GLMRIS

Great Lakes and Mississippi River Interbasin Study

Aquatic Nuisance Species | Ecosystems | Navigation | Recreation | Flood Risk Management | Water Use

Focus Area 2 Aquatic Pathway Assessment Report

Parker-Cobb Ditch, Indiana

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Executive Summary

This assessment characterizes the likelihood that a viable aquatic pathway exists at Parker-Cobb Ditch in Porter County, Indiana, and that it would allow transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi Rivers Basins. This was accomplished through collaboration with other Federal and state resource agencies by evaluating the hydrologic and hydraulic characteristics of the site based on readily available information, and a species-specific assessment of the abilities of potential ANS to arrive at the pathway and cross into the adjacent basin. The Parker-Cobb Ditch aquatic pathway is located southwest of the city of Valparaiso, Indiana, on very flat ground surrounded by farm fields and is linked to a network of ditches that have been excavated for agricultural drainage. Although not indicated on the topographic map for this area, the Parker-Cobb Ditch does in fact cross over the Great Lakes and Mississippi River Basin divide allowing surface water to flow in either direction. This pathway is defined as the Parker-Cobb Ditch channel between West Fork Parker Ditch and 100 West Fork Cobb Ditch [approximately 1,000 feet (305 meters) long]. Drainage from this location to the Great Lakes Basin is through Salt Creek to the Calumet River while drainage toward the Mississippi River Basin is through Sandy Hook Ditch to the Kankakee River.

This site was determined to be capable of conveying water across the basin divide continuously for days to weeks, multiple times per year. The probability of an aquatic pathway existing at this location was therefore rated as “high”. A surface water pathway between the basins occurs most frequently during late winter to early summer and sporadically during heavy rain events other times of the year. While Parker-Cobb Ditch serves as an open surface water connection between the basins, there is a 27-inch (69 cm) diameter underground culvert that connects Parker-Cobb Ditch to West Fork Parker Ditch, through which any aquatic species traversing the basin divide would have to travel.

An interagency team of biologists collaborated to then develop the list of nine species of greatest concern for interbasin spread though the Parker-Cobb Ditch shown in the adjacent table. That team then conducted a systematic analysis of the biological characteristics and capabilities of each of the selected ANS relative to the aquatic habitat in proximity and leading up to Parker-Cobb Ditch from Lake Michigan and the Mississippi River.

Aquatic Nuisance Species of Concern	
Species	**Common Name**
Hypophthalmichthys molitrix	silver carp
Hypophthalmichthys nobilis	bighead carp
Mylopharyngodon piceus	black carp
Channa argus	northern snakehead
Gasterosteus aculeatus	threespine stickleback
Gymnocephalus cernua	ruffe
Proterorhinus semilunaris	tubenose goby
Neoergasilus japonicus	parasitic copepod
Novirhabdovirus sp	viral hemorrhagic septicemia virus (VHSv)

Based on the hydrology of the aquatic pathway and consideration of the above species, it was determined that ANS transfer between the basins by natural aquatic means could occur in either direction at Parker-Cobb Ditch. An overall pathway viability rating of “medium” was given to this pathway, which means in this case that while ANS transfer could occur it is estimated that none of the ANS would likely be able to reach the aquatic pathway within the next 20 years.

For transfer into the Great Lakes Basin, the northern snakehead (*Channa argus*) was determined to be a potential threat due to its ability to thrive in poor quality, low oxygen waters and therefore have the potential to navigate the network of agricultural ditches to arrive at the pathway. The northern snakehead is established within the Mississippi River Basin in Arkansas so it is not expected to be a near-term threat. However, its affinity for ditch and wetland habitat types, and its ability to breath air and survive out of water for short periods of time, make it a species of concern.

For transfer into the Mississippi River Basin, the parasitic copepod and VHSv were found to be the most likely potential threats due to their ability to be transported on numerous host fish species, including the common

carp (*Cyprinus carpio*), which is more likely to be tolerant of the lower water quality found in the ditches connecting to the pathway. In addition, the threespine stickleback was also determined to be a potential threat to the Mississippi River Basin due to a lack of obstructions between the pathway and the Great Lakes, its tolerance of a variety of habitats, and the likelihood that sufficient forage would be available in connecting streams. However, if it were able to reach the vicinity of the pathway it would likely be in only small numbers due to limited habitat and water quality at the basin divide.

The collection of additional information about this pathway and its connecting streams would reduce the level of uncertainty with these ratings. Such information includes the gathering of site specific data on the duration, frequency, and extent of the hydrologic connection at the pathway, further assessment of the ability of ANS to pass over the dams on the Kankakee River, additional study on the life history requirements of specific ANS, and the suitability of the habitat within the connecting waterways to allow for ANS movement and survival. Both structural and non-structural opportunities exist at this site to reduce or eliminate the potential for ANS transfer through this aquatic pathway. Such opportunities include the modification of Parker-Cobb Ditch to sever its connection with 100 West Fork Cobb Ditch, public education on the identification of and threats posed by ANS, and increased and improved ANS monitoring to track the potential movement of ANS in streams connected to this pathway.

Table of Contents

List of Tables

List of Figures

Acronyms

ANS . . . . . Aquatic Nuisance Species
ANSTF. . . . Aquatic Nuisance Species Task Force
CAWS . . . . Chicago Area Waterway System
CEQ. . . . . Council on Environmental Quality
CMP. . . . . Corrugated Metal Pipe
DEM. . . . . Digital Elevation Model
FEMA. . . . . Federal Emergency Management Agency
GIS . . . . . Geographic Information System
GLFC. . . . . Great Lakes Fishery Commission
GLMRIS. . . Great Lakes and Mississippi River Interbasin Study
HUC. . . . . Hyrdologic Unit Codes
INDNR . . . . Indiana Department of Natural Resources
NAS . . . . . Nonindigenous Aquatic Species
NEPA. . . . . National Environmental Policy Act
NOAA. . . . . National Oceanic and Atmospheric Administration
NRCS . . . . Natural Resources Conservation Service
USACE . . . U.S. Army Corps of Engineers
USFWS . . . U.S. Fish and Wildlife Service
USGS . . . . U.S. Geological Survey
WRDA . . . . Water Resources Development Act

1 Introduction

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) was authorized in Section 3061(d) of the Water Resources Development Act of 2007, and therein, it prescribes the following authority to the Secretary of the Army and the U.S. Army Corps of Engineers (USACE) (WRDA, 2007):

> *"(d) FEASIBILITY STUDY. - The Secretary, in consultation with appropriate Federal, State, local, and nongovernmental entities, shall conduct, at Federal expense, a feasibility study of the range of options and technologies available to prevent the spread of aquatic nuisance species between the Great Lakes and Mississippi River Basins through the Chicago Sanitary and Ship Canal and other aquatic pathways."*

This GLMRIS Focus Area 2 Aquatic Pathway Assessment report addresses the Parker-Cobb Ditch location. This is one of 18 locations identified in the Great Lakes and Mississippi River Interbasin Study Other Pathways Preliminary Risk Characterization as a potential aquatic pathway spanning the watershed divide between the Great Lakes and Mississippi River Basins outside of the Chicago Area Waterway System (CAWS) (USACE, 2010). This report is downloadable from the GLMRIS web site (glmris.anl.gov/).

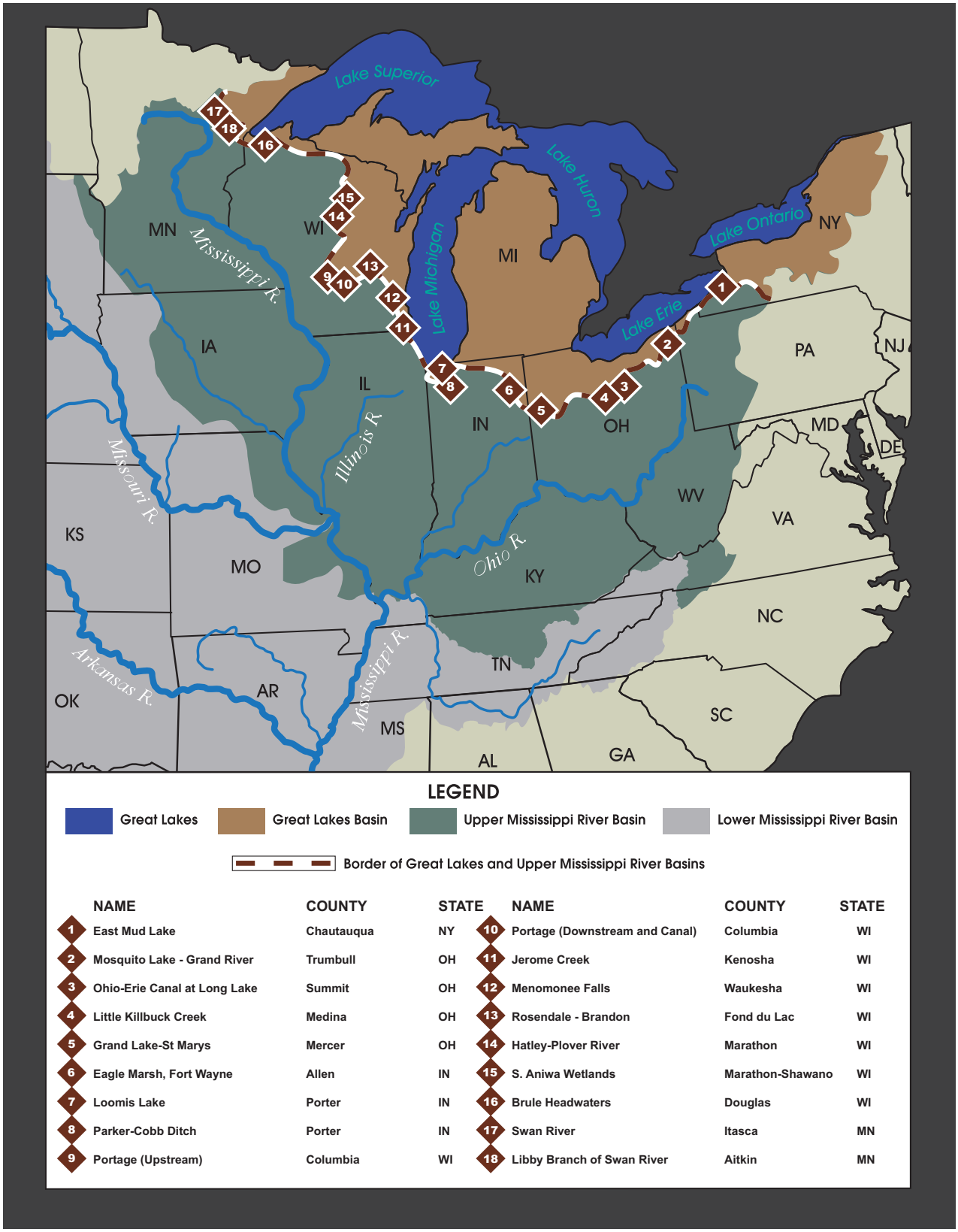
The dashed line in Figure 1 depicts the nearly 1,500-mile (2,414-kilometer) basin divide from the New York - Pennsylvania state line to north eastern Minnesota, and it depicts each of the 18 potential aquatic pathway locations that were previously identified. The Parker-Cobb Ditch location is shown as site number 8 in northeast Indiana (Figure 1).

The GLMRIS is a very large and complicated task involving multiple USACE Districts and Divisions. Program Management of the study is conducted by the Great Lakes and Ohio River Division. The study considers several ANS of concern, however, the proximity of Asian carp in the Mississippi River Basin to the basin divide near two locations lend a sense of urgency and national significance to completion of the GLMRIS. These two locations are the CAWS southwest of Chicago, Illinois and Eagle Marsh in Fort Wayne, Indiana. To help accelerate completion of the feasibility study, the Great Lakes and Ohio River Division split management of the GLMRIS into two separate focus areas. Focus Area 1 is managed by the USACE, Chicago District and addresses the CAWS that open to Lake Michigan. Focus Area 2 is managed by the USACE, Buffalo District and evaluates all other potential aquatic pathways that exist or are likely to form across the basin divide separating runoff that flows into the Mississippi River and its tributaries from runoff that flows into the Great Lakes and its tributaries.

1.1 Study Purpose

The preliminary report from 2010 and the subsequent analysis contained in this report have been produced for a broad audience ranging from the scientific community to the general public, and are specifically intended to identify any locations where an aquatic pathway exists or may form between the basins from up to a one percent annual recurrence interval flood event, and to evaluate the probability that specific ANS would be able to arrive at that pathway and cross into the new basin. The information in this and the other Focus Area 2 reports are intended to provide a sound scientific basis for helping to prioritize future funding of GLMRIS and/or other actions at these potential aquatic pathway locations.

A recurrence interval relates any given storm, through statistical analysis, to the historical records of rainfall and runoff for a given area. The recurrence interval is based on the statistical probability that a given intensity storm event will be equaled or exceeded in any given year. For instance, a one percent annual recurrence interval storm is a rainfall event that has a one percent probability, one chance in 100, of being equaled or exceeded in any given year. This level of storm event was commonly referred to as a 100-year storm event, but this term has led people to incorrectly conclude that a 100-year storm event is one that only occurs once in any given 100 year period. A ten percent annual return frequency storm (formerly referred to as a ten year event) is a smaller event that has a one in ten chance of being exceed during any given year, and a 0.2 percent annual return frequency storm (formerly referred to as a



	NAME	COUNTY	STATE
1	East Mud Lake	Chautauqua	NY
2	Mosquito Lake - Grand River	Trumbull	OH
3	Ohio-Erie Canal at Long Lake	Summit	OH
4	Little Killbuck Creek	Medina	OH
5	Grand Lake-St Marys	Mercer	OH
6	Eagle Marsh, Fort Wayne	Allen	IN
7	Loomis Lake	Porter	IN
8	Parker-Cobb Ditch	Porter	IN
9	Portage (Upstream)	Columbia	WI
10	Portage (Downstream and Canal)	Columbia	WI
11	Jerome Creek	Kenosha	WI
12	Menomonee Falls	Waukesha	WI
13	Rosendale - Brandon	Fond du Lac	WI
14	Hatley-Plover River	Marathon	WI
15	S. Aniwa Wetlands	Marathon-Shawano	WI
16	Brule Headwaters	Douglas	WI
17	Swan River	Itasca	MN
18	Libby Branch of Swan River	Aitkin	MN

Figure 1. Potential aquatic pathway locations identified in the GLMRIS Preliminary Risk Characterization Study (USACE, 2010).

500-year event) is a larger event that has a one in 500 chance of being exceeded in any given year.

This report is part of a tiered approach to assess the likelihood of ANS spreading between the Great Lakes and Mississippi River Basins via aquatic pathways, and it was prepared in accordance with the detailed procedures and criteria specified in the GLMRIS Focus Area 2 Study Plan (USACE, 2011a). The primary purpose of this report is to present the evidence and explain the procedures used to qualitatively estimate the likelihood that a viable aquatic pathway exists at the Parker-Cobb Ditch location that will enable the interbasin spread of ANS. It is also intended to contribute to the accomplishment of each of the four objectives identified in the plan by including the following:

- A definitive determination of whether the Parker-Cobb Ditch location should be included in the inventory of locations where a viable surface water connection between headwater streams on both sides of the drainage divide exists or is likely to form between the Great Lakes and the Mississippi River basins;

- A standalone report that characterizes the probability of aquatic pathway formation and the probability that a viable aquatic pathway exists at the Parker-Cobb Ditch location and will enable the interbasin spread of ANS;

- Development of clear problem statements that frame the means, constraints, and likelihood of the interbasin spread of ANS via the potential aquatic pathway at the Parker-Cobb Ditch location; and

- Development of clear opportunity statements that illustrate how the collective authorities, resources and capabilities of USACE and other applicable Federal, state, local and non-governmental stakeholder organizations may best be coordinated and applied to prevent the interbasin spread of ANS through the Parker-Cobb Ditch, Indiana location.

1.2 Summary of 2010 Preliminary Risk Characterization for Parker-Cobb Ditch, Indiana

The *Great Lakes and Mississippi River Interbasin Study Other Pathways Preliminary Risk Characterization* was designed as the first step of a tiered approach to rapidly conduct a study intended to accomplish two objectives (USACE, 2010). The first and primary objective was to determine if there were any locations within the GLMRIS, aside from the CAWS, where a near term risk for the interbasin spread of ANS exists. Near term, in this case, indicates that implementation of some measure(s) might be warranted to reduce the potential for ANS transfer at that particular location in the short term versus setting that site aside for further analysis. The second objective was to refine the scope of the other aquatic pathways portion of the GLMRIS by developing a list of potential aquatic pathways that could form anywhere along the divide separating the Great Lakes and Mississippi River Basins, and help provide a basis for prioritizing future feasibility study efforts based upon relative risk.

The USACE solicited the input and collaborated with the U.S. Geological Survey (USGS), Natural Resources Conservation Service (NRCS), U.S. Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), Great Lakes Fishery Commission (GLFC). and the natural resource agencies in the states of Minnesota, Wisconsin, Indiana, Ohio, Pennsylvania, and New York. A total of 36 potential locations were initially identified along the divide where it appeared that interbasin flow could occur. These were locations situated in a mixture of rural, forested, suburban, and urban areas, and included locations where surface water flow patterns have been modified through the building of navigation canals, excavation of ditches, and construction of sewers to facilitate storm water management for agricultural, flood damage reduction, or other water management purposes. Also, many of the potential aquatic pathways identified in 2010 were locations where extensive natural wetlands exist in close proximity to, and in some instances appear to span, the basin divide. The lack of prior hydrologic studies and the level of uncertainty in the

hydrology information led to a conservative approach in assigning the individual qualitative aquatic pathway risk ratings.

At 18 of these locations the interagency group determined that it would likely require an epic storm and flooding event (i.e., in excess of a one percent annual recurrence interval) for an aquatic pathway to ever form across the basin divide. These were not recommended for further investigation because this was considered a low level of risk. However, at the remaining 18 locations the group did recommend that a more detailed assessment be conducted (Figure 1). Only one location, Eagle Marsh in Fort Wayne, Indiana, was determined to pose a near term risk for the potential spread of Asian carp into the Great Lakes Basin, and this led to the installation of a temporary barrier by INDNR until a more complete assessment and remedy could be implemented.

Although the preliminary risk characterization did not identify the Parker-Cobb Ditch site as a location where there is a near term risk for the interbasin spread of ANS, there was some uncertainty with this rating largely due to the unknown frequency and duration of the hydrologic connection. It was therefore recommended that a more detailed assessment be conducted. The report characterized the area as very flat with rich soils that had been cleared and extensively ditched and likely tiled to support large scale agricultural use, which affords opportunity for surface water to flow between the basins. This more detailed assessment has been conducted in collaboration with the INDNR, the USFWS, NRCS, and USGS, and other governmental agencies. The following actions were taken:

- Federal, State, and local stakeholders (e.g. USGS Water Science, INDNR, County Surveyor, and local NRCS representatives) were briefed on the preliminary risk characterization results. Detailed site visits to observe potential connection locations were made and the available topographic mapping and flood hazard information were compiled and reviewed.

- Evaluated the dams on the connecting streams to the Great Lakes and Mississippi River relative to the potential for ANS passage through, around, or over each in-stream structure in both directions.

- Consulted with INDNR and several surveyors in counties along the basin divide in Indiana to assure there are no other viable surface water pathways across the basin divide (including those evaluated in this report that were determined not to pose a significant ANS transfer potential), and identify any measures that could potentially be implemented at the local or state levels to mitigate significant transfer potential at all rural locations where there is potential for interbasin flow of surface water;

- Evaluated habitat and abiotic conditions in proximity to the location relative to the needs and preferences of any ANS of concern to each location;

- Met with stakeholders to observe conditions and compile and review available information; and

- Revised ANS transfer ratings based upon a more detailed evaluation of ANS transfer potential via the aquatic pathway in both directions.

1.3 Aquatic Pathway Team

Due to the large amount of unknowns and natural variability associated with the hydrology and the biology of such a large geographic area, the Study Plan specified formation of a “team of teams,” combining the best available local, state, and national hydrologists and biologists to assess conditions at each potential aquatic pathway. The results of this assessment reflect the collective experience, expertise, and focused effort of these biologists and hydrologists from USACE, USGS, NRCS, INDNR, and Porter County. The results also reflect the guidance, input, review comments, and concurrence of the multi-organizational Agency Technical Review of experts from NOAA, Illinois Department of Natural Resources (ILDNR), GLFC, and USGS.

2 Study Methodology

The GLMRIS risk analysis process is an adaptation of the generic model and process described in the Generic Nonindigenous Aquatic Organisms Risk Analysis Review Process (For Estimating Risk Associated with the Introduction of Nonindigenous Aquatic Organisms and How to Manage for that Risk) (ANSTF, 1996). The Aquatic Nuisance Species Task Force (ANSTF) defines the first step in this process as identification of interested parties and solicitation of input.

2.1 Coordination

The USACE identified interested parties and solicited input early in the process for Focus Area 2 and has included individual visits and discussions with the state agencies responsible for water resources, and fish and wildlife management in the eight states bordering the Great Lakes. The process used for the Focus Area 2 assessments has also been discussed in meetings with representatives of the Council on Environmental Quality (CEQ), USGS, USFWS, NOAA, NRCS, and GLFC. Development of this plan also included input from the public and interested non-governmental organizations received during formal National Environmental Policy Act (NEPA) public scoping meetings which were held at 12 locations across the region in both basins between December 2010 and March 2011. The USACE requested the support and participation of the best available experts from the State and Federal agencies responsible for water resources, and fish and wildlife management in the states along the Great Lakes and Mississippi River Basin divide to address the critically important issue of preventing interbasin transfer of ANS. The USGS, NRCS, and each state DNR assigned personnel to assist each USACE pathway assessment team. In addition, a technical review team comprised of 16 senior level experts from the USACE and these external partner agencies, including NOAA and GLFC, was assembled to review and guide the work of these teams. Overall, extensive collaboration among partner agencies, the review team, and other subject matter experts has led to detailed Focus Area 2 pathway assessments.

2.2 Identification of Potential Pathways

At 18 of the potential aquatic pathways identified during the 2010 Preliminary Risk Characterization, it was determined it would likely require an epic storm and flooding event (i.e., greater than a one percent annual recurrence interval storm event) for an aquatic pathway to ever form across the basin divide. These locations were not recommended for further investigation because areas that might require a flooding event in excess (greater magnitude, less frequency) of the one percent annual recurrence interval flood are less likely, and therefore present a low level of risk. This one percent threshold criterion was established through collaboration with the USGS, USFWS, NRCS, GLFC, and the departments of natural resources in the states of MI, MN, WI, IL, IN, OH, PA, and NY. This threshold is also widely used in flood risk management and is typically aligned with most readily available hydrologic information. The one percent annual recurrence interval threshold only indicates at what level event an aquatic connection can begin to form and would indicate a location that should then be subjected to a more labor intensive evaluation of the probability of ANS being able to utilize that pathway. At the remaining 18 locations, it was recommended that a more detailed assessment be conducted (Figure 1). This was subsequently done in 2011-2012 in collaboration with USGS, NRCS, USFWS, state natural resource agencies, and county surveyors (where applicable), and the results for the Parker-Cobb Ditch location are presented in this report.

