# GLMRIS – Brandon Road

## Appendix A - Draft Fish and Wildlife Coordination Act Report

August 2017

U.S.ARMY

US Army Corps of Engineers®
Rock Island & Chicago Districts

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## List of Attachments

# United States Department of the Interior

FISH AND WILDLIFE SERVICE

5600 American Boulevard West, Suite 990
Bloomington, Minnesota 55437-1458

IN REPLY REFER TO:

FWS/AF

SEP 1 6 2016

Colonel Christopher T. Drew
United States Army Corps of Engineers,
Chicago District Commander
231 South LaSalle, Floor 15
Chicago, Illinois 60604

Dear ~~Colonel Drew~~: Chris

On behalf of the U.S. Fish and Wildlife Service Midwest Region (Service), I am pleased to provide you with the draft Fish and Wildlife Coordination Act Report (FWCAR) for the U.S. Army Corps of Engineers' (COE) Great Lakes Mississippi River Interbasin Study - Brandon Road Lock and Dam (BRLD) Project.

In close collaboration with COE teams from both the Chicago and Rock Island Districts, the Service has regularly engaged with agency representatives of all eight Great Lakes States to evaluate the seven alternatives proposed for controlling the upstream movement of aquatic nuisance species (ANS) at BRLD. The draft FWCAR includes a summary of comments provided to date by the participating agencies, a review and relative ranking of the proposed alternatives by the Service, a summary of the significant resources of the Des Plaines River and Great Lakes ecosystems (the two ecosystems potentially impacted by final project alternative selection), and other information. Please note, the Service has not yet received final written comments from Michigan, Minnesota, New York and Pennsylvania (we have been notified by representatives from Michigan and Minnesota that their comments are forthcoming). Any additional input provided by the States will be incorporated in the next iteration of the FWCAR.

Thank you for your ongoing efforts to address the threat of ANS through the BRLD project and other important efforts. The Service looks forward to continuing our close partnership with the COE for the benefit of the natural resources of the United States. Please contact me if you have any questions or would like to discuss further.

Sincerely,

Charlie Wooley

Charles M. Wooley
Acting Regional Director

**Draft Fish and Wildlife Coordination Act Report**

**On**

**U.S. Army Corps of Engineers GLMRIS – Brandon Road Project**

Prepared by:


U.S. Fish and Wildlife Service
Carterville Fish and Wildlife Conservation Office
Marion, IL

U.S. Fish & Wildlife Service
Midwest Regional Office
Fisheries Program
Ecological Services Program
Bloomington, IL

U.S. Fish and Wildlife Service
Green Bay Fish & Wildlife Conservation Office
New Franken, WI



U.S. Fish and Wildlife Service
Midwest Region
Bloomington, Minnesota
September 2016

## Table of Contents

APPENDICIES

I. Corps' Future Without Project Condition for Asian Carp, November 13, 2015

II. USFWS PAL to the Corps, October 30, 2015

III. Corps' GLMRIS-Brandon Road Draft December 2015 Factsheets, December 2015

IV. USFWS PAL to the Corps, March 31, 2016

V. List of the fishes of the Great Lakes and their Federal/State listing statuses

VI. List of the fishes of the Des Plaines River including tributaries from 2013 survey

VII. List of the fish collected by the Service from the Upper Des Plaines River from 2011-2015

VIII. GLMRIS Brandon Road Scoping Comments from the Illinois Department of Natural Resources to the Corps, January 16, 2015

IX. Indiana Department of Natural Resources' letter to the USFWS with comments on the draft Fish and Wildlife Coordination Act Report, September 6, 2016

X. Illinois Department of Natural Resources Des Plaines River Fishery Management Plan, June 2016

XI. Wisconsin Department of Natural Resources' letter to the USFWS with comments on the draft Fish and Wildlife Coordination Act Report, September 12, 2016

# INTRODUCTION

## Purpose, Scope, & Authority

The U.S. Army Corps of Engineers (Corps) is evaluating seven alternatives for controlling the upstream movement of Aquatic Nuisance Species (ANS) at Brandon Road Lock and Dam (BRLD). These measures are focused on preventing the transfer of three key species as identified in the Great Lakes Mississippi River Interbasin Study (GLMRIS) - Bighead Carp (*Hypophthalmichthys nobilis*), Silver Carp (*H. molitrix*; collectively Asian carp), and a scud (*Apocorophium lacustre*). The BRLD project will assess the efficacy of establishing a single point to control the upstream transfer of ANS from the Mississippi River basin into the Great Lakes basin at the BRLD site.
Construction of one-way ANS controls near BRLD is anticipated to enhance protections for the Great Lakes basin while also providing additional information and technology to inform potential two-way risk reduction solutions. Brandon Road Lock and Dam was identified in the GLMRIS analyses as the only single location that can address upstream transfer of Mississippi River species through all Chicago Area Waterway System pathways.

The U.S. Fish and Wildlife Service's (Service) involvement in this project is authorized by the Fish and Wildlife Coordination Act (FWCA). At the request of the Corps, the Service is assisting in coordination with State fish and wildlife management agencies on formal comment and review of the project under the FWCA. The FWCA establishes fish and wildlife conservation as a co-equal purpose or objective of federally-funded or permitted water resource development proposals or projects. A required product under this FWCA consultation is the Draft Fish and Wildlife Coordination Act Report (DFWCAR) which outlines the Service's fish and wildlife concerns and planning objectives, evaluates the anticipated impacts of the alternatives on the significant resources, and recommends alternatives that the Corps should consider selecting with input from affected states fish and wildlife agencies. The Service has submitted two Planning Aid Letters (PAL) to the Corps providing preliminary comments on the BRLD project and the pending evaluation of the proposed alternatives.

This DFWCAR does not constitute the FINAL report of the Secretary of the Interior as required by Section 2(b) of the FWCA. After the Corps selects an alternative, the Service will revise this draft FWCAR and provide the final FWCAR in fulfillment with Section 2(b) of the FWCA.

## FWCA Agency Coordination

The Service has coordinated with fish and wildlife management agencies from all of the Great Lakes states. On October 7, 2015, a meeting was held with Service, Corps and state fish and wildlife management agencies. The object of this meeting was to share information regarding the proposed alternatives, as well as gather comments and input from the affected states. The meeting was attended, either in person or via webinar, by representatives from the Illinois Department of Natural Resources (ILDNR), Michigan Department of Natural Resources (MIDNR), Ohio Department of Natural Resources (OHDNR), Minnesota Department of Natural Resources (MNDNR), Wisconsin Department of Natural Resources (WIDNR), and the New York State Department of Environmental Conservation (NYDEC). The comments received from the states during the meeting are incorporated into our Planning Aid Letter dated October 30, 2015.

On January 19, 2016, the Service convened another meeting with the state fish and wildlife agencies and the Corps to review and discuss the Corps' alternatives and receive an update on control technologies under development and testing conducted by the U.S. Geological Survey (USGS). The meeting was attended, either in person or via webinar, by representatives from the ILDNR, MIDNR, Indiana Department of Natural Resources (INDNR), Corps, USGS, and the Environmental Protection Agency (EPA). As an outcome of that meeting, the Service sent the states a follow-up email correspondence detailing the six alternatives (see the Combined GLMRIS-BR Factsheets – USFWS – 24Dec2015 in Appendix III) and seeking written feedback on the Corps' alternatives with regard to significant fish and wildlife resources. Agencies responses from the INDNR, MIDNR, NYSDEC, and the Service were summarized in our PAL dated March 31, 2016.

On July 26, 2016, the Service hosted a meeting in which the Corps presented draft Expert Elicitation results with state and federal fish and wildlife agencies. The meeting was conducted through the internet and by phone and was attended by representatives from ILDNR, MIDNR, INDNR, OHDNR, and MNDNR. Two days later on July 28, 2016, the Service once again met via phone with the state agencies. Although each state had some issues with the structure of the Expert Elicitation model, each state voted to use the relative ranking of efficacy of the alternatives as was laid out in the Expert Elicitation model.

The Service distributed a draft of the DFWCAR on August 29, 2016, to the ILDNR, INDNR, MIDNR, OHDNR, MNDNR, WIDNR, NYDEC, and Pennsylvania Fish and Boat Commission (PFBC) for their review. We received comments from OHDNR (September 2 and 8, 2016), INDNR (September 6 and 8, 2016), WIDNR (September 12, 2016), and ILDNR (September 13, 2016). We encourage the Corps to review these agency correspondences and consider them in their decision-making process; a summary of the correspondences is as follows:

<u>ILDNR</u>

The ILDNR sent an email with their electronic comments using the Track Changes option of Microsoft Word on September 13, 2016. The ILDNR has substantial disagreements with the content and recommendations of the draft FWCAR. A summary of their concerns is provided here.

In general, the ILDNR disagrees with the scope and purpose of the Service's draft FWCAR. They stated that the goal of the FWCA is to consider the local impacts of the project only in Illinois. For this reason, they also contend that the report should not include comments or considerations from the other Great Lakes states because they believe the alternatives will only impact local fish and wildlife resources in the Des Plaines River and around the BRLD. The ILDNR does not support the planning objectives of the FWCAR and do not think they are appropriate for a FWCAR or consistent with Illinois management of the Des Plaines River. They also commented in various ways that the effects of Asian carp establishment in the Great Lakes or the Des Plaines River are not relevant to the scope of the report and that all discussion of the Great Lakes should be removed. The ILDNR also inferred that impacts of Asian carp to the Des Plaines will not be substantial since anecdotal evidence collected by the MRWG efforts indicated that densities could be reduced by up to 70% with harvest efforts, and no species extinctions have occurred in the Illinois River since Asian carp became established. They also argued that the evaluation and comparison of the effects of the alternatives on the significant resources is not appropriate for the FWCAR and should not be included. Finally, the ILDNR commented that the Service inappropriately prioritized impacts to the Great Lakes resources over the local impacts in the Des Plaines River.

Along with the disagreement about the scope and purpose of the FWCAR, the ILDNR also noted that the descriptions of the alternatives are not consistent with their understanding based on discussion with the Corps, and all alternatives with fish entrainment measures should include a discussion of effects from water jets, flushing locks, and increased vessel movements on native species. The ILDNR also disagreed with the Service's recommended addition of the Black Carp and the use of the expert elicitation. They also commented that the NOAA model used to inform potential impacts to significant resources in the Great Lakes recognizes assumptions that may be flawed. The ILDNR also notes that an additional electric barrier has the same vulnerabilities that the Service cites regarding the Romeoville barriers, and they have significant concerns for health and safety of workers in the area and economic impacts for alternatives involving an electric barrier. Finally, the ILDNR noted that the non-structural alternatives have already reduced risk significantly and adaptive and integrated approaches are likely to improve the non-structural alternatives. They recommend that the Corps consider potential improvements to the Des Plaines jersey barrier as the most appropriate way to address the Des Plaines River over flow issues.

The ILDNR has noted that the non-structural alternatives will minimally affect Illinois' natural resources; however, because the construction alternatives seek to prevent the upstream passage of fish, significant resources in the Des Plaines will be negatively affected and the plan should include the following recommendations to reduce local impacts:

1. Recommendations to limit use of barrier to times when BRLD risk may be highest and otherwise allowing for fish passage
2. Mechanisms to facilitate healthy fish and wildlife resources affected by project (fish and mussels) recovery and sustainability in the Des Plaines River. Specific recommendations to maintain monitoring and evaluations of fish community
3. Habitat - support of habitat projects to provide needed overwintering, spawning, other life stage requirements within Des Plaines River.
4. Consider additional deterrence measures outside the basin, perhaps embolden over flow protection as an alternative, or at least rule out such an alternative could be more cost effective and prudent.
5. Consider additional approach channel technology below existing electric barrier as appropriate alternative to Plan
6. Non-game hatchery/fish culture could assist in mussel and fish species community support as well as sport fish maintenance in the Des Plaines River in absence of fish passage.
7. Fish swaps with other state/federal hatcheries to support, establish fish in absence of fish passage
8. Open up additional tributaries to fish passage by removing other barriers within the basin
9. In concert with the ILDNR Des Plaines River management plan, establish short and long term goals for fish community, mussel community, using common metrics such as IBI, diversity, even-ness, and other appropriate fish management tools. Long term goal would look 50 years + as concurrent with the absence of fish passage.
10. Recognize long term planning by local governmental agencies that include improved water quality, sanitation of effluents, initiatives to heighten water quality to allow swimming and other water contact opportunities.

11. Ensure sportfish opportunities increase concurrently with habitat improvements that are ongoing, but also projected with or without project.
12. Fully evaluate the impacts of barge fleeting area that USACE is publically discussing. This is additional to BR footprint yet can and will likely affect local fish/mussel communities.
13. Identify other impacts from barrier operations, back-up generators, noise, chemical stores, or footprints on ecosystem of supporting infrastructure on bird/wildlife, and local residents, please include human safety of residents as well as navigation and recreation water users.
14. Recognize long term decrease in risk or establishment of target ANS through other pathways that would minimize the projects needs at this location.

The ILDNR also provided comments on the Des Plaines River that were incorporated into this report including: (1) appending and incorporating more information from their 2015 scoping comment letter; (2) moving the discussion of fish passage and BRLD lock use in the Des Plaines section; (3) adding the importance of the Des Plaines watershed corridor for wildlife habitat; (4) adding discussion about American Eels and the federally endangered scaleshell and sheepnose mussels. We also incorporated their comments on the scud, including the results of a recently completed distribution assessment in the Illinois Waterway and its proximity to the Great Lakes.

The Service disagrees with ILDNR's comments about the scope and purpose of the FWCAR, the inclusion of potential impacts to the Great Lakes, the inclusion of the comments from the Great Lakes states, and the inclusion of the evaluation and comparison of the effects of the alternatives on the significant resources. As described in the Service's guidance document on the FWCA (USFWS 2004):

"Fulfillment of FWCA responsibilities ultimately requires that the FWS prepare a 2(b) report that provides 1) clear documentation of the proposed project's impacts on fish and wildlife resources and 2) specific recommendations as to the measures that should be taken to conserve those resources. Until these tasks are completed, the FWS cannot consider that all FWCA requirements have been met. Before the 2(b) report can be completed, there are four basic questions that need to be answered:
1. What are the resources likely to be affected?
2. What are the alternatives being considered or evaluated?
3. What are their impacts?
4. What will be recommended to conserve fish and wildlife resources?"

The first step in identifying the resources likely to be affected is to define the study area, which includes the areas that could potentially be impacted as a result of direct, secondary and cumulative impacts. In this case, the Corps is evaluating alternatives to control the upstream transfer of ANS from the Mississippi River basin into the Great Lakes basin at the BRLD site. The project could result in impacts to the Des Plaines River in its entirety, along with the CAWS and the Great Lakes basin because they are all hydrological connected and Asian carp and scud could move into these areas under the different alternatives. Therefore, it is appropriate to include the Great Lakes and Great Lakes states along with the ILDNR. As described above, it is also appropriate to evaluate the alternatives and their impacts.

The Service agrees with the ILDNR that the resources in the Des Plaines River are significant and impacts to those resources under all of the alternatives should be minimized and mitigation and fully considered. We have incorporated many of the ILNDR's recommendations into the Recommended Mitigation Options section below, and we believe the mitigation recommendations are as specific as possible at this point of the project given that no alternative has been selected by the Corps. The Service will update the recommendations and mitigation section after the Corps' selects their alternative.

INDNR

The INDNR sent a letter with their comments on September 12, 2016 (Appendix VIII), along with an email with their electronic comments using the Track Changes option of Microsoft Word. We incorporated all of their comments into this version of the draft FWCAR. They also raised three additional comments in their letter, summarized below.

The INDNR strongly support adding Black Carp as a species to be addressed at Brandon Road due to the expansion of the black carp population. All management plans addressing species of Asian carp along the Mississippi River or Ohio River should consider options to address black carp.

The INDNR agrees with the Service that the two options supported in the draft FWCAR (Continuous Electric Barrier and Complex Noise with Continuous Electric Barrier) would be the most effective in preventing the expansion of Asian carp populations and would still allow shipping. Continuous electricity however will create a barrier to not only invasive fish species but also to native species. While sound technology may not be fully developed at this time, additional research may reveal effective sounds that completely block Asian carp but allow other native species to pass. For this reason, it is the desire of Indiana DNR that the option that combines the sound barrier with the electric barrier be constructed at Brandon Road lock and dam. Including sound now will speed the process should effective sound technology be discovered in the future.

Finally, the INDNR urges the Corps to continue to investigate methods that may eliminate or reduce the two-way transfer of aquatic invasive species at Brandon Road. There are still a number of invasive species in the Great Lakes that are not yet established in the Mississippi basin.

MIDNR

No comments provided.

OHDNR

The ODNR Division of Wildlife sent an email with their electronic comments using the Track Changes option of Microsoft Word on September 6, 2016. We incorporated all of their comments into this version of the draft FWCAR. On September 8, 2016, they sent an email indicating they support the content and recommendations of the draft FWCAR sent to the States on August 29, 2016.

MNDNR

No comments provided.

WIDNR

The WIDNR sent a letter (Appendix XI) with their comments on September 12, 2016, along with an email with their electronic comments using the Track Changes option of Microsoft Word. We incorporated all of their comments into this version of the draft FWCAR. They also made several additional comments in their letter and these are summarized below.

The WIDNR supports the recommendation of the Service to include Black Carp as a species of concern in the evaluation of alternatives considered for the Bighead and Silver Carp at the Brandon Road Lock and Dam.

The WIDNR agrees with the Service's findings and supports the two options outlined in the draft FWCAR (Continuous Electric Barrier and Complex Noise with Continuous Electric Barrier). The WIDNR also requests that the Corps look into the use of water jets within the engineered channel as well as the chosen alternatives.

The WIDNR also feels that this report should be shared with stakeholders other than the state partners. They feel that there are a number of parties that could provide valuable comments if this was reviewed on a broader scale.

NYDEC

No comments provided.

PFBC

No comments provided.

**Prior Studies and Reports**

The following studies and/or reports are the most pertinent documents involved in producing this DFWCAR:

- Corps' January 6, 2014, Great Lakes & Mississippi River Interbasin Study Report;
- Corps' November 20, 2014 and January 05, 2015, published Federal Register documents regarding a Notice of Intent to prepare a Draft Environmental Impacts Statement and to invite members of the public to comment (open until Jan 31, 2015);
- GLMRIS Brandon Road Scoping Comments from the Illinois Department of Natural Resources to the Corps, January 16, 2015
- Corps' April 30, 2015, Draft GLMRIS-Brandon Road Feasibility Study (Project Management Plan);
- Illinois DNR's 2015, Status of fish assemblages and sport fishery in the Des Plaines River

Watershed and trends over 30 years of Basin Surveys 1983-2013;

- Corps' May 2015, GLMRIS-Brandon Road Environmental Impact Statement Scoping Summary Report;
- Corps' November 13, 2015, Future Without Project Condition for Asian Carp;
- Service's October 30, 2015, PAL to the Corps;
- Corps' December 2015, Great Lakes and Mississippi River Interbasin Study-Brandon Road Draft December 2015 Factsheets;
- Service's February 8, 2016, email to states and agencies;
- Service's March 31, 2016, PAL to the Corps;
- Zhang et.al. Forecasting the Impacts of Silver and Bighead Carp on the Lake Erie Food Web. http://dx.doi.org/10.1080/00028487.2015.1069211;
- Corps' Fact Sheet, Draft GLMRIS-BR Probability of Establishment Assessment Approach for Asian Carp and A. lacustre, USFWS - Coordination Act Submittal, dated July 1, 2016
- Corps' Draft - GLMRIS-BR Probability of Establishment Assessment Approach for Asian Carp and A. lacustre, USFWS - Coordination Act Submittal, dated July 1, 2016
- Corps' July 26, 2016, GLMRIS Brandon Road Alternatives and Expert Elicitation Presentation Slides

## DESCRIPTION OF THE STUDY AREA

The Chicago Area Waterway System is a 128 mile waterway consisting of canals and channelized rivers which are used for recreational and commercial navigation, as well as storm and waste water transport and flood control. The CAWS is located in northeastern Illinois and northwestern Indiana and consists of three lock and dam systems as well as the Corps' Electric Dispersal Barrier System (Figure 1). As you can see from the map, there are five aquatic pathways between the Great Lakes and the Mississippi River (1-5 on the map below). All of the alternatives described in this DFWCAR are focused at the Brandon Road Lock and Dam, which is located in the Des Plaines River downstream of the Electric Dispersal Barrier in Romeoville, IL. The Brandon Road Lock and Dam has been identified as the most strategic location to prevent the upstream movement of ANS because it is a single location downstream of all other hydraulic connections to the Great Lakes via the CAWS (Corps 2015b). With the exception of the lock chamber, the dimensions and configuration of the BRLD prevents the transfer of Mississippi River ANS upstream due to a dam head height of at least 25 feet.

The study area is the geographic limits of the zone of project impacts (i.e., the area being analyzed in the FWCAR). In this case, the Corps is evaluating alternatives to control the upstream transfer of ANS from the Mississippi River basin into the Great Lakes basin at the BRLD site. The study area is the Des Plaines River in its entirety, along with the CAWS and the Great Lakes basin because they are all hydrological connected and the alternatives may result in impacts to the significant fish and wildlife resources in these areas as described in the Evaluation and Comparison of Alternatives section.

