# The GLMRIS Report

## Appendix N - Focus Area II

USACE
01/06/2014

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# N.1 SCOPE OF STUDY FOR FOCUS AREA 2

The United States Army Corps of Engineers (USACE), in consultation with other federal agencies, Native American tribes, state agencies, local governments and non-governmental organizations, is conducting the Great Lakes and Mississippi River Interbasin Study (GLMRIS). In accordance with the study authorization, USACE has identified and evaluated a range of options and technologies that are intended to prevent the transfer of aquatic nuisance species (ANS) between the Great Lakes and Mississippi River basins via the Chicago Area Waterway System (CAWS) and other aquatic pathways.

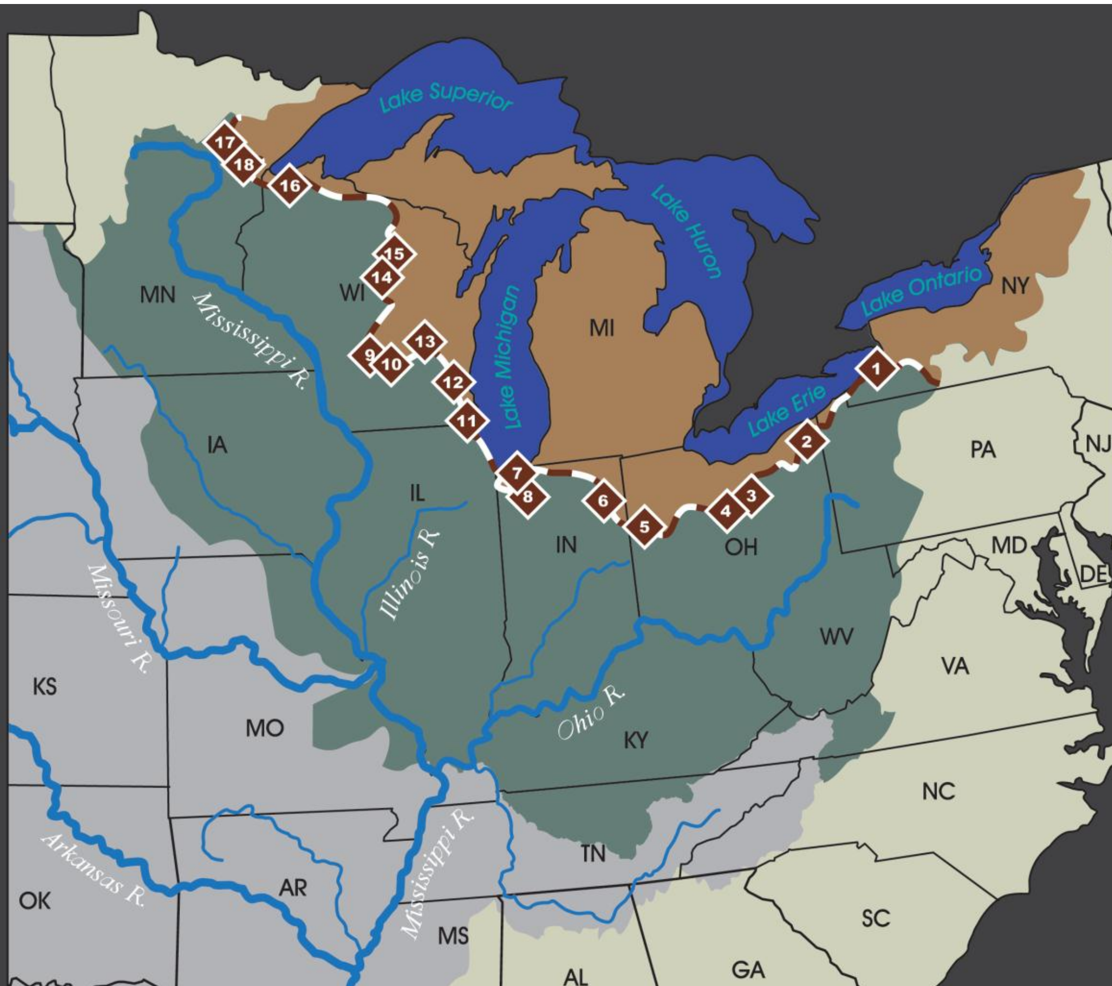
As the CAWS represents the most likely route of interbasin transfer via an aquatic pathway, the main body of the GLMRIS Report focuses on options and technologies specifically developed for this waterway system. This appendix details the scope of efforts that have been completed under the GLMRIS authority to identify, characterize, and prioritize other aquatic pathways that are found outside of the CAWS, along the remainder of the basin divide.

## N.1.1 Focus Area 2 Study Area

Focus Area 2 of GLMRIS evaluates potential surface water connections between the Great Lakes and Mississippi River basins in the states of New York, Pennsylvania, Ohio, Indiana, Wisconsin, and Minnesota. Any surface water connections within the state of Illinois are incorporated within Focus Area 1 of GLMRIS. Focus Area 2 encompasses all natural and man-made aquatic surface water pathways and hydraulic connections that exist or may form between the basins outside of the CAWS. This investigation is focused along the approximately 1,500-mile basin divide which delineates the Great Lakes Basin drainage from the drainage of the Mississippi River Basin (Figure N.1). However, areas throughout each basin located away from the divide were also given consideration during the Focus Area 2 investigation as this was important to developing the lists of ANS of Concern for each applicable pathway location. The known existing locations of ANS within either basin were of importance in rating each species and its ability to reach and possibly cross over the basin divide at each aquatic pathway.

## N.1.2 Preliminary Pathway Assessment

In 2010, the USACE and partner agencies completed a preliminary assessment that identified a total of 36 locations along the basin divide where it appeared that interbasin flow might occur (USACE 2010). 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 dredging 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. This preliminary report was completed and approved for public release within five months of the day it began by engaging with and receiving significant contributions from the USGS; USFWS; NOAA; USEPA; the departments of natural resources of Minnesota, Wisconsin, Indiana, and Ohio; the New York Department of Environmental Conservation, and; the Great Lakes Fishery Commission (GLFC). 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. A list of partner agencies who contributed significantly to Focus Area 2 efforts is identified in Table N.1.




**LEGEND**

Great Lakes — Great Lakes Basin — Upper Mississippi River Basin — Lower Mississippi River Basin

Border of Great Lakes and Upper Mississippi River Basins

| | NAME | COUNTY | STATE |
|---|---|---|---|
| 1 | East Mud Lake | Chautauqua | NY |
| 2 | Mosquito Lake - Grand River | Trumbull | OH |
| 3 | Ohio and 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 N.1 Potential Aquatic Pathway Locations within Focus Area 2**

**TABLE N.1 List of Organizations Contributing to Focus Area 2 Preliminary Assessment**

| Agency |
|---|
| Fisheries and Oceans Canada |
| Great Lakes Commission (GLC) |
| Great Lakes Fishery Commission (GLFC) |
| Illinois Department of Natural Resources (ILDNR) |
| Indiana Department of Natural Resources (INDNR) |
| Michigan Department of Environmental Quality (MDEQ) |
| Michigan Department of Natural Resources (MDNR) |
| Minnesota Department of Natural Resources (MNDNR) |
| National Oceanic and Atmospheric Administration (NOAA) |
| Natural Resources Conservation Service (USDA-NRCS) |
| New York State Department of Environmental Conservation (NYSDEC) |
| Ohio Department of Natural Resources (ODNR) |
| Ontario Ministry of Natural Resources (OMNR) |
| Pennsylvania Department of Environmental Protection (PADEP) |
| Pennsylvania Fish and Boat Commission (PAFBC) |
| United States Environmental Protection Agency (USEPA) |
| United States Fish and Wildlife Service (USFWS) |
| United States Geological Survey (USGS) |
| White House Council on Environmental Quality (CEQ) |
| Wisconsin Department of Natural Resources (WDNR) |

The first and primary objective of the 2010 preliminary assessment was to determine if any of the 36 locations initially identified within the study area, aside from the CAWS, were believed to present a near-term risk for the interbasin spread of ANS. "Near-term," in this case, implied that implementation of some sort of measure(s) might be warranted to reduce the potential for ANS transfer at a particular location in the short term. The only location that was determined to meet this criterion for near-term risk was Eagle Marsh, located south of Fort Wayne, Indiana. The Eagle Marsh location is indicated as site number six (6) in Figure N.1. As it was identified as an impending threat for potential transfer of adult Asian carp, a chain link fence was installed across Eagle Marsh in late 2010, by the state of Indiana. The purpose of this temporary measure was to reduce the likelihood of adult Asian carp from moving into the Great Lakes Basin during significant precipitation events at or near the Eagle Marsh location.

At 18 of the identified 36 locations, the interagency group determined that it would likely require a precipitation and flooding event greater than a 1% annual recurrence interval storm event for an aquatic pathway to form across the basin divide. Locations that did not meet this criterion were not recommended for further investigation. This 1% annual recurrence frequency was chosen because locations that might require a flooding event in excess of this statistic — greater magnitude, less frequency — are less likely to occur and are considered to present a low probability of aquatic pathway formation. This determination was made to allocate limited resources more quickly to focus on evaluating those locations which exhibited the most likely potential threat of aquatic pathway formation. This 1% threshold criterion was established through collaboration with the USGS; USFWS; NRCS; GLFC, and; the departments of natural resources in the states of Michigan, Minnesota, Wisconsin, Illinois, Indiana, Ohio, Pennsylvania, and New York. This threshold is also aligned with the most readily available hydrologic information in more rural or remote areas.

While there were no locations identified within the Commonwealth of Pennsylvania in 2010, additional investigations in 2011, in collaboration with the USGS and NRCS, led to the reassessment of six (6) potential aquatic pathways in Pennsylvania. This reassessment confirmed the 2010 findings reported by USACE; none of these six (6) locations were determined to be viable aquatic pathways.