Although the focus of this assessment is on aquatic pathways, it should also be mentioned that there are other non-aquatic pathways that may enable ANS to transit across the aquatic pathway or across the basin divide. Although these other pathways do not influence the overall pathway rating outlined in this report, they are included to point out potential other pathways (e.g., anthropogenic) and their potential influence on the same list of ANS as evaluated in Section 4 of this report. Any further analysis of these non-aquatic pathways outside of this study should develop a separate list of ANS that will likely differ from the list of ANS evaluated as part of this aquatic pathway report.

2.3 Aquatic Nuisance Species of Concern

This report addresses the problem of ANS invading, via surface-water pathways, the Great Lakes Basin from the Mississippi River Basin and vice versa. ANS is defined by the ANSTF as "… 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 dependent on such waters." The USGS Nonindigenous Aquatic Species (NAS) information resource http://nas.er.usgs.gov/about/faq.aspx defines NAS as "…a species that enters a body of water or aquatic ecosystem outside of its historic or native range." (USGS, 2012). Based on discussions between the USACE, USGS, and USFWS the following definitions were established for the purposes of the GLMRIS. All nonindigenous aquatic species (per the USGS definition above), that are present in the Great Lakes but not known to be present in the Mississippi River and its tributaries are defined as ANS of concern for GLMRIS. Likewise, all nonindigenous aquatic species present in the Mississippi River or its tributaries but not known to be present in the Great Lakes are also considered as ANS of concern for the GLMRIS. Therefore, the term ANS is synonymous with the term nonindigenous aquatic species in this report

2.3.1 Lists of Nonindigenous Species in Great Lakes and Mississippi River Basins

The list of ANS of concern for a particular location was developed by first consulting the USACE white paper titled, Non-Native Species of Concern and Dispersal Risk for the Great Lakes and Mississippi River Interbasin Study released in September 2011 (USACE, 2011b). This technical paper, prepared by a multi-disciplinary USACE natural resources team, took a broad look at the potential range of species that could be of concern to the GLMRIS. The paper is Appendix C of the GLMRIS Focus Area 2 Study Plan and it is an integral component of the plan. This USACE white paper included a review of 254 aquatic species that are either nonindigenous to either basin or native species that occur in one basin or the other. The list of 254 aquatic species were iteratively screened to identify all potential ANS that could be of concern in either basin and to systematically focus the study toward those species judged to pose the highest potential risk of ecological impacts if they became established in the other basin.

In the first screening iteration, 119 of the 254 aquatic species reviewed were determined to pose a potential threat of infiltrating the other basin and were carried into the second iteration of the analysis. The other 135 species were rejected for further analysis for several reasons. Initially, 104 species were dropped from further consideration because they were determined to already be established in both basins. Another 31 species were removed from further analysis because they were not yet located in either basin, could bypass any aquatic control mechanism by terrestrial movement, or had no potential to cause adverse affects to the invaded ecosystem.

2.3.2 List of ANS of Concern for GLMRIS

To determine species of concern that are pertinent for the GLMRIS from the list of 119 species, the USACE natural resources team compiled, reviewed, and analyzed the best available information. Literature reviews, species proximity to aquatic interbasin connections (in particular the CAWS), ecological tolerances and needs, and vagility of the species were all included in the analysis. The team ranked each species as high, medium, or low risk according to these parameters. The result was the establishment of a list of 39 species, each identified as having both a high level of potential risk for both transferring from one basin to another, and potentially a high risk in that if they do disperse, and the invaded ecosystem could be moderately to severely affected by their colonization (Table 1). A fact sheet was developed for each of these species of concern detailing morphological characteristics useful for identification, including color photographs of the species, information on their ecology, habitat, distribution, and current status in the Mississippi River or Great Lakes Basins.

2.3.3 List of ANS of Specific Concern at the Parker-Cobb Ditch

The Parker-Cobb Ditch aquatic pathway team then subdivided the set of species listed in Table 1 into two groups: ANS threatening the Great Lakes, and ANS threatening the Mississippi River and its tributaries. Each of these two lists was then sorted into subgroups in accordance with taxonomy and common dispersal mechanism. Table 2 and Table 3 reflect these groupings of species that were found to pose a significant risk to the Mississippi River and its tributaries, and to the Great Lakes and its tributaries, respectively (USACE, 2011b).

Additionally, the Parker-Cobb Ditch aquatic pathway team reviewed the information on the 119 species initially determined to pose a potential threat of infiltrating the other basin to see if any were in close enough proximity to the Parker-Cobb Ditch location to be of concern. The team reviewed information on the NOAA Watchlist of species threatening the Great Lakes from international waters, and information on other species cited by the review team as high risk potential invaders not yet in either basin (NOAA, 2011). No additional species from the NOAA Watchlist were added to the species of concern for the Parker-Cobb Ditch location. However, the NOAA Watchlist was utilized as a resource, at the recommendation of agency team members, to identify any additional potential future species that could be introduced into either basin and possibly spread from there to the other basin.

Each aquatic pathway team was granted flexibility in determining whether to add additional species to their assessment based on their review of available information and the actual location of the potential pathway relative to the known location of those ANS being considered. Based on concerns from local agencies about the potential for spread of viral hemorrhagic septicemia virus (VHSv), the project team elected to include it on the list of species of concern. Although VHSv has been identified in both basins (i.e., VHSv was confirmed in Ohio River Basin in the Clear Fork Reservoir in Richland and Morrow Counties, Ohio in 2008), it has not yet been determined that VHSv has established within the Mississippi or Ohio River Basins. Minimizing the spread of VHSv remains a priority for local stakeholders and it will therefore be included under the grouping of species which would potentially threaten the Mississippi River Basin (Great Lakes Commission, 2011; USGS, 2011). Mapping was produced, using available USGS occurrence data, to show the relative location of ANS to Grand Lake St. Marys, Figure 2 (USGS, 2011). All records of ANS occurrences in area surrounding Grand Lake St. Marys are detailed in Figure 3. As pathway teams began conferring, and new information became available, VHSv was added to the species from the Great Lakes basin. The alewife was removed from the list because it has established populations in both basins.

Each of the three subgroups in Table 2 and Table 3 were evaluated based on the dispersal mechanisms and general mobility of the species within each group. Since this location is positioned on the basin divide, well upstream of any know ANS listed here, any organism that moves solely through the aquatic pathway must possess either self-propelled mobility or the ability to hitchhike on other organisms to travel upstream. This eliminates organisms that rely on current for dispersal such as plants and algae.

Based on the evaluation by subgroups, only fish, or fish pathogens, were considered to have the requisite means of reaching the Parker-Cobb Ditch from either direction. To facilitate determination of the ANS transfer potential via this site, the team of biologists then selected a smaller group of representative species for focused assessment. The species selected may be those most likely to arrive at the divide, pose the greatest possibility of ecological damage, and/or exhibit a broad range of biological characteristics that provides a more thorough and conservative evaluation of potential probability that ANS could spread between the basins at this location. Of all species considered, the Parker-Cobb Ditch aquatic pathway team determined that four of these possible future invaders were ANS that could potentially pose significant threats to the Great Lakes Basin, and five of these ANS that could potentially pose significant threats to the Mississippi River Basin (Table 4).

Table 1: ANS of Concern for GLMRIS.				
Taxon	**Scientific Name**	**Common Name**	**Basin**	**Interbasin Dispersal Mechanism**
fish	*Alosa aestivalis*	blueback herring	GL	swimmer
fish	*Alosa chrysochloris*	skipjack herring	MS	swimmer
fish	*Alosa psuedoharengus*	Alewife	GL	swimmer
crustacean	*Apocorophium lacustre*	a scud	MS	ballast water
algae	*Bangia atropupurea*	red macro-algae	GL	ballast / rec. boating
annelid	*Branchuris sowerbyi*	tubificid worm	GL	sediment transport
crustacean	*Bythotrephes longimanus*	spiny waterflea	GL	ballast water/sediment transport
plant	*Carex acutiformis*	swamp sedge	GL	recreational boating & trailers
crustacean	*Cercopagis pengoi*	fish-hook water flea	GL	ballast / rec. boating
fish	*Channa argus*	northern snakehead	MS	swimmer
algae	*Cyclotella cryptica*	cryptic algae	GL	unknown / any water
algae	*Cyclotella pseudostelligera*	cylindrical algae	GL	unknown / any water
crustacean	*Daphnia galeata galeata*	water flea	GL	ballast water
crustacean	*Echinogammarus ischnus*	a European amphipod	GL	ballast water
algae	*Enteromorpha flexuosa*	grass kelp	GL	ballast / rec. boating
fish	*Gasterosteus aculeatus*	threespine stickleback	GL	swimmer
plant	*Glyceria maxima*	reed sweetgrass	GL	recreational boating & trailers
fish	*Gymnocephalus cernua*	Ruffe	GL	swimmer
crustacean	*Hemimysis anomala*	bloody red shrimp	GL	ballast water
fish	*Hypophthalmichthys molitrix*	silver carp	MS	swimmer
fish	*Hypophthalmichthys nobilis*	bighead carp	MS	swimmer
plant	*Landoltia (Spirodela) punctata*	dotted duckweed	MS	recreational boating & trailers
bryozoan	*Lophopodella carteri*	bryozoans	GL	with aquatic plants
fish	*Menidia beryllina*	inland silverside	MS	swimmer
plant	*Murdannia keisak*	marsh dewflower	MS	recreational boating & trailers
fish	*Mylopharyngodon piceus*	black carp	MS	swimmer
crustacean	*Neoergasilus japonicus*	a parasitic copepod	GL	parasite to fish
plant	*Oxycaryum cubense*	Cuban bulrush	MS	recreational boating & trailers
fish	*Petromyzon marinus*	sea lamprey	GL	swimmer
mollusk	*Pisidium amnicum*	greater European pea clam	GL	ballast water
fish	*Proterorhinus semilunaris*	tubenose goby	GL	swimmer
protozoan	*Psammonobiotus communis*	testate amoeba	GL	ballast water
protozoan	*Psammonobiotus dziwnowi*	testate amoeba	GL	ballast water
protozoan	*Psammonobiotus linearis*	testate amoeba	GL	ballast water
crustacean	*Schizopera borutzkyi*	parasitic copepod	GL	ballast water
mollusk	*Sphaerium corneum*	European fingernail clam	GL	ballast water
algae	*Stephanodiscus binderanus*	Diatom	GL	ballast water
plant	*Trapa natans*	water chestnut	GL	recreational boating & trailers
mollusk	*Valvata piscinalis*	European stream valvata	GL	ships

Table 2: ANS of Concern Threatening the Mississippi River Basin.			
Taxa	**Species**	**Common Name**	**Interbasin Dispersal Mechanism**
fish	*Alosa aestivalis*	blueback herring	swimmer
fish	*Alosa psuedoharengus*	Alewife	swimmer
fish	*Gasterosteus aculeatus*	threespine stickleback	swimmer
fish	*Gymnocephalus cernua*	Ruffe	swimmer
fish	*Petromyzon marinus*	sea lamprey	swimmer
fish	*Proterorhinus semilunaris*	tubenose goby	swimmer
crustacean	*Neoergasilus japonicus*	a parasitic copepod	parasite to fish
crustacean	*Bythotrephes longimanus*	spiny waterflea	ballast water/sediment
crustacean	*Cercopagis pengoi*	fish-hook water flea	ballast / rec. boating
crustacean	*Daphnia galeata galeata*	water flea	ballast water
crustacean	*Echinogammarus ischnus*	a European amphipod	ballast water
crustacean	*Hemimysis anomala*	bloody red shrimp	ballast water
crustacean	*Schizopera borutzkyi*	parasitic copepod	ballast water
mollusk	*Pisidium amnicum*	greater European pea clam	ballast water
mollusk	*Valvata piscinalis*	European stream valvata	ships
mollusk	*Sphaerium corneum*	European fingernail clam	ballast water
protozoan	*Psammonobiotus communis*	testate amoeba	ballast water
protozoan	*Psammonobiotus dziwnowi*	testate amoeba	ballast water
protozoan	*Psammonobiotus linearis*	testate amoeba	ballast water
annelid	*Branchuris sowerbyi*	tubificid worm	sediment transport
plant	*Carex acutiformis*	swamp sedge	recreational boats & trailers
plant	*Glyceria maxima*	reed sweetgrass	recreational boats & trailers
plant	*Trapa natans*	water chestnut	recreational boats & trailers
bryozoan	*Lophopodella carteri*	bryozoans	with aquatic plants
algae	*Bangia atropupurea*	red macro-algae	ballast / rec. boating
algae	*Cyclotella cryptica*	cryptic algae	unknown / any water
algae	*Cyclotella pseudostelligera*	cylindrical algae	unknown / any water
algae	*Enteromorpha flexuosa*	grass kelp	ballast / rec. boating
algae	*Stephanodiscus binderanus*	Diatom	ballast water

Table 3: ANS of Concern Threatening the Great Lakes.			
Taxa	**Species**	**Common Name**	**Interbasin Dispersal Mechanism**
fish	*Alosa chrysochloris*	skipjack herring	swimmer
fish	*Channa argus*	northern snakehead	swimmer
fish	*Hypophthalmichthys molitrix*	silver carp	swimmer
fish	*Hypophthalmichthys nobilis*	bighead carp	swimmer
fish	*Menidia beryllina*	inland silverside	swimmer
fish	*Mylopharyngodon piceus*	black carp	swimmer
crustacean	*Apocorophium lacustre*	a scud	ballast water
plant	*Landoltia (Spirodela) punctata*	dotted duckweed	recreational boats and trailers
plant	*Murdannia keisak*	marsh dewflower	recreational boats and trailers
plant	*Oxycaryum cubense*	Cuban bulrush	recreational boats and trailers

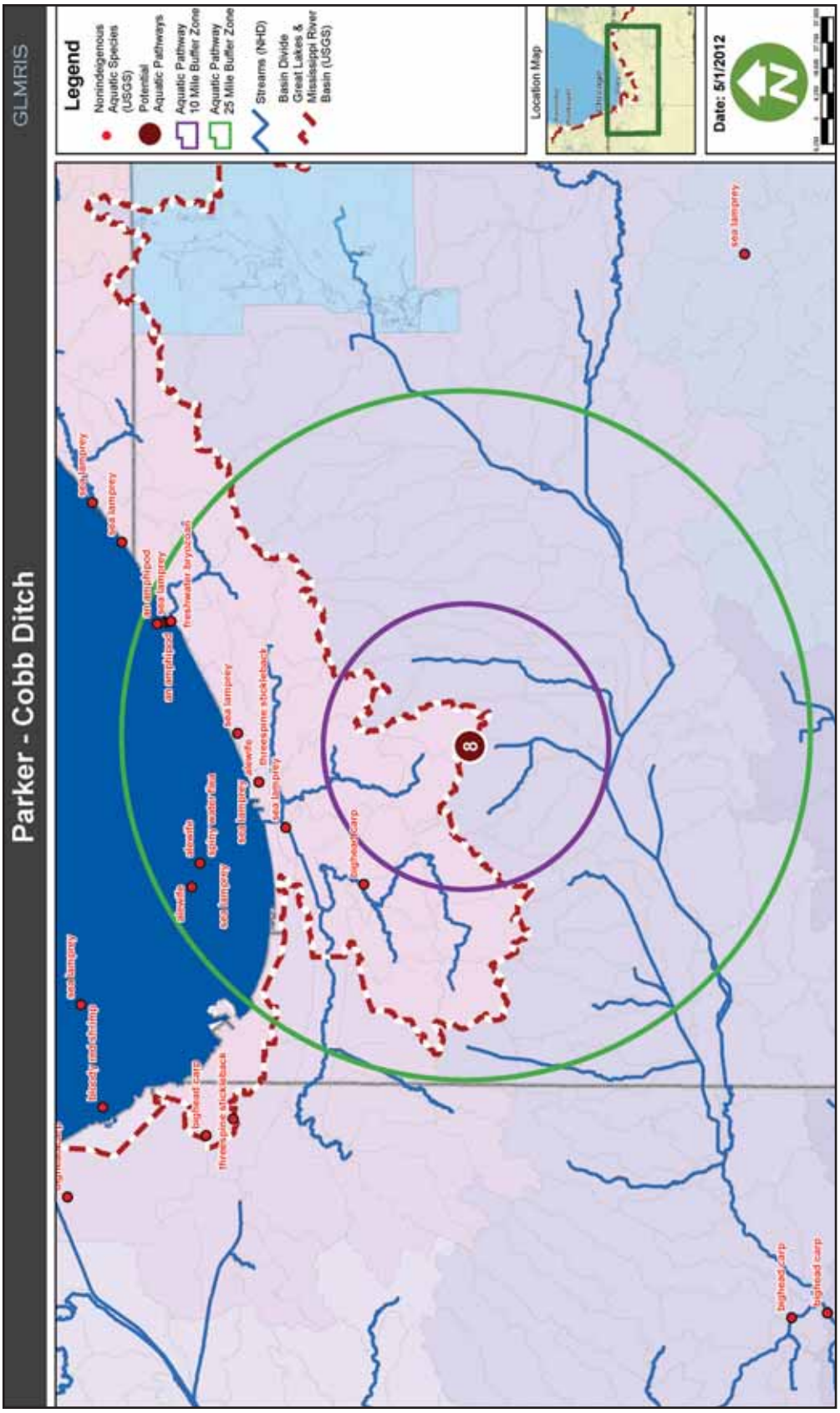


Figure 2. Map of known ANS occurrences near Parker-Cobb Ditch (site number 8) (Source: USGS, 2011).

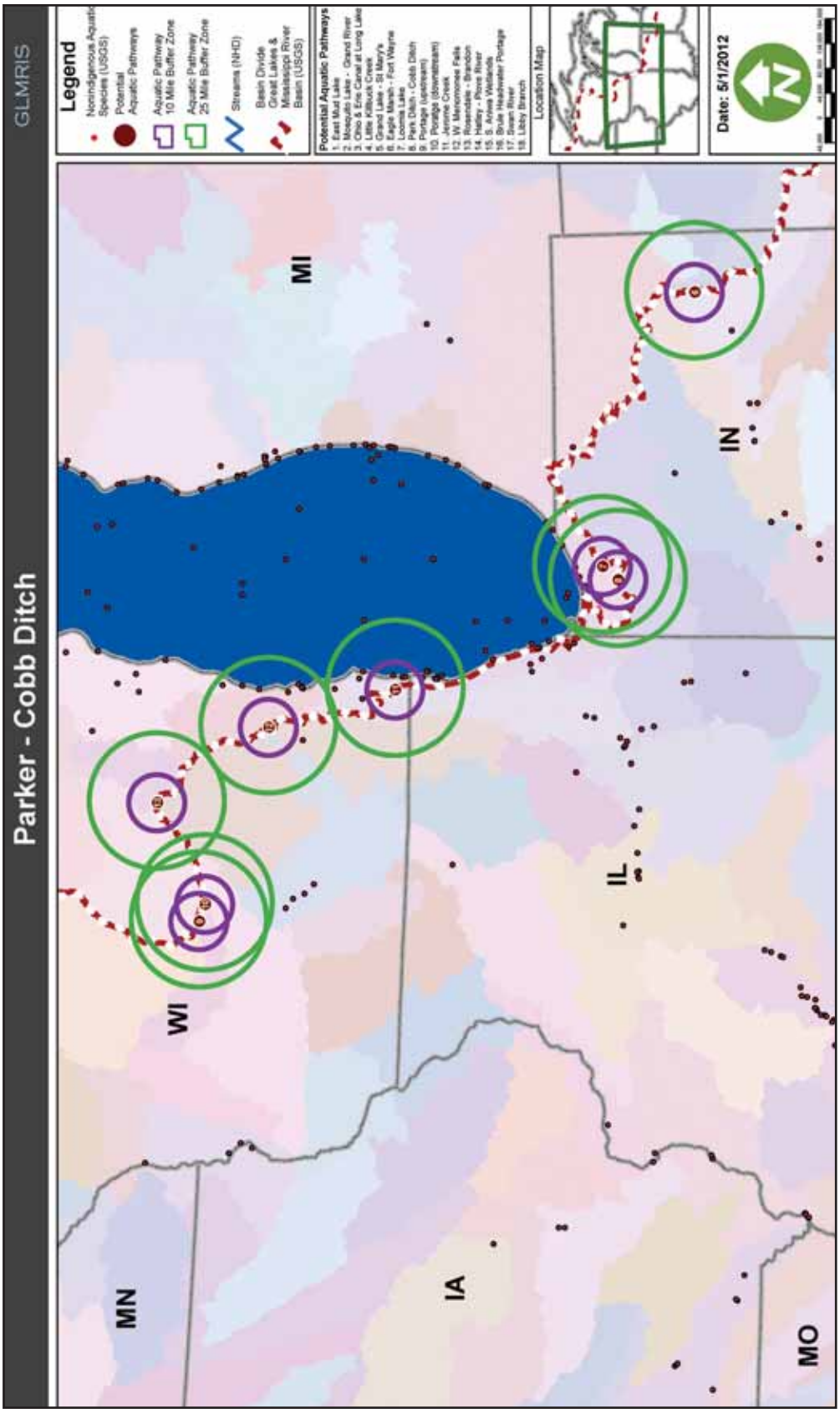


Figure 3. Map of ANS occurrences near Lake Michigan (Source: USGS, 2011). Parker-Cobb Ditch is site number 8 on the map and site number 7 is the nearby Loomis Lake potential pathway evaluated under a separate USACE report..

Table 4: ANS of Greatest Concern for transfer at the Parker-Cobb Ditch				
Taxa	**Species**	**Common Name**	**Basin**	**Interbasin Dispersal Mechanism**
fish	*Hypophthalmichthys molitrix*	silver carp	MS	swimmer
fish	*Hypophthalmichthys nobilis*	bighead carp	MS	swimmer
fish	*Mylopharyngodon piceus*	black carp	MS	swimmer
fish	*Channa argus*	northern snakehead	MS	swimmer
fish	*Gasterosteus aculeatus*	threespine stickleback	GL	swimmer
fish	*Gymnocephalus cernua*	ruffe	GL	swimmer
fish	*Proterorhinus semilunaris*	tubenose goby	GL	swimmer
crustacean	*Neoergasilus japonicus*	parasitic copepod	GL	parasite to fish
Virus	*Novirhabdovirus sp*	VHSv	GL	Pathogen to Fish/Water Column

2.3.4 Key Attributes of Selected Organisms

Excluding the information for VHSv, a significant amount of ANS information was obtained from the USACE White Paper listing the non-native species of concern and dispersal risk for GLMRIS (USACE, 2011b). The VHSv was not identified as a species of concern in this white paper. However, during interagency coordination VHSv was identified as a species of concern for the Parker-Cobb Ditch location. Additional information was obtained from the USGS Nonindigenous Aquatic Species (NAS) website (USGS, 2011).

2.4 Pathway Assessment Process

The GLMRIS risk analysis process is an adaptation of the generic model and process described in the Generic Nonindigenous Aquatic Organisms Risk Analysis Review Process (For Estimating Risk Associated with the Introduction of Nonindigenous Aquatic Organisms and How to Manage for that Risk) (ANSTF, 1996). ANSTF defines the risk associated with an ANS as:

Equation 1

$$R_{Establishment} = P_{Establishment} \times C_{Establishment}$$

Where:

$R_{Establishment}$ = Risk of Establishment

$P_{Establishment}$ = Probability of Establishment

$C_{Establishment}$ = Consequence of Establishment

Note the risk is defined as a multiplicative function. That means, if either of these components is zero or low, the overall risk will also be zero or low. In order to work most efficiently given the large number of potential pathways, the GLMRIS Other Aquatic Pathways Team (Focus Area 2) concentrated its effort on characterizing the probability of establishment, while the GLMRIS Focus Area 1 Team for the CAWS is focusing on both components. An estimate of the consequences of any ANS establishment from the Focus Area 2 aquatic pathways will be deferred until possible future study by USACE or others.