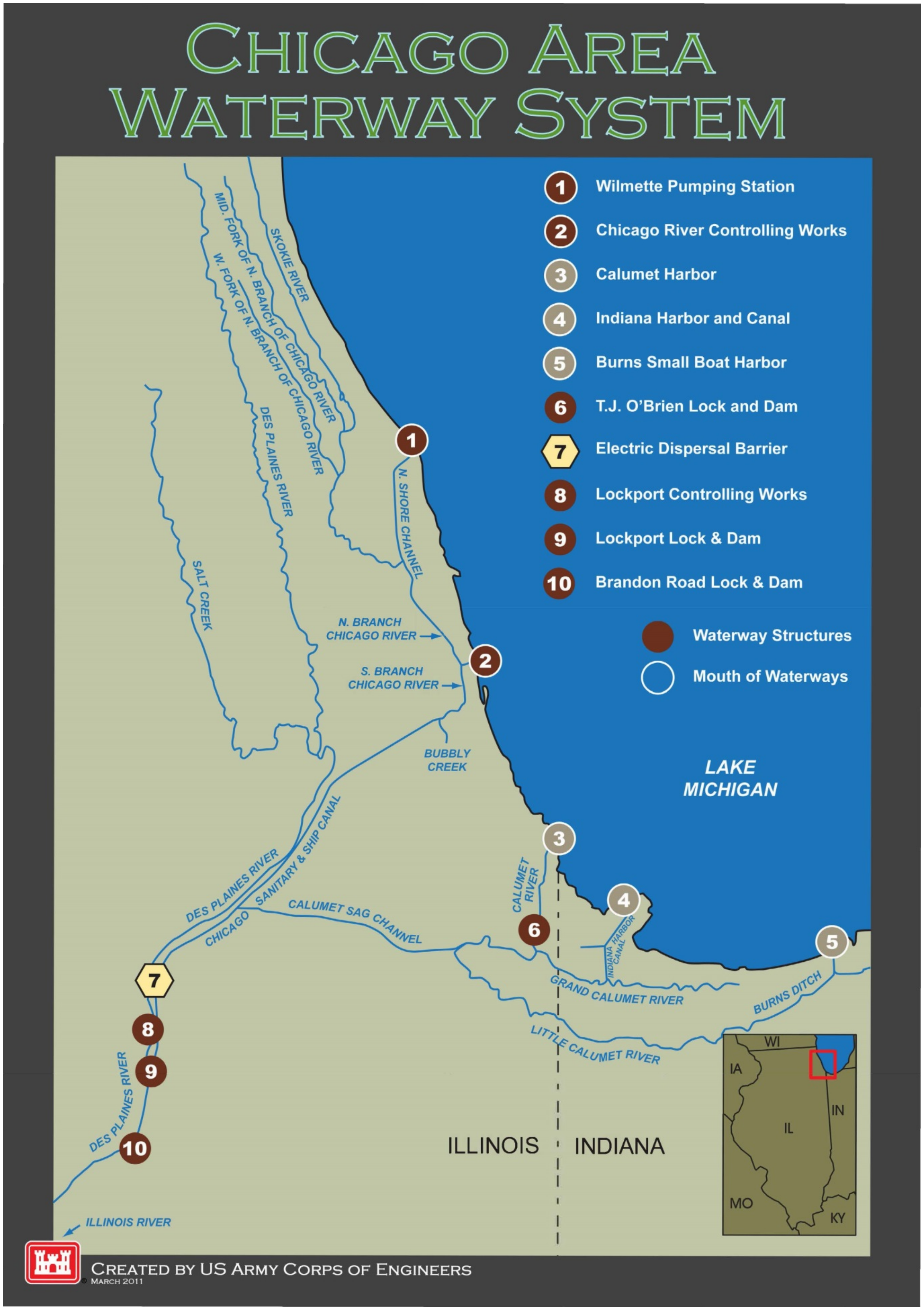


**Figure 1**. Map of the Chicago Area Waterway System showing the location of each lock and dam and the Electric Dispersal Barrier. (http://www.glmris.anl.gov/documents/docs/ChicagoWaterwaySystemOutput.pdf

## DESCRIPTION OF CORPS' ALTERNATIVES

Seven alternatives have been proposed by the Corps, which represent a range of options to prevent the transfer of select ANS from the Mississippi River to the Great Lakes. Of these, two are non-structural in nature (nothing physically constructed) and five contain one or more structural components. The five structural alternatives would also include the actions proposed in the two non-structural options. The descriptions of these alternatives were provided by the Corps.

All alternatives include the continued operation of the Corps' electric barriers at Romeoville and fish monitoring, using the principles of adaptive management. Alternatives 3 through 6 also include activities outlined in the Non-structural Alternative, including fish entrainment mitigation and "swimmer" controls (water jets), and a flushing lock. Assuming authorization for construction in fiscal year 2021 and capability funding for planning, engineering design, and construction, the nonstructural measures are estimated to begin in 2021, and the implementation of new structural features is estimated to be complete in 2025.

### 1. No New Federal Action

This alternative assumes that the monitoring and fishing response actions that are relevant to a GLMRIS-BR project and are currently being conducted by federal, state and local agencies, will continue to be funded through 2018. After 2018, the level of effort for these activities is assumed to be lower than current efforts because no additional funds are assumed to be available through the Great Lakes Restoration Initiative. This alternative does not include the construction of a permanent control point for Asian carp and future ANS at BRLD. No monitoring or control would occur for the scud. This alternative does include the potential use of the ILDNR mobile electric barrier and also includes the continued operation of the CSCC Electric Barriers in Lockport Pool approximately five miles upstream of the Lockport Lock and Dam.

### 2. Non-structural Alternative

Includes the actions included in the No New Federal Action Alternative and brings that effort to the current level of effort pertaining to Asian carp monitoring and control. This alternative does not include the construction of permanent structures. It includes monitoring, overfishing, piscicides, research and development, integrated pest management, and outreach and education. The overfishing is assumed to be more robust compared with the current level of effort. Monitoring would be conducted for the scud. The Nonstructural Alternative includes monitoring to assess whether the alternative achieves its anticipated outcome, and adaptive management promotes flexible decision-making that can be adjusted in light of uncertainties.

### 3. Technology Alternative – Continuous Electric Barrier

This alternative involves the installation of a new electric barrier within an engineered channel downstream of the BRLD, fish entrainment mitigation (water jets), a flushing lock and nonstructural measures. The electric barrier would operate continuously. This alternative will include monitoring and adaptive management. The Romeoville Electric

Barriers would continue to operate.

**4. Technology Alternative 2 – Complex Noise**

This alternative involves the use of complex noise which would be installed within a newly engineered channel at BRLD, fish entrainment mitigation (water jets), a flushing lock and nonstructural measures. This alternative will include monitoring and adaptive management. The Romeoville Electric Barriers would continue to operate. Assuming authorization for construction in fiscal year 2021 and capability funding for planning, engineering design, and construction, the nonstructural measures are estimated to begin in 2021, and the implementation of new structural features is estimated to be complete in 2025.

**5. Technology Alternative 3 - Complex Noise with Intermittent Electric Barrier**

This alternative involves the installation of both an electric barrier and complex noise within an engineered channel at BRLD, fish entrainment mitigation (water jets), a flushing lock and nonstructural measures. The electric barrier would operate when no vessels are present and complex noise would operate at least when the electric barrier is not in use. This alternative will include monitoring and adaptive management. The Romeoville Electric Barriers would continue to operate. Assuming authorization for construction in fiscal year 2021 and capability funding for planning, engineering design, and construction, the nonstructural activities are estimated to begin in 2021, and the implementation of new structural features is estimated to be complete in 2025.

**6. Technology Alternative 4 - Complex Noise with Continuous Electric Barrier**

This alternative involves the installation of both an electric barrier and complex noise within a newly engineered channel at BRLD, fish entrainment mitigation (water jets), a flushing lock and nonstructural measures. The electric barrier would operate continuously and complex noise would supplement the electric barrier. This alternative will include monitoring and adaptive management. The Romeoville Electric Barriers would continue to operate. Assuming authorization for construction in fiscal year 2021 and capability funding for planning, engineering design, and construction, the nonstructural activities are estimated to begin in 2021, and the implementation of new structural features is estimated to be complete in 2025.

**7. Lock Closure**

This alternative would close the upper operational lock gates upon authorization. Later, the upstream lock gates would be removed and a permanent concrete wall along the upstream end of the lock would be installed. This alternative includes nonstructural measures and monitoring and adaptive management. The Romeoville Electric Barriers would continue to operate. Assuming authorization for construction in fiscal year 2021 and capability funding for planning, engineering design, and construction, the lock would be closed in fiscal year 2021, the nonstructural activities are estimated to begin in 2021, and the construction of the permanent lock closure is estimated to be complete in

2023.

**Further Information on the Alternatives**

**Engineered Channel –** This structure would be constructed within the approach channel of the BRLD. The length of the engineered channel is unknown at this time, although the costs and impacts of such a channel are being studied and evaluated. There are several identified benefits to such a channel, such as limit the availability of refugia, increased efficiency for monitoring of Asian carp, increased sound dispersal, easier access to fish clearing, and provides an area where further experimental ANS controls can be studied or implemented.

**Fish Entrainment –** Fish have the potential to become entrained in barge voids as well as by currents created by up-bound and down-bound tows. Several possible actions have been explored to prevent these occurrences.

> **Water jets –** Water jets would be incorporated into the engineered channel and arranged in such a way as to displace fish from potential entrainment areas. Another series of water jets could be installed along the sides of the channel to reduce the number of fish entrained in currents along the sides of the barges passing through the channel. The use and configuration of water jets is still being studied at this time.
>
> **Vessel Maneuvers –** Vessel operations may also provide a potential action to reduce the likelihood of entrainment. These maneuvers could include a reduction in speed or putting the tow in a hard reverse as was seen during the Service's 2015 Barge Entrainment Study. Both of these methods will be tested by the Service during the 2016 Barge Entrainment Studies.

**Flushing Lock –** The purpose of this strategy is to flush floating organisms from within the lock when the lock is at the lower pool elevation. This method also has the potential to flush small fish from the lock. Water would be taken from upstream of the lock (BRLD pool) and pumped through culverts used to fill and empty the lock. This method is still in the developmental stage as the availability of water may be an issue.

| GLMRIS Brand Road Alternative Measures & Features | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Alternative | ANS Control Measures/Features | | | | | | | | | ANS Control Measures/Features Images & Figures |
| | Sustained Current Activity | Non-structural | Engineered Channel | Fish Entrainment Mitigation (Water Jets) | Complex Noise | *Continuous* Electric Barrier | *Intermittent* Electric Barrier | Flushing Lock | Lock Closure | |
| Sustained Current Activity (No New Action) | x | | | | | | | | | |
| Nonstructural Alternative | x | x | | | | | | | | |
| Technology Alternative – Continuous Electric Barrier | x | x | x | x | | x | | x | | |
| Technology Alternative – Complex Noise | x | x | x | x | x | | | x | | |
| Technology Alternative – Complex Noise with Intermittent Electric Barrier | x | x | x | x | x | | x | x | | |
| Technology Alternative – Complex Noise with Continuous Electric Barrier | x | x | x | x | x | x | | x | | |
| Lock Closure/ Physical Barrier | x | x | | | | | | | x | |

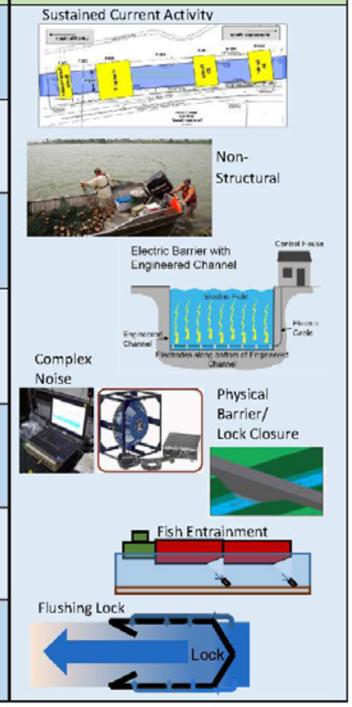


**Figure 2.** Chart summarizing the GLMRIS Brandon Road alternative measures and features. (USACE)

## FISH AND WILDLIFE CONCERNS AND PLANNING OBJECTIVES

Aquatic nuisance species represent a primary threat to the health of aquatic systems and their related economies in the United States, often having significant impacts in areas where they become established. For several decades, the large river systems of the Midwest have been increasingly threatened by impacts from introduced aquatic species. During the past two decades, Asian carp (including Bighead Carp and Silver Carp) have increased their range through portions of the Mississippi and Ohio River basins, as well as the Illinois Waterway and Chicago Area Waterway Systems (CAWS), posing a threat to the rich biodiversity and related economies of the Great Lakes. In total, ANS have cost our nation's economy billions of dollars per year (Pimental 1999).

Prevention of the invasion and establishment of Asian Carp in the Great Lakes is a critical objective of the Service and our partnering agencies efforts and has been a primary focus of the Asian Carp Regional Coordinating Committee (ACRCC) for the last several years. Each species has the potential to cause significant ecological and economical damage to the resources of the Great Lakes if they were to invade and establish.

Silver Carp are produced in aquaculture more than any other fish worldwide. Brought to the United States in the early 1970s to control phytoplankton (algae) in municipal waste water and aquaculture ponds, they eventually spread into the Mississippi River as a result of escapement from hatcheries and research projects that used these fish in municipal sewage systems, and their accidental inclusion in shipments of other non-detrimental fish species. Silver Carp are unique in that, unlike other species of Asian carp, they have a tendency to jump out of the water when disturbed. They thrive in large river systems with high phytoplankton productivity, and have been found in waters of 20 states and Puerto Rico. By the early 2000s, the middle and lower Illinois River was estimated to have the highest density of Silver Carp worldwide.

Silver Carp can exceed 3.5 feet and 60 pounds, and are typically short lived at around 5 to 7 years of age. Silver Carp reach sexual maturity between 2 and 4 years of age, and multiple spawning events during a single year have been documented. Silver Carp are planktivorous, generally consuming microorganisms at the base of the food web, but can be opportunistic and consume a variety of food sources, based on availability. Their dietary patterns may allow them to out-compete both small and large native fish for this important forage resource by quickly and effectively filtering large amounts of plankton from the water column. Silver Carp are currently found in 21 states (source: USGS NAS database, http://nas.er.usgs.gov/).

Bighead Carp, which can tolerate a wide range of temperatures and water quality conditions, were also imported to the United States in the early 1970s for municipal waste water and aquaculture purposes and subsequently escaped into the Mississippi River. Bighead Carp typically have a lifespan of approximately 8 to 10 years and can reach lengths of over 5 feet weighing in excess of 100 pounds. Reaching a large body size early in life limits their susceptibility to native fish predators. Bighead Carp reach sexual maturity between 2 and 4 years of age, and multiple spawning events during a single year have been documented. Bighead Carp are planktivorous, generally consuming microorganisms at the base of the food web, but they can be opportunistic and consume a variety of food sources based on availability. Their dietary patterns may allow them to out-compete both small and large native fish for this important forage resource by quickly and effectively filtering large amounts of plankton from the water column. Bighead Carp are currently found in 27 states (source: USGS NAS database, http://nas.er.usgs.gov/).

Within the Illinois River and the project area, adult Asian carp (specifically Bighead and Silver Carp) are abundant in parts of the Illinois River. Downstream populations are well established in the Alton, LaGrange, and Peoria Pools. While comparatively less than at these downstream locations, Asian carp are still commonly present in the Starved Rock and Marseilles pools. Adult Asian carp are collected in the Dresden Island Pool (including the Rock Run Rookery backwater in that pool) and Lower Kankakee River, but these captures are relatively rare. One adult Bighead Carp was captured in Lockport Pool in 2009 and there have been two credible sightings in the Brandon Road Pool of Asian carp. Additionally, field tracking information demonstrates that telemetered adult Asian carp have been shown to approach the BRLD.

Small Asian carp (<6”) are more of an invasion concern, compared to large adults, due to their being less susceptible to electricity (control and detection) and the higher potential for them to be inadvertently entrained by moving barges. To date, this smaller cohort has not been found as far upstream as adults. Prior to 2015, small Asian carp collections were confined to Peoria Pool and areas downstream. In 2015 small Asian carp have been captured in Starved Rock Pool, just a few hundred feet downstream from Marseilles Lock and Dam, including the presence of three larval Silver Carp in Dresden Island pool in June 2015. Monitoring efforts also take place in Brandon Road and Lockport Pools. There have been no collections of Bighead Carp or Silver Carp in Brandon Road Pool; however, sightings in 2010-2011 of 1 Bighead Carp and 1 Silver Carp have been made by ACRCC’s Monitoring and Response Work Group efforts. This represents an upstream increase in the range of detected small Asian carp of 48 miles from 2014 to 2015. Spawning has been verified as far upstream as Marseilles Lock and Dam. See Figure 3 for more details on adult and juvenile Asian carp and spawning. For more information on these sources, please see: http://asiancarp.us/documents/MRP2014-InterimSummary.pdf.

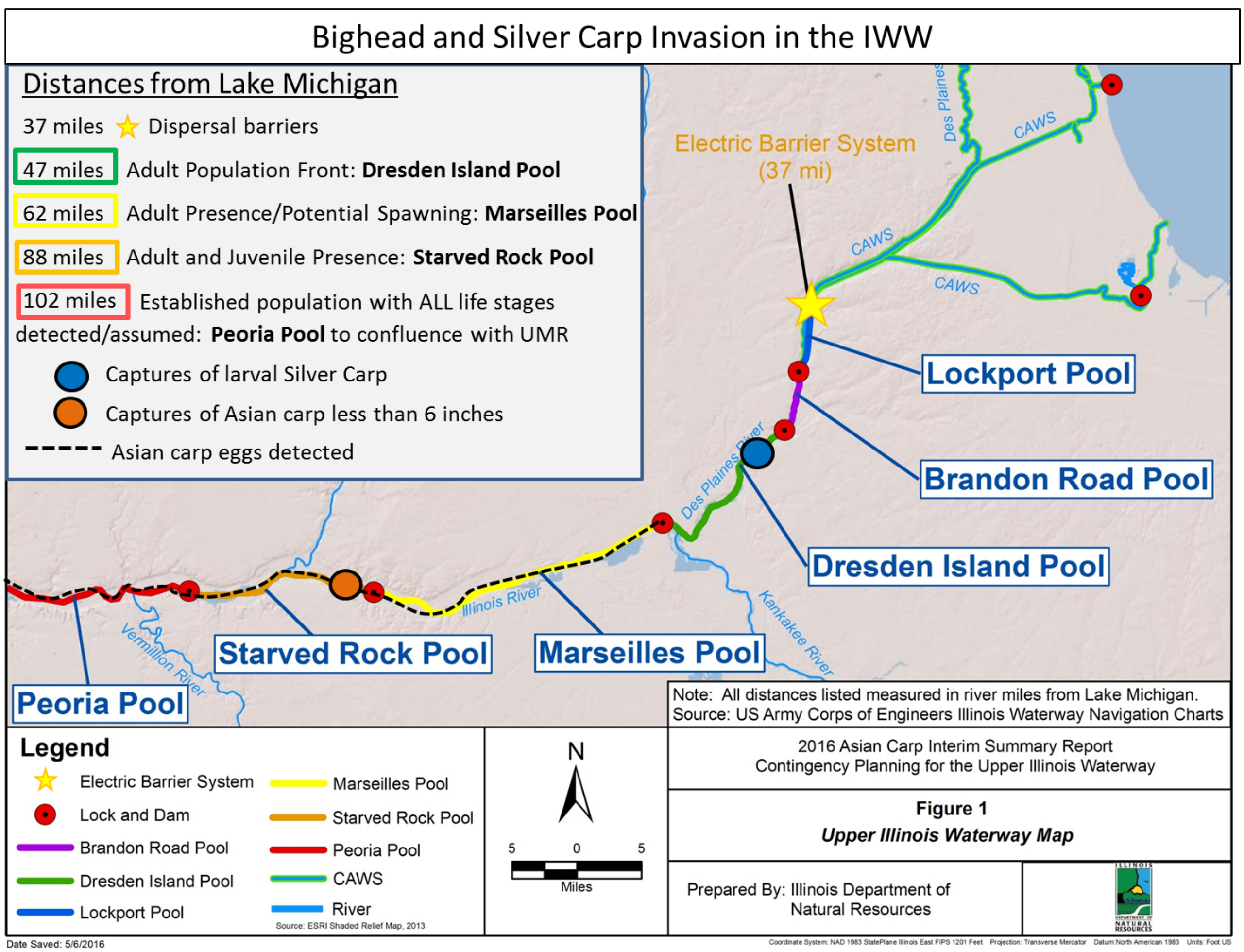


**Figure 3.** Presence of Asian carp in the Illinois Waterway.

Black Carp, which are native to eastern Asia, were first introduced as a control to fish parasites in aquaculture facilities in the 1970’s, and have been reported in at least 5 states since their

14

escapement into the Upper Mississippi River Basin. Its preferred habitat is the bottom of rivers where it is known to feed heavily on mussels and snails, making it suitable for biological control of parasite-infected host snail populations in aquaculture ponds. Its escape from aquaculture has raised significant concern for its preferred food because nearly 70% of native mussel fauna known to have occurred in the Upper Mississippi River Basin are now imperiled or extinct. Black Carp are very large in size, with an average of up to 3 feet in length and 33 pounds but some individuals can reach 5 ft and 150 lbs. It is believed they have a life span that may exceed 15 years and reach sexual maturity anywhere from 6 to 11 years of age.

The increasing frequency of Black Carp captures from the Mississippi River and tributaries since 2011 has raised concerns that this species may be becoming established in the wild; data from 33 Black Carp collected from 2011-2015 (including two age-0 fish caught in November 2015) indicate that natural reproduction and recruitment to adulthood have occurred. In 2016, there has already been 21 confirmed captures of Black Carp within the drainage of the Mississippi River. Nearly all of these specimens were analyzed and determined to be diploid, the others were unable to have their ploidy determined. The implementation of a bounty program funded by the Illinois DNR and Southern Illinois University could have increased the reporting of these fish, nonetheless they are still there and their proximity to the Great Lakes is just over 300 river miles.

The Service is concerned about the increasing captures and location of Black Carp in the Mississippi River basin, and recommends that alternatives considered for Bighead and Silver Carp at the Brandon Road site should also address Black Carp. FWS provided comments to the Corps during the public scoping period in late 2014/early 2015 advising that Black Carp be added to the list of species being considered during project development. We reiterated our recommendation in the October 2015 PAL. However, the Corps has not expanded the scope of species formally being considered beyond the original three species initially identified in the GLMRIS report for the Brandon Road Lock and Dam.

The scud is hull fouling (i.e., transported on boat hulls) species (Grigorovich et al. 2008) and is native to the Atlantic coast of North America, but it has invaded the Mississippi River Basin, with known occurrences in the Mississippi River, Ohio River, and Illinois River (USGS 2011) . Surveys have confirmed its presence just above the Dresden Lock and Dam, less than 20 miles from the BRLD. Although its potential impacts have not been well studied, it is believed that it could out-compete other benthic filter feeders, such as native mussels. In other regions where the species is established it has impacted native food webs.