A more detailed analysis of the 18 remaining sites along the basin divide (Figure N.1) was completed by the Focus Area 2 team between 2011 and 2013, in collaboration with USGS, NRCS, USFWS, state natural resource agencies, and county surveyors. The detailed results for each location were released by each state for public review between September 2012 and March 2013, and most recently released as GLMRIS Interim Products in July 2013. Written for an audience ranging from the scientific community to the general public, this follow-up investigation was specifically intended to identify any locations where an aquatic pathway exists or may form between the basins, and to evaluate the probability that specific ANS would be able to arrive at that pathway and cross into the adjacent basin. These analyses are described in greater detail in the following pages of this appendix. The information resulting from the detailed Focus Area 2 assessments is intended to provide a sound scientific basis by which to prioritize future resourcing decisions and further actions at these potential aquatic pathway locations.

## N.1.3 Planning Constraints

Chapter 1 of the GLMRIS Report identifies and discusses general limiting factors, including issues or constraints that restrict the planning or study process. Some general types of limiting factors or constraints that need to be considered are legal, policy, and resource constraints, as well as environmental factors. Legal and policy constraints are those defined by law, and USACE policy and guidance. Resource constraints are those associated with limits on knowledge, expertise, experience, ability, data, information, money, and time. Environmental constraints are those that may adversely impact significant natural resources. In addition to those already identified in the main body of the GLMRIS Report, the following constraints are specifically applicable to the Focus Area 2 study effort.

### N.1.3.1 Legal and Policy Factors

- The GLMRIS authority is limited to studying only the range of options and technologies available to prevent the spread of ANS between the Great Lakes and Mississippi River basins through aquatic pathways. Other non-aquatic pathways and vectors, including transport by humans on watercraft, bait bucket transfers, aquarium releases, pet trade, aquaculture practices, cultural practices, and the like, are not evaluated in much detail as part of GLMRIS. In addition, the spread of ANS by attachment to non-aquatic animals (e.g., transport by migratory waterfowl) is also outside the scope of this study.

  Although these vectors were not evaluated in the overall assessments, some of these non-aquatic vectors were given consideration at Focus Area 2 locations where they were determined to most likely pose a threat. This approach provided a more comprehensive assessment of the overall ANS threats and residual risk potentially affecting certain aquatic pathways. In general, threats posed by non-aquatic and anthropogenic vectors are not necessarily limited geographically to the aquatic pathways being evaluated. Rather, transfer of ANS by such mechanisms could theoretically occur with equal or even greater likelihood at multiple other locations along the basin divide, or from areas deeper within either basin. An assessment of these non-aquatic and anthropogenic vectors would require separate study and likely a different list of ANS.

- Recognition of potential ANS transfer between the United States and Canada and between the Great Lakes Basin and the Atlantic Slope drainages is warranted; however, it is not within the authority to address ANS issues between international boundaries or beyond the interface of the Great Lakes and Mississippi River basins. Nonetheless, a commensurate level of involvement, coordination, and communication was pursued with stakeholders outside of the immediate project area, which includes other state and bi-national agencies.

### N.1.3.2 Resource Factors

- Limitations on the ability of collaborating agencies and stakeholders to contribute resources and information.
- Limitations in the project schedule which may preclude acquiring and/or analyzing certain data sets for planning level designs, costs, or benefits.
- Very limited and often no existing data available regarding the hydrology of Focus Area 2 pathways.
- High resolution digital elevation model (DEM) data was not always available.
- A complete understanding of specific ANS habitat requirements, capabilities, and habitat tolerances was not always available. Therefore, the applicability of existing and sometimes limited information to the diverse habitats along the basin divide and within each basin does lend a level of uncertainty to predicting ANS behavior.
- Conflicting data between available resources was sometimes present (e.g., FEMA flood mapping versus NRCS soil survey information).
- Some FEMA flood mapping has not been updated recently, or, in some cases, appeared to be inaccurate based on site investigations.
- Potential inaccuracies in National Wetland Inventory (NWI) mapping due to resolution and age of the data at some locations.

# N.2 SUMMARY OF AFFECTED ENVIRONMENT FOR FOCUS AREA 2

This chapter briefly summarizes the existing conditions within the GLMRIS Focus Area 2 study area in order to characterize the diverse and applicable environmental conditions of such a large geographic area. An understanding of these features is important in developing the proper context for understanding the probability and potential consequences associated with ANS interbasin transfer via aquatic pathways. This information, along with the specific characteristics of a particular ANS of Concern, feed directly into the development, comparison, and screening of the available alternatives to prevent the interbasin spread of ANS at applicable Focus Area 2 pathways (e.g., Eagle Marsh). Since Focus Area 2 focused primarily on characterizing the probability of ANS transfer at a multitude of locations, most of the information in the following chapter is provided at a very broad level, as available and applicable.

## N.2.1 Socioeconomic Environment

### N.2.1.1 Demographics

The 18 Focus Area 2 pathway vicinities could be organized as: Park/Preserve (4), Agricultural (4), and Rural/Residential (10). Eight are in relatively close proximity to larger urban centers (e.g., Portage Upstream, Portage Downstream, and Menomonee Falls, in Wisconsin).

### N.2.1.2 Public Facilities and Services

There is no additional applicable information that has been gathered to date for sites in Focus Area 2.

### N.2.1.3 Water and Sewer Facilities

There is no additional applicable information that has been gathered to date for sites in Focus Area 2.

### N.2.1.4 Navigation

An obvious but key distinguishing characteristic of the CAWS from any of the Focus Area 2 pathways is that it provides an uninterrupted connection for the movement of commercial cargo navigation traffic between the Great Lakes and the Mississippi River basins. Manufacturers in the Chicago region have been using the CAWS to meet their transportation needs for over a century. Commodity traffic (e.g., coal, aggregates, chemicals, fuel) on the CAWS in 2008 was 15.9 million tons (USACE 2011a). The CAWS is also used heavily for non-cargo navigation, such as recreational, passenger, fishing, and governmental purposes (USACE 2011b). As a result, there is a much more complex network of potential vectors for the interbasin transfer of ANS at the CAWS than at any of the other aquatic pathways identified along the divide between the Great Lakes and Mississippi River basins. None of the Focus Area 2 pathways are used for commercial navigation, and only some of them are used for recreational navigation (e.g., Grand Lake St. Marys and Mosquito Creek Lake in Ohio).

### N.2.1.5 Recreation

Within Focus Area 2, recreational resources were not a major focus of the pathway assessments since only aquatic vectors of ANS transport factored into the pathway viability ratings. However, in the course of completing these assessments some general information was obtained at a number of locations. The majority of the study locations were on privately owned land that was not known to be used for public recreation. Many of these sites were active agricultural, urban, residential, and emergent wetland areas. Several locations though do experience public recreation and are summarized below:

**Eagle Marsh, IN**. This 716-acre nature preserve sits adjacent to the Fox Island County Park and is a major unit of the Little River Wetlands Project, which is a nonprofit land trust with the goal of restoring and preserving wetlands and providing educational opportunities in the Little River watershed. The marsh was restored in 2009 with help from the Indiana Department of Natural Resources (INDNR), which is also a partial land owner. The preserve has eight miles of walking trails with frequent scheduled ecotourism events (LRWP 2013a).

**Ohio-Erie Canal, OH**. This pathway south of Akron, Ohio, is part of a larger system known as the Portage Lakes, which were originally constructed in the early 19th century to supply water to the Ohio-Erie Canal system and its associated industries. The area resides between Portage Lakes State Park and a Summit County Metro Park. With almost 1,200 acres of water and 46 miles of shoreline, it is used largely for recreational purposes, including boating, swimming, picnicking, and golf. Sport fishing is very popular at these lakes with anglers originating from within both the Great Lakes and Mississippi River basins (ODNR 2012).

**Grand Lake St. Marys, OH**. This shallow, 13,500 acre lake in west-central Ohio, is operated by the Ohio Department of Natural Resources (ODNR), which regulates flow from the lake through two outlets at either end of the lake. The western outlet empties to the Mississippi River Basin and the eastern outlet empties to the Great Lakes Basin. Construction of the lake was completed in 1845, and it was intended to serve as a reservoir for the Miami-Erie Canal. At the time of its construction, it was the largest man-made lake in the world. The lake is now used for recreational boating, with eight state operated boat launches and several private boat launches, camping, swimming, fishing, and naturalist programs (ODNR 2011a).

**Mosquito Creek Lake, OH**. Constructed in 1944, Mosquito Creek Lake is 9.6-miles long and approximately one-mile wide with a maximum depth of 44 feet. The lake is a reservoir behind Mosquito Creek Lake Dam, which provides flood protection for the Mahoning River Valley and the upper Ohio River. The lake stores water and releases it downstream into the Mahoning River, which helps to improve water quality and quantity during dry periods for domestic and industrial uses, recreation, and general support of aquatic life. The northern portion of the lake is part of an ODNR wildlife management area and is closed to boating. The lake has six boat launches and supports public fishing, camping, swimming, equestrian trails, and educational programs. Additional information may be found on the USACE Pittsburg District website: http://www.lrp.usace.army.mil/Missions/Recreation/Lakes/MosquitoCreekLake.aspx.

**Portage Upstream and Portage Downstream and Canal, WI**. The Portage area has historically been an area with high potential for interbasin exchange of water. Early settlers recognized this and actually established a navigable waterway and lock and dam system between the Fox River (Great Lakes Basin) and Wisconsin River (Mississippi River Basin). This waterway, known as the Portage Canal, no longer has a direct surface water connection between these two rivers because of a levee and water control structure. In the vicinity of these pathways (east side of Portage) is the 2,335-acre Swan Lake Wildlife Area managed by the Wisconsin Department of Natural Resources (WDNR) for hunting, fishing, and boating. There are also many recreational boating opportunities on the Wisconsin River and canoeing/kayaking on the Fox River (PACC 2013).