ANSTF divides the probability of establishment component shown in Equation 1 into four basic elements which describe the basic events that must occur for an ANS to establish in the new environment:

Equation 2

$P_{Establishment} = [P_1 \times P_2 \times P_3 \times P_4]$

Where:

P_1 = P *ANS associated with pathway*
P_2 = P *ANS survives transit*
P_3 = P *ANS colonizes in new environment*
P_4 = P *ANS spreads beyond colonized area*

Each of the four elements of Equation 2 is qualitatively rated a High (H), Medium (M), or Low (L) based on the available evidence. They are also qualitatively assigned a level of certainty [Very Certain (VC), Reasonably Certain (RC), Moderately Certain (MC), Reasonably Uncertain (RU), Very Uncertain (VU)]. The overall probability rating is the rating of the element with the lowest probability. Thus, in a quartet of HLHH the overall probability rating is "L". The multiplicative nature of the function assures this is actually a somewhat conservative estimate. With actual numbers the overall probability would always be smaller than the smallest of the four factors. These elements have been modified for use in GLMRIS (Equation 3) to describe the basic sequence of events that must occur for an ANS to successfully cross the basin divide through an aquatic pathway and establish in the new basin:

Equation 3 [FA1 Model]

$P_{Establishment} = [P_0 \times P_1 \times P_2 \times P_3 \times P_4]$

Where:

P_0 = P *Pathway exists*
P_1 = P *ANS has access to pathway*
P_2 = P *ANS transits pathway*
P_3 = P *ANS colonizes in new waterway*
P_4 = P *ANS spreads in new waterway*

This model works well in areas where a viable pathway is already known to exist, such as the CAWS. However, for many of the 18 locations identified in GLMRIS Focus Area 2, it was uncertain at the outset whether or not an aquatic pathway does in fact ever form. The team recognized that formation of a pathway at these locations would likely be infrequent, and with a limited duration and magnitude (width, depth, and rate of surface water flow across the basin divide). Consequently, the model in Equation 3 was modified further for Focus Area 2.

Greater efficiency in analysis can be gained by modifying Equation 3 by eliminating evaluation of the last two elements because if a pathway does not exist there is no reason to collect data on colonization (P_3) and spread (P_4) in the new basin. In addition, the third element of Equation 3, ANS transits pathway (P_2), is broken down into its own sequence of necessary events to characterize in greater detail those variables being evaluated to determine whether or not a viable pathway exists. In setting aside the last two elements in Equation 3 (P_3 and P_4) no attempt is therefore made in this report to assess the probability that an ANS will colonize in or spread through the receiving waterway or basin. USACE or others may assess the last two elements of Equation 3 in the future when evaluating specific measures that could be taken to eliminate the probability of transfer at certain aquatic pathways.

Once again, in order to work efficiently in assessing ANS risk for Focus Area 2, the initial assessment focuses narrowly on the question of whether or not a viable aquatic pathway exists. Equation 4 shows how the third element of Equation 3 has been broken down to provide greater resolution for evaluating the pathway itself:

Equation 4 [Modification of Equation 3 – P2 Element]

$P_2 = [P_{2a} \times P_{2b} \times P_{2c}]$

Where:

P_2 = P *ANS transits pathway*
P_{2a} = P *ANS surviving transit to aquatic pathway*
P_{2b} = P *ANS establishing in proximity to the aquatic pathway*
P_{2c} = P *ANS spreading across aquatic pathway into new basin*

Delaying consideration of the last two elements of Equation 3 and substituting the more detailed consideration of the third element as expressed in Equation 4 yields the following model used in the GLMRIS Focus Area 2 assessments:

Equation 5 [FA2 Modified]

$P_{Viable\ pathway} = [P_0 \times P_{1'} \times P_{2a} \times P_{2b} \times P_{2c}]$

Where:

P_0 = P *Pathway exists*

$P_{1'}$ = P *ANS occurring within either basin*

P_{2a} = P *ANS surviving transit to aquatic pathway*

P_{2b} = P *ANS establishing in proximity to the aquatic pathway*

P_{2c} = P *ANS spreading across aquatic pathway into new basin*

Notice the overall probability is now the "probability a viable pathway exists" ($P_{Viable\ pathway}$) and is no longer the original "probability of establishment" ($P_{Establishment}$) from Equation 3. The probability of establishment for certain aquatic pathways may be assessed in future studies by USACE or others, but likely only for those pathways with an unacceptable rating for the "probability of a viable pathway" existing. Note also that (P_1), ANS has access to pathway from Equation 3 has been renamed ($P_{1'}$), ANS occurring within either basin". This did not change the element being evaluated but made it clearer to team members what "access to the pathway" actually meant.

This model remains consistent with the overall GLMRIS risk assessment approach and the ANSTF methodology, and the refinements enabled the assessors to focus more appropriately on the relevant evidence. At those locations along the basin divide where the first element in Equation 5 (i.e., likelihood that an aquatic pathway exists at up to a one percent annual recurrence interval event) was estimated to be low, no further assessment of that location was necessary. The low rating of this initial element assures that the overall probability of a viable pathway existing (Equation 5), the overall probability of establishment (Equation 3), and the ANS risk potential (Equation 1), will all be low because of the multiplicative nature of the model. This approach assured a more prudent use of public resources in data collection and assessment by minimizing the collection of unnecessary data and the conduct of unnecessary analyses. It should also be understood that a low rating for probability of a pathway existing (P_0) is not necessarily the same as there being no probability of a pathway existing. At those locations where the probability of a pathway existing (P_0) was determined to be medium or high which includes the Parker-Cobb Ditch pathway, the remaining four elements in Equation 5 were evaluated for each ANS of concern specific to that particular location over a 50 year period of analysis.

2.5 Example Calculation of Overall Aquatic Pathway Viability

As described in Section 2.2, a list of ANS of concern for the Parker-Cobb Ditch pathway was developed with input from Federal, State, and local agencies responsible for water resources, and fish and wildlife management in the state of Indiana, and neighboring states along the Great Lakes and Mississippi River Basin divide. ANS of concern were grouped according to which basin they were currently established in to determine the viability of the aquatic pathway to transfer species across the divide in either direction. The determination of the likelihood of a viable aquatic pathway for each ANS of concern is the product of five probability elements (Equation 5). Thus, the probability of a viable pathway for a particular ANS of concern is equal to the lowest rating determined for each of the five probability elements (Table 5 and Table 6). The overall pathway viability for transferring ANS of concern from the Mississippi River Basin to the Great Lakes Basin was equal to the highest probability of a viable pathway for each ANS of concern in Table 5. In this example, all were rated low and thus the overall pathway viability for transferring species from the Mississippi River Basin to the Great Lakes Basin is "low". The overall pathway viability for transferring species from the Great Lakes Basin is calculated the same way and is shown in Table 6. In this example, the overall pathway viability for transferring species from the Great Lakes Basin to the Mississippi River Basin is "medium".

The last calculation is to determine the overall pathway viability for interbasin spread of ANS which is calculated by taking the highest of the overall ANS ratings for unidirectional transfer which were calculated in Tables 5 and 6. Thus, in Table 6, the overall probability that a viable aquatic pathway exists is "medium". The ratings given for each element as well as the overall pathway viability ratings shown in Tables 5 and 6 were coordinated amongst the members of the pathway team regarding the probability rating (H, M, or L) and the level of certainty (VC, RC, MC, RU, or VU). Final agreement was reached on team ratings for each element through collaboration and sharing of applicable information

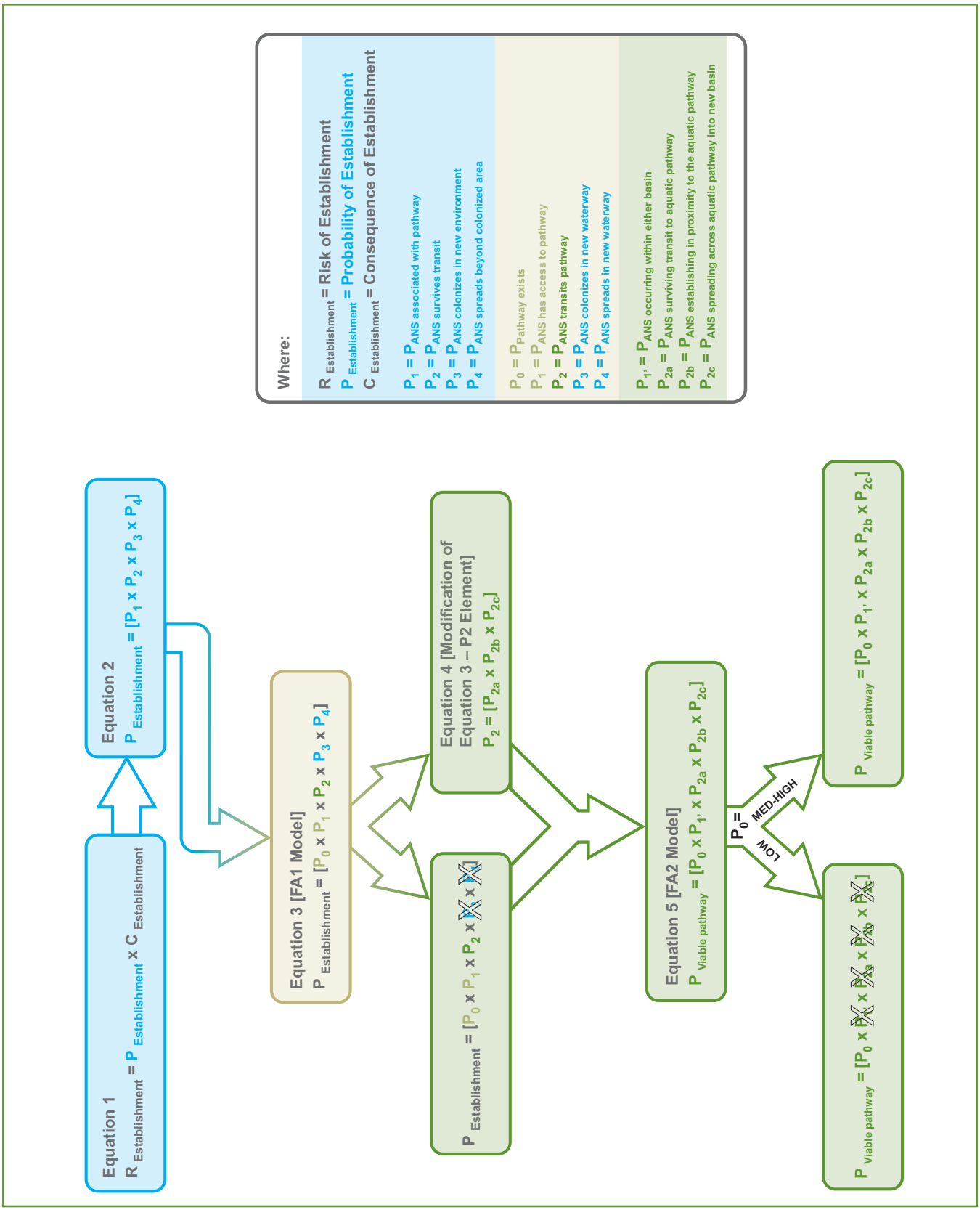


Figure 4. Diagram of the derivation of the GLMRIS Focus Area 2 aquatic pathway assessment model.

Table 5. Example calculation of Pathway Viability for ANS Spreading from Mississippi River Basin to the Great Lakes Basin.

			Form 1 P_0	Form 2 P_1	Form 3 P_{2a}	Form 4 P_{2b}	Form 5 P_{2c}	$P_{viable\ pathway}$
Group	**Common Name**	**Mode of Dispersal**	**Pathway Exists?**	**ANS Occuring Within Either Basin?**	**ANS Surviving Transit to Pathway?**	**ANS Establishing in Proximity to Aquatic Pathway?**	**ANS Spread-ing Across Aquatic Pathway into New Basin?**	**ANS/Path-way Viability Rating**
fish	Asian carp, silver carp, bighead carp, black carp	swimmer	M (RC)	M (RC)	L (RC)	L (MC)	M (RU)	L
fish	inland silverside	swimmer		M (VC)	L (MC)	L (RC)	L (RC)	L
Overall Pathway Viability for Spread of ANS from Mississippi River Basin to Great Lakes Basin								**L**

VC=Very Certain (as certain as going to get), RC=Reasonably Certain (reasonably certain), MC=Moderately Certain (more certain than not), RU=Relatively Uncertain (reasonably uncertain), VU=Very Uncertain (a guess)

Table 6. Example calculation of Pathway Viability for ANS Spreading from Great Lakes Basin to the Mississippi River Basin.

			Form 1 P_0	Form 2 P_1	Form 3 P_{2a}	Form 4 P_{2b}	Form 5 P_{2c}	$P_{viable\ pathway}$
Group	**Common Name**	**Mode of Dispersal**	**Pathway Exists?**	**ANS Occuring Within Either Basin?**	**ANS Surviving Transit to Pathway?**	**ANS Establishing in Proximity to Aquatic Pathway?**	**ANS Spread-ing Across Aquatic Pathway into New Basin?**	**ANS/Path-way Viability Rating**
fish	threespine stickleback	swimmer	M (RC)	M (VC)	L (RC)	L (MC)	L (MC)	L
pathogen	VHSv	fish pathogen / water column		H (VC)	H (MC)	H (RC)	H (RU)	M
Overall Pathway Viability for Spread of ANS from Great Lakes Basin to Mississippi River Basin								**M**

with all team members. The level of certainty in these ratings was modified during these discussions to reflect the range of opinion.

3 Aquatic Pathway Characterization

This section describes and illustrates the topography and features in the vicinity of the potential pathway at the Parker-Cobb Ditch location and is intended to help inform the biological evaluations contained later in this report with a compilation of readily available and applicable information for this area as it may influence local hydrology and aquatic habitat. Maps, photographs, and figures are included to aid understanding of the hydrologic and hydraulic conditions near the drainage divide. Also, this section identifies any significant data gaps and uncertainties related to the topographic and hydrologic information in the area of interest.

3.1 Location

The Parker-Cobb Ditch potential aquatic pathway is located in very flat topography surrounded by farm fields

southwest of the city of Valparaiso, in Porter County, Indiana, in the northwest quadrant of an area bounded by County Road (CR) 100 W to the west, Division Road to the north, Smoke Road to the east, and CR 150 S to the south (Figures 5 and 6). The latitude and longitude of this location is 41.42788 degrees north and 87.07686 degrees west, respectively. This location is part of a network of drainage channels excavated along farm fields to drain the area to allow cultivation. It is situated at the low point of an elongated flat valley which generally runs north and south.

3.2 Climate

Climate is looked at in this section just in terms of identifying any applicable elements of climate (e.g., temperature, rainfall) and how they may influence the likelihood of an aquatic connection forming at the subject pathway that could be utilized by ANS to spread between basins. It is also important to at least have a general understanding of the affect that temperature is likely to have on the quality of surface water relative to the habitat requirements of the ANS of concern for Parker-Cobb Ditch.

This area of northern Indiana is classified as temperate continental with warm summers and cold winters that typically provide enough precipitation, in the form of snow, to supply the soil with sufficient moisture to minimize drought conditions when the hot summers begin (INDNR, 2006). Temperatures in winter average 27ºF (-2.8ºC), while summers are mild, averaging 71º F (22ºC). The average temperatures (given in ºF) in June, July, and August range from highs in the low 80's (27ºC) to lows in the high 50's to low 60's (14-16ºC). Combined with the lack of available shade, surface water temperatures could elevate substantially on hot summer days. Conversely, the average temperature in December, January and February range from highs in the low to mid 30's (ºF) to lows in the teens to low 20's (ºF).

The average annual precipitation is approximately 40 inches (101 cm), with the driest times of the year generally occuring between October and March (Valparaiso Lakes Management Plan, 2006). Precipitation data also indicate that the wettest times of the year occur between April and September (Frankenberger and Carroll, 2011). Area records indicate that especially intense storms are most likely to occur during the spring, and modeling indicates that a one percent annual return frequency storm would be expected to produce approximately eight inches (20 cm) of rainfall in a 24 hour period (Frankenberger and Carroll, 2011).

The climate of Porter County could therefore limit the quality and quantity of surface water in the vicinity of Parker-Cobb Ditch during the hottest summer months (e.g., low levels of dissolved oxygen). Substantial drying in some or all of the connecting ditches could also occur during summer months and freezing of small ditches may occur in the winter. However, it is likely that some irrigation does occur which could provide some measure of sustained surface water in the ditches during dry periods.

3.3 Location Specific Surface Water Features

The information contained in this section is meant to present and interpret the readily available information for this location as it pertains to surface water conditions and any aspects that may influence the behavior of surface water. Parker Ditch and Cobb Ditch are agricultural canals designed to take excess rain water away from cultivated land in order to sustain or improve crop production. The red-white line in Figure 6 shows the 12-digit hydrologic unit code (HUC) boundary which is the line separating where runoff drains either into the Great Lakes Basin or into the Mississippi River Basin. However, as shown in Figure 7 (circled area), an agricultural ditch has been excavated across the basin divide creating a direct surface water connection to streams in both basins.

Parker Ditch and Cobb Ditch flow in opposite directions (Figure 8). Parker Ditch flows north into Salt Creek which then flows into the Little Calumet River and Lake Michigan through the Burns Waterway. Cobb Ditch drains to the south and connects with Sandy Hook Ditch which then continues on to the Kankakee River, a tributary to the Illinois River and ultimately the Mississippi River. However, the Illinois River is also hydraulically connected to Lake Michigan by way of the CAWS which is also being evaluated as part of the GLMRIS, but as a

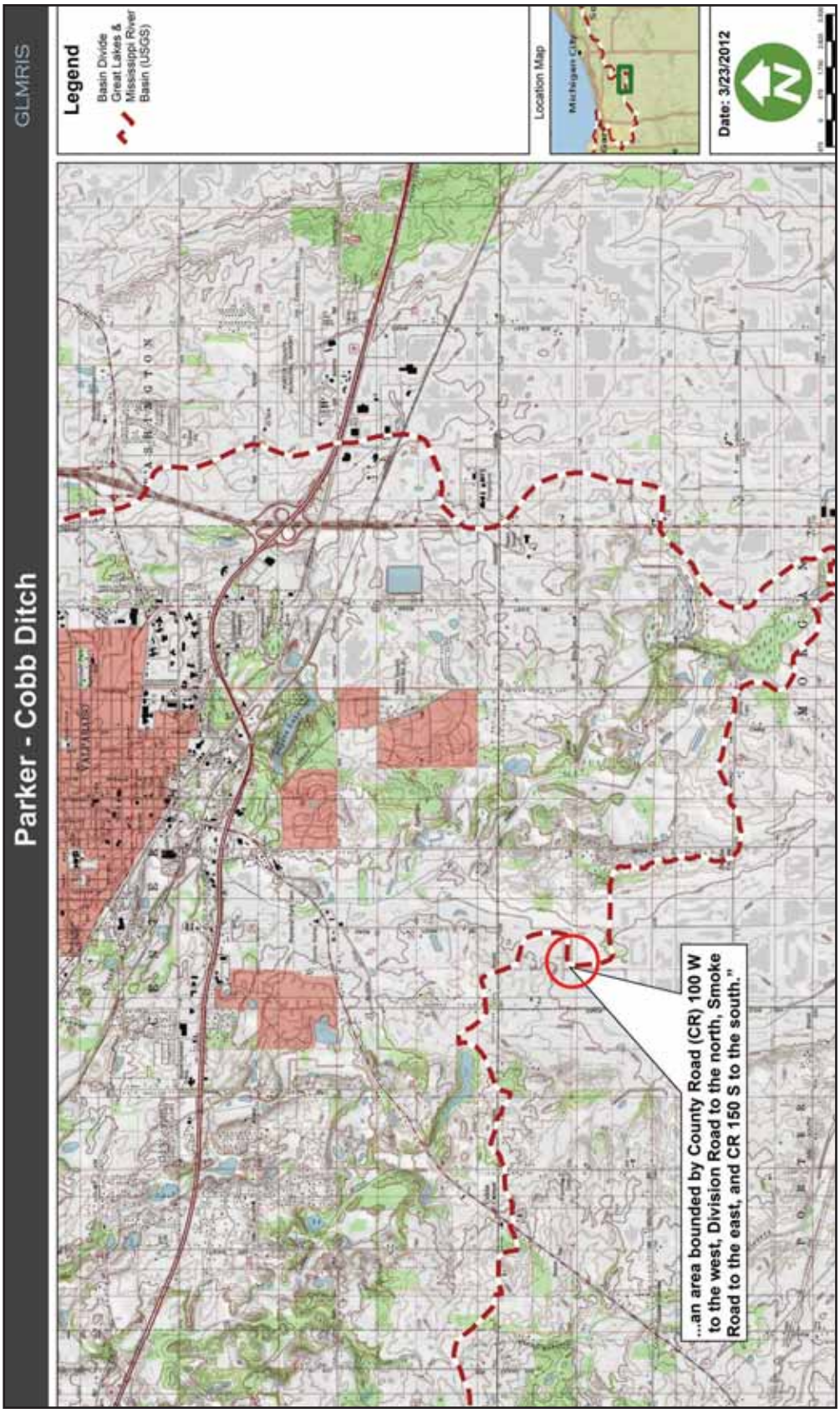


Figure 5. Location of Parker-Cobb Ditch aquatic pathway on USGS Quadrangle, just south of the City of Valparaiso, Indiana. See Figure 6 and Figure 7 for further detail.