Based on the potential impacts from these ANS species, the Service has identified the following three planning objectives that were used to qualitatively evaluate the relative ability of each individual alternative to meet these objectives:

(1) Prevent the introduction and establishment of Bighead, Silver, and Black Carp[1] species in the Great Lakes and the Des Plaines River

[1] FWS added Black Carp to the fish and wildlife planning objectives even though it is not formally under consideration by the Corps.

(2) Prevent the introduction and establishment of scud in the Great Lakes and Des Plaines River

(3) Minimize and mitigate impacts to native species in the Des Plaines River ecosystem.

## DESCRIPTION OF FISH AND WILDLIFE RESOURCE CONDITIONS

In this section, we define the quality, quantity, and significance of the resources likely to be affected by the GLMRIS Brandon Road Project. This section establishes the existing baseline conditions of the resource that ultimately support all future projections, impact evaluations, and mitigation recommendations. We have determined that the ecological resources of the Great Lakes and the Des Plaines River are significant resources likely to be affected by the project.

### The Great Lakes

The five Great Lakes cover about 302,000 square miles and include part or all of the eight U.S. states of Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania and New York and the Canadian provinces of Ontario and Quebec (Figure 4). The Great Lakes basin covers an area of 295,700 square miles and spans over 900 miles from east to west and about 700 miles from north to south. Fifty-nine percent of the surface area of the Great Lakes basin is in the United States; 41 percent is in Canada (Great Lakes Commission 2003). The Great Lakes watershed is comprised of lakes Superior, Michigan, Huron, Erie and Ontario; their connecting waterways, St. Mary's River, St. Clair River, Lake St. Clair, Detroit River and Niagara River; and the St. Lawrence River, which carries the waters of the Great Lakes to the Atlantic Ocean. The system includes several man-made waterways and control structures that either interconnect Great Lakes or connect the Great Lakes to other river systems. The Great Lakes - St. Lawrence River basin consists of 109 watersheds in the U.S. and 67 watersheds in Canada. Because of the size of the system, it responds slowly to environmental and hydraulic changes (Rankin 2002).


**Figure 4.** Map of Great Lakes Watershed (http://www.great-lakes.net/teach/geog/intro/intro_2.html)

16

The Great Lakes basin features an extensive watershed with approximately 5,000 tributaries, more than 1,000 miles of shoreline, and approximately 35,000 islands. The watershed supports thousands of wetlands with diverse plant communities that provide important habitat (e.g. breeding and rearing areas) for wetland-dependent animals including waterfowl and other migratory birds, and over 150 native fish species (including federally- and state-listed species) (OMNR 2011). Hydrology, sediment transport and other fluvial processes work together to shape stream channels, lake shorelines and floodplains throughout the basin. Bedrock, relief and weather also help to determine the physical, chemical and biological qualities of the basin. To the north, the climate is cold and the terrain is dominated by granite bedrock called the Canadian (or Laurentian) Shield consisting of Precambrian rocks under a generally thin layer of acidic soils. In the southern areas of the basin, the climate is much warmer. The soils are deeper with layers or mixtures of clays, silts, sands, gravels and boulders deposited as glacial drift or as glacial lake and river sediments. The lands are usually fertile and can be readily drained for agriculture. About 52 percent of the basin is forested; 35 percent is in agricultural uses; 7 percent is urban/suburban; and 6 percent is in other uses (Great Lakes Commission 2003).

**Cultural and Economic Significance**

The Great Lakes are an important part of the physical and cultural heritage of North America. With the exception of Lake Michigan, the Great Lakes straddle the Canada-United States border and together are the world's largest freshwater system (20% of the world’s fresh surface water). The Great Lakes directly impact the lives of approximately 40 million people (10% of the U.S. and 25% of the Canadian populations), including over 60 aboriginal communities, that live within the watershed. The Great Lakes have played a major role in the history and development of the United States and Canada, with some of the world's largest concentrations of industrial capacity currently located in the watershed. The Great Lakes also support world-class commercial and recreational fisheries in both Canada and the U.S., provide recreation, serve as platforms for commercial transportation, and provide both tangible and intangible benefits to both Canadian and U.S. residents. This includes serving as a primary source of water for municipalities and industries, and serving as a source of both fossil fuels and sustainable energy (including wind power, oil and natural gas), and routes for waterborne transport of iron ore, coal, grain, and other commodities and manufactured goods between domestic and overseas markets. Currently, nearly 25% of the total Canadian agricultural production and 7% of the American production are located in the Great Lakes watershed.

The Great Lakes provide considerable subsistence, social, cultural, and spiritual benefits to the people residing in the watershed, and considerable benefit to the economy as a whole. Socially, the beaches and shorelines provide a “sense of place” and unique source of community pride, and serve as key measures for public perceptions of environmental quality. The Great Lakes also provide opportunities for research and educational activities that result in a better understanding of the ecology. Freshwater fisheries have contributed substantially to the preservation of traditional aboriginal life-styles in the watershed. The Great Lakes commercial fishery is of major economic significance and provides a valuable food supply for numerous Native American Tribes who continue to fish for subsistence under court affirmed treaty rights. Participants in the fishing industry in the U .S. generate about $2.22 billion in sales to local businesses and the industry represents $4.4 billion in annual economic activity. About 75,000 jobs are supported by sport fisheries, and commercial fisheries provide an additional 9,000 jobs and $270 million annually. Recent economic analyses found that the annual benefit from the Great Lakes recreational boating industry and commercial, sport, and tribal fisheries together exceeds 16.4 billion dollars (Southwick Associates 2007; US Army Corps of Engineers (USACE, 2008).

The Great Lakes also provide a wide range of recreational opportunities, ranging from pristine wilderness activities in national parks such as Isle Royale and Pukaskwa to intensive urban waterfront beaches in major urban areas. The major recreational activities in the Great Lakes include commercial fishing, recreational fishing, hunting, boating, beach and lakefront use, and wildlife viewing. It is estimated that the annual value of economic contribution of these activities in and around the Great Lakes watershed is $13.8 billion dollars. Of that total, expenditures made and imputed values/prices for these activities comprised $13.4 billion (96.9%), while consumer surplus made up the remaining $0.4 billion (3.1%). Throughout the Great Lakes region, recreational boating alone accounted for over 246,000 jobs and contributed $19 billion annually to the U.S. economy based on a 2000 report (Great Lakes Waterways Management Forum 2000) and is likely to be greater today. Great Lakes boaters spend over $1.5 billion on annual direct and secondary watercraft-related sales, and support over 50,000 jobs related to watercraft sales and trips (USACE 2008). The eight Great Lakes states have about 3.7 million registered recreational boats, or about one-third of the nation's total. Approximately one million recreational boats ply the U.S. waters of the Great Lakes each year, and the recreational industry generates around $4 billion annually. Governance of the Great Lakes basin and its resources falls under the management of two Federal governments (Canada and the U.S.), eight States (Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania and New York, several Native American Tribes, and two Canadian Provinces (Ontario and Quebec).

**Biological Significance**

Ecologically, the Great Lakes' landscape features and complex habitat types are globally unique, supporting a rich and diverse variety of species. Important migration corridors and critical breeding, feeding, and resting areas are present for numerous species of migratory and resident birds—especially waterfowl, colonial nesting birds, and neotropical migrants. Areas within the Great Lakes shoreline zones are the most diverse and productive areas of the watershed. Examples include relatively warm and shallow waters near the shore, coastal wetlands, and the land areas directly affected by lake processes. Wetlands also play an essential role in sustaining a productive fishery, with many species of Great Lakes fish depending on coastal wetlands for successful reproduction. More than 200 species of fish inhabit the rivers, streams, and coastal areas of the Great Lakes watershed. In addition, the streams provide habitat for many other aquatic organisms throughout various stages of their life cycles such as mussels.

**Ecosystem/Habitat Characteristics**

**Nearshore Areas**

The nearshore areas of the Great Lakes are diverse physical habitats, exhibiting a range of morphometric features, current velocities, substrates, and aquatic vegetation. These features, combined with seasonal fluctuations in temperature, provide conditions optimum to many fish and wildlife species in the Great Lakes for at least a portion of their life cycle. The nearshore waters are areas of permanent residence for some fishes, migratory pathways for anadromous fishes, and temporary feeding or nursery grounds for other species from the offshore waters. Fish species diversity and production in the nearshore waters are higher than in offshore waters; they also vary from lake to lake and are generally highest in the shallower, more enriched embayments with large tributary systems. Nearshore areas are also locations of greatest development and human interaction with the Great Lakes. This concentrated activity has resulted in the degradation of water quality and also in a significant loss of nearshore fish and wildlife habitat. Physical modifications have disrupted coastal and nearshore processes, flow and littoral circulatory patterns, and altered nearshore habitat. This has created ideal conditions for colonization by ANS including lithophilic organisms such as dreissenids, Round Goby, and other non-native species (Environment Canada and the USEPA 2009).

Three major thermal groupings or fish communities—warmwater, coolwater, and coldwater—occur in the Great Lakes. Preferred summer temperatures range from 27$^{o}$C to 31$^{o}$C range for warmwater fish (e.g., catfishes, basses, and sunfishes), from 21$^{o}$C to 25$^{o}$C range for coolwater fish (Yellow Perch, Walleye, and pikes), and coldwater fish (trout, salmon, whitefishes, deepwater sculpins) are usually found at temperatures below 15$^{o}$C (Magnuson et al. 1979). Of 139 Great Lakes fish species reviewed by Lane et al. (1996a), all but five species—the deepwater ciscoes (*Coregonus hoyi*, *C. johannae*, *C. nigripinnis*, *C. reighardi*, *C. zenithicus*) and Deepwater Sculpin (*Myxocephalus thompsoni*)—typically use waters less than 10 m deep as nursery habitat; and even the latter has been captured from shallows in the St. Clair River delta (Leslie and Timmins 1991a). Adults of many species occur over a range of depths, but 80% of fish species in the Great Lakes use nearshore areas for at least part of the year (Lane et al. 1996b).

**Coastal Wetlands**

Along the shoreline, coastal wetlands provide an important link between aquatic and terrestrial systems in the Great Lakes watershed. The functions of Great Lakes coastal wetlands - biological, chemical, and physical processes that occur naturally within a wetland - include the storage and cycling of nutrients and organic materials carried by rivers and streams to the watershed, food web production, biological productivity groundwater recharge, stream base flow maintenance, and habitats for a wide range of Great Lakes species. Many fish species, for example, depend upon coastal wetlands for some portion of their life cycles. Great Lakes coastal wetlands are found throughout the entire watershed and span a diversity of types, from freshwater estuaries to lagoons and marshes. Despite providing significant ecosystem and societal benefits, in many areas 50 to 90% of coastal wetlands have been lost due to development, pollution, invasive species, unnatural water level fluctuations and climate change impacts. Water quality is one factor in determining plant communities and that in turn influences fish community structure. For example, Lakes Erie and Ontario tend to have more wetlands containing cattail communities and therefore fish communities of lower richness and diversity.

The role of coastal wetlands in fish production relates primarily to providing both nursery and spawning habitat, and several authors have reported high species richness of young fishes from wetland habitats (Stephenson 1990). The fundamental prerequisites for nursery habitat of virtually all larval fish species are abundant food supply and protection from predators. The proliferation of aquatic macrophytes in coastal wetlands provides microhabitat for fish eggs and larvae, the necessary cover from predator species, and the storage and release of nutrients (Petering and Johnson 1991). In addition, higher water temperatures promote higher growth rates for larvae, as well as providing favorable conditions for all life phases of certain warm water fish species. Based on intensive fish sampling prior to 2003 at more than 60 sites spanning all the Great Lakes, round gobies have not been sampled in large numbers at any wetland or have been a dominant member of any wetland fish community. Therefore, it seems likely that wetlands may be a refuge for native fishes, at least with respect to the influence of Round Goby. Ruffe (*Gymnocephalus cernuus*) have never been found in high densities in coastal wetlands anywhere in the Great Lakes. In one study, it was concluded that coastal wetlands in western Lake Superior provide a refuge for native fishes from competition with Ruffe. The mudflat-preferring Ruffe avoids wetland habitats due to foraging inefficiency in dense vegetation that characterizes healthy coastal wetland habitats (Environment Canada and the USEPA 2009). Therefore, further degradation of coastal wetlands could lead to increased dominance by Ruffe in shallow water habitats. Bighead Carp and Silver Carp species represent a substantial threat to food webs in wetlands and nearshore habitats.

**Rivers and Streams**

Thousands of rivers and streams flow within the Great Lakes watershed. These watercourses range from small, headwater streams to main tributary rivers to the large connecting channels. More than 170 species of fish inhabit the rivers, streams, and channels of the Great Lakes watershed, and the connecting channels also function as important spawning and nursery habitats. Connecting channels also have an important role in the transport of water, sediments, nutrients, and contaminants (Sparks 1995).

Migratory fishes play a functional role in the dynamics of tributary connectivity and Great Lakes ecology by assisting in the movement of materials (such as nutrients and energy) between and among lake and riverine habitats. As fish migrate up rivers to spawn, the nutrients contained in their tissues come with them. When they die and decompose, or when larvae or unfertilized eggs/sperm decompose, those nutrients become available for incorporation in the local food web. Similarly, fish that feed during migrations assist in consuming and moving energy to different parts of the ecosystem. Some of the native Great Lakes migratory fishes commonly targeted by regional conservation and restoration plans include the following: Lake Sturgeon (*Acipenser fulvescens*), Lake Trout (*Salvelinus namaycush*), Lake Whitefish (*Coregonus clupeiformis*), Longnose Sucker (*Catostomus catostomus*), minnows (Cyprinid spp.), Shorthead Redhorse (*Moxostoma macrolepidotum*), Silver Redhorse (*Moxostoma anisurum*), Walleye (*Sander vitreus*), White Sucker (*Catostomus commersonii*), Northern Pike (*Esox lucius*), Smallmouth Bass (*Micropterus dolomieu*), Yellow Perch (*Perca flavescens*), sunfishes (Centrarchid spp.), Burbot (*Lota lota*), Channel Catfish (*Ictalurus punctatus*), and Atlantic Salmon (*Salmo salar*) (see Appendix V for a comprehensive list).

Streams and rivers provide critical spawning and nursery habitat for over one-third of Great Lakes fishes, including Walleye, Lake Sturgeon, Coaster Brook Trout (*Salvelinus fontinalis)*, suckers, and native lamprey. Dams and barriers have been having a significant impact on the aquatic ecosystems of the Great Lakes for over a century and are a key factor in the decline of several species of fishes. As early as 1861, southern Ontario alone had over 2,000 mills reported in the annual census (Fischer and Harris 2007). Accessibility to streams has been reduced by a variety of anthropogenic barriers such as dams, culverts at road-stream crossings, and dikes. In addition to improvements for migratory fishes, improving aquatic connectivity can also have a number of benefits for restoring aquatic systems. These include: reducing water temperatures, increasing levels of oxygen, transport of nutrients and woody debris, restoring natural flood cycles, and increasing the amount of riparian and coastal wetland cover.

**Offshore Zones**

The offshore zones, or interior of the Great Lakes, are the real unique characteristic of the Great Lakes that makes them stand apart from other large freshwater lake ecosystems. The offshore zone contains most of the water and living components of the Great Lakes ecosystem. The offshore zone is important habitat for Alewife (*Alosa pseudoharengus*) and other prey fishes, as well as trout and salmon and other cold water fishes. The vast size and depth of this zone make it difficult to comprehend and appreciate. An important ecological feature of the offshore zone is its summertime organization into a warmer upper layer (epilimnion) and a deeper, cooler layer (metalimnion), which combined is considered the pelagic (open water) zone. The upper layer receives the most light and nutrients and produces the free-floating algae or phytoplankton which supports all other forms of life in the Great Lakes. The deepest layer of water below the metalimnion, the hypolimnion, sits overtop a large offshore bottom area in which fish and other benthic animals (mussels, worms, clams, amphipods and shrimp) reside. The deep, cool waters of the lakes are primarily home to large, predatory fish. Originally there were Lake Trout, Lake Whitefish, Burbot, sculpins (Cottidae family), and six species of deepwater ciscoes that inhabited the center of the lakes. The latitudinal gradient from Lake Superior to Lake Erie causes the dominant species to vary across the Laurentian system. In Lake Erie, warm-water species like Walleye dominate the food web, while the rest of the four, cooler lakes are dominated by salmonids.

The deepwater fish community of the Great Lakes has undergone drastic changes over the past century (Ebener et al. 1995). Commercial fishing and the invasion by Sea Lamprey (*Petromyzon marinus*) caused lake trout populations to collapse by 1950 (Eshenroder 1992). Two other exotic fish species, the Alewife and Rainbow Smelt (*Osmerus mordax*), have become abundant in the lake since the 1930's and have been implicated in the declines of native species (Evans and Loftus 1987). With the exception of the Bloater (*Coregonus hoyi*), deepwater ciscoes were drastically reduced in abundance or extirpated from some of the Great Lakes by the 1960's (Eshenroder and Burnham-Curtis 1999). Lake Trout have been stocked annually in some of the lakes since the 1970's in an attempt to restore the species, but this effort has been only marginally successful to date (Whelan and Johnson 2004). Since the late 1960's, nonnative Pacific salmon (Oncorhynchus spp.) have been stocked into the lakes (Tanner and Tody 2002), and Sea Lamprey abundance has declined due to an extensive control program (Smith and Tibbles 1980). Chinook salmon (*Oncorhynchus tshawytscha*) now reproduce naturally in some of the lakes and support an economically valuable sport fishery (Bence and Smith 1999). Since the late 1980's, a new wave of exotic species— including the zebra mussel (*Dreissena polymorpha*), quagga mussel (*Dreissena bugensis*), Round Goby (*Neogobius melanostomus*), and spiny water flea (*Bythotrephes longimanus*) (a predatory zooplankter) — invaded the Great Lakes (Ricciardi and MacIsaac 2000). These recent invaders have been responsible for a number of ecological changes in the Great Lakes, from negative interactions with individual species to large-scale ecosystem engineering (Hecky et al. 2004).

A number of significant changes have been observed in offshore ecosystems in recent years, including increased water clarity (Budd et al. 2001); an increase in outbreaks of botulism in fish and birds (Yule et al. 2006); a drastic reduction in abundance of benthic amphipods (Diporeia spp.) (Nalepa et al. 2007); decreased abundance and altered community structure of zooplankton; an increase in the occurrence of natural reproduction by Lake Trout (Riley et al. 2007); decreases in abundance, size at age, and condition of Lake Whitefish (Mohr and Ebener 2005) and Pacific salmon; and precipitous declines in Chinook salmon harvest. Beyond changes in species composition, threats to the offshore zone include warming temperatures and even algal blooms (Vanderploeg et al. 2001).

## Aquatic Species Communities

### Fish

Historically, the food web of the Great Lakes was relatively simple. Phytoplankton and green algae in particular served as the base of the food web. Phytoplankton was consumed by *Diporeia* and zooplankton, and in turn, these organisms were eaten by a host of small and important preyfish species. In general, Lake Trout was the top predator, except in Lake Erie and some of the other shallow embayments of the upper Great Lakes where Walleye was the top predator. However, today Great Lakes fishes are impacted by ongoing food web changes. The phytoplankton communities of Lakes Michigan and Huron have seen a notable reduction in size and extent in the spring. Zooplankton communities are changing and declining throughout much of the watershed. Larger-sized zooplankton species, typically located in waters of low biotic productivity, are making up an increasing proportion of the community during the summer in most of the upper lakes while smaller zooplankton decline. *Diporeia*, once the main food source for small fish in the Great Lakes is now almost gone, except in Lake Superior. The *Diporeia* decline has resulted in a change in the diets of small fish as well as reductions in small fish weight and energy. The overall decline of zooplankton has strong implications for the food web because these organisms are an important link between phytoplankton and healthy fish populations. The establishment of Asian carps would further exacerbate these food web changes.

Lake Sturgeon were historically abundant in the Great Lakes, with spawning populations using many of the major tributaries, connecting waters, and shoal areas across the watershed. The decline of Lake Sturgeon populations in the Great Lakes was rapid and commensurate with habitat destruction, degraded water quality, and intensive fishing associated with settlement and development in the watershed. The Lake Sturgeon is now extirpated from many tributaries and waters where they once spawned and flourished. They are considered rare, endangered, threatened, or of watch or special concern status by the various Great Lakes fisheries management agencies. Their harvest is currently prohibited or highly regulated in most waters of the Great Lakes (Environment Canada and the USEPA 2014).

Historically, Lake Trout were the keystone salmonine predator for most of the Great Lakes. Overfishing and predation by non-native Sea Lamprey, and to a limited extent other factors, destroyed nearshore (lean) populations and deep water (siscowet) Lake Trout populations, but many survived in Lake Superior and a few lean Lake Trout populations in Lake Huron (Lawrie and Rahrer 1972; Berst and Spangler 1972; Wells and McLain 1972; Hartman 1972; Christie 1972). Rehabilitation efforts through stocking and controls on fisheries and Sea Lamprey have been ongoing since the early 1960s (Hansen et al. 1995; Eshenroder et al. 1995; Holey et al. 1995; Cornelius et al. 1995; Elrod et al. 1995). Populations in Lakes Michigan, Erie, and Ontario are mostly below Great Lakes Fishery Commission Lake Committee target levels for relative abundance, and natural reproduction is low (Environment Canada and the USEPA 2014).

In Lake Superior, natural reproduction of both lean and siscowet populations is widespread and supports all populations. Most stocking has been discontinued and fisheries are well managed. Sea Lamprey mortality has been increasing. In Lake Michigan, little natural reproduction or significant recruitment of wild fish to the population has been detected. Survival of stocked fished in northern Lake Michigan is poor due to high Sea Lamprey mortality and fishing resulting in inadequate parental stocks. In Lake Huron, more than ten year classes of wild Lake Trout have been observed lake wide and represent 20% of survey catches and 33-60% of harvest in recent years. Abundant year classes of wild Lake Trout are now entering the adult portion of the population, and their presence on the spawning grounds should help stimulate more natural reproduction.