**Brule Headwaters, WI**. This pathway, which sits within the Brule River State Forest, is managed by WDNR for public recreation. The four-county area comprising this forest in 2010 experienced almost $3.5 million in tourism (WDNR 2012a). The area was historically used to portage canoes between the Great Lakes and Mississippi River basins. The almost two-mile long historic Brule to St. Croix Portage

Trail still exists in the forest and is on the National Register of Historic Landmarks. The state forest encompasses the entire 44-mile length of the Bois Brule River between Lake Superior and Upper St. Croix Lake, and receives more than 120,000 visitors annually who partake in numerous public recreational opportunities such as boating, hiking, camping, and well-known trout fishing (WDNR 2012b; WDNR 2013).

#### N.2.1.6 Noise

The 18 Focus Area 2 pathway vicinities have low ambient noise levels typically associated with rural, residential, park, and agricultural settings. For example: park/preserve (4), agricultural (4), and rural/residential (10). However, eight are in relatively close proximity to larger urban centers (e.g., Portage Upstream, Portage Downstream, and Menomonee Falls, in Wisconsin).

#### N.2.1.7 Aesthetics

The aesthetic conditions and viewshed of most of the 18 Focus Area 2 pathways are typical of what is associated with rural, residential, park, and agricultural settings. For example: park/preserve (4), agricultural (4), and rural/residential (10). However, eight are in relatively close proximity to larger urban centers (e.g., Portage Upstream, Portage Downstream, and Menomonee Falls, in Wisconsin).

#### N.2.1.8 Cultural and Archaeological Resources

There is no additional applicable information that has been gathered to date for sites in Focus Area 2.

#### N.2.1.9 Environmental Justice

There is no additional applicable information that has been gathered to date for sites in Focus Area 2.

#### N.2.1.10 Land Use

Land use at the 18 Focus Area 2 pathway vicinities is predominantly rural/residential (10), with lesser amounts of agricultural areas (4), and parks or preserves (4). At five of the Focus Area 2 locations, surface water is actively managed or has some sort of flood control feature in place. These are: Mosquito Creek Lake, OH; Portage Upstream and Portage Downstream, WI; Grand Lake St. Marys, OH, and; Ohio-Erie Canal, OH.

#### N.2.1.11 Hazardous, Toxic, and Radioactive Waste (HTRW)

There is no additional applicable information that has been gathered to date for sites in Focus Area 2.

### N.2.2 Natural Environment

#### N.2.2.1 Biological Resources

There is no additional information that has been gathered to date for sites in Focus Area 2 beyond what is contained in the applicable detailed pathway reports.

### N.2.2.2 Physical Resources

#### Wetlands

Eleven of the Focus Area 2 locations consisted of headwater wetlands sitting astride or in close proximity to the basin divide. Of these, five locations were assigned overall pathway viability ratings of medium or high. Accordingly, wetlands were a significant component of the Focus Area 2 study area and were a factor in many of the pathway assessments. The types of wetlands encountered included forested (e.g., Brule Headwaters, WI, and Mosquito Creek Lake, OH), scrub-shrub (e.g., Rosendale-Brandon, WI), and emergent/open water (e.g., Libby Branch of Swan River), with others sites containing a diversity of wetland types (e.g., Eagle Marsh, IN; Hatley-Plover, WI; East Mud Lake, NY, and; Menomonee Falls, WI). No site-specific wetland delineations were conducted at any of the GLMRIS pathway locations. Only readily available desktop resources were used (e.g., USFWS National Wetland Inventory and available state wetland mapping). This information was then supplemented, as necessary, by onsite observations.

Where wetlands existed at the basin divide, one of the most important attributes that required documentation was the frequency, duration, and magnitude of their inundation (hydrology), since this information would be useful in helping to determine if certain ANS would be able to use these wetlands to swim or float across the basin boundary. As most of the Focus Area 2 locations are in the upper reaches of watersheds where no site-specific stream gage information is available, assessment teams relied upon existing data to obtain hydrology information (e.g., NRCS soil surveys, FEMA flood mapping). Teams also identified any applicable field indicators of inundation while conducting site visits, such as drift patterns, water marks on trees, and channelization. All applicable information was integrated into and considered as part of the Focus Area 2 pathway assessment ratings.

#### Geology and Topography

The rolling hills and small mountain remnants of the Canadian Shield dominate most of the northern and northwestern Great Lakes Basin. The granitic rock of this vast area extends southward and now lies beneath largely sedimentary rock layers formed during past marine environments of the Paleozoic Era. Vast continental glaciers later advanced and retreated repeatedly across this area during the Pleistocene Epoch. These glaciers scoured the earth, deposited debris, created valleys, and ultimately formed the Great Lakes, which were initially larger than they are today because of the terrain having been depressed from the weight of the glaciers (USEPA 2012). The GLMRIS study area along the basin divide has predominantly flat topography (very little relief). With minor exceptions, significant relief can only be seen at the basin divide in the Allegheny Plateau Region of northeast Ohio and southern New York.

#### Terrestrial Vegetation

Upland vegetation communities are highly variable across the study area. Four of the Focus Area 2 sites are predominantly agricultural areas with little to no remaining native vegetation other than what is associated with ditches and hedgerows, and areas that are too wet to farm. Ten locations are mostly rural/residential and have a greater number of isolated woodlots and hedgerows, often adjacent to or surrounded by more urban areas.

Three of the four locations characterized as parks or preserves have the greatest vegetative diversity. The largest of these is the Brule River State Forest in northern Wisconsin, which is divided into three distinct ecoregions dominated by pine-oak forests, pine barrens, and monoculture plantation pine stands (Bayfield Sand Barrens), aspen and northern hardwood forest (Mille Lacs Uplands), and former spruce-fir forest now dominated by aspen forest and fields/pastures (Lake Superior Clay Plain) (Epstein et al. 1999).

Eagle Marsh, Indiana, consists of a mixture of marsh, forested wetlands and uplands, and wet prairie (LRWP, 2013b). The Ohio-Erie Canal in northeast Ohio, is affiliated with the Portage Lakes State Park. This park is mostly known for its lakes and wetland communities, but is also known for its stands of beech-maple forest as well as tamarack trees, which are more common in northern boreal forests (ODNR 2011b).

### Climate

Climate is evaluated only in terms of identifying applicable elements of climate (e.g., temperature, rainfall) and how they may influence the likelihood of a surface water connection forming between the basins. As GLMRIS covers such an expansive study area over the roughly 1,500-mile basin divide, climate information is summarized for purposes of this report into three generalized climate zones: Northern Zone, Southern Zone, and Eastern Zone.

**Northern Zone (Minnesota, Wisconsin)**. This area is classified as continental, with large seasonal temperature variances, four distinct seasons, and relatively small or moderate precipitation. The National Climatic Data Center (NCDC) shows that winter temperatures typically range from 0ºF to 30ºF, while summers are usually between 60ºF and 75ºF. The highest amount of precipitation occurs between June and August, with annual precipitation ranging between 30 and 35 inches, and snowfall ranging between 39 and 55 inches.

**Southern Zone (Indiana, Illinois, Ohio)**. This zone is within a humid continental climate and also experiences four distinct seasons per year. Winter temperatures range between 20ºF and 28ºF and summer temperatures range between 70ºF and 85ºF. Snowfall averages between 33 and 36 inches per year while average annual precipitation is approximately 36 to 40 inches.

**Eastern Zone (NE Ohio, SW New York)**. This zone was identified mostly by weather influences from Lake Erie and/or elevation. Climate at the East Mud Lake location is influenced by its nearness to Lake Erie (10 miles) and by higher elevations (650–1,850 feet above sea level). Other pathways are even closer to the Great Lakes, however, they are largely upwind of the prevailing weather patterns and are therefore not as likely to be as influenced by lake-effect precipitation. The NCDC and other available information indicates that temperatures in the winter range from 16ºF to 30ºF, while summer months are usually between 60ºF and 70ºF. The highest amount of precipitation occurs between June and October, with an average annual precipitation of about 35-40 inches, and snowfall ranges between 41 and 143 inches, depending on location.

Studies of historical climate data indicate an upward (positive) trend in annual temperature, precipitation, and runoff. Summers that have more superhot days and intense precipitation events are occurring more often throughout the Northeast (NYSDEC 2011; NYSWRI 2012). Trends based on historical climate data and modeled future projections suggest that increases in the frequency of large rainfall events will continue, possibly more in the Northeast than other regions. Daily rainfall simulations suggest a 0.2 inch increase in the 1% annual recurrence interval storm by the end of the century (NYSWRI 2012). The intensity of rainfall is particularly relevant as it is usually these events that exceed the soils ability to hold water, resulting in surface runoff which can cause flooding and possibly form a surface water connection that could be used by ANS to move between the basins. It is certain that hydrologic and hydraulic estimates based on historical flow data will have to be reassessed, as hydroclimate continues to exceed the past envelope of natural variability (Milly et al. 2008).

### N.2.2.3 Hydrologic Resources

#### Hydrology and Hydraulics

GLMRIS has been conducted using a watershed perspective in order to properly identify ANS risks and formulate potential solutions to their interbasin spread in a more thorough manner. This watershed approach provides a better appreciation for the interconnectedness of applicable resources as well as an appropriate means to forecast the effectiveness and impacts of study alternatives. It also enables a more complete identification of interested stakeholders and encourages their active participation so as to ensure the application of applicable technical disciplines to the study.

