property that currently is not open to the public. Plans for new parks, beaches and public access have been proposed by Chicago lakeside development. These plans would provide a waterfront bicycle and jogging path that would link Calumet Park and Beach to the South Shore Cultural Center in South Shore.

1. South Shore Beach

The South Shore Beach (Figure 29) is located at 7059 S. South Shore Drive, near 71st Street, in the South Shore community. It is located behind the South Shore Cultural Center, which is the former South Shore Country Club. The building is on the National Historic Register and has a ballroom, restaurant, Paul Robeson Theater and the Washburn Culinary Institute. The 64.5 acre park has a nine-hole golf course, tennis courts, green spaces for picnics and walks, and the beach.

Figure 29. South Shore Beach

Source: Bing Maps

2. Ashe Beach

Ashe Beach (Figure 30) is located in Ashe Park, at 2701 E. 74th Street, between 74th and 75th Streets in the South Shore Community. The park, founded in 1979, was renamed in 1993 after tennis star Arthur Ashe and offers community gardens, a playground, two tennis courts and the beach.

3. Rainbow Beach

Rainbow Beach (Figure 31) is officially located at 3111 E. 77th Street (2873 E 75th Street), in Rainbow Park, in the South Chicago Neighborhood. The 61 acre park runs from 75th to 78th Street and offers a fitness center, gymnasium, which hosts after school programs and youth and adult fitness classes. The park has comfort stations, basketball/tennis/handball courts, baseball diamonds and two playgrounds.

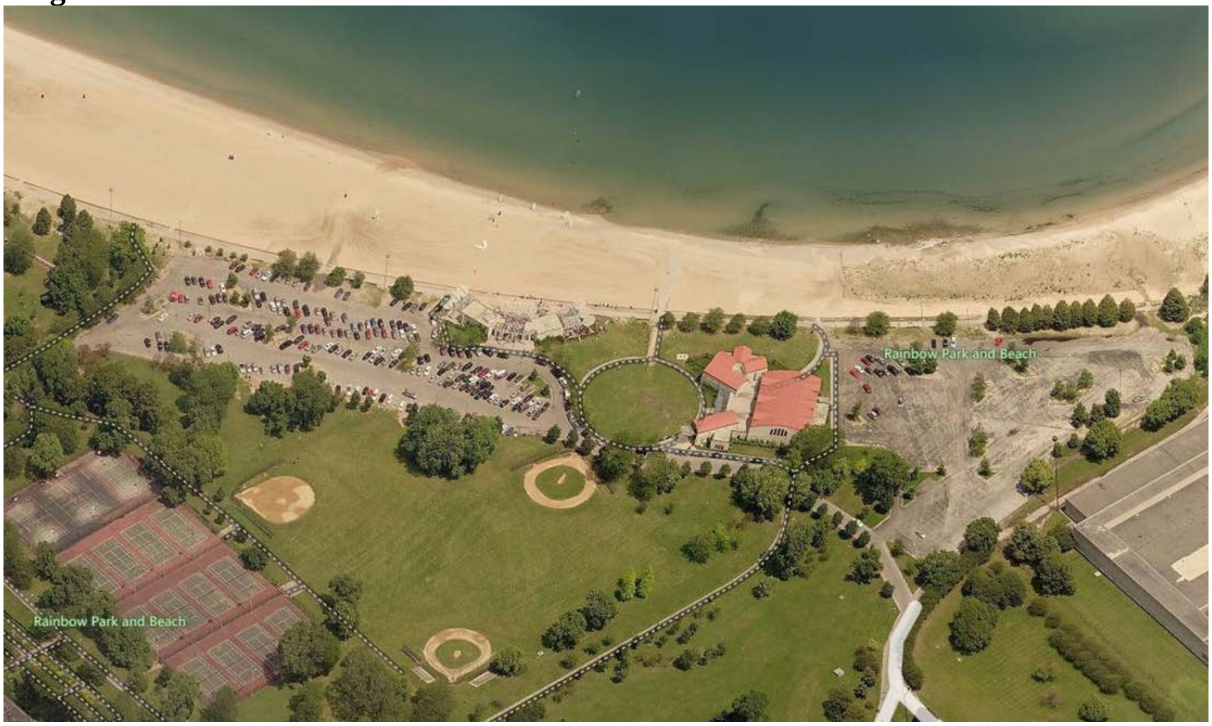
F. Calumet Park Beaches

Calumet Park (Figure 32), located in the East Side neighborhood, has three beaches located at 9600, 9800, and 9900 blocks of South Avenue G. The 199 acre park has a fitness center, two gymnasiums, a gymnastics center and sewing and upholstery studios. The park has picnic groves, softball, football and soccer fields, a boat launch and a beach. There is a beach house and concession stand, restrooms, an ADA accessible beach walk, and distance swimming.

Figure 30. Ashe Beach

Source: Bing Maps

Figure 31. Rainbow Beach



Source: Bing Maps

Figure 32. Calumet Park Beaches

Source: Bing Maps

IV. **ADDITIONAL INFORMATION**

The data for this report was derived from a variety of sources. The primary source of the data was taken from the Chicago Park District Web page. Beach descriptions were obtained from Wikipedia. Chicago neighborhood maps came from Lucid Reality. Most aerial photos were from Bing maps. Information on individual beaches came from various internet sites. A summary of the websites visited are provided in the Addendum.

ADDENDUM

This addendum summarizes the Web sites used to obtain information for the various sections of the report.

Sources

Parks/Beaches in General

Chicago Park District Web Page
http://www.cfmstage.com/beach-report/beach-report-list.cfm

Beach Descriptions From North to South
http://en.wikipedia.org/wiki/Beaches_in_Chicago

Chicago Neighborhood Maps
http://www.dreamtown.com/maps/chicago-neighborhood-map.htm

Listing of all Beaches, North to South
http://www.hearplanet.com/article/948417

Community Neighborhood Maps

http://loftchicago.com/map.php
http://rosesmodernworld.wikispaces.com/file/view/Chicago-Neighborhoods-Map.jpg/222655258/Chicago-Neighborhoods-Map.jpg
http://lucidrealty.com/images/Chicago_Neighborhoods.jpg

Bing Maps

http://www.bing.com/maps/?FORM=MLOMAP&PUBL=GOOGLE&CREA=userid1743gobroadfphumem2khvlw7ml8dkb3h3kcgsoxz1369#JnE9Lndlc3QlMmJjb2x1bWJpYSUyYmNoaWNhZ28lN2Vzc3QuMCU3ZXBnLjEmYmI9NDIuMDA3MTAwOTM0OTIyMSU3ZS04Ny42NTI4NjM1NDg5MDQ0JTdlNDEuOTk4MDUyMzg4MjM5NCU3ZS04Ny42NjI3OTg0NTEwOTU2

Individual Parks/Beaches

A. Rogers Park Community
http://en.wikipedia.org/wiki/Rogers_Park,_Chicago
http://www.dreamtown.com/neighborhoods/east-rogers-park.html

1. Rogers Park Beach
http://www.chicagoparkdistrict.com/parks/Rogers-Beach-Park/
http://wikitravel.org/en/Chicago/Rogers_Park

2. Howard Beach
http://www.chicagoparkdistrict.com/parks/Howard-Beach-Park/

3. Jarvis Beach Park
http://www.chicagoparkdistrict.com/parks/Jarvis-Beach-and-Park/

4. Fargo Beach Park
http://www.chicagoparkdistrict.com/parks/Fargo-Beach-Park/

5. Leone/Loyola Park Beach
http://www.chicagoparkdistrict.com/parks/Leone-Beach-Park/
http://chicago.metromix.com/venues/mmxchi-loyola-leone-beach-venue
http://specialsections.suntimes.com/lifestyle/parenting/13968024-555/top-5-kid-friendly-beaches.html
http://www.chicagoparkdistrict.com/parks/Loyola-Park/

6. Pratt Beach- south of Loyola Leone Beach

7. Columbia Beach
http://www.chicagoparkdistrict.com/parks/Columbia-Beach-Park/
http://beaches.findthebest.com/l/641/Columbia-Beach

8. Hardigan Beach
http://www.chicagoparkdistrict.com/parks/Hartigan-Beach-Park/

9. North Shore Beach

http://www.cfmstage.com/beach-report/beach-report-detail.cfm?objectid=14
North Avenue Beach House
http://www.chicagoparkdistrict.com/parks/north-avenue-beach/

B. Lincoln Park Beaches
http://en.wikipedia.org/wiki/Lincoln_Park,_Chicago
http://en.wikipedia.org/wiki/Lincoln_Park
http://en.wikipedia.org/wiki/Chicago_beaches#Lincoln_Park_Beaches

1. Thorndale Beach
http://en.wikipedia.org/wiki/Chicago_beaches#Lincoln_Park_Beaches

2. Kathy Osterman Beach
http://timeoutchicago.com/things-to-do/35421/beachy-keen

3. Foster Avenue Beach

*4. Montrose Avenue Beach*http://www.cfmstage.com/beach-report/beach-report-detail.cfm?objectid=13

5. North Avenue Beach

6. Oak Street Beach
http://en.wikipedia.org/wiki/Oak_Street_Beach
http://www.explorechicago.org/city/en/things_see_do/attractions/park_district/oak_street_beach.html
7. Ohio Street Beach

C. Burnham Park

http://en.wikipedia.org/wiki/Burnham_Plan

http://en.wikipedia.org/wiki/Burnham_Park_(Chicago)

1. 12th Street Beach
http://www.chicagoparkdistrict.com/parks/12th-street-beach/

2. 25/26th Street Beach

3. 31st Street Beach
http://www.chicagoparkdistrict.com/parks/31st-street-beach/

4. Oakwood/41st Street Beach
http://www.chicagoparkdistrict.com/parks/oakwood-41st-street-beach/

5. 49th Street Beach
http://en.wikipedia.org/wiki/Chicago_beaches#Burnham_Park_Beaches

6. 57th Street Beach
http://www.chicagoparkdistrict.com/parks/57th-street-beach/
http://en.wikipedia.org/wiki/Chicago_beaches#Burnham_Park_Beaches

D. 63 rd Street Beach

http://www.cfmstage.com/beach-report/beach-report-detail.cfm?objectid=21

E. South Shore Beaches

http://en.wikipedia.org/wiki/South_Shore,_Chicago

1. South Shore Beach
http://en.wikipedia.org/wiki/Chicago_beaches#Burnham_Park_Beaches
http://www.chicagoparkdistrict.com/parks/South-Shore-Cultural-Center/

2. Ashe Beach
http://en.wikipedia.org/wiki/Beaches_in_Chicago#31st_Street_Beach
http://www.chicagoparkdistrict.com/parks/Ashe-Beach-Park/
http://books.google.com/books?id=wcWDW9p8wdYC&pg=PT82&lpg=PT82&dq=ashe+beach+park&source=bl&ots=ZJ4Sxz6Sb0&sig=UXR8bUS-2iz7LhqN1VjcItzyvfw&hl=en&sa=X&ei=9QbGUOO0C-bO2QWB8YHICA&ved=0CG4Q6AEwDTgK

3. Rainbow Beach
http://www.cfmstage.com/beach-report/beach-report-detail.cfm?objectid=23
http://en.wikipedia.org/wiki/Chicago_beaches#Burnham_Park_Beaches

F. Calumet Park Beaches

http://books.google.com/books?id=wcWDW9p8wdYC&pg=PT82&lpg=PT82&dq=ashe+beach+park&source=bl&ots=ZJ4Sxz6Sb0&sig=UXR8bUS-2iz7LhqN1VjcItzyvfw&hl=en&sa=X&ei=9QbGUOO0C-bO2QWB8YHICA&ved=0CG4Q6AEwDTgK
http://en.wikipedia.org/wiki/Chicago_beaches#cite_ref-EOCW_1-3
http://www.chicagoparkdistrict.com/parks/Calumet-Park/

Beaches North to South

1. Juneway Terrace	In Rogers Avenue Beach And Park	7800 North & Lake Michigan
2. Rogers Beach	In Rogers Avenue Beach And Park	7705 North
3. Howard Beach	Howard St Beach & Park	7600 North
4. Jarvis Beach		7400 North
5.Fargo Beach		7432 North
6. Loyola/Leone	8 blocks Chicago's largest	7032 North Sheridan
7.Pratt Beach		1050 West Pratt Blvd
8. Hartigan Beach		6800 North of Loyola Ave
9. Columbia Beach		6727 North
10. North Shore Beach		6700 North
11. Thornedale Beach		5934 North
12. Kathy Osterman(Hollywood)	5800 n block Lake Shore Drive, Sheridan Road	
13. Foster Avenue Beach		5200 North
14. Wilson Ave		4600 North
15. Montrose Beach - dog beach		4400 North
16. North Avenue Beach	Premier beach	1600 North
17. Humboldt Park Beach	A lagoon in Humboldt Park	
17. Oak Street Beach	deep water swimming	1000 North
18. Ohio St Beach	In Olive Park	400 North E of Lake Shore Drive
19. 12th Street Beach		On Northerly Island
20. 25/26 Street Beach-		no longer extant
21. 31st Street Bridge	In Burnham Park	31st Street
22. 49th St Beach	Stone beach in Burnham Park, no swimming	
23. 57th Street Beach	In Hyde Park neighborhood 2 large underpasses at 57th street. Deep swimming south of promontory point	
24. 63rd Street Beach	largest and oldest beach house	63rd St.
25. 67th st Beach	in Jackson Park probably same as 63rd St Beach	67th Street
25. South Shore Beach	behind South Shore Cultural Center	71st & South Shore Drive
26. Ashe Beach		74th &75th street
27. Rainbow Beach-	from 75th to 77th street	3111 E. 77th St

Future Without-Project Condition: Assessment of Water Quality

Chicago Area Waterway System

August 2013

Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

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I. EXECUTIVE SUMMARY

In support of the Great Lakes and Mississippi River Interbasin Study (GLMRIS), several alternative plans were developed which seek to prevent the transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River Basins. As a result of implementation of a GLMRIS project (i.e., the future with-project condition) or lack thereof (i.e., the future without-project condition), water quality discharge standards within the Chicago Area Waterway System (CAWS) may change. In order to address these potential changes, *Baseline Assessment of Water Quality – Chicago Area Waterway System* highlighted the entities that either use water from or discharge water into CAWS.

The baseline report established the baseline maintenance and operation costs associated with these three plants. The purpose of this assessment is to quantify the future maintenance and operation costs for these three plants if no further action is taken to prevent the transfer of ANS (i.e., the No New Federal Action plan). This is essentially the future without-project condition. The 50-year period of analysis extends between years 2017 through 2066. A summary of baseline and FWOP condition operation and maintenance costs are summarized in Table 1.

Table 1 Baseline and FWOP Condition Annual Operation and Maintenance Costs: Northside, Calumet and Stickney Water Reclamation Plants

Water Reclamation Plant	Baseline[1] (2012 dollars)	FWOP Condition (2012 dollars)
Northside	$27,096,713	$29,161,713
Calumet	$36,435,174	$39,989,174
Stickney	$87,547,800	$156,698,687

1. Values established in the *Baseline Assessment of Water Quality – Chicago Area Waterway System* report.

II. GLMRIS STUDY INFORMATION

A. Introduction

An aquatic nuisance species (ANS) is a non indigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (2010).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Water quality is now improved, and these canals allow the transfer of species between the basins.

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River by aquatic pathways. In this context, the term "prevent" includes the reduction of risk to the maximum extent possible, because it may not be technologically feasible to achieve an absolute solution. As part of this study, USACE will conduct a detailed analysis of various ANS controls, including hydrologic separation.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and

- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

B. **GLMRIS Study Area**

The GLMRIS study area includes portions of the Great Lakes and Mississippi River basins that fall within the United States.[1]

Potential aquatic pathways between the Great Lakes and Mississippi River basins exist along the basins' shared boundary (illustrated as “ ” in Figure 1). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi Basin ( ) and the Great Lakes Basin ( ). See Figure 1.

Future ANS may transfer beyond the *Detailed Study Area*; this pattern was observed by the spread of zebra mussels, which originated in the Great Lakes and spread throughout the Mississippi River Basin. Therefore, the *General Study Area* encompasses the lower Mississippi River Basin ( ). While the majority of GLMRIS tasks will be completed within

[1] The GLMRIS team recognizes that the transfer of ANS between the Great Lakes, Upper Mississippi River, and Ohio River Basins may potentially impact fisheries in the U.S. and Canadian waters of the Great Lakes. The Team is also aware of ongoing practices to manage the Great Lakes fisheries as a bi-national effort. The GLMRIS team will continue to remain cognizant of potential environmental, economic, and social impacts of ANS transfer to Canadian interests.

the *Detailed Study Area*, USACE will consider specific ANS impacts in the larger *General Study Area*.

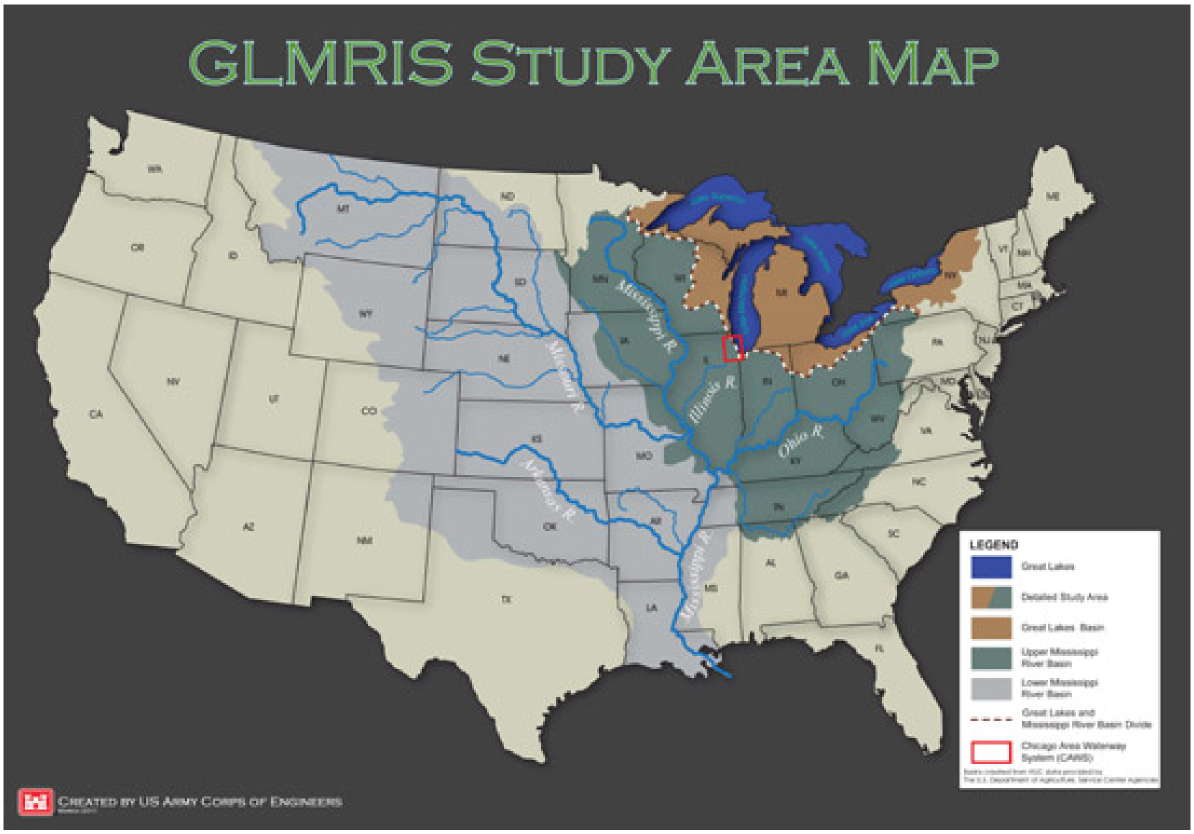


Figure 1. GLMRIS Study Area Map

a. GLMRIS Focus Areas

The U.S. Army Corps of Engineers is conducting GLMRIS along two concurrent tracks: Focus Area I, the Chicago Area Waterway System (CAWS), and Focus Area II, Other Pathways.

(1) Chicago Area Waterway System (CAWS)

Focus Area I, the Chicago Area Waterway System, as shown in the map below, is the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins and, therefore, poses the greatest potential risk of aquatic nuisance species (ANS) transfer between the basins, via an aquatic pathway.

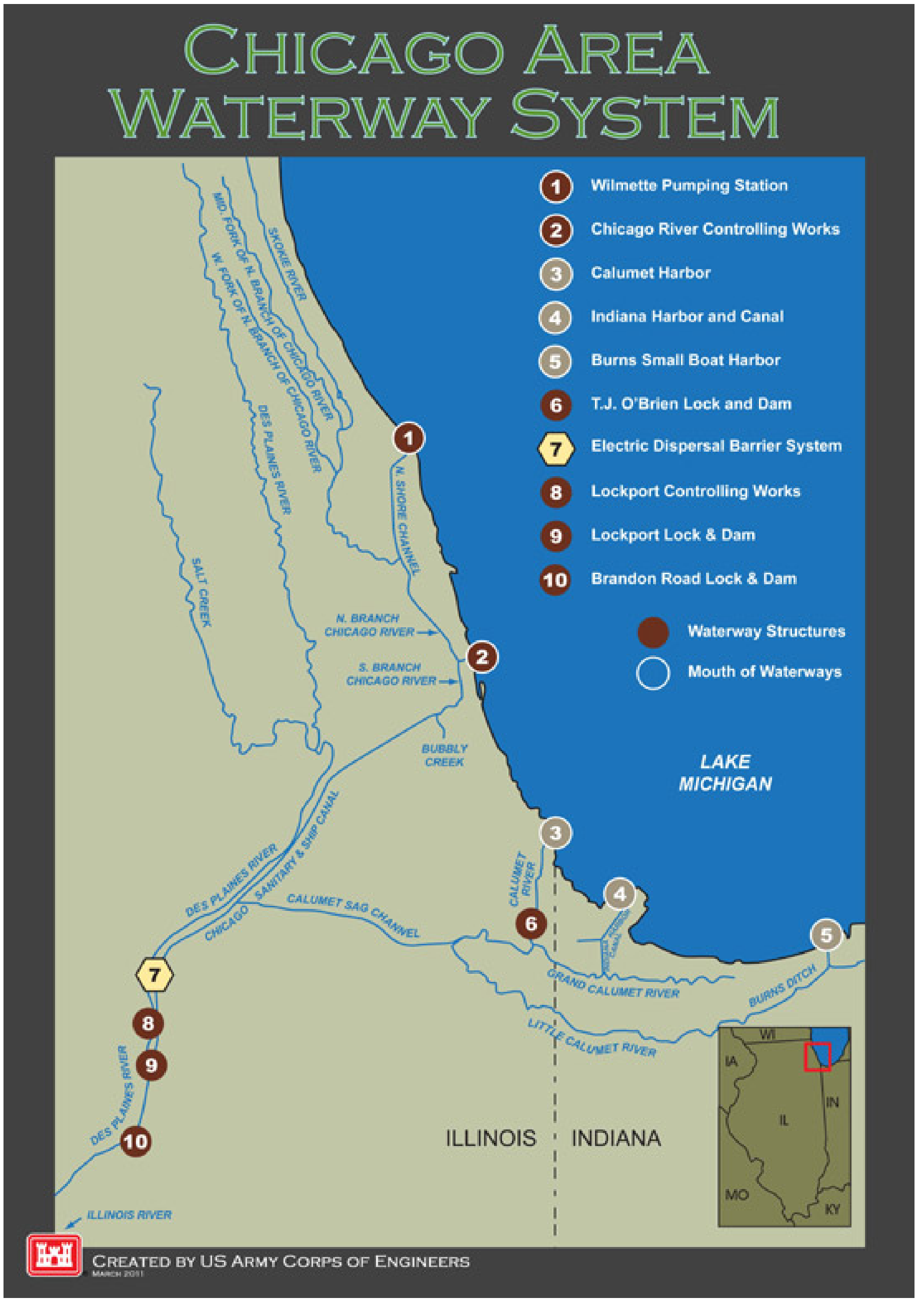


Figure 2. Chicago Area Waterway System

(2) Other Pathways

Focus Area II addresses remaining aquatic pathways. For this focus area, the U.S. Army Corps of Engineers completed a document entitled *Other Pathways Preliminary Risk Characterization Report* that identified other potential aquatic pathways outside of the Chicago Area Waterway System, as well as included a screening-level assessment of potential ANS that may transfer via these connections.

As shown on the *Other Pathways* map below, 18 potential aquatic pathways have suggested that there is significant uncertainty about the relative risks of ANS transfer. Eagle Marsh, located in Fort Wayne, Indiana was identified as having the highest potential risk of ANS transfer. The Indiana Department of Natural Resources has implemented interim measures to mitigate this risk, and USACE is further studying this pathway to determine whether a long-term ANS control should be implemented. For the remaining 17 sites, USACE is coordinating further study to finalize the risk characterization and determine whether ANS controls are recommended.

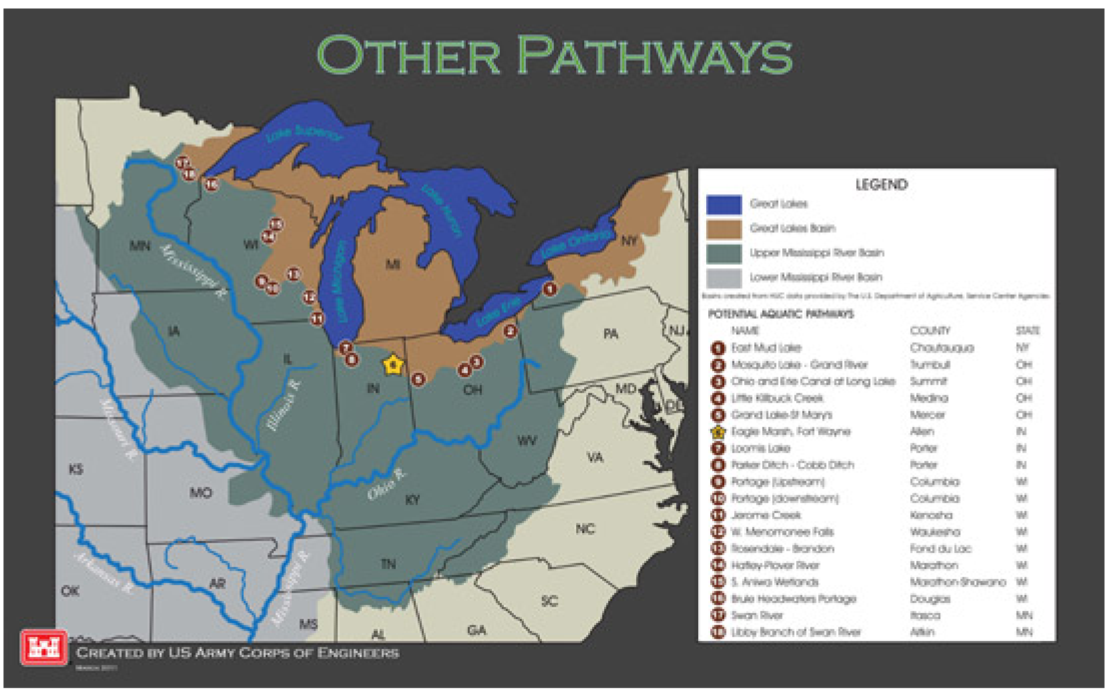


Figure 3. Other Pathways Map

III. OVERVIEW OF THREE MAJOR IMPACTED WASTE WATER RECLAMATION PLANTS

The Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) operates seven wastewater treatment plants and 23 pumping stations in the Chicago Metropolitan area. The seven MWRDGC plants service an 883 square mile area and treat 1.5b gallons of wastewater per day. There are three waste water treatment facilities that discharge water into the CAWS: the North Side, Calumet and Stickney plants (Figure 4). Plant characteristics are provided in Table 1. A brief description of the three plants follows.

A. North Side Waste Water Reclamation Plant

The North Side Water Reclamation Plant (Figure 5) is located at Howard Street and McCormick Boulevard. The plant serves 1.3m people located in 141 square miles, including the city of Chicago north of Fullerton Avenue. It has a design capacity of 330m gallons per day.

B. Calumet Waste Water Reclamation Plant

The Calumet plant (Figure 6) is located at 400 East 130th Street. This plant is the oldest of the seven plants the MWRDGC operates. The plant services a 300 square mile area including parts of the city of Chicago south of 87th Street and its southern suburbs. It has primary and secondary treatment of effluents. The plant has a design capacity of 350m gallons per day. The TARP pumping station is located adjacent to the water treatment plant.

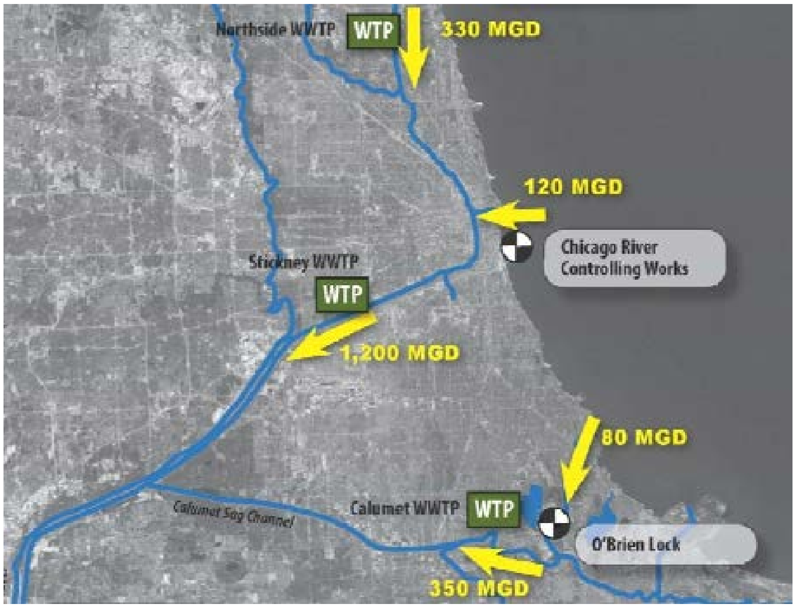
C. Stickney Waste Water Reclamation Plant

The Stickney Plant (Figure 7) is located at 6001 West Pershing Road, near Lombard Road, in Cicero Illinois. This is the largest waste water treatment plant in the world. The 570 acre plant services 2.38m people over 260 square miles which includes 43 suburban communities and the central part of Chicago. This is a three phase treatment plant. The Phase 1 screening process removes debris and settling tanks allow heavier solids to sink to the bottom and lighter waste to float to the top. Skimmers collect material at the bottom and top of the tanks for disposal. Stage 2 uses microorganisms to convert remaining wastes to forms that can be removed. The third phase further filters the water and adds ammonia. The plant has a design capacity of 1,200m gallons per day.

D. NPEDS Discharge Standards and Plant Performance

All three waste water reclamation plants must meet certain effluent discharge standards. Currently these plants discharge their effluent into the CAWS. The water then travels via various connecting channels to eventually flow into the Missouri and Mississippi River. Therefore, effluent currently discharged into the CAWS must meet effluent standards of the rivers the waters eventually flow into (Missouri River). A description of these current water quality standards are provided in Table 2, as well as how well these plants performed in 2010 with respect to these standards.

Figure 4. Waste Water Treatment Plants



Source:"*Evaluation of Physical Separation Alternatives for the Great Lakes and Mississippi River Basins In the Chicago Area, Waterway System, Appendix A 4, Wastewater Improvements Technical Memo*", study performed for the Great Lakes Commission.

Table 2. CAWS Sewage Plant Characteristics

Parameter	North Side WWTP	Calumet WWTP	Stickney WWTP
Design Average Flow (MGD)	330	350	1,200
Daily Maximum Flow (MGD)	450	430	1,440
Liquid	☐Preliminary: Screening	☐Preliminary: Screening	☐Preliminary: Screening
Treatment	and grit removal	and grit removal	and grit removal
Process	☐Primary: Settling using primary clarifiers ☐Secondary: Activated sludge process with nitrification and final clarifiers	☐Primary: Settling using primary clarifiers ☐Secondary: Activated sludge process with nitrification and final clarifiers	☐Primary: Settling using Imhoff tanks and primary clarifiers ☐ Secondary: Activated sludge process with nitrification and final clarifiers
Solids	None; pumped to	☐Thickening, anaerobic	☐Thickening, anaerobic
Treatment	Stickney	digestion, lagoon	digestion, lagoon
Process		storage, air drying ☐ Various land application options	storage, air drying ☐ Various land application options

Source:"*Evaluation of Physical Separation Alternatives for the Great Lakes and Mississippi River Basins In the Chicago Area Waterway System, Appendix A 4, Wastewater Improvements Technical Memo*", study performed for the Great Lakes Commission.

Figure 5. North Side Water Reclamation Plant

Source: Bing Maps

Figure 6. Calumet Waste Water Reclamation Plant

Source: Bing Maps

Figure 7. Stickney Waste Water Reclamation Plant

Source: Bing Maps

Table 3. NPDES Discharge Standards and Plant Performance

WWTP – Permit Number	Monthly Average	Weekly Average	Daily Maximum	2010 Effluent [a]		
Parameter				Mean	Maximum	Minimum
North Side – Permit IL0028088						
CBOD [b] (mg/L)	10	12		<2	11	<2
TSS [c] (mg/L)	12	18		5	18	2
Ammonia – N (mg/L) Apr–Oct Nov–Mar	 2.5 4		 5 8	<0.3 [d]	2.2 [d]	<0.1 [d]
Total – P (mg/L)	No Limit			1.4	2.3	0.4
NO_2 – N (mg/L)	No Limit			<0.2	1.3	<0
NO_3 – N (mg/L)	No Limit			8.9	11.7	3.7
Fecal Coliform (count/100 mL)	No Limit			GM [e]: 7,986	80,000	2,700
Calumet – Permit IL0028061						
CBOD (mg/L)	10	20		<3	8	<2
TSS (mg/L)	15	25		6	13	2
Ammonia – N (mg/L) Apr–Oct Nov–Mar	 2.5 4.0		 5 8	<0.3	2.4	<0.2
Cyanide (mg/L)	0.15		0.3	<0.006	<0.005	0.014
Total - P	No Limit			3.8	9.7	1.0
NO_2 + NO_3 – N (mg/L)	No Limit			8.3	17.0	3.3
Fecal Coliform (count/100 mL)	No Limit			GM: 6,304	24,000	1,600
Stickney – Permit IL0028053						
CBOD (mg/L)	10	15		<3	10	<2
TSS (mg/L)	12	20		<5	12	<4
Ammonia – N (mg/L) Apr–Oct Nov–Mar	 2.4 4.0		 5 8	<0.6	3.6	<0.1
DO [f], Minimum (mg/L)			6 (minimum)	8.3	10.3	6.4
Total – P (mg/L)	No Limit			1.3	3.4	0.2
NO_2 – N (mg/L)	No Limit			<0.3	2.1	<0
NO_3 – N (mg/L)	No Limit			8.6	16.3	3.3
Fecal Coliform (count/100 mL)	No Limit			GM: 7,363	86,000	1,400

Notes:

[a] Based on daily average data published by MWRDGC. See link below for data.
www.mwrd.org/irj/portal/anonymous?NavigationTarget=navurl://14d6b38927bee2ff03c32994983903f0

[b] Carbonaceous biochemical oxygen demand

[c] Total suspended solids

[d] Annual ammonia data from plant effluent are not seasonal. Typical of all ammonia plant effluent data in this table.

[e] Geometric mean

[f] Dissolved oxygen

IV. METHOD OF ANALYSIS

The without-project condition is a forecast of what is expected to happen at a site if no project was to be implemented. For GLMRIS, the base year is 2017 with a study period of 50 years going from 2017 to 2066. The development of operation and maintenance costs for the waste water reclamation plants under without project conditions will be based on costs that occur in the following time frames: existing plant operating and maintenance costs as of 2012, operation and maintenance costs associated with plant improvements that will take place between 2012 and project year 1, 2017, and known plant improvement plans that address discharge water disinfection. Each of these three categories will now be discussed.

A. 2012 Operation And Maintenance Costs

Annual Operation and maintenance costs for the Northside, Calumet and Stickney waste water reclamation plants was obtained from the 2012 budget of the Metropolitan Water Reclamation District Of Greater Chicago. The report provided requested 2012 annual costs for all the various Water treatment plants the District operates. The data was broken down into eight categories: construction and design (32.9%), bond redemption and interest fund (17.9%), plant operation and maintenance (17.7%), staff services (12%), retirement fund (6.2%), claims and judgments (5.9%), storm water management (4.9%), and monitoring and research (2.5%).

Maintenance and operation costs were provided by service area: the North Service area ($40,859,300), the Calumet service area ($36,671,900) and the Stickney service area (87,547,800.) The operation and maintenance costs had 5 cost categories: collection and treatment, solids' processing, solids utilization, flood and pollution control and general support. Operation and maintenance costs associated with the Northside, Calumet and Stickney plants were developed from this data. For the Stickney plant, it is the only plant in the Stickney service area. Thus all Operation and maintenance costs associated with the Stickney service area was for the Stickney plant itself. The Northside and Calumet service areas have more treatment plants in them than just the Northside and Calumet plants. Thus operation and maintenance costs associated with the Northside and Calumet plants were developed from service area operation and maintenance costs. Operation and maintenance costs were allocated to each treatment plant based on its percentage of total service area design flow. Table 3 shows the results of this analysis.

Based on Table 3, existing (2012) annual operation and maintenance costs for the Northside, Calumet and Stickney plants are placed at: $27,096,700, $36,435,200, and $87,547,800 respectively.

Table 4. Annual Operation and Maintenance Costs: Northside, Calumet and Stickney Water Reclamation Plants- 2012

Activity	Northside	Calumet	Stickney
Collection And Treatment	$ 19,244,201	$25,876,415	$ 52,763,401
Solids Processing	$ 4,939,114	$ 6,641,302	$ 23,141,587
Solids Utilization	$ 1,556,127	$ 2,092,422	$ 8,499,823
Flood And Pollution Control	$ 1,083,478	$ 1,456,881	$ 758,965
General Support	$ 273,794	$ 368,153	$ 2,384,024
	------------------	------------------	------------------
	$ 27,096,713	$36,435,174	$ 87,547,800

Source:"*2012 Budget, Metropolitan Reclamation District of Greater Chicago*", adopted December 8, 2011, and amended December 15, 2011.

B. Capital Expenditure Outlook

The 2012 annual budget also outlined future capital expenditures at all of the districts waste water reclamation plants. Data was broken down into three main categories: capital expenditure projects that are currently under way and expected date of completion, capital expenditure projects for 2012, and future capital expenditure projects. Table 4 summarizes the information provided in the Reclamation Districts 2012 budget.

Table 5. Capital Expenditure Outlook: Northside, Calumet and Stickney Water Reclamation Plants.

Projects	Northside	Calumet	Stickney	Total Capital Funding
Projects Currently Under Construction	$ 68,611,000	$ 764,665,000	$ 649,498,000	$ 1,482,774,000
Projects In 2012	$ 48,502,000	$ 47,045,000	$ 68,125,000	$ 163,672,000
Future Projects	$ 147,554,000	$ 190,570,000	$ 320,000,000	$ 658,124,000
	------------------	------------------	------------------	------------------
	$ 264,667,000	$ 1,002,280,000	$ 1,037,623,000	$ 2,304,570,000

Source:"*2012 Budget, Metropolitan Reclamation District of Greater Chicago*", adopted December 8, 2011, and amended December 15, 2011.

Associated with these future projects are some level of annual operation and maintenance costs. However, the development of what these costs are is beyond the scope of this WOP condition evaluation. As more information on these O&M costs becomes available, they will be incorporated in any future economic evaluations.

C. Future Investments In Chlorination

The Calumet and North Side waste water treatment plants will implement disinfection of their waste water by March 2016. This will enable the water in the CAWS to be classified as safe for primary usage (i.e. swimming). A task force of MWRD employees had identified the least costly disinfection technology for the Calumet and North Side WWTP's. The Calumet plant would use chlorination, and the North Side Plant U/V technology. Cost estimates for construction and annual operation and maintenance were developed. Total capital and O&M NPV costs for the two plants, over a 60 year period, came to approximately $310.5 m. These costs are summarized below.

Table 6. Chlorination Costs at the Calumet and Northside Water Reclamation Plants

	Calumet WWTP Chlorination	North Side WWTP ULtrVilt LPHO	Total Disinfection Costs
Capital Costs	$ 31,880,000	$ 77,300,000	$ 109,180,000
O&M Costs	$ 127,376,000	$ 73,974,000	$ 201,350,000
Total NPV	$ 159,256,000	$ 151,274,000	$ 310,530,000
Annual O&M Costs	$ 3,554,000	$ 2,065,000	$ 5,619,000

Annual O&M Costs: Only include costs for electricity and chemicals. It does not include Labor Costs.

Source: "*Evaluation Of Disinfection Technologies for the Calumet and North Side Water Reclamation Plants, Technical Memorandum 3, February 17,2012*", from the Disinfection Task Force to the Disinfection Task Force Advisory Committee

These disinfection costs were included in the WOP condition annual operation and maintenance costs associated with the two treatment plants. These disinfection costs would be added to current costs, to develop WOP costs. From 2012 through 2015, operating costs will remain at current levels. The new disinfection processes will come on line in 2016. The WOP Condition time line starts in 2017 and goes on for 50 years to 2066. The time stream of annual O&M disinfection costs for the two plants, over the WOP condition, are the dollar amounts provide in Table 5. These chlorination O&M costs are assumed to happen in every year of the 50 year WOP condition evaluation period.

Note: the capital costs are considered a sunk cost, since it takes place prior to the beginning of the WOP condition time period: 2017. However, these disinfection O&M costs will be incurred in every year of the WOP condition.

V. WITHOUT PROJECT CONDITION ANNUAL MAINTENANCE COSTS: NORTH SIDE, CALUMET AND STICKNEY WASTE WATER RECLAMATION PLANTS.

Without project condition annual maintenance costs are a composite of existing (2012) operation and maintenance costs (Table 3), operation and maintenance costs associated with new plant improvements, and future plant chlorination costs (Table 5). Table 6 summarizes these WOP condition annual operation and maintenance costs.

Table 7 Without Project Condition Annual Maintenance Costs- Northside, Calumet and Stickney Plants

	Northside	Calumet	Stickney	WOP Annual Operation and Maintenance Costs
Existing Plant (2012) O&M Costs	$ 27,096,713	$ 36,435,174	$ 87,547,800	$ 151,079,687
Plant Improvement O&M Costs	TBD	TBD	TBD	$ -
Chlorination O&M Costs	$ 2,065,000.00	$ 3,554,000.00	IIEC	$ 5,619,000
	------------------	------------------	------------------	------------------
Annual WOP Condtion O&M Costs	$ 29,161,713	$ 39,989,174	$ 87,547,800	$ 156,698,687
TBD=To Be Determined				
IIE=Included In Existing (2012) Costs				

The costs provide in Table 6, are assumed to be annual costs. These costs will occur in every year of the 50 year without project condition evaluation period. This analysis assumes that processing capability of the plants will not be expanded during the 50 year project evaluation period: 2017- 2066. Nor will there be new plants built that will discharge their effluent into the CAWS. All data should be considered preliminary and is subject to updates.

Note: no O&M costs have been assigned to plant capital improvements that will take place between 2012 and project year 1: 2017. These O&M costs may be accounted for at sometime in the future. Currently, identifying these costs is beyond the scope of this evaluation. Not having these costs is not expected to have an impact on future economic evaluations, since these costs will remain the same in the future without project condition as well as all future with project condition scenarios.

VI. ADDITIONAL INFORMATION

This report developed an estimate of operation and maintenance costs under future without project conditions, for the three waste water reclamation plants: North Side, Calumet and Stickney. The WOP condition study period of analysis covers 50 years, and starts in 2017. Data for this report was derived from a variety of sources. A summary table of future WOP condition annual maintenance costs, by waste water reclamation plant is provided in Table 7.

Table 8. Without Project Condition Annual Operation and Maintenance Costs: Northside, Calumet and Stickney Plants

Annual WOP Plant Operation And Maintenance Costs			
Northside	**Calumet**	**Stickney**	**Total O&M Costs**
$29,161,713	$39,989,174	$ 87,547,800	$ 156,698,687

These three plants' O&M costs are subject to change with implementation of various plans that address the migration of aquatic nuisance species between the Mississippi River and the Great Lakes. These without-project condition operation and maintenance costs will later be compared to O&M costs associated with various project alternatives. The differences in operation and maintenance costs between the without-project condition and the alternatives formulated will indicate the economic impact on the waste water reclamation plants of implementing the various alternatives.

A brief listing of the major sources of material provided in this report follows.

North Side Water Reclamation Plant

http://www.google.com/imgres?hl=en&sa=X&tbo=d&biw=1132&bih=764&tbm=isch&tbnid=17V9xBfw3R9hnM:&imgrefurl=http://www.waterandwastewater.com/plant_directory/Detailed/431.html&docid=X6QIKAJhq5n_dM&imgurl=http://www.waterandwastewater.com/plant_directory/images/plants/2/1082-medium_northsideIL_WRP.JPG&w=300&h=126&ei=GHXcUK6hI42k8QSVz4DoAw&zoom=1&iact=hc&vpx=93&vpy=439&dur=3416&hovh=100&hovw=240&tx=155&ty=73&sig=112519885159019781491&page=1&tbnh=100&tbnw=228&start=0&ndsp=31&ved=1t:429,r:12,s:0,i:125

Calumet Waste Water Reclamation Plant

Plant Improvements

http://www.mwrd.org/pv_obj_cache/pv_obj_id_1280442C124912FF4E4EE10FC03DAD14601A1900/filename/CWRP%20full%20document.pdf

North Side and Calumet plants proposed ultraviolet disinfection

http://news.medill.northwestern.edu/chicago/news.aspx?id=201921&terms=rory%20keane

http://www.illinois.gov/PressReleases/ShowPressRelease.cfm?SubjectID=75&RecNum=10164

Stickney Waste Water Reclamation Plant

Plant Improvements

http://www.mwrd.org/pv_obj_cache/pv_obj_id_E52F7E1A7E8A2B3F9FA1A36D2BB7073431054B00/filename/SWRP%20full%20document.pdf

http://www.mwrd.org/irj/portal/anonymous/stickney

http://gizmodo.com/5844925/chicagos-stickney-wastewater-treatment-plant-is-the-crappiest-place-on-earth

http://www.waterandwastewater.com/plant_directory/Detailed/432.html

Water Reclamation District 2012 Annual Budget

https://www.mwrd.org/pv_obj_cache/pv_obj_id_751A13BAD5DC5DB89B9E7AF70EC270A0DB162C01/filename/2012_Final_Budget.pdf

Future Without-Project Condition – Water Quality of Lake Michigan Beaches

August 2013

Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

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FIGURES

I. EXECUTIVE SUMMARY

In support of the Great Lakes and Mississippi River Interbasin Study (GLMRIS), several alternative plans were developed which seek to prevent the transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River Basins. As a result of implementation of a GLMRIS project (i.e., the future with-project condition) or lack thereof (i.e., the future without-project condition), water quality within the Chicago area may change. In order to address how these potential changes may change beach usage, a baseline assessment of the various beaches along Chicago's Lake Michigan shoreline that may be impacted by changes in water quality was developed.

This assessment builds on the previous report by identifying beaches that will be extant under future without-project conditions, and an estimate of beach usage at the current beach locations. This analysis assumes no further action is taken to prevent the transfer of ANS. The 50-year period of analysis extends between 2017 through 2066. Key findings of this analysis include beach visit values estimated by the University of Chicago. These results include:

- The number of beach visits along Chicago's Lake Michigan shoreline in 2004 was estimated at 20 million.
- The value of the beach season for the beaches located along Lake Michigan's shoreline was estimated at $800 million in 2004 (in 2004 dollars).

II. GLMRIS STUDY INFORMATION

A. Introduction

An aquatic nuisance species (ANS) is a non-indigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (2010).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Water quality is now improved, and these canals allow the transfer of species between the basins.

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River by aquatic pathways. In this context, the term "prevent" includes the reduction of risk to the maximum extent possible, because it may not be technologically feasible to achieve an absolute solution. As part of this study, USACE will conduct a detailed analysis of various ANS controls, including hydrologic separation.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and

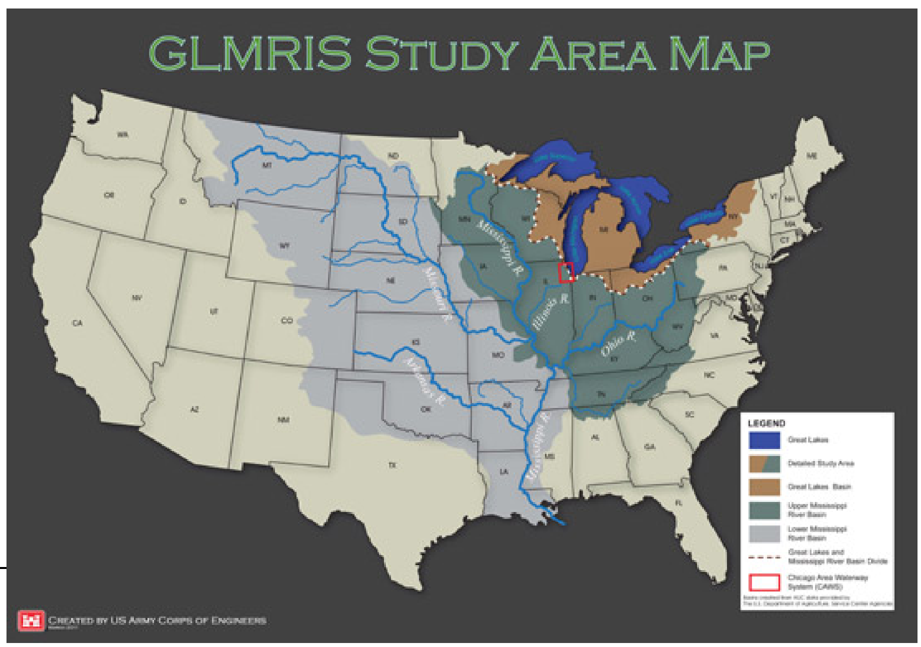
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

B. **GLMRIS Study Area**

The GLMRIS study area includes portions of the Great Lakes and Mississippi River basins that fall within the United States.[1]



[1] The GLMRIS team recognizes that the transfer of ANS between the Great Lakes, Upper Mississippi River, and Ohio River Basins may potentially impact fisheries in the U.S. and Canadian waters of the Great Lakes. The Team is also aware of ongoing practices to manage the Great Lakes fisheries as a bi-national effort. The GLMRIS team will continue to remain cognizant of potential environmental, economic, and social impacts of ANS transfer to Canadian interests.