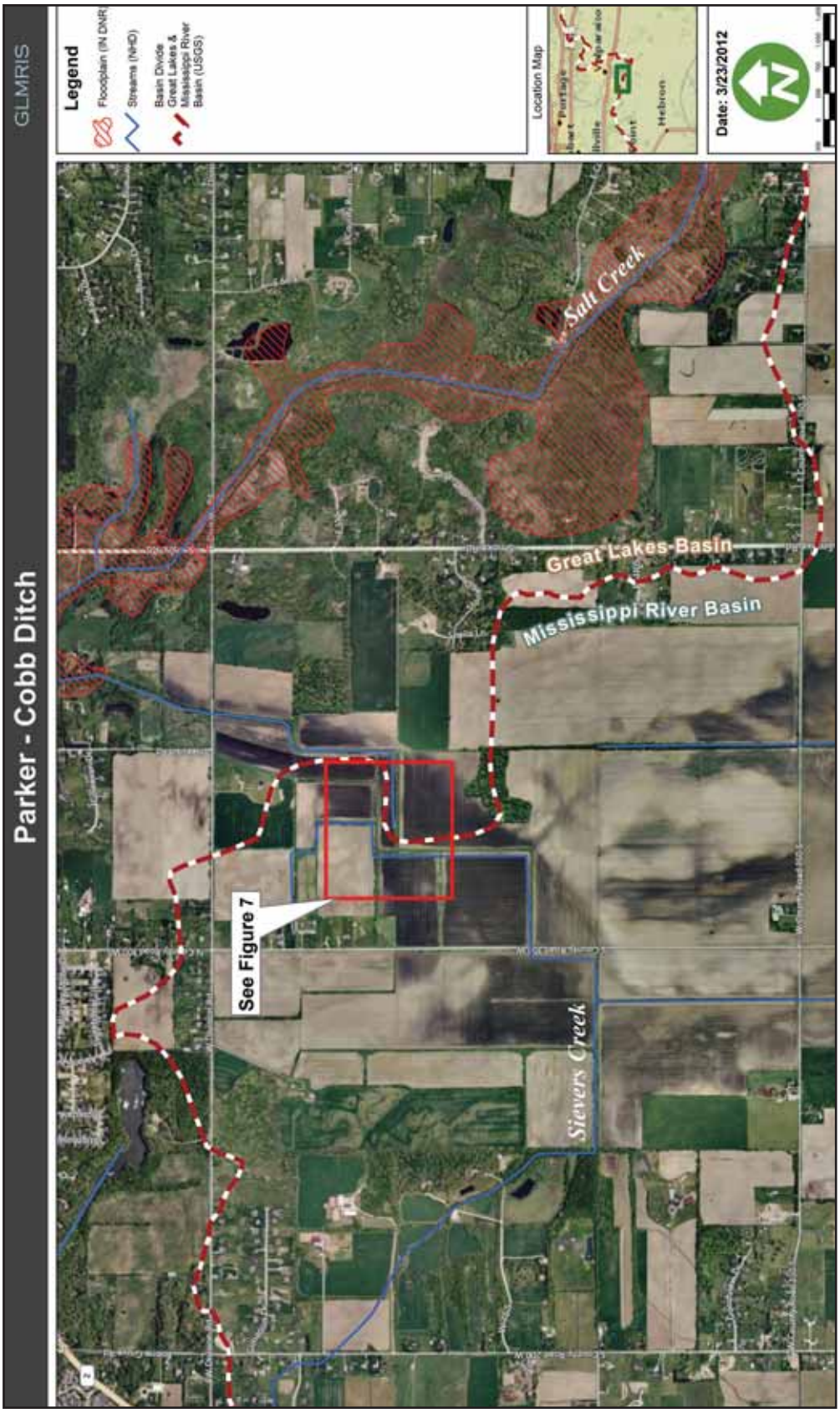


Figure 6. Closer view of site location and basin boundary showing agricultural land use and network of drainage canals.. Base imagery courtesy of Bing Maps.

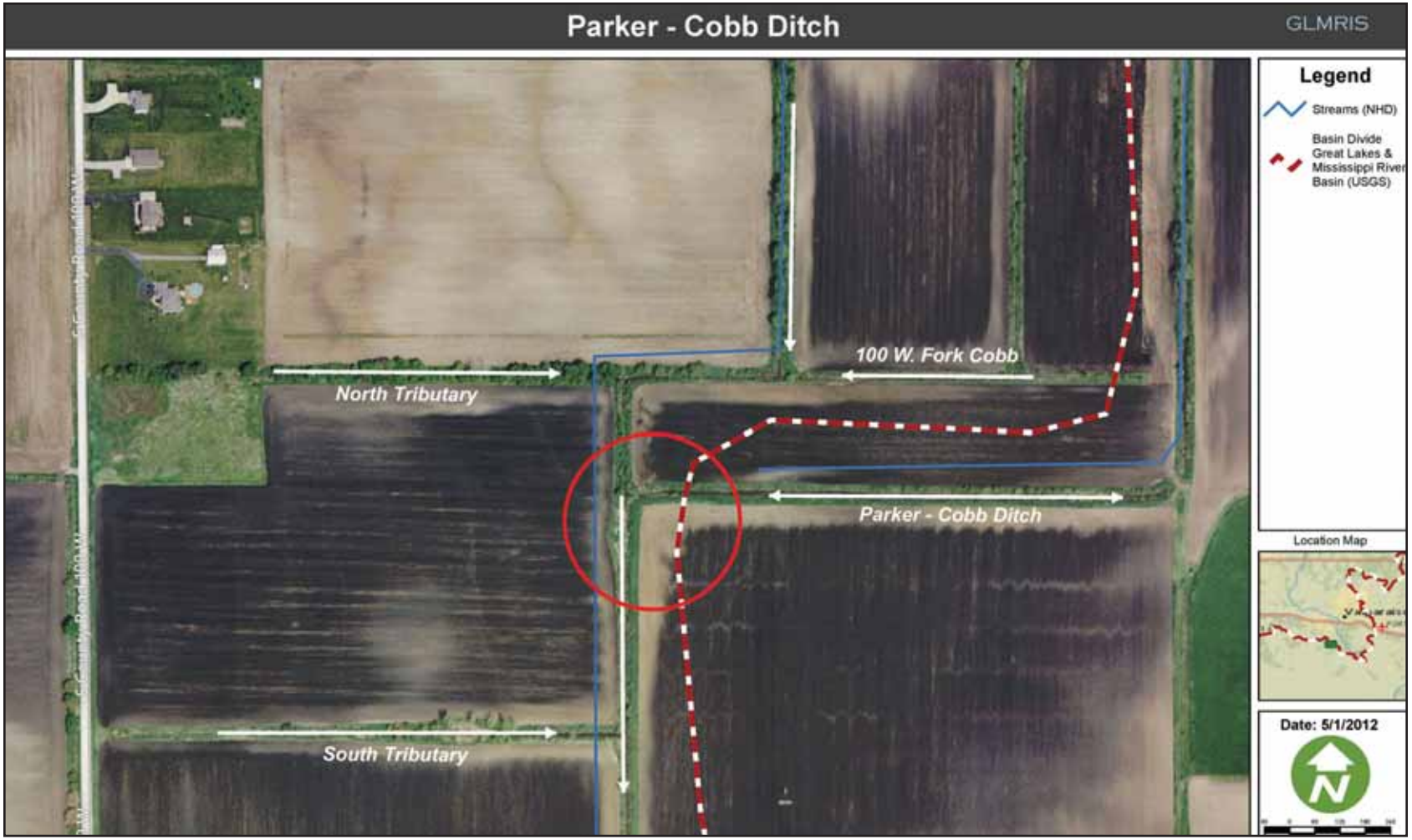


Figure 7. Aerial photograph showing Great Lakes and Mississippi River Basin divide (red-white line) and flow direction in area ditches (white arrows). Circled area shows location of Parker-Cobb Ditch crossing basin divide. Base imagery courtesy of Bing Maps.

Figure 8. Description of the network of agricultural ditches and flow directions connecting to the Parker-Cobb Ditch. The inset photograph is taken from the east bank of W. Fork Parker Ditch looking southwest toward a culvert through a farm field that connects to Parker-Cobb Ditch. Base imagery courtesy of Bing Maps.

separate pathway and therefore not part of this report. There are four ditch tributaries to 100W Fork Cobb Ditch which are labeled based on the relative locations of their confluence: North, South, East, and West.

The topography of the area was examined to see what barrier the slope of the land itself might offer to the spread of ANS between the basins. Using the best available Geographic Information System (GIS) data, elevation contours and representative cross-sections through the area of interest have been overlaid on aerial photography (Figure 9). This figure shows a plan view with elevation contours and the location of the 12-digit HUC boundary in proximity to its intersection with Parker-Cobb Ditch. Also shown are two graphs. One graph depicts an elevation profile along the 12-digit HUC boundary (A1-A2), and the other depicts a cross section through the basin divide (B1-B2) showing the approximate elevation of the bottom of the ditches that constitute the flow path. Both graphs reflect the very flat topographic conditions in proximity to this location.

For this pathway, the elevations in Figure 9 are based on the USGS 10m Digital Elevation Model (DEM) with a vertical accuracy of +/- 5 feet (1.5 m). This level of accuracy may lead one to conclude that there is a high degree of uncertainty regarding the potential for a watershed connection being established during flood events. However, the absolute vertical accuracy (specific elevation) is not nearly as important as the relative, or point-to-point, vertical accuracy (terrain) when evaluating terrain at the divide location to try and predict hydrology. Point-to-point accuracy has been shown to be much greater than this margin of error regarding absolute elevation would indicate. Although the absolute elevation values may vary from the true value (e.g., 600 feet above sea level), they tend to vary a comparable amount at adjacent points so that the terrain of the area is actually depicted relatively well. The grid size used to create the DEM can also affect the accuracy of the DEM. The larger the grid cell size (10 m squares vs. 30 m squares), the more block-like and less detailed the terrain appears and thus the less accurately the DEM depicts the actual terrain. The largest grid size used at any of the pathway locations is 10 m squares with some areas having more detailed information. Even though the 10 m cell size does not depict every hummock or hollow in the terrain, it does provide sufficient detail regarding general terrain and relative elevations to provide useful data in evaluating the potential for a hydrologic connection forming across the basin divide.

Except for the northwest and southeast corners of the figure, the profile and cross-sections in Figure 9 indicate that the land surface along the basin divide is very flat and approximately 694 feet above sea level at this location compared to the average elevation of Lake Michigan of 581 feet above sea level. Figure 9 also shows an area of mapped wetlands from the USFWS National Wetlands Inventory (NWI) at the northern end of the basin divide line; however, the aerial photograph indicates this area to be in agricultural use. There is a headwall in West Fork Parker Ditch and an inlet to a 27-inch (69 cm) diameter pipe that runs a distance of approximately 40 feet (12 m) and connects to the east end of Parker-Cobb Ditch which is shown in Figure 10.

Figure 8 indicates flow out of Parker-Cobb Ditch may be into both basins based on the assumption that the 12-digit HUC boundary is an accurate depiction of the physical location of the drainage divide. However, as can be seen by the photos in Figure 10 through Figure 12 approximately 1-inch (2.5cm) deep water was flowing through the 27-inch pipe from the West Fork Parker Ditch into the Parker-Cobb Ditch at the time of the site visit on June 20, 2011. Contrary to the 10-foot (3 m) contour lines shown in Figure 5, there is no physical divide at the west end of Parker-Cobb Ditch that might prevent it from flowing into 100 West Fork Cobb Ditch. It is uncertain if this is a new connection or just an inaccuracy with the USGS mapping due to the flatness of the area. Because the 27-inch (69 cm) pipe is higher on the West Fork Parker Ditch end, it is likely that at low flow the Parker-Cobb Ditch normally flows west toward Cobb Ditch, meaning that the actual watershed divide may be through the intersection of West Fork Parker Ditch and Parker-Cobb Ditch. The slopes of the connecting channels on both ends of this pathway appear to be very shallow based on contours and the general stagnant nature of flow. Observations of the 100W Fork Cobb Ditch and West Fork Parker Ditch indicate they are generally similar trapezoidal channels with a base width of about 10 feet (3 m), a depth of roughly 6 to 8 feet (1.8-2.4 m), and sides slopes that are approximately between 1.5:1 (horizontal : vertical) and 2:1.

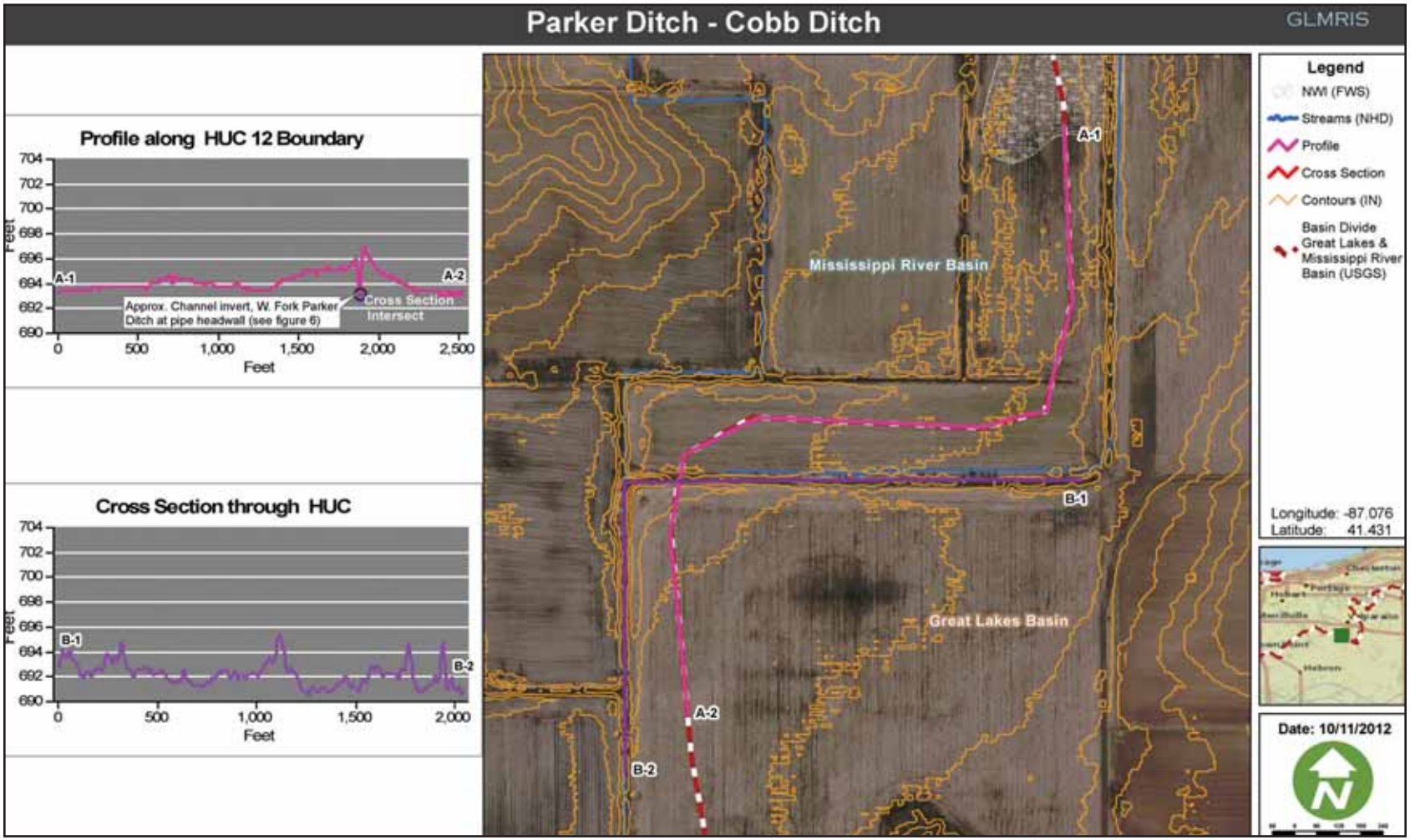


Figure 9. Plan view of pathway area based on one foot (30 cm) contours with a vertical accuracy of +/- 5 feet (1.5 m). The red line (A1-A2) is the location of the 12-digit HUC boundary and the purple line (B1-B2) is a cross section along the connected ditches that cross the basin divide. Base imagery courtesy of Bing Maps.

Figure 10. View looking southwest from east bank of West Fork Parker Ditch showing metal headwall and 27-inch (69cm) CMP culvert that extends approximately 40-feet (12 m) and connects with Parker-Cobb Ditch. Photo by USACE.

Figure 11: Water flowing into Parker-Cobb Ditch through 27-inch (69 cm) CMP from West Fork Parker Ditch. Photo by USACE.

Figure 12: Panoramic view of the junction of Parker-Cobb Ditch and 100West Fork Cobb Ditch, facing northeast. Photo by USACE.

3.4 Groundwater

A groundwater section is included in this report since groundwater can sometimes be a source of base flow for streams. Water levels in aquifers normally fluctuate seasonally in response to variations in groundwater recharge and discharge. Groundwater levels commonly rise in spring, when areal recharge is greatest because of snowmelt, spring rain, and minimal evapotranspiration losses. This means that heavier rainfall events, when they coincide with frozen ground conditions, snowmelt, and higher groundwater conditions, might result in higher volumes of water in the area ditches.

The soils in the vicinity of this pathway are all classified as muck or loam soils (NRCS, 2011). The Porter County Soil Survey indicates that the water table for these soil types at or very near the ground surface. These conditions were not verified during the site visit and the agricultural fields and the corn crops were well established, suggesting that the drainage system in the area is effective and could even lower the groundwater level locally during some times of the year. The only drainage tile observed in the area is visible in Figure 11, with its discharge point into the Parker-Cobb Ditch adjacent to the location of the 27-inch (69 cm) pipe that connects it with the West Fork Parker Ditch. This tile appeared to only be connected to a vertical riser pipe that intercepted surface water collecting in a low point adjacent to the channel. No other potential subsurface drainage pipes were noticed during the site visit on June 20, 2011. It appears that groundwater may provide some seasonal base flow into these channels but is not likely the primary source of flow into these channels. The shallowness of the groundwater in this area may be a contributing element of establishing a surface water connection at this location, especially when heavier rainfall events coincide with frozen ground conditions and snowmelt.

3.5 Aquatic Pathway Temporal Characteristics

Characterizing the temporal variability of the site's hydrology is potentially an important aspect of understanding the likelihood of an ANS being able to traverse the basin divide as certain flood events may coincide with species movement, reproductive patterns, and abilities to survive and establish populations in various areas. The only temporal attributes of note for this site are that the area is subjected to freezing temperatures on an annual basis, meaning that biological activity and possibly water flow could be restricted during these times due at least to the surface of standing water being frozen.

No specific data regarding the range of depths in these ditches was available for this investigation. However, in order to provide some approximation of flow depths in the channels relative to the 27-inch pipe (69 cm), a preliminary computation of the runoff was calculated utilizing the NRCS TR-55 methodology for the areas contributing to the 100 W Fork Cobb Ditch and the West Fork Parker Ditch tributaries (USDA, 1986). This NRCS method is a tool for estimating runoff and peak discharge in small watersheds. Table 7 lists the approximate flows and depths that were calculated in these two ditches using this methodology.

Table 7. Peak flows and depths estimated for 100W Fork Cobb Ditch and West Fork Parker Ditch.		
Tributary	**Frequency Event Peak Flow (cfs) 10% -1%**	**Approximate Flow Depth at Peak Flow (feet)10% -1%**
100 W Fork Cobb Ditch	200 - 470 cfs	4 - 6.5
W Fork Parker Ditch	140 - 330 cfs	3 - 4.5

Even assuming some uncertainty in the parameters used for this flow estimation, because the 27-inch (69 cm) pipe is situated only about 6 inches (15 cm) above the invert of each channel, it is apparent that even during lower magnitude and higher frequency storm events the two ditches are connected very frequently, if not perennially. The parameters used in calculating the amounts shown in Table 5 are purposefully conservative to ensure that conditions during the one percent annual recurrence interval event are adequately captured. Based on this calculation it appears that the flow is generally contained within the channel banks for even the one percent annual recurrence interval event and that overland flow between ditches and overbank flooding are unlikely. If flows did escape the channel, it would likely inundate a larger area due to the flatness of the surrounding fields, but overbank depths would be extremely shallow for these higher magnitude flows in excess of the one percent annual recurrence interval event.

3.6 Probability Aquatic Pathway Exists

The rating discussed in this section is only for the likelihood of an aquatic connection existing at this potential pathway (P_0) up to a one percent annual recurrence interval storm. A surface water connection does exist between the Great Lakes and Mississippi River Basins at the Parker-Cobb Ditch location, based on the following:

- Topography of the area is very flat and a surface water connection with bi-directional flow could therefore form within Parker-Cobb Ditch during both ten percent and one percent annual recurrence interval flood events;

- Based on peak flow depth calculations, surface water would be contiguous across the basin divide at a depth of approximately 3-6 feet (0.9-1.8 m), depending on location, but would likely all be contained within the channel;

- There is no physical obstruction between Parker-Cobb Ditch and 100 West Cobb Ditch; and

- Shallow groundwater depths and agricultural drainage likely contribute to sustained base flows in the ditches during parts of the year.

Due to the above evidence, the probability of a pathway existing from the Great Lakes to the Mississippi River Basin at Parker-Cobb Ditch is rated as “high” since it meets the criteria of a perennial or intermittent stream (in this case a ditch) that is capable of conveying significant volumes of water across the basin divide continuously for days to weeks, multiple times per year (Appendix A). The rating for flow toward the Great Lakes Basin was slightly less at medium. This is due to what visually appeared to be lower flow volumes going toward the Great Lakes Basin than toward the Mississippi River Basin at the time of the site visit and are shown in Figure 10 and Figure 11. This suggests a slightly greater probability for higher flow volumes going toward the Mississippi River Basin.

The ratings for flow into both basins are considered very certain because of the following:

- Although no site specific data was available regarding flow depths and velocities in the ditches, estimates indicate that water depths in the ditches could range between 3-6 feet (0.9-1.8 m) for events up to the one percent annual recurrence interval event, much more than would be needed to establish a surface water connection;

- It is estimated that flows up to the one percent annual recurrence interval event would be

contained within the channel profile of the ditches;

- There is no physical obstruction between Parker-Cobb Ditch and 100 West Cobb Ditch, contrary to what is indicated on the USGS topographic map for this area;

- There is some uncertainty related with the ground elevations as shown in Figure 6, which has a vertical accuracy of +/- 5 feet (1.5 m). However, field observations appear to confirm the accuracy of this mapping; and

- It is uncertain to what extent artificial drainage from surrounding agriculture contributes to flow volume and and frequency in the ditches.

3.7 Aquatic Pathway Habitat

3.7.1 Terrestrial and Riparian Plants and Land Use

The land adjacent to Parker-Cobb Ditch is used almost exclusively for agricultural purposes. Habitat diversity is very low in this area due to removal of natural vegetation for agricultural production. In areas immediately adjacent to the ditches, a narrow strip of riparian vegetation is typically present. This area extends up the banks of the ditches but does not extend into the floodplain. The predominant vegetation in the area is corn (*Zea mays*).

Although no surface water quality data was found for the immediate area, it is likely that runoff to the ditches in the area could be impacted by fertilizers and agricultural chemicals that introduce nutrients and create relatively high biological and chemical oxygen demand within the water column. Likewise, minimal shading from the riparian zone during summer combined with shallow water depth is likely to allow water temperatures to substantially increase and reduce dissolved oxygen levels in waters in the ditches during warm periods.

3.7.2 Aquatic Resources

From Parker-Cobb Ditch to Mississippi River: 100 West Fork Cobb Ditch ▶ Cobb Ditch ▶ Sandy Hook Ditch ▶ Kankakee River ▶ Illinois River ▶ Mississippi River.

The Kankakee River is an approximately 133 mile (214 km) tributary of the Illinois River whose basin has been extensively drained over the years. The natural flow path of the Kankakee River has been replaced by a series of canals and ditches which are generally shallow and exhibit poor habitat quality due to channelization and agricultural and urban run-off (Robertson, 1972; USFWS, 1999). The main branch of the river lacks pools and riffles and is instead a continuous glide. A number of bayous are found along the river. Some remain connected to the river throughout the year while others are connected only during high water or not at all. Fish and wildlife figures indicate that of the 1,200 miles (1,931 km) of stream presently comprising the Kankakee and its minor tributaries, only 16 miles (26 km) remain in the natural state (Robertson, 1972).