At the smallest scale, the GLMRIS study area incorporates both the Great Lakes and Mississippi River basins, but then subdivides these basins into general and detailed study areas. From this point, specific sub-watersheds of concern were identified to allow for more detailed evaluation of the identified aquatic pathways, and estimation of impacts of ANS transfer to environmental, economic, and social resources. These sub-watersheds were identified mainly at the scale of 12-digit hydrologic unit codes (HUC). The USGS established the HUC as a nested hierarchal system for subdividing large river basins into progressively smaller drainage areas, and it was a primary tool used to define the location of the basin divide and the hydrologic conditions in the vicinity of potential surface water pathways across the divide.

Flow data within the CAWS at the 1% annual recurrence interval flow was compared to the estimated 1% flow event at some representative Focus Area 2 pathways (Figure N.2). 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 1% annual frequency storm is a rainfall event that has a 1% 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 10% annual recurrence interval storm (formerly referred to as a 10-year event) is a smaller event that has a one-in-10 chance of being exceeded during any given year, and a 0.2% annual recurrence interval storm (formerly referred to as a 500-year event) is a larger event that has a one-in-500 chance of being exceeded in any given year.

The purpose of this comparison is not meant to convey the risk of any specific ANS transferring through the CAWS as compared to certain Focus Area 2 pathways, nor is it meant to correlate flow data to ANS transfer potential. Rather, it is only presented to help illustrate the perennial nature of the CAWS aquatic pathway as compared to the Focus Area 2 locations. At low flow conditions (99% recurrence interval), the amount of flow within the CAWS can approach near-zero cubic feet per second (CFS) and exhibit relatively stagnant conditions. Even during these low flow conditions, there are still significant water depths (5–26 feet) throughout this pathway. Whereas most of the Focus Area 2 pathways are intermittent in nature and only establish at a 1% or 10% recurrence interval event, the CAWS is able to maintain an aquatic pathway at all times of the year, regardless of flow.

The CAWS is made up of five separate aquatic pathways, which are represented collectively in Figure N.2. The flow information for the CAWS in this figure consists of data collected for the following locations:

1. Chicago River near the Chicago Controlling Works
2. Calumet River near O'Brien Lock and Dam
3. North Shore Channel near Wilmette Pumping Station
4. Little Calumet River near the Hart Ditch confluence
5. Grand Calumet River near Columbia Avenue

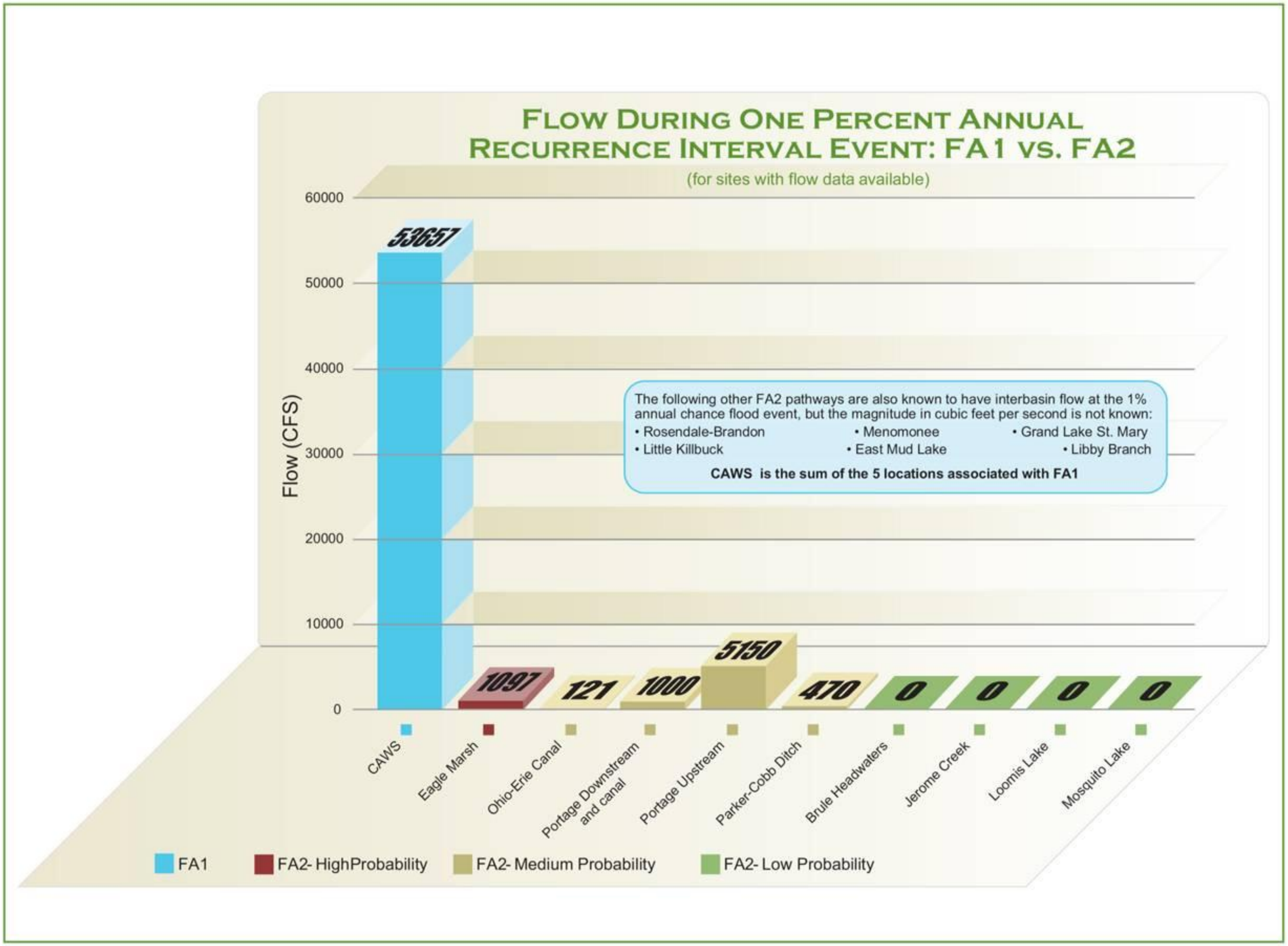



**FIGURE N.2 A Comparison of Similar Flow Conditions among the CAWS and Selected Focus Area 2 Sites**

Where it was determined that aquatic pathways could form within Focus Area 2, this formation was found to be predominantly intermittent (i.e., only possible during certain flood events). However, flows at a limited number of Focus Area 2 locations were determined to be perennial (Table N.2). Focus Area 2 encompasses all natural and man-made aquatic surface water pathways and hydraulic connections that exist or may form between the basins outside of the CAWS. These were locations situated in a mixture of rural, forested, suburban, and urban areas. They include 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 purposes. Also, several of these locations comprised natural wetlands in close proximity to and, in some instances, spanning the basin divide.

### Water Quality

As GLMRIS covers an expansive study area, the Focus Area 2 locations are organized according to three categories for purposes of this report: High Water Quality, Moderate Water Quality, and Low Water Quality. These general and qualitative water quality groupings are based on an assortment of readily available water quality information for the pathways themselves and their respective watersheds.

**High Water Quality (Brule Headwaters, WI; South Aniwa, WI; Libby Branch of Swan River, WI; Hatley-Plover, WI; Mosquito Creek Lake, OH, and; East Mud Lake, NY)**. These locations are characterized by relatively high dissolved oxygen levels and some locations (e.g., Brule, East Mud Lake, Mosquito Creek Lake) may support trout populations or an otherwise healthy fishery. Some sites also consist of moderate-to-high quality wetland areas in or adjacent to relatively healthy watersheds.

**Moderate Water Quality (Swan River, WI; Jerome Creek, WI; Menomonee Falls, WI; Portage Upstream, WI; Portage Downstream & Canal, WI; Eagle Marsh, IN; Ohio-Erie Canal, OH, and; Little Killbuck Creek, OH)**. Although water quality at most of these locations may at times be high,

**TABLE N.2 Summary of Surface Water Connections at Focus Area 2 Locations**

| | | Flow Characterization | | |
|---|---|---|---|---|
| Aquatic Pathway | State | Connects at less than a 10% event | Connects between a 10% and 1% event | Connects over 1% event |
| Eagle Marsh | IN | | X | X |
| Ohio-Erie Canal at Long Lake | OH | X | X | X |
| Little Killbuck Creek | OH | | X | X |
| Parker-Cobb Ditch | IN | X | X | X |
| Brule Headwaters | WI | | X | X |
| Portage Upstream | WI | | X | X |
| Portage Downstream | WI | | X | X |
| Rosendale-Brandon | WI | | X | X |
| Libby Branch SwanRiver | MN | X | X | X |
| Menomonee Falls (South/West) | WI | | X/X | X/X |
| East Mud Lake | NY | | X | X |
| Loomis Lake | IN | | X | X |
| Grand Lake St Marys | OH | X | X | X |
| Mosquito Creek Lake | OH | | | unknown |
| S. Aniwa Wetlands | WI | | | unknown |
| Jerome Creek | WI | | | unknown |
| Swan River | MN | | | unknown |
| Hatley-Plover River | WI | | | unknown |

adjacent land use and/or problems associated with their larger watershed have, to some degree, resulted in degraded water quality near the aquatic pathway. The Menomonee Falls sites are in an urban setting and are likely impacted by storm water runoff and non-point source pollutants. Swan River is an "impaired" water body due to dissolved oxygen and mercury (MPCA 2011). The Rosendale-Brandon site is a large emergent and scrub-shrub wetland, but the aquatic pathway leading to it is impacted by channelization and agricultural and roadside ditches. Both Portage Upstream and Portage Downstream & Canal are comprised of a variety of flood-prone wetlands at the basin divide, but are connected with both the Wisconsin and Fox Rivers which support a relatively large and diverse fishery.