Figure 1. GLMRIS Study Area Map

Potential aquatic pathways between the Great Lakes and Mississippi River basins exist along the basins' shared boundary (illustrated as “ ” in Figure 1). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi Basin ( ) and the Great Lakes Basin ( ). See Figure 1.

Future ANS may transfer beyond the *Detailed Study Area*. This pattern was observed by the spread of zebra mussels, which originated in the Great Lakes and spread throughout the Mississippi River Basin. Therefore, the *General Study Area* encompasses the lower Mississippi River Basin ( ). While the majority of GLMRIS tasks will be completed within the *Detailed Study Area*, USACE will consider specific ANS impacts in the larger *General Study Area*.

a. GLMRIS Focus Areas

The U.S. Army Corps of Engineers is conducting GLMRIS along two concurrent tracks: Focus Area I, the Chicago Area Waterway System (CAWS), and Focus Area II, Other Pathways.

(1) Chicago Area Waterway System (CAWS)

Focus Area I, the Chicago Area Waterway System, as shown in Figure 2, is the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins and, therefore, poses the greatest potential risk of aquatic nuisance species (ANS) transfer between the basins, via an aquatic pathway.

(2) Other Pathways

Focus Area II addresses remaining aquatic pathways. For this focus area, the U.S. Army Corps of Engineers completed a document entitled *Other Pathways Preliminary Risk Characterization Report* that identified other potential aquatic pathways outside of the Chicago Area Waterway System, as well as included a screening-level assessment of potential ANS that may transfer via these connections.

As shown on the *Other Pathways* map (Figure 3), 18 potential aquatic pathways have suggested there is significant uncertainty about the relative risks of ANS transfer. Eagle Marsh, located in Fort Wayne, Indiana was identified as having the highest potential risk of ANS transfer. The Indiana Department of Natural Resources has implemented interim measures to mitigate this risk, and USACE is further studying this pathway to determine whether a long-term ANS control should be implemented. For the remaining 17 sites, USACE is coordinating further study to finalize the risk characterization and determine whether ANS controls are recommended.

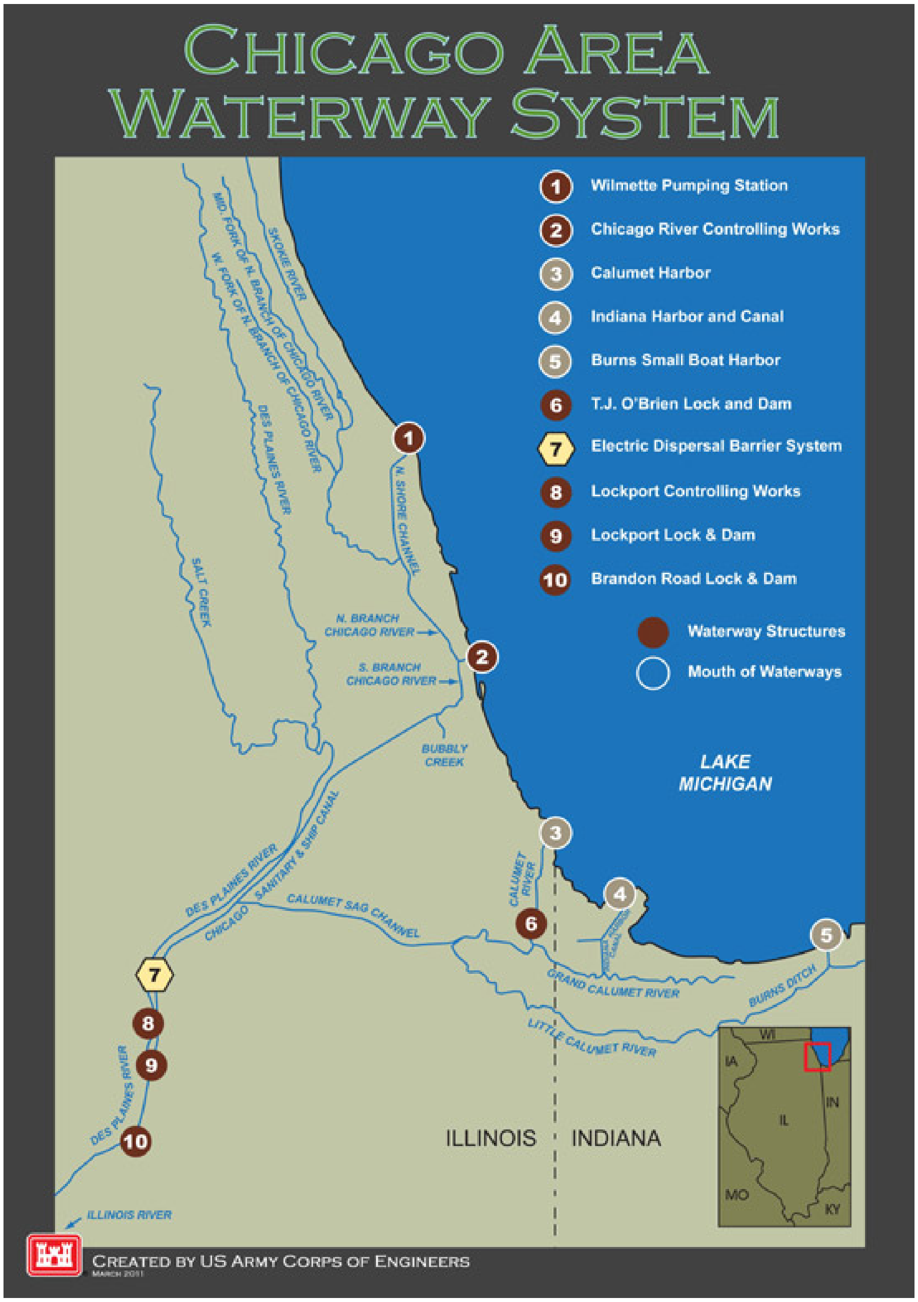


Figure 2. Chicago Area Waterway System

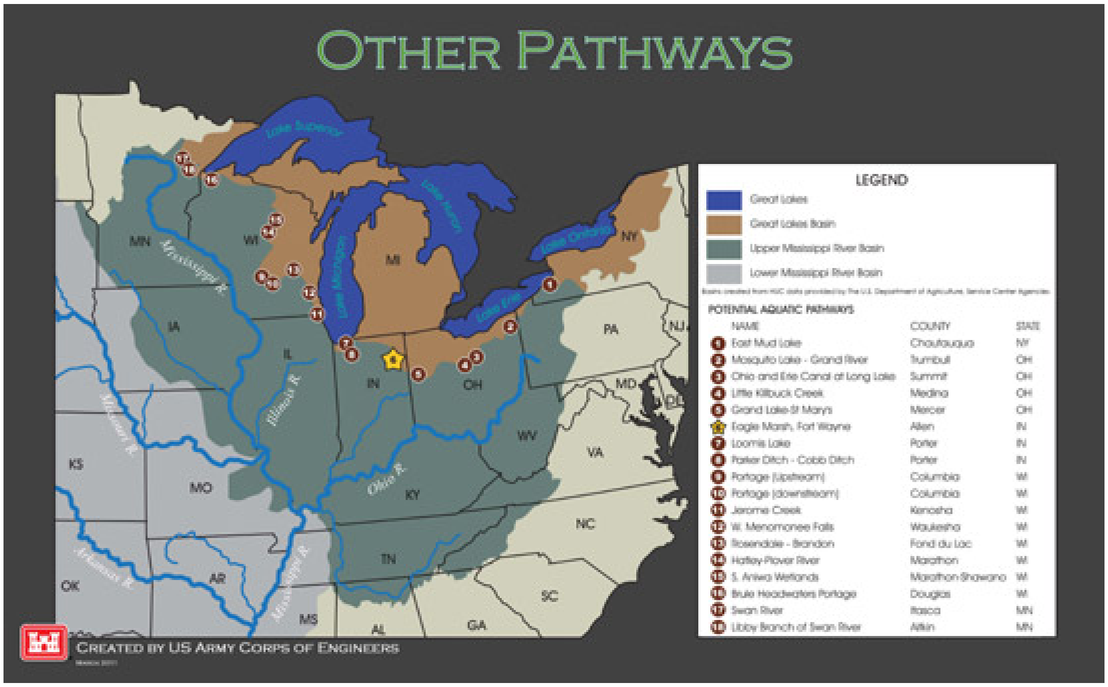


Figure 3. Other Pathways Map

III. METHOD OF ANALYSIS

The without-project condition is a forecast of what is expected to happen at a site if no project was to be implemented. For GLMRIS, the base year is 2017 with a study period of 50 years going from 2017 to 2066.

The number of beaches that will exist under future Without Project conditions equal the number of existing beaches, the number of new beaches built between now (2012) and the beginning of the project evaluation period (2017) and the number of beaches built during the project valuation period (2017-2066). This assumes all current and new beaches will remain in existence over the project evaluation period.

The assessment basically is an inventory of existing public beaches, an identification of potential new beaches, and an indication of past beach usage.

IV. EXISTING PUBLIC BEACHES

All public beaches that were in existence in 2012 are assumed to remain in existence throughout the 50 year without-project condition evaluation period: 2017-2066. These beaches are located in various Chicago shoreline communities. Figure 4 is a map of the various Chicago shoreline Communities.

Public beaches in Chicago are maintained by the Chicago Park District. Private entities such as private clubs and hotels developed the first beaches. The first public beach was located in Lincoln Park, and opened in 1895. An overall plan for the development of the city of Chicago was presented in the 1909 study *Plan of Chicago* (the Burnham Plan). One of the six major topics was improvement of the lakefront. The report emphasized reclaiming the lakefront for the public. It recommended expanding the parks along the lakefront by filling in the existing shoreline. The report acted as a guide to city planners into the 20^{th} century. Today, Chicago's 28 miles of shoreline is completely manmade, its main use is as parkland, and is open to the public for free. There are 33 beaches in Chicago. The beaches are generally located in a park, and the parks typically take the name of the east-west Street at each beach's location.

This evaluation used secondary sources to identify the location and number of public beaches in the Chicago area that are located on Lake Michigan. There are 77 communities in the Chicago area. The evaluation was restricted to the number of public beaches that were located in the 16 shoreline communities of the city of Chicago: Rogers Park, Edgewater, Uptown, Lakeview, Lincoln Park, Near North Side, Chicago Loop, Near South Side, Douglas, Oakland, Kenwood, Hyde Park, Woodlawn, South Shore, South Chicago, and East Side. Figure 4 is a map of the various Chicago Shoreline Communities. A brief description of existing Chicago public beaches, by community, follows.

A. **Rogers Park Beaches**

Rogers Park is on the north side of Chicago. It is bounded basically by West Howard Street on the north, North Ridge Boulevard on the west and East Devon Avenue on the south (Figure 5). Rogers Park was incorporated as a village in 1878. The community has 10 end street beaches.

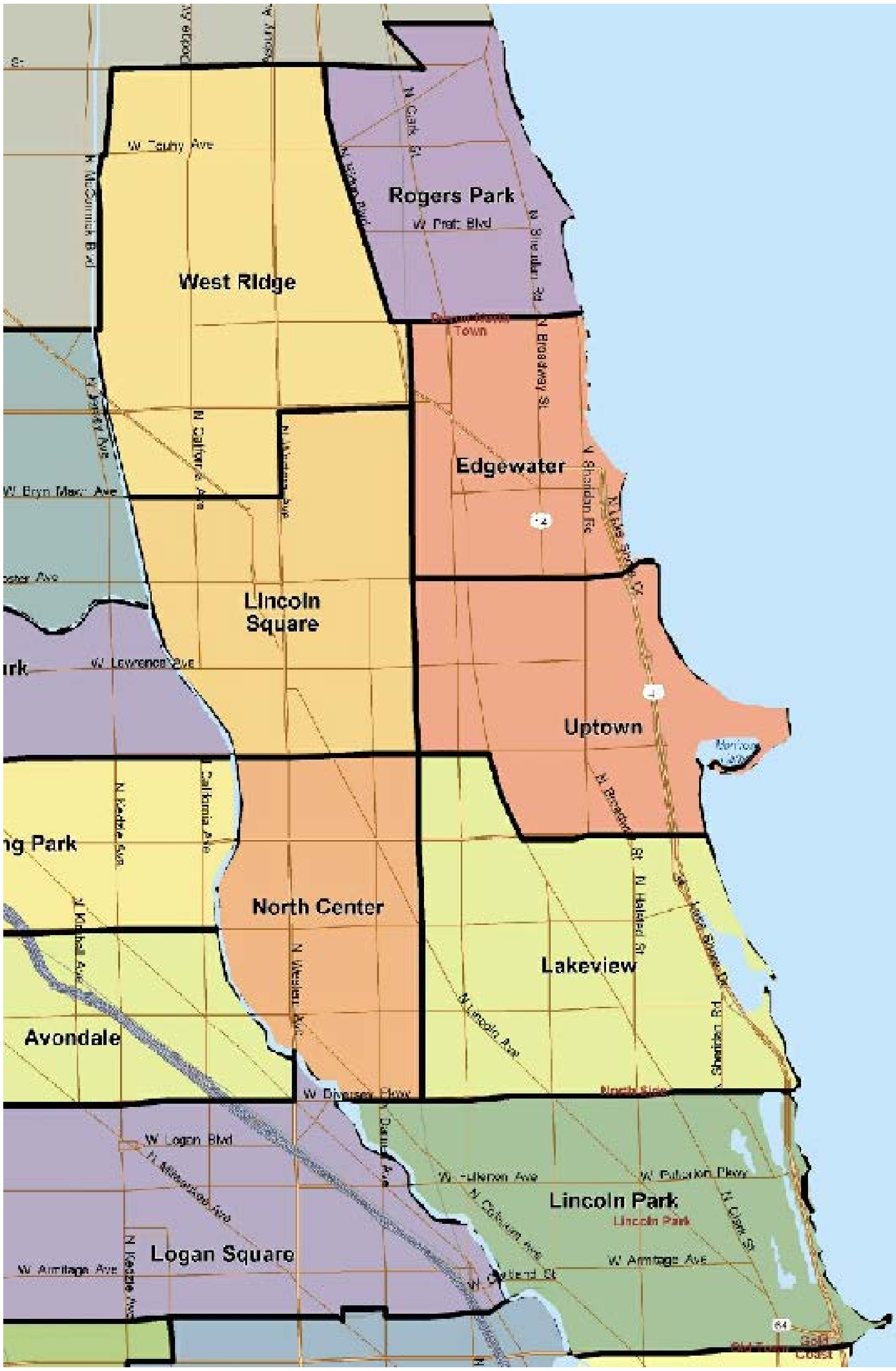
1. Juneway Terrace Beach

Juneway Terrace Beach is located in Rogers Park at 7800 North and Lake Michigan (Figure 6). Its southern border is formed by riprap which protects three apartment buildings. South of Juneway Terrace beach is Rogers Beach.

2. Rogers Beach

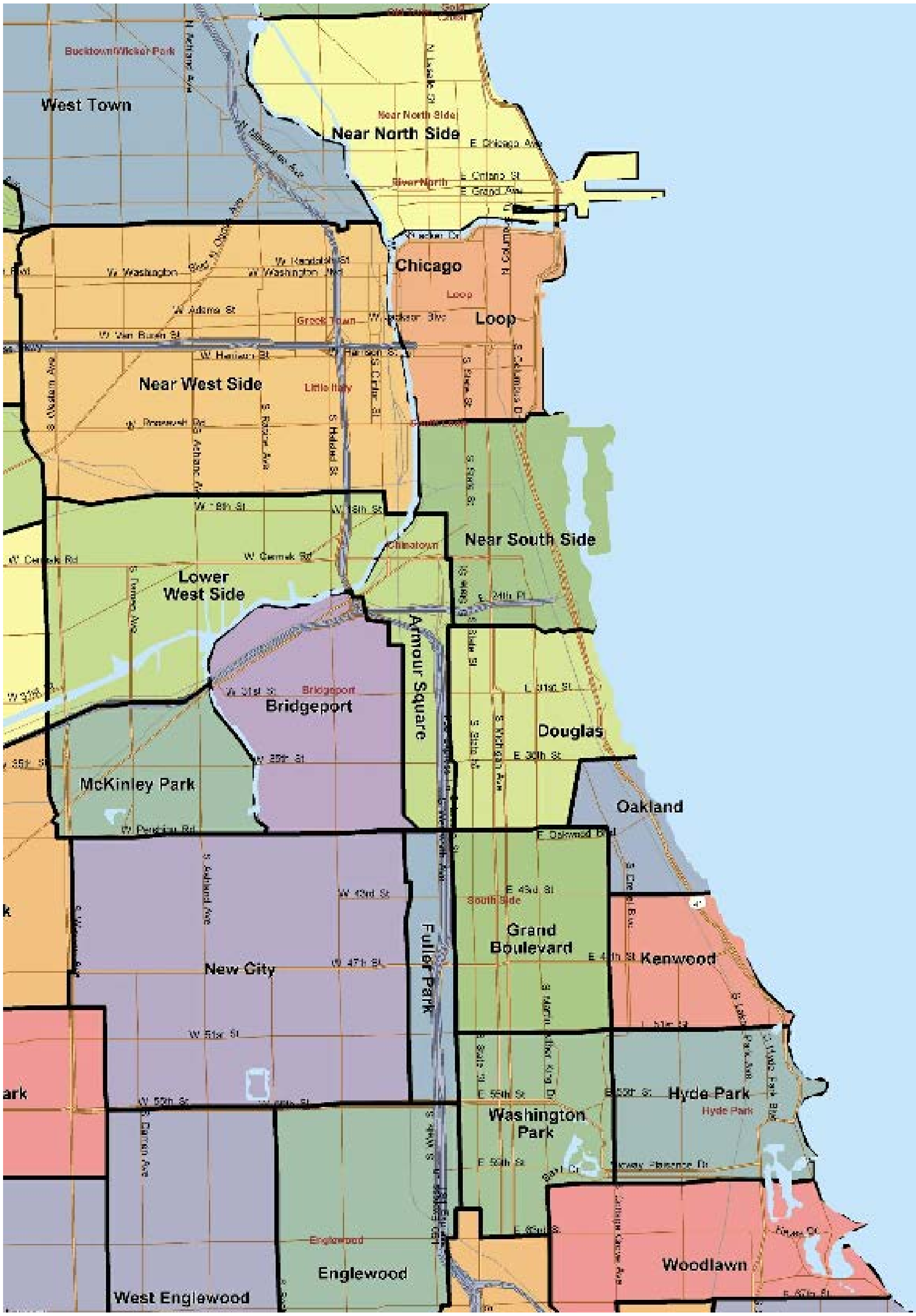
This beach is located at 7705 N Eastlake Terrace. The beach is one block long and has tennis courts. To the north is Juneway Terrace Beach, which is also in Rogers Avenue Beach and park. It is separated from Rogers's beach by riprap, which is protecting four homes.

Figure 4. Chicago Area Communities



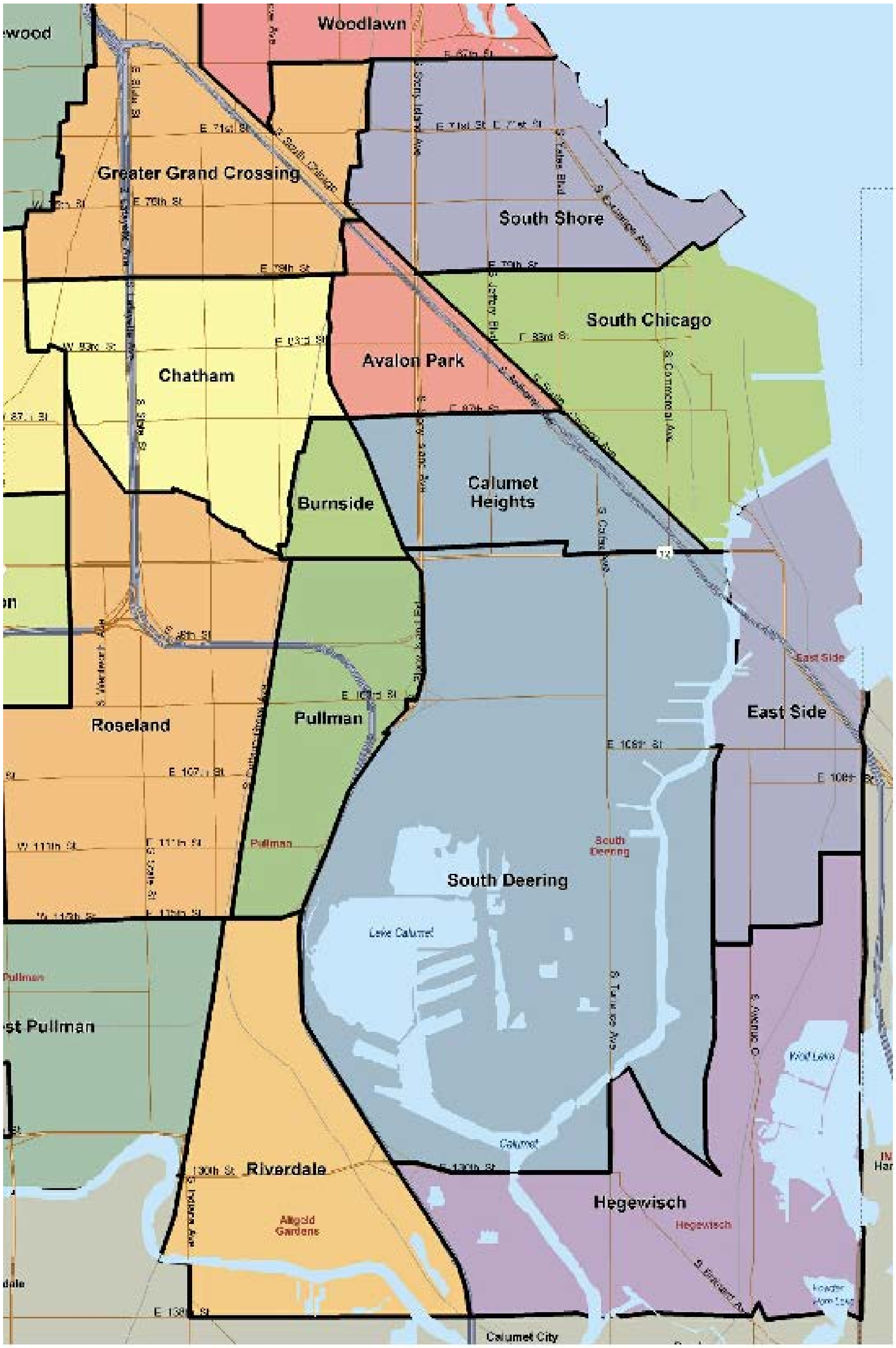
Source: Lucid Realty http://lucidrealty.com/images/Chicago_Neighborhoods.jpg

Figure 4 Chicago Area Communities- Continued



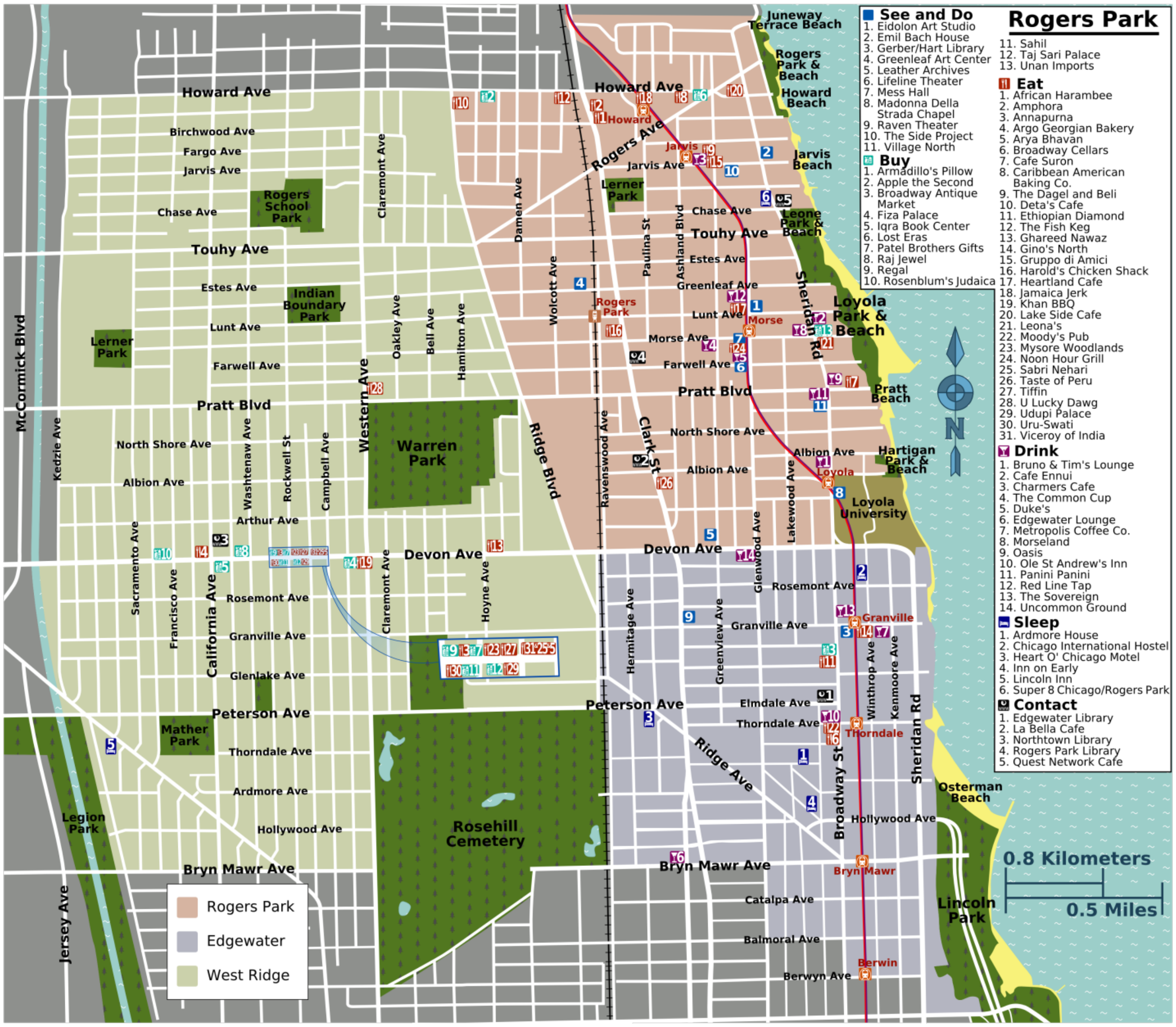
Source: Lucid Realty http://lucidrealty.com/images/Chicago_Neighborhoods.jpg

Figure 4 Chicago Area Communities- Continued



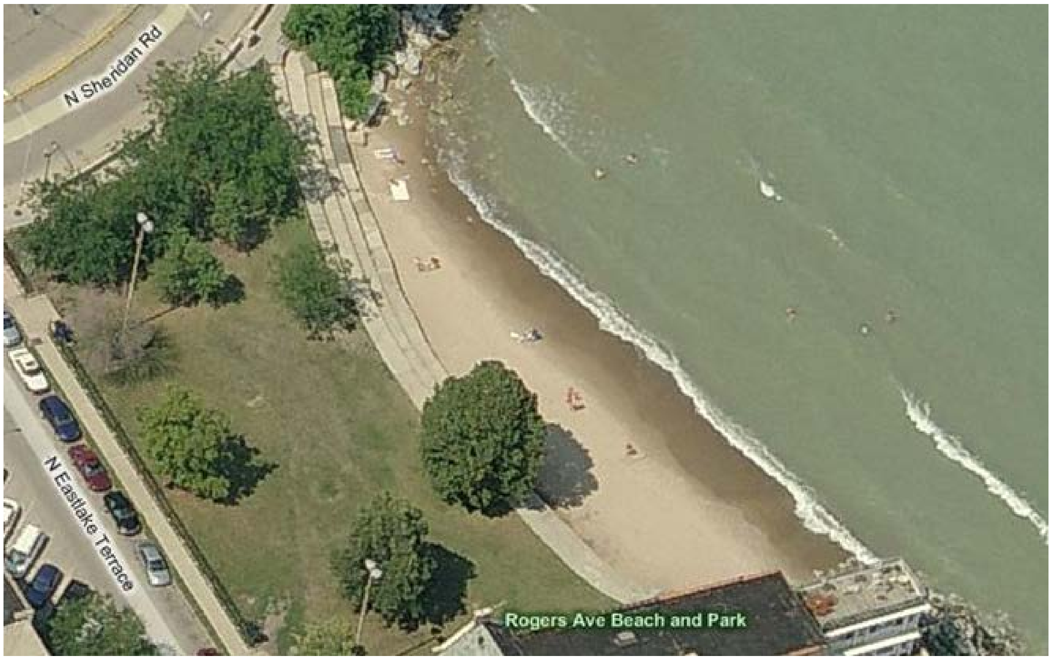
Source: Lucid Realty http://lucidrealty.com/images/Chicago_Neighborhoods.jpg

Figure 5. Rogers Park Community Map



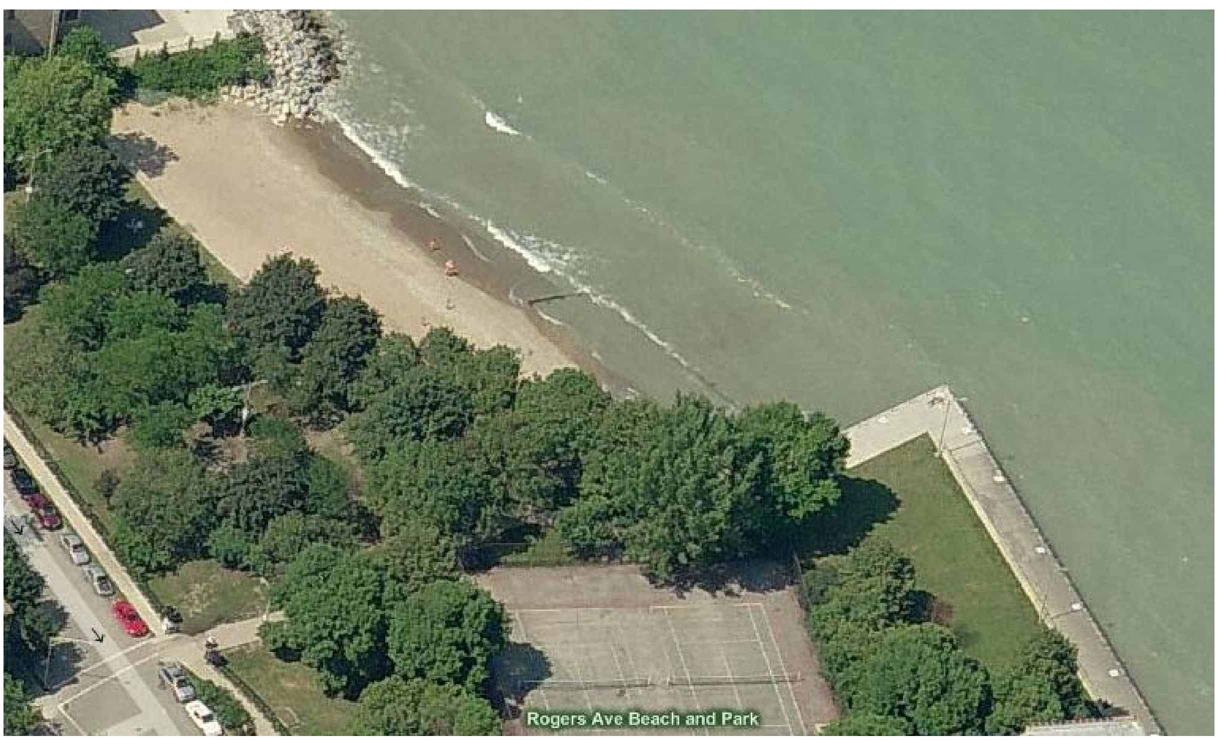
Source: WIKI Travel http://wikitravel.org/en/Chicago/Rogers_Park

Figure 6. Juneway Terrace Beach



Source: Bing Maps

Figure 7. Rogers Beach



Source: Bing Maps

3. Howard Beach

Howard Beach is in Howard St Park at 7519 North Eastlake Terrace (Figure 8). The street and beach are named after Howard Ure, a pioneer Rogers Park family. The Park offers off-street parking, a tree shaded park and a children's playground. The beach is separated from the park by a concrete ledge.

4. Jarvis Beach/Fargo Beach

Jarvis Beach is located in Jarvis Beach Park at 1208 West Jarvis Avenue (Figure 9). The street is named after R.J Jarvis, a friend of the Rogers and Touhy families. Fargo beach is located just north of Jarvis beach (1300 West Fargo Avenue). The beach and street is named after an active north side real estate developer in the late 1900's: James C. Fargo. Two stone groins offer wave protection and foster sand accumulation. There is off street parking but no restrooms or changing facilities.

5. Loyola/Leone Beach

This eight-block long beach is actually in two parks: Leone Park and Loyola Park (Figure 10). The beach stretches from W. Touhy Avenue on the north, to Pratt Avenue on the south. Leone Beach extends from W.Touhy Ave to W. Greenleaf Avenue, and includes a field house/converted water pumping station. Loyola Beach Park is 21.5 acres of land located next to Loyola University, and extends from W. Greenleaf Avenue south to W. Pratt Boulevard. Leone Beach is a training beach for lifeguards. This is one of the largest beach complexes in Chicago. The combined parks offer off street parking, softball diamonds, basketball courts, a wooden playground, tennis courts, sand volleyball courts, picnic grounds, a concession stand and a fishing pier.

6. Pratt Beach

Pratt Beach is located in Pratt Park, at 1050 W. Pratt Boulevard. It is located just south of Loyola Beach (Figure 11).

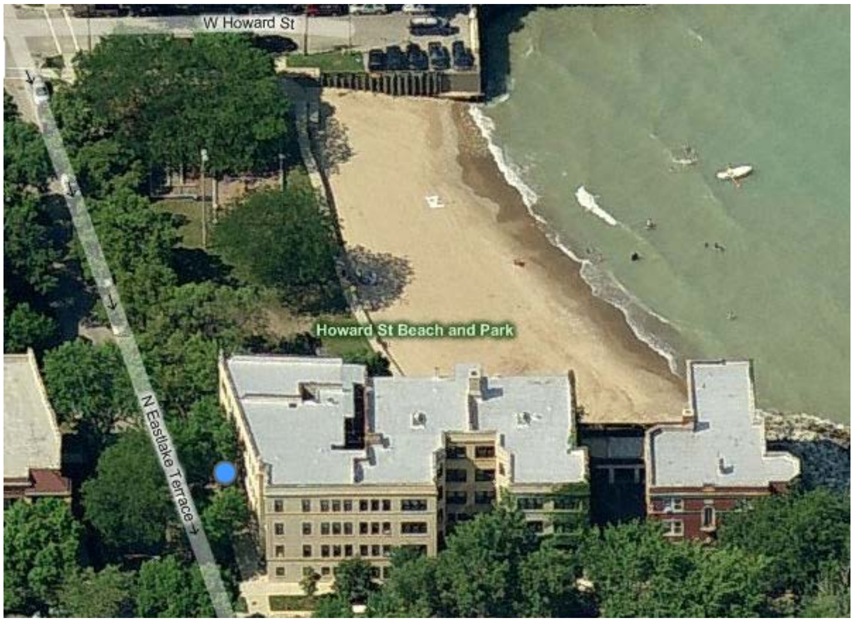
7. Columbia Beach

Columbia Beach is located in Columbia Park, at 1041West Columbia Avenue, just south of Pratt Beach (Figure 12).

8. Hartigan Beach

Hartigan Beach is located at 1050 W. Pratt Boulevard. Prior to 1965 it was known as Albion Beach and Park. The park has a playground and offers distance swimming parallel to the shore at Farwell pier Figure 13).

Figure 8. Howard Beach



Source: Bing Maps

Figure 9. Jarvis Beach

Source: Bing Maps

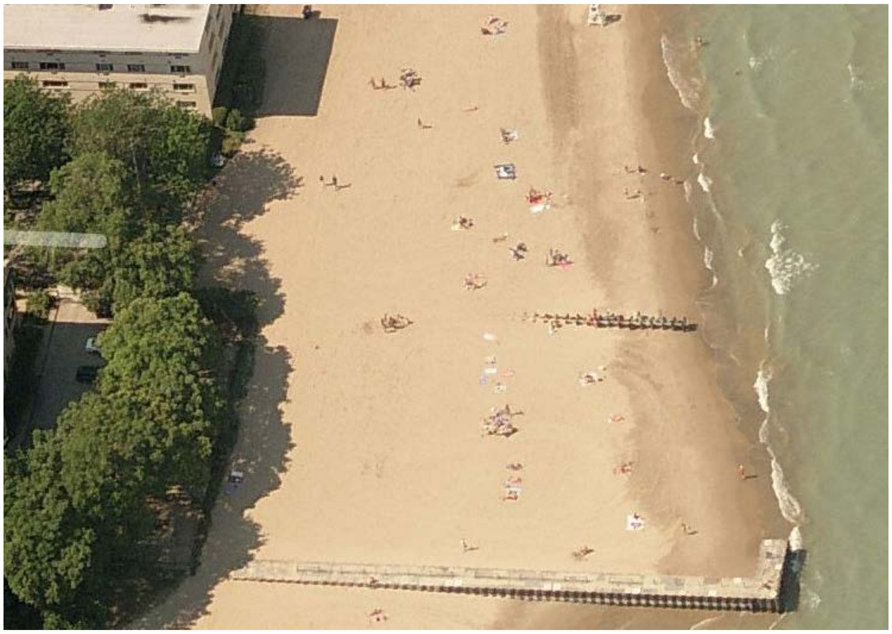
Figure 10. Loyola/Leone Beach

Source: Bing Maps

Figure 11. Pratt Beach

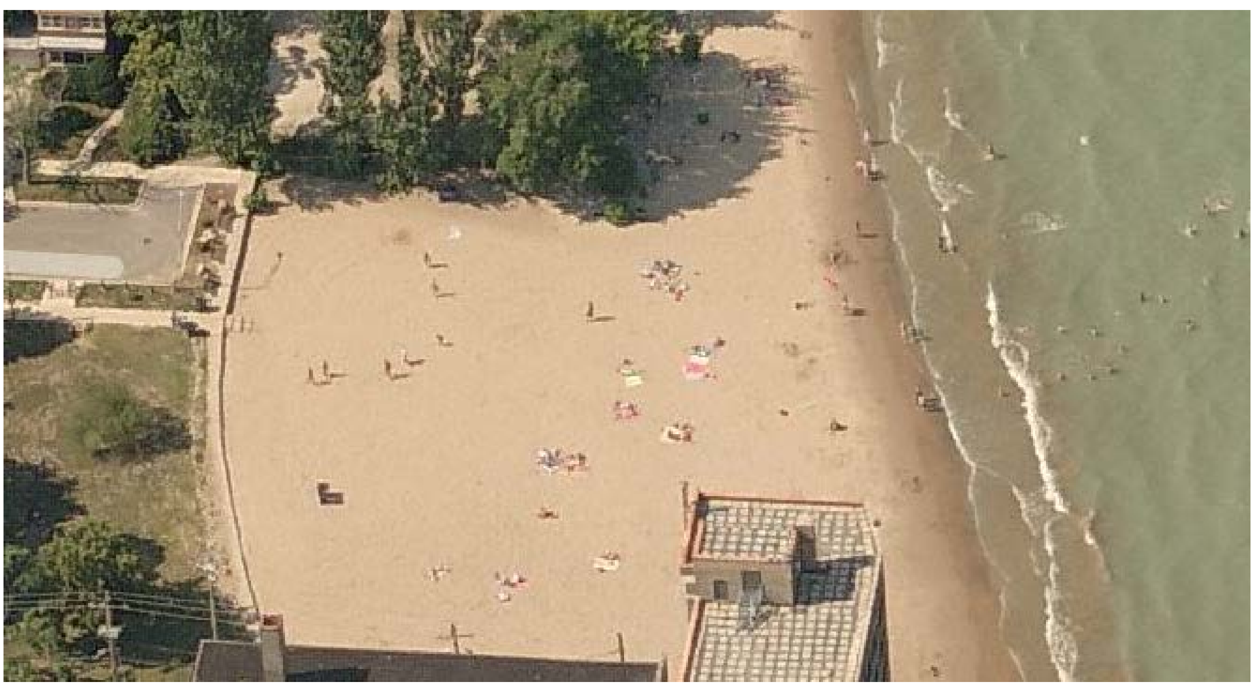
Source: Bing Maps

Figure 12. Columbia Beach



Source: Bing Maps

Figure 13. Hardigan Beach

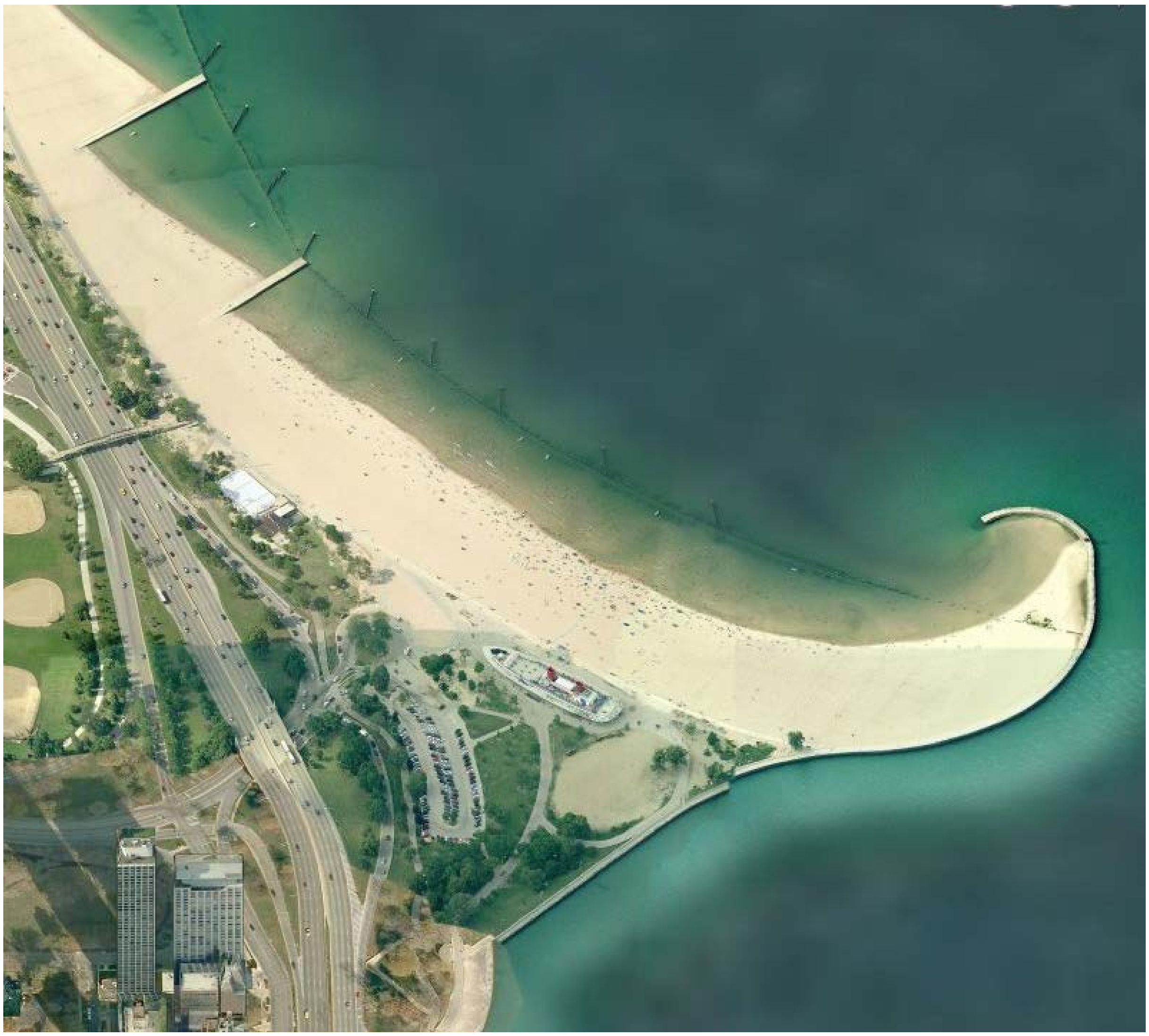


Source: Bing Maps

9. North Shore Beach

The North Shore Beach (North Avenue Beach) is located in Lincoln Park at 6700 North Lake Shore Drive and Shore Avenue. The park offers volleyball, biking, kayaking, paddle board and wake board rentals. The beach offers food concessions, restrooms and an ADA accessible beach walk. There is distance swimming at beaches 3 and 4, north of the boathouse. The North Avenue Beach House was opened in May 2000. The blue and white ocean liner inspired building houses the concessions and has an upper deck for viewing.

Figure 14. North Shore Beach

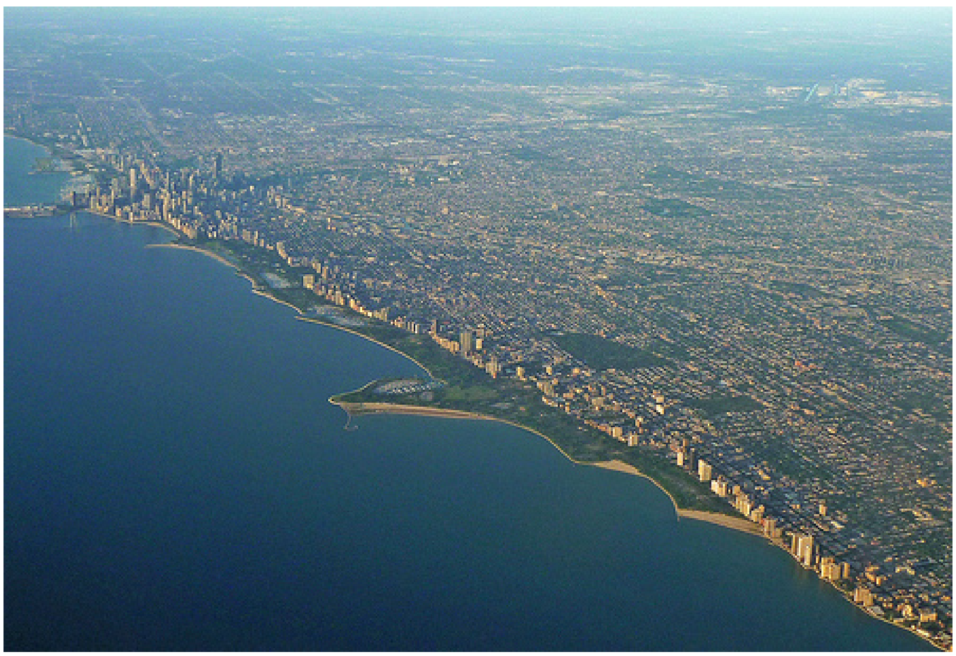


Source: Bing Maps

B. **Lincoln Park Beaches**

Lincoln Park is Chicago's largest public park at 1,208 acres. The park is seven miles long and is located between Ohio Street on its south border and Ardmore Avenue on its north border (Figure 15). The Park is located in the communities of Edgewater, Uptown and Lakeview. The park has a number of boating facilities; a zoo; the Lincoln Park Conservatory; the Chicago History Museum; numerous baseball, basketball, softball, soccer, tennis and volleyball facilities; and seven public beaches. The park has approximately 20m visitors per year.

Figure 15. Lincoln Park



Source: Wikimedia Commons http://www.flickr.com/photos/paytonc/3785616575/

1. George A. Lane Beach

The George A. Lane Beach (Thorndale Beach) is located in George Lane Park, in the Community of Edgewater, at 5934 North Sheridan Road, at the end of Thorndale Avenue. The beach (Figure 16) has a boardwalk ramp which allows wheelchair access. The beach is connected to the Kathy Osterman Beach (Hollywood Beach) to the south.

Figure 16. George A. Lane Beach

Source: Bing Maps

2. Kathy Osterman Beach

The Kathy Osterman Beach (Figure 17) is a crescent shaped beach located in Edgewater, at the 5800 north block, where Lake Shore Drive feeds into Sheridan Road. There is a beach house and concession stand, but no nearby parking lot. The northern half of the beach has shallow water, a long boardwalk ramp that allows shoreline access for strollers and wheelchairs.