In Lake Erie, overall Lake Trout abundance has increased in more recent years due to adoption of a revised rehabilitation plan (Markham et al. 2008) that increased stocking numbers back to their original level. Recruitment of stocked fish, including Klondike strain Lake Trout, has been high. However, Sea Lamprey abundance remains high and above targets despite increased lampricide treatments, and this continues to suppress the adult Lake Trout population. In Lake Ontario, Lake Trout abundance has increased each year since 2007. Post-release survival of stocked fish and natural reproduction has remained low since the early 1990s. Despite widespread catches of small numbers of natural recruits nearly every year during 1993- 2010, a failure to achieve self-sustaining stocks has been attributed to the dense populations of Alewives in Lake Ontario and an associated diet of Lake Trout that favors Alewives (leading to Early Mortality Syndrome), the absence of suitable alternative deepwater preyfishes, and colonization of spawning reefs by invasive Round Goby (Fitzsimons et al. 2003; Lantry et al. 2003; Schneider et al. 1997; Walsh et al. 2011).

The health of native Walleye populations in the Great Lakes is quite variable. In lakes where exotic species have been on the decline (including Alewife) and increases in productivity have been beneficial, there have been some rebounds in the Walleye populations. Where productivity increases or other factors have been deleterious to ecosystem health, Walleye populations have struggled to maintain the robust levels recently attained. Recruitment trends in each Great Lake or in each localized (embayment) sub-population continue to play a large part in the overall health of

Walleye. Consistent years of good recruitment in a given time series has helped fortify specific Great Lakes Walleye populations, while poor overall recruitment trends in spite of one or two banner years of recruitment has eroded some Great Lakes Walleye populations (Environment Canada and the USEPA 2014).

In all five Laurentian Great Lakes, preyfish biomass has decreased since 1988. This decrease in preyfish biomass may be partly attributable to predation by piscivorous fish populations. However, other factors likely contributed to the decrease in preyfish biomass, including variation and gaps in recruitment of ciscoes, shifts of fish populations to waters deeper than those sampled by bottom trawl surveys, declines in offshore primary productivity and phosphorous levels, and negative effects induced by dreissenid mussel and *Bythotrephes* invasions. Expansion of non-native gobies in demersal habitats of the lower lakes is symptomatic of a change in the food web. At present, Bloater, Cisco (*Coregonus artedi*), Rainbow Smelt, Alewife, and Deepwater Sculpin constitute the bulk of the preyfish communities across the five lakes. In Superior, juvenile Lake Whitefish is a principal prey species. Other species contributing a lesser extent to the preyfish assemblages include Pygmy Whitefish (*Prosopium coulteri*), Ninespine Stickleback (*Pungitius pungitius*), Round Goby, Trout-perch (*Percopsis omiscomaycus*), and Slimy Sculpin (*Cottus cognatus*). In Lake Erie, the preyfish community is unique among the Great Lakes in that it is characterized by relatively high species diversity. The preyfish community comprises primarily Gizzard Shad, Alewife, Emerald (*Notropis atherinoides*) and Spottail (*N. hudsonius*) shiners, Silver Chub (*Hybopsis storeriana*), Trout-perch (*Percopsis omiscomaycus)*, Round Goby, Rainbow Smelt, age-0 Yellow Perch, White Perch (*Morone americana*), and White Bass (*M. chrysops*) (Environment Canada and the USEPA 2014).

The preyfish assemblage forms important trophic links in the aquatic ecosystem and constitutes the majority of the fish production in the Great Lakes. In Lake Superior, abundance of preyfish populations, dominated by native coregonids, continues to fluctuate with a downward trend that sharply steepened in 2009. The decline in preyfish populations since the early 1990s is attributed to recruitment variation and predation by recovered lake trout populations. Non-native Rainbow Smelt remains as a principal component of preyfish assemblage. Round Goby are present though rare in western Lake Superior and Eurasian Ruffe, though uncommon, continues to colonize inshore waters and embayments. The Lake Superior preyfish community is considered improving because of an increase in the proportion of native species comprising the assemblage and the prey base's ability to support the recovery of the wild lake trout population (Environment Canada and the USEPA 2014).

In Lake Michigan, several preyfish populations (i.e., Alewife, Bloater, Rainbow Smelt, and Deepwater Sculpin) are near historic lows, while densities of non-native Round Goby are increasing. The decline in *Diporeia* and expansion of dreissenids, particularly quagga mussels, to deeper waters signal a shift in food web toward greater biomass in the benthic food web relative to the pelagic one. In Lake Huron, non-native preyfish populations are at historic lows and native Bloater has become the dominant prey species. The decline in *Diporeia* and colonization of dreissenids likewise signals a shift in food web toward a benthic organization and further community change. In Lake Erie, preyfish (spiny-rayed and softfin fish species) populations have increased since the early1990s but have fluctuated considerably. Biomass of clupeids has declined since 2001. Non-native Round Goby populations expanded rapidly after 1994, peaked in 2007, and afterwards declined by 90%. The colonization of dreissenid mussels has resulted in major changes in the food web (Environment Canada and the USEPA 2014).

In Lake Ontario, non-native preyfish populations have fluctuated about historic lows, and non-native Alewife remains the dominant prey species. Abundance of non-native Round Goby has declined sharply since 2008. Colonization of offshore waters by dreissenids has increased energy flow from the pelagic to the lake bottom. Catches of native Deepwater Sculpin, a population thought to be extirpated from Lake Ontario, have increased steadily in catches taken at depths > 70 m since 2005. Native deepwater ciscoes have not been reported in the lake since 1983, however, initial restoration efforts have begun. A new invasive invertebrate, *Hemimysis anomala*, was discovered in 2006 and has become widely established in nearshore waters. Thus far, its impacts on the lake ecosystem appear to be minimal (Environment Canada and the USEPA 2014).

The Great Lakes still support a sustainable commercial fishery. The U.S. portion of the Great Lakes fishery is valued at $22.5 million with a harvest level of 19.3 million pounds. Lake Michigan's baseline harvest level is approximately 6.4 million pounds with an associated value of $8.9 million. The primary contributor to Lake Michigan's harvest levels and values is comprised of Lake Whitefish, which is harvested by state-licensed commercial fishermen in Michigan and Wisconsin, as well as tribal commercial fishermen (of the CORA member tribes). Lake Whitefish accounted for approximately 88% of Lake Michigan's total harvest level and 29% of the total Great Lakes harvest level in 2009. Lake Erie's baseline harvest level is 4.9 million pounds with an associated value of $5.0 million. The harvest of species in the temperate bass and perch families (such as White Bass, White Perch, Yellow Perch, and Walleye) account for the majority of the harvest level on Lake Erie. In 2009, the total harvest of all these species accounted for approximately 3.0 million pounds and represented 55% of the Lake's total harvest level. Lake Huron, Lake Superior and Lake Ontario accounted for a total of 41.9% of the Great Lakes' baseline harvest level and 38.1% of its value. The harvest of Lake Whitefish on Lake Huron and Lake Superior, and Yellow Perch on Lake Ontario, are key contributors to the watersheds' baseline values (Kinnunen 2003).

Based on information collected by the OMNRF, the Ontario commercial fishing industry harvested 27.5 million pounds of fish in 2014. Of this amount, 22.8 million pounds were harvested from Lake Erie. Lake Erie has consistently provided between 74% and 83% of the total fish harvested over the 2004-2014 time period. In 2014, Ontario's commercial fish landings were valued at $34.7 million, with $27 million attributed to Lake Erie. The commercial landed values were $43.3 million in 2006, falling to $30.6 million in 2009, before increasing to $40.9 million in 2012. In 2014, the primary contributors to Ontario's harvest levels and values were composed of Yellow Perch (42%), Walleye (29%) and Lake Whitefish (15%). While some fish (such as Walleye) are harvested for their high quality, species of lower value (such as Rainbow Smelt) are still sought after due to their abundance. Commercial fishing generated revenues of $1.11 million for the Ministry of Natural Resources and Forestry in 2014-2015. In 2013, the commercial fishing industry contributed approximately $35.4 million to the economy (Ontario Ministry of Natural Resources and Forestry 2016, Statistics Canada, and Ontario Commercial Fisheries' Association 2016).

**Mussels**

Freshwater mussels are of unique ecological value as natural biological filters, food for fish and wildlife, and indicators of good water quality. In the United States, some species are commercially harvested for their shells and pearls. These slow-growing, long-lived organisms can influence ecosystem function such as phytoplankton ecology, water quality, and nutrient cycling. As our largest freshwater invertebrate, freshwater mussels may also constitute a significant proportion of the freshwater invertebrate biomass where they occur. Because they are sensitive to toxic chemicals, mussels may serve as an early warning system to alert us of water quality problems. They are also good indicators of environmental change due to their longevity and sedentary nature. Since mussels are parasitic on fish during their larval stage, they depend on healthy fish communities for their survival. Native mussels inhabit the riverine areas of the Great Lakes but are now in severe decline due to habitat alteration, poor water quality, and invasive species, such as zebra and quagga mussels (collectively referred to as dreissenids) (Environment Canada and the USEPA 2009).

Many areas in the Great Lakes, such as Lake St. Clair and Lake Erie, have lost over 99% of their native mussels of all species as a result of the impacts of dreissenids. Although Lake Erie, Lake St. Clair, and their connecting channels historically supported a rich mussel fauna of about 35 species, unionid mussels were slowly declining in some areas even before the zebra mussel invasion. For example, densities in the western basin of Lake Erie decreased from 10 unionids/$m^2$ in 1961 to 4/$m^2$ in 1982, probably due to poor water quality. In contrast, the impact of the zebra mussel was swift and severe. Unionids were virtually extirpated from the offshore waters of western Lake Erie by 1990 and from Lake St. Clair by 1994, with similar declines in the connecting channels and many nearshore habitats. The average number of unionid species found in these areas before the zebra mussel invasion was 18; after the invasion, 60% of surveyed sites had 3 or fewer species remaining, 40% of sites had none left, and abundance had declined by 90 to 95%. It was feared that unionid mussels would be extirpated from Great Lakes waters by the zebra mussel. However, significant communities were recently discovered in several nearshore areas where zebra mussel infestation rates are low. These remnant unionid populations, found in isolated habitats such as river mouths and lake-connected wetlands, are at severe risk. Reproduction is occurring at some of these sites, but not all. Further problems are associated with unionid species that were in low numbers before the influx of the non-native dreissenids. A number of species that are listed as endangered or threatened in the United States or Canada are found in some of these isolated populations in the Great Lakes and in associated tributaries (Environment Canada and the USEPA 2009).

**Migratory Birds**

The Great Lakes watershed provides important migration corridors and critical breeding, feeding, and resting areas for numerous species of migratory and resident birds - especially waterfowl, colonial nesting birds and neotropical migrants. Marshes and mudflats along Great Lakes shorelines are key for migrating shorebirds, waterfowl, and waterbirds. Wetlands are the most important part of the migratory cycle, providing food, resting places and seasonal habitats. In addition to wetlands, the other habitat that is exceedingly important to birds in the Great Lakes is islands. Most of the islands in the Great Lakes occur in nearshore areas (i.e., in water that is less than 30 meters deep). On the Great Lakes, islands provide nesting habitat for more than 105 species of aquatic birds including colonially nesting gulls, terns, herons, cormorants, waterfowl, and aquatic raptors.

## Interjurisdictional Species

Interjurisdictional fish are fish populations whose management and allocation of use are the collective responsibility of two or more States, Tribes, and/or Nations. Interjurisdictional fish are not necessarily migratory, but can move either short or long distances between political jurisdictions in the completion of their life cycles. Many fish inhabiting the Great Lakes are interjurisdictional and fall under the management of two Federal governments, eight States, several Native American Tribes, and two Provinces. Interjurisdictional fish species of the Great Lakes include Lake Sturgeon, Brook Trout, Lake Trout, Lake Whitefish, Muskellunge, American Eel, Short-jaw Cisco (*Coregonus zenithicus*), Yellow Perch, Walleye, and Smallmouth Bass.

## Treaty Species

At present, there are 27 federally recognized Native American tribes residing within the U.S. portion of the Great Lakes watershed, and more than half of the tribes are part of negotiated treaty settlements with the U.S. Government. The fish, wildlife and natural resource interests of Native Americans in the Great Lakes cover large areas included under the Treaties of 1836, 1837, 1842 and 1854. These treaty settlements have secured the tribes' rights to continue and uphold traditional way-of-life practices on the lands ceded to the U.S. Government. Today, the tribes that continue to practice subsistence harvesting recognize the importance of maintaining a sustainable resource and, through the treaties, are able to regulate and monitor their own harvesting while still utilizing and promoting traditional fishing methods. The tribes are involved in protecting and managing traditional fisheries and certain tribes maintain fish hatcheries along the shores of the Great Lakes and raise native species such as Walleye and Sturgeon. Species of principal subsistence and commercial fishing importance to the tribes include catfish, Burbot, Freshwater Drum, bowfins, lampreys, minnows, mooneyes, smelt, White Sucker, sunfishes, Trout-perch, White Bass, Lake Sturgeon, Lake Trout, Lake Whitefish, Yellow Perch, Walleye, and Northern Pike.

Management jurisdiction within Treaty ceded waters is held by the federal court system. Fishery resources within each Treaty boundary are allocated among Tribal and State governments through a federal court order. Fisheries are co-managed by Federal, State, and Tribal governments to meet target levels of harvest based on the presence of available native and stocked fish populations at the time of signing each Consent Decree. Federal, Tribal, and State fishery agencies manage and sustain fisheries through stocking, fishery regulations, habitat restoration and sea lamprey control. For example, the 2000 Consent Decree, resulting from federal litigation in U.S. v Michigan, governs the allocation, co-management, and regulation of fisheries by the State of Michigan and five Tribes in the 1836 Treaty waters of the Great Lakes. The Decree was signed in August 2000 by Bay Mills Indian Community, Grand Traverse Band of Ottawa and Chippewa Indians, Little River Band of Ottawa Indians, Little Traverse Bay Bands of Odawa Indians, Sault Ste. Marie Tribe of Chippewa Indians, the State of Michigan, and the United States and is in place through 2020. Agencies annually devote significant resources toward ensuring the goals are met or exceeded, and disputes are minimized or avoided through consensus. Estimates of harvest and recruitment, as well as management goals for each season, rely heavily on accurate and state-of-the-art stock assessment and population dynamics modelling and science. Any action that substantially frustrates achieving the harvest goals and objectives within the 1836 Treaty waters could result in reopening the terms of the Decree and cause each of the parties to spend considerable resources to renegotiate the terms of the Decree.

**Threatened and Endangered Species**

A recent survey of biological diversity identified 130 globally endangered or rare plant and animal species which inhabit the Great Lakes ecosystem. Human population growth, and the disturbances in the natural environment that are often a consequence, have impacted trust resource species and their habitats. The Great Lakes ecosystem has lost more than half of its original wetlands, and the changes in habitat type and extent have contributed to numerous plant and animal extirpations throughout the Great Lakes watershed.

At least 60 fish species are federally- or state-listed as threatened or endangered or are considered special concern in the Great Lakes and include the following: Spoonhead Sculpin (*Cottus ricei*), Deepwater Sculpin, Lake Sturgeon, Mooneye, Lake Herring (*Coregonus artedi*), Kiyi (*Coregonus* kiyi), Short-jaw Cisco, River Redhorse (*Moxostoma carinatum*), Greater Redhorse (*Moxostoma valenciennesi*), Sauger (*Sander canadensis*), Round Whitefish (*Prosopium cylindraceum*), Brook Trout, Northern Madtom (*Noturus stigmosus*), River Darter (*Percina shumardi*), Eastern Sand Darter (*Ammocrypta pellucida*), Channel Darter (*Percina copelandi*), Pugnose Minnow (*Opsopoeodus emiliae*), Bigmouth Shiner (*Notropis dorsalis*), Silver Shiner (*Notropis photogenis*), Bridle Shiner (*Notropis bifrenatus*), Striped Shiner (*Luxilus chrysocephalus*), Silver Chub, Lake Chubsucker (*Erimyzon sucetta*), Northern Brook Lamprey (*Ichthyomyzon fossor*), Spotted Gar (*Lepisosteus oculatus*), Northern Redbelly Dace (*Phoxinus eos*), and Redside Dace (*Clinostomus elongatus*) (see Appendix V for a comprehensive list of Great Lakes fishes and Federal/State listing statuses).

Native mussels also inhabit riverine areas within the Great Lakes watershed. Numerous mussel species are federally- or state-listed as threatened or endangered in the Great Lakes and include the following: clubshell (*Pleurobema clava*), northern riffleshell (*Epioblasma torulosa rangiana*), rabbitsfoot (*Quadrula cylindrical*), rayed bean (*Villosa fabalis*), snuffbox mussel (*Epioblasma triquetra*), spectaclecase (*Cumberlandia monodonta*), purple wartyback (*Cyclonaias tuberculata*), scaleshell (*Leptodea leptodon*), black sandshell (*Ligumia recta*), threehorn wartyback (*Obliquaria reflexa*), hickorynut (*Obovaria olivaria*), round hickorynut (*Obovaria subrotundra*), round pigtoe (*Pleurobema sintoxia*), kidney shell (*Ptychobranchus fasciolaris*), fawnsfoot (*Truncilla donaciformis*), lilliput (*Toxolasma parvum*), paper pondshell (*Utterbackia imbecillis*), fat pocketbook (*Potamilus capax*), white catspaw (*Epioblasma obliquata perobliqua*), wavyrayed lampmussel (*Lampsilis fasciola*), salamander mussel (*Simpsonaias ambigua*), and higgins eye pearly mussel (*Lampsilis higginsii*). In addition, a large amount of mussel species in the Great Lakes watershed are considered special concern species and are not listed.

Declines in populations of bird species that use wetlands almost exclusively for breeding, combined with an increase in some wetland edge and generalist species, suggest changes in wetland habitat conditions may be occurring. Over the past decade, statistically significant declining trends were detected for wetland bird species including: American coot (*Fulica americana*), black tern (*Chlidonias niger*), blue-winged teal (*Anas discors*), common grackle (*Quiscalus quiscula*), common moorhen (*Gallinula chloropus*), least bittern (*Ixobrychus exilis*), undifferentiated common moorhen/American coot, northern harrier (*Circus cyaneus*), pied-billed grebe (*Podilymbus podiceps*), red-winged blackbird (*Agelaius phoeniceus*), sora (*Porzana carolina*), tree swallow (*Tachycineta bicolor*), and Virginia rail (*Rallus limicola*). Much of the Great Lakes coastal aquatic and terrestrial landscapes that once supported migrating birds has been lost or degraded, yet the watershed supports hundreds of millions of migrants during both spring and fall migration. Several migratory bird species are federally- or state-listed as threatened or endangered or are considered special concern in the Great Lakes and include the following: piping plover (*Charadrius melodus*), red knot (*Calidris canutus*), whooping crane (*Grus americana*), black tern (*Chlidonias niger),* and common tern (*Sterna hirundo*).

**Overview and Threats/Stresses**

Today, the Great Lakes face a number of serious challenges. The most significant of these include toxic substances, invasive species, nonpoint source pollution and nearshore impacts, habitat and species loss, and a need for better information to guide decision making.

Aquatic and terrestrial invasive species continue to cause ecological and economic damage, and greatly complicate efforts to restore the Great Lakes. New aquatic species of invaders have arrived at the rate of about one every eight months, adding to the more than 180 already established in the basin. Enhanced prevention and control efforts are necessary to stop new invasive species like Asian carp and the scud from becoming established in the Great Lakes. Pollution from nonpoint sources contributes to impaired water quality and excess nutrients. Many of our coastal areas also suffer from sewer overflows that contaminate the water and close the beaches. Habitat destruction and degradation due to development, competition from invasive species, and alteration of natural lake level fluctuations and flow regimes, poor coastal development planning and land management, and habitat fragmentation have negatively impacted wildlife. This has led to altered food webs, a loss of biodiversity, and poorly functioning ecosystems (Great Lakes Restoration Initiative Action Plan 2011).

While the Great Lakes region has been a leader for innovative science and advances in natural resource management, there are still significant gaps in knowledge about ecological processes and key indicators of ecosystem health. Efforts must be strategically chosen in order to obtain the additional information needed to inform implementation activities, assist tracking and reporting of progress, and to identify adaptive management actions. The Great Lakes also face new and emerging problems such as the effects of climate change, including potentially changing long-term Great Lakes water levels and the timing and duration of ice cover. Collectively, these problems have seriously compromised the environmental health of the Great Lakes. As a result, there is a new sense of urgency for action to address the highest priorities for restoring and protecting the Great Lakes (Great Lakes Restoration Initiative Action Plan 2011).

## Overview of Restoration and Recovery Efforts

History has shown that the Great Lakes are highly sensitive to biological and chemical stresses. While restoration progress has been made through years of concerted effort and expenditures on the part of federal, state, tribal and local governments and other stakeholders, progress has been slow-moving in the past. When running for president, Barack Obama issued a campaign promise to protect and restore the Great Lakes. The pledge built upon a May 2004 Executive Order that created the Great Lakes Interagency Task Force to coordinate federal restoration efforts. In 2005, some 1,500 stakeholders created the Great Lakes Regional Collaboration Strategy (GLRC Strategy) that outlined challenges facing the lakes, a framework for restoration and protection, and a common set of recommended solutions across eight priority issue areas:

The President's FY 2010 budget included $475 million for a new Great Lakes Restoration Initiative (Initiative), strategically targeting programs and projects to address the most significant problems in the Great Lakes ecosystem to demonstrate measurable results. The EPA, in concert with its federal partners on the Task Force and other stakeholders, lead the development and implementation of the Initiative and administer the funding. Building upon the extensive planning and collaboration that was done by the Task Force and a wide variety of stakeholders and non-governmental partners in development of the GLRC Strategy, the Task Force developed a plan for FY 2010 (Great Lakes Restoration Initiative Action Plan 2011).

During the first five years of the Great Lakes Restoration Initiative, federal agencies and their partners completed all of the management actions required to remove five Areas of Concern from the list of areas designated as the most contaminated sites on the Great Lakes by the 1987 Great Lakes Water Quality Agreement: Ashtabula River, Deer Lake, Sheboygan River, Waukegan Harbor, and White Lake. The Presque Isle Bay Area of Concern was also delisted in 2013—only the second delisting on the U.S. side of the border since Areas of Concern were designated pursuant to the 1987 Great Lakes Water Quality Agreement (Great Lakes Restoration Initiative 2014).

Federal agencies and their partners have engaged in an unprecedented level of activity to prevent new introductions of invasive species in the Great Lakes ecosystem. Surveillance programs formed the foundation for a multi-species early detection network, and partner agencies responded to several detections, including red swamp crayfish in Wisconsin and Ohio, Grass Carp in Michigan and Ohio, hydrilla in New York and Ohio, and eDNA for Silver and Bighead Carp in the Chicago Area Waterway System. Federal agencies and their state partners have also reduced the risk of invasive species in ballast water discharges, and public education efforts have helped boaters, anglers and other resource users prevent the spread of invasive species. No new introductions have occurred through the ballast water pathway since 2006 (Great Lakes Restoration Initiative 2014).