The INDNR sampled the Kankakee River for habitat in 2001. Qualitative Habitat Evaluation Index (QHEI) scores for 13 stations sampled ranged from a high of 50 to a low of 30.5. Scores between 45 and 60 indicate “Fair” aquatic habitat, and scores below 45 are poor habitat. The scores indicate that the habitat is poor at five of 13 Kankakee River stations (Price & Robertson, 2005).

The Illinois River supports a diverse fishery, but is currently threatened by pollution and invasive species like Asian carp. The deposition of sediments into the basin’s rivers has resulted in a loss of flow capacity, the filling of adjacent bottomland lakes and associated wetlands which are essential fish production areas, and has caused the smothering of valuable bottom-dwelling organisms and plants, thus degrading quality habitat areas. The loss of depth and increased turbidity from the sedimentation threatens the present aquatic habitat and fisheries resources (ILDNR, 2011). Contaminants in sediments have also had negative impacts on many benthic organisms (Sparks and Ross, 1992). In addition, the increased production of row crops and the practice of monoculture have resulted in a greater use

of herbicides, insecticides and fertilizers. Many of the agricultural chemicals used are toxic to fish. Habitat quality is also diminished by numerous discharges from industrial and manufacturing operations within the basin, some of which have heavy metals, inorganic and organic chemicals, and oxygen demanding organic waste such as wood pulp fibers, canning, and dairy and food processing wastes.

From Parker-Cobb Ditch to Lake Michigan: West Fork Parker Ditch ▶ Parker Ditch ▶ Salt Creek ▶ East Arm Little Calumet River ▶ Little Calumet River ▶ Lake Michigan.

West Fork Parker Ditch and Parker Ditch are small headwater streams that have been modified for agricultural drainage over the years. An ANS traveling from the Mississippi River Basin to the Great Lakes Basin would enter West Fork Parker-Cobb Ditch and then Parker Cobb Ditch before entering Salt Creek. Based on observations during the site visit, water quality is generally poor in West Fork Parker-Cobb Ditch and Parker-Cobb Ditches. This poor water quality is likely exacerbated during drought and dry conditions and high temperatures when the water in the ditches can become stagnant. Further downstream, land use within the Salt Creek Watershed includes agricultural, forest, grassland, residential, commercial, industrial, and recreational and the Salt Creek mainstream is considered a cold water fishery (Salt Creek Water Management Plan, 2008).

Salt Creek drains into the East Arm of the little Calumet River. The East Arm of the Little Calumet River is largely protected as part of the Indiana Dunes National Lakeshore. Despite this designation the East Arm of the Little Calumet River has several health advisories including: Mercury Fish Consumption Advisory, PCB Fish Consumption Advisory, and Pathogens (USEPA, 2012). Some sections of the river contain habitat suitable for salmonids and the INDNR stocks the river with several species of salmonids (INDNR, 2012). Beaver have been detected in the river which may lead to improvements in habitat for a variety of aquatic organisms via the construction of beaver dams and the creation of ponds behind the dams (Whitaker, 1999; Pollock et. al., 2003). The section of the East Arm of the Little Calumet River between Salt Creek and the Burns Ditch is approximately 1.5 miles (2.4 km).

Upon exiting the East Arm of the Little Calumet River, an ANS would then need to travel through Burns Ditch which is a constructed diversion of the Little Calumet River into Lake Michigan near Portage, Indiana. Construction of the ditch drained most of the wetlands in the area leading to extensive development (Chicago Historical Society, 2005). Burns Ditch has poor water quality with unsafe levels of *E. coli*. The Indiana Geological Survey conducted an E coli forecasting and modeling study at Burns Ditch stating that “the Burns Ditch location was chosen because it is the outfall point for the largest watershed (Little Calumet drainage) contributing contaminated streamflow to Indiana’s southern Lake Michigan” (Harper and Olyphant, 2010). Burns Ditch has several impairments including Mercury Fish Consumption Advisory, PCB Fish Consumption Advisory, and Pathogens (IDEM, 2011). The distance between Burns Ditch and Lake Michigan is approximately 1.5 miles (2.4 km).

3.7.3 Water Quality

It was observed during the site visit that the aquatic habitat within Parker-Cobb Ditch is degraded, likely due to channel straightening and agricultural runoff. Locations near Parker-Cobb Ditch that would once have been the site of ponds and wetlands have been drained for agricultural production over many years. Despite having degraded water quality, Parker-Cobb Ditch could provide adequate habitat and food sources to harbor a small number of ANS. One reason many invasive species are successful is the fact that they are able to tolerate a wide range of environmental parameters and out-compete native species for limited resources, especially in disturbed environments (National Wildlife Federation, 2012). Any ANS that crossed the divide at Parker-Cobb Ditch would likely be able to disperse downstream into larger water bodies that may be more suitable for establishing new populations. Although some ANS may be able to survive in the Parker-Cobb Ditch (e.g., northern snakehead), suitable habitat for Asian carp reproduction is not present. Common carp have been found in ditches similar to Parker-Cobb Ditch, but no data exists regarding the presence of common carp in Parker-Cobb Ditch (D. Keller, INDNR, personal communication, August 26, 2011).

3.7.4 Aquatic Organisms

Parker-Cobb Ditch should be able to support some tolerant fish species such as sunfish, common carp, and a few minnow species. Parker-Cobb Ditch is likely subject to periodic low dissolved oxygen levels and algal blooms when velocities are low. Aquatic invertebrates inhabiting the ditch likely include oligochaetes, dipterans, and pulmonates, all of which are tolerant of low water quality.

The Indiana Natural Heritage Data Center database lists five state endangered animal species as occurring in Porter County, Indiana. These include the least bittern (*Ixobrychus exilis*), black-crowned night heron (*Nycticorax nycticorax*), king rail (*Rallus elegans*), spotted turtle (*Clemmys guttata*), and Blanding's turtle (*Emydoidea blandingii*). There are also two plant species listed as state endangered: the forget-me-not (*Myosotis laxa*) and Vasey's pondweed (*Potamogeton vaseyi*). The database also lists Richardson's pondweed (*Potamogeton richardsonii*), a state threatened plant species as occurring within the watershed, and pale duckweed (*Lemna valdiviana*), a state extirpated species, as formerly occurring in the watershed. The establishment of ANS within Parker-Cobb Ditch may affect some listed species, even though some listed species in the area are terrestrial. Aquatic nuiscance species are known to upset the balance of an ecosystem's food web dynamics, and sensitive species are usually the first to be affected. Aquatic nuisance species can also negatively affect higher trophic levels in the food chain, by preying on lower level species, or by outcompeting them for food or habitat.

3.8 Connecting Streams to Great Lakes and Mississippi or Ohio River

The connecting streams and/or water bodies downstream in both directions from Parker-Cobb Ditch are as follows:

From pathway to Great Lakes: West Fork Parker Ditch ▶ Parker Ditch ▶ Salt Creek ▶ East Arm Little Calumet River ▶ Little Calumet River ▶ Lake Michigan.

From pathway to Mississippi River: 100 West Fork Cobb Ditch ▶ Cobb Ditch ▶ Sandy Hook Ditch ▶ Kankakee River ▶ Illinois River ▶ Mississippi River.

Possible obstructions to ANS movement to and from this pathway are found only on the Mississippi River Basin side of the drainage divide. On the Kankakee River, there are three low head dams near the towns of Momence (river mile 316.0), Kankakee (302.0), and Wilmington (282.5). Momence and Wilmington dams are very small with effective dam heights of 3-5 feet (1-1.5 m), so they are commonly inundated during floods. Kankakee Dam has an approximate pool differential of 18 feet (5.5 m) under normal low flows, but is also capable of being inundated during high flow events. Downstream of the Kankakee River on the Illinois River, five navigation dams maintain pool differentials of up to 30 feet (9 m) during low flows, but also do not impede movement of ANS during high flows when the tainter gates are completely open. Additional information and mapping of the location of these dams can be found at PaddleAway.com (PaddleAway, 2012). These dams are not expected to significantly impede the movement of ANS in the upstream or downstream direction. The interested reader can refer to the National Inventory of Dams for additional information (NID, 2010).

4 Aquatic Pathway Viability for ANS of Concern

The potential for species transfer was assessed by the project team for the ANS of concern for the Parker-Cobb Ditch location in accordance with the procedures outlined in the Methodology Section of this report. The following subsections present the results of the biological evaluation of the likelihood of ANS spreading between the Great Lakes and Mississippi River Basins via the

Parker-Cobb Ditch aquatic pathway. This potential was characterized as high, medium, or low for the following categories:

- Probability that pathway exists (Section 3)
- Probability of the target ANS occurring within either basin
- Probability target ANS survive transit to reach aquatic pathway
- Probability of ANS establishment in proximity to the aquatic pathway
- Probability of ANS spreading across aquatic pathway into new basin

The criteria for designating probabilities of high, medium or low are provided under each category. In addition, a "certainty" rating is also assigned with each probability assessment. Certainty ratings associated with any given probability ratings include:

- Very Certain (As certain as we will get with this effort)
- Reasonably Certain
- Moderately Certain (More certain than not)
- Reasonably Uncertain
- Very Uncertain (An educated guess)

A team rating is provided based on the professional collaboration of the interagency team of biologists. A team probability and certainty rating is provided for each species for each category, as appropriate, and the rating represents the most conservative probability assessment for each category considered. Just as important as the subjective estimates of probability are the remarks that summarize the key data that supports the estimates, which were made by an interagency team of biologists for each ANS of concern to the Parker-Cobb Ditch location. The completed forms, which include the probability and certainty ratings and the remarks from all agency professionals participating in this assessment, are included in Attachment A.

4.1 Probability of the ANS Being Within Either Basin

General Considerations for Assigning Probability Ratings:

High - Target ANS exists on connected waterways in close enough proximity to be capable of moving to the aquatic pathway within 20 years.

Medium - Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of moving to the aquatic pathway within 20 years.

Low - Target ANS is not known to exist on a connected waterway.

Certainty ratings were applied as outlined above.

Asian Carp

Silver carp and bighead carp are established throughout the middle and lower Mississippi River Basin. Both silver carp and bighead carp have been recorded in significant numbers in the Illinois River. In the spring of 2011, an adult bighead carp was taken from the Kankakee River near Channahon, Illinois (CBS Chicago, 2011). Black carp may be established in portions of the lower Mississippi River Basin. The known distribution of black carp is not as extensive as that of the silver and bighead carp.

Team Rating: **High**
Certainty rating: Very Certain

Northern Snakehead

The northern snakehead was found in 2008 in Arkansas, and has since established a reproducing population in the area. This population is within the Mississippi River Basin and represents a population that could spread throughout the basin. Although in a different basin, this species is also established in the Potomac River in Maryland and Virginia (USGS, 2011). While this species

is within the Mississippi River watershed, its population does not seem to be spreading at a high rate at this time and it is unlikely that it would reach the Parker-Cobb Ditch divide location within the next 20 years without the assistance of some non-aquatic vector.

Team Rating: **Medium**
Certainty rating: Very Certain

Parasitic Copepod

The parasitic copepod has a life cycle in which the female adopts a parasitic phase on several fish species, including members of the minnow, sunfish, and catfish families, as well as potentially other fish species. The common carp (*Cyprinus carpio*) is a frequent host of the parasite (Hudson and Bowen, 2002). The females can detach and re-attach to host species. The invasive copepod has been established in Lake Huron since 1994 and was reported from Lake Erie in 2011 (P. Hudson-USGS, personal communication, September 26, 2011). The common carp is established in Lake Michigan, as well as the rivers and streams leading to Parker-Cobb Ditch from Lake Michigan. While other host fish species are known to exist in the pathway system, the common carp was selected as the most likely host species because of the life cycle capabilities of the common carp and the likelihood the common carp would use, and survive within, the pathway habitats. The parasitic copepod species and a necessary host species are in the Great Lakes Basin. The males are free living but do not have the capability of dispersal upstream. The parasitic copepod is small and relatively easy to miss in field surveys, even by trained biologists. Therefore, the parasitic copepod may be much more prevalent than distribution maps depict.

Team Rating: **Medium**
Certainty rating: Reasonably Certain

Viral Hemorrhagic Septicemia Virus

Viral hemorrhagic septicemia virus can infect a wide range of host fish species causing a variety of external and internal pathology including death of the host fish. Variables such as host fish species and water temperature can impact the pathology of the virus. Seemingly healthy individuals that have been previously infected with VHSv can have chronic infections and be carriers of the disease (Skall et al., 2005). This virus has been reported from throughout the Great Lakes Basin (USGS, 2011).

Viral hemorrhagic septicemia virus has been found in many species of fish including common carp. The common carp is established in Lake Michigan, as well as many of the rivers and streams leading to the Parker-Cobb Ditch pathway from Lake Michigan. While other host fish species are known to exist in the pathway system, the common carp was selected as the most likely host species because of the life cycle capabilities of the common carp and the likelihood the common carp would use and survive in the pathway habitats. Viral hemorrhagic septicemia virus and a necessary host species are both within the Great Lakes Basin. It should also be noted that VHSv has been found in 28 different host fish species in the Great Lakes Basin and that it can survive without a host in the water column (WDNR, 2012).

Team Rating: **High**
Certainty rating: Very Certain

Ruffe and Tubenose Goby

The ruffe and tubenose goby are located within the Great Lakes and are associated with river mouths and estuaries of large river systems entering the Great Lakes. The ruffe exists in northern Lake Michigan in Green Bay, but is not widespread and there are no high density populations in Lake Michigan (Bowen and Goehle, 2011). The ruffe prefers deep waters of lakes and pools of rivers, usually over sand and gravels but has a tolerance for different habitats and environmental conditions (Gray and Best, 1989). The ruffe has a high reproductive rate and spawns in clean water. Females produce up to 200,000 eggs in the first batch, and up to 6,000 eggs per subsequent batch (Global Invasive Species Database, 2012). The ruffe is an aggressive species that possesses the ability to feed in darkness, cold temperatures, and turbid conditions. The ruffe has extended its range rapidly and modeling predicts it will find suitable habitat in all five Great Lakes (USGS, 2012). Literature reviews and actual fish survey data have not documented the collection of the ruffe in smaller upstream tributaries. The tubenose goby's introduced

range includes Lake St. Clair, Erie, Huron, Superior, and Ontario and is a benthic species that consumes a wide variety of invertebrates (USGS, 2011). They are found in the open waters and estuaries of slow flowing rivers and are often quite abundant in backwaters and lakes and seem to prefer dense vegetation. It has been collected in the lower reaches of larger Great Lakes rivers and estuaries, but no tubenose goby have been collected locally in upper Great Lakes river tributaries to date. Tubenose gobies have exhibited a much slower rate of expansion in the Great Lakes than the round goby (*Neogobius melanostomus*), also an invasive species in the Great Lakes and now located within both the Great Lakes Basin and the Mississippi River Basin. The tubenose goby's nearest locations are in Lake Superior and Lake Huron (USGS, 2011).

Team Rating: **High**
Certainty rating: Very Certain

Threespine Stickleback

The threespine stickleback is found in each of the Great Lakes (Lake Ontario HUC 8 records are within native range) and has been collected in some inland river systems (USGS, 2011). This species prefers to live in smaller streams but may occur in a variety of habitat including lakes and large rivers. The threespine stickleback was first encountered in lower Green Bay about 25 years ago, but has never been seen upstream from this area. Great Lakes populations of this species tend to be potamodromous (truly migratory but within fresh water only) and only enter the lower reaches of streams briefly during spring spawning.

Team Rating: **High**
Certainty rating: Very Certain

4.2 Probability ANS Surviving Transit to Aquatic Pathway

4.2.1 Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

High - Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the connecting streams to arrive at the subject pathway within 10 to 20 years.

Medium - Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage through the connecting streams to arrive at the subject pathway within 20 to 50 years.

Low - Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations through the connectin streams to arrive at the subject pathway within next 50 years.

Asian Carp

Spawning and the subsequent dispersal of silver and bighead carp is initiated by rising water levels following heavy rains (Jennings, 1988; Verigin et al., 1978). Both species are strong swimmers and silver carp are capable of jumping considerable distances out of the water. There are no obstacles in the Kankakee that would permanently prevent upstream movement of Asian carp. In addition to some low head dams, there are two substantial dams on the Kankakee River that are inundated at very high flows. Asian carp in the Mississippi River Basin might be able to bypass these dams during high flow events when they become completely inundated. The proximity of the silver and bighead carp to the Parker-Cobb Ditch pathway (lower Kankakee River), combined with their history of dispersal throughout the Mississippi River Basin,

indicates that these species are species of concern for the Parker-Cobb Ditch location. Habitat present within most of Sandy Hook Ditch and Cobb Ditch is not ideal for silver and bighead carp which thrive in large rivers, but there is a slight level of uncertainty regarding to what extent this poor habitat quality may prevent movement of Asian carp through the network of connecting ditches. While both species are highly opportunistic, bighead carp are primarily zooplanktivorous, whereas silver carp primarily consume smaller phytoplankton and fine particulate organic matter (Dong and Li, 1994; Jirasek et al., 1981; Williamson and Garvey, 2005). Sufficient forage is available throughout the Kankakee River for adult silver and bighead carp. Forage abundance, diversity, water quality, and water volume all decreases as one moves up Sandy Hook Ditch and into Cobb Ditch.

Adult black carp are primarily molluscivores. However, they will opportunistically consume a wide variety of food items (USFWS, 2002). Juvenile black carp have a diet more similar to silver and bighead carp, consisting primarily of zooplankton (USACE, 2011b). The diet of juvenile black carp may allow them to survive in areas unsuitable for adults. The habitat of black carp is very similar to the grass carp (*Ctenopharyngodon idella*) (Nico et al., 2005). It is believed that black carp should be able to colonize the same areas of the United States where the grass carp have established (USFWS, 2002)."

Juvenile Asian carp have been observed in the uppermost reaches of small tributaries to large rivers attempting to pass over in-stream barriers (e.g., dams) to continue their upstream movement (D. Chapman-USGS, personal communication, September 12, 2011; N. Caswell, U.S. Fish and Wildlife Service, September 12, 2011). It is unknown if Asian carp would be likely to spread into Sandy Hook Ditch. Sandy Hook Ditch is a small tributary with limited habitat for adult Asian Carp. It shares several characteristics (e.g., small size, located high in the watershed) with the Graham-McCulloch Ditch in Fort Wayne, Indiana which has been tested for Asian carp using an environmental DNA (eDNA) sampling technique in the fall of 2010 and during the early summer of 2011, all with negative results (D. Keller-INDNR, personal communication, August 16, 2011). The technique is useful for detection of the presence of Asian carp DNA in water when species populations are at very low levels of abundance (Jerde et al., 2011; Dejean et al. 2011; and Minamoto et al., 2011). A positive eDNA sample indicates the presence of Asian carp DNA and the potential presence of live fish. At present, eDNA evidence cannot verify whether live Asian carp are present, whether the DNA may have come from a dead fish, or whether water containing Asian carp DNA may have been transported from other sources, such as bilge water. The U.S. Army Corps of Engineers is leading an Asian Carp eDNA Calibration Study (ECALS) with the U.S. Geological Survey and the U.S. Fish and Wildlife Service to reduce the uncertainty surrounding eDNA results and investigate alternative sources and pathways for eDNA detections beyond a live fish.

It is important to note that young Asian carp tend to move laterally away from the river in which they were spawned and not back upstream (D. Chapman-USGS, personal communication, September 12, 2011). It has also been observed that Asian carp, as small as advanced fingerlings, have traveled up to 37 miles (60 km) through tributaries of the lower Missouri River. These tributaries were located laterally to the Missouri river segment in which these fish hatched (D. Chapman, personal communication, September 12, 2011). Adult, sexually mature Asian carp have occasionally been found in very small streams, which appear scarcely large enough to support the fishes at low water (D. Chapman-USGS, personal communication, September 12, 2011).

There are many uncertainties one must take into account when attempting to predict the temporal and spatial dispersal patterns of Asian carp. While on-going research by INDNR may suggest adult Asian carp have no interest in spreading into smaller streams, more long term studies are needed, and even these may not help explain the seemingly random movements of juveniles that have been witnessed in Midwestern rivers and their tributaries (Coulter and Goforth, 2012; D. Chapman-USGS, personal communication, September 12, 2011; D. Keller-INDNR, personal communication, August 16, 2011). Even with these uncertainties, the ability of Asian carp to arrive at the Parker-Cobb Ditch aquatic pathway location was given a rating of low for several reasons: (1) the presence of dams on the Kankakee River prevent the upstream movement of Asain Carp in all but the most severe flood events, (2) the Kankakee River floods across a large food plain and the velocity of the Kankakee River during these events is low, which may be inadequate to trigger

a spawning run by Asian carp in the upper Kankakee River, and (3) the lack of suitable spawning habitat for adult Asian carp in the ditches leading to the pathway further inhibit the upstream movement of Asian carp to the Parker-Cobb Ditch pathway. All these elements combined make it unlikely that Asian carp will be able reach this pathway location within the next 50 years.

Team Rating: **Low**
Certainty rating: Reasonably Certain

Northern Snakehead

The northern snakehead utilizes specialized structures (suprabranchial organ and a bifurcate ventral aorta) that permits aquatic and aerial respiration (Ishimatsu and Itazaw, 1981; Graham, 1997). This species thrives in stagnant, oxygen depleted back-waters and marshes (Courtenay, Jr. and Williams, 2004). The northern snakehead likely possesses the ability to migrate through the interconnecting ditches leading to the Parker-Cobb Ditch pathway. However, its preferred habit is not flowing waters, which may slow its spread up the Mississippi River and larger streams leading to the tributaries connecting with Parker-Cobb Ditch. Despite this information, the northern snakehead has been consistently caught by anglers in the Potomac River near Great Falls Virginia during spring high flow events (J. Newhard-USFWS, personal communication, December 22, 2011). Based on data from external tags recaptured by anglers, in rare instances northern snakehead have been found to move as far as 50 river miles (80 km) upstream at a rate of approximately one mile (1.5 km) per day. This extensive movement typically occurs in the spring with the fish returning back downstream to slower moving water in the summer (J. Newhard-USFWS, personal communication, December 22, 2011). The primary reason that northern snakehead was rated higher than Asian carp for this section is because the habitat between the Kankakee River and the vicinity of Parker-Cobb Ditch is more sutiable for northern snakehead than it is for adult Asian carp.

Team Rating: **Medium**
Certainty rating: Moderately Certain

Parasitic Copepod

The parasitic copepod has been found on the common carp, and the common carp was therefore used as a surrogate potential host for the parasitic copepod to estimate the probability of the copepod moving from its current location in the Great Lakes Basin to the Parker-Cobb Ditch pathway location. During spring run-off events typically in April and May, common carp migrate into the shallow waters of bays and river systems to spawn. Within the rivers, common carp migrate upstream to spawn in suitable habitat such as marshes and even drainage ditches with as little as a one foot or less of water depth. Common carp are strong swimmers and though they cannot jump like members of the salmon family, they can migrate upstream during moderate flow events. Common carp are present in the ditches that make up the Salt Creek Watershed (D. Keller, INDNR, September 7, 2011). The surface water connection from Lake Michigan to Parker-Cobb Ditch provides suitable habitat for carp during run-off events. It is possible that common carp could migrate to the watershed divide since it is a very resilient species that is capable of surviving a wide range of water quality parameters. It is also likely that if the common carp arrived with the copepod attached, the host fish could pass between the watershed divide under a suitable runoff event.