For Eagle Marsh, drainage toward the Great Lakes is through the Maumee River, which becomes more degraded as it flows toward Lake Erie, although its reach through Indiana is considered of average water quality due to mixing with other tributaries (INDNR 2006). The lower 23 miles are classified as an Area of Concern (AOC) due to heavy metals, organic chemical sediment contamination, suspended sediment, and phosphorus (Maumee RAP 2006). On the Mississippi River Basin side, the Wabash River is impacted by increased levels of nitrates and total dissolved solids. The ditches at Eagle Marsh also contribute to water quality degradation due to urban and agricultural runoff and high temperature (McFall et al. 2000).

Little Killbuck Creek generally has higher water quality; however, much of its watershed in the Great Lakes Basin is part of an AOC due to degradation of fish and wildlife populations, eutrophication, and habitat loss (OEPA 2008). Most of its watershed is also agricultural with channelized streams, livestock production, sedimentation, and nutrient loading (OEPA 1999). Although partly surrounded by the Portage Lakes, the Ohio-Erie Canal functions as a series of ponds with very little flow. Water is provided to the canal from Long Lake (one of the Portage Lakes) to provide flow and to ensure it does not turn anoxic. Both the canal and the Little Cuyahoga River downstream in the Great Lakes Basin are surrounded by industrial and residential land uses which contribute to eutrophication, low dissolved oxygen, and habitat alterations (OEPA 2003). On the other side of the basin divide, the upper Tuscarawas River is impacted by municipal and industrial discharges, nutrient enrichment, low dissolved oxygen, and pathogens (OEPA 2009).

**Low Water Quality (Grand Lake St. Marys, OH; Loomis Lake, IN; Parker-Cobb Ditch, IN)**. By the time water exits Grand Lake St. Marys, it has been exposed to agricultural chemicals and livestock operations within the watershed that are responsible for heavy nutrient loading (OEPA 2007). This has contributed to high algae growth and low dissolved oxygen levels which are made worse by high water temperatures and lower flows during the summer months. The OEPA has also identified three known toxins in the lake: microsystin, cylindrospermopsin, and saxitoxin, which are caused in part by elevated phosphorus levels from nutrient runoff (OEPA 2007). Loomis Lake is part of the headwaters of the Salt Creek watershed, which is considered to be impaired, according to the Indiana Department of Environmental Management (IDEM), and is on the 303(d) list for *E. coli*, biotic community impairment, and nutrient loading (e.g., nitrates, phosphorus, and sediment loading) (INDNR 2011; JFNew 2006). Although no surface water quality data was available for Parker-Cobb Ditch, it is likely that high water temperatures (no shading) and nutrient loading from agricultural runoff create relatively high biological and chemical oxygen demand throughout much of the drainage system downstream of this pathway.

### Floodplains

As the Focus Area 2 pathway assessments were completed mainly by using readily available information, floodplain mapping was very important and provided key information in helping to determine the frequency of inundation. Using a Geographic Information System (GIS), available FEMA mapping was overlaid and compared to other available resources, such as aerial photography, National Wetland Inventory mapping, NRCS soil survey, USGS contour mapping, and streams. Of the 18 locations evaluated in Focus Area 2, ten are completely or partially located within the FEMA 1% recurrence interval floodplain. Of these, it was determined that eight may form a surface water connection between the basins on a permanent or periodic basis. An additional six locations were immediately adjacent to 1% floodplain boundaries, of which, three had either a surface water connection or the ability to form one. Two locations were neither in nor adjacent to mapped floodplains; however, both of these have surface water connections into both basins.

# N.3 ASSESSMENT METHODOLOGY AND FINDINGS

This chapter contains an explanation of the process used to assess the probability of ANS transfer at each pathway, starting with identification of the applicable ANS of Concern. The Aquatic Nuisance Species Task Force (ANSTF) defines the first step in a risk assessment process as identification of interested parties and solicitation of input (ANSTF 1996). USACE identified interested parties and solicited input early in the process for GLMRIS and has included individual visits and discussions with the general public, state and federal agencies, and other stakeholders in the Great Lakes and Mississippi River basins. USACE requested the support and participation of 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. Overall, extensive collaboration among partner agencies and other subject matter experts throughout the study has led to a sound, scientifically based foundation for evaluating the likelihood of ANS transfer, and in some cases, the development of alternatives to prevent their interbasin spread.

GLMRIS addresses the problem of ANS invading, via surface water pathways, the Great Lakes Basin from the Mississippi River Basin and vice versa. An 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 website (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 2011). Based on discussions between USACE, USGS, and USFWS, the following definitions were established for the purposes of 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 GLMRIS. Therefore, ANS is synonymous with nonindigenous aquatic species in this report.

## N.3.1 ANS of Concern

A list of ANS of Concern for GLMRIS was developed early in the study and outlined in a 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. This technical paper, prepared by a multi-disciplinary USACE Natural Resources Team, with the assistance of partner agencies, took a broad look at the potential range of species that could be of concern in GLMRIS. This USACE white paper included a review of 254 aquatic species that are either non-indigenous to either basin or native species that occur only 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 determined to pose the highest potential risk of ecological impacts if they were to become 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 opposite 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 be already 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 effects to the invaded ecosystem.

To determine species of concern that are pertinent for 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, resulting in the establishment of a list of 39 species of concern for the CAWS. Each species was identified as having a likelihood for transferring from one basin to another and, if so dispersed, the invaded ecosystem could be moderately to severely affected by their colonization (Table N.3). 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. The list of ANS of Concern for GLMRIS was then subdivided into two groups (Table N.4 and Table N.5): (1) ANS threatening the Great Lakes, and (2) ANS threatening the Mississippi River and its tributaries. Each of these two lists was then further organized into subgroups according to taxonomy and common dispersal mechanism.

Within Focus Area 2, each Pathway Assessment Team also developed a list of ANS of Concern that was specific to each location. In doing this, each team consulted the ANS white paper and 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 their particular pathway to be of concern. The teams also 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). Each Focus Area 2 team was granted flexibility in determining whether to add additional species to their assessment based on their review of available information and based on the actual location of their potential pathway relative to the known location of those ANS being considered. No assessment of specific ANS was completed at those Focus Area 2 locations where there was a low likelihood of an aquatic pathway existing at up to a 1% annual recurrence interval storm event. In this manner, limited resources could more quickly be focused on evaluating those locations which exhibited a greater potential threat of aquatic pathway formation.

## N.3.2 Summary of Focus Area 2 Probability Assessment Process

The overall GLMRIS risk assessment 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 evolution from the generic model to what was used in GLMRIS is graphically illustrated in Figure N.3. The ANSTF defines the risk associated with ANS establishment 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 that the risk of ANS establishment is defined as a multiplicative function. That means, if either of the components representing probability or consequence of establishment is zero or low, the overall risk of establishment will also be zero or low.

## TABLE N.3 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 pseudoharengus* | Alewife | GL | swimmer |
| crustacean | *Apocorophium lacustre* | a scud | MS | ballast water |
| algae | *Bangia atropupurea* | red macro-algae | GL | ballast / recreational 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 / recreational 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 / recreational boating |
| fish | *Gasterosteus aculeatus* | three-spine 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 N.4 ANS of Concern Threatening the Mississippi River Basin

| Taxa | Species | Common Name | Interbasin Dispersal Mechanism |
|---|---|---|---|
| fish | *Alosa aestivalis* | blueback herring | swimmer |
| fish | *Alosa pseudoharengus* | Alewife | swimmer |
| fish | *Gasterosteus aculeatus* | three-spine 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 / recreational 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 / recreational boating |
| algae | *Stephanodiscus binderanus* | Diatom | ballast water |

### TABLE.N.5 ANS of Concern Threatening the Great Lakes Basin

| 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 & trailers |
| plant | *Murdannia keisak* | marsh dewflower | recreational boats & trailers |
| plant | *Oxycaryum cubense* | Cuban bulrush | recreational boats & trailers |