The GLMRIS included the evaluation of potential secondary hydrologic pathways for the movement of AIS between the Great Lakes and Mississippi River basins, including Asian carp. These were identified as hydrologic interbasin connections that exist intermittently between the two watersheds during periods of high water/flooding. The report identified a total of 18 secondary pathways, and generally categorized them with respect to their relative risk as a pathway of AIS interbasin movement. In Indiana, a secondary pathway was identified at Eagle Marsh, near Fort Wayne, intermittently connecting the Wabash River and Maumee River watersheds. The pathway was closed in May 2016 as result of construction of an earthen berm and fencing to divide the area where floodwaters from the two different basins would historically meet during high-water events (above the 100-year flood level). In Ohio, additional GLMRIS secondary pathways were identified at Little Killbuck Creek, Ohio-Erie Canal, Mosquito Creek Lake, and Grand Lake St Marys. The USACE subsequently developed an individual GLMRIS Aquatic Pathway Assessment Report for each of the four locations. Building on these findings, planning efforts are currently underway to develop options for mitigating risk, with the goal of evaluating, identifying and implementing preferred alternatives for closure of these pathways to AIS. Collaboration on secondary pathway closure efforts in Ohio includes the Ohio DNR, USACE, USDA-NRCS, US EPA, private landowners and others.

Federal agencies and their partners also targeted activities to reduce the largest nonpoint source of phosphorus inputs to Great Lakes nearshore areas – nutrient runoff from agricultural lands. Farmers were provided with financial and technical resources to implement conservation systems to reduce nutrient runoff and to control soil erosion. Conservation programs in GLRI priority watersheds helped producers reduce phosphorus in runoff that impacts the Great Lakes nearshore waters, contributing to nuisance and harmful algal blooms and hypoxia (Great Lakes Restoration Initiative 2014).

Finally, federal agencies and their partners, including states and tribes, have worked to protect, restore and enhance habitat in the Great Lakes basin. More than 600 habitat protection, restoration, and enhancement projects were implemented throughout the Great Lakes basin by federal agencies and their partners. More than 80,000 acres of wetlands and 33,000 acres of coastal, upland, and island habitat were protected, restored and enhanced. Data was also collected to document baseline conditions for fish, amphibian, invertebrate, bird, plant, and water quality for all coastal wetlands in order to inform protection and restoration decisions. The following actions were taken to conserve native species that were once broadly distributed across the lakes: assisted with the delisting of the federally endangered Lake Erie water snake; improved conditions for endangered and threatened species including the bog turtle, Canada lynx, copperbelly water snake, Eastern Massasauga rattlesnake, Hines emerald dragonfly, Karner blue butterfly, Kirtland's warbler, lakeside daisy, Mitchell's satyr butterfly, piping plover, and Pitchers thistle; implemented projects that led to 48 populations of native aquatic non-threatened and non-endangered species becoming self-sustaining in the wild (e.g. Lake Sturgeon and Lake Trout) (Great Lakes Restoration Initiative 2014).

## The Des Plaines River

The Des Plaines River (Figure 5), which originates in the counties of Kenosha and Racine, Wisconsin, starts as a small prairie stream and flows south into the state of Illinois. The river flows through five counties in Illinois before joining with the Kankakee River forming the Illinois River. The Des Plaines is approximately 133 miles in length and encompasses a watershed of 2110 square miles, of which 1,231 are in the state of Illinois (Appendix X). In the early 1900's, water from

Lake Michigan was diverted through the Chicago Sanitary and Shipping Canal (CSSC) and the Calumet-Saganashkee (Cal Sag) Channel which then flow into the Des Plaines River. The CSSC joins the Des Plaines River just north of Joliet, Illinois. As part of the CSSC construction, a 16 mile section of the Des Plaines was channelized (Appendix X). The gradient of the Des Plaines River is fairly low and falls around 120 feet in elevation over the 110 mile stretch through Illinois.

Within the northeastern section of Illinois, the watershed of this system includes parts of Lake, Cook, DuPage, Grundy, and Will counties. There are currently over 6 million people living in the Des Plaines watershed which leads to the primary land uses being urban (58.7%) and agricultural (33.2%). The Des Plaines River has five major tributaries which comprise 693 square miles of the 2,110 square mile watershed. Of these tributaries, the largest is the DuPage River (353 sq. miles) which is located in DuPage County (Appendix X). Within the Des Plaines River watershed, there are 85 waste water treatment plants and 44 dams. Since 2011, 6 of the 12 low head dams on the mainstream have been removed. Five of the remaining six dams (i.e., all except Brandon Road) located in Cook and Lake Counties are slated for removal (Pescitteli 2015).

The Brandon Road Lock and Dam, which is located on the Des Plaines River, is 13 miles upstream of the confluence with the Illinois River. The lock opened in 1933 as a joint effort by the state of Illinois and the federal government. The lock is 600 feet long and 110 feet wide. The dam is a total of 2,931 feet long. In 2015, almost 12 million tons of freight was moved through the lock (USACE 2016). Although Brandon Road Lock and Dam is a partial barrier there is evidence that fish are passing through the lock and dam, however the extent is unknown (see more information below).

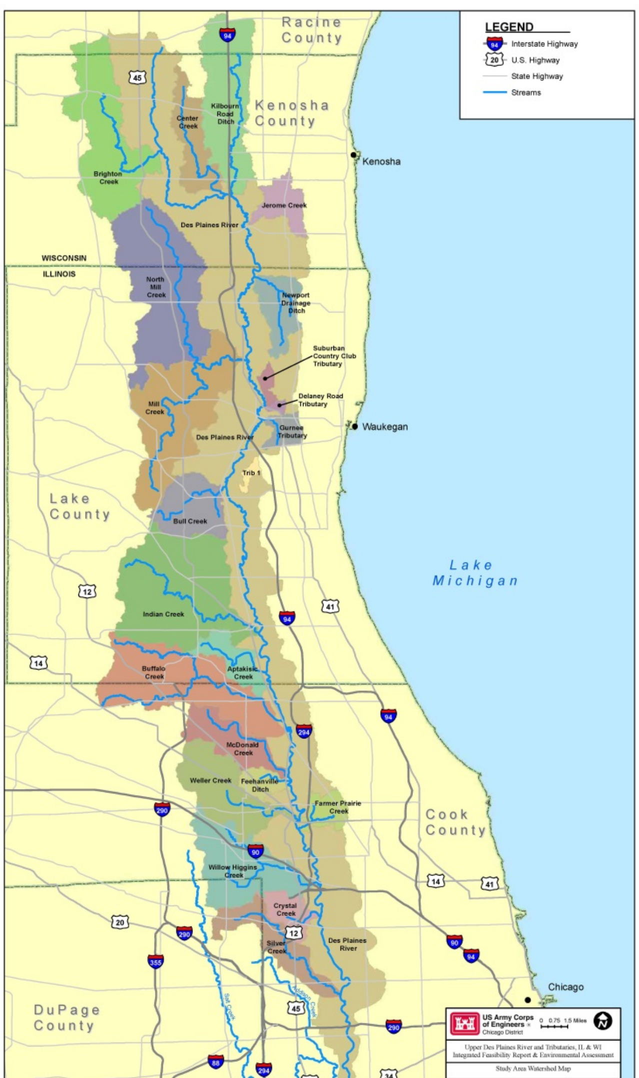

**Figure 5.** Des Plaines River watershed map. (http://www.lrc.usace.army.mil/)

Throughout the Des Plaines River Watershed there are 24 state nature preserves, natural areas, and the Des Plaines State Conservation area located near the junction with the Kankakee River. In all, these areas total around 23,450 acres of area open to the public for recreation. Forest Preserves own over 300 properties, many of which are within the Des Plaines River Watershed. These areas provide ample recreation opportunities for the public, including, biking, kayaking, hiking and fishing.

**Cultural and Economic Significance**

The Des Plaines River plays an important part in the history of the Chicago area. In 1673, Jacques Marquette and Louis Joliet embarked on a journey to explore the mighty Mississippi River. On May 17, 1673 the two explores departed St. Ignace, MI in two canoes and headed south along the western border of the Upper Peninsula to present day Green Bay, Wisconsin. After several portages, the explorers arrived on the Wisconsin River and finally arrived on the Mississippi River on June 17, 1673. They continued down the Mississippi River until they reached the Arkansas River. Fearing they may be captured by Spaniards, they turned around and headed north up the Illinois River. With help from the local Indian tribes, they were shown the route from the Mississippi Valley to the Great Lakes. This route took them up the Illinois River and into the Des Plaines River where they portaged near present day Chicago before re-entering the Great Lakes.

The Des Plaines River presents a wide variety of recreational opportunities for residents and visitors alike (Appendix X). In 2016, hundreds of people will take part in the 59th annual Des Plaines River Canoe and Kayak Marathon. With almost 40,000 acres of conservation and natural areas (state, county, local and private), the Des Plaines River watershed provides hiking, biking, horseback riding, cross-country ski trails, golf courses and boating opportunities for the public.

## Biological Significance

The Des Plaines River is the longest flowing stream in the Chicago area. It provides fishing, kayaking, canoeing, and wading opportunities to locals and visitors alike. The Des Plaines River supports a thriving urban fishery with ample opportunities for the fishing community. The Lake and Cook County Forest Preserves own a lot of the land that borders the Des Plaines River allowing for easy access to the rivers plentiful fishing spots. This gives the visitors the sense of being on a wild and remote stretch of river. The slower currents throughout the river, along with the shallow (around 3ft deep or less) stretches, provide great wadding possibilities. The Des Plaines River has the highest catch rate for Northern Pike than any other river in the state. In the fall, Walleye are a common catch throughout the river. Fishermen can also expect to catch Channel Catfish, Smallmouth Bass, Sauger, Rock Bass, Crappie, Largemouth Bass and Bluegill.

The Des Plaines River is made up of nine nature preserves which offer wet prairies, fens, sedge meadows, marsh, oak savanna and oak woods. The Des Plaines is home to unique flora. Over 660 species have been identified including the northern cranesbill and hairy white violet more typical of Canada. Twenty-four species found along the Des Plaines River are listed as state threatened or endangered; the prairie white fringed orchid is also listed as federally threatened (ILDNR Website). TThe Des Plaines watershed is home to over 40 species of mammals. The Des Plaines also plays host to nearly 270 of the 300 bird species that occur in Illinois can be found here. There are also 23 species of reptiles and 16 species of amphibians (ILDNR Website).

## Aquatic Species Communities

### Fish

The ILDNR has been conducting assessments and surveys since the mid-1960s (Pescitteli 2015).

These early surveys looked at the fish communities throughout the watershed. Surveys conducted by the ILDNR in 1975 produced very few fish species throughout the CAWS and the CSSC (Appendix IX). However in 2012, 26 species were collected during sampling events. The ILDNR has seen similar improvements throughout the CAWS. Between 1974 and 2014, 100 fish surveys were conducted at 24 different locations. Seven locations were surveyed in 1983 and yielded 21 native fish in 300 minutes of electrofishing. Surveys were again conducted at these same locations in 1997 and 37 native species were collected in 323 minutes (Appendix IX).

In 1983, basin wide surveys began and are now completed on a bi-yearly basis, and extensive fish surveys are conducted every five years (Pescitteli 2015). In 2015, the Illinois DNR released a report that summarized the results of the 2013 basin survey and examined trends from survey data from 1983-2013 (Pescitelli 2015). During the 2013 Basin Study, biologist collected 19,655 fish from 34 stations. Sixty-one native species and 3 non-native species were collected in the 2013 survey (Pescitelli 2015). Two state threatened species were also collected during this survey: Banded Killifish (*Fundulus diaphanous*) and the Iowa Darter (*Etheostoma exile*). Of the fish sampled, five species accounted for 72% of the total number collected: Spotfin Shiner (*Cyprinella spiloptera*), Sand Shiner, Blackstripe Topminnow (*Fundulus notatus*), Bluntnose Minnow (*Pimephales notatus*) and Bluegill (*Lepomis macrochirus*). In 2013, 55 species were collected at 15 locations where as in 1983 only 28 species were found at those same location . Lower species richness in 1983 was the result of poor water quality (Pescitteli 2015). As a measure of water quality, tolerant verses intolerant species were quantified as a part of this survey. In 1983, the percentage of tolerant species collected was 72% where as in 2008 it was 45%, and in 2013 it further reduced to 18%. No intolerant species were collected in 1983; however, in 2013 five intolerant species were collected (Pescitteli 2015).

From 1983 to 2013, the overall composition of species has changed (Pescitteli 2015). This could be due to dam removals but also from migration of species through the Brandon Road Lock and Dam, the Upper Des Plaines River, Lake Michigan or the CAWS. In the 2013 survey, Bluegill was the most abundant sport fish collected with a total of 684 (Pescitteli 2015). Other noteworthy species include; Channel Catfish, Largemouth Bass (*Micropterus salmoides*), Northern Pike, Smallmouth Bass, and Rock Bass. The Round Goby (non-native) and Banded Killifish (state threatened) collected are believed to have entered the system from Lake Michigan (Appendix X). The appearance of the Rosyface Shiner is another indicator of upstream movement throughout the system (Pescitteli 2015). This species is also an intolerant species indicating that water quality is improving in the Des Plaines River. The Freckled Madtom was discovered in the Lower Des Plaines River and had not been collected in the Chicago are in 100 years (Pescitteli 2015). This fish has been collected on several occasions located 22 miles below the Brandon Road Lock and Dam (Willink et al. 2006).

TThe Hoffman Dam (River Mile 44.5 on the Des Plaines River) was removed in 2012 becausebecause it waswas a barrier to upstream fish movement. Prior to the removal very few large-bodied riverine species were collected (Pescitteli 2015). Since the removal, 11 species have been found above the removal site and the Channel Catfish has shown significant repopulation. There has also been a transfer of species downstream of the Hoffman Dam site. These species include the Horneyhead Chub, Bigmouth Shiner, Central Stoneroller, Johnny Darter, and the

Blackside Darter (Pescitteli 2015). Several large-bodied riverine species were also found below the dam site that had not been seen prior to 2013. The ILDNR stated that the most likely source of these species is the Lower Des Plaines River/Illinois River where these species are common (Appendix IX).

Since 2011, the Service has been conducting Asian carp surveys within the Upper Des Plaines River as outlined in the 2011 Asian Carp Monitoring and Rapid Response Plan. Sampling has been conducted in the area from Riverside, IL to Romeoville, IL. Between 2011 and 2015, sampling has included over 45 hours of electrofishing and deployment of 16,084 yards of gill net. Sampling efforts from 2011-2015, have resulted in 7,926 fish collected representing 53 species and three hybrid groups (Appendix VII). To date in 2016, sampling was conducted in April and included 2.7 hours of electrofishing and 1500 yards of gill net. Data entry and summarization is ongoing for 2016 data. No Bighead or Silver Carp have been collected or observed throughout the project. Seven Grass Carp have been collected. Six of these were delivered to Whitney Genetics Laboratory for genetic ploidy determination. All six were determined to be triploid.

While there has been a lot of effort to restore the ecosystem of the Des Plaines River, it remains a highly impaired system. The Index of Biotic Integrity (IBI) for the Des Plaines River is low and received a rating of “Poor Resource Quality/Not Supportive” (Appendix X). Although scores were low, the appearance of more intolerant species could mean that the river is capable of supporting additional fish species which would increase the IBI scores. Improvements completed in the last several years have shown an increase in new species and a decline in tolerant species.
In 2016, the ILDNR drafted a Des Plaines River Management Plan for division review. This plan builds upon findings from prior basin surveys and begins to project reasonable and attainable goals to continue development of the river fauna (fish, mussels, invertebrates). It notes that future management of the river should include monitoring, fish community assessment, habitat assessment and improvement using appropriate metrics and management goals to achieve improved structure and function of this river ecosystem. .(Appendix X).

**Current Status of Fish Passage at BRLD**

The U.S. Fish and Wildlife Service recently conducted several studies designed to evaluate utilization of the Brandon Road Lock structure by fish, including lock mediated fish passage. These studies included: 1) the use of mobile split beam hydroacoustic to conduct surveys inside and within the approach channels of the lock chamber, 2) a stationary hydroacoustic fish observation system deployment directly upstream of the lock chamber to continuously collect fish movement data over full 24-hour cycle from June 25 through September 29, 2015, 3) a fish habitat utilization study inside the lock chamber using multi-beam sonar (DIDSON), and 4) a physical capture fish survey utilizing electrofishing and gillnets. Preliminary results of these studies suggest that fish (of several species and life stages) commonly utilize the lock chamber at Brandon Road as habitat. No Asian carp were observed within the Brandon Road Lock during these evaluations.

Mobile hydroacoustic surveys conducted inside the lock chamber during July 2014 observed mean densities of 38.6 fish/1000 $m^3$. This is greater than 10 times the peak fish density measured with similar hydroacoustic techniques within the Brandon Road Pool (3.52 fish/ 1000 $m^3$) and more than

60 times the peak density observed within the Dresden Island Pool (0.63 fish/ 1000 m3) in July 2014. Given the observation that fish heavily utilize the lock chamber, in 2015 the USFWS deployed a stationary fish observation system to document changes in fish density and movement patterns within the upstream approach channel at the Brandon Road Lock. Preliminary results from the stationary hydroacoustic deployment suggested that large differences in fish abundance occur within the upstream approach channel (88.9-3.7 fish observed/min.); however, there was no significant correlation between changes in fish density and the state of lock operations (i.e. lock doors opened/lock doors closed). Furthermore, there were no significant differences in the number of fish moving upstream or downstream based on the state of lock and barge movement operations. Data processing from this study is currently ongoing.

In 2016, the USFWS conducted physical capture surveys inside the lock chamber and observed a number of fish species including Common Carp (adult), Northern Pike (adult), Smallmouth Buffalo (adult), Emerald Shiner (adult), Gizzard Shad (adult) and Gizzard Shad (juvenile). Additionally, a study conducted by the USFWS in 2015 and 2016 demonstrated that small fish can be inadvertently entrained and transported into the Brandon Road lock chamber within junction gap spaces between barges in a tow and subsequently transported upstream (Davis et al 2016). While further evaluations of the upstream movement of fish through the Brandon Road Lock chamber could provide more conclusive data, results from these evaluations demonstrate that fish movement through the lock chamber (either actively or passively) is probable.

**Mussels**

There are no federally listed mussels in the Des Plaines River. For decades, mussel populations in the Des Plaines River have been declining (Price et. al 2012). In 2009 and 2011, basin surveys were conducted to evaluate mussel populations. During these surveys, only 18 of the 38 historically known species were collected, which means more than fifty percent of the historical mussels were missing from this system. Most of the species that were not collected have not been seen in the Des Plaines since the 1920s. Within the Des Plaines River basin, 19 species were observed in the 18 sites surveyed including the giant floater (*Pyganodon grandis*), white heelsplitter (*Lasmigona complanata*), cylindrical papershell (*Anodontoides ferussacianus*), and the fatmucket (*Lampsilis siliquoidea*) (Prince 2012). One species, the pond mussel (*Ligumia subrostrata*) was found that has never been documented in the Des Plaines River. The pond mussel is relatively common and uses Centrarchid fish as hosts. While the giant floater was the most prevelant species across the sites, the white heelsplitter comprised 80% of all of the mussels collected in the Des Plaines River (Price et. al. 2012). Reproduction throughout the basin was also measured and there was no observed reproduction at any of the sites within the Des Plaines River. According to the ILDNR, recent surveys around the Dresden Lock and Dam area have documented significant establishment of mussels, including state listed species with a likely source being the Kankakee River.

**Migratory Birds**

The urbanization of the Chicagoland area has affected many different aspects of our natural resources including habitat used by migrating waterfowl. In 1983, the Forest Preserve District of

Lake Country Illinois along with the Open Lands Project of Chicago founded the Wetlands Research, Inc. of Chicago, Illinois. Two years later, the Des Plaines River Wetlands Demonstration Project was started to survey and rehabilitate some of the wetlands surrounding the Des Plaines River. Loss of wetland habitat has severely reduced the amount of available stopover locations used by migratory birds.

Migratory waterfowl was surveyed seven times during March and April of 1985. A total of 13 individual birds were noted representing 3 species, Canada goose, mallard, and the blue winged teal (*Anas discors*). Over the next several years six new habitats were created at the restoration site. In 1990, surveys were once again conducted, however, due to the increase in habitat available an additional five sites were surveyed for a total of eleven. The number of species identified increased from 3 to 15 with a total of 617 individual birds.

Surveys conducted by the Illinois DNR in January 2014 and 2015, resulted in six species being identified in the Des Plaines River. The most abundant species was the Canada goose followed by mallard. Other species identified were the common golden eye (*Bucephala clangula*), bufflehead (*Bucephala albeola*), and American coot (*Fulica americana*).

## Interjurisdictional Species

Interjurisdictional fish are fish populations whose management and allocation of use are the collective responsibility of two or more States, Tribes, and/or Nations. Interjurisdictional fish are not necessarily migratory, but can move either short or long distances between political jurisdictions in the completion of their life cycles. American eels are observed on occasion in the Illinois River and CAWS river systems. In 2015, the State of Illinois listed the American Eel as a state threatened species. Declines in American Eel populations have been attributed to dams and other river impediments which prevent this species from accessing habitat and migration routes. In 2014, a fishermen collected an American Eel in Tampier Lake (Cook County) which probably migrated their either from the Mississippi River or the Great Lakes (Appendix VIII). In 2016, USFWS crews have collected two American Eel during Asian carp sampling events. One was collected in the Hanson Materials East Pit and the other was captured just below the Brandon Road Dam.

## Threatened and Endangered Species

There are currently no federally threatened or endangered species within the Des Plaines River. The federally endangered scaleshell (*Leptodea leptodon*) was recently rediscovered in the Marseilles Pool of the Illinois River in 2013, and the federally endangered sheepnose (*Plethobasus cyphyus*) occurs in the Kankakee River. We do not anticipate any effects to these species because they do not occur within the action area; however, if water quality and mussel habitat continue to improve in the Des Plaines River, it may be suitable for these species in the future. The scaleshell uses Freshwater Drum as a host fish, and the sheepnose uses Sauger; both fish species occur in the Des Plaines River.