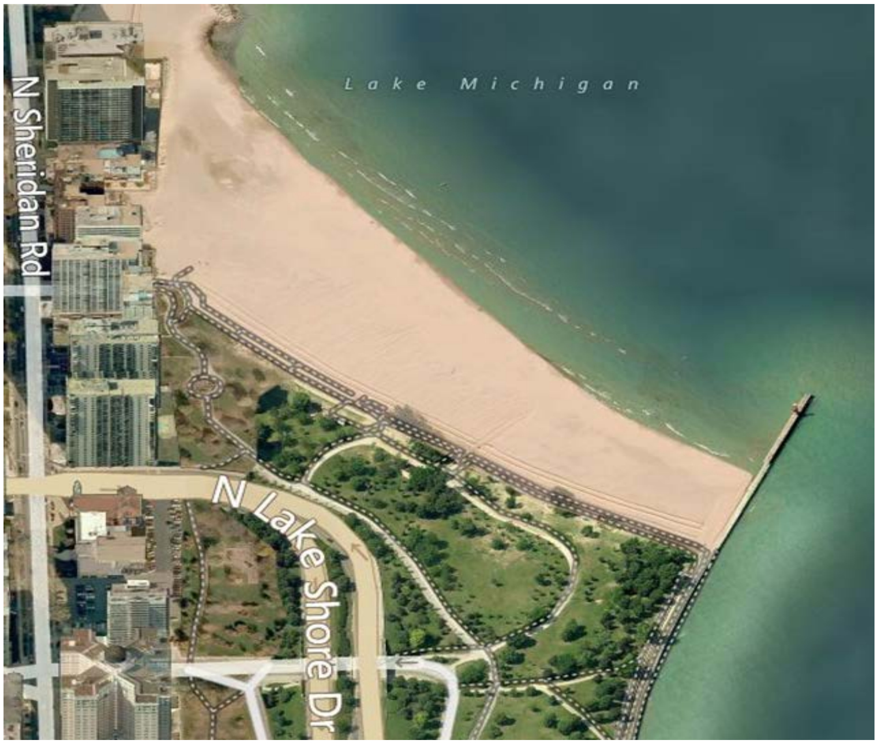
3. Foster Avenue Beach

Foster Avenue Beach, located at 5200 North Lake Shore Drive in Edgewater, is actually a landfill extension of Lincoln Park. The work started in 1947 and concluded in 1958. The beach has a beach house with amenities such as showers, restrooms, etc (Figure 18).

4. Montrose Avenue Beach

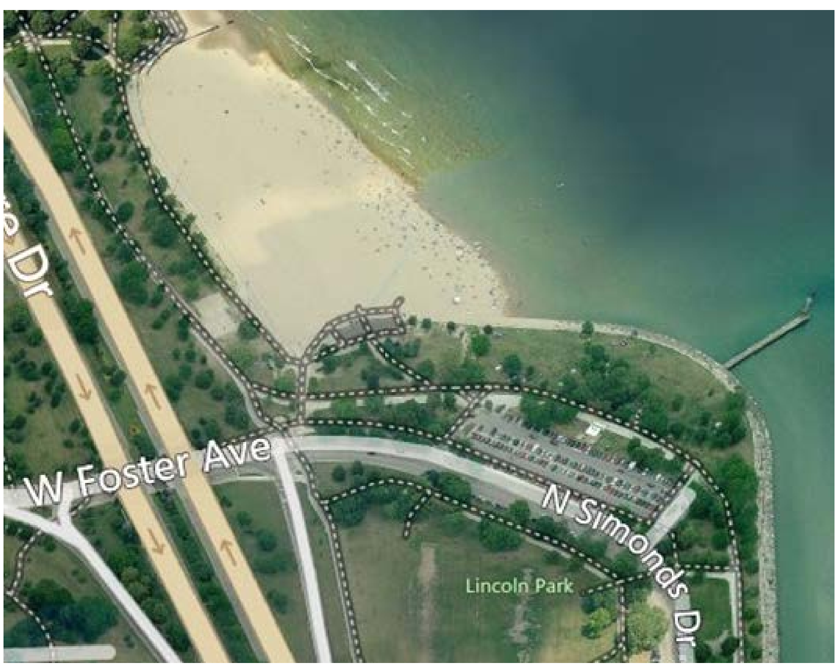
Montrose Beach (Figure 19) is located in Uptown, at 4400 North Lakeshore Drive, at Montrose Drive. It is Chicago's largest beach, with ample parking, and allows launching of non motorized watercraft, as well as offering a dog beach in its northern section. Its beach house, which looks like a lake steamer, has a full service restaurant, patio deck, restrooms, showers, an ADA accessible beach walk and distance swimming from Tower 4. Montrose small boat harbor is located south of the beach.

Figure 17. Kathy Osterman Beach



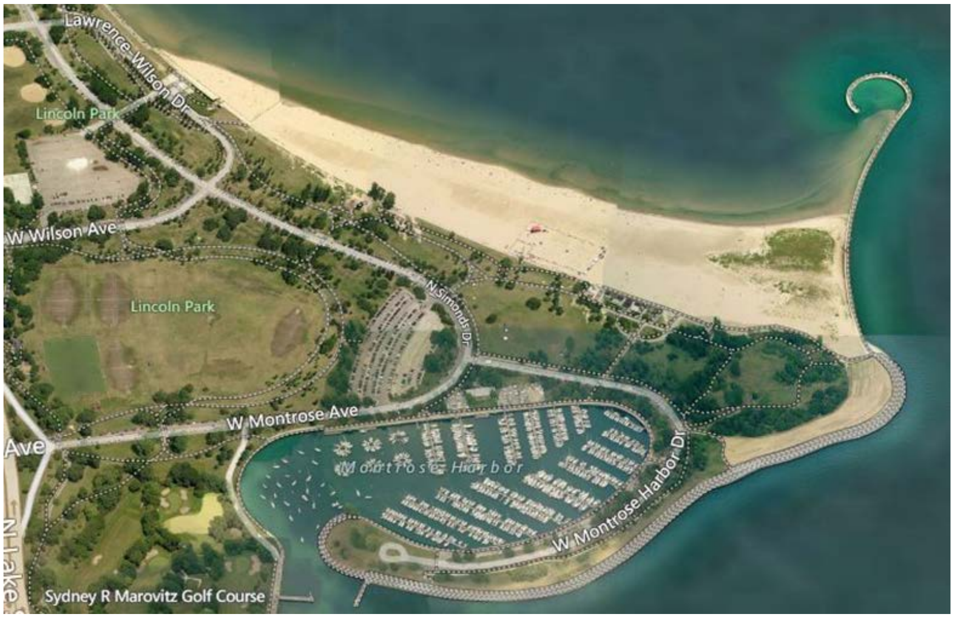
Source: Bing Maps

Figure 18. Foster Avenue Beach



Source: Bing Maps

Figure 19. Montrose Avenue Beach



Source: Bing Maps

5. North Avenue Beach

North Avenue Beach (Figure 20) is located at 1600 North Avenue, in the Lincoln Park neighborhood. The beach has a scalloped shoreline, formed by its sand holding piers. International volleyball tournaments are held here, and the beach is a prime viewing location for the Chicago Air and Water show. The beach's beach house, which looks like an ocean liner, offers a bar and restaurant, a concession stand, restroom and rentals of bikes and sports equipment.

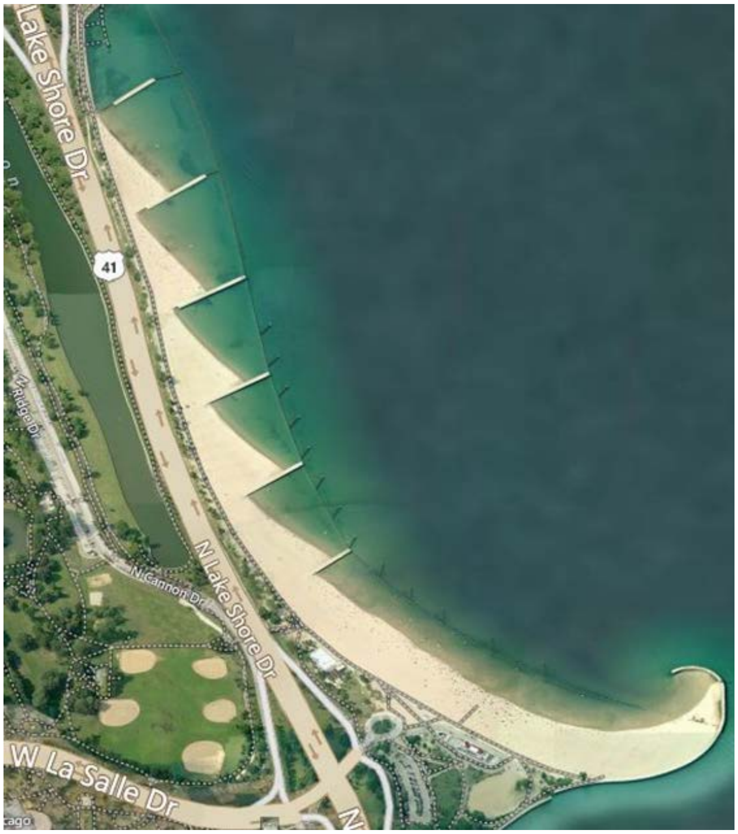
6. Oak Street Beach

Oak Street Beach (Figure 21) is located at 1000 North Lake Shore Drive. The beach extends from 1550 to 500 North Lake Shore Drive, is 1.5 miles long, and has about a half mile of deep water swimming, which is used by SCUBA divers. The park offers an outdoor restaurant and a chess pavilion.

7. Ohio Street Beach

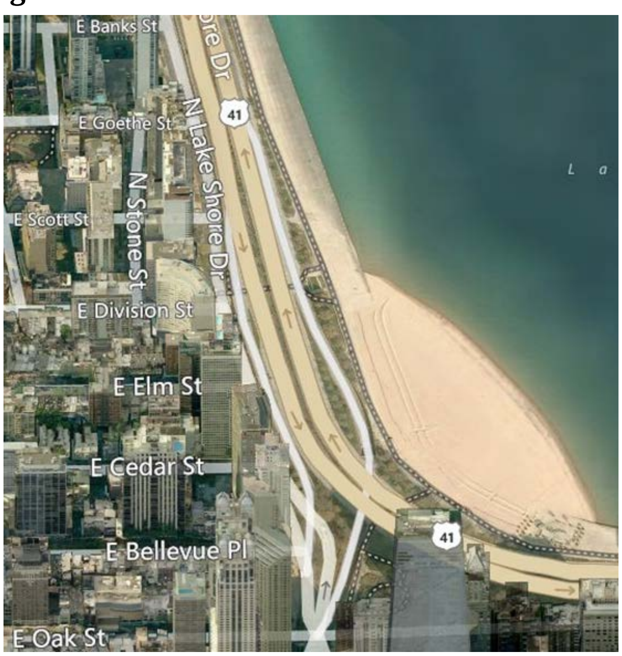
Ohio Street Beach (Figure 22) is just north of Ohio Street and borders the Jane Adams Memorial Park and Olive Park. The beach is unique in that it faces north, and is formed in a bay made by the Jardine Water Purification plant. The north oriented seawall provides a half mile of open lake swimming in relatively shallow water.

Figure 20. North Avenue Beach



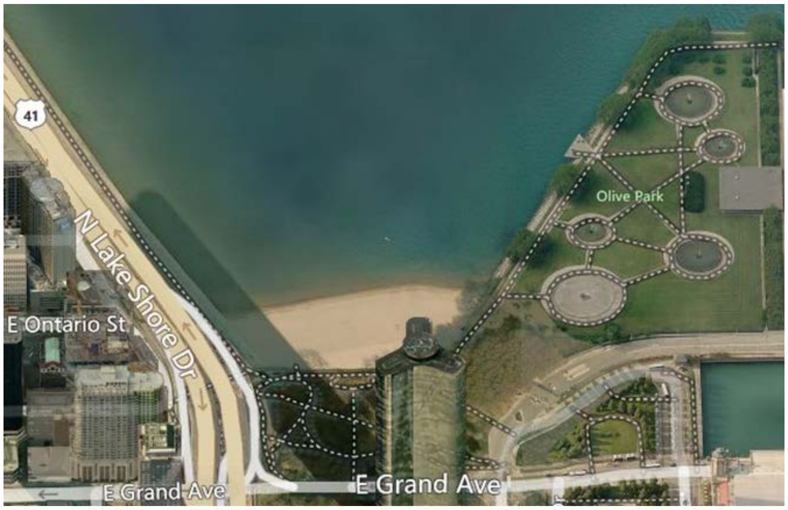
Source: Bing Maps

Figure 21. Oak Street Beach



Source: Bing Maps

Figure 22. Ohio Street Beach



Source: Bing Maps

C. **Burnham Park Beaches**

Burnham Park is 598 acres in size and runs from Jackson Park in the south to Grant Park in the north. The Park is six miles long and is located in the communities of Near South, Douglas, Oakland, Kenwood and Hyde Park (See Figure 4). The Park is named after Daniel M Burnham, the architect who developed the park plan for Chicago's lakefront land. The park contains Soldier Field, McCormack Place convention center, an all concrete skate park, two harbors (Burnham Harbor and 31st Harbor) which offer over 2,100 slips, and seven beaches

1. 12th Street Beach

The 12th Street Beach (Figure 23) is located at 1200 South Linn White Drive, on Northerly Island. The beach offers concessions, a beach house with restrooms, an accessible beach walk, a non motorized boat launch, and distance swimming located parallel to the shoreline.

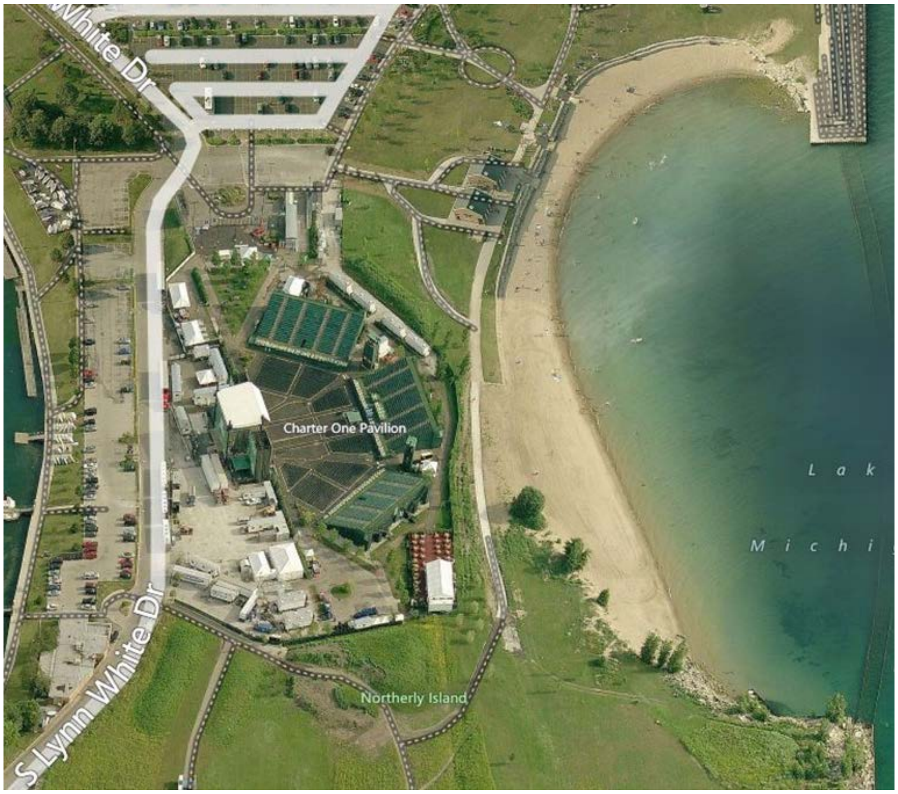
2. 31st Street Beach

The 31st Street Beach (Figure 24) is located at 3100 South Lakeshore Drive, in Burnham Park. The beach house has food and restrooms, an accessible beach walk, and distance swimming from the pier to the tower.

3. Oakwood/41St. Beach

This beach is located at 4100 South Lake Shore Drive (Figure 25). The beach opened in 2010 and offers food concessions, restrooms and an ADA accessible beach walk. Distance swimming is available parallel to the shoreline.

Figure 23. 12th Street Beach



Source: Bing Maps

Figure 24. 31st Street Beach

Source: Bing Maps

Figure 25. Oakwood/41st Street Beach

Source: Bing Maps

4. 49th Street Beach

The 49th Street Beach (Figure 26) is a small stone beach with no swimming, located at **4900** South Lakeshore Drive.

5. 57th Street Beach

The 57th Street Beach (Figure 27) is located at 5700 South Lakeshore Drive in Jackson Park, in the Hyde Park community. The beach has food concessions, restrooms, an ADA accessible beach walk and distance swimming parallel to the shore. Limited street parking is available.

D. **East 63rd St. Beach**

The E. 63rd Street Beach (Figure 28) is located at 6300 South Lakeshore Drive in the Jackson Park community. The beach includes a historic beach house with restrooms, showers, food concessions and meeting rooms. There are bike rentals and a non-motorized boat launch. There is an ADA accessible beach walk and long distance open lake swimming between buoys one and three.

Figure 26. 49th Street Beach

Source: Bing Maps

Figure 27. 57th Street Beach

Source: Bing Maps

Figure 28. 63rd Street Beach

Source: Bing Maps

E. **South Shore Beaches**

The South Shore community stretches from E67th to E. 79th Street. This community has much shoreline property that currently is not open to the public. Plans for new parks, beaches and public access have been proposed by Chicago lakeside development. These plans would provide a waterfront bicycle and jogging path that would link Calumet Park and Beach to the South Shore Cultural Center in South Shore.

1. South Shore Beach

The South Shore Beach (Figure 29) is located at 7059 S. South Shore Drive, near 71st Street, in the South Shore community. It is located behind the South Shore Cultural Center, which is the former South Shore Country Club. The building is on the National Historic Register and has a ballroom, restaurant, Paul Robeson Theater, and the Washburn Culinary Institute. The 64.5 acre park has a nine-hole golf course, tennis courts, green spaces for picnics and walks, and the beach.

Figure 29. South Shore Beach

Source: Bing Maps

2. Ashe Beach

Ashe Beach (Figure 30) is located in Ashe Park, at 2701 E. 74th Street, between 74th and 75th Streets in the South Shore Community. The park, founded in 1979, was renamed in 1993 after tennis star Arthur Ashe offers community gardens, a playground, two tennis courts and the beach.

3. Rainbow Beach

Rainbow Beach (Figure 31) is officially located at 3111 E. 77th Street (2873 E 75th Street), in Rainbow Park, in the South Chicago Neighborhood. The 61 acre park runs from 75th to 78th Street and offers a fitness center, gymnasium, which hosts after school programs and youth and adult fitness classes. The park has comfort stations, basketball/tennis/handball courts, baseball diamonds and two playgrounds.

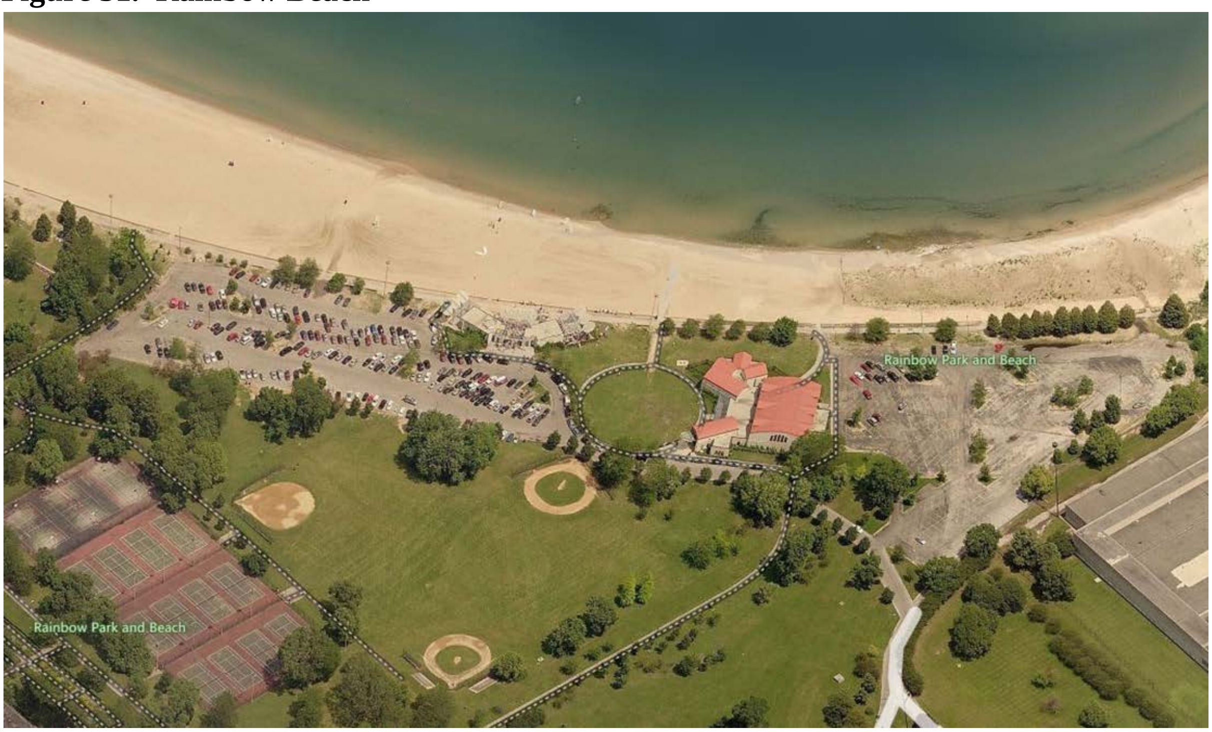
F. Calumet Park Beaches

Calumet Park (Figure 32), located in the East Side neighborhood, has three beaches located at 9600, 9800, and 9900 blocks of South Avenue G. The 199 acre park has a fitness center, two gymnasiums, a gymnastics center and sewing and upholstery studios. The park has picnic groves, softball, football and soccer fields, a boat launch and a beach. There is a beach house and concession stand, restrooms, an ADA accessible beach walk, and distance swimming.

Figure 30. Ashe Beach

Source: Bing Maps

Figure 31. Rainbow Beach



Source: Bing Maps

Figure 32. Calumet Park Beaches

Source: Bing Maps

V. NEW BEACHES

There are indications that a number of new beaches could possibly come into existence between 2012 and the project evaluation year 1, 2017. Out of the 26 miles of Chicago Lakefront, about 2 miles on the south lakefront and 2 miles on the north lakefront remain undeveloped, unconnected and blocked from public use. A number of new beach initiatives have arisen, such as: *The Last Four Miles: A Plan to Complete Chicago's Lakefront Parks*" in 2009 by the Friends of the Parks. The Last 4 Miles Plan will now be discussed.

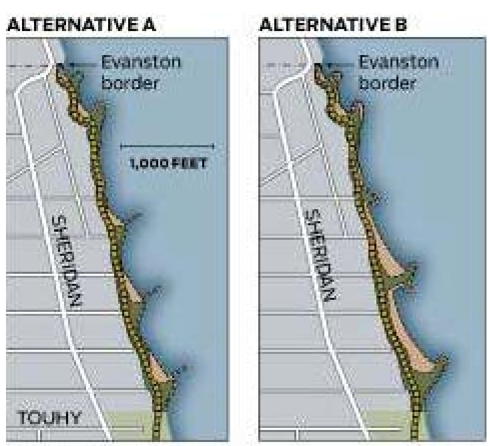
A. **The Last Four Miles Plan by the Friends of the Parks.**

The Friends of the Parks is a nonprofit Chicago organization whose mission is to preserve, protect, improve, and promote the use of parks and preserves in the city of Chicago. They started identifying expansion plans in 2006. Through a series of public meetings and charettes, over a number of years, "A Plan to Complete Chicago's Lakefront Parks" was published in 2009. The plan called for the construction of 100 acres of new parks and beaches on the north lakefront, and 400 acres of new parks and beaches on the south lakefront. This plan was developed to accommodate a trail along the entire city shoreline. It also identified the need for building new aquatic and wildlife habitat that benefit Lake Michigan's ecosystem. The key components of this plan will now be discussed.

1. City Limits to Touhy Avenue

The plan for the area from the city limits to Touhy Avenue is to build 70 to 111 acres of parks and beaches. A strip of parkland would be built east of the current beaches that would provide a continuous link for the multiple end-street beaches in this area.

Figure 33. City Limits to Touhy Avenue



Source: Chicago Tribune:
http://featuresblogs.chicagotribune.com/.a/6a00d834518cc969e2011570e5a1ac970b-popup

2. Farwell Avenue to Ardmore Avenue

The first concept plan would create 53 acres of new parkland, which would include the expansion of Berger Park, and the creation of three new beaches. The lakefront path would be continued from Hollywood to Loyola Beach Park. The second concept plan would create 82 acres of beaches and parks between Lane Beach and Berger Park**.**

Figure 34. Farwell Avenue to Ardmore Avenue

Source: Chicago Tribune:

3. 71st Street to 75th Street

This area would have 23 to 40 acres of new parks and beaches. The lakefront trail would be relocated to the east of its existing location.

Figure 35. 71st Street to 75th Street.

Source: Chicago Tribune:

4. 79th Street to Calumet Park

This area would have 139 acres of new parks and beaches at the former U.S. Steel site located between 79th and 91st Streets. This site also has a private developer creating 95 acres of beaches/parklands. The plan also calls for the development of 140 acres of parkland at 95th Street, on former steel mill land just north of Calumet Park, at Iroquois Landing.

Figure 36. 79th Street to Calumet Park

Source: Chicago Tribune:

VI. **HISTORICAL PARK USAGE**

The value of a beach day was determined by the University Of Chicago in 2004-2005 by surveying 1,500 Chicago beach users in 2004. The study indicated that the value of a day at the beach was placed at $35. There were over 20m beach visits in 2004. The total value of the 2004 beach season was placed at $800,000,000. It is estimated that the 2004 season lost $17m of beach value due to beach closings (i.e. swimming bans due to poor lake water quality). This is a conservative estimate since the survey only considered respondents who stated they would not visit the beach if there was a swimming ban in effect.

VII. **ADDITIONAL INFORMATION**

The data for this report was derived from a variety of sources. The primary source of the data was taken from the Chicago Park District Web page. Beach descriptions were obtained from Wikipedia. Chicago neighborhood maps came from Lucid Reality. Most aerial photos were from Bing maps. Information on individual beaches came from various internet sites. A summary of the websites visited are provided in the Addendum.

ADDENDUM

This addendum summarizes the Web sites used to obtain information for the various sections of the report.

Sources

Parks/Beaches in General

Chicago Park District Web Page
http://www.cfmstage.com/beach-report/beach-report-list.cfm

Beach Descriptions from North to South
http://en.wikipedia.org/wiki/Beaches_in_Chicago

Chicago Neighborhood Maps
http://www.dreamtown.com/maps/chicago-neighborhood-map.htm

Listing of all Beaches, North to South
http://www.hearplanet.com/article/948417

Community Neighborhood Maps

http://loftchicago.com/map.php

http://rosesmodernworld.wikispaces.com/file/view/Chicago-Neighborhoods-Map.jpg/222655258/Chicago-Neighborhoods-Map.jpg

http://lucidrealty.com/images/Chicago_Neighborhoods.jpg

Bing Maps

http://www.bing.com/maps/?FORM=MLOMAP&PUBL=GOOGLE&CREA=userid1743gobroadfphumem2khvlw7ml8dkb3h3kcgsoxz1369#JnE9Lndlc3QlMmJjb2x1bWJpYSUyYmNoaWNhZ28lN2Vzc3QuMCU3ZXBnLjEmYmI9NDIuMDA3MTAwOTM0OTIyMSU3ZS04Ny42NTI4NjM1NDg5MDQ0JTdlNDEuOTk4MDUyMzg4MjM5NCU3ZS04Ny42NjI3OTg0NTEwOTU2

Individual Parks/Beaches

A. Rogers Park Community
http://en.wikipedia.org/wiki/Rogers_Park,_Chicago
http://www.dreamtown.com/neighborhoods/east-rogers-park.html

1. Rogers Park Beach
http://www.chicagoparkdistrict.com/parks/Rogers-Beach-Park/
http://wikitravel.org/en/Chicago/Rogers_Park

2. Howard Beach
http://www.chicagoparkdistrict.com/parks/Howard-Beach-Park/

3. Jarvis Beach Park
http://www.chicagoparkdistrict.com/parks/Jarvis-Beach-and-Park/

4. Fargo Beach Park
http://www.chicagoparkdistrict.com/parks/Fargo-Beach-Park/

5. Leone/Loyola Park Beach
http://www.chicagoparkdistrict.com/parks/Leone-Beach-Park/
http://chicago.metromix.com/venues/mmxchi-loyola-leone-beach-venue
http://specialsections.suntimes.com/lifestyle/parenting/13968024-555/top-5-kid-friendly-beaches.html
http://www.chicagoparkdistrict.com/parks/Loyola-Park/

6. Pratt Beach- South of Loyola Leone Beach

7. Columbia Beach
http://www.chicagoparkdistrict.com/parks/Columbia-Beach-Park/
http://beaches.findthebest.com/l/641/Columbia-Beach

8. Hardigan Beach
http://www.chicagoparkdistrict.com/parks/Hartigan-Beach-Park/

9. North Shore Beach

http://www.cfmstage.com/beach-report/beach-report-detail.cfm?objectid=14
North Avenue Beach House
http://www.chicagoparkdistrict.com/parks/north-avenue-beach/

B. Lincoln Park Beaches
http://en.wikipedia.org/wiki/Lincoln_Park,_Chicago
http://en.wikipedia.org/wiki/Lincoln_Park
http://en.wikipedia.org/wiki/Chicago_beaches#Lincoln_Park_Beaches

1. Thorndale Beach
http://en.wikipedia.org/wiki/Chicago_beaches#Lincoln_Park_Beaches

2. Kathy Osterman Beach
http://timeoutchicago.com/things-to-do/35421/beachy-keen

3. Foster Avenue Beach

4. Montrose Avenue Beach

http://www.cfmstage.com/beach-report/beach-report-detail.cfm?objectid=13

5. North Avenue Beach

6. Oak Street Beach
http://en.wikipedia.org/wiki/Oak_Street_Beach
http://www.explorechicago.org/city/en/things_see_do/attractions/park_district/oak_street_beach.html
7. Ohio Street Beach

C. Burnham Park

http://en.wikipedia.org/wiki/Burnham_Plan
http://en.wikipedia.org/wiki/Burnham_Park_(Chicago)

1. 12th Street Beach
http://www.chicagoparkdistrict.com/parks/12th-street-beach/

2. 25/26th Street Beach

3. 31st Street Beach
http://www.chicagoparkdistrict.com/parks/31st-street-beach/

4. Oakwood/41st Street Beach
http://www.chicagoparkdistrict.com/parks/oakwood-41st-street-beach/

5. 49th Street Beach
http://en.wikipedia.org/wiki/Chicago_beaches#Burnham_Park_Beaches

6. 57th Street Beach
http://www.chicagoparkdistrict.com/parks/57th-street-beach/
http://en.wikipedia.org/wiki/Chicago_beaches#Burnham_Park_Beaches

D. 63 rd Street Beach

http://www.cfmstage.com/beach-report/beach-report-detail.cfm?objectid=21

E. South Shore Beaches

http://en.wikipedia.org/wiki/South_Shore,_Chicago

1. South Shore Beach
http://en.wikipedia.org/wiki/Chicago_beaches#Burnham_Park_Beaches
http://www.chicagoparkdistrict.com/parks/South-Shore-Cultural-Center/

2. Ashe Beach
http://en.wikipedia.org/wiki/Beaches_in_Chicago#31st_Street_Beach
http://www.chicagoparkdistrict.com/parks/Ashe-Beach-Park/
http://books.google.com/books?id=wcWDW9p8wdYC&pg=PT82&lpg=PT82&dq=ashe+beach+park&source=bl&ots=ZJ4Sxz6Sb0&sig=UXR8bUS-2iz7LhqN1VjcItzyvfw&hl=en&sa=X&ei=9QbGUOO0C-bO2QWB8YHICA&ved=0CG4Q6AEwDTgK

3. Rainbow Beach
http://www.cfmstage.com/beach-report/beach-report-detail.cfm?objectid=23
http://en.wikipedia.org/wiki/Chicago_beaches#Burnham_Park_Beaches

F. Calumet Park Beaches

http://books.google.com/books?id=wcWDW9p8wdYC&pg=PT82&lpg=PT82&dq=ashe+beach+park&source=bl&ots=ZJ4Sxz6Sb0&sig=UXR8bUS-2iz7LhqN1VjcItzyvfw&hl=en&sa=X&ei=9QbGUOO0C-bO2QWB8YHICA&ved=0CG4Q6AEwDTgK
http://en.wikipedia.org/wiki/Chicago_beaches#cite_ref-EOCW_1-3
http://www.chicagoparkdistrict.com/parks/Calumet-Park/

Beach Expansion

http://fotp.org/wp-content/uploads/2011/01/FOTP_Nov_8.pdf
http://www.ilapa.org/news/2010/Jan10/miles.html
http://fotp.org/programs/the-last-four-miles-completing-chicagos-lakefront-park-system/last-4-miles

Beach Visitation

http://www.beachapedia.org/State_of_the_Beach/State_Reports/IL/Beach_Access
http://www.glin.net/lists/beachnet/2006-02/msg00004.html

Beaches North to South

1. Juneway Terrace In Rogers Avenue Beach And Park 7800 North & Lake Michigan
2. Rogers Beach In Rogers Avenue Beach And Park 7705 North
3. Howard Beach Howard St Beach & Park 7600 North
4. Jarvis Beach 7400 North
5.Fargo Beach 7432 North
6. Loyola/Leone 8 blocks Chicago's largest 7032 North Sheridan
7.Pratt Beach 1050 West Pratt Blvd
8. Hartigan Beach 6800 North of Loyola Ave
9. Columbia Beach 6727 North
10. North Shore Beach 6700 North
11. Thornedale Beach 5934 North
12. Kathy Osterman (Hollywood) 5800 Block Lake Shore Drive, Sheridan Road
13. Foster Avenue Beach 5200 North
14. Wilson Ave 4600 North
15. Montrose Beach - dog beach 4400 North
16. North Avenue Beach Premier beach 1600 North
17. Humboldt Park Beach A lagoon in Humboldt Park
17. Oak Street Beach deep water swimming 1000 North
18. Ohio St Beach In Olive Park 400 North E of Lake Shore Drive
19. 12th Street Beach On Northerly Island
20. 25/26 Street Beach- no longer extant
21. 31st Street Bridge In Burnham Park 31st Street
22. 49th St Beach Stone beach in Burnham Park, no swimming
23. 57th Street Beach In Hyde Park neighborhood 2 large underpasses 57th street. Deep swimming south of promontory point
24. 63rd Street Beach largest and oldest beach house 63rd St.
25. 67th St Beach in Jackson Park probably same as 63rd St Beach 67th Street
25. South Shore Beach behind South Shore Cultural Center 71st & South Shore Drive
26. Ashe Beach 74th &75th street
27. Rainbow Beach- from 75th to 77th street 3111 E. 77th St

ATTACHMENT 10

WATER SUPPLY

Baseline Economic Assessment of Water Supply in the Chicago Area

August 2013

Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

GREAT LAKES MISSISSIPPI RIVER INTERBASIN STUDY (GLMRIS)
BASELINE ASSESSMENT OF WASTER SUPPLY IN THE CHICAGO AREA

Contents

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I. EXECUTIVE SUMMARY

In support of the Great Lakes and Mississippi River Interbasin Study (GLMRIS), several alternative plans were developed which seek to prevent the transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River Basins. As a result of implementation of a GLMRIS project (i.e., the future with-project condition) or lack thereof (i.e., the future without-project condition), water usage within the Chicago Area Waterway System (CAWS) may change. In order to address these potential changes, this assessment establishes a baseline of water use for water originating from Lake Michigan, diverted via cribs along the Illinois shoreline, and distributed to users in the Chicago Area. As communities and water users often rely on more than one source of water, and may rely more heavily on water diverted from Lake Michigan in the future, water use in Northeast Illinois as a whole is also examined.

II. GLMRIS STUDY INFORMATION

A. Introduction

An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (2010).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River by aquatic pathways. In this context, the term "prevent" includes the reduction of risk to the maximum extent possible, because it may not be technologically feasible to achieve an absolute solution. As part of this study, USACE will conduct a detailed analysis of various ANS controls, including hydrologic separation.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

B. GLMRIS Study Area

The GLMRIS study area includes portions of the Great Lakes and Mississippi River basins that fall within the United States.

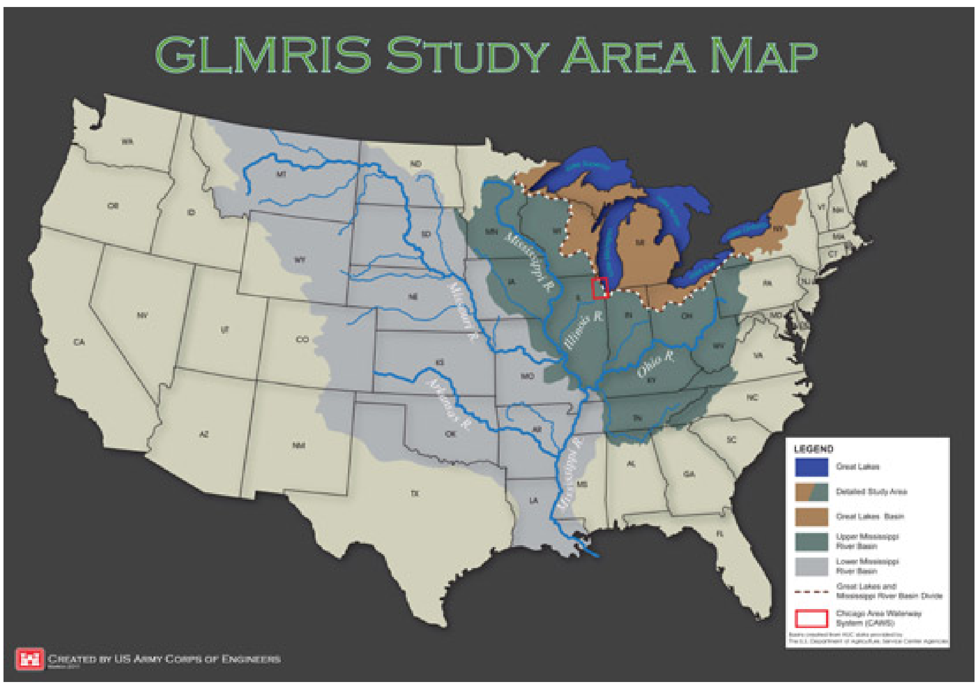

Figure 1. GLMRIS Study Area Map

Potential aquatic pathways between the Great Lakes and Mississippi River basins exist along the basins' shared boundary (illustrated as “” in Figure 1). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi Basin ( ) and the Great Lakes Basin ( ). See Figure 1.

Future ANS may transfer beyond the *Detailed Study Area*; this pattern was observed by the spread of zebra mussels, which originated in the Great Lakes and spread throughout the Mississippi River Basin. Therefore, the *General Study Area* encompasses the lower Mississippi

River Basin ( ). While the majority of GLMRIS tasks will be completed within the *Detailed Study Area*, USACE will consider specific ANS impacts in the larger *General Study Area*.

a. GLMRIS Focus Areas

The U.S. Army Corps of Engineers is conducting GLMRIS along two concurrent tracks: Focus Area I, the Chicago Area Waterway System (CAWS), and Focus Area II, Other Pathways.

(1) Chicago Area Waterway System (CAWS)

Focus Area I, the Chicago Area Waterway System, as shown in the map below, is the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins and, therefore, poses the greatest potential risk of aquatic nuisance species (ANS) transfer between the basins, via an aquatic pathway.

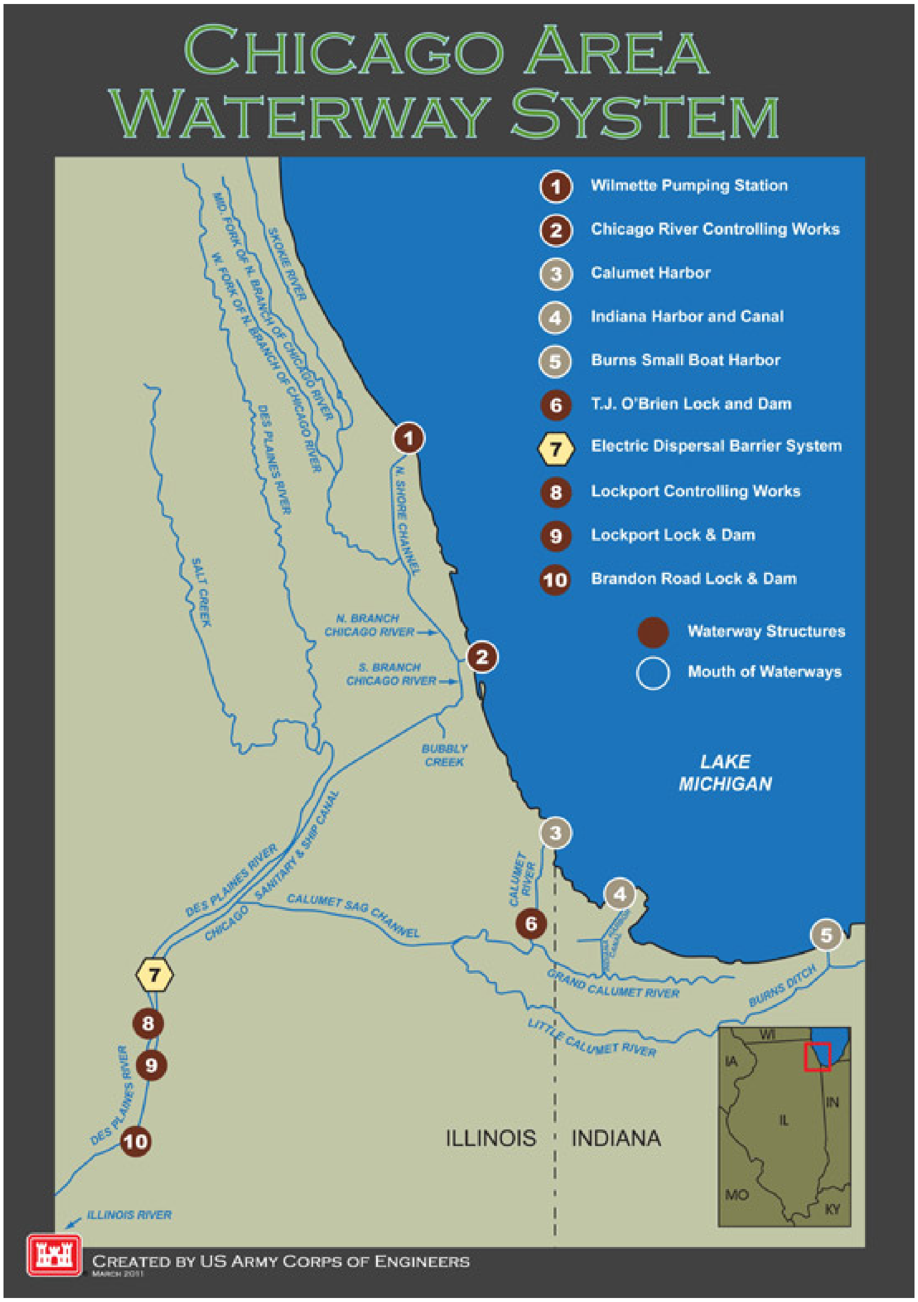

Figure 2. Chicago Area Waterway System

(2) Other Pathways

Focus Area II addresses remaining aquatic pathways. For this focus area, the U.S. Army Corps of Engineers completed a document entitled *Other Pathways Preliminary Risk Characterization Report* that identified other potential aquatic pathways outside of the Chicago Area Waterway System, as well as included a screening-level assessment of potential ANS that may transfer via these connections.

As shown on the *Other Pathways* map below, 18 potential aquatic pathways have suggested that there is significant uncertainty about the relative risks of ANS transfer. Eagle Marsh, located in Fort Wayne, Indiana was identified as having the highest potential risk of ANS transfer. The Indiana Department of Natural Resources has implemented interim measures to mitigate this risk, and USACE is further studying this pathway to determine whether a long-term ANS control should be implemented. For the remaining 17 sites, USACE is coordinating further study to finalize the risk characterization and determine whether ANS controls are recommended.

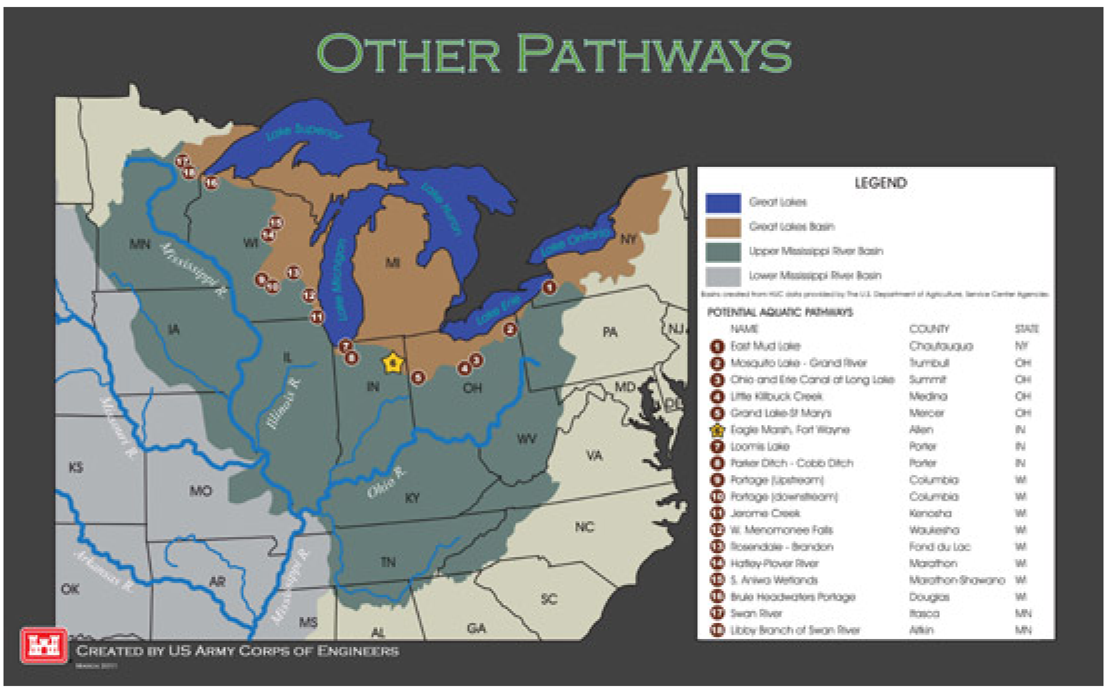

Figure 3. Other Pathways Map

III. REVIEW OF REPORTS AND PLANNING EFFORTS

The information presented in this assessment is not based on original analysis or primary data collection; it is derived from several interconnected reports examining the region's water resources, demands and future needs. This assessment recognizes significant forethought, planning and cooperation already underway by a large group of vested stakeholders in Northeast Illinois. For the sake of brevity, the facts, findings and excerpts from these reports are used liberally throughout this assessment.

The year 2005 is used as a base year throughout much of this assessment, as it is used in both the *Demand Report* and the *Findings of the Sixth Technical Committee.* Future conditions are projected as far as 2050, as they are in both the *Demand Report* and the *Groundwater Report*.

Executive order 2006-1, Issued in January 2006 by Governor Rod Blagojevich, called for the creation of the Northeast Illinois Regional Water Supply Planning Group (RWSPG) with the purpose:

> *To consider the future water supply needs of northeastern Illinois and develop plans and programs to guide future use that provide adequate and affordable water for all users, including support for economic development, agriculture, and the protection of our natural ecosystems.*

The Chicago Metropolitan Agency for Planning (CMAP) guided formation of the RWSPG, a 35-member grassroots water supply planning group for northeastern Illinois, charged with the task of developing water supply planning and management recommendations for the region. The 11-county northeastern Illinois region was identified as a priority planning area due to the degree of population growth occurring regionally. The Illinois State Water Survey (ISWS) and the Illinois State Geological Survey (ISGS), both within the University of Illinois' Prairie Research Institute, along with the Illinois Department of Natural Resources' Office of Water Resources (IDNROWR), were responsible for providing technical support to the RWSPG.

The following paragraphs summarize some of the key findings of significant reports, relevant to water supply in Northeast Illinois.

A. Water 2050, Northeastern Illinois Regional Water Supply Demand Plan (2010)

The *Water Plan* is the result of a three-year planning effort undertaken by the CMAP and the RWSPG and establishes a framework for future planning efforts. The report acknowledges that the projected population growth in northeastern Illinois will lead to an increase in water demand, which could lead to conflict between users over constrained water resources if appropriate water management actions are not taken. The preparers clearly emphasize that this report is the outcome of an initial planning phase, and recommend further planning iterations and a more comprehensive look at the challenges confronted. An extensive number of recommendations are presented for future study, planning and implementation.