Team Rating: **Medium**
Certainty rating: Moderately Certain

Viral Hemorrhagic Septicemia Virus

In addition to the parasitic copepod, common carp is also a potential host for VHSv (USGS, 2011). The common carp was therefore used as a surrogate potential host to estimate the probability of VHSv moving from its current location in the Great Lakes Basin to the Parker-Cobb Ditch pathway location. During spring run-off events in April and May, common carp migrate into the shallow waters of bays and river systems to spawn. Within the rivers, common carp migrate upstream to spawn in suitable habitat such as marshes and even drainage ditches with as little as one foot or less of water depth. Common carp are strong swimmers and though they cannot jump like members of the salmon family, they can migrate upstream during moderate flow events.

Common carp are present in the ditches that make up the Salt Creek Watershed (D. Keller-INDNR, personal

communication, September 7, 2011). The surface water connection from Lake Michigan to Parker-Cobb Ditch provides suitable habitat for carp during run-off events. It is possible that the common carp could migrate to the watershed divide since it is a very resilient species capable of surviving a wide range of water quality parameters. However, the presence of VHSv in the water column or in an infected fish is not known in any downstream connecting waters to Parker-Cobb Ditch until one reaches the Great Lakes. It is therefore unlikely that the virus or an infected fish would reach the Parker-Cobb Ditch pathway location within the next 10-20 years.

Team Rating: **Medium**
Certainty rating: Moderately Certain

Ruffe and Tubenose Goby

The ruffe prefers deep waters of lakes and pools of rivers, usually over sand and gravel, but has a tolerance for different habitats and environmental conditions (Gray and Best, 1989). Ballast water transport has been the key means for the spread of ruffe in the Great Lakes (USFWS, 1996). The ruffe has a high reproductive rate and spawns in clean water. The ruffe's ability to swim upstream during high flow events and migrate over dams is questionable, especially since it prefers still or slow moving water (Fishbase, 2011). Natural rates of dispersion are not well known and ruffe have not spread beyond Green Bay in the nine years since its detection in that area, and populations have been trending down (Bowen and Goehle, 2011). The tubenose goby is found in the open waters and estuaries of slow flowing rivers. The tubenose goby appears to be more capable of living in more diverse types of riverine habitat than the ruffe (Dopazo et al., 2008; Jude and DeBoe, 1996). Sufficient forage ranging from zooplankton to fish may be available throughout the Great Lakes side of the connection. However, suitable habitat for the ruffe and tubenose goby in Salt Creek and Parker Ditch may be limited or even nonexistent.

Team Rating: **Low**
Certainty rating: Moderately Certain

Threespine Stickleback

The threespine stickleback has been found in the Great Lakes and in smaller river systems (USGS, 2011). The species has been found in Lake Michigan in locations near Chicago, Illinois, which indicates the potential exists for this species to gain access and transfer to the Parker-Cobb Ditch location. There are some obstacles to upstream movement within the Mississippi River Basin such as on the Kankakee River, but there are no known obstacles to prevent the spread of the threespine stickleback within the Great Lakes Basin to the Parker-Cobb Ditch pathway. It is likely that sufficient forage and habitat is available throughout the pathway for the threespine stickleback.

Team Rating: **Medium**
Certainty rating: Reasonably Certain

4.2.2 Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

This section does not influence the overall pathway rating outlined in this report and is only included to point out other potential pathways (e.g., anthropogenic) that may be important to different audiences. Any further analysis of non-aquatic pathways outside of this study should develop a separate list of ANS that will likely differ from those which may exploit the aquatic pathway.

General considerations for assigning probability ratings:

High - Target ANS are established in relatively close proximity to location and have ample opportunity, capability, and motivation to successfully navigate through a non-aquatic pathway to arrive at the subject pathway within 10 to 20 years.

Medium - Target ANS are established at locations in close enough proximity to the location and have limited capability to survive passage through a non-aquatic pathway to arrive at the subject pathway within 20 to 50 years.

Low - Target ANS are not in proximity to the

pathway, and/or it is highly unlikely that they could survive transit from current locations through a non-aquatic pathway to arrive at the subject pathway within next 50 years.

Asian Carp, Northern Snakehead, Parasitic Copepod, VHSv, Threespine Stickleback, and Ruffe, and Tubenose Goby

Fishing and boating are unlikely to occur in the Parker-Cobb Ditch area. The ditches are too small to support sport fishing and are also too small for boating or kayaking. The small size of the ditches virtually eliminates the threat of ANS transfer via water craft, associated equipment, or fishing gear. Dumping of ANS (discarded aquarium pets, religious ceremonies, etc.) within the area is also considered unlikely. The pathway vicinity is located on privately owned agricultural fields and therefore has greatly restricted access. Possession of Asian carp in Indiana is prohibited which would further aid in reducing the likelihood of human movement of this species. It is probable that bait-bucket transport has aided in the movement of the threespine stickleback in the past and Indiana state regulations do not prohibit transport or possession of this species. However, as fishing and boating are unlikely at this location the probability of anthropogenic transport of this species would also be low.

Team Rating: **Low**
Certainty rating: Reasonably Certain

4.3 Probability of ANS Establishment in Proximity to the Aquatic Pathway

General Considerations for Assigning Probability Ratings:

High - Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range, and there are no known predators or conditions that would significantly impede survivability or reproduction.

Medium - Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at the location can be expected to effectively compete and survive.

Low - Habitat and abiotic conditions in proximity are outside the range where the target ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

Asian Carp

Silver and bighead carp are fast growing species that are capable of surviving in a wide range of water temperatures and reproducing quickly, providing suitable habitat is available. Life history and habitat requirements generally include diverse needs for current areas, backwater habitats, deep overwintering holes, and other habitat types needed for survival (Nico et al., 2005). In some stretches of the Illinois River, silver and bighead carp make up as much as 90 percent of the biomass. It is believed that silver and bighead carp require sufficient flow to keep fertilized eggs suspended for successful reproduction (Gorbach and Krykhtin, 1980). Black carp reach sexual maturity in as little as five years and adult females can produce up to one million eggs per spawning event. It is unlikely that spawning of any of the Asian Carp species would occur within most of the streams in the Park-Cobb Ditch pathway due to the small sizes of the streams. It is not known if the Kankakee River offers suitable habitat for Asian Carp spawning. The flow of Parker and Cobb ditches near the pathway are often sluggish and the ditches are generally shallow. During periods of prolonged cold weather, as is common in this area, the water in the connection may freeze solid. During the summer months the water in the connection often becomes stagnant, depleted of oxygen, and very shallow. These conditions at and near pathway location make it exceptionally difficult for an adult Asian Carp to survive in the area year round, but given how much is unknown about the species some individuals may establish in under favorable flow conditions.

Team Rating: **Medium**
Certainty rating: Reasonably Certain

Northern Snakehead

The northern snakehead's native range (latitude 24-53ºN) and temperature tolerance of 32ºF-86ºF (0-30ºC) indicates a species that could establish populations throughout most of the contiguous United States (Courtenay, Jr. and Williams, 2004). Northern snakeheads are naturally aggressive predators that could easily acclimate to the conditions in and around Parker-Cobb Ditch as long as there is an ample food supply, which is likely to be the case. They can be very opportunistic in their feeding habits, preying on everything from insect larvae to fish, frogs, and crustaceans. Northern snakeheads prefer shallow ponds and marshes with aquatic vegetation. Parker-Cobb Ditch often becomes stagnant in the summer and substantial amounts of aquatic vegetation may develop during that timeframe. This type of habitat would be suitable for northern snakehead. In addition, northern snakeheads aggressively defend their nest and young fry, reducing predation on young snakehead by other fish.

Team Rating: **High**
Certainty rating: Moderately Certain

Parasitic Copepod

The parasitic copepod is very capable of persisting in eutrophic and polluted waters (USGS, 2011). The copepod demonstrates a rapid reproductive cycle and is capable of utilizing many different host species. It is likely that the copepod would be successful in establishing in Parker-Cobb Ditch and connecting tributaries since numerous potential host fish species such as common carp can be present in the area.

Team Rating: **High**
Certainty rating: Moderately Certain

Viral Hemorrhagic Septicemia Virus

Survival and reproduction of common carp as a potential carrier of VHSv is considered high at this location during the spring. During spring runoff, the connecting ditches and streams would provide the necessary habitat for occupation of any VHSv carrier/host fish species, at least temporarily. The virus is also capable of persisting outside of a host for several days when water temperatures are cool 37ºF-54ºF (2.8ºC-12.2ºC) (USGS, 2011). It also demonstrates a rapid reproductive cycle and is capable of utilizing many different host species, including the common carp (WDNR, 2012). However, the higher water temperatures that likely occur in the summer months in the area ditches might prevent the establishment of VHSv during that time. It is likely that VHSv would be successful in establishing in or near Parker-Cobb Ditch, but this has only a moderate level of certainty due to the likely warm temperatures in the ditches much of the summer.

Team Rating: **High**
Certainty rating: Moderately Certain

Ruffe and Tubenose Goby

The ruffe is an aggressive species that possesses the ability to feed in darkness, cold temperatures and turbid conditions. Tubenose gobies are benthic species that consume a wide variety of invertebrates (USGS, 2011). They are often quite abundant in backwaters and lakes, and seem to prefer dense vegetation. However, survival of a viable, reproducing population of ruffe and tubenose goby within Parker-Cobb Ditch may be unlikely due to low water quality and high temperatures in summer months. The receiving stream (Sandy Hook Ditch) from Cobb Ditch also offers only limited habitat due to the same reasons listed for Cobb Ditch. Limited suitable habitat may be present in the most downstream reaches of Sandy Hook Ditch.

Team Rating: **Low**
Certainty rating: Moderately Certain

Threespine Stickleback

As a visual predator, the turbid waters of the connecting ditches may be unsuitable for the threespine stickleback. The establishment of a sustained population of threespine stickleback within Parker-Cobb Ditch is possible, but the intermittent nature of flows, and poor water quality in Parker-Cobb Ditch and connecting ditches, may limit the numbers and health of any such population. Portions of connecting streams between

Parker-Cobb Ditch and Lake Michigan may provide sufficient habitat for this species. It may be able to establish in fairly close proximity to the pathway location and at some point take advantage of a suitable flood event and cross the basin divide.

Team Rating: **Medium**
Certainty rating: Moderately Certain

4.4 Probability of ANS Spreading Across Aquatic Pathway into the New Basin

General Considerations for Assigning Probability Ratings:

> **High** - Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
>
> **Medium** - There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
>
> **Low** - There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

Asian Carp

During a flood event there would likely be favorable conditions for a sufficient period of time to allow Asian carp to move through the pathway. Asian carp have demonstrated exceptional capabilities of spreading through large river systems, and will likely continue to do so. If Asian carp are able to spread past the Parker-Cobb Ditch connection, they will likely survive as the small ditches and creeks leading to this location from the Mississippi River are similar to those leading away from this connection to the Great Lakes Basin.

Team Rating: **High**
Certainty rating: Reasonably Certain

Northern Snakehead

It is very likely that the northern snakehead possesses the ability to spread into the Great Lakes Basin from Parker-Cobb Ditch if a population were established near that location, even though it is less certain if or how quickly the northern snakehead could reach the pathway. As an air breather that has been known to move short distances over land, under proper environmental conditions this species could potentially transfer from Cobb to Parker Ditch even if a substantial hydrologic connection is not present.

Team Rating: **High**
Certainty rating: Reasonably Certain

Parasitic Copepod

When a surface water connection is established, it is likely that carp hosting the parasitic copepod could spread through the pathway into the Mississippi River Basin. The female copepod can detach and re-attach to another host fish. Potential host fish for this species are present throughout the connecting streams between Cobb Ditch and the Mississippi River.

Team Rating: **High**
Certainty rating: Reasonably Certain

Viral Hemorrhagic Septicemia Virus

This virus is capable of persisting outside of a host for several days, demonstrates a rapid reproductive cycle, and is capable of utilizing many different host species. It is highly probable that VHSv would be successful in spreading into exposed fish populations already on both sides of the basin divide in the event infected fish reached the Parker-Cobb Ditch pathway.

Team Rating: **High**
Certainty rating: Moderately Certain

Ruffe and Tubenose Goby

Ruffe and the tubenose goby have not been found in rivers

or streams similar to Sandy Hook Ditch or its tributaries. If the fish were introduced into the ditch network at the basin divide, they would likely be successful in passing Parker-Cobb Ditch into the Mississippi River Basin.

Team Rating: **Medium**
Certainty rating: Moderately Certain

Threespine Stickleback

The threespine stickleback has been found in small river systems and therefore downstream movement from Parker-Cobb Ditch into the Mississippi River Basin would be possible. It is also possible that life history requirements of threespine stickleback could be met in the receiving streams of Cobb Ditch, although the intermittent nature of flows and poor water quality in Parker-Cobb Ditch and Cobb Ditch may limit the numbers and health of any individuals that are able to cross into the Mississippi River Basin.

Team Rating: **High**
Certainty rating: Moderately Certain

5 Overall Aquatic Pathway Viability

As discussed in Sections 2.4 and 2.5, the determination of the likelihood of a viable aquatic pathway occurring at the Parker-Cobb Ditch location for each ANS of concern is the product of five probability elements (Equation 5). Thus, the probability of a viable pathway for a particular ANS of concern is equal to the lowest rating determined for each of the five probability elements (Table 8 and Table 9). The overall pathway viability for transferring ANS of concern from the Mississippi River Basin to the Great Lakes Basin was equal to the highest probability of a viable pathway for each ANS of concern in Table 8. At the Parker-Cobb Ditch location, three of the four species were rated as “low”, the fourth was rated as “medium, thus the overall pathway viability for transferring species from the Mississippi River Basin to the Great Lakes Basin is “medium”. The overall pathway viability for transferring species from the Great Lakes Basin is calculated the same way and is shown in Table 9. At the Parker-Cobb Ditch location, the overall pathway viability for transferring species from the Great Lakes Basin to the Mississippi River Basin is “medium”. The last calculation is to determine the overall pathway viability for interbasin spread of ANS which is calculated by taking the highest of the overall ANS ratings for unidirectional transfer which were calculated in Tables 8 and 9. Thus, the overall probability that a viable aquatic pathway exists at the Parker-Cobb Ditch Pathway is “medium”.

Table 8. Summary of individual probability elements and overall pathway viability rating (Mississippi River Basin to Great Lakes Basin). Certainty ratings for each element are in parentheses.

			Form 1 (P_0)	Form 2 (P_1)	Form 3a (P_{2a})	Form 4 (P_{2b})	Form 5 (P_{2c})	$P_{Viable\ pathway}$
Group	**Common Name**	**Mode of Dispersal**	**Pathway Exists? (Sect. 3.6)**	**ANS Occurring Within Either Basin? (Sect. 4.2.1)**	**ANS Surviv-ing Transit to Pathway? (Sect. 4.2.1)**	**ANS Establishing in Proximity to Aquatic Pathway? (Sect. 4.3)**	**ANS Spread-ing Across Aquatic Pathway into New Basin? (Sect. 4.4)**	**Aquatic Pathway Viability Rating**
fish	*Asian Carp, silver carp, bighead carp, black carp*	swimmer	H (VC)	H (VC)	L (RC)	M (RC)	H (RC)	L
fish	*northern snakehead*	swimmer		M (VC)	M (MC)	H (MC)	H (RC)	M
Overall Pathway Viability for Spread of ANS from Mississippi River Basin to Great Lakes Basin:								**M**

Table 9. Summary of individual probability elements and overall pathway viability rating (Great Lakes Basin to Mississippi River Basin). Certainty ratings for each element are in parentheses.

			Form 1 (P_0)	Form 2 (P_1)	Form 3a (P_{2a})	Form 4 (P_{2b})	Form 5 (P_{2c})	$P_{Viable\ pathway}$
Group	**Common Name**	**Mode of Dispersal**	**Pathway Exists? (Sect. 3.6)**	**ANS Occurring Within Either Basin? (Sect. 4.1)**	**ANS Surviving Transit to Pathway? (Sect. 4.2.1)**	**ANS Establishing in Proximity to Aquatic Pathway? (Sect. 4.3)**	**ANS Spreading Across Aquatic Pathway into New Basin? (Sect. 4.4)**	**Aquatic Pathway Viability Rating**
fish	*threespine stickleback*	swimmer	H (VC)	H (VC)	M (RC)	M (MC)	H (MC)	M
fish	*Benthic fish* *ruffe and tubenose goby*	swimmer		H (VC)	L (MC)	L (MC)	M (MC)	L
crustacean	*parasitic copepod*	parasite		M (RC)	M (MC)	H (MC)	H (RC)	M
virus	*VHSv*	fish pathogen/ water column		H (VC)	M (MC)	H (MC)	H (RC)	M
Overall Pathway Viability for Spread of ANS from Great Lakes Basin to Mississippi River Basin:								**M**

6 Conclusions

The Parker-Cobb Ditch aquatic pathway is defined as the Parker-Cobb Ditch channel between Parker Ditch and 100 West Fork Cobb Ditch. A viable aquatic pathway does exist at Parker-Cobb Ditch for the potential transfer of northern snakehead into the Great Lakes Basin. A viable aquatic pathway also exists at this location for the potential transfer of threespine stickleback, parasitic copepod, and VHSv into the Mississippi River Basin. The overall aquatic pathway viability rating for Parker-Cobb Ditch is medium, which in this case means that while ANS transfer could occur, there is limited opportunity for them to reach the Parker-Cobb Ditch pathway location and then transfer into the adjacent basin within the next 20-50 years.

6.1 Parker-Cobb Ditch Problem Statements

This section presents a general summary of the Parker-Cobb Ditch aquatic pathway and frames the nature and extent of the problems associated with the potential for movement of ANS through Parker-Cobb Ditch, in either direction between the Great Lakes and Mississippi River Basins.

- A hydrologic connection between the basins occurs most frequently during late winter to early summer, and sporadically during heavy rain events in drier times of the year. The connection may last for several days, several times per year and requires passage through an existing 27 inch (69 cm) culvert.

- The primary ANS of concern for interbasin transfer into the Mississippi River Basin are: VHSv, threespine stickleback, and a parasitic copepod. The primary ANS of concern for interbasin transfer into the Great Lakes Basin is the northern snakehead. The snakehead's affinity for ditches and wetland habitats and its amphibious traits make it a species with a high likelihood of being able to establish a population and spread across the basin divide if it reaches Parker-Cobb Ditch.

- A contributing factor to the level of uncertainty in understanding the hydrologic conditions at this pathway is the lack of stream gauges and site-

specific data on water levels which limits the ability to accurately characterize the width, depth, velocity, and frequency of various flow events at this location.

- There was some uncertainty associated with assessing the capabilities of specific ANS to reach the pathway location due in some cases to an incomplete understanding of their current locations within each basin, the speed at which they might move in the upstream direction, and their life history requirements.

- Other pathways and vectors for ANS interbasin transfer exist that are not evaluated as part of the Parker-Cobb Ditch aquatic pathway assessment. These collectively comprise what is called "residual probability," and are not necessarily specific to the Parker-Cobb Ditch location. Such other pathways could include, but are not limited to: collection of bait in one basin and release in the adjacent basin; ANS adhering to recreational boats in one basin and then being released when the vessel is placed in a water body in the adjacent basin; release of imported aquaria fish and other exotic species; terrestrial transport, and transport by birds or other animals.

6.2 Parker-Cobb Opportunity Statements

While it is not the purpose of this assessment to produce and evaluate an exhaustive list of potential actions to prevent ANS transfer at this location, some opportunities were still identified that, if implemented, could prevent or reduce the probability of ANS spreading between the basins at the Parker-Cobb Ditch site. The opportunities listed below are not necessarily specific to the Parker-Cobb Ditch location and they are also not specific to the USACE authorities, but incorporate a wide range of possible applicable authorities, capabilities, and jurisdictions at the Federal, state, and local levels and include some more regional opportunities. These are as follows:

- Physical separation of the interbasin connection at Parker-Cobb Ditch may provide the highest level of confidence in preventing interbasin transfer of ANS from either direction.

In addition to physical separation of the basins at Parker-Cobb Ditch, various non-structural opportunities could be considered at the pathway and/or regionally. There are broad categories of technology for potential active measures to prevent ANS transfer at this locations, such as:

  - Chemical deterrents in order to reduce habitat suitability at or near the pathway.

  - Biological control measures that prevent ANS reproduction or prevent the ability of ANS to establish a sustainable population in the vicinity.

  - Physical removal of ANS at their current locations.

  - Increase commercial and recreational harvest, specifically of bighead and silver carp.

- New or improved regulations or ordinances prohibiting the establishment of drainage ways that would connect the Mississippi River tributaries with Great Lakes tributaries.

- Take ANS transfer potential into account for proposed water resource projects (e.g., ecosystem restoration, dam removal, stream restoration, water management).

- Public education to:

  - Prevent bait bucket transfers of ANS

  - Prevent transfer via boating and recreational equipment

  - Prevent transfer due to religious or cultural ceremonies

  - Improve identification and reporting of ANS to the appropriate authorities

- Support research on the biology of ANS so transfer potential can be better understood.
    - Life history
    - Habitat requirements and tolerances
    - History of invasiveness
- Improve and increase field sampling and monitoring for the presence of ANS to support better informed water resource management decisions within the state and region:
- Develop integrated ANS sampling and analysis plan utilizing eDNA and conventional biological sampling events at times when ANS would be expected to be present in an area, such as during flood events.
- Target, encourage, and train recreational fishermen, boaters and other direct users of the surface waters of the state of Indiana to identify, report, collect, and deliver ANS to the appropriate agencies.
- Prevent introductions of additional ANS
    - Improve regulations for bilge releases
    - Improve regulations on the pet industry
    - Impose regulations on the live bait industry
    - Improve regulations on the aquaculture industry

None of the opportunities identified above are exclusive of the others. In fact, any single structural measure to prevent ANS transfer through Parker-Cobb Ditch would likely benefit from corresponding development and implementation of one or more of the other types of opportunities identified. The results of this assessment may also aid in the implementation of, and future updates to, the Indiana Aquatic Nuisance Species (ANS) Management Plan.

7 References:

ANSTF. (1996). Generic Nonindigineous Aquatic Organisms Risk Analysis Review Process for Estimating Risk Associated with the Introduction of Nonindigineous Aquatic Organisms and How to Manage for that Risk. Report to the Aquatic Nuisance Species Task Force. Risk Assessment and Management Committee, Aquatic Nuissance Species Task Force.

Bowen, A.K. and M.A. Goehle. (2011). Surveillance for ruffe in the Great Lakes, 2011. http://www.fws.gov/midwest/alpena/documents/2011-GL-Ruffe-Report.pdf

CBS Chicago. (2011). Fifty Pound Asian Carp Caught Near Joliet Considered Moderate in Size. Accessed March 23, 2012: http://chicago.cbslocal.com/2011/04/15/50-pound-asian-carp-caught-near-joliet-considered-moderate-in-size/

Chicago Historical Society. (2005). Electronic Encyclopedia of Chicago. Retrieved from http://www.encyclopedia.chicagohistory.org/pages/300076.html

Courtenay, W.R. and J.D. Williams. (2004). Snakeheads (*Pisces, Channidae*) - A Biological Synopsis and Risk Assessment. USGS Circular 1251.