The state of Illinois has a state specific list of threatened and endangered species. As described above the state threatened American Eel can be found in the Des Plaines River and CAWS. Although biologist collected one Banded Killifish and one Iowa Darter, both state listed species, during the 2013 survey, biologists with the ILDNR believe that these fish originated from Lake Michigan and entered the Des Plaines through the CSSC (Pescitelli 2016). The state threatened blackchin shiner has also been found in the Des Plaines River.Appendix X).

**Institutional Significance**

The only federal trust species in the Des Plaines River that may be affected by the GLMRIS Brandon Road Project is the American Eel, but it only rarely occurs in the basin. Regardless of the federal trust species that may be affected, the institutional significance of the Des Plaines ecosystem is documented by the state's fishery management plan, federal interest in the basin, and other local county watershed management plans. For example, the Des Plaines River is also home to many friends groups who work to improve conditions in the waterway including the Des Plaines River Watershed Workgroup. This group monitors water quality and determines the best ways to improve water quality based on scientific data on a local level (DPRMP 2016).

Federal and state interest in the basin is documented in the Corps September 2013 Upper Des Plaines River and Tributaries, IL & WI Integrated Feasibility Report & Environmental Assessment (USACE 2003). In this report the Corps recommended plans that included fish passage at all main stem dams on the Des Plaines and one on Salt Creek. These actions were proposed by the Corps restore connectivity between fragmented sections of the river. This project was also focused on reducing flooding throughout the system which can significantly impact habitat.

Below is an excerpt from the Corp's Rock Island District Illinois River Basin Restoration Comprehensive Plan with Integrated Environmental Assessment, March 2007 (Section 2-56) (USACE 2007) which references the Corps desire to increase connectivity of the Des Plaines River with the Illinois River without the transfer of invasive species:

"The desired future condition is unimpeded passage of 100 percent of large-river fish on the Illinois River main stem up to RM 286 at Brandon Road Lock and Dam. This would require improved passage at Starved Rock, Marseilles, and Dresden Lock and Dams. The Lockport and Brandon Locks and Dams would continue to block fish movement, thus limiting dispersal of invasive aquatic species between the Upper Mississippi River System and the Great Lakes. Additional study is needed to assess the desirability of facilitating passage at the Brandon Road Lock and Dam. Restored connectivity between the main stem and the Des Plaines River is desirable, but this will need to be balanced with the desire to limit dispersal of invasive species. Restoring aquatic connectivity to aquatic systems restores a measure of ecological integrity to an area. By allowing access to habitats that supply different life requisites for fish species, the future of those species is more likely. In addition, transport of mussel glochidia by different fish species ensures that mussel communities and species have access to appropriate habitats. Finally, by restoring this component to the ecosystem, some of the building blocks for a healthy and functioning system are restored."

An excerpt from the Corp's Chicago District Upper Des Plaines River and Tributaries, Illinois and Wisconsin Integrated Feasibility Report and Environmental Assessment, September 2013 (Page 114) (USACE 2013) also recognized the importance of dam removal to fish passage and connectivity within the system. The Upper Des Plaines River and Tributaries plan included removal of the Des Plaines River dams and included riverine fish species of interest; Silver Redhorse, Skipjack Herring, Freckled Madtom and Sauger.

"Analysis focusing on the streams and rivers of the watershed suggests the future without project condition to be the current present condition. Data from a 30 year period show that stream conditions have not changed much in terms of biological integrity and habitat quality. If no in-stream restoration activities were to occur, these streams would be roughly in the same condition in 50-years based on reasonable foresight. The Hofmann, Fairbanks, Armitage, and Ryerson dams are removed, and the Dan Wright and MacArthur Woods dams (scheduled for removal in 2013) will be removed under the future without project conditions. These actions will improve certain reaches of river, but the five remaining dams still fragment lower system from the upper system. These actions were considered in the future without and with conditions for those sites that would benefit. It was assumed there would be improvement in riverine habitat and an increase is species richness since free flowing hydraulics and fish passage would then be possible. These dams are scheduled to be removed by 2013. There have been no significant riverine restoration projects in the past nor are any reasonably foreseen within the 50 year period of analysis."

**Overview of Threats/Stresses**

Over the last hundred years, the Des Plaines River has been in the middle of a vastly changing landscape. Since the late 1800's, the area has been severely impacted due to modifications of the land made by humans. As mentioned, the Des Plaines River starts in a primarily agricultural area in southern Wisconsin and then flows south into the highly populated and overly developed areas, where it becomes a suburban stream before it turns into a large urbanized stream and finally finishes as a major industrial waterway (Appendix X). Development within the watershed coincided with the development of the Chicago area, where about 9.5 million currently live. During this time of expansion, changes to the hydrology of the watershed became more common place. The installation of drainage tiles in agricultural fields, low head dams, bridges, increased amounts of impervious surfaces, and channelization of the river have contributed to the degraded water quality, changes in hydrology, poor biological integrity and a loss in aquatic diversity (USACE 2013). In 2001, the watershed of the Des Plaines River within Illinois consisted of 57% urban, 23% open space and 19.6% agriculture.

Over the years, the river has been extensively modified and channelized which has resulted in flooding along the Des Plaines River (Appendix X). Due to the high levels of run off from urban areas, channelization, dams and drain tile systems, flooding occurs frequently during heavy rain events. Although several of the dams currently on the system were built to prevent flooding, flooding is still an issue in several areas of the watershed. Several communities along the Upper Des Plaines have suffered from extensive flooding in the past.

While there has been a lot of effort to restore the ecosystem of the Des Plaines River, it remains a highly impaired system. The upper Des Plaines watershed has greater than 47% impervious surface (USACE 2015a), and streams with 25-60% impervious cover typically no longer support their designated uses in terms of hydrology, channel stability, habitat, water quality, or biological diversity (Schueler et al. 2009). Point source pollution and urban runoff from the Chicago Metro area have led to severely polluted waters in some sections of the stream. This has led to poor water and sediment quality. Increased nutrient loads, elevated sediment levels, and above average water levels due to increased run-off from urban areas and agriculture have led to the loss of aquatic diversity and decreased habitat quality within the system. The Illinois EPA has also determined that the river is impaired for aquatic life, recreation, and fish consumption, and much of the Des Plaines River watershed is on the list of 303d streams. As described above, the IBI for the Des Plaines River reflects these impairments as it received a rating of "Poor Resource Quality/Not Supportive" (Appendix X). Even with the low IBI score and the impaired water quality, the Des Plaines has benefited from the passing of the Clean Water Act in 1972 as evidenced by the fish survey results.

**Overview of Restoration and Recovery Efforts**

As a significantly historical water way, preservation of the watershed is important to local communities. Extensive efforts have been made to restore the river and include removing of dams, restoring channels and remediation. All of the remaining mainstream dams above Brandon Road are slated for removal which would open up 96 miles of free flowing river. Several work groups, associations and friends groups work to restore the health and diversity of the Des Plaines River. Some of the restoration and recovery efforts currently being conducted by these groups as well as federal and state partners are:

- Stream habitat restoration
- Removal of invasive and emergent plant species
- Fish stocking
- Flood prevention
- Woodland restoration
- Waterfowl enhancements
- Watershed restoration

The state of Illinois Department of Natural Resources has been instrumental in the restoration and recovery of several aspects of the Des Plaines River watershed. In order to improve stream habitat, the ILDNR installed five rock bars and three islands within the seventeen mile stretch of river that was channelized when the CSSC was created. Harvest limits were established in areas where fishing pressure was high due to a more productive higher gradient section of river. In 1998, the ILDNR partnered with the Hoffmann Dam River Rats to plant over 1,000 Water Willow (*Justicea americana*) to reestablish emergent plants within the river system. The Des Plaines River Valley Restoration Project works throughout the river to remove invasive plant species in order to restore native plant habitat.

The ILDNR conducts fish surveys every five years as part of a basin wide monitoring project. The Illinois EPA also conducts monitoring during these surveys looking at water and sediment quality, macroinvertebrates and habitat evaluations. Along with their long standing monitoring program the state of Illinois also stocks the Des Plaines River with Sauger. An average of 19,000 fingerlings are stocked each year at three different locations along the river. Smallmouth Bass were also stocked from 1997-2002 due to low natural reproduction in the river.

In order to combat the reoccurring flooding issues, the Corps proposed in the Des Plaines River Phase II the building of levees and reservoirs to store excess water (USACE 2015a). The Illinois EPA has also completed, through the CWA, the creation and restoration which aids in the reduction of floods. Associated with flood prevention, is the restoration of the woodland areas surrounding the river system which reduces soil erosion along the rivers banks. The Woodland Habitat Restoration Project, managed by the Lake County Forest Preserve, is working with partners to preserve and restore the unique oak forests that surround the Des Plaines River. As older oak trees die, younger oaks are not growing at a fast enough rate. Dense and dark forests are replacing the oak woodlands due to the fact that low amounts of light are reaching the forest floor.

The Wetlands Research, Inc. of Chicago, IL was established to restore migratory bird habitat along the Des Plaines River. After five years and extensive habitat restoration migratory bird species and individuals increased. In 1985, only three species and fifteen individuals were collected. Only five years later, thirteen species were identified and 617 individuals were collected. The Upper Des Plaines River Ecosystem Partnership is comprised of non-profit organizations, businesses, landowners, planning agencies, and government representatives who are dedicated to improving habitat, water quality, flooding and soil erosion, as well as increasing recreational opportunities.

## EVALUATION METHODOLOGY

The Service relied upon the expertise and best professional judgment of staff scientists in conjunction with the relative ranking of alternatives sections of the Corps' draft expert elicitation report to evaluate the proposed alternatives. In addition, NOAA forecast modeling, and other available science and data were used to objectively determine impacts to the significant resources in the Great Lakes and Des Plaines ecosystems. It is important to note that we evaluated the alternatives relative to each other.

As part of the GLMRIS-BR, the Corps developed the "GLMRIS – Brandon Road Probability of Establishment Assessment Approach for Asian carp and A. lacustre", which includes an expert elicitation (EE), as a tool to compare the effectiveness of the alternatives. The Corps convened an EE Panel in which two groups (one focused on Asian carp and the other on the scud) were formed to assess the probability of establishment of Asian carp and the scud provided by each alternative. To compare the alternatives outlined by the Corps, the panel was asked to compare the reduction in the probability of establishment of each alternative provides compared to the future without project condition. Five elements were evaluated as a part of this process: pathway, arrival, passage, colonization, and spread. This method does not include analysis of nonaquatic pathways. Experts were asked to assess the probability of arrival by the years 2021, 2031, and 2071. These dates coincide with the proposed completion of different alternatives proposed by the Corps (2021 for Nonstructural and Lock Closure alternatives, 2031 for the remaining five technology alternatives and 2071 as a 50-year period of analysis).

At the beginning of the process the experts were given information on all of the alternatives, current and future Asian carp and scud population status, as well as key factors affecting the probability of colonization and spread in the Great Lakes. During the elicitation, the Corps' and experts assumed that the Technology Alternative – Continuous Electric Barrier was not significantly different than the establishment probability of the Technology Alternative – Complex Noise with Continuous Electric Barrier. In the results, these two alternatives were presented together. The results of each elicitation as to the probability of establishment were then expressed as a range of uncertainty for each of the alternatives. In order to easily make comparisons between the different alternatives, a composite expert was created. The composite expert is a cumulative distribution function or an average of the six expert's elicitations for each alternative.

The results of the EE are presented in Table 1. Results indicated that there is no alternative that had a zero risk of establishment. The Lock Closure alternative had the smallest range of uncertainty of establishment for both species while the No New Federal Action alternative held the highest uncertainty. For Asian carp, the results of the expert elicitation indicate that the No Action Alternative has the highest risk of establishment, followed by the Non-Structural Alternative, the Complex Noise Alternative, the Complex Noise/Intermittent Electric Barrier Alternative, the Continuous Electric Barrier Alternative, and the Lock Closure Alternative, respectively. For the scud, the results of the expert elicitation indicate that, with the exception of Lock Closure, all of the alternatives perform similarly and are not expected to differ from the No Action Alternative. Although the Lock Closure Alternative performed better, there is a large amount of uncertainty in the effectiveness of lock closure to prevent establishment of the scud since it is a hull-fouling species.

**Table 1**. Range of Estimated P (establishment) for all experts for Asian carp and *A. lacustre* from the Corps draft report (Corps 2016).

| **Alternatives** | **Probability of Establishment in the Great Lakes** | |
|---|---|---|
| | **Asian carp** | ***A. lacustre*** |
| Sustained Current Activities (No New Action) | 21-32% | 36-88% |
| Nonstructural Alternative | 13-19% | 36-88% |
| Technology Alternative - Continuous Electric Barrier | 7-10% | 34-86% |
| Technology Alternative - Complex Noise | 9-14% | 34-86% |
| Technology Alternative - Complex Noise with Intermittent Electric Barrier | 8-10% | 34-86% |
| Technology Alternative - Complex Noise with Continuous Electric Barrier* | 7-10% | 34-86% |
| Lock Closure | 1-2% | 17-78% |

*Assumed to be the same as Technology Alternative – Continuous Electric Barrier

The States and the Service have concerns about the methods and results of the Corps' expert elicitation process, particularly the highly variable statistical probabilities generated for the establishment in the Great Lakes of Asian carps and scud by the various experts. Some states also indicated concern that the expert panel did not include participants with expertise on Great Lakes invasion theory. In general, we do not agree with the way the composite expert was calculated. The use of this type of average does not preserve the range of uncertainty expressed by the individual experts. For instance, the probability of establishment by Asian carp with the No New Action alternative ranged from 0 to almost 100% probability but the composite expert is 27%.

In addition, the EE results for each individual expert have a high degree of overlap. This was evident for both species but extremely variable in the scud. For six of the alternatives, the range in probability was 52% (36-88% and 34-86%). This high degree of spread indicates a high uncertainty in the estimate of the probability of establishment, and the Service and States feel that the uncertainty levels are too high to make any valid conclusions about its probability of establishment. There was also a high amount of overlap for the technology alternatives with regards to Asian carp establishment. The range for those three alternatives shown is 7-10% for two of the alternatives and 8-10% for the third.

For these reasons, the Service is not relying on the probability of establishment values for the Asian carp or the scud. However, expert opinion on the relative ranking of the efficacy of the alternatives was consistent among experts and the Service and the states agree that the expert elicitation report can be used to examine the relative differences in the probability of establishment of these species among the different alternatives. The proposed alternatives, as evaluated by the EE, in order of MOST to LEAST effective are Lock Closure, Continuous Electric Barrier, Complex Noise/Intermittent Electric Barrier, Complex Noise, Non-structural, and No action.

## EVALUATION AND COMPARISON OF ALTERNATIVES

### Potential Significant Impacts of Asian Carp Establishment

### Great Lakes

If Asian carp were to become established in the Great Lakes, they and other ANS populations could expand rapidly and change the composition of the lake ecosystems. In July 2012, a Bi-national U.S.-Canadian Asian Carp Risk Assessment concluded that the spread of Bighead and Silver Carp would pose a substantial environmental risk to the Great Lakes within 20 years, with the risk increasing over time, especially for Lakes Michigan, Huron, and Erie. This assessment further concluded that should Bighead and Silver Carp become established in the Great Lakes, their spread would not likely be limited. Direct ecological effects are likely to result from their various diets: Silver Carp generally eat phytoplankton, Bighead Carp generally eat zooplankton, and Black Carp eat benthic invertebrates such as snails and mussels. Resident Great Lakes fish species could be harmed, because Asian carp are likely to compete with them for food and modify their habitat. Species at greatest risk include native mussels, other aquatic invertebrates, and fishes.

The NOAA forecast model for Asian carp demonstrated their potential to have significant negative impacts on native species at the lake-basin scale. Recent research investigated the potential impacts from established populations of Bighead and Silver carp on established native species in Lake Erie (Hongyan Zhang et al., 2015). Results indicated that if Asian carp successfully invaded Lake Erie, they could potentially account for a third of the total fish biomass (weight) in the lake; and would directly compete with native fish for food, as well serve as prey for other already-established piscivores, notably smallmouth bass. The invasion would cause a decline in most other fish species, including walleye, a widely utilized sport and commercial fish. According to the study, walleye, rainbow trout, gizzard shad and emerald shiners could all decline, with declines in emerald shiner of up to 37 percent. Results of the model predict that Smallmouth bass biomass could increase up to 16 percent. In the Lake Erie basin, the Maumee, Sandusky, and Grand Rivers were determined to be the most likely to be able to support spawning of Asian carp (Kocovsky et al. 2012). Ecological consequences might include competition for planktonic food, leading to reduced growth rates, and recruitment and abundance of fish dependent upon this plankton, as well as reduced abundance of fishes with pelagic, early life stages.

Asian carp diets overlap with that of Great Lakes native fish species, potentially resulting in competition for food resources and causing: (i) reduced abundance of near-shore planktivorous forage/prey/bait fishes (e.g. Cisco, Bloater, Rainbow Smelt) and adult piscivores (fish-eating species, such as Lake Trout), reduced growth rates, and reduced recruitment in Lake Superior; (ii) reduced abundance of near-shore planktivorous forage/prey/bait fishes (e.g. Alewife, Cisco, Bloater, Rainbow Smelt, Yellow Perch) and adult piscivores (e.g. Chinook Salmon, Lake Trout, Walleye, Northern Pike), reduced growth rates, and reduced recruitment in Lake Huron; (iii) reduced abundance of planktivorous forage/prey/bait fishes (e.g. Emerald Shiner, Gizzard Shad, Rainbow Smelt, White Perch), fishes with pelagic early life stages and adult piscivores (e.g. Lake Trout, Rainbow Trout, Walleye, Yellow Perch), reduced growth rates, and reduced recruitment in Lakes Michigan and Erie; and (iv) reduced Alewife biomass by up to 90%, which could damage salmonine populations in Lake Ontario. It was also found that Asian carp show high flexibility in terms of food habits. They are capable of changing food behavior in accordance with food availability, without any impact on their high survival rate (Hayder 2014). There is great concern that Asian carp will hasten the extinction of threatened native species such as Lake Sturgeon. The population of Lake Sturgeon is less than one percent of original numbers and, should Asian carp enter the Great Lakes, they would directly compete with lake sturgeon for a limited food supply and crowd them out.

Presence of Asian carp in the Great Lakes would increase costs and decrease revenues for commercial harvesters. It would increase the operational costs of commercial fishing industry (e.g. relocation of sites, frequent repair of nets), which would in turn reduce the fishing activities and profit earned by harvesters. The presence of Asian carp would also damage the commercial fishing industry through the expected impact on fishing revenue. Asian carp would reduce the plankton and prey species available for commercially harvested fish species. Prey species would be impacted through decreased food availability. Less food availability would adversely affect commercially targeted fish populations, which would in turn reduce the catches of commercially fished species and harvesters' revenues/activities. The decrease in revenue would in turn reduce the level of gross profit and thereby create a circular flow of impact. The sector would also be adversely affected because of a reduced quality of native fish species, reflected through the smaller size of commercially targeted fish. As the commercially harvested fish species are impacted by the presence of Asian carp in the Great Lakes basin, it is anticipated that all sectors associated with commercial fishing through forward and backward linkages would be proportionally impacted (e.g. food processing and export sectors).

Presence of Asian carp in the Great Lakes may also discourage recreational fishing through direct harm to people. Silver carp startle easily at the sound of a boat motor, leading them to leap out of the water and land in boats, and thereby damage property and injure boaters. The jumping behavior of Asian carp might not only discourage people from fishing, but also result in a transfer of wealth from boat owners to service providers operating in the Great Lakes region. While Asian carp might raise the operational and maintenance costs of boat owners (e.g. installing protective equipment), the additional costs borne on boat owners would cause a transfer of resources from boat owners to those service providers. Reduced recreational fishing and related activities will have economic impact to those whose livelihood depends on the development of this sector.

Asian carp may cause cladophora mats in the Great Lakes basin to expand, particularly around the nearshore areas. The presence of Asian carp will further enhance cladophora build-up capacity in the Great Lakes, increase cladophora-related problems, pose increased health risk to Great Lakes users, and contribute to a decreased level of wildlife viewing and lakefront activities around the Great Lakes basin (Hayder 2014). Despite some feeding on phytoplankton by silver carp, the decline in zooplankton would release top-down control on phytoplankton and a subsequent decline in benthic productivity, as nutrients would be consumed by increased phytoplankton biomass (Freedman et al. 2012). There has been a resurgence of cladophora in recent years for a variety of reasons (e.g. zebra and quagga mussels, agricultural operations, and sewage), with mass cladophora accumulations occurring along shoreline areas. Decomposing cladophora provides a breeding ground for enteric bacteria, including some pathogens which can produce dangerous toxins, which in turn impact beach water quality. Similar to recreational fishing, it is likely that there would be some relocation of expenditures by beach users to other sectors in the economy due to the expected damage to beaches and lakefront use activities that the presence of Asian carp would cause.

Over time, the presence of Asian carp in the Great Lakes would change lake ecosystems from ones dominated by native fish species to ecosystems dominated by carp, and has the potential to damage the public image of the lakes regionally, nationally and internationally. It would also harm the well-being of residents living close to the unique natural resource. Despite that Asian carp may present an opportunity for subsistence harvests, Asian carp species may significantly damage subsistence harvests of native species from the Great Lakes and reduce the social, cultural and spiritual values of the lakes and lake-related activities. Subsistence harvests may be impacted due to (1) changes in the ecosystem which may result in less native species as well as poor food quality for subsistence harvesters with negative impacts on subsistence harvesters and communities; and (2) gaining access to subsistence fishing may be impaired or may require travelling greater distances which will increase costs of harvesting. This will weaken traditional knowledge and observations, and inter-generational transfer of knowledge and culture will become obsolete. Finally, the presence of Asian carp may also encourage the increased level of competition among subsistence harvesters/communities for fewer native fish species and conflict and compete with recreational and commercial harvesters.

**Des Plaines River**

Although there is uncertainty about the impacts of Asian carp in the Des Plaines River ecosystem, Freedman et.al, released a report in 2012 regarding their findings on the impacts of invasive Asian carps on native food webs. Asian carp make up the majority of the fish biomass in the lower Illinois River, but their effects on the native fish and food webs are not fully understood. This study focused on the direct and indirect effects that Asian carp in the Illinois River would have on the food webs. Using stable carbon isotopes to examine the food webs, they found that Asian carp, in high density areas, are consuming the majority of the available zooplankton and therefore are dominating the food web. Conversely, they also found that in areas with low Asian carp densities, limited nutrient availability may be hindering the movement of Asian carp upstream in the Illinois River.