The *Water Plan* highlights the need to address the interrelated monitoring, data collection, and funding needs of the region necessary to continue effective planning. The RWSPG recommended that the state fund the Illinois State Water Survey (ISWS) to conduct an impact analysis of new withdrawals on groundwater supplies as required by the Water Use Act of 1983 and that ISWS provide updated well-withdrawal data and impacts to counties and to CMAP annually to facilitate comprehensive water supply planning efforts. In addition, the RWSPG recommended study of the relationship between shallow groundwater pumping and groundwater contributions to the base flow of headwater streams. Additional recommendations included:

- expansion of the shallow aquifer study beyond the Fox River Basin
- establishment of a shallow aquifer well network throughout the 11-county region
- establishment a water quality and quantity monitoring network for the deep-bedrock aquifer
- consideration of a means of collecting data on water used for irrigation and self-supplied water
- new-model simulations that could include optimization of shallow aquifer withdrawal scenarios in combination with new Fox River withdrawals; optimization of deep-aquifer withdrawals; Kankakee River withdrawal simulations; and validation of current and future model output
- consideration of intergovernmental agreements among counties and municipalities that establish water withdrawal standards in accordance with projected growth, e.g., communities commit to specific withdrawal limits based on their future populations and with knowledge from ISWS on groundwater supplies for the purpose of water resources management
- collection of a variety of data from public-water suppliers to add value to those data reported to the Illinois Water Inventory Program (IWIP) maintained by ISWS and enhance regional understanding of water use

B. Regional Water Demand Scenarios for Northeastern Illinois:2005-2050 (2008)

The *Demand Report* was prepared for the Chicago Metropolitan Agency for Planning, by Southern Illinois University Carbondale (SIUC), in collaboration with the Illinois State Water Survey (ISWS), and the Illinois District of the United States Geological Survey (USGS). USGS data sets on historical withdrawals were used in developing water-demand relationships for future scenarios.

This study presents three future water-demand scenarios for geographical areas which encompass groundwater withdrawal points and surface water intakes in the 11-county regional planning area of Northeastern Illinois. The region under study includes the Illinois counties of Boone, Cook, DeKalb, DuPage, Kane, Kankakee, Kendall, Grundy, Lake, McHenry, and Will. The study generated demand scenarios by major user sectors and geographical subareas within the region. The three scenarios represent water withdrawals under current demand conditions representing the baseline scenario, a less resource intensive scenario, and a more resource intensive scenario, extended to the year 2050. The scenarios were defined by varying assumptions regarding the future values of demand drivers and explanatory variables. The main drivers of future water demand are future population and economic growth, represented in the study as future employment.

The study found that total water withdrawals will continue to increase to meet the demands of growing population and associated growth in the economy of the region. However, the growth in total water demand could be faster or slower depending on the accuracy of the assumptions made and expectations concerning future conditions.

The large growth in total water withdrawals in Northeast Illinois of 530.4 MGD under the baseline scenario and 949.1 MGD under More-Resource-Intensive scenario underscores the need to manage regional water demands. Meeting these additional demands would require large capital expenditures on water infrastructure and would likely have significant impacts on some of the regional sources of water supply, especially groundwater aquifers and local rivers.

The report recommends that state resource agencies consider actions that would improve the quality of water withdrawal data, as well as expand the scope of data collection. Improved data reporting would provide a basis for future studies of water demands.

C. Opportunities and Challenges of Meeting Water Demand in Northeastern Illinois (2012)

The Illinois State Water Survey (ISWS) Prairie Research Institute prepared the *Groundwater Report* as a product of its technical support to the RWSPG. A water supply study program, developed by IDNR-OWR and the State Surveys, called for estimation of water withdrawals to 2050 and assessment of the impact on the region's water resources of these withdrawals. The *Groundwater Report* describes estimated impacts based on scenarios of future water withdrawals developed by Southern Illinois University in the *Demand Report.* The authors discuss impacts to three principal sources of water available to the region: the deep bedrock aquifers (called the deep aquifers) underlying all of the region; sand and gravel and shallow bedrock aquifers (called the shallow aquifers) underlying only the Fox River watershed; and the inland surface waters of the Fox River. The authors also assess the ability of Lake Michigan to meet public water supply demand. A surface water accounting tool, a watershed model, and a groundwater flow model were developed to estimate the impacts of future demands on the Fox River and aquifers within the region. Neither shallow aquifers outside of the Fox River watershed nor other inland surface waters such as the Kankakee River were evaluated.

The *Groundwater Report* applies the regional water-demand scenarios to the groundwater resources in Northeastern Illinois to indicate likely impacts over time. The report finds drawdown interference commonplace throughout the deep-bedrock aquifer due to regional withdrawals exceeding the recharge rate. Drawdown is greater in the deep-bedrock aquifer than in the shallow aquifers in response to differing replacement water availability. Drawdown in the Ancell and Ironton-Galesville Units in southeastern Kane County and northern Will County suggest high potential for adverse impacts by 2050: decreasing well yields, increasing pumping expenses, increases in salinity, and increased concentrations of radium, barium and arsenic.

The ISWS concludes: model results suggest the deep bedrock aquifers cannot be counted on (indefinitely) to meet all future demand scenarios across the entire 11-county area. There is time in the short term to pursue alternative sources (e.g. Fox River or Lake Michigan water) and demand management.

D. Lake Michigan Diversion Accounting Reports **and** *Findings of the Sixth Technical Committee for Review of Diversion Flow Measurements and Accounting Procedures*

Under the provisions of the U.S. Supreme Court Decree in the Wisconsin, et. al. v. Illinois et. al., 388 U.S. 426,87 S.Ct. 1774 (1967) as modified in 449 U.S. 48, 101 S.Ct. 557 (1980), the Chicago District of the Corps of Engineers is responsible for monitoring the measurement and computation of diversion of Lake Michigan water by the State of Illinois. The Water Resources Development Act of 1986 (Section 1142 of PL 99-662) gave the Corps total responsibility for the computation of diversion flows as formerly done by the State of Illinois. The Corps' new mission became effective on October 1, 1987. Chicago District now prepares Lake Michigan Diversion Accounting Reports on an annual basis. The most recent Accounting Report was completed for Water Year 2009.

The current Supreme Court Decree specifies several limitations on the diversion of Lake Michigan water by the State of Illinois. The Lake Michigan diversion accountable to Illinois is limited to 3,200 cubic feet per second (cfs) over a forty (40) year averaging period. During the forty (40) year period, the average diversion in any annual accounting period may not exceed 3,680 cfs, except in two accounting periods due to extreme hydrologic conditions in which the average diversion may not exceed 3,840 cfs. During the first thirty nine (39) year period, the maximum allowable cumulative difference between the calculated diversion and 3,200 cfs is 2,000 cfs-years. These limits apply to the forty year period beginning with WY81.

The Sixth Technical Committee was appointed by the U.S. Army Corps of Engineers (USACE) in December of 2007 to conduct an assessment and evaluation of the accounting procedures and methodology used in the determination of diversion from Lake Michigan, and to ascertain whether or not the methods are in accordance with the “best current engineering practice and scientific knowledge”, as stipulated by the 1967 Supreme Court Decree and the 1980 modifications. Such a review is to be performed by a Technical Committee appointed every five years, and a report evaluating the accounting and operation procedures is to be presented to the USACE and to other interested parties. The key topics reviewed by the Sixth Technical Committee include recent accounting results for Water Years (WYs) 2000, 2001, 2002, 2003, 2004 and 2005.

IV. MAJOR SOURCES OF WATER SUPPLY

Northeast Illinois water supplies in the region are provided by Lake Michigan, inland surface waters of the Chicago Sanitary and Ship Canal, the Cal Sag Channel, and the Chicago, Des Plaines, Fox, Illinois and Kankakee Rivers (only the Fox and Kankakee Rivers are used currently for community water supply), and groundwater sources (shallow and deep aquifer). The majority of the region's water use comes from Lake Michigan, allocated to approximately 200 communities. Figure 4 shows the source of water supply by municipality.

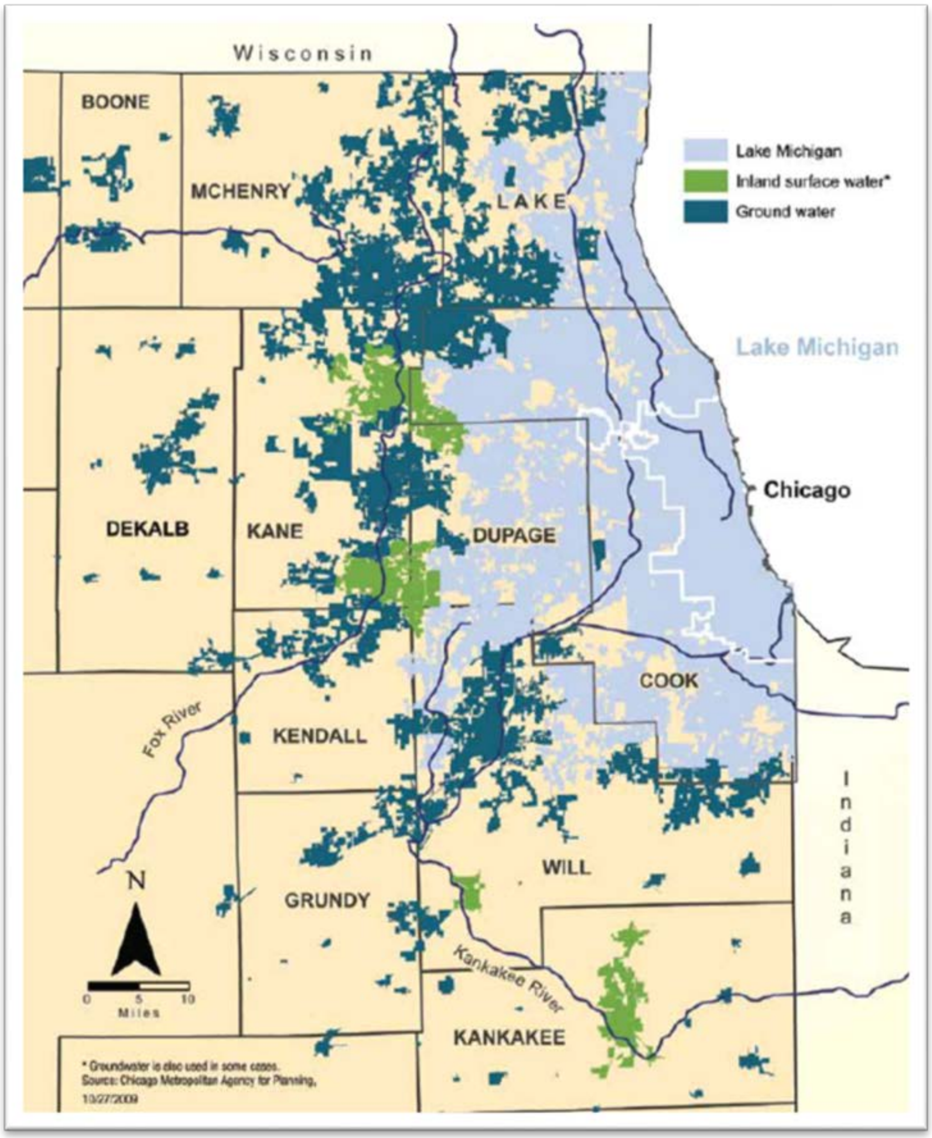

Figure 4. Source of Public Water Supply by Municipality. Source: *Water Plan*.

A. Lake Michigan Diversion

The majority of the region's water use comes from Lake Michigan water allocations to about 200 communities, including the City of Chicago. In 2005, Lake Michigan provided about 69 percent of water used for all purposes except power generation, and about 85 percent of public water supply. Lake Michigan Diversion is governed by a U.S. Supreme Court Consent Decree that limits Illinois' withdrawal to 3,200 cubic feet/second or about 2.1 billion gallons/day. Under the terms of the Supreme Court Decree, the U.S. Army Corps of Engineers performs the annual diversion accounting for Illinois' Lake Michigan Diversion.

All diversions of water from Lake Michigan require authorization in the way of an allocation permit from the USACE, Chicago Office. The Chicago Office reviews all applications for new allocation permits and requests for modifications to existing allocation permits. The Chicago Office undertakes a complete review and reallocation of all existing allocation permits approximately every ten years.

All existing domestic water allocation permittees are required to submit an annual water audit form (LMO-2). The LMO-2 form details the amount of water used, sold and lost by a permittee in the past water year (October - September). The Chicago Office uses these forms to track individual user's compliance with the conditions of their allocation permits and to produce reports. In addition to the annual LMO-2 form all direct diverters must submit a monthly pumpage form (LMO-3) which shows daily pumpage numbers and the amount of water sold to other Lake Michigan allocation permittees. A direct diverter is a permittee who has an intake structure on Lake Michigan or is the first Illinois user of water diverted outside of Illinois. The Metropolitan Water Reclamation District of Greater Chicago submits monthly reports detailing Lake Michigan water used for Direct Diversion. All data collected is submitted to the Corps of Engineers to be used in their diversion accounting.

The Illinois Lake Michigan Water Allocation Program (Program) was developed to manage Illinois' diversion of water from Lake Michigan in response to the 1967 Supreme Court Decree. The Program is authorized by the "Level of Lake Michigan Act" [615 ILCS 50] and is implemented by the IDNR/OWR's Lake Michigan Management Section (Chicago Office) using the Department's Part 3730 Rules "Allocation of water from Lake Michigan".

The Lake Michigan diversion consists of three primary components: domestic pumpage from Lake Michigan used for water supply and not returned to Lake Michigan, stormwater runoff from the diverted Lake Michigan watershed, and direct diversions through the three lakefront control structures.

a. Lake Michigan Water Intakes

Chicago has four functional water intake cribs: the Wilson Avenue crib, the Four Mile Crib, the William E. Dever Crib and the 68th Street crib. Water is collected from Lake Michigan either at the intake cribs, or the shore intakes of the water purification plants. The four active or standby intake cribs are located in the Lake, two miles off shore in water 32 to 35 feet deep. Cribs in service are monitored continuously throughout the year.

Lake water enters the crib through ports near the bottom of the crib, rises around the outside of the central shaft and flows through upper openings in the central shaft and down the shaft to large supply tunnels located from 75 to 200 feet below the surface of the Lake. These horseshoe and circular shaped water tunnels vary in size from 10 to 20 feet in height and have a concrete liner to reduce friction.

Figure 5 shows the location of Lake Michigan Diversions at Chicago, including the referenced intake cribs.

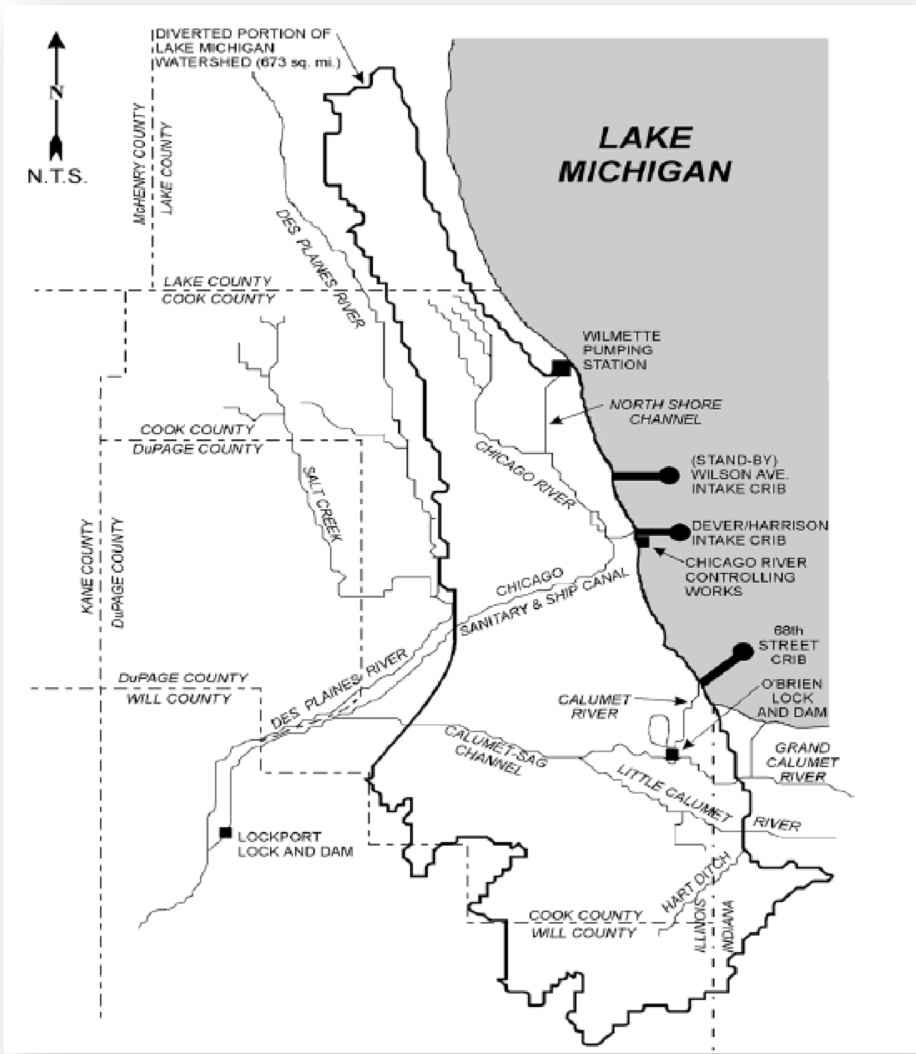

Figure 5. Location Map - Lake Michigan Diversions at Chicago

B. Deep Aquifers

Figure 6 depicts the types of groundwater withdrawn by communities in Northeast Illinois.

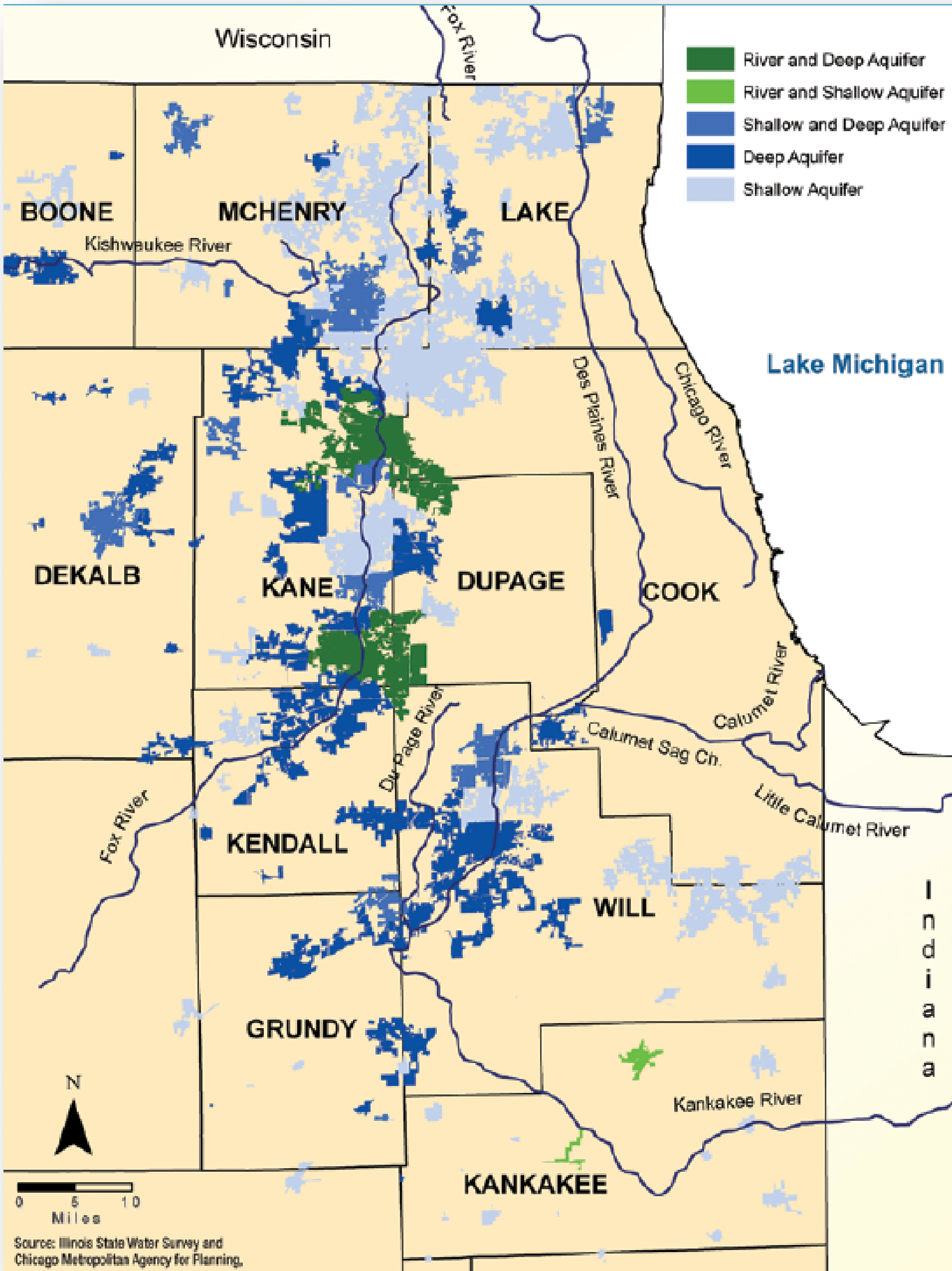

Figure 6. Types of Aquifer Used By Groundwater Dependent Communities. Source: Water Plan.

The *Groundwater Report* examines the relationships between groundwater resources, the relationship between groundwater and surface waters, and their response to withdrawals utilizing a quantitative approach that assimilates the available observations and knowledge, computes flow rates and water levels, and projects these into the future for alternative water-withdrawal scenarios. These requirements were met using a computer model of groundwater flow and a set of equations representing aquifers, wells, and streams.

Groundwater withdrawals in northeastern Illinois have declined since the 1980s, largely as a consequence of public water systems in Cook, DuPage, and Lake Counties shifting from groundwater to Lake Michigan as a water source, but also because of improvements in efficiency, reduction of leakage, and deindustrialization. The largest annual declines in total groundwater withdrawals occurred in the early 1990s, when many public water systems in DuPage County shifted to Lake Michigan. Declines in withdrawals from deep wells have been greater than those from shallow wells, principally because many of the public water systems that switched to the Lake Michigan source relied heavily on deep wells. The overall spatial effect of this shift has been to move the band of groundwater withdrawals farther west and south as pipelines deliver Lake Michigan water to inland areas at progressively greater distances from the lake. Moreover, groundwater withdrawals by western and southern suburban systems that remain dependent on groundwater continue to increase in response to population growth.

The “deep aquifers” refer to layers that consist principally of sandstone, referred to as the Ancell Unit, Ironton-Galesville Unit, and Mt. Simon Unit. In northeast Illinois, the Mt. Simon Unit is used far less than the Ancell and Ironton-Galesville Units because of the expense of drilling and because deeper portions of the Mt. Simon contain water that is too salty for most uses. Principal areas of withdrawals from the deep units in 2005 are (1) the industrial corridor along the CSSC and Des Plaines River, (2) the Fox River Valley area of southeastern Kane County, and (3) southeastern McHenry County.

In addition, the low transmissivity of the deep aquifers limits eastward movement of replacement water from northcentral Illinois. As a result, water levels (heads) have fallen 500 to 800 feet in many deep wells. This slow replacement of water has great implications for future use of the deep aquifers in Northeast Illinois.

Model simulations suggest that by 2005, over 500 feet and over 1100 feet of drawdown had occurred in the Ancell and Ironton-Galesville Units, respectively, in southeastern Kane County and northern Will County since pumping began in the 1860s. These units are the principal deep aquifers in the region. Drawdown causes water levels in wells open to the aquifers to decline, decreasing well yields, increasing pumping expenses and, in extreme cases, causing water supply interruptions that can only be addressed by replacement of the wells or lowering of pumps. Simulations of the baseline scenario suggest that pumping of the Ancell and Ironton-Galesville heads in southeastern Kane County and northern Will County will have declined by over 800 and over 1,500 feet, respectively, by 2050.

C. Shallow Aquifers Beneath Fox River

In most of northeastern Illinois, shallow and deep aquifers are separated by a laterally extensive, relatively impermeable confining unit that greatly limits vertical leakage of water to the deep aquifers. The *shallow* and *deep* aquifers, units, and wells are all separated by the top of the Ancell Unit: *shallow* units and aquifers overlie the top of the Ancell Unit, and *deep* units and aquifers underlie the top of the Ancell Unit. Shallow wells do not penetrate below the top of the Ancell Unit, and deep wells penetrate below it.

Withdrawals from the shallow units in 2005 were concentrated within a corridor extending from the Indiana boundary in Will County northwestward through the Fox River Valley of Kane County and extreme northwestern Cook County and northward into McHenry County. The source of these shallow withdrawals is predominantly the shallow bedrock aquifer in the southern part of the corridor, while the source of these withdrawals is mainly the Quaternary sand and gravel aquifers in the northern part of the corridor.

Replacement water enters the shallow aquifers much more readily, and these comparatively higher rates of leakage function to reduce drawdown. Shallow aquifers, however, are not consistently present throughout northeastern Illinois and well yields are much more variable than deep aquifer wells. Moreover, the shallow aquifers, by their very nature, are more closely connected to streams and wetlands.

D. River Withdrawals

The *Groundwater Report* includes an assessment of current and potential future usage of Fox River surface water. Withdrawal from the Kankakee River is also mentioned as a potential source of water supply, but not assessed.

Fox River withdrawal is the subject of prior and ongoing modeling and analysis. The watershed population and water use are rapidly increasing, and it is already used for water supply by two public water systems: Elgin and Aurora. For the past 100 years, almost all of the water used in the Fox watershed was obtained from groundwater sources. In 1983, Elgin’s public water system began withdrawing water from the Fox River, and, except for one year, over 90 percent of Elgin’s water was obtained from the river during the period 1991–2005. Aurora began withdrawing water from the Fox in 1992. Total Fox River withdrawals by the two water systems have remained fairly steady since 1992, averaging 19.8 MGD from 1992 to 2005.

IDNR commonly uses the 7-day 10-year low flow value (Q7, 10) as the protected minimum flow for Illinois’ public waters, including the Fox River. This means that no new withdrawal from these rivers is permitted if it causes flow to be reduced below the Q7,10. Four primary factors have had a direct influence on the change in low flow quantity: (1) climate variability, (2) discharge of treated wastewaters into the Fox River, (3) water use withdrawals from the river, and (4) modifications in the gate operations of Stratton Dam, which partially controls the outflow of water from the Fox Chain of Lakes in McHenry County. Of these factors, effluent (treated wastewater) discharges have had the greatest overall impact on low flow amounts along most reaches of the Fox River.

Model simulations examined the potential that new withdrawals from the Fox River could provide water to additional communities. Instream flow guidelines used by IDNR specify that new withdrawals should not cause flow in the Fox River to fall below the Q7,10. In consideration of this constraint, projected increases in low flow under most mode simulations support the conclusion that additional surface water withdrawals from the Fox River can meet approximately half of the expected public sector demand increases in major portions of the Fox River basin, such as the Kane-Kendall County region.

V. PUBLIC WATER USERS IN NORTHEAST ILLINOIS

A. Public

Public water supply refers to water that is withdrawn, treated, and delivered to individual residential, commercial, industrial, institutional, and governmental users by public water supply systems. Water can also be purchased from a nearby system and delivered to users. The U.S. EPA defines a "public" water system as a publicly-owned or privately-owned system that serves at least 25 people or 15 service connections for at least 60 days per year. Not all users of water within a given geographical area rely on water delivered by public systems; some users have their own sources of supply and are considered to be self-supplied. The self-supplied users include industrial and commercial establishments using their own wells or surface water intakes, as well as residential users who rely on private wells. The latter group of users is called the self-supplied domestic sector.

There are 530 public water supply systems in the 11-county area of Northeastern Illinois. These systems serve the estimated population of 8,238,560 persons, as well as local businesses and institutions. In addition, it is estimated that an additional 392,650 people are served by domestic wells and other sources in the self-supplied domestic sector in 2005. A total of 194 public water systems hold Lake Michigan allocation permits from IDNR-OWR. Public water supply use principally includes household domestic uses, but also includes water purchased for industrial, commercial, and recreational purposes from a public water system holding a lake allocation.

County	Public Supply Withdrawals				Self-supplied Domestic	
	Population Served	26 Systems MGD	County Remainder MGD	Total Public MGD	Self-supplied Population	Total MGD
Boone	39,320	3.66	0.66	4.31	11,160	1.00
Cook	5,445,377	916.14	9.53	925.67	5,300	0.48
DeKalb	82,120	4.36	4.26	8.62	15,550	1.40
DuPage	810,417	90.62	7.92	98.55	22,160	2.00
Grundy	35,140	1.64	1.34	2.97	8,700	0.78
Kane	581,277	33.64	26.38	60.01	1,930	0.17
Kankakee	87,200	12.89	2.13	15.01	20,770	1.87
Kendall	52,190	2.36	2.11	4.47	27,320	2.46
Lake	615,870	55.09	18.77	73.87	86,810	7.81
McHenry	284,947	5.43	20.36	25.79	54,860	4.94
Will	317,349	16.47	19.96	36.43	138,090	12.43
Total 11 Co.	8,351,206	1,142.29	113.42	1,255.71	392,650	35.34

Figure 7. Public Supply and Self-Supplied Domestic Population Estimates for 2005. Source: Demand Report.

Figure 7 (above) shows the total domestic withdrawals made by publicly-supplied and self-supplied users in 2005. A total of 1,255.71 MGD and 35.34 MGD were withdrawn from public supply and self-supplied sources, respectively. The vast majority of the withdrawal was made in Cook County.

B. Commercial and Industrial Users

Industrial, commercial and institutional water demand represents self-supplied or purchased (i.e., delivered by public system) water by industrial, commercial, and other nonresidential establishments. The industrial sub-sector includes water used for "industrial purposes such as fabrication, processing, washing, and cooling, and includes such industries as steel, chemical and allied products, paper and allied products, mining, and petroleum refining," and the commercial sub-sector includes water used for "motels, hotels, restaurants, office buildings, other commercial facilities, and institutions" (Avery, 1999).

Figure 8 contains a table comparing self-supplied withdrawal and publicly-supplied deliveries to commercial and industrial users in 2005.

County	Total County Employ-ment	Self-Supplied Withdrawal (MGD)	Public-supply Deliveries to C&I (MGD)	Total C&I Water Demand (MGD)	Unit Withdrawal Per Employee (GPED)
Boone	17,428	0.57	1.40	1.97	113.0
Cook	2,420,303	123.73	302.60	426.33	176.1
DeKalb	51,069	2.54	0.93	3.47	67.9
DuPage	677,073	0.96	25.05	26.01	38.4
Grundy	21,975	6.99	0.02	7.01	319.0
Kane	237,175	4.34	14.09	18.43	77.7
Kankakee	49,889	5.09	2.19	7.28	145.9
Kendall	42,608	0.78	0.28	1.06	24.9
Lake	357,871	13.88	14.02	27.90	78.0
McHenry	160,222	6.58	4.09	10.67	66.6
Will	319,603	24.97	9.39	34.36	107.5
Total/Avg.	4,355,216	190.43	374.06	564.49	129.6

MGD = million gallons per day, GPED = gallons per employee per day

Figure 8. Estimated Combined Self-Supplied and Purchased Industrial and Commercial Water Demand in 2005. Source: Demand Report.

Figure 9 shows historical water demand by self-supplied commercial and industrial users. Higher estimates for Cook County in 2005 as compared to 2000 are a result of an additional facility with comparatively large withdrawals to the Illinois Water Inventory Program (IWIP) database. One additional facility was also added for DeKalb County. The reduction in DuPage County is a result of one large facility reporting reduced withdrawals. Detailed explanations of USGS methodology for data compilations and quality assurance are available from a USGS document entitled *Narrative for 2005 Water-Use Compilation* (USGS, 2008).

The long term trends in total industrial and commercial (I&C) water withdrawals are readily apparent. For the entire 11-county study area in Northeastern Illinois, total self-supplied I&C withdrawals (including mining) have been gradually decreasing during the last two decades from 362.80 mgd in 1985 down to 190.43 mgd in 2005. During the last reporting period for the individual counties, between 2000 and 2005, both increases and decreases of withdrawals are reported. The combined effect of these changes is a net increase in total reported withdrawals although part of this increase is the result of adding new facilities to the data inventory.

County	1985	1990	1995	2000	2005
Boone	1.37	0.07	0.41	0.47	0.57
Cook	316.97	235.55	143.10	95.53	123.73
DeKalb	0.72	0.67	0.78	0.18	2.54
DuPage	5.65	6.43	4.95	5.48	0.96
Grundy	7.14	6.31	6.80	7.07	6.99
Kane	3.18	2.50	2.05	1.57	4.34
Kankakee	0.21	0.17	0.18	0.16	5.09
Kendall	0.83	0.33	0.31	0.29	0.78
Lake	7.33	13.12	16.95	20.61	13.88
McHenry	3.39	4.02	3.92	4.92	6.58
Will	16.01	22.04	15.71	11.96	24.97
Totals.	362.80	291.21	195.16	148.23	190.43

Source: Published by the USGS National Water Use Information Program, various years.
The data are based on the ISWS Illinois Water Information Program. MGD = million gallons per day.

Figure 9. Historical Industrial and Commercial Water Demand. Source: Demand Report.

Water withdrawals and purchases for industrial and commercial purposes are most often explained in economic terms, where water is treated as a factor of production. Ideally, econometric models of I&C water demand could be developed based on a comparison of the outputs and the price of water and other inputs. Unfortunately, such data are rarely collected at the county level, or are not publicly available because of their proprietary nature. An alternative approach that has been commonly used is to estimate water demand based upon the size and type of products or services produced by the firm. This can be accomplished by using unit-use coefficients. Because the size of the firm is frequently represented by its number of employees, total water demand estimates for the I&C sector are frequently calculated in terms of the quantity of water per employee, for a specified type of business enterprise.

C. Make up and flow through systems

Much of the water withdrawn for power generation is returned directly to its source, with a small percentage lost to evaporation after being circulated once for cooling in through-flow power plants. The *Demand Report* distinguishes this category of power generation water use—referred to as *once-through flow* or *through flow*—from *makeup water* pumped by *closed-loop power plants*, which recirculate cooling water. Makeup water is water that is pumped to replace losses and ―blowdown in cooling towers or losses and discharges from perched lakes or ponds. Power generation through-flow totaled more than 4,200 million gallons per day (MGD) in 2005.

This distinction is made because the power industry representatives on the RWSPG expressed a concern that the very high volumes of water withdrawals for once-through cooling are not directly comparable to withdrawals by other sectors. In order to address this concern, thermoelectric water withdrawals were separated into two categories: withdrawals by through flow plants and withdrawals by makeup water intake plants. Once-through flow (run-of-the-river) plants pump water directly to the condensers and almost immediately return it back to the river or lake. Closed-loop makeup water plants withdraw water to replace losses and "blowdown" in cooling towers, or water losses and discharges from perched lakes or ponds. This separation of plants provides for a better consistency in representing non-consumptive and consumptive water withdrawals for power production. Water withdrawn by through flow plants represents non-consumptive use since nearly all water withdrawn is returned to the source. Withdrawals by makeup water plants represent a sum of both consumptive and non-consumptive use and are comparable with withdrawals by the industrial/commercial and agricultural sectors.

D. Irrigation and Agricultural Users

The irrigation and agricultural (IR&AG) sector includes self-supplied withdrawals of water for irrigation of cropland, turfgrass-sod farms, and golf courses, as well as water for livestock and environmental purposes. In the USGS inventories of water demand, the designation of "irrigation" water demand includes "all water artificially applied to farm and horticultural crops as well as self-supplied water withdrawal to irrigate public and private golf courses" (Solley et al., 1998).

Agricultural livestock water demand includes water for animals, feedlots, dairies, fish farms, and other on-farm needs. The categories of livestock water demand include water used to care for all cattle, sheep, goats, hogs, and poultry, including such animal specialties as horses, rabbits, bees, pets, fur-bearing animals in captivity, and fish in captivity (Avery, 1999).

The irrigation and agricultural sector represents a significant component of total water demand, especially in the counties with large proportions of land in agricultural use. Boone, DeKalb, Kankakee, and Kendall Counties all have more than three fourths of county land area in cropland. In the urbanized counties of Cook, DuPage, and Lake, only small fractions of land area are in agricultural use.

Figure 10 shows the total withdrawals and acreage attributed to irrigated cropland in Northeast Illinois in 2005. Total withdrawals in all counties reached 30.44 MGD, with highest total withdrawals occurring in Kankakee and McHenry Counties. Figure 11 shows total withdrawals and acreage attributed to golf course irrigation, representing a total withdrawal of 18.29 MGD in 2005, with the highest total withdrawal occurring in Cook County.

County	Irrigated Cropland (acres)	Withdrawals and Demand (MGD)		
		Ground-water	Surface Water	Total Withdrawals
Boone	1,632	1.80	0.00	1.80
Cook	134	0.21	0.00	0.21
DeKalb	1,022	0.85	0.35	1.20
DuPage	380	0.41	0.00	0.41
Grundy	60	0.05	0.00	0.05
Kane	2,089	2.47	0.00	2.47
Kankakee	13,695	10.85	1.60	12.45
Kendall	520	0.60	0.00	0.60
Lake	680	0.71	0.00	0.71
McHenry	7,040	7.80	0.06	7.86
Will	2,540	1.81	0.87	2.68
Total	29,792	27.56	2.88	30.44

Source: US Geological Survey, Illinois Water Science Center

Figure 10. Cropland Areas Under Irrigation and Estimated Water Demand in 2005. Source: Demand Report.

County	Golf Course Irrigation (Acres)	Water Withdrawals (MGD)		
		Ground-water	Surface Water	Total Withdrawals
Boone	99	0.07	0.07	0.14
Cook	4,177	4.58	1.52	6.10
DeKalb	257	0.2	0.20	0.40
DuPage	2,091	1.62	1.61	3.23
Grundy	121	0.07	0.07	0.14
Kane	802	0.93	0.31	1.24
Kankakee	403	0.24	0.23	0.47
Kendall	99	0.07	0.07	0.14
Lake	2,300	2.38	0.79	3.17
McHenry	995	0.69	0.69	1.38
Will	1,343	1.41	0.47	1.88
Total NE Illinois	12,688	12.26	6.03	18.29

Source: US Geological Survey, Illinois Water Science Center

Figure 11. Golf Course Area under Irrigation and Estimated Water Withdrawals in 2005. Source: Demand Report.

VI. COMPONENTS OF LAKE MICHIGAN DIVERSION

Illinois' Lake Michigan Diversion is made up of three components: domestic water supply, direct diversion, and stormwater runoff. Domestic water supply is used to serve communities and industries within Cook, Lake, DuPage, Kane and Will Counties. Domestic Water supply is taken from Lake Michigan intake cribs and discharged into the river canal system or Des Plaines River, in the greater Chicago area, as water reclamation plant effluent and occasional combined-sewer overflows. Direct diversion consists of lockages, leakages, navigation makeup flow, and discretionary diversion. Stormwater runoff is that runoff from the diverted watershed area of Lake Michigan, draining to the river and canal system in the greater Chicago area.

A. Direct Diversion

a. Navigation

More information on navigation diversion can be found in *GLMRIS-Baseline Assessment of Non-Cargo CAWS Traffic.*

Direct water diversions occur at multiple locations - the Chicago River Controlling Works (CRCW), the O'Brien Lock and Dam, Lockport Lock and Dam, Brandon Lock and Dam, and the Wilmette Pumping Station. Diversion at these locations consists of four components; lockage, leakage, discretionary flow, and navigation makeup flow. The lockage component is the flow used in locking vessels to and from the lake. The leakage component is water estimated to pass, in an uncontrolled way, through or around the lakefront structures. The purpose of the discretionary diversion is to dilute effluent from sewage discharges and improve water quality in the canal system.

Water levels in Lake Michigan are typically higher than water levels in the channels, however during high rain events this is not always the case. The fourth component of water diversion is navigation makeup water. When large storms are forecast, the canal is drawn down before the storm to prevent flooding, and navigation makeup water is used during this draw down period to maintain navigation depths. If the runoff is not enough to refill the canal, additional navigation makeup water is allowed to pass from Lake Michigan to return the canal system to its normal operating stages.

b. Water Quality Dilution

Discretionary diversion is used to improve water quality in the canal system. Flow within the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) waterway system and the Lake Michigan discretionary diversion flow are controlled by three inlet structures on Lake Michigan: Wilmette Pumping Station, Chicago River Controlling Works and O’Brien Lock and Dam. The single outlet control structure is the Lockport Powerhouse and Controlling Works. More information on the MWRDGC is provided in Section VI.

B. Domestic Water Supply

Domestic water supply is used to serve communities and industries within Cook, Lake, DuPage, Kane and Will Counties. The Lake Michigan diversion accountable to the State of Illinois is calculated by using the AVM (Acoustic Velocity Meter) measured flow in the Chicago Sanitary Ship Canal at Lemont and deducting flows that do not constitute Lake Michigan diversion and are not accountable to the State of Illinois. Additions are made to the Lemont record for diversions that are not discharged to the canal. The deductions include groundwater water supply pumpage whose effluent is discharged to the canal, Lake Michigan water supply pumpage from Indiana discharged to the canal, runoff from the Des Plaines River watershed discharged to the canal, and water supply pumpage from Lake Michigan used for Federal facilities discharged to the canal. The additions to the Lemont record include flows diverted from the canal upstream of Lemont, and Lake Michigan water supply whose effluent is not discharged to the canal.

C. Stormwater runoff

Stormwater runoff from the diverted watershed area of Lake Michigan, draining to the river and canal system in the greater Chicago area is calculated as a component of the total diversion. Stream gage budgets are used to make estimates of runoff from portions of the diverted Lake Michigan watershed. Sanitary and other point source flows are subtracted from the stream gaging record to develop the runoff estimates. The flows at the stream gaging sites are also part of the canal system budget. Figure 12 presents the estimated runoff from these budgets for Water Year 2009. Budgets for Little Calumet River at IL-IN State Line and Thornton Creek at Thornton, IL contribute to the budget for Little Calumet River at South Holland, as they are upstream of, or tributary to this segment.

Budget Number	Location	Stream Flow (cfs)	Sanitary Flow (cfs)	Runoff (cfs)
3	North Branch Chicago River at Niles, IL	212.9	19.1	193.8
4	Little Calumet River at IL-IN State Line	78.1	8.6	69.5
5	Thorn Creek at Thornton, IL	163.5	17.9	145.6
6	Little Calumet River at South Holland, IL	248.0	225.9	22.1 *

* The runoff for Budget 6 is that runoff which occurs in the reach between South Holland and the 2 upstream gages (Little Calumet River at the State Line and Thorn Creek at Thornton). The runoff is computed by taking the measured streamflow at South Holland and subtracting off the measured flow at the two upstream gages and the sanitary portion of the CSOs that occur in the reach between the state line and South Holland. If a negative discharge at South Holland is computed for a day, it is set equal to zero in the annual runoff computation.

Figure 12. Stream Gage Flow Separation.

VII. METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO (MWRDGC)

The information provided in this section was obtained from the MWRDG website. Domestic pumpage from Lake Michigan is used for water supply and its effluent is discharged to the canals by various Water Reclamation Plants (WRP's). Currently, the WRP's that divert domestic pumpage from the lake either discharge to the canal system or to the Des Plaines River and its tributaries. In the future as more communities convert to Lake Michigan water supply, water supply effluent may also be discharged to the Fox River. The Fox River is approximately 35 miles west of downtown Chicago.

The Mission of the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) is to protect the health and safety of the public in its service area, protect the quality of the water supply source (Lake Michigan), improve the quality of water in watercourses in its service area, protect businesses and homes from flood damages, and manage water as a vital resource for its service area. The District's service area is 883.5 square miles of Cook County, Illinois. The District is committed to achieving the highest standards of excellence in fulfilling its mission

The District's seven modern water reclamation plants provide excellent treatment for residential and industrial wastewater, meeting permitted discharge limits virtually at all times. Treated wastewater, along with runoff from rainfall, enters local canals, rivers and streams that serve as headwaters of the Illinois River system. Stormwater in the separate sewered area is controlled to reduce flood damages by a number of stormwater detention reservoirs. In the combined sewer area, the District's tunnel and reservoir project (TARP) has significantly reduced basement backup and overflows to local waterways.

Flow within the District's waterway system and the Lake Michigan discretionary diversion flow are controlled by three inlet structures on Lake Michigan: Wilmette Pumping Station, Chicago River Controlling Works and O'Brien Lock and Dam. The single outlet control structure is the Lockport Powerhouse and Controlling Works.

While exercising no direct control over wastewater collection systems owned and maintained by cities, villages, sewer districts and utilities, the District does control municipal sewer construction by permits outside the city of Chicago. It also owns a network of intercepting sewers to convey wastewater from the local collection systems to the water reclamation plants.
The District is located primarily within the boundaries of Cook County, Illinois . The District serves an area of 883 square miles which includes the City of Chicago and 125 suburban communities. The District serves an equivalent population of 10.35 million people; 5.25 million real people, a commercial and industrial equivalent of 4.5 million people, and a combined sewer overflow equivalent of 0.6 million people. The District's 554 miles of intercepting sewers and force mains range in size from 12 inches to 27 feet in diameter, and are fed by approximately 10,000 local sewer system connections.

The District owns and operates one of the world's largest water reclamation plants, in addition to six other plants and 23 pumping stations. The District treats an average of 1.4 billion gallons of wastewater each day. The District's total wastewater treatment capacity is over 2.0 billion gallons per day.

The District controls 76.1 miles of navigable waterways, which are part of the inland waterway system connecting the Great Lakes with the Gulf of Mexico. It also owns and operates 30 stormwater detention reservoirs to provide regional stormwater flood damage reduction. The District owns approximately 9,500 acres of property in Cook County for its operations.

VIII. PRESENT AND FUTURE DEMAND FOR WATER SUPPLY

A. Current Demand

Figure 13 shows the usage for water by all sectors in 2005. The total for all sectors was 5,805.6 MGD and 1,546.1 MGD excluding power generation. Consuming 1,255.7 MGD, the public supply sector consumed the second-most water, following the power generation sector.

a. Current Demand in Northeast Illinois

Water-supply sector or other accounting category		*Reported*	*Adjusted to 1971-2000 climate*
Public supply		1,255.7	1,189.2
Self-supplied commercial and industrial		191.6	162.4
Self-supplied domestic		36.8	31.8
Irrigation and agriculture		62.0	44.6
Power generation	makeup	52.3	52.3
	through flow	4,207.2	4,207.2
TOTAL all sectors		**5,805.6**	**5,687.5**
TOTAL excluding power generation through-flow		**1,598.4**	**1,480.3**
TOTAL excluding power generation		**1,546.1**	**1,428.0**

Figure 13. Water Withdrawals in Northeast Illinois, 2005 (MGD).

b. Current Demand for Lake Michigan Diversion

The cumulative deviation of Lake Michigan diversion had increased from 1983 until 1994, when the trend reversed. Based on the data provided by the USGS and the USACE, the cumulative deviation has decreased dramatically since 1999. This in part can be attributed to the levels of Lake Michigan and the reduction in leakage at the CRCW as a result of the repairs made to the lock gates and completion of the new turning basin all by the summer of 2000. The continued reduction in Lake Michigan pumpage since the early 1990s reflecting an aggressive campaign by the City of Chicago to repair leaky water mains also has contributed to the reduction in the cumulative deviation from allowed diversion flows.

Figure 14 shows Annual Domestic Pumpage from 1981-2008. The line chart shows a peak in pumpage in 1988, followed by a steady decline. During this period, the proportion of withdrawn groundwater steadily decreased. By 2003, the difference between total pumpage and water withdrawn from Lake Michigan is negligible.