Dejean, T., A. Valentini, A. Duparc, S. Pellier-Cuit, F. Pompanon, P. Taberlet, and C. Miaud. (2011). Persistence of environmental DNA in freshwater ecosystems. PLoS One 6(8): e23398.

Dong, S., and D. Li. (1994). Comparative studies of the feeding selectivity of silver carp, *Hypophthalmichthys molitrix*, and bighead carp, *Aristichthys nobilis*. Journal of Fish Biology 44:621-626.

Dopazo, S.N., L.D. Corkum, and N.E. Mandrak (2008). Fish assemblages and environmental variables associated with Gobiids in nearshore areas of the Lower Great Lakes. Journal of Great Lakes Research 34(3): 450-460.

Fishbase. (2011). Froese, R. and D. Pauly. Editors. World Wide Web electronic publication: www.fishbase.org.

Frankenberger, J.R. and N. Carroll. (2011). Website accessed December 5, 2011. Water Resources of Porter County, Indiana. (Purdue University): https://engineering.purdue.edu/SafeWater/watershed/porter.pdf

Global Invasive Species Database. Accessed May 24, 2012: http://www.issg.org/database/species/ecology.asp?si=544&fr=1&sts=sss&lang=EN.

Gorbach, E.I. and M.L. Krykhtin. (1980). Maturation rate of the white amur *Ctenopharyngodon idella* and silver carp *Hypophthalmichthys molitrix* in the Amur River. Journal of Ichthyology 21(4):835–843.

Graham, J.B. (1997). Air-breathing fishes: evolution, diversity, and adaptation. Academic Press. San Diego, California. xi +. 299 pp.

Gray, J.A.B. and A.C.G. Best. (1989). Patterns of excitation of the lateral line of the ruffe. Journal of the Marine Biological Association of the United Kingdom 69:289-306.

Great Lakes Commission. (2011). Website accessed February 21, 2012: http://www.great-lakes.net/envt/flora-fauna/invasive/pdf/vhs_glc_factsheet_2011.pdf

Harper, D. and Olyphant, G. (2010). Monitoring and Forecasting Outfalls of Streamflow Contaminated by E. Coli at Burns Ditch, Lake Michigan, Indiana. Indiana Geological Survey (IGS). Retrieved from http://igs.indiana.edu/WatershedHydrology/BurnsDitch.cfm?sublogo=CGDA.shoreline.http://igs.indiana.edu/WatershedHydrology/BurnsDitch.cfm?sublogo=CGDA

Hudson, P.L. and C.A. Bowen II. (2002). First record of *Neoergasilus japonicus* (*Poecilostomatoida: Ergasilidae*), a parasitic copepod new to the Laurentian Great Lakes. Journal of Parasitology 88(4):657-663.

IDEM. (2011). Indiana Department of Environmental Management. Site accessed March 12, 2012: http://www.in.gov/idem/nps/2853.htm)

INDNR. (2006). Salt Creek Watershed Management Plan (DRAFT).

INDNR. (2012). Indiana Department of Natural Resources. Stocking Schedule, accessed March 13, 2012 http://www.in.gov/dnr/fishwild/3626.htm

ILDNR. (2011). Erosion and Sedimentation. The Changing Illinois Environment: Critical

Ishimatsu, A. and Y. Itazaw. (1981). Ventilation of the air-breathing organ in the snakehead *Channa argus*. Japanese Journal of Ichthyology 28(3): 276–282.

Jennings, D.P. (1988). Bighead carp (*Hypophthalmichthys nobilis*): a biological synopsis. Biological Report. U.S. Fish and Wildlife Service. 88(2): 1-35.

Jerde, C.L., A.R. Mahon, L. Chadderton, and D.M. Lodge. (2011). “Sight-unseen” detection of rare aquatic species using environmental DNA. Conservation Letters 00: 1-8.

Jirasek, J., A. Hampl, and D. Sirotek. (1981). Growth morphology of the filtering apparatus of silver carp (*Hypophthalmichthys molitrix*). Gross anatomy state. Aquaculture 26:41-48.

Jude, D.J. and S.F. DeBoe. (1996). Possible Impact of Gobies and other Introduced Species on Habitat Restoration Efforts. Canadian Journal Fisheries and Aquatic Sciences. 53:136-141.

Minamoto, T., H. Yamanaka, T. Takahara, M.N. Honjo, and Z. Kawabata. (2011). Surveillance of fish species composition using environmental DNA. Limnology. DOI: 10.1007/s10201-011-0362-4.

National Wildlife Federation. (2012). Invasive species. Accessed May 17, 2012: http://www.nwf.org/Wildlife/Wildlife-Conservation/Threats-to-Wildlife/Invasive-Species.aspx

Nico, L.G., J.D. Williams, and H.L. Jelks. (2005). Black Carp: biological synopsis and risk assessment of an introduced fish. American Fisheries Society, Special Publication 32. Bethesda, Maryland.

NID. (2010). U.S. Army Corps of Engineers, 2010 National Inventory of Dams: http://nid.usace.army.mil.

NOAA. (2011). Great Lakes Nonindiginous Aquatic Species Information System (GLANSIS). National Oceanic and Atmospheric Administration. http://www.glerl.noaa.gov/res/Programs/glansis/watchlist.html.

NRCS. (2011). Web Soil Survey information for Porter County. Accessed on March 14, 2012: http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

PaddleAway. (2012). Website accessed May 24, 2012: http://www.paddleaway.com/dams?river_id_param=39

Pollock, M.M. and M. Heim and D. Werner. (2003). Hydrologic and Geomorphic Effects of Beaver Dams and Their Influence on Fishes. American Fisheries Society Symposium 37.

Price, Jeremy and Bob Robertson. (2005). Fishery, Habitat, and Recreational Use Surveys for the Kankakee River, Indiana. Final Report - Workplans 200766 & 202766. Indiana Department of Natural Resources, Division of Fish and Wildlife - Fisheries Section. January 2005.

Robertson, R. N. (1972). “Kankakee River Basin stream survey report.” Indiana Division of Fish and Wildlife. Indianapolis, Indiana.

Salt Creek Water Management Plan. (2008). Porter County, Indiana. Coordinated by Save the Dunes Conservation Fund, and funded by Indiana Department of Environmental Management.

Skall, H.F., N.J. Olesen and S. Mellergaard. (2005). “Viral hemorrhagic septicemia virus in marine fish and its implications for fish farming – a review.” Journal of Fish Diseases 28:509-529.

Sparks, R.E. and P.E. Ross. (1992). Identification of toxic substances in the Upper Illinois River. Illinois Department of Energy and Natural Resources, Springfield. Contract Report ILENR/RE–WR–92/07. 59 pp.

USACE. (2010). Great Lakes and Mississippi River Interbasin Study Other Pathways Preliminary Risk Characterization. Great Lakes and Ohio River Division. United States Army Corps of Engineers.

USACE. (2011a). GLMRIS Focus Area 2 Study Plan. Great Lakes and Ohio River Division. United States Army Corps of Engineers.

USACE. (2011b). Non-Native Species of Concern and Dispersal Risk for the Great Lakes and Mississippi River Interbasin Study. United States Army Corps of Engineers.

USDA. (1986). U.S. Department of Agriculture (USDA), Natural Resources Conservation Service, Conservation Engineering Division, Technical Release 55 (TR-55) (210-VI-TR-55). Second Edition, June 1986. (Update of Appendix A January 1999).

USEPA. (2012). USEPA Watershed Assessment, Tracking & Environmental Results for Indiana, Little Calumet-Galien Watershed. Accessed March 13, 2012: http://iaspub.epa.gov/tmdl_waters10/attains_watershed.control?p_huc=04040001&p_state=IN&p_cycle=&p_report_type=T

USFWS. (1996). Ruffe control plan. Submitted to the Aquatic Nuisance Species Task Force by the Ruffe Control Committee. Available at: http://www.fws.gov/midwest/ashland/ruf_cont.html

USFWS. (1999). Grand Kankakee Marsh National Wildlife Refuge Environmental Assessment. Accessed March 23, 2012: http://www.fws.gov/midwest/planning/GrandKankakee/

USFWS. (2002). Black Carp Invasive Species Program Fact sheet. Accessed March 23, 2012: http://www.fws.gov/southeast/hotissues/Black_Carp_FS.pdf

USGS. (2011). Nonindigenous Aquatic Species (NAS) website. Retrieved from http://nas.er.usgs.gov. United States Geological Survey.

USGS. (2012). Nonindigenous Aquatic Species (NAS) website, ruffe. http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=7 Accessed 13 June 2012.

Valparaiso Lakes Watershed Management Plan. (2006). Prepared for Valparaiso Lakes Area Conservancy District, the city of Valparaiso Stormwater Management Board, and the city of Valparaiso Parks Department (JFNew, Walkerton, IN).

Verigin, B.V., A.P. Makeyeva and M.I. Zaki Mokhamed. (1978). Natural spawning of the silver carp (*Hypophthalmichthys nobilis*), the bighead carp (*Aristichthys nobilis*), and the grass carp (*Ctenopharyngodon idella*) in the Syr-Dar'ya River. Journal of Ichthyology 18(1):143-146.

WDNR. (2012). VHS 101 Fact Sheet. Wisconsin Department of Natural Resources. Website accessed April 10, 2012: http://dnr.wi.gov/fish/vhs/vhsfacts.html#3a

WRDA. (2007). Water Resources Development Act of 2007 [Section 3061(d): P.L. 110-114; amends Section 345: P.L. 108-335; 118 Stat. 1352].

Whitaker, J.O. (1999). "Mammals of the Grand Calumet River Region". Proceedings of the Indiana Academy of Science: 122–143.

Williamson, C.J. and J.E. Garvey. (2005). Growth, fecundity, and diets of newly established silver carp in the Middle Mississippi River. Transactions of the American Fisheries Society 134(6): 1423-1430.

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Appendix A

Evaluation Forms for each ANS of Concern Selected for Parker-Cobb Ditch

Parker-Cobb Ditch Report

May, 2013

Parker-Cobb Ditch, Porter County, IN - Asian Carp

1. Probability of aquatic pathway existence

Aquatic Pathway Team	Expertise Position title or team role	Rating Flow into GLB	Certainty	Rating Flow into MRB	Certainty
	USACE, Detroit - Hydraulic Engineer	High	VC	High	VC
	USACE, Louisville - Hydraulic Engineer	High	VC	High	VC
	USGS, Indiana WSC - Hydrologist	High	VC	High	VC
	Indiana DNR - Engineering Geologist	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**High**	**VC**

1. How do you rate the likelihood of the existence of a viable aquatic pathway at the subject location? Assume a viable aquatic pathway is any location where untreated surface water flow across the divide is deemed likely to occur and connect headwater streams in both basins from any storm up to the 1% annual return frequency storm.

Qualitative Rating	Qualitative Rating Category Criteria
High	Perennial streams and wetlands or intermittent stream known/documented to convey significant volumes of water across the basin divide for days to weeks multiple times per year.
Medium	Intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a 10% annual return frequency storm; or, location of wetland spanning basin divide which maintains significant ponds that are likely to become inter connected and connect with streams on both sides of the basin divide from a 10% annual return frequency storm.
Low	Intermittent stream or marsh forming a surface water connection between streams on either side of the basin divide from larger than a 1.0% annual return frequency storm.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: A hydraulic connection is likely to be maintained through the field access culvert for multiple days multiple times per year, based upon professional judgement and cursory runoff calculations and calculated depths of flow. A hydraulic connection is likely to be maintained through the field access culvert through late winter to early summer, then episodically as sufficient rain falls, and again more continuously after transpiration declines and precipitation falls in late fall to winter. This is based on my understanding of drainage of similar areas and soils and flow patterns in the region. The ditch system leading to the culvert under the farm road at the basing boundary appears to be very low gradient for a distance of over one mile. It likely behaves more like a wetland scenario than a flowing stream. The upland nature of the site, lacking significant watershed to provide for a larger water volume, would serve to decrease any long term flow volume.

Parker-Cobb Ditch, Porter County, IN - Asian Carp

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	High	VC		
	USACE, Louisville - Biologist	High	RC		
	USACE, Detroit - Biologist	High	RC		
	Indiana DNR - AIS Coordinator	Medium	RC		
	Team Rating	**High**	**VC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of moving to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of moving to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	Symbol					
Very Certain	VC	As certain as I am going to get.				
Reasonably Certain	RC	Reasonably certain.				
Moderately Certain	MC	More certain than not.				
Reasonably Uncertain	RU	Reasonably uncertain				
Very Uncertain	VU	A guess				

Remarks: Silver carp and bighead carp are established throughout the Mississippi River Basin. Both silver carp and bighead carp have been recorded in significant numbers in the Illinois River. In the Spring of 2011, an adult bighead carp was taken from the Kankakee River near Channahon, Illinois (CBS Chicago, 2011). Black carp may be established in portions of the lower Mississippi River Basin. The known distribution of black carp is not as extensive as that of the silver and bighead carp.

Parker-Cobb Ditch, Porter County, IN - Asian Carp

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, Louisville - Biologist	Low	RC	Low	RC
	USACE, Louisville - Biologist	Medium	RC	Medium	RC
	USACE, Detroit - Biologist	Medium	RC	Low	RC
	Indiana DNR - AIS Coordinator	Low	RC	Low	RC
	Team Ratings	**Low**	**RC**	**Low**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

Spawning and the subsequent migration of silver and bighead carp is initiated by rising water levels following heavy rains (Jennings, 1988; Verigin, 1978). Both species are strong swimmers and silver carp are capable of jumping considerable distances out of the water. There are no obstacles in the Kankakee that would permanently prevent upstream migration of Asian carp. In addition to some low head dams, there are two substantial dams on the Kankakee River that are inundated at very high flows (Section 2.7). Asian carp in the Mississippi River Basin might be able to bypass these dams during high flow events when they become completely inundated. The proximity of the silver and bighead carp to the Parker-Cobb Ditch pathway (lower Kankakee River), combined with their history of dispersal throughout the Mississippi River Basin, indicates that these species are likely capable of utilizing this pathway if hydrological conditions allow. Habitat present within most of Sandy Hook Ditch and Cobb Ditch is not ideal habitat for silver and bighead carp which thrive in large rivers, but there is a slight level of uncertainty regarding to what extent this poor habitat quality may prevent movement of Asian carp through the network of connecting ditches. While both species are highly opportunistic, bighead carp are primarily zooplanktivorous, whereas silver carp primarily consume smaller phytoplankton and fine particulate organic matter (Dong and Li, 1994; Jirasek et al., 1981; Williamson and Garvey, 2005). Sufficient forage is available throughout the Kankakee River for adult silver and bighead carp. Forage abundance, diversity, water quality, and water volume all decreases as one moves up Sandy Hook Ditch and into Cobb Ditch.

Adult black carp are primarily molluscivores. However, they will opportunistically consume a wide variety of food items (USFWS, 2002). Juvenile black carp have a diet more similar to silver and bighead carp, consisting primarily of zooplankton (USACE, 2011b). The diet of juvenile black carp may allow them to survive in areas unsuitable for adults. The habitat of black carp is very similar to the grass carp (Ctenopharyngodon idella) (Nico et al, 2005). It is believed that black carp should be able to colonize the same areas of the United States where the grass carp have established (USFWS, 2002)."

Juvenile Asian carp have been observed in the upmost reaches of small tributaries to large rivers attempting to pass over in-stream barriers (e.g., dams) to continue their upstream movement (D. Chapman, personal communication, September 12, 2011; N. Caswell, U.S. Fish and Wildlife Service, September 12, 2011). It is unknown if Asian carp would be likely to spread into Sandy Hook Ditch. Sandy Hook Ditch is a small tributary with limited habitat for adult Asian Carp. It shares several characteristics (e.g., small size, located high in the watershed) with the Graham McCulloch Ditch in Fort Wayne, Indiana which has been tested for Asian carp using an environmental DNA (eDNA) sampling technique in the fall of 2010 and during the early summer of 2011, all with negative results (D. Keller, IDNR, personal communication, August 16, 2011).Young Asian carp tend to move laterally away from the river in which they were spawned and not back upstream (D. Chapman, personal communication, September 12, 2011). While newly hatched fry are not known to move significant distances upstream, they may move long distances up small tributaries and side channels in the vicinities of where they hatch. It has also been noted that 12-18-inch Asian carp have been known to travel long distances, throughout river systems, for no apparent reason (D. Chapman, personal communication, September 12, 2011). Adult, sexually mature Asian carp have also been found in very small streams (D. Chapman, personal communication, September 12, 2011). While on-going research by IDNR may suggest adult Asian carp have no interest in spreading into small ditches and streams from more suitable areas, more long term studies are needed, and even these may not help explain the seemingly random movements of juveniles that have been witnessed (D. Chapman, personal communication, September 12, 2011 and D. Keller, IDNR, personal communication, August 16, 2011). The ability of Asian carp to arrive at the Parker-Cobb Ditch aquatic pathway location was given a rating of low for several reasons: (1) the presence of dams on the Kankakee River prevent the upstream movement of Asain Carp in all but the most severe flood events (Section 2.6), (2) the Kankakee River floods across a large food plain and the velocity of the Kankakee River during these events is low, which may be inadequate to trigger a spawing run by Asian carp in the upper Kankakee River, and (3) the lack of suitable spawning habitat for adult Asian carp in the Ditches leading to the pathway further inhibit the upstream movement of Asian carp to the Parker-Cobb Ditch pathway. All these elements combined make it unlikely that Asian carp will be able reach this pathway location within the next 50 years.

Parker-Cobb Ditch, Porter County, IN - Asian Carp

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty
	USACE, Louisville - Biologist	Medium	RC
	USACE, Louisville - Biologist	Medium	RC
	USACE, Detroit - Biologist	Medium	RC
	Indiana DNR - AIS Coordinator	Medium	RC
	Team Ratings	**Medium**	**RC**

4. How do you rate the probability of ANS establishing at the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Silver and bighead carp are fast growing species that are capable of surviving in a wide range of water temperatures and reproducing quickly, providing suitable habitat is available. In some stretches of the Illinois River, silver and bighead carp make up as much as 90% of the biomass. It's believed that silver and bighead carp require sufficient flow to keep fertilized eggs suspended for successful reproduction (Gorbach and Krykhtin 1980). Black carp reach sexual maturity in as little as 5 years and adult females can produce up to one million eggs per spawning event. It is unlikely that spawning, of any of the Asian Carp species, would occur within most of streams in the Park-Cobb pathway due to the small sizes of the streams (Cobb Ditch, Sandy Hook Ditch). It is not know if the Kankakee River offers suitable habitat for Asian Carp spawning. The flow of Parker and Cobb ditch, at the connection location, is often sluggish and the ditches are generally shallow. During periods of prolonged cold weather, as is common in this area, the water in the connection may freeze solid. Additionally, during the summer months the water in the connection often becomes stagnant, depleted of oxygen, and very shallow. The conditions at the area of the watershed connection would make it exceptionally difficult for an adult Asian Carp to survive in the area year-round.

Parker-Cobb Ditch, Porter County, IN - Asian Carp

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	High	RC		
	USACE, Louisville - Biologist	Medium	RC		
	USACE, Detroit - Biologist	High	RC		
	Indiana DNR - AIS Coordinator	Medium	RC		
	Team Ratings	**High**	**RC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Asian carp have demonstrated exceptional capabilities of spreading through large river systems, and will likely continue to do so. If Asian carp are able to establish in the area ditches, then will likely then be able to spread past the Parker-Cobb Ditch connection into the Great Lakes Basin.

Parker-Cobb Ditch, Porter County, IN - Northern Snakehead (*Channa argus*)

1. Probability of aquatic pathway existence

Aquatic Pathway Team	Expertise Position title or team role	Rating Flow into GLB	Certainty	Rating Flow into MRB	Certainty
	USACE, Detroit - Hydraulic Engineer	High	VC	High	VC
	USACE, Louisville - Hydraulic Engineer	High	VC	High	VC
	USGS, Indiana WSC - Hydrologist	High	VC	High	VC
	Indiana DNR - Engineering Geologist	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**High**	**VC**

1. How do you rate the likelihood of the existence of a viable aquatic pathway at the subject location? Assume a viable aquatic pathway is any location where untreated surface water flow across the divide is deemed likely to occur and connect headwater streams in both basins from any storm up to the 1% annual return frequency storm.

Qualitative Rating	Qualitative Rating Category Criteria
High	Perennial streams and wetlands or intermittent stream known/documented to convey significant volumes of water across the basin divide for days to weeks multiple times per year.
Medium	Intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a 10% annual return frequency storm; or, location of wetland spanning basin divide which maintains significant ponds that are likely to become inter connected and connect with streams on both sides of the basin divide from a 10% annual return frequency storm.
Low	Intermittent stream or marsh forming a surface water connection between streams on either side of the basin divide from larger than a 1.0% annual return frequency storm.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: A hydraulic connection is likely to be maintained through the field access culvert for multiple days multiple times per year, based upon professional judgement and cursory runoff calculations and calculated depths of flow. A hydraulic connection is likely to be maintained through the field access culvert through late winter to early summer, then episodically as sufficient rain falls, and again more continuously after transpiration declines and precipitation falls in late fall to winter. This is based on my understanding of drainage of similar areas and soils and flow patterns in the region. The ditch system leading to the culvert under the farm road at the basing boundary appears to be very low gradient for a distance of over one mile. It likely behaves more like a wetland scenario than a flowing stream. The upland nature of the site, lacking significant watershed to provide for a larger water volume, would serve to decrease any long term flow volume.

Parker-Cobb Ditch, Porter County, IN - Northern Snakehead (*Channa argus*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	Medium	RC		
	USACE, Louisville - Biologist	Medium	RC		
	USACE, Detroit - Biologist	High	RC		
	Indiana DNR - AIS Coordinator	Medium	MC		
	Team Rating	**High**	**RC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of moving to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of moving to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	Symbol					
Very Certain	VC	As certain as I am going to get.				
Reasonably Certain	RC	Reasonably certain.				
Moderately Certain	MC	More certain than not.				
Reasonably Uncertain	RU	Reasonably uncertain				
Very Uncertain	VU	A guess				

Remarks: The northern snakehead was found in 2008 in Arkansas, and has since established a reproducing population in the area. Although in a different basin, this species is also established in the Potomac River in Maryland and Virginia (USGS, 2011). While this species is within the Mississippi River watershed, its population does not seem to be spreading at a high rate at this time and it is unlikely that it would reach the Parker-Cobb Ditch divide location within the next 20 years without the assistance of some non-aquatic vector.

Parker-Cobb Ditch, Porter County, IN - Northern Snakehead (*Channa argus*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, Louisville - Biologist	Medium	MC	Low	RC
	USACE, Louisville - Biologist	Low	MC	Medium	RC
	USACE, Detroit - Biologist	Medium	RC	Low	RC
	Indiana DNR - AIS Coordinator	Medium	RC	Low	RC
	Team Ratings	**Medium**	**MC**	**Low**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

As obligate air breathers, northern snakeheads obtain required oxygen directly from the atmosphere. This species thrives in stagnant, oxygen depleted back-waters and marshes (Courtenay, Jr. and Williams, 2004). The northern snakehead likely possesses the ability to migrate to the Parker Cobb Ditch pathway through the interconnecting network of ditches. However, its preferred habit is not flowing waters, which may slow its spread up the Mississippi River and to the tributaries connecting to Parker-Cobb Ditch.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

Fishing and boating are unlikely to occur in the Parker-Cobb Ditch area. The ditches are too small to support sport fishing and are also too small for boating or kayaking. The small size of the ditches virtually eliminates the threat of ANS transfer via water craft, associated equipment, or fishing gear.