When they looked at the stable isotope signatures of Asian Carp, they found that they were comparable to that of Bluegill, Emerald Shiner, and Gizzard Shad, suggesting that there is overlap with these planktivores. There was less overlap with the larger filter feeding Bigmouth Buffalo and Paddlefish. If Asian carp establish in the Des Plaines River the effects to native filter feeding fish could be significant (Irons et.al. 2007). We assume that the effects to Asian carp in the Des Plaines River would be similar to their impacts in the Illinois River, and we anticipate that they would dominate and shift the food web.

**Potential Significant Impacts of Scud Establishment**

Little is known about the potential impacts of the scud to the Great Lakes and the Des Plaines River. Although its potential impacts have not been well studied, it is believed that it could out-compete other benthic filter feeders, such as native mussels. In other regions where the species is established it has impacted native food webs. The USGS has developed a fact sheet on the scud noting:

"There is insufficient information available to determine whether the (scud) poses a threat to other species or water quality. There are no reports on how it affects or interacts with other species. It is unknown whether this species alters the physical components of the ecosystem. There is little or no evidence to support that the scud has the potential for significant socio-economic impacts of introduced to the Great Lakes or poses a threat to human health or water quality. There is no evidence that this species negatively impacts infrastructure, economic sectors, recreational activities and associated tourism, or the aesthetic appeal of the areas it inhabits." (http://nas.er.usgs.gov/queries/greatlakes/FactSheet.aspx?SpeciesID=56&Potential=Y&Type=2&HUCNumber)

Dr. Reuben Keller of Loyola University produced a report in June 2016 that assessed the distribution of the scud in the CAWS, where 25 sites were sampled from Dresden Island Pool up to Lake Michigan. The last time this area was sampled was in 2005, where the scud was found in Dresden Island Pool. The 2016 assessment indicated the same locations for scud, where it was again found in Dresden Island pool and not anywhere closer to Lake Michigan (Keller 2016).

**Potential Significant Impacts to Native Species in the Des Plaines**

As identified in the ILDNR letter to the Corps dated January 16, 2015 (Appendix VIII), the ILDNR has significant concerns as to the potential negative impacts on the ability of native aquatic organisms to traverse the proposed project at this location as they continue to facilitate the ecological recovery of the Upper Des Plaines River (UDPR, upstream of Brandon Lock and Dam) and CAWS. The Lower Des Plaines River and Illinois River are a source of new species and continued migration of new individuals of the established species. The primary migration route from the Lower Des Plaines River to the Upper Des Plaines River is through Brandon Road Lock. Maintaining connectivity within river systems is critical to preserving and restoring native fish diversity and creating a sustainable fishery. Their concerns are based on survey data and published reports collected from our Fisheries Division, Impact Assessment Section, and freshwater mussel experts with the Illinois Natural History Survey. In the ILDNR letter sent to the Corps (Appendix VIII), the ILDNR stated that while they understand the primary targets of this project are Bighead and Silver Carp, the project will also impact the movement of native fish species.

The ILDNR also expressed how critical connectivity within river systems is to maintaining and/or restoring sustainable fisheries and native fish diversity. This is particularly true in systems such as the UDPR and the CAWS, which have experienced a long history of water quality degradation (Appendix VIII). The ILDNR also stated that the UDPR will likely continue to rely on a downstream connection to the Lower Des Plaines/Illinois River to maintain and expand current fish assemblages. There are additional species, such as the Redhorse species, present in the lower Des Plaines River which would be potential candidates for migration into the UDPR through the Brandon Lock (Appendix VIII). All five Redhorse species occur in the lower Des Plaines and Illinois Rivers, including the Illinois State listed species, River and Greater Redhorse.

In the letter to the Corps from the ILDNR (Appendix VIII), there is also concern as to how this project will affect the native mussels within the system. Dams can change and alter host fish assemblages and restrict host fish movement which can result in restricted distributions, blockage of gene flow, fragmented and declining populations, and altered community composition of mussels. As was mentioned in the letter, dams near a river's mouth can impact the (re)colonization of mussels into a basin because the dam prohibits the dispersal of host fishes.

Below is an excerpt from the ILDNR letter to the Corps (Appendix VIII) which addresses the potential movement and establishment of mussel species in the Des Plaines River.

"The upper Illinois River, long considered a wasteland and devoid of freshwater mussels (Starrett 1971), is recovering and now has 24 species inhabiting its waters (Sietman et al. 2001; INHS Mollusk Collection database, Champaign). The species from the lower Kankakee and upper Illinois River, which include the federally-endangered scaleshell (*Leptoda leptodon*), the federally-endangered sheepnose (*Plethobasus cyphyus*), the state-threatened purple wartyback (*Cyclonaias* *tuberculata*), and the state-threatened black sandshell (*Ligumia recta*), likely will not have the opportunity to recolonize the Des Plaines River and CAWS if their host fishes are not able to pass through the proposed project at Brandon Road Lock and Dam."

**Assessment of Individual Alternatives**

Based on the results of the Corps' expert elicitation process and our own expertise, we anticipate that no alternative will effectively prevent the introduction and establishment of scud in the Great Lakes ecosystem. The effectiveness of the alternatives to prevent scud invasion are not clearly identified, since the scud is a hull fouler and the technology alternatives have not been evaluated to prevent this mode of invasion. We anticipate that it could establish in the Great Lakes and the Des Plaines River ecosystem under all alternatives, which may result in impacts to both ecosystems through competition with native benthic invertebrates and the disruption of food webs. According to the EE, the highest probability of stopping a scud invasion is lock closure; however, there is too much uncertainty to make any valid conclusions about its probability of establishment. Therefore, we do not further consider the scud in the DFWCAR because the alternatives do not differ in their ability to meet our planning objectives.

We assess the ability of the individual alternatives below to prevent the introduction and establishment of Bighead, Silver, and Black Carp in the Great Lakes and Des Plaines River, while minimizing impacts to native species in the Des Plaines River:

**1. No New Federal Action**

The no action alternative would be least effective alternative for prevention of Asian carp invasion into the Great Lakes and Des Plaines River basins. Although the no action alternative would still rely on the Romeoville electric barriers to prevent invasion, it would also allow the potential for Asian carp to access the Illinois Water Way (IWW) above the barriers via flooding overflow in the Des Plaines River. The USACE completed construction of a wire mesh fencing and jersey barrier to reduce this risk, but they are not thought to be fully effective against all life stages of Asian carp. Additionally, although the Romeoville barriers have proven to be very effective against most life stages of potentially invading Asian carp, there are still some vulnerabilities such as smaller sized fish not being completely incapacitated by the electric array, barge entrainment of small sized fish, and outages at the barrier due to power supply issues or required maintenance.

As referenced above, the impacts of Asian carp establishing in the Great Lakes and Des Plaines ecosystems would be significant, and this alternative does not meet our Planning Objectives for the prevention of invasion of Asian carp.

**2. Non-structural Alternative**

The non-structural alternative, although slightly more effective than the No Action alternative, would not meet our Planning Objectives for the prevention of invasion of Asian carp or scud. This alternative would still leave an alternate pathway for small sized Asian carp to enter the

IWW above the Romeoville barriers via the Des Plaines in times of high water, and it does not address the potential vulnerabilities of the Romeoville barriers described in the no action alternative above. As referenced above, the impacts of Asian carp on the Great Lakes and Des Plaines ecosystems would be significant, and this alternative does not meet our Planning Objectives for the prevention of invasion of Asian carp.

**3. Technology Alternative – Continuous Electric Barrier**
This technology alternative uses the proven effective technology of electricity to meet our Planning Objectives to prevent invasion of Asian carp. It addresses the current vulnerabilities of alternative pathway through the Des Plaines and builds in additional redundancy for the Romeoville barriers. The Service recommends this alternative as one technology alternative that would be the most effective to prevent invasion in both the Great Lakes and Des Plaines basins, which would avoid impacts of Asian carp on significant resources in the Great Lakes and Des Plaines. Conversely, there may be some negative impacts in restricting all fish passage to the Des Plaines basin, and mitigation measures for native aquatic animals may be a necessary trade-off. The Service supports this technology alternative with the construction of an engineered channel, where other developing technologies could also be integrated into this measure in the future.

**4. Technology Alternative – Complex Noise**
This second technology alternative would also utilize an engineered channel that could be adaptively managed to integrate other developing technologies. However, the effectiveness of complex noise as an independent technology to prevent invasion of Asian carp has not been fully evaluated or can be considered as effective as electricity; therefore, we do not recommend this alternative as one of the most effective to meet our Planning Objectives. This technology may not effectively address the alternative pathway and current vulnerabilities, and as referenced above, the impacts of Asian carp establishment in the Great Lakes and Des Plaines ecosystems would be significant.

**5. Technology Alternative - Complex Noise with Intermittent Electric Barrier**
The third technology objective again would utilize an engineered channel that could be adaptively managed to integrate developing technologies in the future, and the combination of complex noise with an intermittent electric barrier could be a promising technology to prevent the invasion of Asian carp. However, the exact effectiveness of electricity used at intervals in combination with complex noise cannot be assessed for its effectiveness at this point in time without further study. The integration of a proven technology likely makes this alternative more effective than complex noise alone, but the intermittent application of that technology cannot fully meet our Planning Objectives of prevention of invasion for Asian carp. This technology may not effectively address the alternative pathway and current vulnerabilities, and as referenced above, the impacts of Asian carp establishment in the Great Lakes and Des Plaines ecosystems would be significant.

**6. Technology Alternative - Complex Noise with Continuous Electric Barrier**
This fourth technology alternative also utilizes the engineered channel to deploy the proven effective technology of electricity at a continuous rate, similar to what is deployed already at

the Romeoville barriers, and in addition deploys the still developing technology of complex noise. Again, the effectiveness of complex noise on its ability to prevent invasion of Asian carp or the scud is yet unproven, but the addition of this technology could potentially offset some of the limitations of electric barriers as noted previously. This would require further study and monitoring, but its promise as an effective alternative is supported by the Service and therefore is our top recommendation for this project to meet our Planning Objectives of prevention of Asian carp invasion. This alternative addresses the current vulnerabilities of alternative pathway through the Des Plaines and builds in additional redundancy for the Romeoville barriers. As noted in the continuous electric barrier alternative, there may be some negative impacts in restricting all fish passage to the Des Plaines basin, and mitigation measures for native aquatic animals may be a necessary for trade-off.

**7. Lock Closure**

This alternative would result in the least impacts to significant resources in the Great Lakes. Although this alternative would be best for the significant resources in the Great Lakes, it does not meet the Corps' primary project purpose of navigation at BRLD, and could only be achieved through direction from Congress. Under the FWCA, we consult with the Corps to ensure that fish and wildlife resources receive equal consideration with other project purposes. In light of the extreme impacts to BRLD's authorized project purpose of navigation and the fact that congressional action would be required to permanently close the BRLD, we do not recommend the Lock Closure Alternative.

## Summary of Evaluation and Comparison of Alternatives

We agree with the order of the effectiveness of the alternatives from the Corps' Asian carp expert elicitation. Based on their results and our expert opinion, the No Action and Non-Structural alternatives have a substantially higher likelihood (again speaking relative to the other alternatives) of resulting in the introduction and establishment of Asian carp in the Great Lakes and the Des Plaines River than the structural alternatives. The NOAA model indicates that the establishment of an Asian carp population that could result from the selection of either of these alternatives would yield potentially severe impacts to the significant resources in the Great Lakes. If Asian carp establish in the Des Plaines River the effects to native filter feeding fish could be significant (Irons et.al. 2007). Conversely, the No Action Alternative does not result in additional impacts directly to native fishes in the Des Plaines River, and the Non-Structural Alternative would also have minimal immediate negative impacts directly the Des Plaines River ecosystem. However, these options could also result in establishment of Asian carp in the Des Plaines River, which would have subsequent negative impacts on native species within infested areas. Additionally, some concern has been expressed that the establishment of Asian carp in the Des Plaines could make the electric barriers at Romeoville more susceptible to passage via overland flooding of the Des Plaines into areas of the CAWS upstream of the barrier. Although we have identified the Des Plaines River as a significant resource, these two alternatives do not meet our planning objectives, which are to prevent establishment of Asian carps in the Great Lakes and Des Plaines River while minimizing impacts to the Des Plaines River ecosystem.

The structural alternatives all have a lower likelihood of Asian carp establishment in the Great Lakes and Des Plaines River than the No Action and Non-Structural Alternatives. Currently, the only proven, effective technique to prevent upstream movement of Asian carps is the continuous use of an electric barrier; therefore, we conclude that the Complex Noise Alternative and the Complex Noise/Intermittent Electric Barrier Alternative have a higher likelihood of resulting in the introduction and establishment of Asian carp in the Great Lakes than the alternatives with a continuous electric barrier. Assuming complex noise is somewhat effective, we anticipate that both of the structural alternatives without a continuous electrical barrier could reduce passage of native fishes and Asian carps through BRLD, but may allow for enough Asian carp to pass through BRLD to result in their introduction and establishment in the Great Lakes and the Des Plaines River. If that is the case, both of these alternatives would result in impacts to the significant resources in the Great Lakes and the Des Plaines River.

We assume that the remaining alternatives (Continuous Electric Barrier, Complex Noise/Continuous Electric Barrier, and Lock Closure) will all result in impacts to the Des Plaines River ecosystem by eliminating native fish passage through the existing lock. However, our planning objectives prioritize risk and impacts to the Great Lakes over the Des Plaines River, which is a smaller, more highly impaired system that does not support a multi-billion dollar fishery, according to an estimate from the Great Lakes Fishery Commission. In addition, the remaining alternatives also have the smallest risk of establishment of Asian carps in the Des Plaines River, which minimizes impacts to native species in the Des Plaines River as well.

The expert elicitation report demonstrates that Lock Closure would be the most effective alternative to prevent the introduction and establishment of Asian carps in the Great Lakes and Des Plaines River. This alternative would result in the least impacts to significant resources in the Great Lakes. Although this alternative would be best for the significant resources in the Great Lakes, it does not meet the Corps' primary project purpose of navigation at BRLD. Under the FWCA, we consult with the Corps to ensure that fish and wildlife resources receive equal consideration with other project purposes. In light of the extreme impacts to BRLD's authorized project purpose of navigation, we do not recommend the Lock Closure Alternative.

It is our expert opinion, supported by the expert elicitation, that either alternative with continuous electric barriers would sufficiently reduce the risk of the introduction and establishment of Asian carps in the Great Lakes and Des Plaines River and avoid impacts to significant resources in the Great Lakes. We also support these alternatives because they include the construction of an engineered channel, which provides the best platform for the use of future control technologies that may be developed in the near future. Given the uncertainty and rapidly evolving state of the science underlying the development of new potential control technologies for Asian carp, we feel that the flexibility to include any proven new tools must be inherent to the final selected alternative.

The proposed timeframes for implementation of these alternatives are a concern. We encourage the Corps' to implement construction of the engineered channel and preferred technologies as they develop and efficacy is proven, as quickly as possible. While the adult Asian carp invasion front has not advanced in numerous years, other aquatic invasive species in other systems have advanced rapidly in range and abundance after being seemingly stagnant in these areas. Additionally, recent data (MRWG 2015) indicate that small Asian carp are further upstream in the IWW and research studies have indicated that small Asian carp are more of a threat to the barrier and subsequently pose a higher risk of invasion than larger individuals. It is critical that measures are implemented in a timely fashion; since the possibility exists that Asian carp could get past the Brandon Road location in the construction interim.

## FISH AND WILDLIFE CONSERVATION MEASURES AND RECOMMENDATIONS

The Service and States continue to recommend that the Corps explicitly include the Black Carp as one of the Asian carp species targeted in the GLMRIS-BR project. In addition, we also recommend the following conservation measures:

1. The Corps should continue to evaluate potential measures that may be more effective at controlling hull-fouling species, like the scud. If new information or technology is developed prior to 2021, we recommend including these controls in the selected alternative.

2. The Corps should consider using AC current if any alternatives with an electric barrier are selected. The MIDNR previously suggested that the Corps should evaluate Alternating Current (AC) as an alternative to Direct Current (DC) with alternative barrier designs to those currently in operation. The MIDNR believes there are alternatives with electric barriers that can be safer for people and more effective for fish when combined with a confined channel design.

## RECOMMENDED MITGATION OPTIONS

The structural alternatives have the potential to non-selectively decrease or eliminate all fish passage through BRLD. If any of these alternatives are selected, the Service recommends the Corps: (1) work with the USFWS and the ILDNR to develop an assisted migration plan for the Des Plaines River for select priority species[2], and (2) assists with or contribute funding towards the removal of dams within the Des Plaines River that are already slated for removal, for the purposes of enhancing restoration and connectivity within the watershed upstream of the BRLD. Prior studies have demonstrated that upstream tributaries in both Illinois and Wisconsin have been important areas for spawning and rearing, and as locations for source populations of historically-important native fish species. Dam notching and removals would augment these restoration opportunities downstream of headwaters and upstream of BRLD.

While further technical evaluation and site-specific project analysis and development would be required, the U.S. Fish and Wildlife Service supports the following general concepts and request for mitigation proposed by the State of Illinois (as enumerated in the state summary comments):

[2] We also recommend that the selection of priority species consider host fish for federally endangered mussels, provided water quality and mussel habitat continue to improve in the Des Plaines River.

**(2) Implementation of mechanisms to facilitate healthy fish and wildlife resources affected by project (fish and mussels) recovery and sustainability in the Des Plaines River (includes specific recommendations to maintain monitoring and evaluations of fish community)**

- The Service agrees, in general, with implementation of such mechanisms. This could be addressed 1) evaluation of impacts to select resources due to implementation of identified project alternative, and by subsequently identifying, developing, and implementing specific actions deemed appropriate to meet goals as described in species/watershed management plans. The establishment of a baseline of data to support further development would be supported by maintaining existing monitoring and evaluations of fish communities, and augmenting monitoring, to the extent needed to properly assess project impacts.

**(3) Habitat - Support of habitat projects to provide needed overwintering, spawning, other life stage requirements within Des Plaines River.**

- The Service supports development and implementation of select habitat projects (as described above) to the extent they are linked to resource enhancement needed to offset confirmed impacts directly related to implementation of the selected project alternative at the Brandon Road Lock and Dam. The Service is aware of completed habitat restoration efforts in the Des Plaines watershed (e.g. dam-notching and removal) and advises that projects considered for potential implementation be considered within a watershed-scale management plan, and consider potential risks for increasing introduction of AIS (e.g. Bighead and Silver carp)

**(6) Non-game hatchery/fish culture could assist in mussel and fish species community support as well as sport fish maintenance in the Des Plaines River in absence of fish passage.**

- The Service supports exploring opportunities to augment select mussel and fish species populations; however, this should initially be conducted on a pilot basis, with a component to evaluate stocking success, and (if proven successful) ultimately to the extent stocking needs are linked to offset for potential losses from implementation of Brandon Rd project alternative.

**(7) Fish swaps with other state/federal hatcheries to support, establish fish in absence of fish passage I think this is something that could be supported**

- The Service supports exploring opportunities to augment select mussel and fish species populations using this mechanism (as previously caveated in (6))

**(11) Ensure sportfish opportunities increase concurrently with habitat improvements that are ongoing, but also projected with or without project.**

- The Service agrees with and supports the State of Illinois' interest in increasing sportfish opportunities concurrently with existing or potential new habitat improvements. However, we feel that the outcome of increased sportfishing opportunities is dependent not just upon the habitat improvement fish stock augmentation actions referenced above, but on State management plans and regulation of the sportfishery in the Des Plaines watershed, as well as natural variability and other factors. We advise that the goal of forthcoming mitigation actions should be focused on ecosystem restoration with an additional goal of increased sportfish opportunities arising from those efforts.

**SUMMARY**

The Service recommends the Corps implement Alternative 3 (Technology Alternative - Continuous Electric Barrier) or Alternative 6 (Technology Alternative – complex Noise with Continuous Electric Barrier). Alternative 3 uses the proven effective technology of electricity to meet our Planning Objectives to prevent invasion of Asian carp. The Service recommends this alternative as one technology alternative that would be the most effective to prevent invasion in both the Great Lakes and Des Plaines basins, which would avoid impacts of Asian carp on significant resources in the Great Lakes and Des Plaines. The Service supports this technology alternative with the construction of an engineered channel, where other developing technologies could also be integrated into this measure in the future. Alternative 6 utilizes the engineered channel to deploy the proven effective technology of electricity at a continuous rate, similar to what is deployed already at the Romeoville barriers, and in addition deploys the still developing technology of complex noise. This alternative addresses the current vulnerabilities of alternative pathway through the Des Plaines and builds in additional redundancy for the Romeoville barriers. Both of these alternatives incorporate proven and effective deterrent methods (electricity) and possess the engineered channel where other developing technologies could be implemented at a future date.

The Service recognizes the current electric barriers at Romeoville, IL, although effective at deterring larger sizes of fish, have some limitations such as small fish entrainment issues and is susceptible to power outages, which would still likely be limitations of an electric barrier system installed at the Brandon Road location. However, the installation of a technology alternative at the Brandon Road location would further decrease the potential for Asian carp to invade the Great Lakes (in addition to the line of defense at Romeoville) by impeding passage of Asian carp into the Des Plaines River, preventing them from another access point to Lake Michigan. The Service also recognizes that this impediment to passage for Asian carp would also have a negative impact to native migratory aquatic species and therefore we encourage the Corps to support reasonable and effective mitigation plans, to be fully developed in coordination with the Service and ILDNR.

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# Future Without Project Condition for Asian Carp



The following overview is the anticipated Future Without Project (FWOP) condition for Asian carp within the Illinois Waterway (IWW) and Chicago Area Waterway System (CAWS). The FWOP condition is the basis for comparing alternative plans for the GLMRIS-Brandon Road study. Conditions are reviewed for a 'period of analysis' which usually extends for 50 years or for the duration that significant impacts are expected, but not to exceed 100 years. The 'period of analysis' for the GLMRIS-Brandon Road Study extends for 50 years, from 2021 to 2071. The year 2021 is assumed to be when the U.S. Army Corps of Engineers (USACE) would have authorization and funding to construct the recommended plan. This FWOP condition forecast is intended to provide information regarding the uncertainty associated with (1) the U.S. Fish and Wildlife Service's (USFWS) considerations concerning the Asian carp population front, (2) Asian carp control activities, and (3) water quality upstream of the Brandon Road Lock and Dam (BRLD) which could impact Asian carps' desire to move upstream.