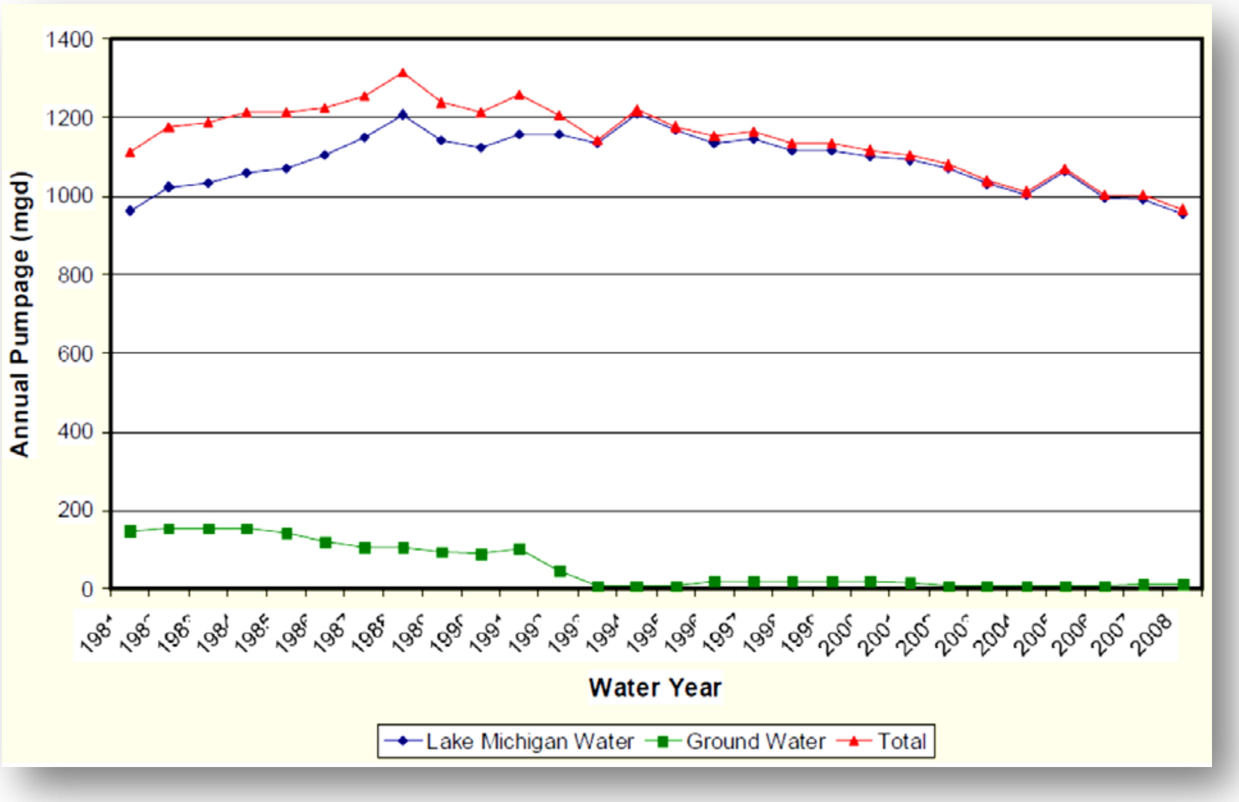

Figure 14. Annual Domestic Pumpage (MGD) 1981-2008.

The size of Illinois' lake diversion can change dramatically from year to year, and the changes are challenging to predict. A major influence on the lake diversion is climate variability, since climate affects precipitation, runoff, and Lake Michigan water levels. Several measures or tools can be implemented to make more water available for domestic/public supply use. Such measures include, for example, completion of the Tunnel and Reservoir Project (TARP).

Figure 15 provides a summary of diversion flows for Water Year 2009, the most recent diversion accounting report to date. The total WY09 Lake Michigan diversion accountable to the State of Illinois is 3,135 cfs (Column 10). This diversion is 65 cfs less than the 3,200 CFS average specified by the Decree. The running average to date, beginning with WY81, and rounded to the nearest CFS is 3,164 CFS.

LAKE MICHIGAN DIVERSION ACCOUNTING WY 2009	LEMONT AVM GAGE RECORD	DIVERSIONS ABOVE THE GAGE	TOTAL FLOW THROUGH THE CANAL	GROUNDWATER PUMPAGE DISCHARGED INTO THE CANAL	WATER SUPPLY PUMPAGE FROM INDIANA REACHING THE CANAL	RUNOFF FROM THE DES PLAINES RIVER WATERSHED REACHING THE CANAL	LAKE MICHIGAN PUMPAGE BY FEDERAL FACILITIES DISCHARGED TO THE CANAL	TOTAL DEDUCTION FROM THE LEMONT GAGE RECORD	LAKE MICHIGAN PUMPAGE NOT DISCHARGED TO THE CANAL	TOTAL DIVERSION ACCOUNTABLE TO THE STATE OF ILLINOIS	PUMPAGE FROM LAKE MICHIGAN ACCOUNTABLE TO THE STATE OF ILLINOIS	RUNOFF FROM THE DIVERTED LAKE MICHIGAN WATERSHED	DIRECT DIVERSION ACCOUNTABLE TO THE STATE OF ILLINOIS
DATE	1	2	3	4	5	6	7	8	9	10	11	12	13
Oct-08	2,721.7	-	2,721.7	67.3	15.9	180.1	0.6	263.9	225.6	2,683.4	1,248.1	667.8	459.8
Nov-08	1,470.2	-	1,470.2	39.1	8.6	89.4	0.4	137.5	213.9	1,546.6	1,185.9	314.3	43.0
Dec-08	3,629.2	-	3,629.2	82.9	8.4	525.7	0.6	617.6	220.8	3,232.3	1,256.1	2,429.1	42.1
Jan-09	2,262.3	-	2,262.3	51.2	7.8	170.1	0.6	229.7	226.2	2,258.7	1,298.4	537.2	52.5
Feb-09	3,452.7	-	3,452.7	87.2	7.5	376.1	0.7	471.5	224.5	3,205.8	1,280.3	1,829.6	84.6
Mar-09	4,598.8	-	4,598.8	90.1	14.5	602.9	0.6	708.1	213.1	4,103.7	1,232.1	2,568.9	65.5
Apr-09	4,144.2	-	4,144.2	106.4	17.5	408.5	0.6	533.0	215.4	3,826.7	1,207.8	1,938.7	128.6
May-09	3,704.8	-	3,704.8	95.3	22.0	342.1	0.6	460.1	239.6	3,484.4	1,287.4	1,406.4	234.9
Jun-09	4,286.9	-	4,286.9	92.0	23.6	317.1	0.5	433.2	252.7	4,106.4	1,353.9	1,498.3	666.0
Jul-09	2,915.7	-	2,915.7	54.1	27.2	85.2	0.7	167.3	277.5	3,025.9	1,432.3	325.9	889.9
Aug-09	3,419.6	-	3,419.6	76.9	24.3	177.7	0.9	279.8	281.8	3,421.6	1,485.4	864.0	909.8
Sep-09	2,601.6	-	2,601.6	44.7	17.9	74.7	0.5	137.9	259.5	2,723.2	1,403.9	241.8	963.4
Averages	3,267.3	-	3,267.3	73.9	16.3	279.0	0.6	369.8	237.7	3,135.2	1,307.1	1,215.9	381.6

Computations:

1. Column 3 equals the sum of Columns 1 and 2.
2. Column 8 equals the sum of Columns 4 through 7.
3. Column 10 = Column 3 - Column 8 + Column 9.

Note: The averages presented in the final row are calculated from the daily values contained in Appendix B.

Deductions from the Lemont Gage Record

Additions to the Lemont Gage Record

Figure 15. Lake Michigan Diversion Accounting for Water Year 2009, Summary of Diversion Flows (CFS).

Figure 16 shows the total average annual flows of different components of the Lake Michigan Diversion from 2000-2005. Lake Michigan Pumpage makes up the greatest proportion, followed by diverted runoff and then direct diversions.

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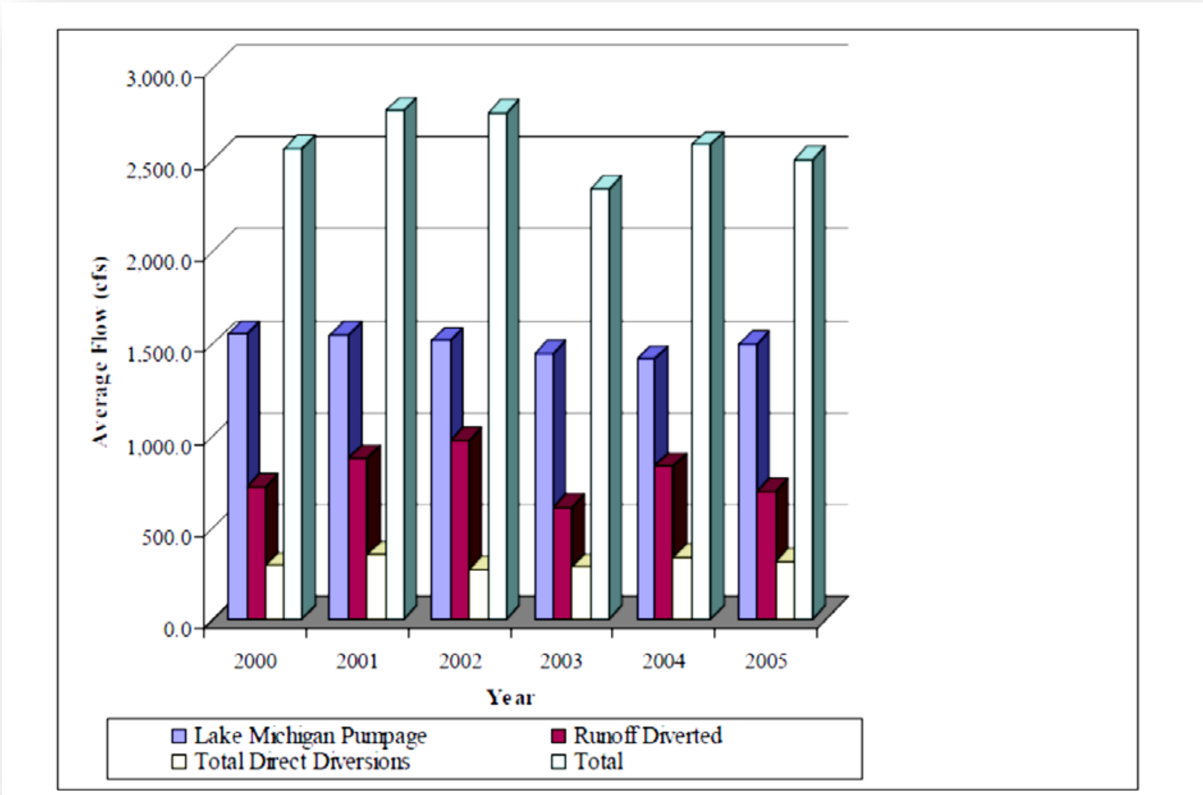

Figure 16. Total Average Annual Flows of Different Components of the Lake Michigan Diversion, 2000-2005 (CFS).

B. Future Demand for Water Supply

a. Future Demand in Northeast Illinois

As described, the *Demand Report* forecasts water-demand under three scenarios. The three scenarios represent water withdrawals under current demand conditions representing the baseline scenario, a less resource intensive scenario, and a more resource intensive scenario, extended to the year 2050. The explanatory variables investigated in *Demand Report* to forecast future conditions included: Air temperature, Precipitation, Employment fraction, Price of water, Median household income, Cooling degree-days, Manufacturing employment (%), Transportation employment (%) Fraction of self-supplied (%), Conservation trend, Rainfall deficit, Unit-use coefficients, and Median household income.

The main driver of increased water demand into the project future is population growth and the resulting regional economic growth. Figure 17 shows historical and projected population growth until 2050. Population in Northeast Illinois is expected to exceed 12 million people by 2050, with most growth occurring in Cook and Collar Counties.

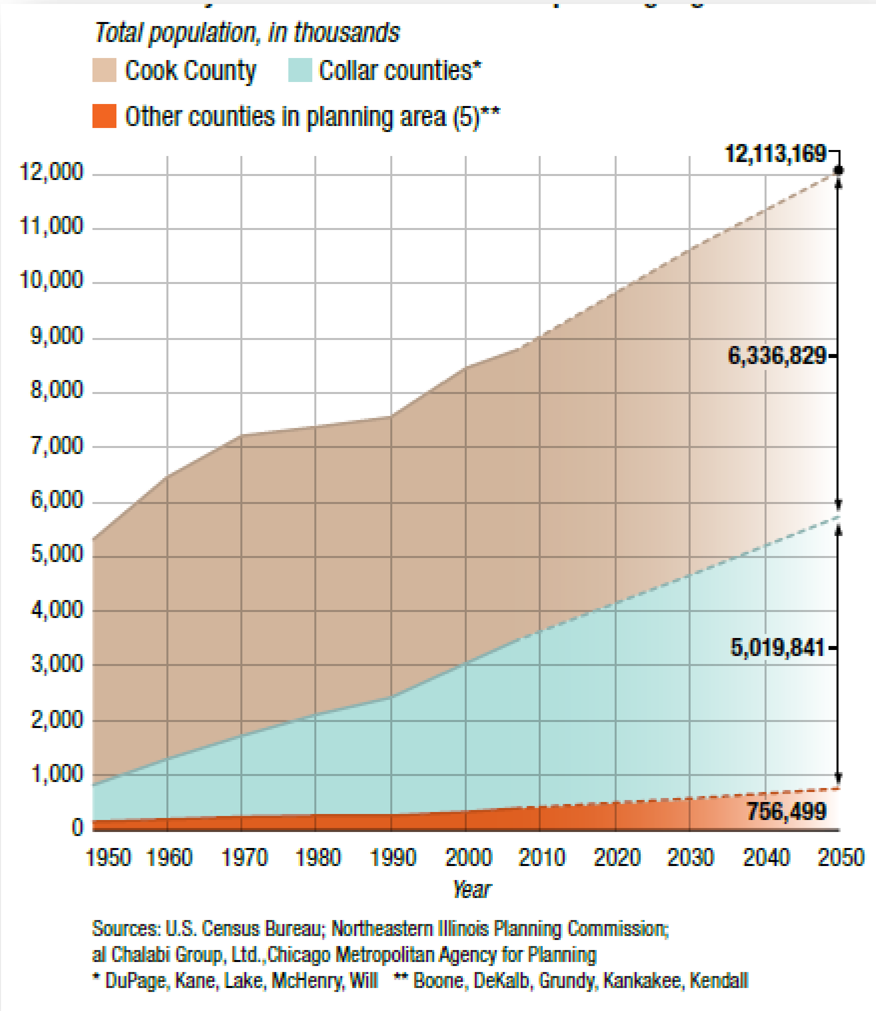

Figure 17. Projected Population Growth in Northeast Illinois. Source: Water Plan.

Figure 18 provides a summary of the future scenarios of average day water withdrawals for six categories of users within the four major sectors. For 2005, both the reported values and weather adjusted values (where adjustments were possible) are shown. The future scenario withdrawals in 2050 are compared to 2005 values – both withdrawal numbers represent normal weather conditions. The last column of the table shows changes in 2050 withdrawals relative to the baseline CT scenario.

Scenario/ Sector	2005 Reported With-drawals	2005[a] Normal With-drawals	2050 Normal With-drawals	2005-2050 Change MGD	2005-2050 Change (%)	Change From CT Scenario MGD
CT- Current Trends (Baseline)						
Public Supply	1,255.7	1,189.2	1,570.2	381.0	32.0	0.0
Self-supplied I&C	191.6	162.4	291.6	129.2	79.6	0.0
Self-supplied Domestic	36.8	31.8	41.2	9.4	29.6	0.0
Irrigation and Agriculture	62.0	44.6	55.4	10.8	24.2	0.0
Power Plants (Makeup)	52.3	52.3	52.3	0.0	0.0	0.0
Power Plants (Through flow)	4,207.2	4,207.2	3,830.2	-377.0	-9.0	0.0
Total - All sectors	5,805.6	5,687.5	5,840.9	153.4	2.7	0.0
Total w/o through-flow power	1,598.4	1,480.3	2,010.7	530.4	35.8	0.0
LRI – Less Resource Intensive						
Public Supply	1,255.7	1,189.2	1,217.9	28.7	2.4	-352.3
Self-supplied I&C	191.6	162.4	222.1	59.7	36.8	-69.5
Self-supplied Domestic	36.8	31.8	37.3	5.5	17.3	-3.9
Irrigation and Agriculture	62.0	44.6	43.8	-0.8	-1.8	-11.6
Power Plants (Makeup)	52.3	52.3	66.4	14.1	27.0	14.1
Power Plants (Through flow)	4,207.2	4,207.2	2,472.3	-1,734.9	-41.2	-1,357.9
Total - All sectors	5,805.6	5,687.5	4,059.8	-1,627.7	-28.6	-1,781.1
Total w/o through-flow power	1,598.4	1,480.3	1,587.5	107.2	7.2	-423.2
MRI – More Resource Intensive						
Public Supply	1,255.7	1,189.2	1,837.2	648.0	54.5	267.0
Self-supplied I&C	191.6	162.4	391.4	229.0	141.0	99.8
Self-supplied Domestic	36.8	31.8	49.3	17.5	55.0	8.1
Irrigation and Agriculture	62.0	44.6	60.7	16.1	36.1	5.3
Power Plants (Makeup)	52.3	52.3	90.8	38.5	73.6	38.5
Power Plants (Through flow)	4,207.2	4,207.2	3,830.2	-377.0	-9.0	0.0
Total - All sectors	5,805.6	5,687.5	6,259.6	572.1	10.1	418.7
Total w/o through-flow power	1,598.4	1,480.3	2,429.4	949.1	64.1	418.7

Figure 18. Summary of Water Withdrawal Scenarios for Northeastern Illinois (in MGD). Source: Demand Report.

Future demands in all sectors are likely to be higher if future annual average air temperature increases and/or annual precipitation decreases. If, by 2050, temperature increases by 6ºF, total withdrawals would increase by 178.0 mgd (9.1 percent) above baseline scenario values.

Future demands will also likely increase during future droughts. Given a re-occurrence of a worst historical drought, with a 40 percent deficit in precipitation during the summer growing season, total water withdrawals in 2050 would increase by 128.1 mgd (or 6.5percent) as compared to the baseline scenario.

With respect to the 11-county study area in Northeastern Illinois, the large growth in total water withdrawals of 530.4 mgd under the baseline scenario and 949.1 mgd under More-Resource-Intensive scenario makes a compelling case for the need to manage regional water demands. Meeting these additional demands would require large capital outlays on water infrastructure and would likely have significant impacts on some of the regional sources of water supply, especially groundwater aquifers and local rivers.

b. Future Demand for Lake Michigan Diversion

Chicago water supply from Lake Michigan is not naturally constrained. The Diversion limit of 2,068 MGD is very real in that it is a legal and institutional constraint, but this does not imply that Lake Michigan water intakes near Chicago are incapable of exceeding the diversion limit. Groundwater sources, however, are naturally constrained. Drawdown causes water levels in wells open to the aquifers to decline, decreasing well yields, increasing pumping expenses and, in extreme cases, causing water supply interruptions that can only be addressed by replacement of the wells or lowering of pumps. Simulations of baseline scenario pumping suggest that Ancell and Ironton-Galesville heads in southeastern Kane County and northern Will County will have declined by over 800 and over 1,500 feet, respectively, by 2050. As these resources expire or become impractical for use, demand for Lake Michigan Water Supply may increase. Figure 19 shows the estimated total Lake Michigan Diversion from 2015-2050. Under the Less Resource Intensive scenario, the Lake Michigan Diversion is expected to remain static through 2050 at approximately 1,625 MGD. Under the Baseline Scenario, the Lake Michigan Diversion is expected to steadily increase from 1,750 MGD in 2015 to approximately 1,925 MGD in 2050 (still below the Diversion Limit). Under the More Resource Intensive Scenario, the Lake Michigan Diversion is expected to reach 2,098 MGD by 2050, exceeding the limit by 30 MGD.

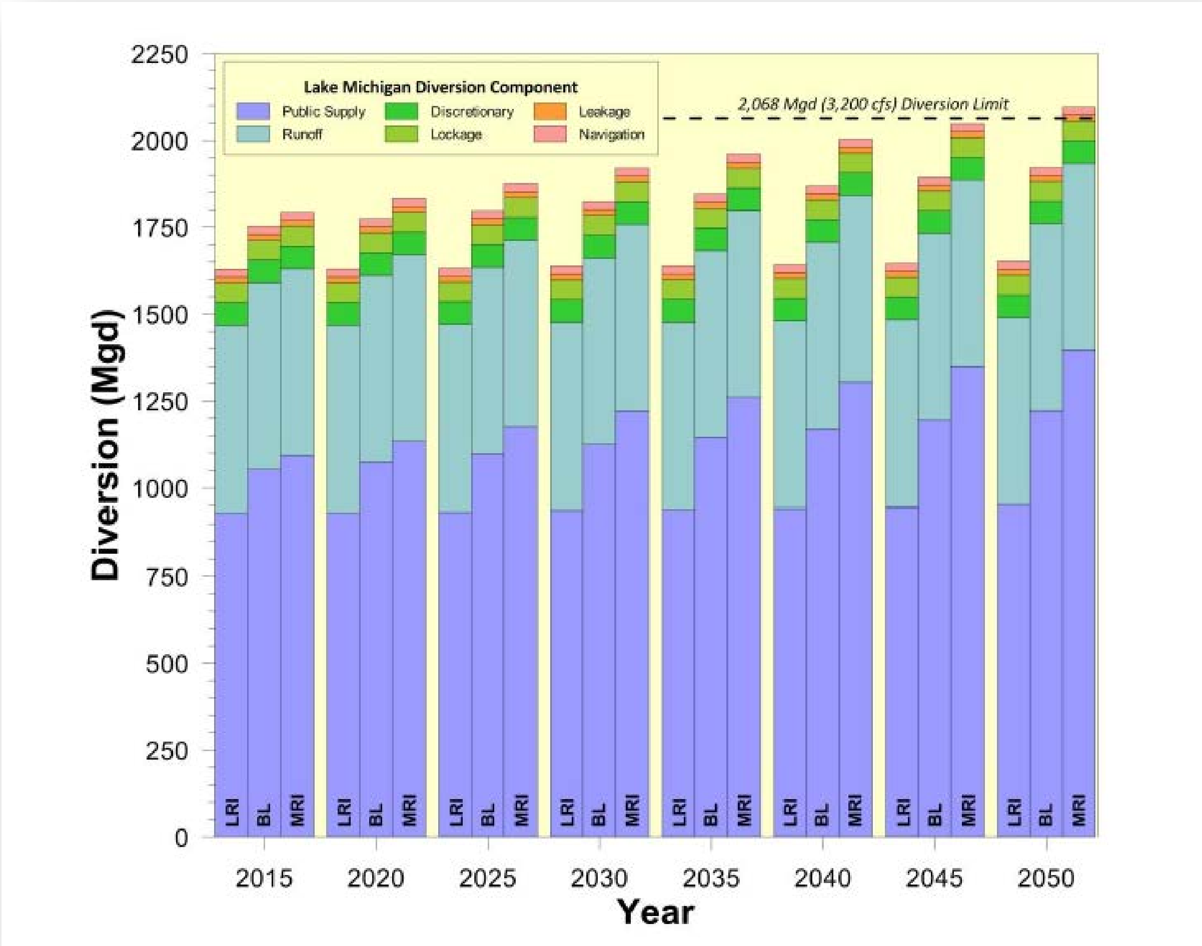

Figure 19. Estimated total Lake Michigan Diversion, 2015-2050. Source: Groundwater Report.

Steadily increasing public supply (pumpage) is the main factor causing the projected increases in the Lake Michigan Diversion. Under the 1967 Supreme Court Decree, domestic use of lake water (public supply) has priority over other uses (i.e., diversions into the Chicago Sanitary and Ship Canal). Projected public supply withdrawals in 2050 range from 953 MGD under the Less Resource Intensive Scenario, 1,223 MGD under the Baseline Scenario, and 1,397 MGD under the More Resource Intensive Scenario. See Figure 20, below.

Year	*BL Scenario*	*LRI Scenario*	*MRI Scenario*
2015	1,054	931	1,094
2020	1,075	931	1,134
2025	1,098	934	1,176
2030	1,125	939	1,221
2035	1,146	940	1,261
2040	1,170	943	1,304
2045	1,195	947	1,349
2050	1,223	953	1,397

Figure 20. Estimated Lake Michigan Public Supply Withdrawals (MGD). Source: Demand Report via Groundwater Report.

The state's diversion over the past 14 years has remained consistently below the court limit. Per capita use appears to be on a slight downward trend, and Lake Michigan water levels remain below the long-term average, resulting in less diversion for lockage and leakage. In 2015, completion of the TARP is expected to reduce discretionary diversion into the CSSC by about 110 MGD. Although the Lake Michigan water allocation program must remain flexible to remain in compliance with the Decree, IDNR believes that it can accommodate an increase of about 50–75 MGD in public water demand without major changes in diversion management policy (while also continuing to satisfy growing water demand within the current Lake Michigan service area).

IX. POTENTIAL IMPACTS TO WATER SUPPLY (WITH PROJECT CONDITIONS)

The with-project conditions scenario assumes implementation of basin hydro-separation between the Great Lakes and the Mississippi River Watersheds. The Lake Michigan Diversion would therefore cease to exist. Water used in the Chicago area, including wastewater and runoff, would return to Lake Michigan.

Under this scenario, the U.S. Supreme Court Decree in the Wisconsin, et. al. v. Illinois et. al., 388 U.S. 426,87 S.Ct. 1774 (1967), as modified, would essentially become irrelevant. Water diverted from Lake Michigan would be used by the various sectors, as predicted in the three demand scenarios, and ultimately discharged back to the lake. The meticulous accounting of the Lake Michigan diversion would no longer be required or relevant and water originating from Lake Michigan to supply the Chicago area would not be constrained. The More Resource-Intensive demand model scenario forecasted that by 2050, demand for water in the Chicago Area could exceed the maximum allowable Lake Michigan Diversion. In terms of water *supply* alone, basin hydro-separation could alleviate future conflict between water users in the Chicago area.

Water *quality* under with-project conditions, however, poses a separate challenge. At present domestic pumpage from Lake Michigan is used for water supply and its effluent is discharged to the canals by various Water Reclamation Plants. The Water Reclamation Plants that divert domestic pumpage from the lake either discharge to the canal system or to the Des Plaines River and its tributaries. Treated wastewater, along with runoff from rainfall, enters local canals, rivers and streams that serve as headwaters of the Illinois River system. Under a with-project conditions scenario, this effluent would be treated by the Metropolitan Water Reclamation District of Greater Chicago, and then ultimately returned to Lake Michigan. Impacts associated water treatment standards and costs are being evaluated under a separate assessment.

X. PRICE OF WATER

The Demand Report included the price of water as an explanatory variable in the development of the three future water demand scenarios. The current trend, used in the development of the baseline scenario for Northeast Illinois, indicates that the price of water will increase 0.9% per year. Higher future price increases of 2.5% per year were used to forecast the less-resource intensive scenario, as higher prices would curb per capita usage. The more-resource intensive scenario assumed that prices will remain at 2005 levels in real terms.

Future changes in retail water prices will result in changes of per capita water usage as determined by the estimated price elasticity of -0.1458. Future values of marginal price will depend on the adoption of pricing strategies by retail water suppliers as well as the frequency of rate adjustments. Water rate structures often remain unchanged for several years thus resulting in a decline of real price with respect to inflation. There is an expectation in the water supply industry, however, that in the future the retail prices for water will increase faster than inflation because of several factors – water quality issues will require more investment in treatment processes, the increasing cost of energy, and the other increasing water system costs, especially infrastructure replacement costs.

Recent trends in water prices were determined from a survey of water rates in Illinois (Dziegielewski, Kiefer and Bik, 2004). The data for 219 water systems in Illinois showed only a 3 percent increase in median value of total water bill at the consumption level of 5,000 gallons per month between 1990 and 2003 (increasing from $18.18 in 1990 to $18.70 in constant 2003 dollars). During the same period, the median value of the marginal price of water increased from $2.59 to $2.90, which represents an increase of 12 percent (in constant 2003 dollars) or 0.9 percent per year. The modest increase in price is a result of a number of systems which kept the nominal prices of water unchanged. Real water price declined (due to inflation) in 112 systems and was increased in 107 systems. The average increase in the 107 systems in terms of total bill was 25 percent, and 39.6 percent in average marginal price (or 2.6 percent per year).

ATTACHMENT 11

HYDROPOWER

Baseline Economic Assessment of Hydropower Generation – Lockport Powerhouse

August 2013

U.S. Army Corps
of Engineers
Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

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EXECUTIVE SUMMARY:

In support of the Great Lakes and Mississippi River Study (GLMRIS) an array of alternative plans were developed which seek to prevent the transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River Basins. In order to address the potential impacts of implementing any of the alternative plans on hydropower generation within the Chicago Area Waterway System (CAWS), a baseline assessment of the current hydropower generation at Lockport Powerhouse was completed. This report briefly describes the Lockport Powerhouse project and the regional energy landscape for the State of Illinois. The report then quantifies the current average annual generation, energy value and dependable capacity values. The findings of this analysis serve as a basis for which future without-project (FWOP) and future with-project (FWP) conditions will be compared.

GLMRIS BACKGROUND INFORMATION:

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River basins by aquatic pathways

An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (FY13).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

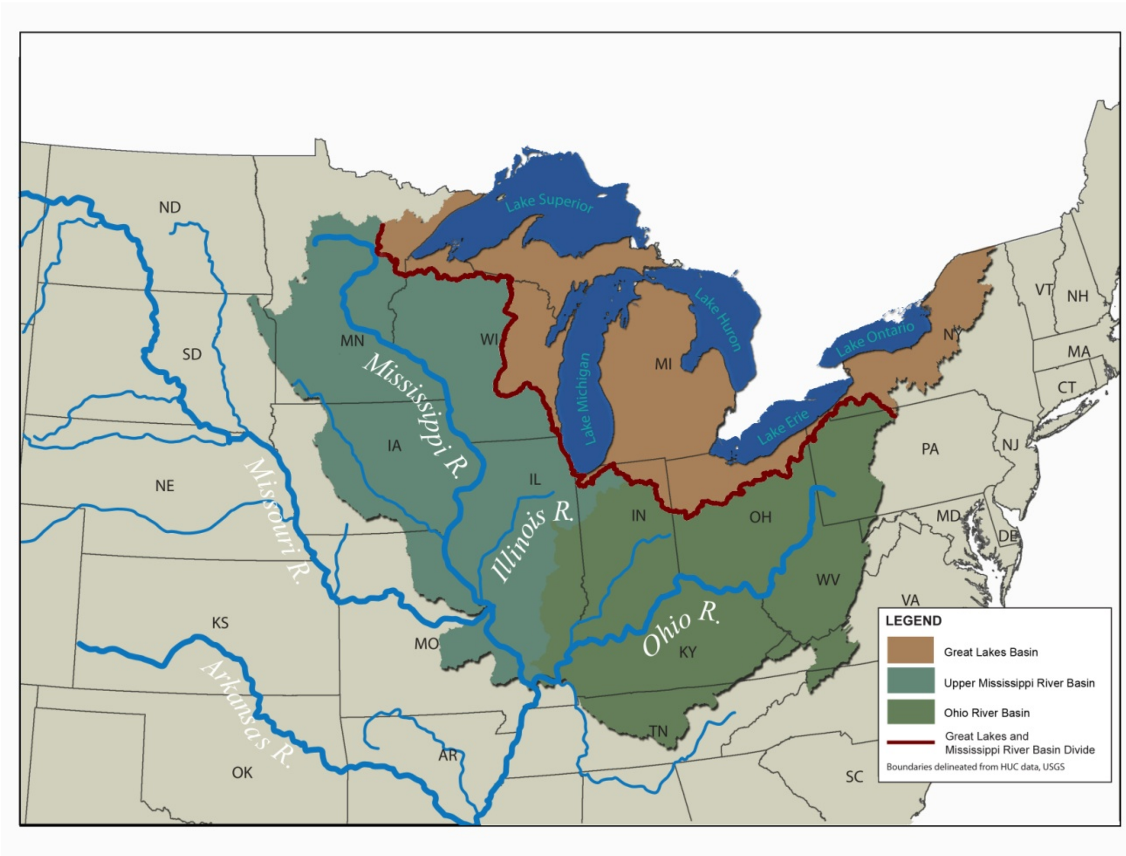
Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

GLMRIS STUDY AREA

The GLMRIS study area includes portions of the Great Lakes, Mississippi River, and Ohio River Basins that fall within the United States.

Figure 1: GLMRIS Study Area Map



Potential aquatic pathways between the Great Lakes, Mississippi River, and Ohio River Basins exist along the basins' shared boundary (illustrated in *Figure 1: GLMRIS Study Area Map*). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi and Ohio River Basins (green shaded areas) and the Great Lakes Basin (brown shaded area).

The Chicago Area Waterway system consists of a number of rivers, locks and canals that connect Lake Michigan with the Mississippi River system via the Illinois River. Focus Area I, the Chicago Area Waterway System, as shown in Figure 2, is the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins. It, therefore, poses the greatest

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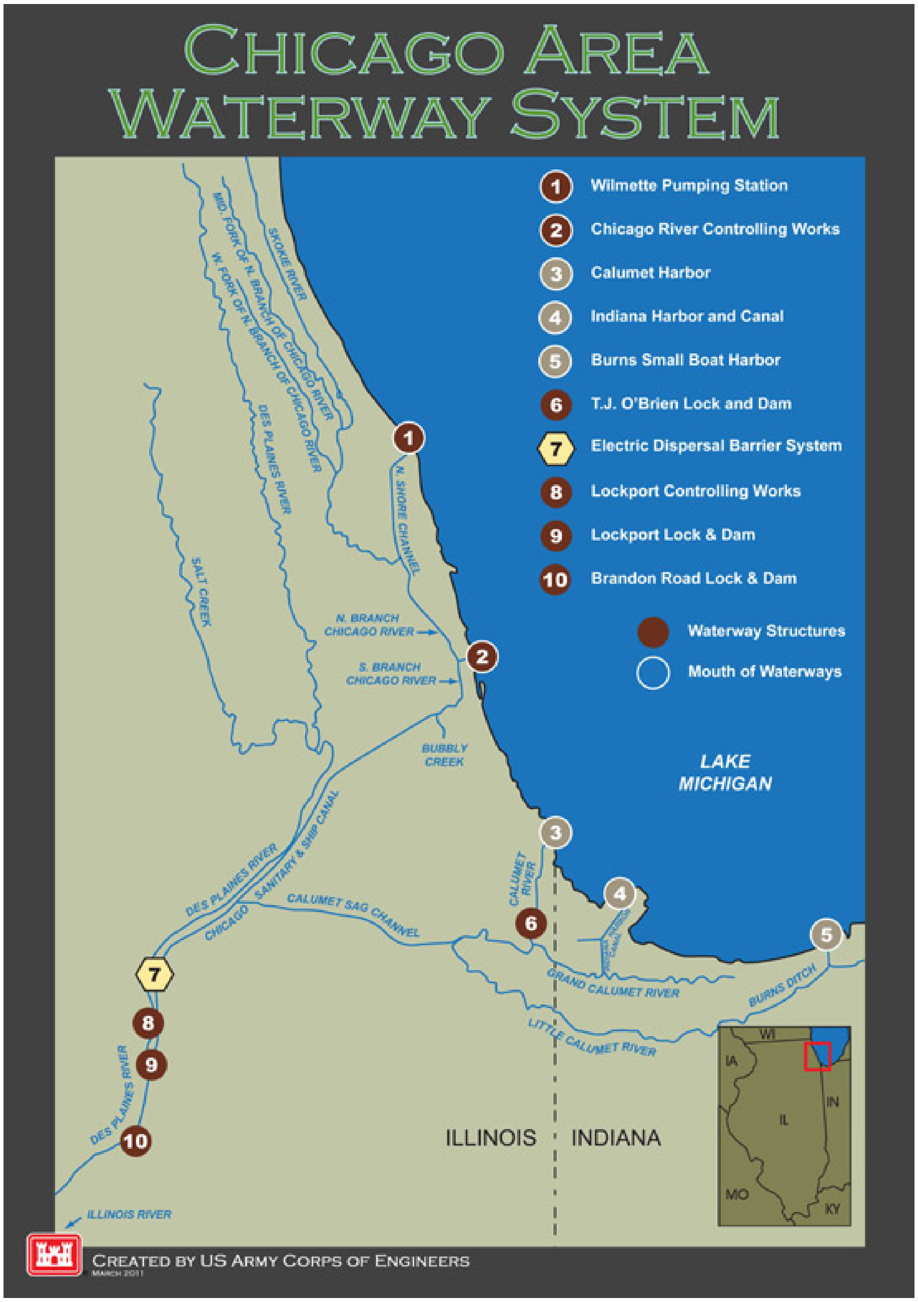


Figure 2. Chicago Area Waterway System

NAVIGATION AND ECONOMICS PRODUCT DELIVERY TEAM:

In support of the Great Lakes and Mississippi River Interbasin Study, the Navigation and Economics Product Delivery Team (PDT) was formed. The PDT was tasked with assessing the current value of *economic* activities within the GLRMIS detailed study area that *could* change with the implementation (FWP condition) or lack of implementation (FWOP condition) of a GLMRIS project. The PDT is comprised of several sub-teams, each of which focuses on a specific economic activity within the GLRMIS study area. These categories include:

Navigation Related Economic Categories
- Commercial Cargo
- Non-Cargo Related Navigation

Other Related Economic Categories
- Flood Risk Management
- Hydropower
- Commercial and Recreational Fishery[1]
- Water Quality
- Water Supply
- Regional Economics

Hydropower Focus:

In support of the Navigation and Economics PDT, the Hydropower Team was formed to address the future changes in hydropower generation that may occur in the case where Federal action is taken (i.e., the future with-project condition) or is not taken (i.e., the future without-project condition) to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins.

[1] Charter and subsistence fishing, as well as pro-fishing tournaments will also be assessed.

LOCKPORT POWERHOUSE PROJECT DESCRIPTION:

The Chicago Sanitary & Ship Canal (CSSC) was completed in 1900, with the purpose of preventing sewage from flowing into Lake Michigan. Originally, the canal terminated at the Lockport Controlling Works. However, it was soon extended to meet the Des Plaines River, in the interest of navigation. Because of an existing significant water elevation change on the canal extension, the Lockport Powerhouse was constructed there in 1907. The powerhouse initially housed seven horizontal generators.

Vertical generators, with their greater efficiency, replaced two of the horizontal generators in 1935. The remaining five horizontal generators were then slowly retired. One of the original vertical generators was replaced by a more efficient generator, with a rated capacity of 6.5 megawatts (MW) in 1999. The second original generator was replaced in 2001. It too has a rated capacity of 6.5 MW. In addition to controlling the generators, the Waterways Control Room at Lockport is also responsible for control of canal levels to prevent flooding and river backup into Lake Michigan, while also maintaining commercial and recreational navigation on the Chicago Area Waterway.

The Lockport Powerhouse is owned and operated by the Metropolitan Water Reclamation District of Greater Chicago (MWRD), formerly the Metropolitan Sanitary District of Greater Chicago. The mission of MWRD is to keep sewage pollution out of Lake Michigan (the area's drinking water supply); to treat sewage to avoid contamination of the Chicago, Des Plaines and Illinois Rivers; and, to remove obstructions to navigation from these bodies of water.

In 1957, the MWRD signed a fifty-year agreement with Commonwealth Edison (ComEd) to buy and sell power generated at the MWRD facilities. During this time period, the MWRD received a credit for the power used at other MWRD facilities in lieu of payment. When the original contract expired in 2007, a new compensation contract was established based on PJM projected Locational Marginal Pricing (Yurik, 2012). Table 1 below provides the MWRD's annual revenue for the years 2007 through 2011 associated with the Lockport Powerhouse. Revenues in 2010 and 2011 were significantly lower due to a drop in natural gas prices.

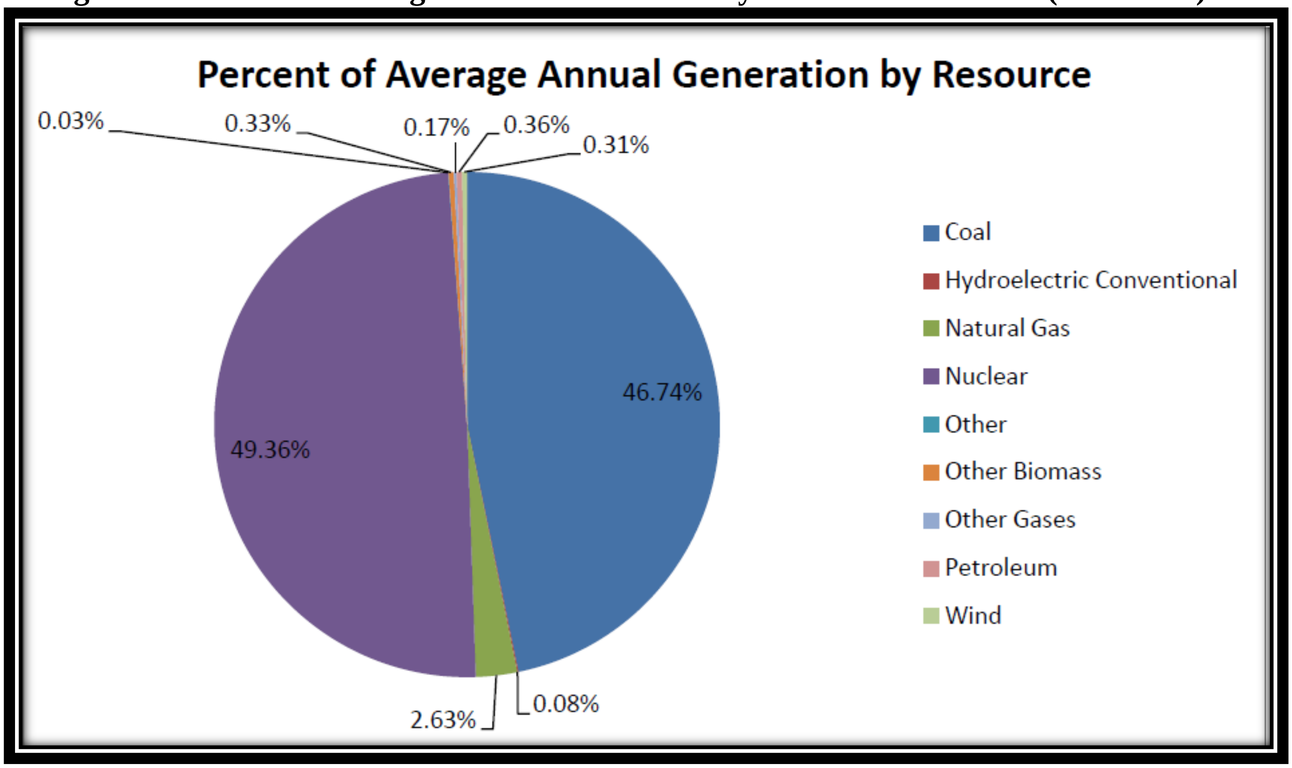
Table 1: MWRD Annual Revenue for Lockport Powerhouse (Years 2007-2011)

Year	Revenues (2012 Dollars)
2007	$1,759,000
2008	$2,729,000
2009	$1,970,000
2010	$1,080,000
2011	$1,329,000

REGIONAL ENERGY LANDSCAPE

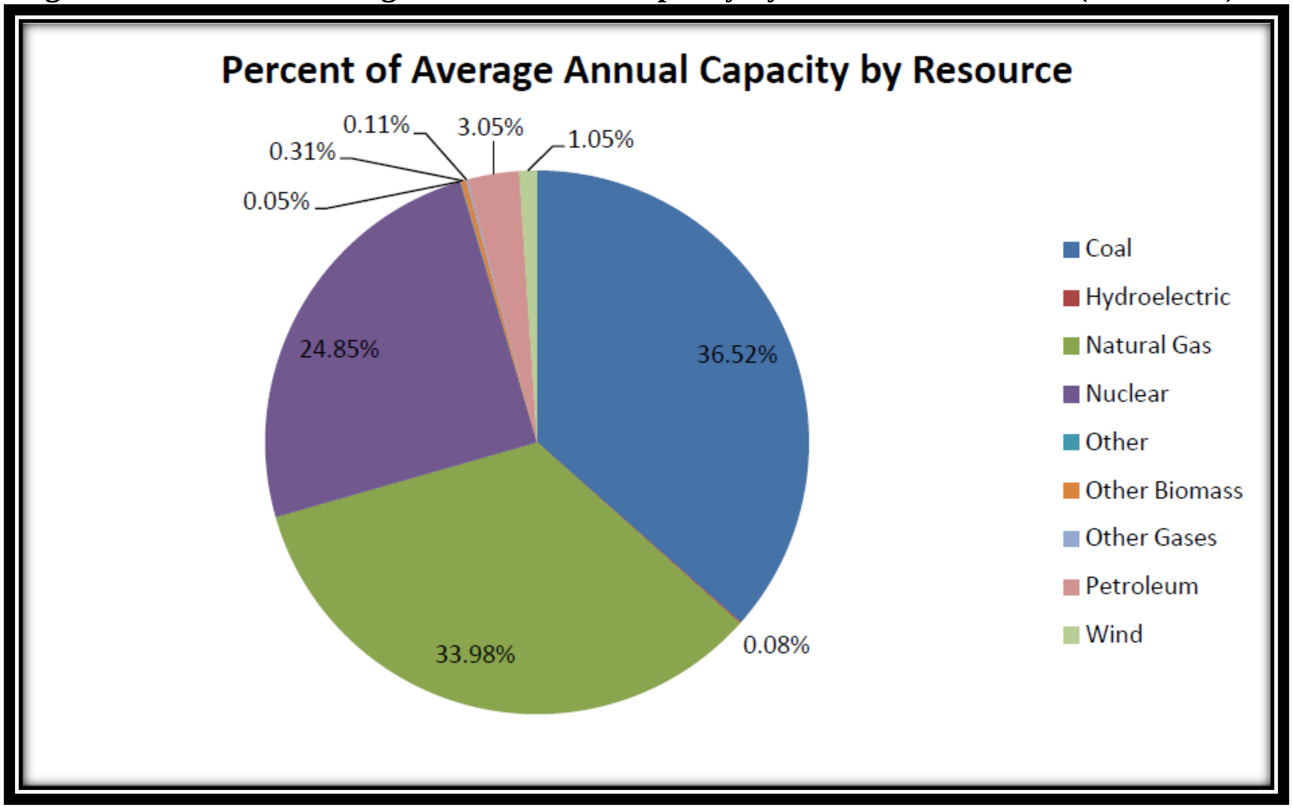
This section presents a brief summary of the energy landscape in the State of Illinois. Figure 3 displays the average annual generation in the state for the period from 1990 to 2010, broken down by energy source. Taken together, coal and nuclear account for approximately 96 percent of the region's average annual generation, amounting to 321,600 gigawatt hours (GWh). Natural gas accounts for 2.6 percent of generation, or approximately 8,800 GWh annually. Of the remaining 1.4 percent of Illinois' generation, 0.08 percent comes from hydroelectric power, about 270,000 MWh annually (Figure 1).

Figure 3: Percent of Average Annual Generation by Resource for Illinois (1990-2010)



The capacity picture for the region is shown in the Figure 3. Coal accounts for about 36.5 percent of the State of Illinois' average annual capacity for the period from 1990 to 2010, or about 34,500 MW of nameplate capacity. Natural gas represents about 34 percent of the state's total capacity, which amounts to 33,600 MW, with another almost 25 percent (24,800 MW) of capacity accounted for by nuclear. Petroleum represents just over 3 percent (2,600 MW) of capacity, and of the remaining 1.5 percent, hydropower accounts for .08 percent (80 MW) (U.S. Energy Information Agency).

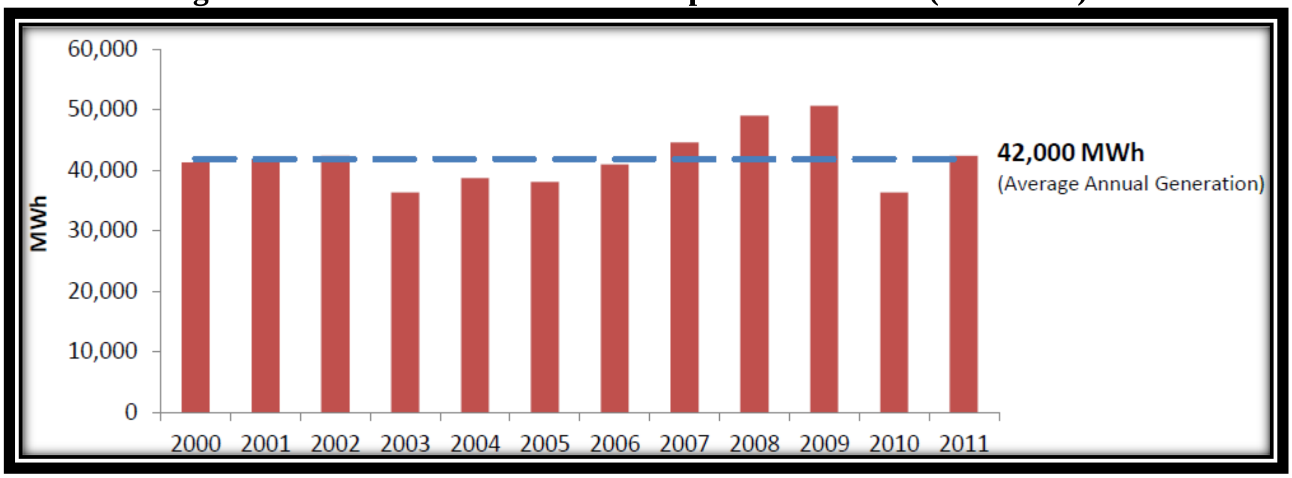
Figure 4: Percent of Average Annual Rated Capacity by Resource for Illinois (1990-2010)



ANNUAL GENERATION

The MWRD provided historical annual generation records from year 2000 to 2011 for the Lockport Powerhouse. During this period, annual generation ranged from a high of 50,000 MWh in 2009 to a low of 36,000 MWh hours in 2010 (Figure 3). Analysis over twelve years of data shows little to no evidence of annual trends in either reduction or growth. In this regard, the annual generation numbers are assumed to be acting independently and can be averaged over the historical record, yielding an average annual generation of 42,100 MWh.