Parker-Cobb Ditch, Porter County, IN - Northern Snakehead (*Channa argus*)

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	High	MC		
	USACE, Louisville - Biologist	High	MC		
	USACE, Detroit - Biologist	High	RC		
	Indiana DNR - AIS Coordinator	High	RC		
	Team Ratings	**High**	**MC**		

4. How do you rate the probability of ANS establishing at the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: The northern snakehead's native range and temperature tolerance indicates a species that could establish populations throughout most of the contiguous United States (Courtenay, Jr. and Williams, 2004). Northern snakeheads are naturally aggressive predators that could easily acclimate to the conditions in and around Parker-Cobb Ditch as long as there is an ample food supply, which is likely to be the case. They can be very opportunistic in their feeding habits, preying on everything from insect larvae to fish, frogs, and crustaceans.

Parker-Cobb Ditch, Porter County, IN - Northern Snakehead (*Channa argus*)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	High	RC		
	USACE, Louisville - Biologist	Medium	RC		
	USACE, Detroit - Biologist	High	RC		
	Indiana DNR - AIS Coordinator	High	RC		
	Team Ratings	**High**	**RC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: It is very likely that the northern snakehead possesses the ability to spread into the Great Lakes Basin from Parker-Cobb Ditch if a population were established near that location.

Parker-Cobb Ditch, Porter County, IN - Parasitic Copepod (*Neoergasilus japonicus*)

1. Probability of aquatic pathway existence

Aquatic Pathway Team	Expertise Position title or team role	Rating Flow into GLB	Certainty	Rating Flow into MRB	Certainty
	USACE, Detroit - Hydraulic Engineer	High	VC	High	VC
	USACE, Louisville - Hydraulic Engineer	High	VC	High	VC
	USGS, Indiana WSC - Hydrologist	High	VC	High	VC
	Indiana DNR - Engineering Geologist	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**High**	**VC**

1. How do you rate the likelihood of the existence of a viable aquatic pathway at the subject location? Assume a viable aquatic pathway is any location where untreated surface water flow across the divide is deemed likely to occur and connect headwater streams in both basins from any storm up to the 1% annual return frequency storm.

Qualitative Rating	Qualitative Rating Category Criteria
High	Perennial streams and wetlands or intermittent stream known/documented to convey significant volumes of water across the basin divide for days to weeks multiple times per year.
Medium	Intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a 10% annual return frequency storm; or, location of wetland spanning basin divide which maintains significant ponds that are likely to become inter connected and connect with streams on both sides of the basin divide from a 10% annual return frequency storm.
Low	Intermittent stream or marsh forming a surface water connection between streams on either side of the basin divide from larger than a 1.0% annual return frequency storm.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: A hydraulic connection is likely to be maintained through the field access culvert for multiple days multiple times per year, based upon professional judgement and cursory runoff calculations and calculated depths of flow. A hydraulic connection is likely to be maintained through the field access culvert through late winter to early summer, then episodically as sufficient rain falls, and again more continuously after transpiration declines and precipitation falls in late fall to winter. This is based on my understanding of drainage of similar areas and soils and flow patterns in the region. The ditch system leading to the culvert under the farm road at the basing boundary appears to be very low gradient for a distance of over one mile. It likely behaves more like a wetland scenario than a flowing stream. The upland nature of the site, lacking significant watershed to provide for a larger water volume, would serve to decrease any long term flow volume.

Parker-Cobb Ditch, Porter County, IN - Parasitic Copepod (*Neoergasilus japonicus*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	Medium	MC		
	USACE, Louisville - Biologist	High	VC		
	USACE, Detroit - Biologist	Medium	RC		
	Indiana DNR - AIS Coordinator	Medium	MC		
	Team Rating	**High**	**RC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of moving to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of moving to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	Symbol					
Very Certain	VC	As certain as I am going to get.				
Reasonably Certain	RC	Reasonably certain.				
Moderately Certain	MC	More certain than not.				
Reasonably Uncertain	RU	Reasonably uncertain				
Very Uncertain	VU	A guess				

Remarks: The common carp (*Cyprinus carpio*) is a frequent host of the parasite. The common carp is established in Lake Michigan, as well as the rivers and streams leading to Parker-Cobb Ditch from Lake Michigan. While other host fish species are known to exist in the pathway system, the common carp was selected as the most likely host species because of the life cycle capabilities of the common carp and the likelihood the common carp would use, and survive within, the pathway habitats. The parasitic copepod species and a necessary host species are in the Great Lakes Basin.

Parker-Cobb Ditch, Porter County, IN - Parasitic Copepod (*Neoergasilus japonicus*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, Louisville - Biologist	Medium	MC	Low	MC
	USACE, Louisville - Biologist	Medium	MC	Medium	MC
	USACE, Detroit - Biologist	Medium	RC	Low	RC
	Indiana DNR - AIS Coordinator	Medium	MC	Medium	MC
	Team Ratings	**Medium**	**RC**	**Low**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

The parasitic copepod has been found on the common carp, and the common carp was therefore used as a surrogate potential fish host to estimate the probability of the parasitic copepod moving from its current location in the Great Lakes Basin to the Parker-Cobb Ditch pathway location. It is possible that common carp could migrate to the watershed divide since it is a very resilient species that is capable of surviving a wide range of water quality parameters.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

Fishing and boating are unlikely to occur in the Parker-Cobb Ditch area. The ditches are too small to support sport fishing and are also too small for boating or kayaking. The small size of the ditches virtually eliminates the threat of ANS transfer via water craft, associated equipment, or fishing gear.

Parker-Cobb Ditch, Porter County, IN - Parasitic Copepod (*Neoergasilus japonicus*)

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	High	MC		
	USACE, Louisville - Biologist	Medium	MC		
	USACE, Detroit - Biologist	Medium	RC		
	Indiana DNR - AIS Coordinator	High	RC		
	Team Ratings	**High**	**MC**		

4. How do you rate the probability of ANS establishing at the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: The parasitic copepod is very capable of persisting in eutrophic and polluted waters (USGS, 2011). The copepod demonstrates a rapid reproductive cycle and is capable of utilizing many different host species. It is likely that the copepod would be successful in establishing in Parker-Cobb Ditch and connecting tributaries since numerous potential host fish species such as common carp can be present in the area.

Parker-Cobb Ditch, Porter County, IN - Parasitic Copepod (*Neoergasilus japonicus*)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	High	MC		
	USACE, Louisville - Biologist	Medium	MC		
	USACE, Detroit - Biologist	High	RC		
	Indiana DNR - AIS Coordinator	High	RC		
	Team Ratings	**High**	**RC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: The copepod could easily spread beyond the pathway location into the Mississippi River Basin. The female copepod can detach and re-attach to another host fish. Potential host fish for this species are present throughout the connecting streams between Cobb Ditch and the Mississippi River.

Parker-Cobb Ditch, Porter County, IN - Viral Hemorrhagic Septicemia virus (VHSv)

1. Probability of aquatic pathway existence

Aquatic Pathway Team	Expertise Position title or team role	Rating Flow into GLB	Certainty	Rating Flow into MRB	Certainty
	USACE, Detroit - Hydraulic Engineer	High	VC	High	VC
	USACE, Louisville - Hydraulic Engineer	High	VC	High	VC
	USGS, Indiana WSC - Hydrologist	High	VC	High	VC
	Indiana DNR - Engineering Geologist	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**High**	**VC**

1. How do you rate the likelihood of the existence of a viable aquatic pathway at the subject location? Assume a viable aquatic pathway is any location where untreated surface water flow across the divide is deemed likely to occur and connect headwater streams in both basins from any storm up to the 1% annual return frequency storm.

Qualitative Rating	Qualitative Rating Category Criteria
High	Perennial streams and wetlands or intermittent stream known/documented to convey significant volumes of water across the basin divide for days to weeks multiple times per year.
Medium	Intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a 10% annual return frequency storm; or, location of wetland spanning basin divide which maintains significant ponds that are likely to become inter connected and connect with streams on both sides of the basin divide from a 10% annual return frequency storm.
Low	Intermittent stream or marsh forming a surface water connection between streams on either side of the basin divide from larger than a 1.0% annual return frequency storm.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: A hydraulic connection is likely to be maintained through the field access culvert for multiple days multiple times per year, based upon professional judgement and cursory runoff calculations and calculated depths of flow. A hydraulic connection is likely to be maintained through the field access culvert through late winter to early summer, then episodically as sufficient rain falls, and again more continuously after transpiration declines and precipitation falls in late fall to winter. This is based on my understanding of drainage of similar areas and soils and flow patterns in the region. The ditch system leading to the culvert under the farm road at the basing boundary appears to be very low gradient for a distance of over one mile. It likely behaves more like a wetland scenario than a flowing stream. The upland nature of the site, lacking significant watershed to provide for a larger water volume, would serve to decrease any long term flow volume.

Parker-Cobb Ditch, Porter County, IN - Viral Hemorrhagic Septicemia virus (VHSv)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	High	VC		
	USACE, Louisville - Biologist	High	VC		
	USACE, Detroit - Biologist	High	RC		
	Indiana DNR - AIS Coordinator	Medium	MC		
	Team Rating	**High**	**VC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of moving to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of moving to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	Symbol					
Very Certain	VC	As certain as I am going to get.				
Reasonably Certain	RC	Reasonably certain.				
Moderately Certain	MC	More certain than not.				
Reasonably Uncertain	RU	Reasonably uncertain				
Very Uncertain	VU	A guess				

Remarks: This virus has been reported from throughout the Great Lakes Basin (USGS, 2011). VHSv has been found in many species of fish including common carp. The common carp is established in Lake Michigan, as well as the rivers and streams leading to Parker Cobb Ditch from Lake Michigan.

Parker-Cobb Ditch, Porter County, IN - Viral Hemorrhagic Septicemia virus (VHSv)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, Louisville - Biologist	Medium	RC	Low	RC
	USACE, Louisville - Biologist	Medium	RC	Medium	MC
	USACE, Detroit - Biologist	High	RC	Low	RC
	Indiana DNR - AIS Coordinator	Medium	MC	Medium	MC
	Team Ratings	**Medium**	**MC**	**Low**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

The common carp is also a potential host for VHSv. The common carp was therefore used as a surrogate potential fish host to estimate the probability of VHSv moving from its current location in the Great Lakes Basin to the Parker-Cobb Ditch pathway location. During spring run-off events in April and May, common carp migrate into the shallow waters of bays and river systems to spawn. Common carp are strong swimmers and though they cannot jump like members of the salmon family, they can migrate upstream during moderate flow events. The surface water connection from Lake Michigan to Parker-Cobb Ditch provides suitable habitat for carp during run-off events. It is possible that the common carp could migrate to the watershed divide since it is a very resilient species capable of surviving a wide range of water quality parameters.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

Fishing and boating are unlikely to occur in the Parker-Cobb Ditch area. The ditches are too small to support sport fishing and are also too small for boating or kayaking. The small size of the ditches virtually eliminates the threat of ANS transfer via water craft, associated equipment, or fishing gear.

Parker-Cobb Ditch, Porter County, IN - Viral Hemorrhagic Septicemia virus (VHSv)

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	High	RC		
	USACE, Louisville - Biologist	Medium	RC		
	USACE, Detroit - Biologist	High	MC		
	Indiana DNR - AIS Coordinator	High	RC		
	Team Ratings	**High**	**MC**		

4. How do you rate the probability of ANS establishing at the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: VHSv is capable of persisting outside of a host for several days when water temperatures are cool. The virus demonstrates a rapid reproductive cycle and is capable of utilizing many different host species . It is likely that VHSv would be successful in establishing in Parker -Cobb ditch and/or the receiving streams of Parker-Cobb Ditch.

Parker-Cobb Ditch, Porter County, IN - Viral Hemorrhagic Septicemia virus (VHSv)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	High	MC		
	USACE, Louisville - Biologist	Medium	RC		
	USACE, Detroit - Biologist	High	RC		
	Indiana DNR - AIS Coordinator	High	RC		
	Team Ratings	**High**	**RC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Since VHSv can survive for periods of time outside of a host fish, this pathogen could spread beyond the pathway to the Mississippi River Basin on or off a host fish via the Parker-Cobb Ditch pathway. However, as VHSv is active at water temperatures less than 60ºF, the higher water temperatures that likely occur in the summer months at Parker-Cobb Ditch might prevent the establishment and passage of VHSv during that time (USGS, 2011).

Parker-Cobb Ditch, Porter County, IN - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

1. Probability of aquatic pathway existence

Aquatic Pathway Team	Expertise Position title or team role	Rating Flow into GLB	Certainty	Rating Flow into MRB	Certainty
	USACE, Detroit - Hydraulic Engineer	High	VC	High	VC
	USACE, Louisville - Hydraulic Engineer	High	VC	High	VC
	USGS, Indiana WSC - Hydrologist	High	VC	High	VC
	Indiana DNR - Engineering Geologist	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**High**	**VC**

1. How do you rate the likelihood of the existence of a viable aquatic pathway at the subject location? Assume a viable aquatic pathway is any location where untreated surface water flow across the divide is deemed likely to occur and connect headwater streams in both basins from any storm up to the 1% annual return frequency storm.

Qualitative Rating	Qualitative Rating Category Criteria
High	Perennial streams and wetlands or intermittent stream known/documented to convey significant volumes of water across the basin divide for days to weeks multiple times per year.
Medium	Intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a 10% annual return frequency storm; or, location of wetland spanning basin divide which maintains significant ponds that are likely to become inter connected and connect with streams on both sides of the basin divide from a 10% annual return frequency storm.
Low	Intermittent stream or marsh forming a surface water connection between streams on either side of the basin divide from larger than a 1.0% annual return frequency storm.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: A hydraulic connection is likely to be maintained through the field access culvert for multiple days multiple times per year, based upon professional judgement and cursory runoff calculations and calculated depths of flow. A hydraulic connection is likely to be maintained through the field access culvert through late winter to early summer, then episodically as sufficient rain falls, and again more continuously after transpiration declines and precipitation falls in late fall to winter. This is based on my understanding of drainage of similar areas and soils and flow patterns in the region. The ditch system leading to the culvert under the farm road at the basing boundary appears to be very low gradient for a distance of over one mile. It likely behaves more like a wetland scenario than a flowing stream. The upland nature of the site, lacking significant watershed to provide for a larger water volume, would serve to decrease any long term flow volume.

Parker-Cobb Ditch, Porter County, IN - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	High	RC		
	USACE, Louisville - Biologist	High	VC		
	USACE, Detroit - Biologist	High	RC		
	Indiana DNR - AIS Coordinator	Medium	RC		
	Team Rating	**High**	**VC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of moving to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of moving to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	Symbol					
Very Certain	VC	As certain as I am going to get.				
Reasonably Certain	RC	Reasonably certain.				
Moderately Certain	MC	More certain than not.				
Reasonably Uncertain	RU	Reasonably uncertain				
Very Uncertain	VU	A guess				

Remarks: The ruffe and tubenose goby are located within the Great Lakes and are associated with river mouths and estuaries of large river systems entering the Great Lakes, and the ruffe has been identified in Lake Michigan. The tubenose goby has been collected in the lower reaches of larger Great Lakes rivers and estuaries.

Parker-Cobb Ditch, Porter County, IN - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, Louisville - Biologist	Low	MC	Low	RC
	USACE, Louisville - Biologist	Low	MC	Medium	MC
	USACE, Detroit - Biologist	Low	RC	Low	RC
	Indiana DNR - AIS Coordinator	Low	MC	Medium	MC
	Team Ratings	**Low**	**MC**	**Low**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

The ruffe prefers deep waters of lakes and pools of rivers, usually over sand and gravel, but has a tolerance for different habitats and environmental conditions. The ruffe's ability to swim upstream during high flow events and migrate over dams is questionable. The tubenose goby is found in the open waters and estuaries of slow flowing rivers. The tubenose goby appears to be more capable of living in more diverse types of riverine habitat than the ruffe. Sufficient forage ranging from zooplankton to fish may be available throughout the Great Lakes side of the connection. However, suitable habitat for the ruffe and tubenose goby in Salt Creek and Parker Ditch may be limited or even nonexistent.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

Fishing and boating are unlikely to occur in the Parker-Cobb Ditch area. The ditches are too small to support sport fishing and are also too small for boating or kayaking. The small size of the ditches virtually eliminates the threat of ANS transfer via water craft, associated equipment, or fishing gear.

Parker-Cobb Ditch, Porter County, IN - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	Low	MC		
	USACE, Louisville - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Low	RC		
	Indiana DNR - AIS Coordinator	Low	MC		
	Team Ratings	**Low**	**MC**		

4. How do you rate the probability of ANS establishing at the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: The ruffe is an aggressive species that possesses the ability to feed in darkness, cold temperatures and turbid conditions. Tubenose gobies are benthic species that consume a wide variety of invertebrates. They are often quite abundant in backwaters and lakes and seem to prefer dense vegetation. However, survival of a viable, reproducing population of ruffe and tubenose goby within Parker-Cobb Ditch may be unlikely due to low water quality and high temperatures in summer months. The receiving stream (Sandy Hook Ditch) of Cobb Ditch also offers only limited habitat due to the same reasons listed for Cobb Ditch. Limited suitable habitat may be present in the most downstream reaches of Sandy Hook Ditch.

Parker-Cobb Ditch, Porter County, IN - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	Medium	MC		
	USACE, Louisville - Biologist	Medium	MC		
	USACE, Detroit - Biologist	Medium	RC		
	Indiana DNR - AIS Coordinator	Medium	RC		
	Team Ratings	**Medium**	**MC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Ruffe and the tubenose goby have not been found in rivers or streams similar to Sandy Hook Ditch or its tributaries.

Parker-Cobb Ditch, Porter County, IN - Threespine Stickleback (*Gasterosteus aculeatus*)

1. Probability of aquatic pathway existence

Aquatic Pathway Team	Expertise Position title or team role	Rating Flow into GLB	Certainty	Rating Flow into MRB	Certainty
	USACE, Detroit - Hydraulic Engineer	High	VC	High	VC
	USACE, Louisville - Hydraulic Engineer	High	VC	High	VC
	USGS, Indiana WSC - Hydrologist	High	VC	High	VC
	Indiana DNR - Engineering Geologist	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**High**	**VC**

1. How do you rate the likelihood of the existence of a viable aquatic pathway at the subject location? Assume a viable aquatic pathway is any location where untreated surface water flow across the divide is deemed likely to occur and connect headwater streams in both basins from any storm up to the 1% annual return frequency storm.

Qualitative Rating	Qualitative Rating Category Criteria
High	Perennial streams and wetlands or intermittent stream known/documented to convey significant volumes of water across the basin divide for days to weeks multiple times per year.
Medium	Intermittent stream capable of maintaining a surface water connection to streams on both sides of the basin divide continuously for multiple days from a 10% annual return frequency storm; or, location of wetland spanning basin divide which maintains significant ponds that are likely to become inter connected and connect with streams on both sides of the basin divide from a 10% annual return frequency storm.
Low	Intermittent stream or marsh forming a surface water connection between streams on either side of the basin divide from larger than a 1.0% annual return frequency storm.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: A hydraulic connection is likely to be maintained through the field access culvert for multiple days multiple times per year, based upon professional judgement and cursory runoff calculations and calculated depths of flow. A hydraulic connection is likely to be maintained through the field access culvert through late winter to early summer, then episodically as sufficient rain falls, and again more continuously after transpiration declines and precipitation falls in late fall to winter. This is based on my understanding of drainage of similar areas and soils and flow patterns in the region. The ditch system leading to the culvert under the farm road at the basing boundary appears to be very low gradient for a distance of over one mile. It likely behaves more like a wetland scenario than a flowing stream. The upland nature of the site, lacking significant watershed to provide for a larger water volume, would serve to decrease any long term flow volume.

Parker-Cobb Ditch, Porter County, IN - Threespine Stickleback (*Gasterosteus aculeatus*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	Medium	MC		
	USACE, Louisville - Biologist	High	VC		
	USACE, Detroit - Biologist	High	RC		
	Indiana DNR - AIS Coordinator	Medium	MC		
	Team Rating	**High**	**VC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of moving to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of moving to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	Symbol					
Very Certain	VC	As certain as I am going to get.				
Reasonably Certain	RC	Reasonably certain.				
Moderately Certain	MC	More certain than not.				
Reasonably Uncertain	RU	Reasonably uncertain				
Very Uncertain	VU	A guess				

Remarks: The threespine stickleback is found in each of the Great Lakes except Lake Ontario and has been collected in some inland river systems. Literature indicates this species prefers to live in smaller streams but may occur in a variety of habitat including lakes and large rivers.

Parker-Cobb Ditch, Porter County, IN - Threespine Stickleback (*Gasterosteus aculeatus*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, Louisville - Biologist	Medium	RC	Low	RC
	USACE, Louisville - Biologist	Medium	RC	Medium	RC
	USACE, Detroit - Biologist	Medium	RC	Low	RC
	Indiana DNR - AIS Coordinator	High	MC	Medium	RC
	Team Ratings	**Medium**	**RC**	**Low**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

There are no known obstacles to prevent the spread of the threespine stickleback on the Great Lakes side of the Parker- Cobb Ditch pathway. It is likely that sufficient forage and habitat is available throughout the pathway for the threespine stickleback.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

Fishing and boating are unlikely to occur in the Parker-Cobb Ditch area. The ditches are too small to support sport fishing and are also too small for boating or kayaking. The small size of the ditches virtually eliminates the threat of ANS transfer via water craft, associated equipment, or fishing gear.

Parker-Cobb Ditch, Porter County, IN - Threespine Stickleback (*Gasterosteus aculeatus*)

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	Medium	MC		
	USACE, Louisville - Biologist	Medium	MC		
	USACE, Detroit - Biologist	Medium	RC		
	Indiana DNR - AIS Coordinator	Medium	RC		
	Team Ratings	**Medium**	**MC**		

4. How do you rate the probability of ANS establishing at the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: Establishment of a sustained population of threespine stickleback within Parker-Cobb ditch is possible, but the intermittent nature of flows and poor water quality in Parker-Cobb Ditch and connecting ditches may limit the numbers and health of any such population. Portions of connecting streams between Parker-Cobb Ditch and Lake Michigan may provide sufficient habitat for this species and it may be able to establish in fairly close proximity to the pathway location to at some point take advantage of a suitable flood event and cross the basin divide.

Parker-Cobb Ditch, Porter County, IN - Threespine Stickleback (*Gasterosteus aculeatus*)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, Louisville - Biologist	High	MC		
	USACE, Louisville - Biologist	Medium	MC		
	USACE, Detroit - Biologist	High	RC		
	Indiana DNR - AIS Coordinator	High	RC		
	Team Ratings	**High**	**MC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	Symbol	
Very Certain	VC	As certain as I am going to get.
Reasonably Certain	RC	Reasonably certain.
Moderately Certain	MC	More certain than not.
Reasonably Uncertain	RU	Reasonably uncertain
Very Uncertain	VU	A guess

Remarks: The threespine stickleback has been found in small river systems and therefore downstream migration from Parker-Cobb Ditch into the Mississippi River Basin would be possible.