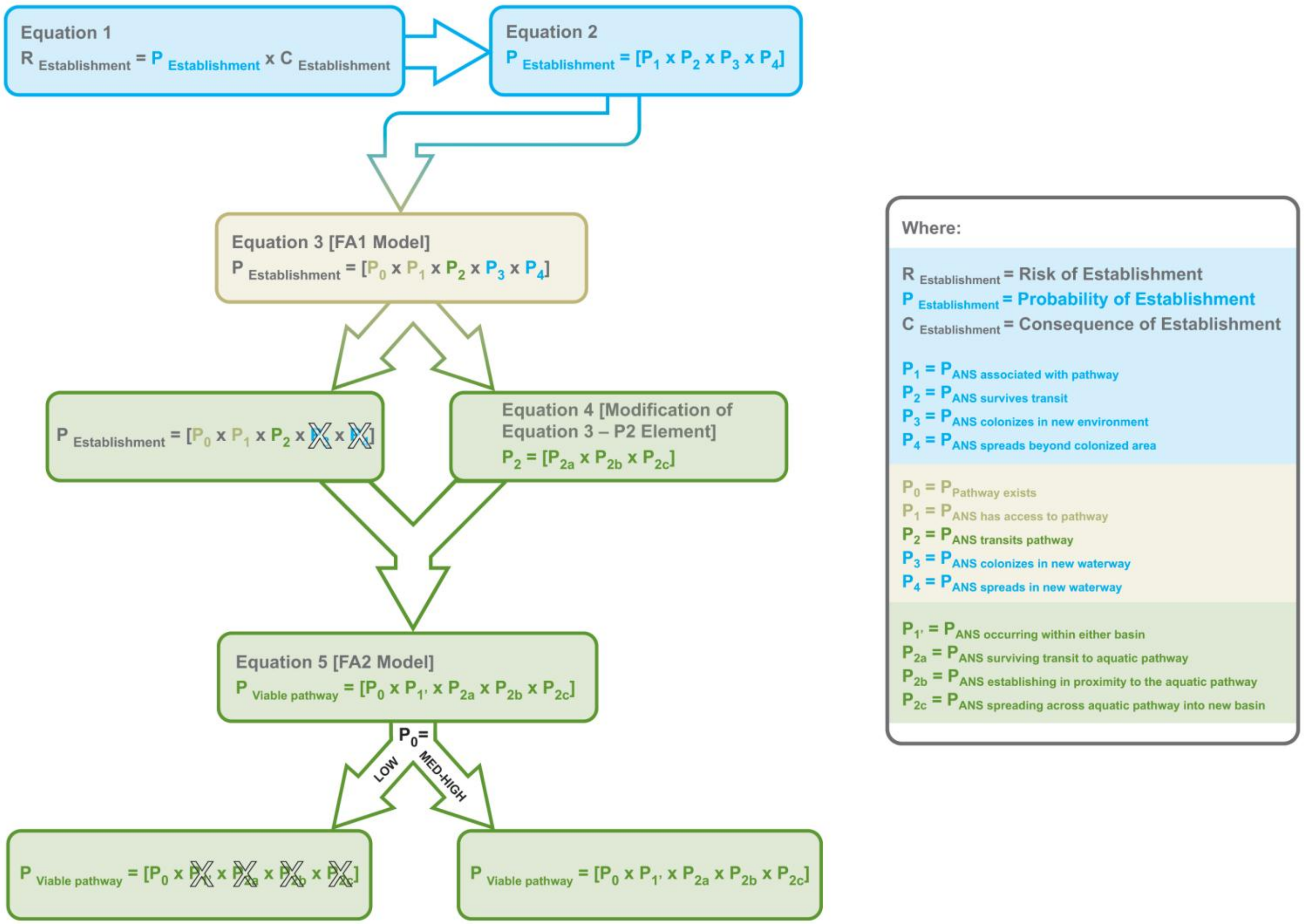



**FIGURE N.3 Diagram of the Derivation of the GLMRIS Aquatic Pathway Assessment Models for Focus Area 2**

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 ANS establishment in proximity to the aquatic pathway and being able to cross that pathway into the adjacent basin. This differs from the more rigorous assessment process that was employed by the GLMRIS Focus Area 1 Team in the CAWS, which addressed both components of risk — probability and consequence. For a complete discussion of the Risk Assessment process utilized for the CAWS, please refer to Appendix C — Risk Assessment. The remainder of the discussion of risk in this appendix will be focused on the probability assessment conducted in Focus Area 2.

The 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**

$P_{\mathit{Establishment}} = [P_{1} \times P_{2} \times P_{3} \times P_{4}]$

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*

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Each of the four elements in this equation can be qualitatively rated High (H), Medium (M), or Low (L) based on the available evidence. They can also be 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 [Focus Area 1 Model]**

$P_{\mathit{Establishment}} = [P_{0} \times P_{1} \times P_{2} \times P_{3} \times P_{4}]$

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 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 (e.g., 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.

For purposes of Focus Area 2, Equation 3 was modified for greater efficiency in analysis by eliminating evaluation of the last two elements; if a pathway does not exist then 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, the 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 was made at this time in Focus Area 2 to assess the probability that an ANS will colonize or spread in the receiving waterway or basin.

In order to work efficiently in assessing the probability of ANS transfer 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]**

$P_{2} = [P_{2a} \text{ x } P_{2b} \text{ x } P_{2c}]$

Where:
$P_2$ = P *ANS transits pathway*
$P_{2a}$ = P *ANS surviving transit to aquatic pathway*
$P_{2b}$ = P *ANS establishing in proximity to 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, which is employed in GLMRIS Focus Area 2 assessments:

**Equation 5 [Focus Area 2 Modified]**

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

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

In this construct, the overall probability is now termed the "probability a viable pathway exists" ($P_{\textit{Viable pathway}}$) and is no longer the original "probability of establishment" ($P_{\textit{Establishment}}$) from Equation 3. 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 was revised in an attempt to provide clearer nomenclature to team members as to what "access to the pathway" actually meant.

This model remains consistent with the ANSTF methodology, and the Focus Area 2 refinements enable the assessors to focus more appropriately on the relevant evidence. At locations along the basin divide where the first element in Equation 5 (i.e., likelihood that an aquatic pathway exists at up to a 1% annual recurrence interval flood 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 the same rating as there being no probability of a pathway existing. At those Focus Area 2 locations where the probability of a pathway existing ($P_0$) was determined to be medium or high, 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.

### N.3.2.1 Example Calculation of Overall Aquatic Pathway Viability (Focus Area 2)

A list of ANS of Concern was developed for each Focus Area 2 pathway. The ANS of Concern were grouped according to the basin in which they are currently established, in order 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 N.6 and Table N.7).

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 N.6. 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 N.7. In this example, the overall pathway viability for transferring species from the Great Lakes Basin to the Mississippi River Basin is medium.

The final calculation determines the overall pathway viability for interbasin spread of ANS, and is arrived at by taking the highest of the overall ANS ratings for unidirectional transfer, which is presented in Tables N.6 and N.7. Thus, as demonstrated in Table N.7, the overall probability that a viable aquatic pathway exists is medium.

**TABLE N.6 Pathway Viability for ANS Transfer — Mississippi River → Great Lakes**

| | | | 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** |

**TABLE N.7 Pathway Viability for ANS Transfer — Great Lakes → Mississippi River**

| | | | 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 | three-spine 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 |

## N.3.3 Findings from Focus Area 2 Assessments

There are various reasons for the differences in overall aquatic pathway ratings for the Focus Area 2 locations, but most relate to individual species habitat requirements and tolerances, habitat and water quality at the pathway and connecting tributaries, and the presence or absence of barriers to upstream movement. Such rationales are outlined in more detail within each detailed pathway report, which can be found online at http://glmris.anl.gov.

It is important to note that these findings represent only a snapshot in time and any subsequent modification of on-the-ground conditions, including those downstream from the sites, could affect the study findings. Accordingly, resource agencies may need to take into consideration any potential effect that prospective projects in these areas, or on connecting streams and ditches, might have on pathway connectivity, fish passage, and ultimately on how a proposed action(s) could change the risk assessment ratings completed as part of this study.

As explained earlier in this chapter, the overall pathway viability rating for each Focus Area 2 location is the product of several probability elements. For some locations, the only element rated was whether or not a pathway exists ($P_0$). If it was determined that there was a low probability that a pathway exists at up to a 1% annual recurrence interval storm event, then no further analysis was required. However, for most of the locations, it was determined that a pathway does exist at up to a 1% annual return storm event, and thus the remaining probability elements in Equation 5 were characterized to describe the overall rating for the pathway. The combined results from these calculations for all the Focus Area 2 pathways are shown in Table N.8.

The combined results of the ratings from all Focus Area 2 locations for all the ANS of Concern, are presented in Table N.9. The information in this table indicates the source basin for each particular species. It also identifies which of the species at each pathway location are the key factors for the overall pathway viability ratings. For example, the only ANS causing the Rosendale-Brandon site to be rated as medium was viral hemorrhagic septicemia virus (VHSv). However, there were three species driving the medium rating for Parker Ditch-Cobb Ditch (i.e., northern snakehead, three-spine stickleback, and VHSv). Information about which species are correlated to the overall rating is an important aspect in understanding the likelihood of interbasin spread of ANS and determining the potential options and technologies to prevent it from occurring.

### TABLE N.8 Summary of Pathway Viability for All Focus Area 2 Locations

| Pathway Name | State | Probability of Viable Pathway (to MRB) | Probability of Viable Pathway (to GLB) | Overall Pathway Viability Rating |
|---|---|---|---|---|
| Eagle Marsh | IN | High | Medium | High |
| Ohio-Erie Canal at Long Lake | OH | Low | Medium | Medium |
| Little Killbuck Creek | OH | Medium | Medium | Medium |
| Parker-Cobb Ditch | IN | Medium | Medium | Medium |
| Brule Headwaters | WI | Medium | Low | Medium |
| Portage Upstream | WI | Medium | Low | Medium |
| Portage Down-stream and canal | WI | Medium | Low | Medium |
| Rosendale-Brandon | WI | Medium | Low | Medium |
| Libby Branch Swan River | MN | Low | Low | Low |
| Menomonee Falls (South/West) | WI | Low | Low | Low |
| East Mud Lake | NY | Low | Low | Low |
| Loomis Lake | IN | Low | Low | Low |
| Grand Lake St Marys | OH | Low | Low | Low |
| Mosquito Creek Lake | OH | Low | Low | Low |
| S. Aniwa Wetlands | WI | Low | Low | Low |
| Jerome Creek | WI | Low | Low | Low |
| Swan River | MN | Low | Low | Low |
| Hatley-Plover River | WI | Low | Low | Low |
| MRB is defined as Mississippi River Basin | | | | |
| GLB is defined as Great Lakes Basin | | | | |

As most of the Focus Area 2 pathways are located along the basin divide in headwater streams, ditches, lakes, or wetlands, it has been stated in many of the detailed pathway reports that the ANS of greatest concern are those that have the ability to self-propel or be carried by host fish. Therefore, the only species that received ratings of medium or high were those species with these abilities. In the case of the Parker Ditch-Cobb Ditch and Little Killbuck Creek pathways, each had two ANS that required host fish (i.e., VHSv and the parasitic copepod [*N. japonicus*]) to be able to move to the basin divide.