Figure 5: Annual Generation for Lockport Powerhouse (2000-2011)



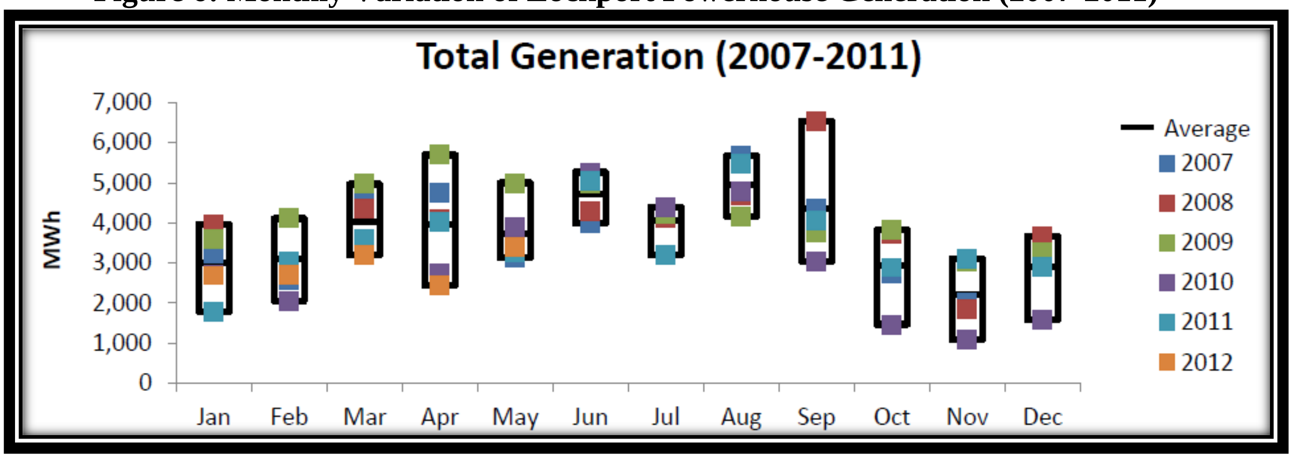
ANNUAL GENERATION

Demand for electricity can vary significantly throughout the day and year. During low demand periods, the least costly generating sources are used first. As demand increases over the duration of a period, more expensive generating resources are used, thus increasing the price of electricity. In this section we present a valuation of the Lockport generation. First, seasonality and peaking pattern of generation under current operations are defined. Second, the value of seasonal peak and off –peak electricity for the ComEd region is estimated. Finally, the value of Lockport's current generating pattern is determined.

Typical Seasonality and Peaking Capability of Generation

As shown in Figure 4, Lockport's generation demonstrates a modest seasonality. Minimum generation occurs during the winter months of October through November, while the maximum generation occurs during the summer months of June through September. To translate this seasonal pattern to an annual generation, each month's proportion of total annual generation was computed for 2007 through 2011 and then averaged.

Figure 6: Monthly Variation of Lockport Powerhouse Generation (2007-2011)



The contracts associated with ComEd's purchase of Lockport generation define two periods for compensation: a summer period from May through August, and non-summer period from September through April. Peak Hours for both the summer and non-summer periods fall between the hours of 9 am and 10 pm, Monday through Friday. All other hours are defined as Off-Peak (Yurik). This distribution corresponds to roughly 60 percent off-peak hours and 40 percent peak hours available for generation in any given week. Review of historic generation records shows that this distribution is consistent with actual generating patterns. Table 2 shows the average monthly generation, as well as estimated peak and off-peak energy generated by month.

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Table 2: Estimated Average Peak and Off-Peak Generation of Lockport Powerhouse by Month (2007-2011)

Month	Average % of Annual Generation	Average Generation (MWh)	Average % Peak Generation	Average % Off-Peak Generation	Peak Generation (MWh)	Off-Peak Generation (MWh)
January	7%	2,900	40%	60%	1,160	1,740
February	7%	2,900	40%	60%	1,160	1,740
March	9%	3,900	40%	60%	1,560	2,340
April	9%	4,000	40%	60%	1,600	2,400
May	9%	3,600	40%	60%	1,440	2,160
June	11%	4,500	40%	60%	1,800	2,700
July	9%	3,900	40%	60%	1,560	2,340
August	11%	4,800	40%	60%	1,920	2,880
September	10%	4,100	40%	60%	1,640	2,460
October	6%	2,700	40%	60%	1,080	1,620
November	5%	2,100	40%	60%	840	1,260
December	6%	2,700	40%	60%	1,080	1,620
*MWh stands for megawatt hours.						

Electricity Value

As shown in Figure 4, Lockport's generation demonstrates a modest seasonality. Minimum generation occurs during the winter months of October through November, while the maximum generation occurs during the summer months

For the ComEd distribution region, electricity value can be estimated using PJM's Locational Marginal Pricing (LMP). LMP is a computational technique that determines a shadow price for an additional kilowatt-hour (kwh) of demand. Ten years of hourly historic zonal LMP prices for the ComEd region is used in this analysis (PJM).

The value of energy has a seasonal trend based on demand and generating resource availability throughout the year. The seasonality of electricity value can be captured on a monthly level and is usually highly correlated with extreme temperatures of the summer. Another non-seasonal trend that can affect LMP is the price of natural gas, which is often the generating resource used in peak time periods. Figure 7 and Figure 8 illustrate the correlation of natural gas prices and peak LMP prices for the ComEd region for 2007-2012. For the years 2007 and 2008 natural gas prices averaged around \$9/1000 ft^3 and peak electricity prices averaged around \$70/MWh. In 2009 when natural gas prices fell to around \$5/1000 ft^3, peak electricity prices fell to around \$40/MWh (Energy Information Agency).

Figure 7: Historical Records of National Averaged Natural Gas Prices (2007-2012)

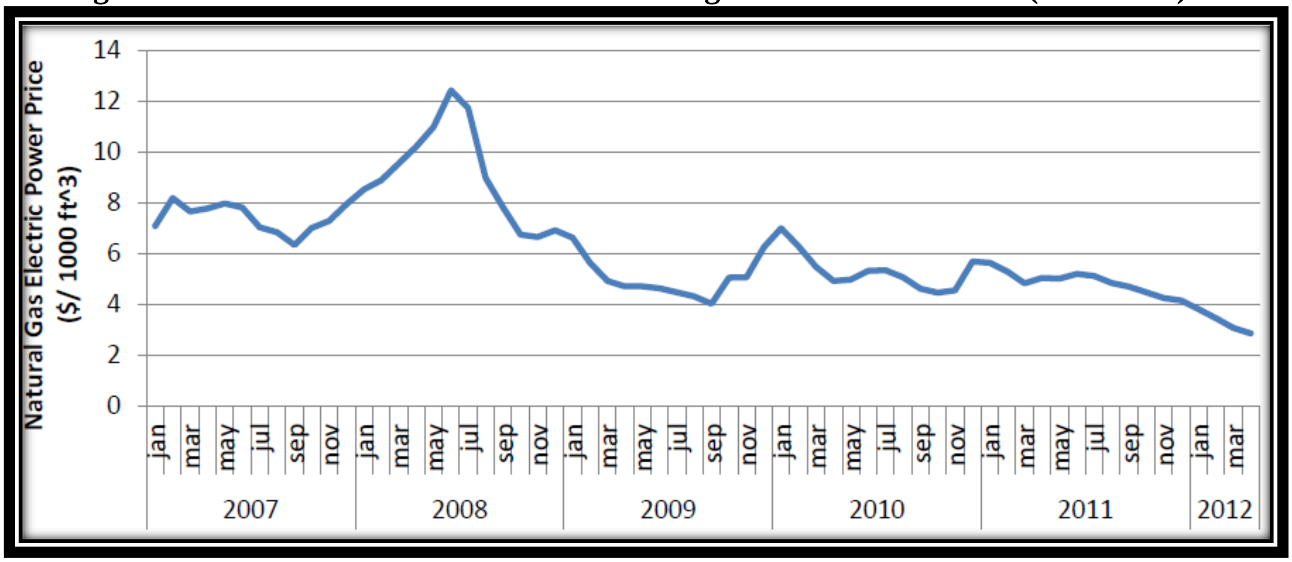
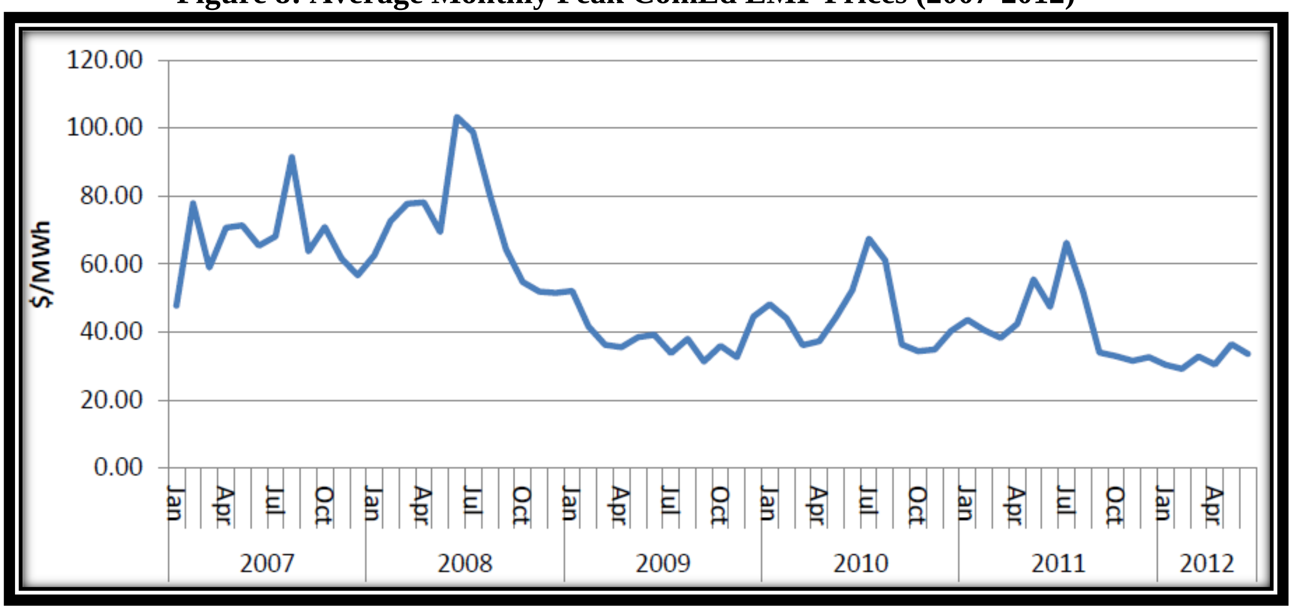
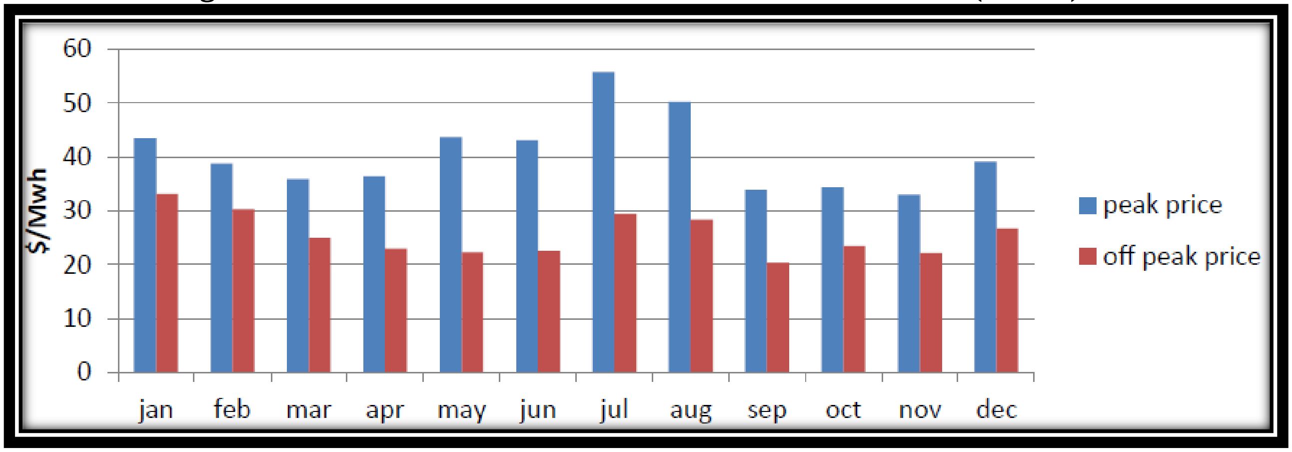


Figure 8: Average Monthly Peak ComEd LMP Prices (2007-2012)



Since 2009, natural gas prices have remained low and recent reports from the EIA suggest this trend will continue (Energy Information Agency). In that regard, the monthly average LMP price for this study are based on 2009 to 2011 LMP prices for both peak and off peak time periods. Monthly averages are computed in 2012 dollars and shown in Figure 7.

Figure 9: Estimated Peak and Off-Peak Prices for ComEd (2012 $)



Average Annual Energy Value of Lockport Powerhouse Generation:

Table 3 provides the monthly breakdown and average annual energy for the Lockport Powerhouse. The powerhouse energy value ranges from a low in November of $56,000 to a high in August of $178,000, three times November's value. The total annual energy value of $1.3 million resembles the MWRD's revenues associated with the Lockport Powerhouse (Table 3), after the fall of natural gas prices.

Table 3: Average Annual Energy Value of Lockport Generation by Month

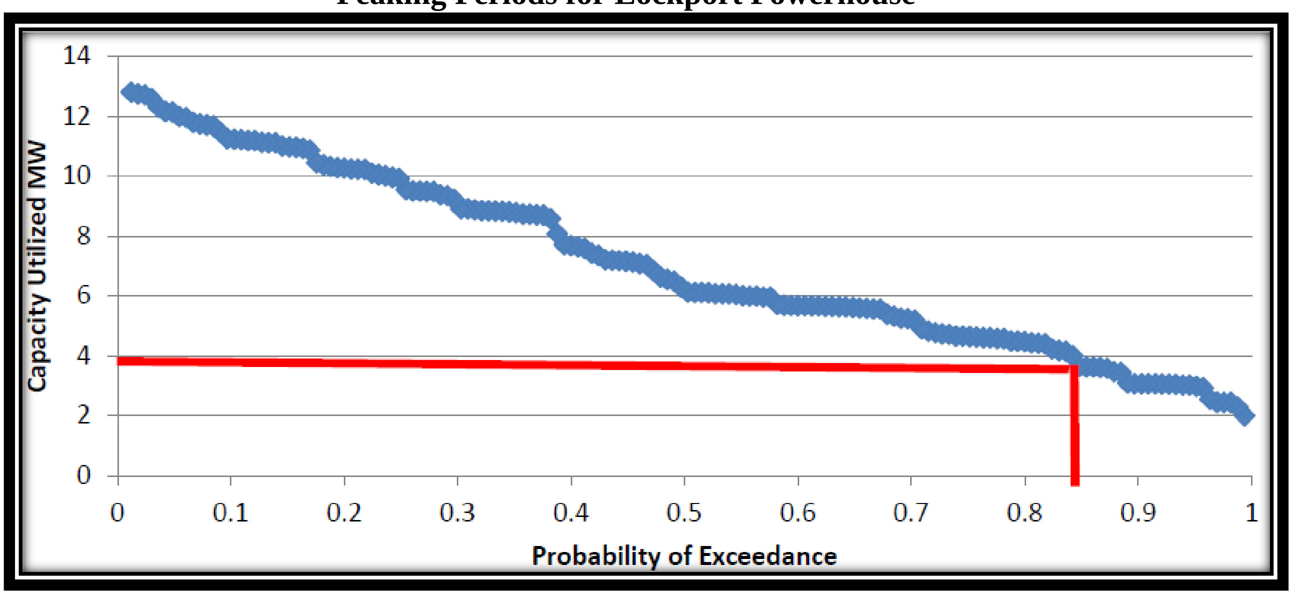
	Estimated Generation (MWh)		$/MWh (2012 dollars)		Energy Value
Month	**Peak**	**Off-Peak**	**Peak**	**Off-Peak**	
January	1,160	1,740	$43.54	$33.13	$108,000
February	1,160	1,740	$38.88	$30.29	$98,000
March	1,560	2,340	$35.88	$25.00	$114,000
April	1,600	2,400	$36.45	$23.05	$114,000
May	1,440	2,160	$43.72	$22.26	$111,000
June	1,800	2,700	$43.11	$22.57	$139,000
July	1,560	2,340	$55.85	$29.39	$156,000
August	1,920	2,880	$50.28	$28.40	$178,000
September	1,640	2,460	$33.89	$20.45	$106,000
October	1,080	1,620	$34.41	$23.48	$75,000
November	840	1,260	$33.00	$22.15	$56,000
December	1,080	1,620	$39.18	$26.65	$85,000
				Total	**$1,340,000**
*MWh stands for megawatt hours.					

DEPENDABLE CAPACITY

The dependable capacity of a hydropower project is a measure of the amount of capacity that the project can reliably contribute towards meeting system peak power demands. The Corps guidance on hydropower economics, EM 1110-2-1701 *Hydropower Engineering and Design*, suggests a number of methods to estimate dependable capacity. The different methods are based on available data, primary purpose of generating facility, and the facilities overall contribution to regional capacity. In this case, with limited data on a small facility whose primary purpose is not hydropower generation, the Specified Availability method is chosen (United States Army Corps of Engineers).

For the Specified Availability method, dependable capacity is based on the amount of capacity that is available during peak times for a specified percentage of the time. The specified percentage is based on the average availability of an alternative thermal plant, assumed to be 85 percent in this case. Thus the dependable capacity is obtained from the 85 percent exceedance on the generation–duration curve for the peak summer period of May to August. Since this is a measure of capability, daily maximum hourly output was used in developing the generation-duration curve shown in Figure 10. This daily maximum hourly generation represents the maximum amount of capacity utilized in a given day. The analysis shows that 4 MW of capacity can be defined as dependable for the Lockport Powerhouse.

Figure 10: Generation-Exceedance Graph of Maximum Daily Generation for Summer Peaking Periods for Lockport Powerhouse



Capacity Value

To associate a value to this dependable capacity, EM 1110-2-1701 suggests the use of a screening curve analysis to determine the most likely thermal alternative for Lockport generation. In this method, a linear equation is used to represent total annual cost (fixed capacity cost and variable energy cost) associated with a thermal alternative as a function of plant factor. (Equation 2).

$$AC = CV + (EV * 0.0876 * PF) \quad \text{(Equation 2)}$$

where:
AC = annual thermal generating plant total cost ($/kW-year)
CV = thermal generating plant capacity cost ($/kW-year)
EV = thermal generating plant operating cost ($/MWh)
PF = capacity utilization (actual output/max potential output)

When this equation is applied to multiple types of thermal generation resources, the screening curve provides an algebraic way to show which type of thermal generation is the least cost alternative for each plant factor range. As shown in the equation, the capacity value acts as the intercept of the linear equation and the energy value acts as the slope. In general, natural gas-fired generating resources have a small capacity cost, but more expensive energy value cost than coal-fired resources. This implies that for small plant factors, natural gas-fired generating resources will have the lowest cost, and as the plant factor increases coal may have the lowest annual cost.

Capacity and energy value cost for coal-fired steam (CO), gas-fired combined cycle (CC) and gas-fired combustion turbine (CT) plants were developed using procedures developed by FERC. These procedures utilize information obtained from the publication EIA Electric Power Monthly (DOE/EIA-0226) and other sources. The information obtained includes fuel costs, heat rates and variable O&M costs. Table 4 shows the capacity and energy values for the state of Illinois using 2012 dollars and assuming a 4 percent interest rate. As shown in Figure 9, the combustion turbine is cheapest up until a 20 percent plant factor. After that, the combined cycle is cheapest up until a 40 percent plant factor. Coal remains the cheapest for plant factors exceeding 40 percent (U.S. Energy Information Agency).

Table 4: Estimated Capacity and Energy Values for Alternative Thermal Resource in the State of Illinois

Illinois	Coal	CC	CT
Capacity Value ($/kW-yr)	$236	$122	$59
Energy Value ($/MWh)	$19	$52	$87
CC: Gas-fired combined cycle CT: Gas-fired combustion turbine			

A generation-exceedance curve is developed for the Lockport Powerhouse using hourly generating data from 2009 to 2011(Figure 10). Associating the exceedance probability in Figure 10 with the plant factor in Figure 9 allows one to estimate the thermal mix that might be used to replace the Lockport Powerhouse generation. About 6.5 MW of capacity is used 20 percent of the time, associating it with a combustion turbine. A combined cycle plant would replace 1.5 MW of capacity used between 20 and 40 percent of time. Coal is estimated to replace 5 MW of capacity utilized greater than 40 percent of the time. These capacity values are used to compute a weighted average unit capacity value for the Lockport Powerhouse. The resulting unit capacity value for Lockport Powerhouse is $134/kw-year (Table 5).

Figure 11: Estimated Annual Cost for Alternative Generating Resources for the State of Illinois as a Function of Plant Factor

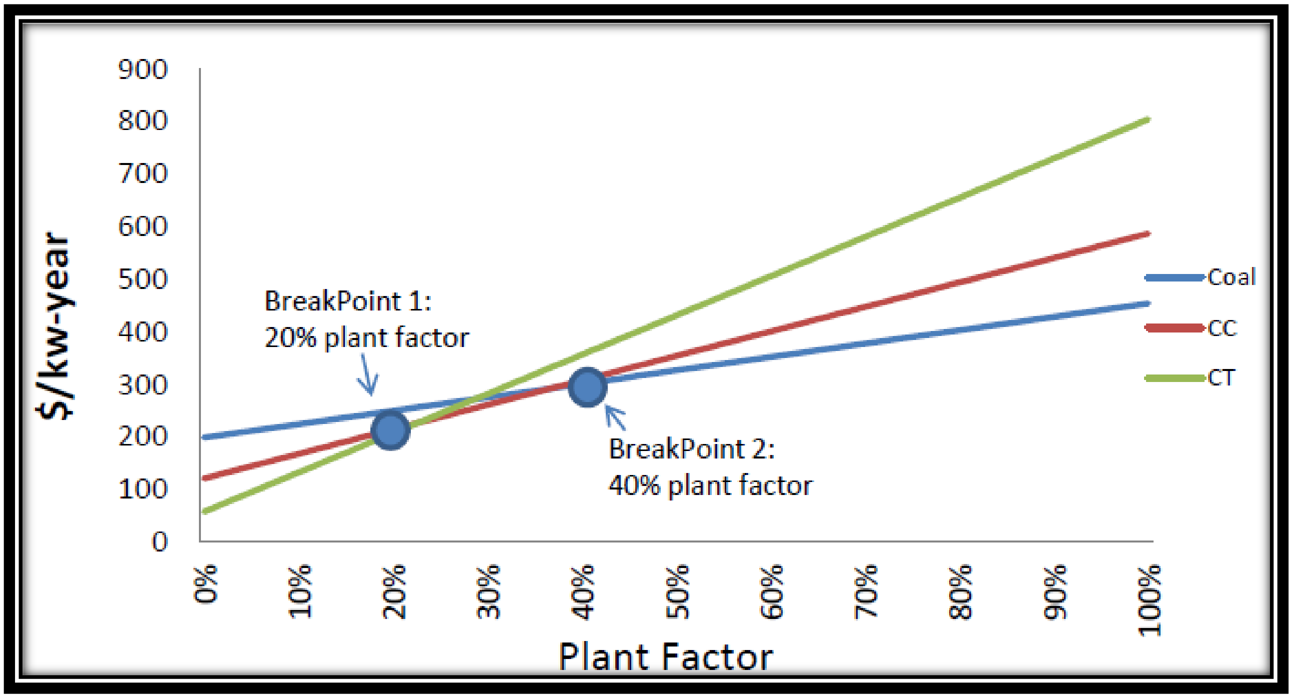


Figure 12: Generation-Exceedance Curve for Lockport Powerhouse (Peak and Off-Peak_ Used in Screening Curve Analysis

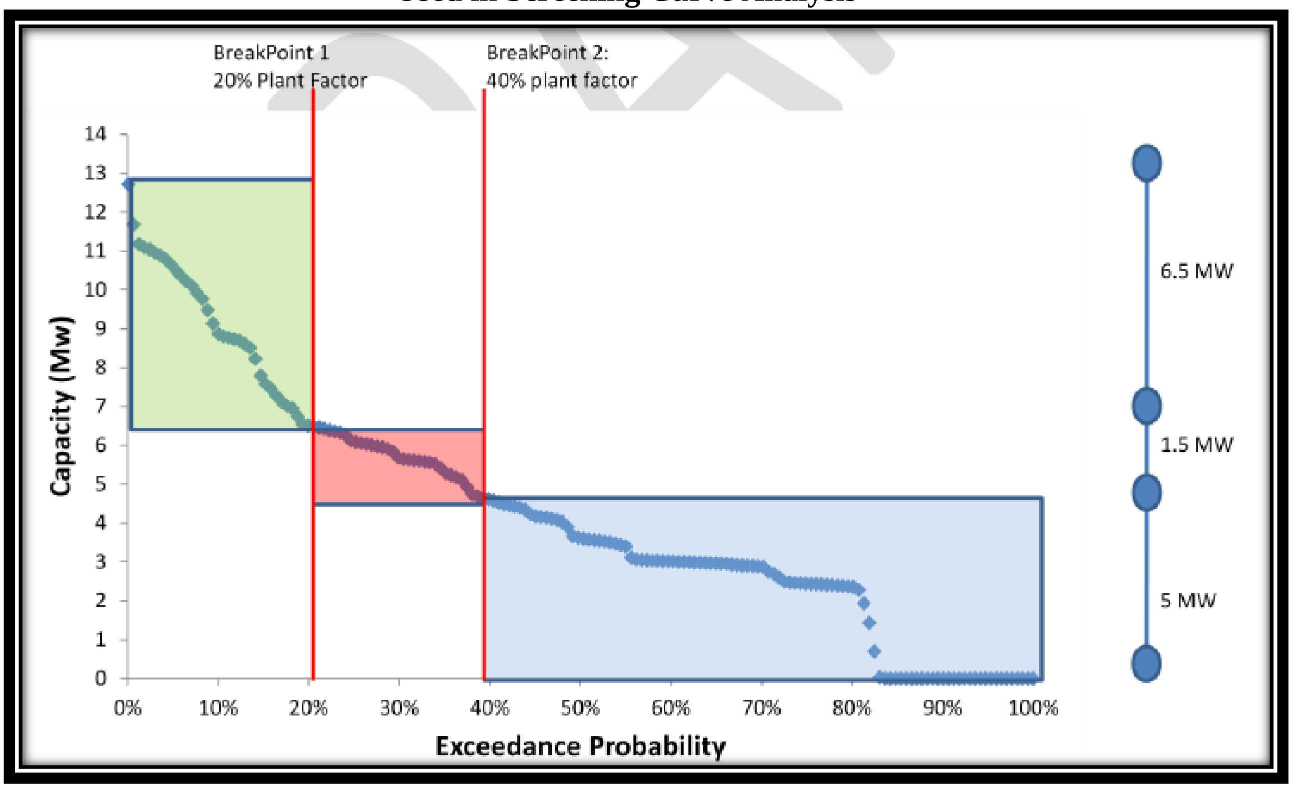


Table 5: Weighted Unit Capacity Value for Lockport Powerhouse

Lockport Dam	Estimated Replacement Capacity (MW)	Percentage of Total Generating Capacity	Capacity Cost ($/KW-yr)	Weighted Value ($)
Combustion Turbine	6.5	50%	59	$29
Combined Cycle	1.5	12%	122	$14
Coal	5.0	38%	236	$91
Weighted Average Unit Capacity Value ($/KW-yr)				**$134**

Average Annual Lockport Powerhouse Capacity Value

The average annual Lockport Powerhouse capacity value is defined as the dependable capacity of 4 MW (or 4000 kw) multiplied by the weighted average unit capacity value of $134/kw-year. Lockport Powerhouse has an estimated average annual capacity value of $536,000 per year (Table 6).

Table 6: Average Annual Capacity Value for Lockport Powerhouse

Dependable Capacity (MW)	Dependable Capacity (kw)	Unit Capacity Value ($/kw-year)	Total Capacity Vlaue ($/year)
4	4,000	$134	$536,000

Estimated Emissions for Thermal Alternative

One of the benefits of hydropower generation is that it is a relatively clean resource that results in few air emissions. Replacing any or all of the Lockport generation may require increased generation from thermal plants. Table 7 shows the average emissions/MWh for carbon dioxide, sulfur dioxide, and nitrogen oxide. Table 8 shows the 2007 total emissions for the State of Illinois (Environmental Protection Agency).

Table 7: Estimated Emissions for Electricity Generation by Fuel Source

	Lbs per MWh of Generation		
	Carbon Dioxide	Sulfur Dioxide	Nitrogen Oxide
Coal	2,294	13	6
Natural Gas	1,135	0.1	1.7

Table 8: Illinois Emissions 2007

	2007 Emissions (lbs)		
	Carbon Dioxide	Sulfur Dioxide	Nitrogen Oxide
Illinois	220,000,000,000	580,000,000	245,356,000

To accurately estimate the possible increased emissions brought on by thermal replacement of the Lockport generation, an understanding of what thermal resource would replace it is required. For this section the goal is only to define a range of values. Table 9 presents three possible scenarios: first, an all- coal replacement, secondly, an all-natural gas replacement, and finally a mix of 60 percent coal and 40 percent natural gas, which reflects the percentage of peak and off-peak generation. Table 9 shows both the increased emissions in pounds and percent increase from Illinois 2007 emissions, assuming 42,100 MWh of annual thermal generation is needed to replace the Lockport generation.

Table 9: Estimated Emissions for Thermal Alternatives to Replace Lockport Annual Generation

Alternative Thermal Generation Mix Assumption	**Increased Emissions (lbs)**			**% Increase from 2007 Emissions for the State of Illinois**		
	Carbon Dioxide	Sulfur Dioxide	Nitrogen Oxide	Carbon Dioxide	Sulfur Dioxide	Nitrogen Oxide
100% Coal	94,682,900	547,300	252,600	0.04	0.09	0.10
100% Natural Gas	47,783,500	4,210	71,570	0.02	0.00	0.03
60% Coal - 40% Natural Gas	75,923,140	330,064	180,188	0.03	0.06	0.07

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Future Without-Project Condition Assessment of Hydropower Generation – Lockport Powerhouse

August 2013

U.S. Army Corps of Engineers
Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

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EXECUTIVE SUMMARY:

In support of the Great Lakes and Mississippi River Study (GLMRIS) an array of alternative plans were developed which seek to prevent the transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River Basins. In order to address the potential impacts of implementing any of the alternative plans on hydropower generation within the Chicago Area Waterway System (CAWS), a baseline assessment of the current hydropower generation at Lockport Powerhouse was completed. This future without-project condition report briefly estimates how the energy value will change over the fifty-year planning horizon. This document also displays an estimation of the capacity of the Lockport Powerhouse in meeting the Renewable Portfolio Standards for the State of Illinois established in year 2007.

GLMRIS BACKGROUND INFORMATION:

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River basins by aquatic pathways

An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (FY13).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

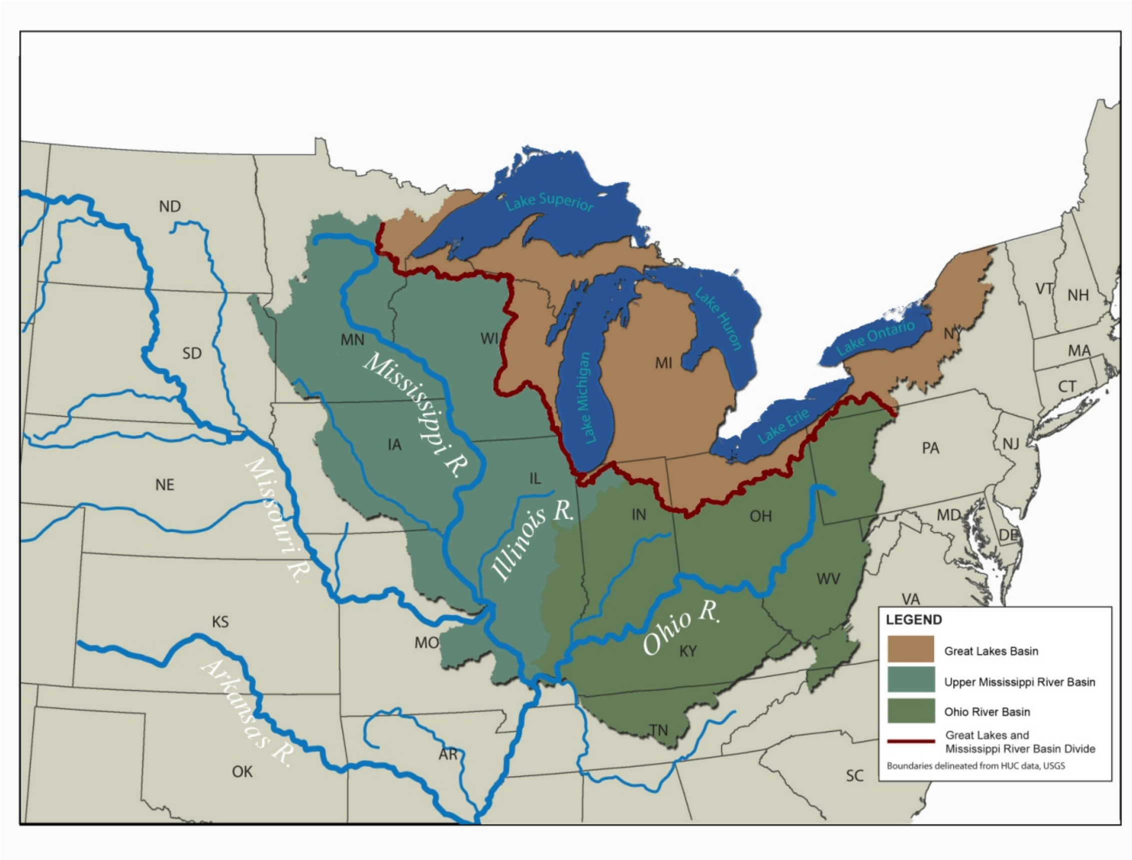
Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

GLMRIS STUDY AREA

The GLMRIS study area includes portions of the Great Lakes, Mississippi River, and Ohio River Basins that fall within the United States.

Figure 1: GLMRIS Study Area Map



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The Chicago Area Waterway system consists of a number of rivers, locks and canals that connect Lake Michigan with the Mississippi River system via the Illinois River. Focus Area I, the Chicago Area Waterway System, as shown in Figure 2, is the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins. It, therefore, poses the greatest

potential risk of aquatic nuisance species (ANS) transfer between the basins, via an aquatic pathway.

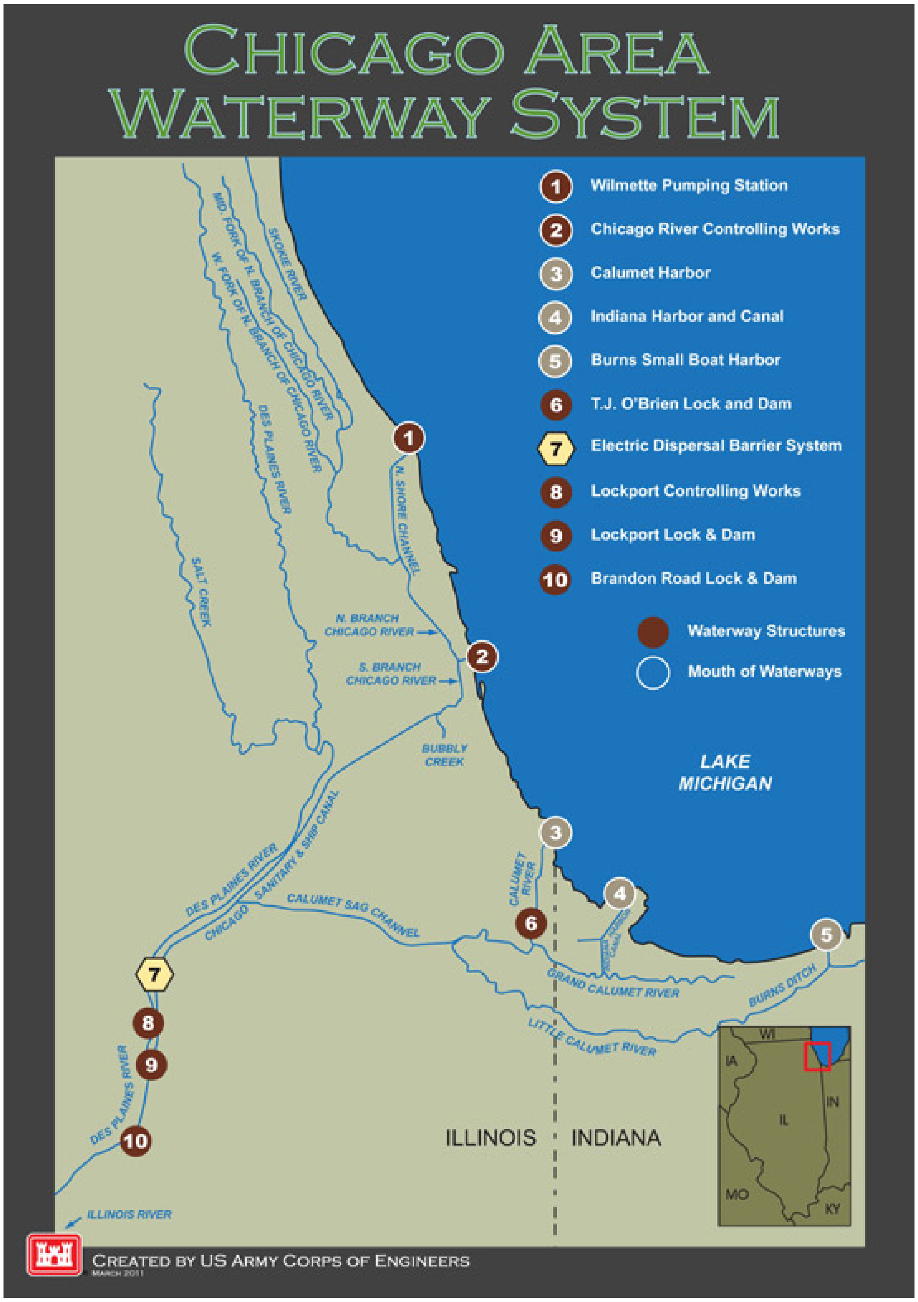


Figure 2. Chicago Area Waterway System

NAVIGATION AND ECONOMICS PRODUCT DELIVERY TEAM:

In support of the Great Lakes and Mississippi River Interbasin Study, the Navigation and Economics Product Delivery Team (PDT) was formed. The PDT was tasked with assessing the current value of *economic* activities within the GLRMIS detailed study area that *could* change with the implementation (FWP condition) or lack of implementation (FWOP condition) of a GLMRIS project. The PDT is comprised of several sub-teams, each of which focuses on a specific economic activity within the GLRMIS study area. These categories include:

Navigation Related Economic Categories

- Commercial Cargo
- Non-Cargo Related Navigation

Other Related Economic Categories

- Flood Risk Management
- Hydropower
- Commercial and Recreational Fishery[1]
- Water Quality
- Water Supply
- Regional Economics

Hydropower Focus:

In support of the Navigation and Economics PDT, the Hydropower Team was formed to address the future changes in hydropower generation that may occur in the case where Federal action is taken (i.e., the future with-project condition) or is not taken (i.e., the future without-project condition) to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins.

[1] Charter and subsistence fishing, as well as pro-fishing tournaments will also be assessed.

FUTURE WITHOUT-PROJECT CONDITIONS:

This section describes the methodology and assumptions in estimating the future value of Lockport's energy and capacity. The FWOP analysis assumed a fifty-year planning horizon beginning in 2017 and ending 2066.

Generation and Energy Value

Annual Generation

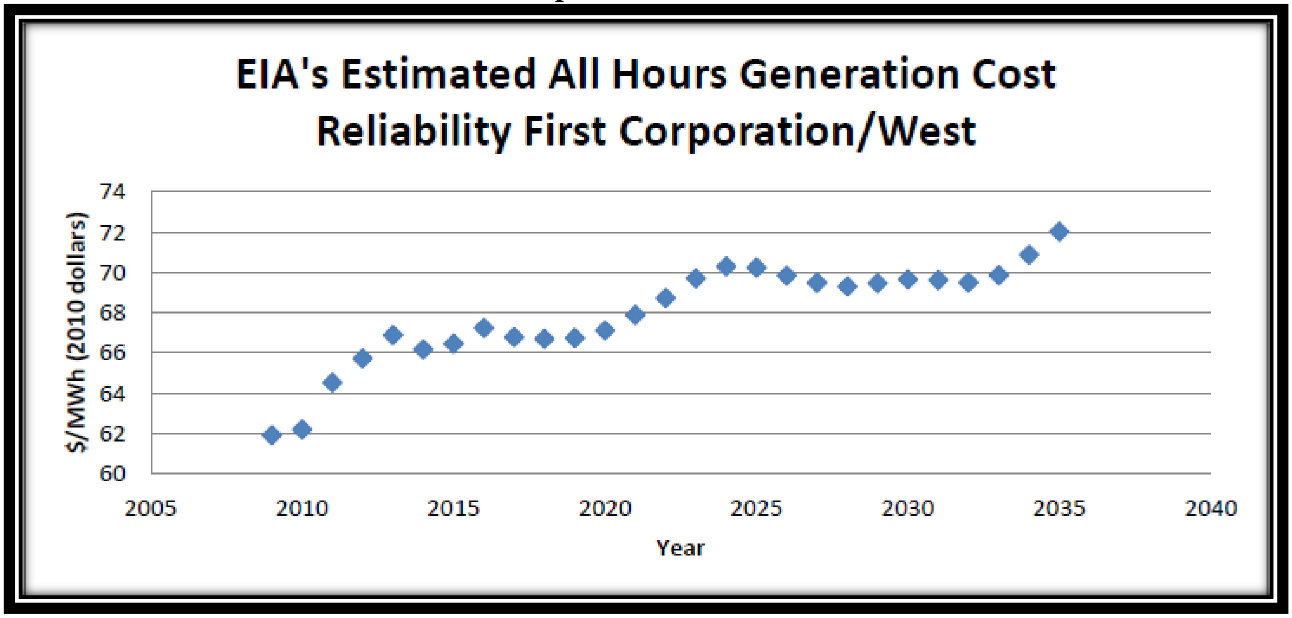
Lockport's generation is a secondary project purpose to water management, which includes both flood risk management and navigation. In this regard, the variability of hydropower generation at the Lockport Powerhouse is primarily a function of the region's hydrology. In the baseline hydropower report, the monthly average generation values were computed using twelve years of historical records. This FWOP report assumes that this period of record is sufficient in capturing the variability of the region's hydrology, and that no systematic changes in operations resulting in significant changes in the monthly generation distribution are anticipated to occur. This report further assumes the same monthly peak and off-peak generation values as described in hydropower baseline report, and presented again in this report in Figure 1.

Energy Value

Following the analysis for the baseline assessment, we assume the energy value will be defined by the estimated zonal LMP value for the ComEd region of the PJM. Since there are only historical records of the LMP value, future LMP value estimates require developing a suitable index of future energy value forecasts.

Each year the Energy Information Administration (EIA) publishes a thirty-five year forecast of energy supply, demand and prices based on the EIA's National Energy Modeling System. For this analysis, the EIA's 2012 Annual Energy Outlook, which provided forecasted values for 2009 through 2035, was used to represent the average annual all hours energy generation price Figure 3. Values beyond 2035 were set to the 2035 price since no other data was available.

Figure 3: EIA Forecasted All-Hours Generation Cost for EMM: Reliability First Corporation/West



To develop the correlation between monthly peak and off-peak LMP values for the ComED region, scaling ratios were developed between the nominal historical LMP values and the nominal EIA all-hours energy values for the overlapping years 2009-2011 (LMP/EIA). As shown in Figure 4, the ratios were all less than 1 for both peak and off-peak values. An average of each month's scaling ratio was determined for the future LMP projections.

Figure 4: Peak Price Scaling Ration Between EIA Annual All-Hours Energy Price and ComEd Zonal LMP Prices

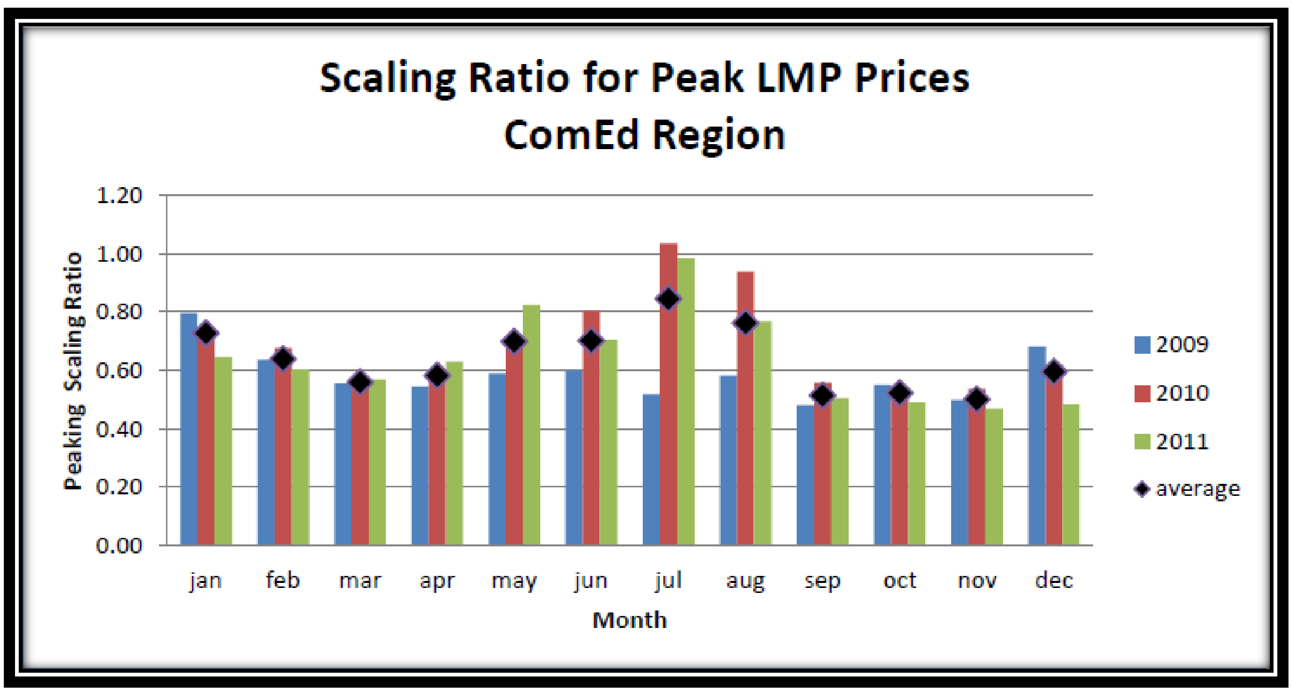
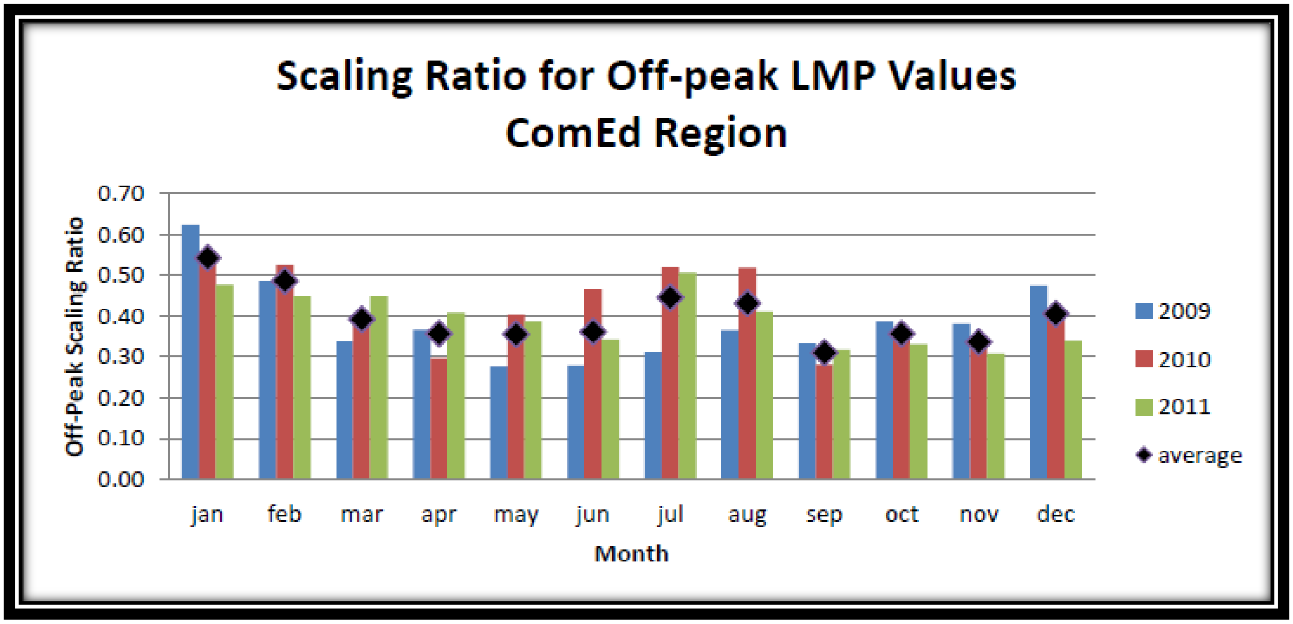


Figure 5: Off-Peak Price Scaling Ratio Between EIA Annual All-Hours Energy Price and ComEd Zonal LMP Prices



The scaling distribution was applied to the EIA forecast for the entire 30-year forecast period, creating a monthly time-series for peak and off-peak prices. Monthly values for each year following the forecast period (analysis period years 30 through 50) were assumed to be the same as the monthly value in the last year of the forecast. The federal discount rate of 4 percent was applied to the time-series and then summed to create the present value for each month. As shown in Table 1, the present value of the monthly energy prices was amortized to produce annualized monthly prices for peak and off-peak energy prices. The amortized annual energy value of the Lockport Powerhouse is $1.4 million.

Table 1: Future Estimated Energy Values for the Lockport Powerhouse

Month	Estimated Peak Generation (MWh)	Estimated Off-Peak Generation (MWh)	Amortized Peak Value ($/MWh)	Amortized Off-Peak Value ($/MWh)	Average Monthly Energy Value
January	1160	1740	$47.34	$35.27	$116,288.94
February	1160	1740	$41.57	$31.59	$103,194.23
March	1560	2340	$36.39	$25.49	$116,417.28
April	1600	2400	$37.89	$23.20	$116,307.79
May	1440	2160	$45.44	$23.10	$115,333.19
June	1800	2700	$45.68	$23.50	$145,669.31
July	1560	2340	$55.03	$28.97	$153,622.11
August	1920	2880	$49.62	$28.05	$176,043.75
September	1640	2460	$33.45	$20.17	$104,484.47
October	1080	1620	$33.97	$23.19	$74,255.53
November	840	1260	$32.59	$21.88	$54,943.36
December	1080	1620	$38.74	$26.35	$84,518.55

Average Annual Energy Value	**$1,361,078.50**
*MWh stands for megawatt hours.	

Capacity Value

This FWOP report evaluates the capacity value of the Lockport Powerhouse in two categories. First is dependable capacity value, which is the value of the portion of Lockport's total capacity that can be relied upon during peak hours of summer months. Since this capacity must be relied upon, it is calculated as the cost of the most likely thermal alternative. Secondly, this report determines a renewable energy capacity value. The Illinois Renewable Energy Portfolio Standard considers generation from Lockport Powerhouse renewable. To satisfy this standard in the future, Lockport's capacity would need to be replaced by a renewable energy source rather than a thermal alternative.

Dependable Capacity Value

Like the future without project energy value calculation, the dependable capacity value calculation assumes that the historical generation records will be sufficient in calculating future conditions. In this regard, Lockport's Powerhouse dependable capacity will remain at 4 MW with the same thermal mix alternatives as calculated in the baseline condition estimate. Lockport's dependable capacity calculation is shown in Table 2. Since current U.S. Army Corps of Engineers policy does not allow the use of real fuel cost escalation, these values were assumed to apply over the entire period of analysis.

Table 2: Dependable Capacity Lockport Powerhouse

Dependable Capacity (MW)	Dependable Capacity (kw)	Unit Capacity Value ($/kw-year)	Total Capacity Value ($/year)
4	4,000	$134	$536,000

Renewable Energy Capacity Value

Created in 2007, the Illinois Renewable Energy Portfolio Standard (RPS) mandates that by the Energy Year 2026, 25 percent of retail electricity sales in the State of Illinois must come from renewable energy sources. The RPS distinguishes between investor-owned electric utilities (EUs) and alternative retail electric suppliers (ARES). The main difference is the required composition of the increased renewable generation across the 18-year period from 2009 to 2026. In particular, EUs are required to generate 75 percent of their renewable power from wind each year, whereas wind generation need only make up 60 percent of ARES renewable power annually (North Carolina State University).

Under the Illinois RPS, generation from the Lockport Powerhouse may be considered in partial fulfillment of the renewable portfolio. Since the Illinois RPS has minimum requirements for wind generation, it is assumed that Lockport's hydropower generation, if lost, would be replaced by wind turbines. The equivalent wind capacity required to generate the same amount of annual generation as the Lockport Powerhouse can be computed by using Equation 1, displayed below, and solving for Installed Capacity. Wind generation has a capacity factor ranging from 25 percent to 45 percent, the variability of which is due to wind availability (Renewable Energy Research Lab, University of New Hampshire).

Equation 1: Capacity Factor

$$\text{Capacity Factor} = \frac{\text{Annual Generation (MWh)}}{24 * 365 * \text{Installed Capacity (MW)}}$$

The equivalent wind capacity required to reliably generate Lockport Powerhouse's average annual generation is displayed below in Table 3. The equivalent capacity varies from 11MW to 19MW, assuming capacity factors of 45% and 25%, respectively.

Table 3: Equivalent Wind Capacity and Cost to Replace Lockport Average Annual Generation

Lockport Average Annual Generation (MWh)	Estimated Capacity Factor for Wind Generation	Equivalent Wind Capacity (MW)
42,100	45%	11
42,100	25%	19

The National Renewable Energy Laboratory estimates the cost of wind energy as an expression termed the levelized cost of energy (LCOE). The LCOE is intended to incorporate total costs, including installed capital cost, annual operating expenses, annual energy production, and fixed charge rate (i.e., cost of project financing). The LCOE calculated by the NREL is a standard method for comparing costs across energy technologies. In simple terms, the LCOE is defined as the ratio presented below in Equation 2.

Equation 2: Levelized Cost of Energy

LCOE = Present Value of Total Costs ($) / Energy Produced Over Project Lifetime (MWh)

The 2010 LCOE estimate for a typical land-based U.S. wind plant is $71 per MWh. (National Renewable Energy Lab). The wind energy replacement cost of the Lockport Powerhouse average annual generation of 42,100 MWh is estimated to be $2,989,100.

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GLMRIS

GREAT LAKES AND MISSISSIPPI RIVER INTERBASIN STUDY

AQUATIC NUISANCE SPECIES ECOSYSTEMS NAVIGATION RECREATION FLOOD RISK MANAGEMENT WATER USE

Future With-Project Condition Assessment of Hydropower Generation – Lockport Powerhouse

August 2013

U.S. Army Corps
of Engineers
Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

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EXECUTIVE SUMMARY:

In support of the Great Lakes and Mississippi River Study (GLMRIS) an array of alternative plans were developed which seek to prevent the transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River Basins. In order to address the potential impacts of implementing any of the alternative plans on hydropower generation within the Chicago Area Waterway System (CAWS), a baseline assessment of the current hydropower generation at Lockport Powerhouse was completed. The future without-project condition report then quantified the current average annual generation, energy value and dependable capacity values. This future with-project condition assessment briefly describes the alternative plans considered in GLMRIS and describes the potential impacts to hydropower generation at Lockport Powerhouse.

GLMRIS BACKGROUND INFORMATION:

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River basins by aquatic pathways

An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (FY13).

As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

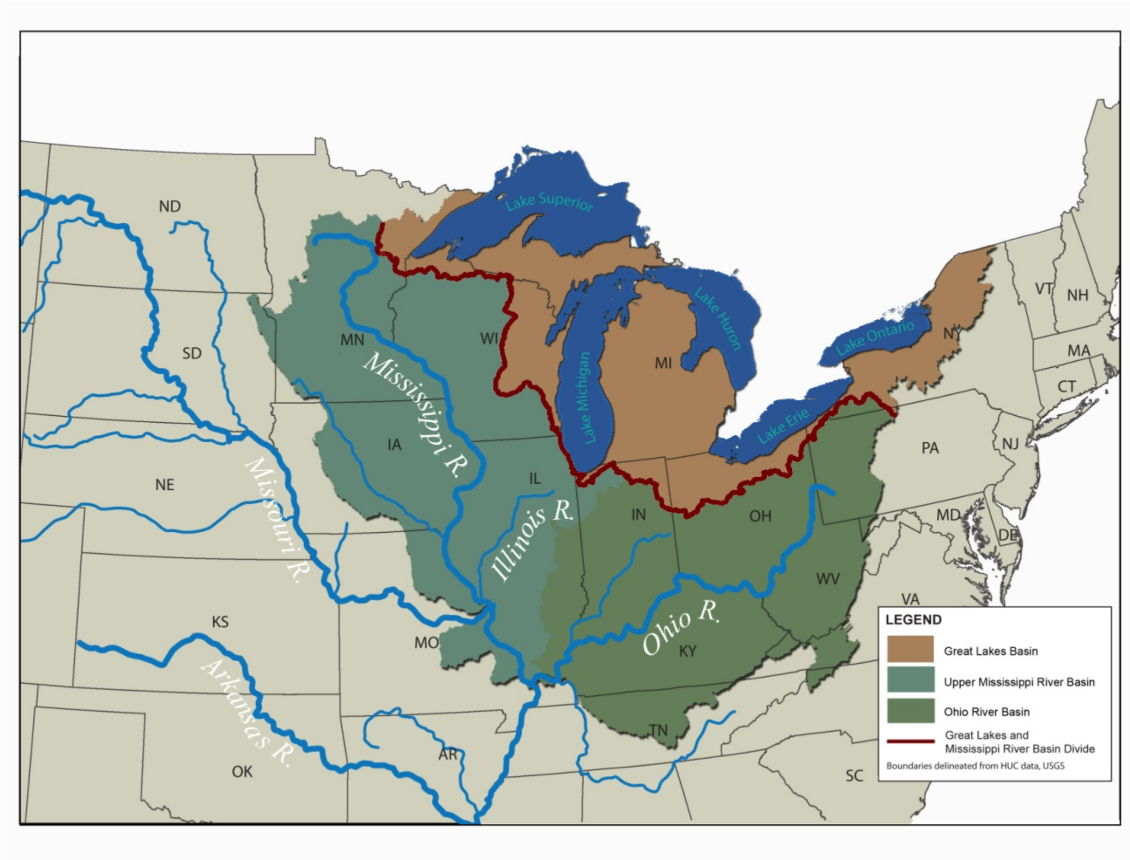
Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

GLMRIS STUDY AREA

The GLMRIS study area includes portions of the Great Lakes, Mississippi River, and Ohio River Basins that fall within the United States.

Figure 1: GLMRIS Study Area Map



Potential aquatic pathways between the Great Lakes, Mississippi River, and Ohio River Basins exist along the basins' shared boundary (illustrated in *Figure 1: GLMRIS Study Area Map*). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi and Ohio River Basins (green shaded areas) and the Great Lakes Basin (brown shaded area).

The Chicago Area Waterway system consists of a number of rivers, locks and canals that connect Lake Michigan with the Mississippi River system via the Illinois River. Focus Area I, the Chicago Area Waterway System, as shown in Figure 2, is the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins. It, therefore, poses the greatest

potential risk of aquatic nuisance species (ANS) transfer between the basins, via an aquatic pathway.

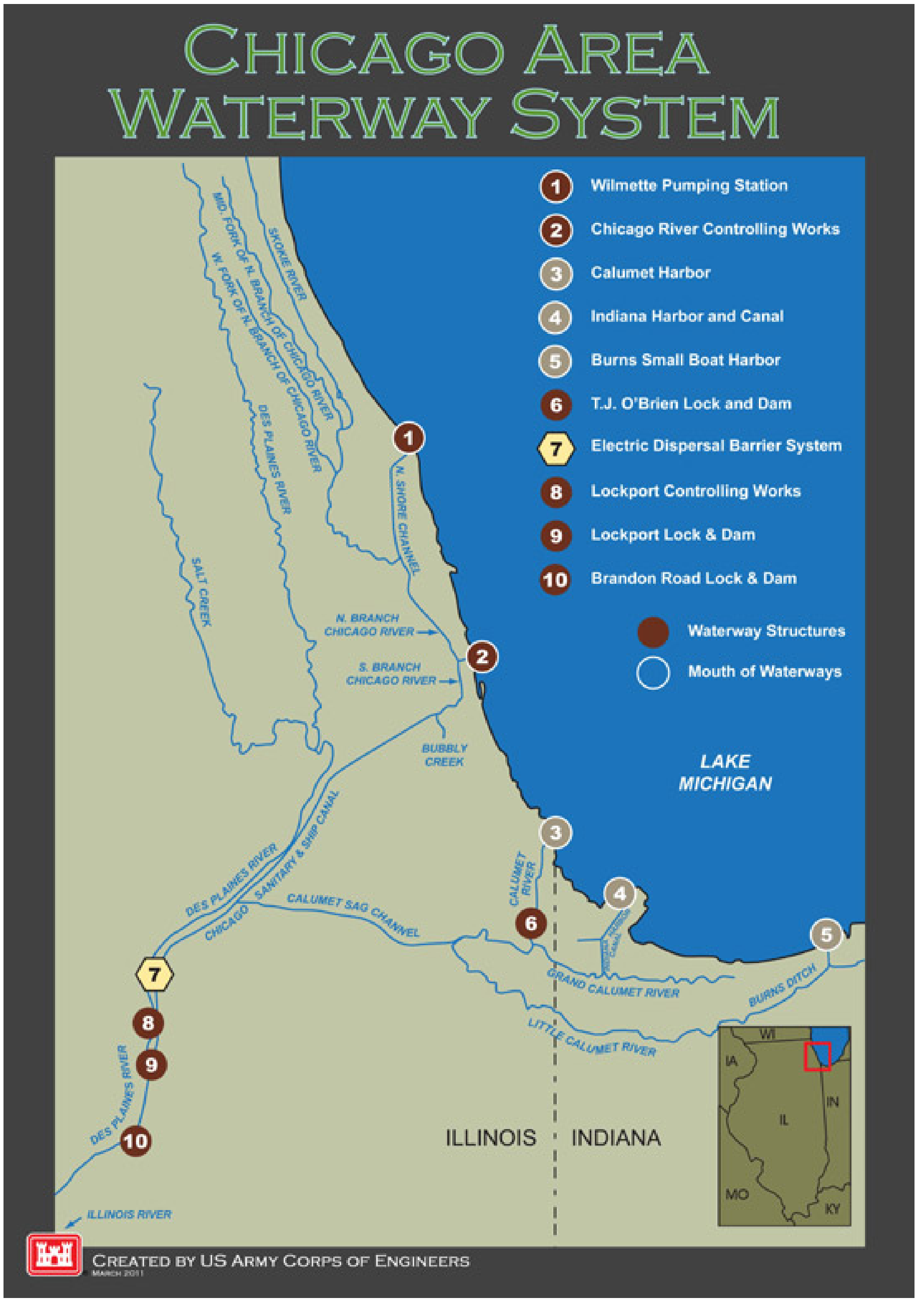


Figure 2. Chicago Area Waterway System

NAVIGATION AND ECONOMICS PRODUCT DELIVERY TEAM:

In support of the Great Lakes and Mississippi River Interbasin Study, the Navigation and Economics Product Delivery Team (PDT) was formed. The PDT was tasked with assessing the current value of *economic* activities within the GLRMIS detailed study area that *could* change with the implementation (FWP condition) or lack of implementation (FWOP condition) of a GLMRIS project. The PDT is comprised of several sub-teams, each of which focuses on a specific economic activity within the GLRMIS study area. These categories include:

Navigation Related Economic Categories

- Commercial Cargo
- Non-Cargo Related Navigation

Other Related Economic Categories

- Flood Risk Management
- Hydropower
- Commercial and Recreational Fishery[1]
- Water Quality
- Water Supply
- Regional Economics

Hydropower Focus:

In support of the Navigation and Economics PDT, the Hydropower Team was formed to address the future changes in hydropower generation that may occur in the case where Federal action is taken (i.e., the future with-project condition) or is not taken (i.e., the future without-project condition) to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins.

[1] Charter and subsistence fishing, as well as pro-fishing tournaments will also be assessed.

FUTURE WITH-PROJECT CONDITON ASSESSMENT

This section describes the potential effects to hydropower at Lockport Powerhouse that are estimated to result from the various alternatives being considered under the GLMRIS study. Hydropower effects are addressed in terms of potential changes in generation and in the value of Lockport's energy and capacity.

Alternatives considered in this analysis include the future without-project condition (no new Federal action), Non-Structural Measures, Flow-Bypass Alternative, CAWS Buffer Zone Alternatives, and Hydrologic Separation Alternatives. The alternatives analysis assumed a fifty-year planning horizon beginning in 2017 and ending 2066.

No New Federal Action

The "No New Federal Action" plan assumes that no further Federal action will be taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins (i.e., the future without-project condition). The FWOP condition is addressed in detail in the previous report, *Future Without-Project Condition Assessment of Hydropower Generation – Lockport Powerhouse*. The results are summarized in this report for comparison purposes. The following paragraphs describe the annual generation, energy value, and capacity value associated with the FWOP condition.

Generation

Lockport's hydropower generation is a secondary project purpose to water management including both flooding and navigation. Monthly average generation values were computed using twelve years of historical records, which is assumed sufficient in capturing the variability of the region's hydrology. Monthly peak and off-peak generation values are presented in Table 1. Average annual generation at Lockport Powerhouse is calculated to be 42,000 MWh (see the hydropower baseline economic assessment report for further details).

Energy Value

Calculation of the FWOP energy value is presented in detail in the future without-project condition report. Future energy values were calculated based on historical zonal LMP value for the ComEd region and the Energy Information Administration's (EIA) thirty-five year forecast of energy supply, demand, and prices. The correlation between monthly peak and off- peak values is based on scaling ratios between the historical LMP values and the EIA all-hours energy values. The scaling distribution was applied to the EIA forecast for the entire 30 year forecast period, creating a monthly time-series for peak and off-peak prices. As shown in Table 1, the present value of the monthly energy prices was amortized to produce annualized monthly prices for peak and off-peak energy prices. The amortized annual energy value of the Lockport Powerhouse is $1.4 million.

Table 1: Future Estimated Energy Values for the Lockport Powerhouse

Month	Estimated Peak Generation (MWh)	Estimated Off-Peak Generation (MWh)	Amortized Peak Value ($/MWh)	Amortized Off-Peak Value ($/MWh)	Average Monthly Energy Value
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November	840	1260	$32.59	$21.88	$54,943.36
December	1080	1620	$38.74	$26.35	$84,518.55
Average Annual Energy Value					**$1,361,078.50**
*MWh stands for megawatt hours.					

Capacity Value

For the future with project assessment, the value of the Lockport Powerhouse capacity was calculated in terms of both dependable capacity and in terms of renewable energy capacity, both of which are described in detail in the *Future Without Project* report, and summarized in this section. The dependable capacity value calculation assumes that the historical generation records will be sufficient in calculating future conditions. Consequently, Lockport Powerhouse's dependable capacity will remain at 4 MW with the same thermal mix alternatives as calculated in the baseline assessment report. Lockport's dependable capacity calculation is shown in Table 2. Since current U.S. Army Corps of Engineers policy does not allow the use of real fuel cost escalation, these values were assumed to apply over the entire period of analysis.

Table 2: Dependable Capacity Lockport Powerhouse

Dependable Capacity (MW)	Dependable Capacity (kw)	Unit Capacity Value ($/kw-year)	Total Capacity Value ($/year)
4	4,000	$134	$536,000

The renewable energy capacity value is calculated given the condition of the Illinois Renewable Energy Portfolio Standard (RPS), which mandates certain renewable energy source benchmarks by the energy year 2026. Under the RPS, generation from the Lockport Powerhouse may be considered in partial fulfillment of the renewable portfolio, and any loss in Lockport generation would be presumed to be replaced by wind power.

The equivalent wind capacity required to generate the same amount of annual generation as the Lockport Powerhouse was computed assuming variability in its capacity factor ranging from 25 percent to 45 percent, primarily due to wind availability (Renewable Energy Research Lab, University of New Hampshire). Table 3 shows the equivalent wind capacity required to generate the same annual generation as the Lockport Powerhouse. The equivalent capacity varies from 11MW to 19MW, assuming capacity factors of 45 percent and 25 percent, respectively.

Table 3: Equivalent Wind Capacity and Cost to Replace Lockport Average Annual Generation

Lockport Average Annual Generation (MWh)	Estimated Capacity Factor for Wind Generation	Equivalent Wind Capacity (MW)
42,100	45%	11
42,100	25%	19

The National Renewable Energy Laboratory estimates the cost of wind energy as an expression termed the levelized cost of energy (LCOE). The LCOE calculated by the NREL is a standard method for comparing costs across energy technologies. The 2010 LCOE estimate for a typical land-based U.S. wind plant is $71 per MWh. (National Renewable Energy Lab). The wind energy replacement cost of the Lockport Powerhouse average annual generation of 42,100 MWh is estimated to be $2,989,100.

Non-Structural Control Technologies

Activities associated with the Non-Structural Measures include monitoring certain ANS, use of pesticides for nuisance plants and fish, education of boat owners and water users, ballast water management, and related research on the prevention of ANS spread. Results of the H&H analysis (Appendix E) indicate that these activities would not yield changes in head or flow such that would affect hydropower generation at Lockport Powerhouse, therefore expected annual generation, energy and capacity value would not changed as a result of implementation of these measures.

Mid-System Control Technology without a Buffer Zone (Flow Bypass Alternative)

This alternative includes two Flow Bypass Technology locations, located generally in the area of the natural divide of the Great Lakes and Mississippi River basins. To ensure the ANS would not be able to bypass the technology locations during a flood event, FRM mitigation is required to detain the storm water to maintain operation capacity of the Flow Bypass Technologies. A water treatment facility and lock would be constructed east of Sticky WRP outfall at river station 316.01 and west of Natalie Creek confluence at river station 315.89. The normal flow of the CAWS would be diverted through the treatment plan to ensure it would be ANS free, and used to fill the lock chamber. All other water would be maintained in the reservoir and process by the treatment plan before discharge. Results of the H&H analysis (Appendix E) indicate that these activities would have a negligibly small effect to hydropower at Lockport, therefore expected generation, energy and capacity value would not be expected to change as a result of implementation of the Flow Bypass Alternative.

Technology Alternative with a Buffer Zone (CAWS Buffer Zone Alternative)

The Technology Alternative with a Buffer Zone incorporates ANS controls including electrical barriers, physical structures, lock-flushing technologies, and ANS treatment plans as a means of reducing the probability of ANS transfer through the CAWS. The CAWS Buffer Zone Alternative create an ANS-free buffer zone within the CAWS by a downstream control point located at Brandon Road Lock and Dam and several upstream control points including the Wilmette Pumping Station, Chicago River Controlling Works, and T.J. O'Brien Lock and Dam, and within the Grand and Little Calumet Rivers. This alternative was formulated with the goal of maintaining the waterway's current functions.

Activities associated with this Alternative involve flushing the lock with buffer zone water to remove potential ANS water in the lock, electrical barriers at the downstream side of the lock, monitoring and other management of ANS in certain pools, and pump out of ballast and bilge water of vessels entering the CAWS ANS Buffer Zone. Treated water would be returned to the river, resulting in negligible effects to hydropower, therefore the expected generation, energy and capacity value at Lockport Powerhouse would not be expected to change as a result of implement of the CAWS Buffer Zone Alternative.

Hydrologic Separation Alternatives

The Hydrologic Separation Alternatives were developed through running many iterations of the CAWS H&H models with varying separation points. The models were run to capture a design for a 500-year event. The Lakefront Hydrologic Separation Alternative's hydrologic separation points are located generally in the area of the mixing areas of the CAWS outlets to Lake Michigan, which were selected to minimize the impacts to Lake Michigan Water Quality. The Hybrid Mid-System Separation Alternative's (Cal Sag Open and Chicago Sanitary and Ship Canal Open) is the hydrologic separation that minimizes the amount of FRM mitigation necessary in the CAWS area. Results of the H&H models indicate that potential effects of the hydrosep alternatives on hydropower at Lockport Powerhouse would be negligibly small, therefore expected generation, energy and capacity value at Lockport Powerhouse would not be affected under this Alternative.

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ATTACHMENT 12

REGIONAL ECONOMICS

Regional Economic Contribution Assessment

September 2013

U.S. Army Corps
of Engineers
Product of the GLMRIS Team

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) Team consists of a regional, collaborative effort led by the U.S. Army Corps of Engineers (Corps), including various District and Division offices, as well as Corps Centers of Expertise and Research Laboratories. Products of the GLMRIS Team are also made possible in collaboration with various federal, state, local, and non-governmental stakeholders.

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EXECUTIVE SUMMARY

The *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) establishes four accounts to facilitate evaluation and display of the effects of alternative plans. These accounts are: national economic development (NED), environmental quality (EQ), regional economic development (RED), and other social effects (OSE)." Consistent with the P&G, "the RED account registers changes in the distribution of regional economic activity that result from each alternative plan." Regional economic activity is measured in sales, jobs, and income.

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) authorizes the Secretary to evaluate a range of options and technologies to prevent the transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River basins by aquatic pathways. The GLMRIS Product Delivery Team (PDT) developed various alternatives to prevent the transfer of ANS between the basins, the future with-project (FWP) conditions. The PDT also developed the a most likely future without-project (FWOP) condition alternative. Each alternative has the potential to affect one or several economic activities that currently take place within the basins. Economic activities considered include commercial, recreational, and charter fishing, and commercial navigation (cargo and passenger).

This document demonstrates the existing commercial, recreational, and charter fishing industries within the U.S. waters of the GL, UMR, and OHR Basins – that could change in the FWOP *or* FWP conditions. The transfer of ANS, or other factors such as plans implemented by fisheries management agencies, could negatively or positively change the quality or quantity of fisheries within the three basins. Therefore, industries dependent on these fisheries could also be impacted to a certain (currently unquantifiable) extent; this could then change the level of sales and employment associated with the various forms of fishing in the basins. However, USACE was not able to obtain sufficient information to quantify the timing or magnitude of the impacts of ANS or fisheries management measures on fisheries within the basins; therefore, the *impacts* on fishing-related industries are not quantified in this document.

Table 1 and Table 2 demonstrate the sales, jobs, and income associated with fishing-related industries within the GL, UMR, and OHR Basins. They show the economic contribution of fishing-related industries at risk from ANS transfer or agency management measures. It is imperative to note that although this document quantifies the current contributions of fishing-related activities within the Great Lakes Basin to the national economy, it does not imply that the identified values would be entirely or partially lost in the FWOP or FWP conditions. *This document solely exhibits how the current economy responds to fishing-related activities within the Great Lakes, Upper Mississippi River, and Ohio River Basins at risk of ANS transfer and agency management measures.*

Table 1: Economic Contributions of Fishing-Related Industries within the U.S. Waters of the Great Lakes Basin

Economic Activity within the Great Lakes Basin[1,2]	Sales Associated with Economic Activity (Nation-Wide)	Jobs Associated With Economic Activity (Nation-Wide)	Income[3] Associated With Economic Activity (Nation-Wide)
Commercial Fishing	$55,480,000	570	$13,860,000
Recreational Fishing	$14,253,000,000	111,693	$4,488,000,000
Charter Fishing	$105,000,000	828	$39,000,000

1. Fishing activities assessed for the Great Lakes Basin address the U.S. waters of the Great Lakes (GL) and their tributaries below impassible barriers. The portions of tributaries that lie between the GL and the first dam are considered to be "below" impassible barriers. A key assumption is that aquatic nuisance species (ANS) could not pass the barriers via an aquatic pathway. The fisheries studies focused on waters that could be susceptible to ANS transfer.
2. All values presented in this table represent *national* sales, jobs, and income associated with the fishing-related industries within the GL Basin. The fishing activities in these basins generate sales, jobs, and income throughout the nation. This is because of indirect and induced effects. Indirect effects include the sales, employment and income of industries that support the fishing industries within the GL Basin, while induced effects include the spending throughout the nation due to the employment of individuals associated with fishing-related and supporting industries.
2. Income is the total earnings associated with the employment level supported by the given economic activity.

Table 2: Economic Contributions of Fishing-Related Industries within the U.S. Waters of the Upper Mississippi River and Ohio River Basins

Economic Activity within the UMR and OHR Basins[1,2]	Sales Associated with Economic Activity (Nation-Wide)	Jobs Associated With Economic Activity (Nation-Wide)	Income[3] Associated With Economic Activity (Nation-Wide)
Commercial Fishing	$14,050,000	150	$3,480,000
Recreational Fishing	$5,783,000,000	49,200	$1,839,000,000
Charter Fishing[4]	NA	NA	NA

1. Fishing activities assessed for the Upper Mississippi River (UMR) and Ohio River (OHR) Basins address the U.S. waters of the UMR and OHR as well as their tributaries below impassible barriers. The portions of tributaries that lie between the UMR and the first dam, and the portions of tributaries that lie between the OHR and the first dam, are considered to be "below" impassible barriers. A key assumption is that aquatic nuisance species (ANS) could not pass the barriers via an aquatic pathway. The fisheries studies focused on waters that could be susceptible to ANS transfer.
2. All values presented in this table represent *national* sales, jobs, and income associated with the fishing-related industries within the UMR and OHR Basins. The fishing activities in these basins generate sales, jobs, and income throughout the nation. This is due to indirect and induced effects. Indirect effects include the sales, employment and income of industries that support the fishing industries within the UMR and OHR Basins, while induced effects include the spending throughout the nation due to the employment of individuals associated with fishing-related and supporting industries.
3. Income is the total earnings associated with the employment level supported by the given economic activity.
4. Note that the charter fishing industry within the UMR and OHR Basins is not included in this assessment since statistically reliable information was not available for this group.

Navigation activities *within the CAWS* could be adversely impacted in the FWP condition. The implementation of a GLMRIS project, in many of the alternatives, involves ANS control technologies that include aspects such as physical barriers in the CAWS and increased lockage times in the CAWS. Since the vessel movements that were examined in GLMRIS take place within the CAWS, these movements could be negatively impacted by implementation of a GLMRIS project. This report addresses the impacts of project implementation in a qualitative way, as the choices of business owners depend on their own, unique situation. Business owners may elect to move their businesses elsewhere, modify their existing infrastructure, or shut down. The effects of these choices are uncertain.

Table 3 demonstrates the sales, jobs, and income associated with commercial cargo and non-cargo-related industries within the CAWS. These values demonstrate aspects of the current economy that could change in the FWOP or FWP condition. It is imperative to note that although this document quantifies the current contributions of navigation-related activities within the CAWS to the national economy, it does not imply that the identified values would be entirely or partially lost in the FWOP or FWP conditions. *This document solely exhibits how the current economy responds to navigation-related activities within the CAWS at risk of implementation of FWP condition measures.*

Table 3: Economic Contributions of Navigation-Related Industries within the Chicago Area Waterway System

Economic Activity within the Chicago Area Waterway System[1]	Sales Associated with Economic Activity (Nation-Wide)	Jobs Associated With Economic Activity (Nation-Wide)	Income[2] Associated With Economic Activity (Nation-Wide)
Commercial Cargo Navigation	$1,584,000,000	9,625	$485,000,000
Non-Cargo Navigation	$88,000,000	469	$22,000,000

1. Values presented in this table represent *national* sales, jobs, and income associated with the navigation-related industries within the Chicago Area Waterway System (CAWS). Even though the navigation-related industries examined in GLMRIS include those within the CAWS, they still generate sales, jobs, and income throughout the nation. This is because of indirect and induced effects. Indirect effects include the sales, employment and income of industries that support the navigation industries within the CAWS, while induced effects include the spending throughout the nation due to the employment of individuals associated with navigation-related and supporting industries.
2. Income is the total earnings associated with the employment level supported by the given economic activity.

GLMRIS BACKGROUND INFORMATION

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE will evaluate a range of options and technologies (collectively known as "ANS controls") to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River basins by aquatic pathways.

An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters. See 16 U.S.C. § 4702(1) (FY13). As a result of international commerce, travel and local practices, ANS have been introduced throughout the Mississippi River and Great Lakes basins. These two basins are connected by man-made channels that, in the past, exhibited poor water quality, which was an impediment to the transfer of organisms between the basins. Now that water quality has improved, these canals allow the transfer of both indigenous and nonindigenous invasive species.

USACE is conducting a comprehensive analysis of ANS controls and will analyze the effects each ANS control or combination of ANS controls may have on current uses of: i) the Chicago Area Waterway System (CAWS), the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins; and ii) other aquatic pathways between these basins. Following the *Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Studies*, Water Resource Council, March 10, 1983, USACE will:

- Inventory current and forecast future conditions within the study area;
- Identify aquatic pathways that may exist between the Great Lakes and Mississippi River basins;
- Inventory current and future potential aquatic nuisance species;
- Analyze possible ANS controls to prevent ANS transfer, to include hydrologic separation of the basins;
- Analyze the impacts each ANS control may have on significant natural resources and existing and forecasted uses of the lakes and waterways within the study area; and
- Recommend a plan to prevent ANS transfer between the basins. If necessary, the plan will include mitigation measures for impacted waterway uses and significant natural resources.

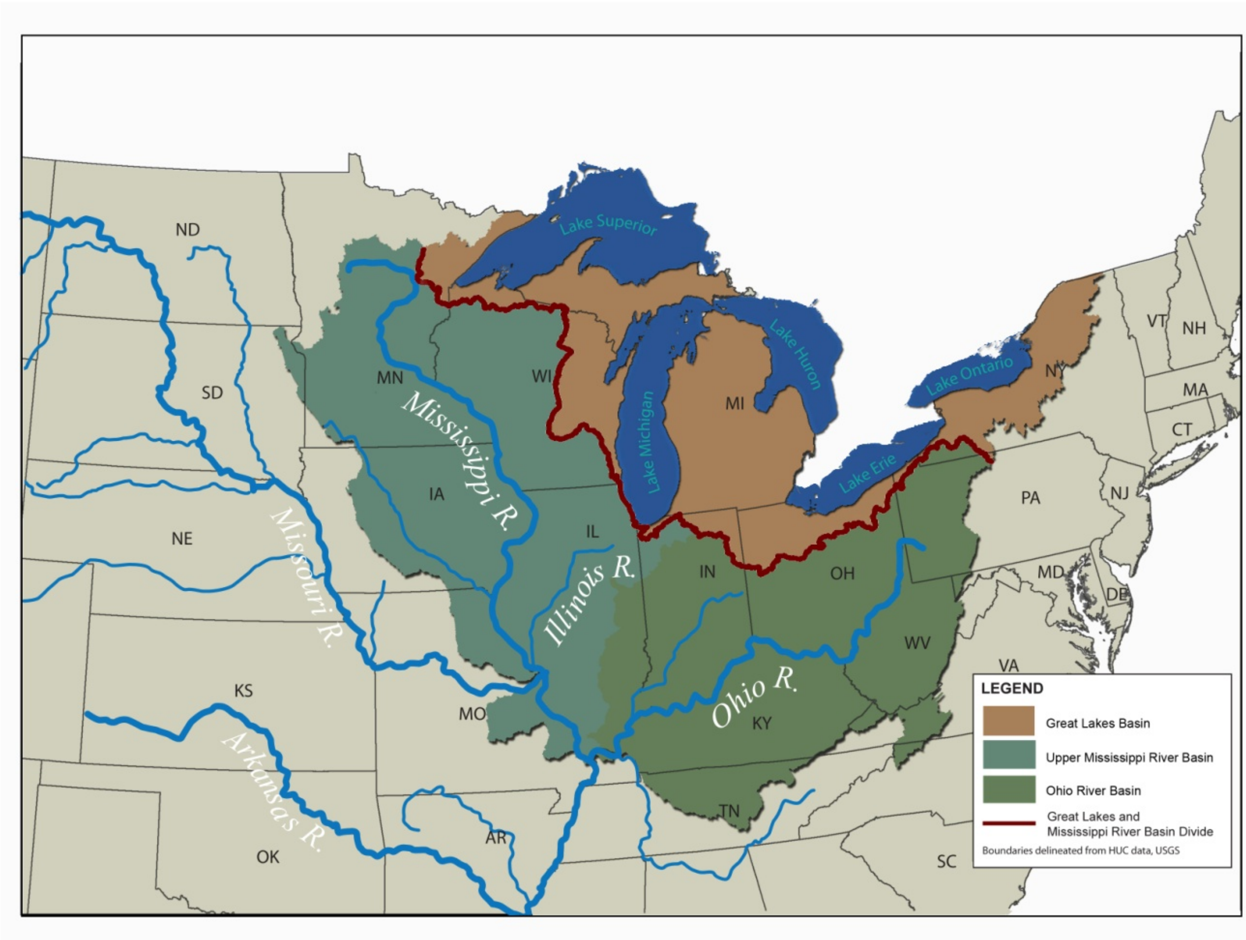
Significant issues associated with GLMRIS may include, but are not limited to:

- Significant natural resources such as ecosystems and threatened and endangered species;
- Commercial and recreational fisheries;
- Current recreational uses of the lakes and waterways;
- ANS effects on water users;
- Effects of potential ANS controls on current waterway uses such as flood risk management, commercial and recreational navigation, recreation, water supply, hydropower and conveyance of effluent from wastewater treatment plants and other industries; and
- Statutory and legal responsibilities relative to the lakes and waterways.

GLMRIS STUDY AREA

The GLMRIS study area includes portions of the Great Lakes, Mississippi River, and Ohio River Basins that fall within the United States. The study area is the combined continental United States Great Lakes, Upper Mississippi River, and Ohio River watershed.

Figure 1: GLMRIS Study Area Map

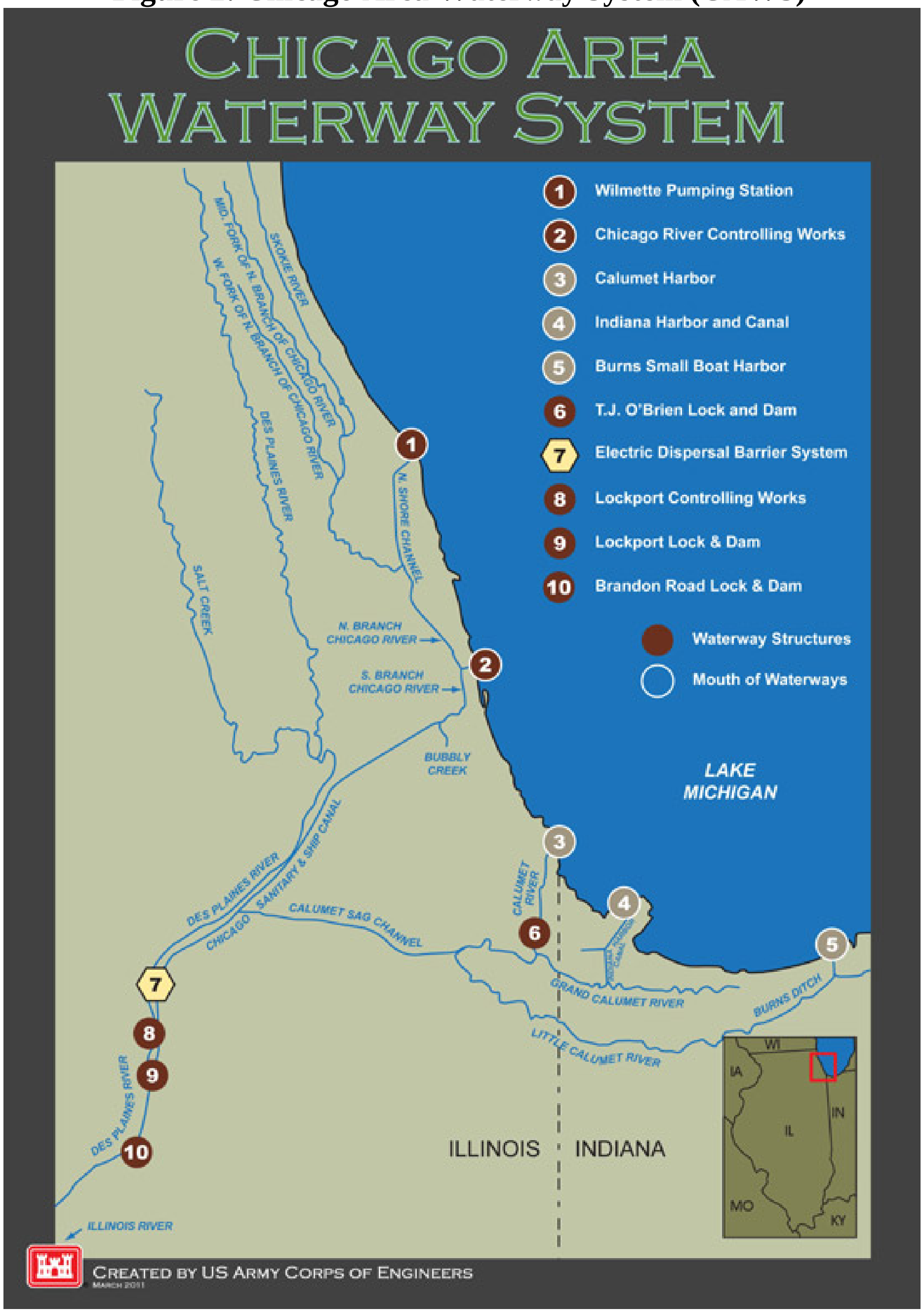


Potential aquatic pathways between the Great Lakes, Mississippi River, and Ohio River Basins exist along the basins' shared boundary (illustrated in *Figure 1: GLMRIS Study Area Map*). This shared boundary is the primary concentration of the study.

The *Detailed Study Area* is the area where the largest economic, environmental and social impacts from alternative plans are anticipated to occur. The *Detailed Study Area* consists of the Upper Mississippi and Ohio River Basins (green shaded areas) and the Great Lakes Basin (brown shaded area).

Focus Area I, the Chicago Area Waterway System (CAWS), as shown in Figure 2, is the only known continuous aquatic pathway between the Great Lakes and Mississippi River basins and, therefore, poses the greatest potential risk of aquatic nuisance species (ANS) transfer between the basins, via an aquatic pathway.

Figure 2: Chicago Area Waterway System (CAWS)



GLMRIS NAVIGATION AND ECONOMICS PDT

The GLMRIS Navigation and Economics Product Delivery Team (PDT) is tasked with demonstrating the economic activities that could be impacted by the implementation or lack of implementation of a GLMRIS project. The PDT is comprised of several sub-teams that examined economic activities that take place within the GLMRIS detailed study area – which are displayed in Table 4. The table also demonstrates which of the economic activities are included in this regional economic contribution assessment.

Table 4: GLMRIS Navigation and Economics PDT

Sub-Team	Focus	Study Area[1]	Included/Excluded from Regional Economic Contribution Report
Fisheries Economics	Commercial Fishing	GL, UMR, & OHR Basins	**INCLUDED**
	Recreational Fishing	GL, UMR, & OHR Basins	**INCLUDED**
	Charter Fishing	GL Basin	**INCLUDED**
	Subsistence Fishing	GL, UMR, & OHR Basins	-
	Pro-Fishing Tournaments	GL, UMR, & OHR Basins	-
Cargo Navigation	Cargo navigation activities	CAWS	**INCLUDED**
Non-Cargo Navigation	Non-cargo navigation activities	CAWS	**INCLUDED**
Hydropower	Lockport Lock and Dam hydropower generation	CAWS	-
Water Quality & Water Supply	Water Quality	CAWS	-
	Water Supply	CAWS	-
Flood Risk Management	Flooding impacts due to hydrologic separation	CAWS	-
Regional Economic Development	Economic contribution and impacts associated with activities within the GLMRIS study area	GL, UMR, & OHR Basins	N/A

1. "GL" indicates the Great Lakes; "UMR" indicates the Upper Mississippi River; "OHR" indicates the Ohio River; "CAWS" indicates the Chicago Area Waterway System.
2. "-" indicates that the information derived from the particular study focus was not included in this regional economic contribution report.

The Fisheries Economics Team conducted five studies which focus on the following economic activities: commercial fishing, recreational fishing, charter fishing, subsistence fishing, and pro-fishing tournaments. Commercial, recreational and charter fishing assessments are included in this document, but subsistence and pro-fishing tournaments are not. This is due to the fact that while the first three studies produced quantitative analyses that could be utilized in the REMI PI^+ model, the other assessments were primarily qualitative – and could not be utilized in the model.

Hydropower generation was excluded from this regional economic contribution assessment due to the relatively low revenues produced by this activity within the CAWS. The focus of this report is to highlight the major economic activities that could be impacted by implementation or lack of implementation of a GLMRIS project.

Water quality and water supply assessments are excluded from this document due to the fact that these GLMRIS analyses are primarily qualitative, and therefore, were not utilized in the REMI PI^+ model.

Flood risk management (FRM) data is excluded from this assessment because this assessment solely exhibits the current economic *contributions* associated with economic activities within the GLMRIS detailed study area. The FRM Team assessed the *impacts* associated with hydrologic separation. This document does not seek to quantify regional economic *impacts* associated with the FWOP or FWP conditions.

This report establishes the current economic contributions – measured by value added, output, employment, and income – associated with several existing economic activities within the Great Lakes, Upper Mississippi River, and Ohio River Basins. The economic contribution associated with each of the existing economic activities serves as a baseline assessment of what could be affected in the future without-project or future with-project conditions.

KEY TERMINOLOGY: DEFINITIONS AND APPLICATIONS

Aquatic Nuisance Species

An aquatic nuisance species (ANS) is a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural or recreational activities dependent on such waters.

The Fisheries Economics Team – identified economic activities, including commercial fishing, recreational fishing, and charter fishing that *could* be impacted by ANS if *no* new Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins (i.e. the FWOP condition). Due to the fact that USACE does not have sufficient information to quantify the timing or magnitude of impacts associated with ANS transfer on commercial, recreational, or charter fisheries, the baseline regional contribution assessment solely serves as an indicator of what output, value added, employment, and income *could* be impacted by ANS transfer between the basins.

Placing a value on the economic contribution of the commercial, recreational, and charter fishing industries is *not* intended to imply that all output, value added, employment, or income would be lost if no new Federal action is not taken to prevent ANS transfer between the basins.

Baseline Condition

According to the U.S. Army Corps of Engineers' IWR 96-R-21, *Planning Manual*, the base conditions are the "conditions that exist at the time of the study."

The GLMRIS Navigation and Economics PDT identified various economic activities that take place within the GLMRIS detailed study area, and their associated current economic value. This regional economic contribution report exemplifies how various economic activities within the study area contribute to the current economy by way of output, value added, employment, and income.

The baseline economic contribution values demonstrate the various aspects of the economy that could be impacted in the FWOP or FWP conditions. Placing a value on the various economic activities is *not* intended to imply that all output, value added, employment, or income would be lost if new Federal action is or is not taken to prevent ANS transfer between the basins.

Direct Effect

Direct effects can be measured by value added, output, employment and income. "In the impact area in which a project or economic activity is located, direct output (i.e., sales or revenues)… represents that proportion of the spending or sales in each industry that flows to material and service providers *in* the given region. For employment, income, and gross regional product [value added] measures, the direct effect represents the jobs, income, and gross regional product [value added] associated with the directly affected industry" (RECONS User Guide).

Note that direct effects are not specifically called out in this report, as this document seeks to identify a comprehensive estimate of economic contribution associated with specific activities with the GLMRIS detailed study area. They are included in the "total" approximations of value added, output, employment, and income – which also include indirect and induced effects. Note that all dollar values presented in this report are displayed in calendar year (CY) 2012 dollars.

Employment

"Employment comprises estimates of the number of jobs, full-time plus part-time, by place of work. *Full-time and part-time jobs are counted at equal weight*. Employees, sole proprietors, and active partners are included, but unpaid family workers and volunteers are not included" (REMI).

Total employment (the sum of direct, indirect, and induced employment) is presented in the economic contribution assessment for each identified economic activity.

Hydrologic Separation

The GLMRIS Navigation and Economics PDT is composed of several sub-teams that identified the current economic value of activities in the Chicago Area Waterway System (CAWS), and the Great Lakes, Upper Mississippi River, and Ohio River Basins. Several of the identified economic activities, including cargo navigation, non-cargo navigation, hydropower, and water supply could be impacted if USACE implements any of the alternative plans (i.e., future with-project conditions), some of which include hydrologic separation measures. Regional economic contribution assessments were generated for the economic activities related to cargo navigation and non-cargo navigation in order to provide a baseline as to what *could* be impacted if new Federal action *is* taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins via hydrologic separation or other measures.

Placing a value on the economic contribution associated with cargo navigation and non-cargo navigation activities that take place in the CAWS is *not* intended to imply that all output, value added, employment, or income would be lost if new Federal action *is* taken to prevent ANS transfer between the Great Lakes and Mississippi River Basins.

Indirect Effect

The indirect effects include "the backward-linked industry suppliers for goods and services that support the directly affected industries, supporting indirect jobs, labor income, value added, and economic output. For example, if construction activity is the direct effect, indirect business supporting construction would include architectural and engineering, lumber suppliers, trucking, steel manufacturers, among others; these are considered backward-linked industries supporting the construction activity" (RECONS User Guide).

Indirect effects are captured in the "total" output, value added, employment, and income estimates. Note that all dollar values presented in this report are displayed in CY2012 dollars.

Induced Effect

The induced effect occurs from household expenditures or consumer spending associated with the direct and indirect workers spending their earnings within the impact area, supporting induced economic output, jobs, labor income, and gross regional product (RECONS User Guide).

Induced effects are captured in the "total" output, value added, employment, and income estimates. All dollar values presented in this report are displayed in CY2012 dollars.

Output

Output is defined as "the amount of production, including all intermediate goods purchased as well as value added (the contribution of an industry sector to gross domestic product (GDP)). [It] can also be thought of as sales…" (REMI).

Total output (the sum of direct, indirect, and induced output) is presented in the economic contribution assessment for each of the identified economic activities. All dollar values presented in this report are displayed in CY2012 dollars.

Regional Economic Contribution

Economic contribution estimates the existence (contribution) of an economic activity (output, labor income, value added, and employment) associated with an *already occurring* economic stimulus to an economy (RECONS User Guide).