Lastly, an overall pathway viability rating of low is not necessarily synonymous with there being "no probability" for ANS transfer to occur across an aquatic pathway. For example, a rating of low for the probability of pathway existence ($P_0$) only means that it is unlikely for an aquatic connection to establish between headwater tributaries on either side of the basin divide unless possibly from a storm and subsequent interbasin flow event somewhere in excess of the 1% annual recurrence interval storm. In addition, an aquatic pathway can still develop from storm events up to the 1% annual recurrence interval, even at some of those locations that were given overall pathway viability ratings of low (e.g., Portage, WI, locations). In these cases though, the overall pathway viability rating of low was assigned most likely because of downstream obstructions (e.g., dams) preventing the ANS from reaching the aquatic pathway. Despite the overall low ratings, such locations may be of great importance should such downstream obstructions be modified or removed in the future. The results from all the Focus Area 2 pathway assessments, regardless of their overall viability ratings, should therefore be evaluated and taken into consideration by the appropriate federal, state, or local resource agencies concerned with ANS in their respective areas of concern.

## TABLE N.9 Summary of Probability Ratings for Individual Species or Species Groups

| | From Mississippi River Basin | | | | | |
|---|---|---|---|---|---|---|
| Pathway Name | Asian Carps[1] (three species) | Inland silverside (*Menidia beryllina*) | Skipjack herring (*Alosa chrysochloris*) | Northern Snakehead (*Channa argus*) | Scud (*Apocorophium lucustre*) | Plants[2] (three species) |
| Eagle Marsh | M | M | * | M | * | * |
| Brule Headwaters | L | L | * | L | * | * |
| Ohio-Erie Canal at Long Lake | M | * | L | M | * | * |
| Little Killbuck Creek | M | M | L | M | * | * |
| Parker-Cobb Ditch | L | * | * | M | * | * |
| Portage Upstream | L | L | * | L | L | L |
| Portage Downstream | L | L | * | L | L | L |
| Rosendale-Brandon | L | L | * | L | * | * |
| Libby Branch Swan River | L | L | * | L | * | * |
| Menomonee Falls | L | L | * | L | * | * |
| East Mud Lake | L | L | L | * | * | * |
| Loomis Lake | L | * | * | L | * | * |
| Grand Lake St Marys | L | * | * | L | * | * |
| | **From Great Lakes Basin** | | | | | |
| Pathway Name | Three-spine Stickleback (*Gasterosteus aculeatus*) | Benthic[3] Ruffe & Tubenose goby | VHSv (*Novirhabdovirus sp*) | European Fingernail Clam (*Sphaerium corneum*) | Parasitic Copepod (*Neoergasilus japonicus*) | European Stream Valvata (*Valvata piscinalis*) |
| Eagle Marsh | M | L | H | * | M | * |
| Brule Headwaters | L | L | M | * | * | * |
| Ohio-Erie Canal at Long Lake | * | * | * | * | * | * |
| Little Killbuck Creek | M | M | M | L | M | L |
| Parker-Cobb Ditch | M | L | M | * | M | * |
| Portage Upstream | L | L | M | * | * | * |
| Portage Downstream | L | L | M | * | * | * |
| Rosendale-Brandon | L | L | M | * | * | * |
| Libby Branch Swan River | L | L | L | * | * | * |
| Menomonee Falls | L | L | L | * | * | * |
| East Mud Lake | * | * | * | * | * | * |
| Loomis Lake | L | L | L | * | L | * |
| Grand Lake St Marys | L | L | L | * | L | * |

Asterisk indicates species determined not to be applicable for detailed evaluation at that particular pathway.

[1] Silver carp (*Hypophthalmichthys molitrix*), Bighead carp (*Hypophthalmichthys nobilis*), and Black carp (*Mylopharyngodon piceus*)

[2] Dotted duckweed (*Landoltia* (*Spirodela*) *punctata*), marsh dewflower (*Murdannia keisak*), and Cuban bulrush (*Oxycaryum cubense*)

[3] Ruffe (*Gymnocephalus cernua*) and Tubenose goby (*Proterorhinus semilunaris*)

### N.3.4 Current Status of Focus Area 2 Pathways Rated Medium or High

Below are short executive summaries and a current status for each of the Focus Area 2 pathways assigned overall pathway viability ratings of medium or high. All other Focus Area 2 locations were assigned overall ratings of low for various reasons, and consequently no further study is anticipated by USACE at these sites. For example, some sites were rated low because aquatic pathways were determined unlikely to form at up to the 1% flood event, and other sites were rated low due to downstream obstructions (e.g., dams) that currently block natural movement of ANS to the pathway. However, ongoing monitoring for changing conditions and potential ANS threats is recommended for low-rated locations; this information may be important to those responsible for local resource management. Additional details on all of the Focus Area 2 pathways may be found by consulting the specific detailed pathway assessment reports for each location at http://glmris.anl.gov.

**Eagle Marsh, IN**. Eagle Marsh is jointly owned by Little River Wetlands Project and the Indiana Department of Natural Resources. Eagle Marsh was previously restored by NRCS utilizing Wetland Reserve Program (WRP) funding and the Indiana Nature Conservancy was a supporting partner in the land acquisition. The wetlands at Eagle Marsh form an aquatic pathway between the basins starting at about a 10% annual recurrence interval flood event based on modeling. The overall pathway viability rating for Eagle Marsh is high due to the threat posed to the Mississippi River Basin by VHSv. Additional ANS (i.e., three-spine stickleback and parasitic copepod) were also found to be of concern to the Mississippi River Basin at Eagle Marsh and were each rated medium. Five other species were also rated medium for their probability of entering the Great Lakes Basin through Eagle Marsh (i.e., silver, bighead, and black carp; northern snakehead, and; inland silverside).

Of the 18 pathways studied in GLMRIS Focus Area 2, Eagle Marsh was the only one identified as having a high potential for transfer of ANS between the basins. This warranted completion of a more detailed ANS Controls Report, which was done concurrently with a detailed Pathway Assessment Report that identified the likelihood of a viable aquatic pathway existing at Eagle Marsh that could allow transfer of ANS between the basins. The ANS Controls Report for Eagle Marsh, which builds upon the findings of the Pathway Assessment, evaluates the available options and technologies that may be available to prevent the transfer of ANS from occurring at this location. A public information meeting was held in December 2012, and the report was completed by the USACE in January 2013.

*Current Status*: The ANS Controls Report identifies nine structural alternatives for preventing ANS transfer between the basins via Eagle Marsh. Public comments supported rebuilding the Graham-McCulloch Ditch to create a permanent barrier to stop invasive species transfer at Eagle Marsh. The NRCS may receive WRP funding to implement this rebuilding effort, and final designs will be completed by a partnership of NRCS and USACE engineers. The USACE will complete hydrology and hydraulic modeling in support of NRCS' final design of the berm and documentation for permitting and real estate efforts. This effort has included additional surveys of channels and topography at select areas along Junk Ditch and Graham-McCulloch Ditch to refine the modeling and further improve the understanding of expected impacts. A study of the Graham-McCulloch watershed will be conducted to develop more accurate flow values for modeling purposes.

**Parker-Cobb Ditch, IN**. This is an agricultural ditch spanning the basin divide on very flat ground surrounded by farm fields south of the city of Valparaiso, Indiana. Drainage from this location into the Mississippi River Basin is through the Kankakee River, while drainage into the Great Lakes Basin is through Salt Creek and the Calumet River. The overall aquatic pathway viability rating of medium for this pathway reflects the possibility that the northern snakehead eventually could use this pathway to enter the Great Lakes Basin, and the possibility that the three-spine stickleback, parasitic copepod, and VHSv (on suitable host) could use this pathway to enter the Mississippi River Basin.

*Current Status*:  Although there may be a relatively simple way to sever the surface water connection between the basins at this location, further hydrologic and hydraulic study may be necessary to determine the effect this might have on induced flooding of nearby crop fields.  The USACE is working with the Porter County Soil and Water Conservation District, the NRCS, and applicable landowners to identify an effective and acceptable solution(s).

**Ohio-Erie Canal, OH**. This canal serves as a unidirectional and perennial surface water pathway from the Tuscarawas River (Ohio River basin) near Portage Lakes, Ohio, to the Great Lakes Basin in the city of Akron.  The actual basin divide is located north of Portage Lakes in the city of Akron, where the canal joins the Cuyahoga River.  Any ANS from the Tuscarawas River would only potentially be able to enter the canal in the area of Portage Lakes.  Any species from the Great Lakes Basin would not be able to reach the canal because of an existing lock on the canal in the city of Akron.  The critical area of the Ohio-Erie Canal is the Long Lake (Ohio River Basin) feeder gate which provides water to the canal from Long Lake, and this lake is connected to the headwaters of the Tuscarawas River through flood gates.  Areas of potential flooding between the Tuscarawas River and the canal were also evaluated.  Three species of Asian carp and the northern snakehead could potentially use the canal to enter the Great Lakes Basin, although not likely within the next 20 years given the current known distribution and ecology of these species.

*Current Status*:  Through the Economy Act, the USEPA is funding the USACE to develop and provide structural design options to ODNR that would prevent ANS from moving through this pathway into the Great Lakes Basin.  Any alternatives selected by ODNR would likely be implemented by the state of Ohio.

**Little Killbuck Creek, OH**. This pathway consists of a large agricultural area located in Medina County, Ohio, just south of the village of Lodi.  An aquatic pathway may form when floodwaters from Little Killbuck Creek and Repp Run in the Ohio River basin (south side of the pathway) connect with extensive agricultural and roadside ditches leading to Clear Creek in the Great Lakes Basin (north side of the pathway).  Pumps are also utilized to transfer water from the fields into either basin, while check valves create the ability to bring water from either basin into the ditch system for irrigation.  An overall pathway viability rating of medium was assigned for this pathway due to the potential for the three Asian carp species, inland silverside, and northern snakehead to enter the Great Lakes Basin, and for three-spine stickleback, ruffe, tubenose goy, parasitic copepod, and VHSv to enter the Mississippi River Basin.