Economic contribution assessments were generated for the various economic activities. These economic activities are *already occurring* economic stimuli to the economy. Therefore, this report examines the contribution of these economic activities to the U.S. economy.

Regional Economic Impact

Regional economic impact estimates the change in economic activity (output, labor income, value added, and employment) associated with the *new* economic stimulus to an economy (RECONS User Guide).

The impacts associated with the FWOP condition are not presented in this report. This is because FWOP conditions were not quantified for commercial, recreational, and charter fishing due to the fact that USACE does not have sufficient information to quantify the timing or magnitude of impacts associated with ANS transfer on targeted commercial, recreational, and charter fisheries. Further, a complete set of management plans detailing the anticipated future harvest levels in the water bodies in each basin was not available. This report solely exhibits the economic contribution of– commercial, recreational, and charter fishing activities – that *could* be changed by the transfer of ANS or plans to prevent the transfer of ANS between the Great Lakes and Mississippi River basins.

Further, the impacts associated with the implementation of the FWP conditions to economic activities that could be impact by project implementation – cargo navigation, non-cargo navigation, water supply, and hydropower – are not presented in this document. This is due to the fact that FWP conditions were not quantified for all of the economic activities. This report solely exhibits the economic contribution of these economic activities that could be impacted by implementation of a GLMRIS project.

REMI PI$^+$

"The REMI model incorporates aspects of four major modeling approaches: Input-Output, General Equilibrium, Econometric, and Economic Geography. Each of these methodologies has distinct advantages as well as limitations when used alone. The REMI integrated modeling approach builds on the strengths of each of these approaches.

The REMI model at its core, has the inter-industry relationships found in Input-Output models. As a result, the industry structure of a particular region is captured within the model, as well as transactions between industries. Changes that affect industry sectors that are highly interconnected to the rest of the economy will often have a greater economic impact than those for industries that are not closely linked to the regional economy.

PI$^+$…generates realistic year-by-year estimates of the total regional effects of any specific policy initiative. A wide range of policy variables allows the user to represent the policy to be evaluated, while the explicit structure in the model helps the user to interpret the predicted economic and demographic effects. The model is calibrated to many sub-national areas for policy analysis and forecasting, and is available in single- and multi-area configurations. Each calibrated area (or region) has economic and demographic variables, as well as policy variables so that any policy that affects a local economy can be tested" (REMI).

The Regional Economic Models, Inc. (REMI) Policy Insight Plus (PI$^+$) model, version 1.4, was utilized to generate the economic contribution assessments presented in this report.

Total Income

Total income includes "income received by persons from all sources. It includes income received from participation in production as well as from government and business transfer payments. It is the sum of compensation of employees (received), supplements to wages and salaries, proprietors' income with inventory valuation adjustment (IVA) and capital consumption adjustment (CCAdj), rental income of persons with CCAdj, personal income receipts on assets, and personal current transfer receipts, less contributions for government social insurance" (REMI). Note that all dollar values presented in this report are displayed in CY2012 dollars.

Total income (the sum of direct, indirect, and induced income) is presented in the economic contribution assessment for each economic activity. All dollar values presented in this report are displayed in CY2012 dollars.

Value Added

Value added is defined as "the gross output of an industry or a sector less its intermediate inputs; the contribution of an industry or sector to gross domestic product (GDP)" (REMI). Note that gross domestic product (GDP) is defined as the "market value of goods and services produced by labor and property in the United States, regardless of nationality" (REMI PI$^+$). Value added can also be measured as the sum of compensation of employees, taxes on production and imports less subsidies, and gross operating surplus.

Total value added (the sum of direct, indirect, and induced value added) is presented in the economic contribution assessment for each economic activity. All dollar values presented in this report are displayed in CY2012 dollars.

REGIONAL ECONOMIC CONTRIBUTION OVERVIEW

Study Approach

In support of GLMRIS, this regional economic contribution assessment will demonstrate the value added (the contribution of an industry sector to gross domestic product (GDP)), output (sales), employment, and income (economic contribution) supported by the following economic activities that take place within the GLMRIS study area: commercial fishing, recreational fishing, charter fishing, cargo navigation, and non-cargo navigation.

These economic activities can be assembled into two categories: (1) those that could be affected in both the future without-project (FWOP) condition *and* the future with-project (FWP) condition and, (2) those that could be affected in the future FWP condition.

Fishing-Related Industries

In the case of the FWOP condition, *no* new Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basin. The primary economic activities at could be affected in the FWOP condition includes: commercial fishing, recreational fishing, and charter fishing.

Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since native and commercial fish species have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Consequently, this economic assessment demonstrates the fishing-related industries that *could* be affected if no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins (i.e., the future without-project condition).

In the case of the FWP condition, new Federal action *is* taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basin. Commercial fishing, recreational fishing, and charter fishing could also be affected in the FWP condition, due to fisheries management practices, as well as other factors.

However, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future resource availability and regulations regarding charter fishing activities in the case where Federal action *is* taken to prevent the transfer of ANS between the basins (i.e., the FWP condition). Since these management plans were not available, this assessment serves as a baseline of the charter fishing industry within the Great Lakes, Upper Mississippi River, and Ohio River Basins *could* be affected in the FWP condition.

This report will first address the economic contribution associated with commercial fishing, recreational fishing, and charter fishing – those economic activities that would likely to be affected in both the FWOP and FWP conditions.

Navigation-Related Industries

In the FWP condition, new Federal action *is* taken to prevent the transfer of ANS between the basins. These FWP condition alternatives include a hydrologic separation measure or other measures that would take place within the CAWS – and could impact the following economic activities: cargo navigation and non-cargo navigation.

Therefore, this report will exhibit the economic contribution associated with cargo navigation, non-cargo navigation – those economic activities that would likely be most affected in the FWP condition.

Method of Analysis

The method for generating economic contribution varies slightly for each of the economic activities that are assessed. However, the underlying premise of the analyses is consistent across each of the assessments.

Background Information

Background information is provided for each of the economic activities that are assessed – which explains how each of the values utilized in the REMI PI^+ model were generated. For instance, the commercial fisheries regional economic assessment includes a brief explanation of how the GLMRIS Fisheries Economics Team derived the harvest values associated with commercial fisheries in the Great Lakes, Upper Mississippi River, and Ohio River Basins. These total harvest values were utilized in the REMI PI^+ model.

Regional Economic Contribution Assessment

After the background information is presented, the regional economic contribution assessments are then displayed. The REMI PI^+ model was utilized to estimate the total value added (the contribution of an industry sector to gross domestic product (GDP)), output (sales), employment, and income associated with the given economic activity.

Prior to use, the REMI PI^+ model was segmented into four different regions to address the specific needs of GLMRIS: (1) the Chicago combined statistical area (CSA), (2) the Great Lakes, Upper Mississippi River, and Ohio River Basins, (3) the Lower Mississippi River Basin, and (4) the rest of the nation. However, for the analysis of each economic activity, the analyst combined these four regions into three regions, to include: (1) the Chicago CSA, (2) the Great Lakes, Upper Mississippi River and Ohio River Basins, and (3) the Lower Mississippi River Basin and the rest of the nation. Note that the primary difference between how the model was originally set up and the latter configuration is that the Lower Mississippi River is not a singular region- it is combined with the rest of the nation. This is due to the fact that this region, although it is a portion of the GLMRIS study area, is not a part of the detailed study area - which was the focus of the economic analyses. The results of the given regional economic assessment are presented for each of the identified regions, as well as the national total.

A counterfactual analysis was employed for the analysis of the individual economic activities. In a counterfactual analysis, the policy variable levers (e.g., consumption amounts) are pulled in the model but instead of entering positive values, negative values are entered to represent the loss of the existing industry. The model will interpret this as an entity leaving a region. The exogenous (i.e. values determined outside of the model) changes to jobs, income, output, etc., whether they are positive or negative, will trigger the endogenous (i.e. variables determined within the model) linkages within the REMI model.

The reason a counterfactual analysis is recommended for GLMRIS is because the goal of this regional economic contribution assessment is to measure the contribution of an industry to the existing economy, rather than adding additional industries to the current economy. The results associated with this analysis exhibit the current economic contribution of each of the economic activities within the GLMRIS study area, and the rest of the nation. This yields the total sales, value added (the contribution of an industry sector to gross domestic product (GDP)), employment, and earnings that are generated from the existence of the given industry.

For example, a part of the commercial fishing regional economic contribution analysis required the total harvest value of commercial fisheries in the Great Lakes – which was estimated at $21,793,000 – to be extracted from the relevant industry sector[1]. This is done by identifying the industry sector that encompasses commercial fishing activities in Region 2[2], which in this case, is the “forestry; fishing, hunting, trapping” sector. The output (sales) for this sector within Region 2 is reduced by $21,793,000. This simulation yields the total output, value added, employment, and income that are generated from the *existence* of the given industry. Counterfactual analysis was the method of analysis employed for each of the five economic activities examined in this report.

Interpretation of the Results

[1] The various economic activities were organized by the appropriate North American Industry Classification System (NAICS) code. Note that – “NAICS is based on a production-oriented concept, meaning that it groups establishments into industries according to similarity in the processes used to produce goods or services” (U.S. Census Bureau).

[2] Note that in some cases, such as recreational fishing, the given economic activity takes place in two of the identified regions within this specific REMI PI+ model (both regions 1 and 2). Therefore, the “spreader” tool was utilized. This tool allowed for the analyst to distribute consumption amounts (or other variable) associated with a given industry based on the consumption levels within the given regions. For instance, if $1 million was spent on hotels in both regions 1 and 2, the spreader tool (based on regional consumption amounts for the given sector) would distribute the total amount between the two regions (e.g., $200,000 to region 1, and $800,000 to region 2).

The resulting total value added, output, employment, and income is the economic contribution associated with the specified activity (e.g. commercial fishing in the U.S. waters of the Great Lakes).

Economic contribution "estimates the existence… of an economic activity associated with an already occurring economic stimulus to an economy" (RECONS User Guide). Therefore, the correct interpretation of total employment figure generated by the assessment of commercial fishing activities that take place within the Great Lakes, Upper Mississippi River and Ohio River Basins is: "Commercial fishing activities in the Great Lakes Basin *supports* x jobs in Region y." The key term is "supports," rather than "creates."

The results of this regional economic contribution assessment are important for determining how existing economic activities currently contribute to the United States' economy, and what economic values could change under the GLMRIS FWOP and/or FWP conditions.

For example, the GLMRIS FWOP condition alternative – the case where *no* new Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins – could result in a change in the fishery populations within these basins. Economic activities dependent on these fisheries could also be impacted to a certain (currently unquantifiable) extent. Changes in the populations of various fisheries could alter the annual harvest levels for commercial fishermen in the given region. These new harvest levels would yield a new total harvest value. Different measures of economic factors (i.e. a new measure of value added, output, employment, and income) would be exhibited in the economy in the absence of a particular economic activity (e.g., commercial fishing).

However, the *impacts* associated with the FWOP condition are not presented in this report. This is because FWOP conditions were not quantified for commercial, recreational, and charter fishing due to the fact that USACE does not have sufficient information to quantify the timing or magnitude of impacts associated with ANS transfer on commercial fisheries. Further, a complete set of management plans detailing the anticipated future harvest levels in the water bodies in each basin was not available. This report solely exhibits the economic contribution of the activities – commercial, recreational, and charter fishing – that could be impacted in the FWOP condition.

The FWP condition alternatives – the case where new Federal action *is* taken to prevent the transfer of ANS between the two basins – could also have implications for fishing activities within the GLMRIS detailed study area. Fisheries management techniques, as well as other factors, could impact the available fisheries populations within the study area. Again, changes in the populations of various fisheries may alter the annual harvest levels for commercial fishermen in the given region. These new harvest levels would yield a new total harvest value. The economy would then react differently than is estimated in this report. Recall, this report solely exhibits the economic contribution of the activities – commercial, recreational, and charter fishing – that could change in the FWP condition.

The FWP condition alternatives could also impact cargo navigation and non-cargo navigation activities within the CAWS. This is because various measures within the GLMRIS alternative plans, such as hydrologic separation, could change the operational activities of the CAWS. For instance, a severed waterway (due to hydrologic separation) would result in new methods and costs of transferring goods within this region. This is because various companies currently utilize the CAWS to transport goods and any change to this waterway will impact the users in some way – whether it be increased transportation costs (due to lack of availability of the current waterway to be utilized), or some other impact. A new level of economic activity would yield a new measure of value added, output, employment, and income associated with these activities in the given region(s) than is estimated in this report.

However, the *impacts* associated with the implementation of the FWP conditions to these industries are not presented in this document. This report solely exhibits the economic contribution of commercial, recreational and charter fishing, as well as cargo and non-cargo navigation that could be impacted by the implementation of a GLMRIS project.

It is important to note that economic activities in one region (e.g. the Chicago CSA – Region 1), also have effects on other regions (e.g. Region 2). This is because there are interdependencies between industries. For example, if a factory is built in Region 1, many of the goods required to construct the factory may not be available from producers within the region; therefore, goods must be obtained from another region (e.g. Region 2) which do produce the given products. This is an example of an indirect effect, which in this case, implies that there is spending from Region 1 in Region 2. This demonstrates why that an activity in Region 1 provides a certain level of economic contribution in Region 1, as well as Regions 2 and 3.

Similarly, induced effects also occur in all regions. For instance, in the factory example above, some products for Region 1 are produced by Region 2. The workers in Region 2 who provided this good to Region 1 receive an income for doing so. These workers in Region 2 spend some of their earnings to buy other goods and services, such as groceries and education. This spending is called an “induced effect.” Again, this explains why an activity in Region 1 provides a certain level of economic contribution in Regions 2 and 3.

REGIONAL ECONOMIC CONTRIBUTION: COMMERCIAL FISHING IN THE GREAT LAKES, UPPER MISSISSIPPI RIVER, AND OHIO RIVER BASINS

Background Information

In support of GLMRIS, the Fisheries Economics Team generated the following report – *Commercial Fisheries Baseline Economic Assessment - U.S. Waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins*, which established the current economic value of the commercial fisheries in the U.S. waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins based on the most recent annual harvest data available from state agencies (or equivalents) and inter-tribal agencies or organizations.

The findings of the commercial fisheries assessment report include the harvest values for the commercial fisheries in the U.S. waters of the three basins. The five year average annual commercial fisheries harvest value for the combined basins is $27.6 million. This represents the value of the commercial fishing industry in the three basins that *could* be impacted in the FWOP or FWP conditions. These findings are further summarized in Table 5.

Table 5: Commercial Fishing Baseline Harvest Levels and Values- Summary Data

Basin	Baseline Harvest Level[1] (Pounds of Fish)	Baseline Harvest Value[2] ($)
Great Lakes	20,243,000	21,793,000
Upper Mississippi and Ohio River	11,381,000	5,825,000
Total [3]	**31,624,000**	**27,618,000**

1. This is a five-year average of the annual harvest levels in pounds (rounded to the nearest thousand). Harvest levels for the Great Lakes Basin are reflective of 2005 through 2009 harvest data; harvest levels for the Upper Mississippi River and Ohio River Basins are reflective of 2001 through 2005 harvest data.
2. This is a five-year average of the annual harvest values displayed (rounded to the nearest thousand). Harvest values for the Great Lakes Basin are reflective of 2005 through 2009 harvest data; values for the Upper Mississippi River and Ohio River Basins are reflective of 2001 through 2005 harvest data.
3. This baseline reflects harvest levels and values of the fisheries in the U.S. waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins.

Regional Economic Contribution Assessment

Method

Table 5 exhibits the total baseline commercial fishing value for the U.S. waters of the Great Lakes, Upper Mississippi River, and Ohio River Basins. A counterfactual analysis utilizing the REMI PI$^+$ model – which involved reducing the production (sales) of the “forestry; fishing, hunting, trapping” sector in Region 2 – provides the total economic contribution associated with the U.S.’ Great Lakes, and Upper Mississippi River and Ohio River Basins’ commercial fishing industry to Region 2, as well as the indirect and induced effects in Regions 1 and 3.

Results

Table 6 exhibits the economic contribution associated with commercial fishing in the Great Lakes Basin (to include the Great Lakes, and all tributaries below impassible barriers[3]) in each of the Regions 1, 2, and 3. The table also displays the national totals of value added, output, employment, and income.

The total sales supported by the commercial fishing industry in the U.S. waters of the Great Lakes Basin is estimated at $55 million for the nation, with an associated $31 million in value added. The total employment supported in the United States – by commercial fishing activities within the basins – is approximately 570 jobs. This total is the sum of the direct, indirect, and induced jobs supported by this portion of the total U.S. commercial fishing activity. This total employment is associated with a total income of $14 million.

The majority of the economic contribution takes place in Region 2- the Great Lakes, Upper Mississippi River, and Ohio River Basins due to the fact that all of the Great Lakes commercial fishing activities assessed for GLMRIS takes place in this region. There are also indirect and induced effects associated with the Great Lakes commercial fishing industry in these basins. These effects take place throughout the United States, which is why value added, output, employment, and income (economic contributions) are displayed in Table 6 for each region, as well as the national total.

Table 6: Regional Economic Contribution of Commercial Fishing in the U.S. Waters of the Great Lakes Basin

Region	Region Description	Total Value Added[1]	Total Output[2]	Total Employment[3]	Total Income[4,5]
1	Chicago CSA	$730,000	$1,280,000	7	$430,000
2	GL, UMR, & OHR Basins	$22,710,000	$38,570,000	422	$10,500,000
3	Rest of the Nation	$7,810,000	$15,630,000	141	$2,930,000
U.S. Total	**All Regions**	**$31,250,000**	**$55,480,000**	**570**	**$13,860,000**

1. "Value added" is defined as the contribution of an industry sector to gross domestic product (GDP).
2. "Output" is defined as total sales.
3. "Employment" is number of jobs supported, both full-time and part-time.
4. Income includes all employment earnings.
5. "Total" value added, output, employment, and income include the sum of direct, indirect, and induced effects.

[3] Note that the portions of tributaries that lie between the Great Lakes and the first dam are considered to be "below" impassible barriers. Portions of tributaries that lie beyond the first dam are considered to be "above" impassible barriers.

Table 7 exhibits the economic contribution associated with commercial fishing in the U.S. waters of the Upper Mississippi River and Ohio River Basins (below impassible barriers[4]) in each of the Regions 1, 2, and 3. The table also displays the national totals of value added, output, employment, and income.

The total output (sales) supported by the commercial fishing industry in the U.S. waters of these two basins is estimated at $14 million for the nation, with an associated $8 million in value added. The total employment supported in the United States – by commercial fishing activities within the basins – is approximately 150 jobs. This total is the sum of the direct, indirect, and induced jobs supported by this portion of the total U.S. commercial fishing activity. This total employment is associated with a total income of $3 million.

The majority of the economic contribution takes place in Region 2- the Great Lakes, Upper Mississippi River, and Ohio River Basins due to the fact that all of the Upper Mississippi River and Ohio River commercial fishing activities assessed for GLMRIS takes place in this region. There are also indirect and induced effects associated with the Great Lakes commercial fishing industry in these basins. These effects take place throughout the United States, which is why value added, output, employment, and income (economic contributions) are displayed in Table 7 for each region, as well as the national total.

Table 7: Regional Economic Contribution of Commercial Fishing in the U.S. Waters of the Upper Mississippi River and Ohio River Basins

Region	Region Description	Total Value Added[1]	Total Output[2]	Total Employment[3]	Total Income[4,5]
1	Chicago CSA	$180,000	$370,000	2	$60,000
2	GL, UMR, & OHR Basins	$6,100,000	$9,770,000	117	$2,440,000
3	Rest of the Nation	$1,950,000	$3,910,000	31	$980,000
U.S. Total[6]	**All Regions**	**$8,230,000**	**$14,050,000**	**150**	**$3,480,000**

1. "Value added" is defined as the contribution of an industry sector to gross domestic product (GDP).
2. "Output" is defined as total sales.
3. "Employment" is number of jobs supported, both full-time and part-time.
4. Income includes all employment earnings.
5. "Total" value added, output, employment, and income include the sum of direct, indirect, and induced effects.
6. Total may not equal sum of regions due to rounding.

[4] Note that the portions of tributaries that lie between the Upper Mississippi River and the first dam are considered to be "below" impassible barriers. Similarly, portions of tributaries that lie between the Ohio River and the first dam are considered to be "below" impassible barriers. Portions of tributaries that lie beyond the first dam are considered to be "above" impassible barriers.

The *impacts* associated with the FWOP condition are not presented in this report. Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since native and commercial fish species have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Consequently, this baseline economic assessment demonstrates the commercial fishing industry that *could* be affected if no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins (i.e., the FWOP condition).

Further, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future resource availability regarding commercial fishing activities in the case where Federal action is taken to prevent the transfer of ANS between the basins (i.e., the FWP condition). Since these management plans were not available, this assessment serves as a baseline of the commercial fishing industry within the Great Lakes, Upper Mississippi River, and Ohio River Basins that *could* be affected in the FWP condition.

Therefore, Table 6 and Table 7 display the total value added, output, employment and income in each region of the United States that *could* be impacted in the FWOP or FWP condition.

REGIONAL ECONOMIC CONTRIBUTION: RECREATIONAL FISHING IN THE GREAT LAKES, UPPER MISSISSIPPI RIVER, AND OHIO RIVER BASINS

Background Information

In support of the GLMRIS Fisheries Economics Team, Cornell University was, in part, tasked with determining total expenditures that can be attributed to recreational fishing activities in the Great Lakes, Upper Mississippi River, and Ohio River Basins. Findings from this evaluation are identified in the following report – *Net Benefits of Recreational Fishing in the Great Lakes, Upper Mississippi River, and Ohio River Basins* (Ready, et al.). The recreational fishing report established three components that were critical in determining the total recreational fishing expenditures within the three basins, including: (1) total number of days fished per household, (2) the total mean expenditures per day per household, and (3) the average number of household members participating on most recent fishing trip.

Great Lakes Fishing Expenditure Estimates

For the Great Lakes Basin, fishing trips targeted one of three areas: (1) the Great Lakes (GL), (2) GL tributaries below impassible barriers (i.e. dams), and (3) GL tributaries above impassible barriers. Note that the portions of tributaries that lie between the Great Lakes and the first dam are considered to be "below" impassible barriers. Portions of tributaries that lie beyond the first dam are considered to be "above" impassible barriers. The recreational fishing expenditure estimates will only be presented for the Great Lakes and the portions of their tributaries that lie below impassible barriers. These are the areas that are considered to be at risk of being impacted by ANS transfer in the FWOP condition. Great Lakes recreational fishing expenditures were derived from the following pieces of information: (1) total number of days fished per household, (2) the total mean expenditures per day per household, and (3) the average number of household members participating on most recent fishing trip. This is exemplified in Table 9. Expenditures associated with fishing on GL tributaries *below* impassible barriers are derived in the same way. This is presented in Table 9.

Table 8: Annual Great Lakes Basin Recreational Fishing Expenditure Estimates

Fishing Location	Days Fished[1] (a)	Total Mean Expenditures/Day/ Household[2] (b)	# of Household Members[3] (c)	Expenditure Estimate =(a*b)/(c)
Great Lakes	33,000,000	173	1.4	4,000,000,000
Great Lakes Tributaries Below Impassible Barriers	30,000,000	88	1.4	1,900,000,000
			Total	**5,900,000,000**

1. Estimates are based on the respondents' most recent fishing trip – in May 2012 or earlier.
2. Value generated by utilizing the annual Consumer Price Index (CPI) values (as reported by the Bureau of Labor Statistics (BLS)), for 2011 (224.939) and 2012 (229.594) to update calendar year 2011 estimates to 2012 dollars. The average CPI was used because expenditures represented the sum from numerous states in the Great Lakes Basin.
3. Average number of household members participating in the most recent trip.

Upper Mississippi River and Ohio River Basin Expenditure Estimates

For the Upper Mississippi River and Ohio River Basins (UMORB), fishing trips targeted one of three areas: (1) Upper Mississippi River and Ohio Rivers, as well as tributaries below impassible barriers (i.e. dams), and (2) tributaries above impassible barriers.

Note that the portions of tributaries that lie between the Upper Mississippi River and the first dam are considered to be "below" impassible barriers. Similarly, portions of tributaries that lie between the Ohio River and the first dam are considered to be "below" impassible barriers. Portions of tributaries that lie beyond the first dam are considered to be "above" impassible barriers.

The recreational fishing expenditure estimates will only be presented for the Upper Mississippi and Ohio Rivers, and the portions of their tributaries that lie below impassible barriers. These are the areas that are considered to be at risk of being impacted by ANS transfer in the FWOP condition.

Expenditures associated with fishing on the Upper Mississippi River, Ohio River, and their tributaries *below* impassible barriers are derived in the same way as the Great Lakes Basin expenditures, as demonstrated in Table 9.

Table 9: Annual UMORB Recreational Fishing Expenditure Estimates (2012 Dollars)

Fishing Location	Days Fished[1] (a)	Total Mean Expenditures/Day/Household[2] (b)	# of Household Members[3] (c)	Expenditure Estimate[4] (2012 $) =(a*b)/(c)
UMORB Rivers Below Impassible Barriers	58,000,000	88	1.4	3,600,000,000
			Total	**3,600,000,000**

1. Estimate based on most recent fishing trip – May 2012 or earlier.
2. This value was generated by utilizing the annual Consumer Price Index (CPI) values (as reported by the Bureau of Labor Statistics (BLS), for 2011 (224.939) and 2012 (229.594) to update the 2011 estimate ($86.06) to calendar year 2012 dollars, which resulted in the value of $87.84. Note that the average CPI was used due to the fact that expenditures represented the sum from numerous states in the UMORB.
3. Average number of household members participating in trip.
4. Total recreational fishing expenditure estimate.

Regional Economic Contribution Assessment

Method

In order to perform the counterfactual analysis which involved extracting this value from various sectors in Regions 1 and 2[5], the appropriate consumption categories needed to be identified. Table 22 of the *Net Benefits of Recreational Fishing in the Great Lakes, Upper Mississippi River, and Ohio River Basins* document provides the various expenditure categories and associated portion of expenditures to be allocated to each group.

Table 10: Expenditure Categories for Great Lakes Basin and UMORB Recreational Fishing (2012 Dollars)

Expenditure Category[1]	Great Lakes Fishing	Inland Fishing[2]
Bait and Tackle	10.2%	14.9%
Restaurants or Bars	13.8%	15.5%
Grocery Stores	7.9%	12.7%
Lodging	14.6%	19.0%
Gas Stations	18.4%	25.5%
Marinas or Yacht Clubs	12.5%	5.5%
Fishing Charters or Guides	20.5%	3.2%
Other	2.1%	3.7%
Total	**100.0%**	**100.0%**

1. As defined by Table 22 of the *Net Benefits of Recreational Fishing in the Great Lakes, Upper Mississippi River, and Ohio River Basins* document.
2. This includes Great Lakes tributaries below impassible barriers, and all fishing in the Upper Mississippi River and Ohio River Basins below impassible barriers.

The expenditure categories identified in Table 10 were then matched to the appropriate REMI PI$^+$ consumption category. These category conversions and associated total expenditures – for: (1) the Great Lakes, (2) Great Lakes tributaries below impassible barriers, (3) Upper Mississippi River and its tributaries below impassible barriers, and (4) Ohio River and its tributaries below impassible barriers – are presented in Table 11.

The counterfactual analysis was performed utilizing the REMI PI$^+$ consumption categories and total expenditures exhibited in Table 11. However, unlike commercial fishing, recreational fishing takes place in Regions 1 and 2, and therefore, the consumption amount in the various sectors was reduced within each region via spreading. This analysis yields the total regional economic contribution that can be attributed to spending on recreational fishing in the GLMRIS study area below impassible barriers.

[5] Recreational fishing occurs in Regions 1 (the Chicago combined statistical area), and Region 2 (the Great Lakes, Upper Mississippi River, and Ohio River Basins).

Table 11: Annual Recreational Fishing Expenditures in Great Lakes Basin (2012 Dollars)

Expenditure Category[1]	→	REMI Consumption Category[2]	Total Expenditures[3] ($Millions)
Bait and Tackle	→	Sporting Equipment- Supplies, Guns, Ammunition	$696.09
Restaurants or Bars	→	Purchase Meals And Beverages	$849.80
Grocery Stores	→	Food And Non-Alcoholic Beverages For Off-Premise Consumption	$558.82
Lodging	→	Accommodations	$947.69
Gas Stations	→	Motor Vehicle Fuels, Lubricants And Fluids	$1,227.10
Marinas or Yacht Clubs	→	Membership Clubs, Sport Centers, Parks, Theaters And Museums	$607.57
Fishing Charters or Guides	→	Other Recreational Services	$1,044.68
Other			
		Total	**$5,931.75**

1. As defined by Table 22 of the *Net Benefits of Recreational Fishing in the Great Lakes, Upper Mississippi River, and Ohio River Basins* document.
2. As defined by REMI PI+.
3. Total recreational fishing expenditures for: (1) Great Lakes, and (2) Great Lakes tributaries below impassible barriers.

Table 12: Annual Recreational Fishing Expenditures in the Upper Mississippi River and Ohio River Basins (2012 Dollars)

Expenditure Category[1]	→	REMI Consumption Category[2]	Total Expenditures[3] ($Millions)
Bait and Tackle	→	Sporting Equipment- Supplies, Guns, Ammunition	$539.39
Restaurants or Bars	→	Purchase Meals And Beverages	$558.70
Grocery Stores	→	Food And Non-Alcoholic Beverages For Off-Premise Consumption	$458.80
Lodging	→	Accommodations	$685.05
Gas Stations	→	Motor Vehicle Fuels, Lubricants And Fluids	$922.21
Marinas or Yacht Clubs	→	Membership Clubs, Sport Centers, Parks, Theaters And Museums	$198.97
Fishing Charters or Guides	→	Other Recreational Services	$249.34
Other			
Total			$3,612.46

1. As defined by Table 22 of the *Net Benefits of Recreational Fishing in the Great Lakes, Upper Mississippi River, and Ohio River Basins* document.
2. As defined by REMI PI+.
3. Total recreational fishing expenditures for: (1) Upper Mississippi River and its tributaries below impassible barriers, and (2) Ohio River and its tributaries below impassible barriers.

Results

Table 13 exhibits the economic contribution associated with recreational fishing within the Great Lakes Basin (to include the Great Lakes and all tributaries below impassible barriers) to Regions 1, 2, and 3, as well as the national total.

The total sales supported by the recreational fishing industry for the U.S. waters of the Great Lakes Basin is estimated at $14 billion for the nation - with an associated $8 billion in value added, and 112,000 jobs. This total employment is associated with a total income of $4 billion.

Table 13: Regional Economic Contribution of Recreational Fishing in the Great Lakes Basin

Region	Region Description	Total Value Added[1]	Total Output[2]	Total Employment[3]	Total Income[4,5]
1	Chicago CSA	$992,000,000	$1,645,000,000	12,287	$600,000,000
2	GL, UMR, & OHR Basins	$4,108,000,000	$6,837,000,000	63,750	$2,225,000,000
3	Rest of the Nation	$3,249,000,000	$5,771,000,000	35,656	$1,663,000,000
U.S. Total[6]	**All Regions**	**$8,349,000,000**	**$14,253,000,000**	**111,693**	**$4,488,000,000**

1. "Value added" is defined as the contribution of an industry sector to gross domestic product (GDP).
2. "Output" is defined as total sales.
3. "Employment" is number of jobs supported, both full-time and part-time.
4. Income includes all employment earnings.
5. "Total" value added, output, employment, and income include the sum of direct, indirect, and induced effects.
6. Total may not equal sum of regions due to rounding.

Table 14 exhibits the economic contribution associated with recreational fishing within the Upper Mississippi River and Ohio River Basins (to include the Upper Mississippi River and Ohio River, as well as their tributaries below impassible barriers) to Regions 1, 2, and 3, as well as the national total. The total sales supported by this recreational fishing industry is estimated at $6 billion for the nation - with an associated $3 billion in value added, and 49,000 jobs. This total employment is associated with a total income of $2 billion.

Table 14: Regional Economic Contribution of Recreational Fishing in the Upper Mississippi River and Ohio River Basins

Region	Region Description	Total Value Added[1]	Total Output[2]	Total Employment[3]	Total Income[4,5]
1	Chicago CSA	$578,000,000	$971,000,000	7,167	$347,000,000
2	GL, UMR, & OHR Basins	$2,470,000,000	$4,156,000,000	38,125	$1,331,000,000
3	Rest of the Nation	$340,000,000	$656,000,000	3,908	$161,000,000
U.S. Total[6]	**All Regions**	**$3,388,000,000**	**$5,783,000,000**	**49,200**	**$1,839,000,000**

1. "Value added" is defined as the contribution of an industry sector to gross domestic product (GDP).
2. "Output" is defined as total sales.
3. "Employment" is number of jobs supported, both full-time and part-time.
4. Income includes all employment earnings.
5. "Total" value added, output, employment, and income include the sum of direct, indirect, and induced effects.
6. Total may not equal sum of regions due to rounding.

The *impacts* associated with the FWOP condition are not presented in this report. Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since targeted recreational fish species have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Consequently, this baseline economic assessment demonstrates the recreational fishing industry that *could* be affected if no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins (i.e., the FWOP condition).

Further, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future resource availability regarding recreational fishing activities in the case where Federal action is taken to prevent the transfer of ANS between the basins (i.e., the FWP condition). Since these management plans were not available, this assessment serves as a baseline of the recreational fishing industry within the Great Lakes, Upper Mississippi River, and Ohio River Basins that *could* be affected in the FWP condition.

Therefore, Table 13 and Table 14 display the total value added, sales, employment and income in each region of the United States that *could* be impacted in the FWOP or FWP condition.

REGIONAL ECONOMIC CONTRIBUTION: CHARTER FISHING IN THE GREAT LAKES BASIN

Background Information

In support of GLMRIS Fisheries Economics Team, the Ohio Sea Grant College Program led a survey of charter captains in the Great Lakes Basin in order to establish the current economic value of the charter fishing industry in the U.S. waters of the Great Lakes Basin.

As part of the Great Lakes survey of the charter fishing industry, a total of about 1,150 Great Lakes charter fishing captains were surveyed in 2012 about their 2011 fishing season, with about a 30 percent response rate. The survey aided in the identification of detailed business expenditures, the number of trips taken per charter captain, and the targeted species. In 2011, there were an estimated 1,900 active licensed charter captains in the Great Lakes who generated approximately $38.7 million[6] in annual sales and salary, in calendar year 2012 dollars.

Due to the low number of respondents to the Mississippi River Basin (MRB) river guide survey, statistically reliable information was not presented for this group.

Table 15: Great Lakes Charter Fishing Industry Baseline Economic Assessment

Basin[1]	Estimated Number of Active Licensed Fishermen	Estimated Total Revenues
Great Lakes	1,904	$38,700,000
1. Due to the low number of respondents to the Mississippi River Basin (MRB) river guide survey, statistically reliable information is not presented for this group.		

Regional Economic Contribution Assessment

Method

Table 15 demonstrates that the total baseline charter fishing value for the U.S. waters of the Great Lakes is approximately $38.7 million. A counterfactual analysis which involved subtracting this value (total production or sales) from the “scenic and sightseeing transportation and support activities” sector in Regions 1 and 2 provides the total economic contribution associated with the charter fishing industry to these regions, as well as the rest of the nation (Region 3).

[6] This value was generated by utilizing the total Great Lakes charter fishing revenues ($37,874,960 in calendar year 2011 dollars) as presented in the *Great Lakes Charter Fishing Industry- Baseline Economic Assessment* report, and the annual Consumer Price Index (CPI) values (as reported by the Bureau of Labor Statistics (BLS), for 2011 (224.939) and 2012 (229.594) to update the estimate to calendar year 2012 dollars, which resulted in the value of $38.7 million. The average CPI was used due to the fact that charter fishing revenues represented the sum from numerous states in the Great Lakes Basin.

Results

Table 16 exhibits the economic contribution associated with Region 1, 2, and 3, as well as the national total. The total output (sales) supported by the charter fishing industry in the U.S. waters of the Great Lakes is estimated at $105 million for the nation, with an associated $65 million in value added. The total employment supported in the United States by this charter fishing industry is approximately 830 jobs. This total employment is associated with a total income of $39 million.

Table 16: Regional Economic Contribution- Charter Fishing

Region	Region Description	Total Value Added[1]	Total Output[2]	Total Employment[3]	Total Income[4,5]
1	Chicago CSA	$5,000,000	$7,000,000	51	$3,000,000
2	GL, UMR, & OHR Basins	$46,000,000	$71,000,000	625	$29,000,000
3	Rest of the Nation	$15,000,000	$27,000,000	156	$8,000,000
U.S. Total[6]	**All Regions**	**$65,000,000**	**$105,000,000**	**828**	**$39,000,000**

1. "Value added" is defined as the contribution of an industry sector to gross domestic product (GDP).
2. "Output" is defined as total sales.
3. "Employment" is number of jobs supported, both full-time and part-time.
4. Income includes all employment earnings.
5. "Total" value added, output, employment, and income include the sum of direct, indirect, and induced effects.
6. Total may not equal sum of regions due to rounding.

The *impacts* associated with the FWOP condition are not presented in this report. Informed by a literature review, a qualitative risk assessment identified 35 species that could pose a high or medium risk to the receiving basin, if they were to transfer and become established. Since targeted charter fish species have not yet been exposed to the identified ANS, potential environmental, economic and social/political effects (consequences) were assessed at a basin scale (receiving basin), rather than an assessment of ANS at a species scale. Fish community responses to invading ANS are variable and difficult to predict in a scientifically defensible manner. Consequently, this baseline economic assessment demonstrates the charter fishing industry that *could* be affected if no Federal action is taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins (i.e., the FWOP condition).

Further, USACE was not able to obtain a complete set of fisheries management plans from fisheries management agencies, which were sought to aid in the determination of future resource availability regarding commercial fishing activities in the case where Federal action is taken to prevent the transfer of ANS between the basins (i.e., the FWP condition). Since these management plans were not available, this assessment serves as a baseline of the charter fishing industry within the Great Lakes Basins that *could* be affected in the FWP condition. Therefore, Table 13 and Table 14 display the total value added, sales, employment and income in each region of the United States that *could* be impacted in the FWOP or FWP condition.

REGIONAL ECONOMIC CONTRIBUTION: CARGO NAVIGATION ON THE CAWS

Background Information

In support of GLMRIS, the Cargo Navigation Team examined the cargo movements on the CAWS. The Team generated estimates of total tonnage movements and the associated rate savings. "Rate savings," often expressed as dollars per ton, indicate the amount of savings to be had by moving a given ton of cargo on a given waterway over the next cheapest alterative (whether that is by truck or rail). Total savings are calculated by deriving the product of "total tonnage" and "dollars per ton." Table 17 exhibits the baseline cargo movements and associated rate savings for the CAWS.

Table 17: Cargo Navigation on the CAWS: Tonnage and Rate Savings

	Coal & Coke[1]	**Petro. Fuels[2]**	**Aggreg.[3]**	**Grains[4]**	**Chemicals[5]**	**Ores & Min.[6]**	**Iron & Steel[7]**	**Others[8]**
Tons[9] (1,000s)	1,954	1,821	2,314	316	1,435	1,049	2,150	1,236
Rate Savings[10] ($/Ton)	16.05	19.83	9.34	25.31	34.11	60.90	33.67	26.06
Total Savings[11] ($1,000s)	**31,365**	**36,104**	**21,619**	**7,993**	**48,948**	**63,910**	**72,387**	**32,215**

1. The **Coal and Coke** group consists of coal, metallurgical coke, petroleum coke, and other related commodities. Coke and coal movements were allocated to the iron and steel and ferroalloy manufacturing industries only because of the recent closure of the electric utility plants in the CAWS.
2. The **Petroleum Fuels** group consists of gasoline, gas oils, fuel oils, kerosene, and other related commodities.
3. The **Aggregates** group consists of sands, pebbles and crushed stone, limestone, and other related commodities.
4. The **Grains** group consists of farm products such as wheat, corn, soybeans, and other related commodities.
5. The **Chemicals** group consists of antifreeze and deicer, propylene glycol, ethanol glycol, fertilizers, and other related commodities.
6. The **Ores and Minerals** group consists of salt, clays, and other related commodities.
7. The **Iron and Steel** group consists of iron ore, pig iron, iron and steel bars, and other related commodities.
8. The **All Others** group consists of crude petroleum, wood, cement, iron or steel scraps, paper, autos, machinery, and other related commodities.
9. Values presented in thousands. Tonnage levels reflect the 5-year average between 2007 and 2011.
10. Values presented are in 2012 dollars.
11. Values presented in thousands.

Method

In order to generate the economic contribution of moving commodities on the CAWS, the tonnage and rate savings information presented in Table 17 were utilized in a counterfactual analysis in the REMI PI$^+$ model. The various commodities were matched to the relevant consuming industries identified within the model. The industries that consume the various commodities were assumed to have an increase in production costs (value equal to total savings) - which exemplifies the advantage utilizing the CAWS over other forms of transporting goods (such as truck or rail).

Note that several industries consume any given commodity; consultation with the Cargo Navigation Team allowed for the appropriate portion of total savings to be allocated to each consuming industry. Table 18 and Table 19 indicate the industries that consume the majority of the given commodity moved on the CAWS.

Table 18: Commodity Consumers: Coal & Coke, Petroleum Fuels, Aggregates, Grains

	Coal & Coke[2]	Petro. Fuels	Aggregates	Grains[3]
Top Consuming Industries[1]	o Iron and steel mills & ferroalloy manuf.	o Petro. & coke product manuf. o Iron and steel mills & ferroalloy manuf.	o Cement and concrete product manuf. o Construction	o Farm

1. Exhibits industries that are estimated to assume at least 25 percent of the given commodity group. See below for distinct grain assessment.
2. Coke and coal movements were solely allocated to the following industries: iron and steel mills, and ferroalloy manufacturing. Due to the recent closure of electric utility generators in the CAWS, coal movements to this consuming industry were omitted from this analysis.
3. Grain was treated differently than the other commodity analyses due to the fact that increases in grain transportation costs would likely fall on the producer, rather than the consuming industry. In this counterfactual assessment, the analyst assumed a decrease in proprietors' income.

Table 19: Commodity Consumers: Chemicals, Ores & Minerals, Iron & Steel, Others

	Chemicals	Ores & Min.[2]	Iron & Steel	Others
Top Consuming Industries[1]	o Basic chemical manuf.	o Local government agencies	o Iron and steel mills & ferroalloy manuf.	o Cement and concrete product manuf. o Construction

1. Exhibits industries that are estimated to assume at least 25 percent of the given commodity group. See below for distinct salt assessment.
2. Salt – a part of the ores and minerals group – was treated differently than the other commodity analyses due to the fact that the primary consumer of road salt is local government agencies. It was assumed for the purpose of this assessment, that local governments wouldn't raise taxes or divert money away from other projects in order to accommodate additional salt costs. Therefore, the analyst provided an increase in production to rail and truck transportation. The percentages allocated to each mode of transportation were determined by the Cargo Navigation Team.

Results

Table 20 exhibits the economic contribution supported by cargo navigation on the CAWS in Regions 1, 2, and 3. The table also displays the national totals of value added, output, employment, and income.

The total output (sales) supported by cargo navigation movements on the CAWS is estimated at $1.6 billion for the nation, with an associated $885 million in value added; the total employment supported in the United States is approximately 10,000 jobs. This total employment is associated with a total income of $485 million.

Table 20: Regional Economic Contribution- Cargo Navigation in the CAWS

Region	Region Description	Total Value Added[1]	Total Output[2]	Total Employment[3]	Total Income[4,5]
1	Chicago CSA	$162,000,000	$317,000,000	1,480	$92,000,000
2	GL, UMR, & OHR Basins	$187,000,000	$340,000,000	2,242	$103,000,000
3	Rest of the Nation	$536,000,000	$928,000,000	5,906	$292,000,000
U.S. Total[6]	**All Regions**	**$885,000,000**	**$1,584,000,000**	**9,625**	**$485,000,000**

1. "Value added" is defined as the contribution of an industry sector to gross domestic product (GDP).
2. "Output" is defined as total sales.
3. "Employment" is number of jobs supported, both full-time and part-time.
4. Income includes all employment earnings.
5. "Total" value added, output, employment, and income include the sum of direct, indirect, and induced effects.
6. Total may not equal sum of regions due to rounding.

Cargo navigation activities within the CAWS could be impacted in the FWP condition – the case where new Federal action *is* taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins. The implementation of a GLMRIS project, in many of the alternatives, involves ANS control technologies that include aspects such as physical barriers in the CAWS and increased lockage times in the CAWS. Since the cargo vessel movements that were examined in GLMRIS take place within the CAWS, these specific movements could be impacted by implementation of a GLMRIS project. This is exemplified in Table 20. However, this report does not seek to quantify the impact of project implementation on these activities as the choices of business owners depend on their own, unique situation. Business owners may elect to move their businesses elsewhere, modify their existing structure, or shut down.

REGIONAL ECONOMIC CONTRIBUTION: NON-CARGO NAVIGATION ON THE CAWS

Background Information

In support of GLMRIS, the Non-Cargo Navigation Team *Baseline Assessment of Non-Cargo CAWS Traffic* report identified the various non-cargo users of the CAWS, including: "passenger boats and ferries, non federal government vessels, commercial fishing vessels, federal government vessels, and recreation vessels." A contributor to the tourism industry in Chicago is passenger vessels, which include tour boats and ferries, as well as cruise ships. Interviews with passenger vessel companies were conducted in order to generate the current revenues associated with passenger vessels that utilize the CAWS. These revenues are estimated at $36.8 million in calendar year 2012 dollars[7]; this information is further summarized in Table 21.

Table 21: Passenger Vessel Annual Revenues

Study Area	Annual Revenues (2012 $)
Chicago Area Waterway System	$36,800,000

Regional Economic Contribution Assessment

Method

Table 21 demonstrates that the total baseline passenger vessel revenues associated with businesses operating in the CAWS is approximately $36,800,000. This value was subtracted from the total industry sales (production) associated with the "water transportation" sector in Region 1. The results of this counterfactual analysis provide the total economic contribution associated with a given industry.

Results

Table 22 exhibits the economic contribution associated with Region 1, 2, and 3, as well as the national total.

The total output (sales) supported by the passenger vessels (e.g., tour boats, ferries, and cruise ships) in the CAWS is estimated at $88 million for the nation, with an associated $39 million in value added.

The total employment supported in the United States by this passenger vessel industry is approximately 470 jobs. This total employment is associated with a total income of $22 million.

[7] The *Baseline Assessment of Non-Cargo CAWS Traffic* report identified annual revenues in CY 2011 dollars. The annual consumer price indexes for CY 2011 (224.939) and CY 2012 (229.594) were utilized to convert CY 2011 dollars to CY 2012 dollars.

The majority of the economic contribution takes place in Region 1 due to the fact that all of the identified passenger vessel activities assessed in GLMRIS take place in the CAWS.

Table 22: Regional Economic Contribution- Non-Cargo Navigation

Region	Region Description	Total Value Added[1]	Total Output[2]	Total Employment[3]	Total Income[4,5]
1	Chicago CSA	$21,000,000	$54,000,000	241	$14,000,000
2	GL, UMR, & OHR Basins	$6,000,000	$12,000,000	82	$3,000,000
3	Rest of the Nation	$12,000,000	$21,000,000	141	$5,000,000
U.S. Total[6]	**All Regions**	**$39,000,000**	**$88,000,000**	**469**	**$22,000,000**

1. "Value added" is defined as the contribution of an industry sector to gross domestic product (GDP).
2. "Output" is defined as total sales.
3. "Employment" is number of jobs supported, both full-time and part-time.
4. Income includes all employment earnings.
5. "Total" value added, output, employment, and income include the sum of direct, indirect, and induced effects.
6. Total may not equal sum of regions due to rounding.

Non-cargo navigation activities within the CAWS could be impacted in the FWP condition – the case where new Federal action *is* taken to prevent the transfer of ANS between the Great Lakes and Mississippi River Basins. The implementation of a GLMRIS project, in many of the alternatives, involves ANS control technologies that include aspects such as physical barriers in the CAWS and increased lockage times in the CAWS. Since the non-cargo vessel movements that were examined in GLMRIS take place within the CAWS, these specific movements could be impacted by implementation of a GLMRIS project. However, this report does not seek to quantify the impact of project implementation on these activities as the choices of business owners depend on their own, unique situation. Business owners may elect to move their businesses elsewhere, modify their existing structure, or shut down.

Non-cargo users of the CAWS could be impacted by basin separation measures, not so much by the transfer of ANS. The number depicted here are for passenger vessel association companies. Other non-cargo users such as police, fire, search and rescue, and research vessels are not included in this calculation but would need to modify their operations in the event a basin separation measure or other control technologies are implemented.

CONCLUSION

Aquatic nuisance species transfer between the GL and Mississippi River Basins, or any new Federal action to prevent this transfer could have a significant impact on the fishing industries in the GL, UMR, and OHR Basins, as well as navigation industries within the CAWS. Commercial, recreational, and charter fishing are at risk in both the FWOP and FWP condition. Commercial cargo and passenger navigation are most at risk from the FWP conditions that include measures such as hydrologic separation implementation and/or new lock construction within the CAWS. This document shows the significance of these industries to the national economy. This is the level of regional economic activity at risk given ANS transfer or its prevention. This document doesn't attempt to quantify the impacts of ANS transfer or prevention measures because of uncertainty associated with impacts to and responses of fishing and navigation industries.

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