*Current Status*:  Ohio DNR is currently attempting to work directly with the farmer/landowner with assistance from the local NRCS and the Medina County Soil and Water Conservation District to explore ways to alter water management practices on the farm, as well as possibly design, construct, and raise levees along Repp Run and Little Killbuck Creek.  The USACE is providing a supporting role at this time to ODNR, as necessary.

**Rosendale-Brandon, WI**. Located in east-central Wisconsin, this pathway is characterized as a mile-wide emergent and scrub-shrub wetland sitting astride the basin divide about midway between the communities of Rosendale and Brandon.  The wetland drains into both the Great Lakes and Mississippi River basins.  A total of nine ANS were evaluated for this pathway.  However, only VHSv was determined to be potentially capable of transferring into the Mississippi River Basin via a host fish species (e.g., common carp).  There were no ANS found capable of reaching this pathway from the Mississippi River Basin because of downstream obstructions on the Saint Croix, Fond du Lac, and Wisconsin rivers.

*Current Status*: The USACE has been in frequent coordination with WDNR and they are continuing to evaluate this report internally to determine their possible options. It is unknown at this time if they will have need for the USACE to provide further assistance.

**Brule Headwaters, WI**. Located in northern Wisconsin within the Brule River State Forest and at the headwaters of the Brule (Great Lakes Basin) and St. Croix rivers (Mississippi River Basin), this pathway consists primarily of coniferous and deciduous forested wetland habitats within a narrow valley. An intermittent surface water connection may form in the bottom of this valley connecting Porcupine Creek (Mississippi River Basin) with the West Fork Brule River, which drains to Lake Superior. An overall viability rating of medium was given to this site due only to the potential of VHSv being able to use this location to transfer into the Mississippi River Basin via a host fish species (e.g., brown trout). There were no ANS found capable of reaching this pathway from the Mississippi River Basin because of downstream obstructions on the Saint Croix River.

*Current Status*: The USACE has been in frequent coordination with WDNR and they are continuing to evaluate this report internally to determine their possible options. It is unknown at this time if they will have need for the USACE to provide further assistance.

**Portage Upstream, WI**. This pathway is comprised of three discrete locations where interbasin flood flow may occur between the Wisconsin River (Mississippi River Basin) and the Fox River (Great Lakes Basin). Historically, the Portage area has had a high potential for interbasin exchange of water, and significant rates of interbasin flow can occur from the Wisconsin River into the Great Lakes Basin. A total of 13 ANS were evaluated for this pathway. However, only VHSv was determined as potentially capable of transferring into the Mississippi River Basin via a host fish species (e.g., common carp). For this reason, the overall aquatic pathway viability rating was determined to be medium. There were no ANS found capable of reaching this pathway from the Mississippi River Basin because of downstream obstructions on the Saint Croix, Fond du Lac, and Wisconsin rivers (e.g., Prairie du Sac Dam on the Wisconsin River).

*Current Status*: The USACE has been in frequent coordination with WDNR and they are continuing to evaluate this report internally to determine their possible options. It is unknown at this time if they will have need for the USACE to provide further assistance. Although, currently, there is no fish passage on the Wisconsin River at the Prairie du Sac Dam, Alliant Energy Company has a relicensing requirement to install fish passage.

**Portage Downstream and Canal, WI**. This pathway is comprised of two discrete locations where interbasin flow may occur between the Wisconsin River (Mississippi River Basin) and the Fox River (Great Lakes Basin). A total of 13 ANS were evaluated for this pathway. However, only VHSv was determined as potentially capable of transferring into the Mississippi River Basin via a host fish species (e.g., common carp). For this reason, the overall aquatic pathway viability rating was determined to be medium. There were no ANS found capable of reaching this pathway from the Mississippi River Basin because of downstream obstructions on the Saint Croix, Fond du Lac, and Wisconsin rivers (e.g., Prairie du Sac Dam on Wisconsin River).

*Current Status*: The USACE has been in frequent coordination with WDNR and they are continuing to evaluate this report internally to determine their possible options. It is unknown at this time if they will have need for the USACE to provide further assistance. Although, currently, there is no fish passage on the Wisconsin River at the Prairie du Sac Dam, Alliant Energy Company has a relicensing requirement to install fish passage.

## N.3.5 Focus Area 2 Future Opportunities

It was not the intent of the Focus Area 2 pathway assessments to produce and evaluate exhaustive lists of potential actions to prevent ANS transfer between the basins outside of the CAWS. Nonetheless, several opportunities were identified while performing these assessments that, if implemented, could prevent or reduce the probability of ANS spreading between the basins at some Focus Area 2 locations. This information and the opportunities associated with particular pathways have been shared with the respective state resource agencies and the general public. Follow-up actions have already been initiated by some states and/or other organizations (reference Section 3.4). As is the status of the CAWS pathway, USACE does not have a recommended plan for any of the Focus Area 2 locations. Instead, for certain pathways, USACE continues to work directly with the respective state agencies and, in some cases, non-governmental organizations, to further identify potential options, and provide engineering support and design assistance for structural measures to prevent ANS transfer. USACE does not currently have authority to implement any solutions as part of GLMRIS. However, some organizations outside of USACE have demonstrated willingness and capability to advance and, in some cases, implement solutions at the higher priority Focus Area 2 pathways, including Eagle Marsh, Ohio-Erie Canal, Little Killbuck Creek, and Parker-Cobb Ditch.

The list of opportunities below is not specific to USACE authorities and is grouped according to possible structural and non-structural measures. This is a general list that has been consolidated from those pathway reports which received overall aquatic pathway viability ratings of medium or high. It also incorporates a wide range of possible authorities, capabilities, and jurisdictions at the federal, state, and local levels. Prevention of ANS transfer is most appropriately a shared responsibility among stakeholders, such that a collaborative and comprehensive approach can be pursued in the event of further study or action. All opportunities listed do not necessarily apply to every pathway. For an understanding to which of the Focus Area 2 pathways these opportunities might apply, interested parties are directed to read the site specific reports located at http://glmris.anl.gov.

**Structural Opportunities**:

- In-stream structures to block upstream ANS movement (e.g., low-head dam, increase flow velocities through streambed slope modifications, weirs);
- New and/or modified berms and levees to reduce or eliminate overland flood connections between basins;
- Installation and/or modification of drop structures;
- Culvert modifications (e.g., re-route, block, grates);
- Drainage ditch reconfiguration.

**Nonstructural Opportunities**:

- New and/or modified regulations prohibiting establishment of new connections between basins (e.g., roadway culverts, ditch construction, storm water management);
- Reduce source populations of ANS (e.g., harvesting, chemical treatment);
- Public education to prevent bait bucket and boating transfers, and improve ANS reporting;
- Support funding for further ANS research to improve knowledge on the biological requirements and tolerances of ANS, and the development of control methodologies;
- Improve ANS monitoring at federal, state, and local levels;
- Take ANS transfer potential into account for proposed water resource projects (e.g., dam removal, stream restoration, water management);
- Site specific elevation surveys and hydrologic and hydraulic investigations at some aquatic pathways to better correlate precipitation events to surface flows in order to gain

an improved understanding of the potential for an aquatic pathway existing at such pathways (e.g., collection of stream gage data where it currently does not exist);
- Where possible, maintain pristine habitats as whole, intact ecosystems to help prevent any ANS establishment at or near the basin divide. This could also include ecosystem restoration (e.g., habitat) and/or restoration of native fish populations, where appropriate;
- Land use changes at applicable areas so that potential ANS control options, if implemented, would not interfere with existing land uses (e.g., agriculture).

None of the opportunities identified above are exclusive of another. In fact, any single measure to prevent ANS transfer at a particular location may benefit from corresponding development and implementation of one or more of the other types of opportunities.

The results of these Focus Area 2 aquatic pathway assessments may also be taken into consideration during the next updates to the Statewide Invasive Species Management Plans in Minnesota, Wisconsin, Indiana, Ohio, Pennsylvania, and New York. USACE will continue to work with each state, as appropriate, on how to best incorporate the results of these aquatic pathway assessments into their individual Statewide Invasive Species Management Plans.

Where applicable, and based on authority and availability of funding, USACE will also work with states and other appropriate federal agencies to provide additional technical support and/or analysis to help identify any potential site specific measures that could be implemented by someone to prevent the interbasin transfer of ANS at any of the Focus Area 2 aquatic pathways.

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# N.5 LIST OF ACRONYMS

| | |
|---|---|
| ANS | aquatic nuisance species |
| AOC | Areas of Concern |
| Cal-Sag | Calumet-Saganashkee Channel |
| CAWS | Chicago Area Waterway System |
| CRCW | Chicago River Controlling Works |
| FEMA | Federal Emergency Management Agency |
| GLC | Great Lakes Commission |
| GLFC | Great Lakes Fishery Commission |
| GLMRIS | Great Lakes Mississippi River Interbasin Study |
| HTRW | Hazardous, Toxic, and Radioactive Waste |
| ILDNR | Illinois Department of Natural Resources |
| ILEPA | Illinois Environmental Protection Agency |
| INDEM | Indiana Department of Environmental Management |
| INDNR | Indiana Department of Natural Resources |
| NGO | nongovernmental organization |
| NPDES | National Pollutant Discharge Elimination System |
| NRCS | Natural Resources Conservation Service |
| TOC | Total Organic Carbon |
| USACE | U.S. Army Corps of Engineers |
| USEPA | U.S. Environmental Protection Agency |