## Asian Carp Population Front

The current distribution of the Asian carp population front within the IWW is discussed below. On October 30, 2015 the following updated risk map (**Figure 1**) was published on the Asian Carp Regional Coordinating Committee (ACRCC) website: www.asiancarp.us. The risk map was updated based on the recent capture of two small Silver Carp (approximately 6.5 in total length) in the Marseilles Pool of the Illinois River. This marked the furthest upstream location that fish of this size have been captured. The previous risk map (**Figure 2**) is provided for reference.

According to the USFWS Planning Aid Letter received October 30, 2015, although the Asian carp population front has seemingly demonstrated relatively little upstream movement in recent years, it is not a certainty that this will remain as such in the future. As mentioned, small Asian carp have been collected from further upstream with increasing frequency in 2015. Additionally, results from a recently completed study by the USFWS demonstrate that barge entrainment may serve as a mechanism to inadvertently move small fish further upstream from their current locations. The phenomenon of invasive species halting their invasion progress for long periods of time, only to continue their advancement in future years, is well known. Examples include the rapid expansion of Smallmouth Bass in the Colorado River and the proliferation of American Shad in the Columbia River basin. Both of these examples highlight situations where an introduced fish was present for decades, to later greatly expand its range and abundance.

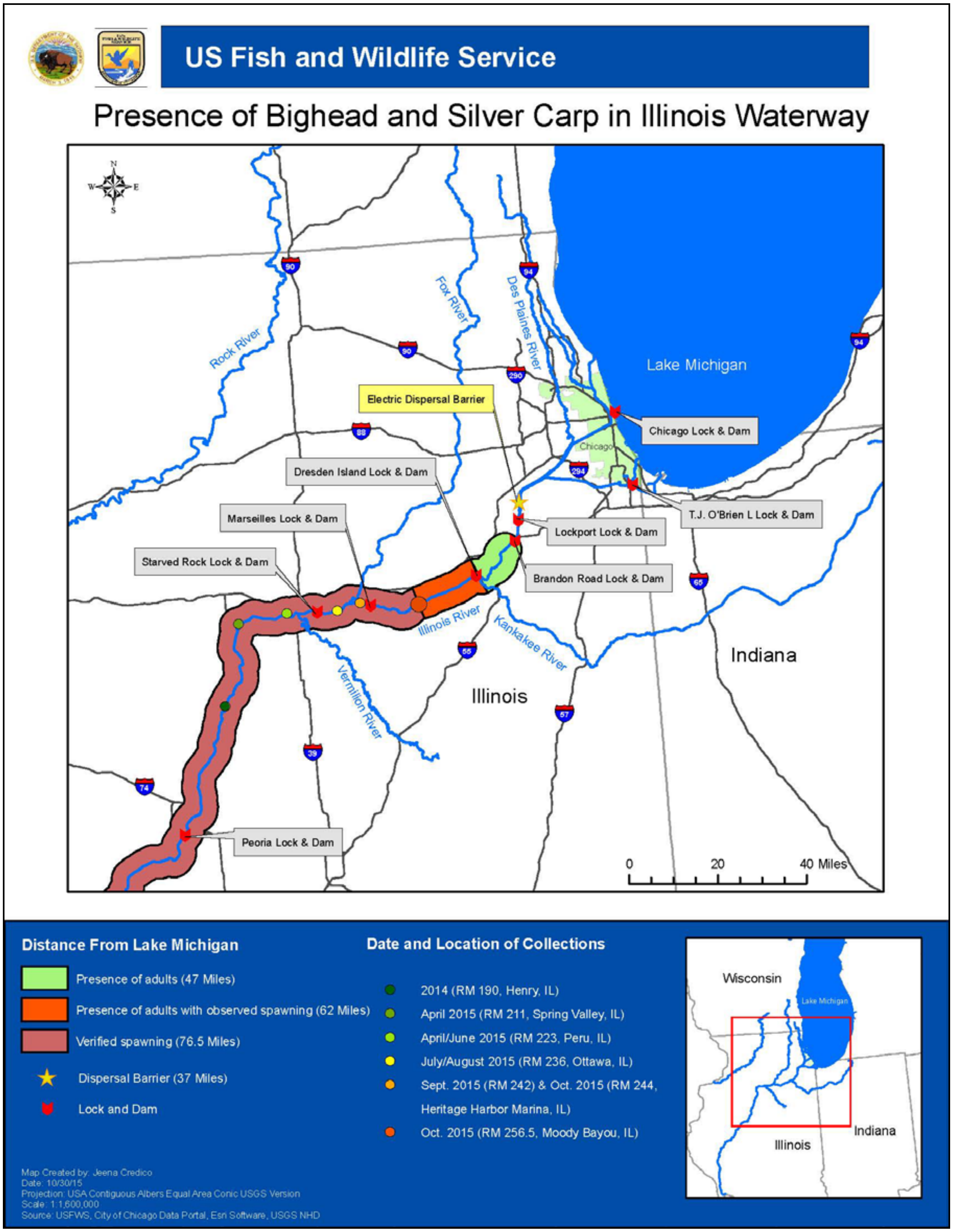



**Figure 1. Current risk map depicting distribution of Asian carp population front within the CAWS and IWW[1].**

[1] U.S. Fish and Wildlife Service. Presence of Bighead and Silver Carp in the Illinois River Map. [Accessed] November 16, 2015:http://www.asiancarp.us/news/Map103015.htm

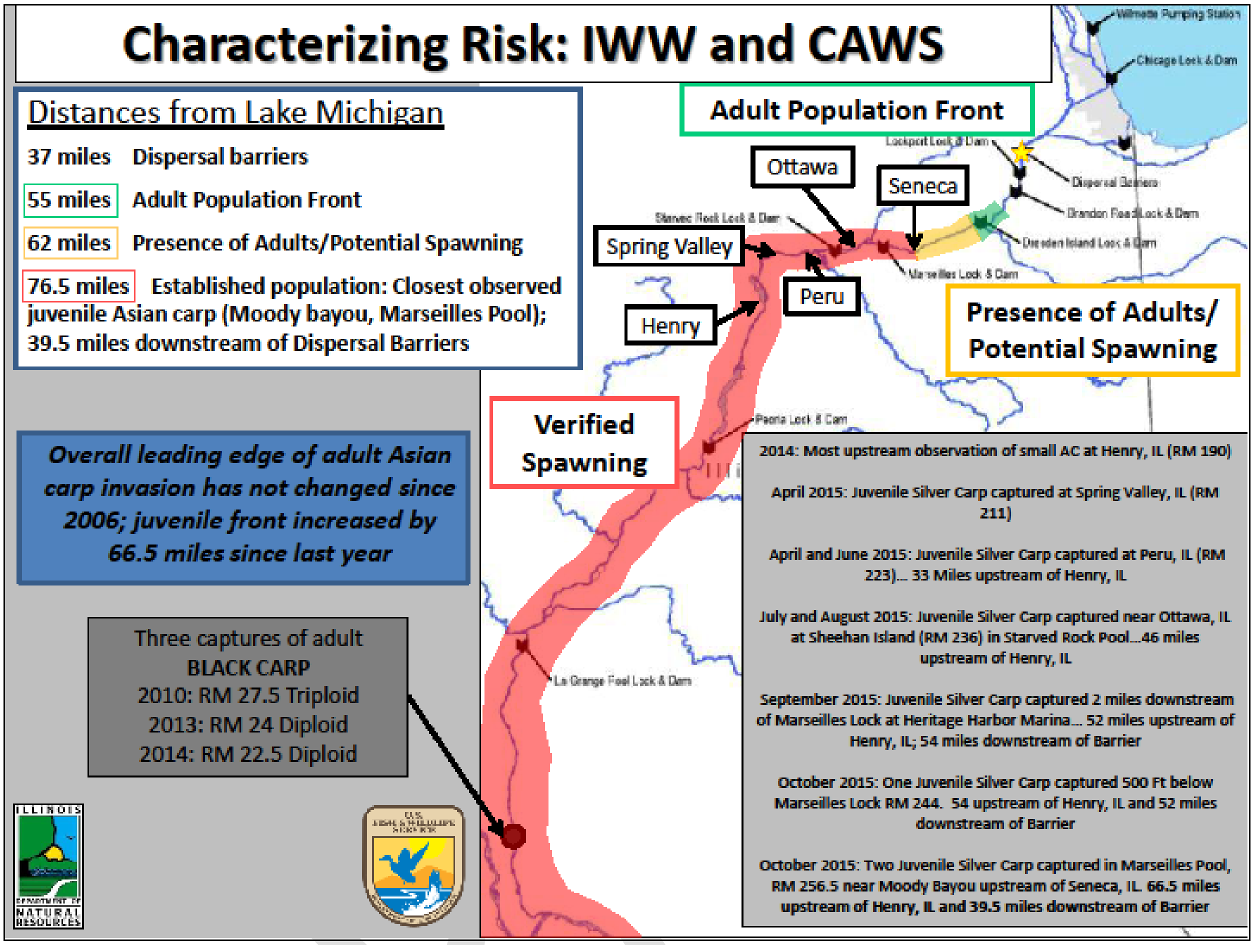



**Figure 2. Prior risk map depicting distribution of Asian carp population front within the CAWS and IWW[2].**

## ANS Control Efforts

Current control efforts such as monitoring activities being conducted within the IWW and CAWS by the ACRCC's Monitoring and Response Work Group (MRWG) and the Electric Dispersal Barrier System in Romeoville, Illinois are discussed below. For additional information on the ACRCC and MRWG please refer to their website, www.asiancarp.us.

### Monitoring Activities

Following is a list of monitoring activities currently being carried out within the IWW and CAWS by the ACRCC's Monitoring and Response Work Group.

- Seasonal Intensive Monitoring Upstream of the Dispersal Barrier
- Strategy for eDNA Monitoring in the CAWS and Temporal eDNA Quantification Below the Dispersal Barrier
- Larval Fish and Productivity Monitoring in the Illinois Waterway
- Young-of-Year and Juvenile Asian Carp Monitoring

[2] ACRCC. 28 October 2015. Characterizing Risk: IWW and CAWS.

- Distribution and Movement of Small Asian Carp in the Illinois Waterway
- Fixed and Random Site Monitoring Downstream of the Barrier
- Response Actions in the CAWS
- Barrier Maintenance Fish Suppression
- Barrier Defense Asian Carp Removal Project
- Identifying Movement Bottlenecks and Changes in Population Characteristics of Asian Carp in the Illinois River
- Telemetry Monitoring Plan
- Understanding Surrogate Fish Movement with Barriers
- Monitoring Fish Abundance, Behavior, Identification, and Fish-Barge Interactions at the Electric Dispersal Barrier, Chicago Sanitary and Ship Canal, Illinois
- Monitoring Fish Density and Spatial Distribution in Lockport, Brandon Road, and Dresden Island Pools and the Associated Lock and Dam Structures
- Des Plaines River and Overflow Monitoring
- Evaluation of Gear Efficiency and Asian Carp Detectability
- Asian Carp Gear Development and Evaluation
- Unconventional Gear Development
- Water Gun Development and Testing
- Alternate Pathway Surveillance in Illinois – Law Enforcement
- Alternate Pathway Surveillance in Illinois – Urban Pond Monitoring

Since 2010, monitoring and response work as well as project plans listed above proposed in the annual MRP[3], have been funded primarily through the U.S. Environmental Protection Agency (USEPA) funds for GLRI. The Great Lakes Restoration Initiative (GLRI) was launched in 2010 to accelerate efforts to protect and restore the Great Lakes as well as to provide additional resources to make progress toward the most critical long-term goals for this important ecosystem. During the first five years of the GLRI, federal agencies and their partners engaged in an unprecedented level of activity to prevent new introductions of invasive species in the Great Lakes ecosystem.

During FY15-19, federal agencies plan to continue to use Great Lakes Restoration Initiative resources to strategically target the biggest threats to the Great Lakes ecosystem and to accelerate progress toward long term goals – by combining Great Lakes Restoration Initiative resources with agency base budgets and by using these resources to work with nonfederal partners to implement protection and restoration projects. To guide this work, federal agencies have drafted GLRI Action Plan II[4], which summarizes the actions that federal agencies plan to implement during FY15-19 using GLRI funding. Under GLRI Action Plan II, federal agencies and their partners will continue to prevent new invasive species from establishing self-sustaining populations in the Great Lakes ecosystem. **Table 1** shows the FY15-19 GLRI Action Plan Summary for Invasive Species.

[3] Monitoring and Response Workgroup. 2015. Monitoring and Response Plan for Asian Carp in the Upper Illinois River and Chicago Area Waterway System. Monitoring and Response Workgroup, Asian Carp Regional Coordinating Committee, Council on Environmental Quality, Washington. 128 pp.

[4] Great Lakes Interagency Task Force. 2014. Great Lakes Restoration Initiative Action Plan II. 30 pp.

**Table 1 – FY15-19 GLRI Action Plan Summary for Invasive Species[5].**

| Focus Area | Objectives | Commitments |
|---|---|---|
| Invasive Species | Prevent new introductions of invasive species | ▪ Block pathways through which aquatic invasive species can be introduced to the Great Lakes ecosystem<br>▪ Conduct early detection monitoring activities<br>▪ Work with Great Lakes states to conduct rapid response actions or exercises |
| | Control established invasive species | ▪ Implement control projects for GLRI-targeted invasive species |
| | Develop invasive species control technologies and refine management techniques | ▪ Develop/enhance technologies and methods to prevent the introduction and to control the spread of invasive species<br>▪ Develop/enhance invasive species specific collaborative to support rapid responses and communicate the latest control and management techniques |

For the GLMRIS-Brandon Road Study, USACE is utilizing a 50-year period of analysis (i.e., through 2071). The GLRI Action Plan II only projects funding for invasive species programs through FY19, after that time it is unknown whether funding will continue or be phased out. USACE sent letter requests to agencies whose invasive species monitoring and response activities are part of the annual MRP and/or receive funds from GLRI. Respondents to information requests provided the following regarding future funding of invasive species programs and projects:

- The Illinois Department of Natural Resources (IDNR) responded that their agency is operating under significant fiscal constraints. Currently, the majority of funding for Aquatic Nuisance Species (ANS) research, controls, and monitoring is funded by Federal funds, which originate within USFWS to support Illinois' Statewide Aquatic Nuisance Species (ANS) Comprehensive Management Plan. Additionally, USEPA funds for GLRI through the USFWS are necessary to support ACRCC actions, including monitoring and response work. There are no current alternative funding strategies for Asian carp work near Chicago[6].

- The U.S. Environmental Protection Agency (USEPA) responded that they anticipate, "continued funding of various Asian carp activities as part of the Asian Carp Control Strategy Framework via the Great Lakes Restoration Initiative for local, state, and federal partners involved in this effort to prevent Asian carp from migrating upstream of the Corps of Engineers' electric barriers. The Framework presents a multi-tiered strategy to combat the spread of Asian carp into the Great Lakes and to ensure coordination and the most effective response across all levels of government. It represents a comprehensive Asian carp prevention plan that includes chemical, structural, monitoring, biological, management and operational strategies. The Framework complements the broader national approach to the management and control Asian carp as presented in the Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States (National Carp Plan), approved by the National Aquatic Nuisance Species Task Force in November 2007[7]." Future funding Asian carp activities is subject to appropriations.



[5] Great Lakes Interagency Task Force. 2014. Great Lakes Restoration Initiative Action Plan II. 30 pp.
[6] IDNR letter dated September 8, 2015, page 2.
[7] USEPA letter dated September 23, 2015, page 11.

- The U.S. Fish and Wildlife Service responded that starting in FY2015 they received an additional $2 million in their base funds to support ANS monitoring and control activities outside of the Great Lakes Basin (e.g., Ohio River Basin and Mississippi River Basin). If GLRI funding is not continued past FY19 (current end date for GLRI Action II), then the USFWS is permitted to use a portion of these additional funds to supplement high priority work, such as that in the CAWS and upper Illinois Waterway. However, if GLRI funding does cease after FY2019, then the ability of the USFWS to continue funding ANS control/monitoring projects within the CAWS and upper Illinois Waterway at the level they are currently being funded decreases significantly. At this time, the USFWS expects to continue to carry out its mission objectives at a minimum at current FY16 base levels through the 50-year period of analysis (i.e., 2071). Per WRRDA 2014, Section 1039 Invasive Species, the USFWS in coordination with the National Park Service, and the U.S. Geological Survey is tasked with leading a multiagency effort to slow the spread of Asian carp in the Upper Mississippi and Ohio River basins and tributaries through technical assistance, coordination, best practices, and support to state and local governments in carrying out activities designed to slow the threat posed by Asian carp. In FY2015 the USFWS provided a combined $800,000 in base appropriations to implement priority projects in support of the "Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States", the "Ohio River Basin Asian Carp Control Strategy Framework", the "Minnesota Asian Carp Action Plan", the draft "Action Plan for Management of Asian Carp in the Upper Mississippi River Basin", and other basin-wide partnership plans. The USFWS also supports actions to provide benefits to the Upper Mississippi River Basin, as described in the ACRCC's annual prevention strategy the "Asian Carp Control Strategy Framework". The USFWS will continue to work with partners to implement actions in support of these strategies, based on availability of resources. Future funding for Asian carp activities is subject to appropriations.

Currently, other new tools and technologies in the fight against Asian carp are under development that could be implemented in the future. These include, but are not necessarily limited to, more efficient detection and capture methods; the use of dissolved carbon dioxide ($CO_2$) and complex sounds to herd or otherwise deter fish; algal attractant to aggregate fish for control actions; and species-specific piscicides for use against Asian carp. In addition, the Illinois Department of Natural Resources (IDNR) is beginning to coordinate a contract for the construction of a mobile electric barrier which is expected to be delivered Spring 2016 with field testing beginning upon delivery. The design of the electric barrier is still in the preliminary stages; however, it is anticipated that it would be effective to a depth of 30 feet and potentially adaptable to shallower habitats. The mobile electric barrier could be used to restrict movement of Asian carp and assist in contract harvest activities conducted by IDNR. When the mobile barrier is in use, commercial navigation would be unable to traverse through the immediate area.

On November 5, 2015 a meeting was held between members of the MRWG to discuss level of response to changes in the population front of Asian carp within the IWW and CAWS. The anticipated end product from the meeting will be a framework describing actions that could be included as part of a low, medium, or high level of response. Additionally, the framework is anticipated to describe qualifications for a response action to be deemed necessary.

## Electric Dispersal Barrier

The Electric Dispersal Barriers includes three (3) barriers (i.e., Demonstration Barrier, Barrier IIA, Barrier IIB) in operation in the Chicago Sanitary and Ship Canal at Romeoville, IL. The Demonstration Barrier is being upgraded to a more powerful barrier (Permanent Barrier I) and construction is currently underway with installation of underwater components having been completed in October 2014. Permanent Barrier I is scheduled for activation in 2017 after completing construction and operational and safety testing. Barrier I is designed to operate at higher voltages than Barriers IIA and IIB; and therefore, may have an increased ability to deter small fish. Barriers IIA and IIB currently operate at a maximum in-water field strength at the water surface of 2.3 Volts/inch with a pulse frequency of 34 pulses/second and a pulse duration of 2.3 milliseconds. It is projected that through the duration of the period of analysis (i.e., 2071) at least two barriers, potentially all three, will be in operation under normal circumstances (excluding maintenance, etc.) with operating parameters no lower than the current parameters of Barriers IIA and IIB.

To inform mitigation measures to address fish entrainment between and around barges and tugs, USACE has initiated a scaled physical model study at the USACE Engineering and Research Development Center. The study will test water jet designs and configurations to dislodge trapped fish. These experiments will be conducted under different vessel speeds and drafts to examine a range of flow and entrainment conditions typical of full scale vessels navigating the Chicago Sanitary and Ship Canal. These experiments will determine minimum discharge, nozzle diameter and pump requirements to remove fish as well as optimal configurations for water jet placement within the channel cross-section. The model study will also evaluate tow speeds in the canal to determine optimal speed requirement to minimize return current (current opposite to vessel movement) of tows.

Informed by the physical model study, USACE's goal is to complete a field study later in FY 2016 of the mitigation measures that are most promising. If the field-tested mitigation measures are found to be effective, then USACE would consider implementing these measures at the Electric Dispersal Barriers.

## Chicago Area Waterway System (CAWS)

The CAWS consists of approximately 128 miles of waterways in the Chicago Metropolitan area used for conveyance of stormwater runoff and municipal wastewater, commercial navigation, and flood control. Many of the waterways are manmade canals and channels, while others are natural streams, many of which have been dredged, realigned, widened, and straightened. The absence of gradual sloping banks, shallow littoral zone habitat, and bends result in a limited habitat for aquatic biota. Homogenous silt sediments that restrict macroinvertebrate and fish populations are deposited throughout much of the CAWS due to the unnatural stream flow dynamics[8].

Flow in the CAWS is managed by the Metropolitan Water Reclamation District of Greater Chicago (MWRD), but is subject to regulation under U.S. Supreme Court Decrees and Title 33 of the Code of Federal Regulations (CFR), Sections 207.420 and 207.425. The CFR provides for the maintenance of navigable depths to support commercial navigation and to prevent unintentional reversal into Lake Michigan. The U. S. Supreme Court Decrees govern the quantity of water from Lake Michigan that is diverted out of the Great Lakes Basin into the Mississippi River Basin by the State of Illinois. Within Illinois, this quantity is subject to regulation by the Illinois Department of Natural Resources (IDNR), Division of Water Resources (DWR).

The IDNR issues allocation orders for annual average quantities of diversion which is allocated to municipalities for domestic consumption. MWRDGC has an order allowing it to divert Lake Michigan water into the CAWS to improve water quality. This diversion is called "discretionary diversion," and it is seasonal and is scheduled such that most flow is during the warm weather months of June through October. In a response letter dated September 15, 2015, the MWRD stated, "the current diversion allocation is 270 cfs but is scheduled to decrease to 101 cfs in water year 2015. MWRD has petitioned

[8] MWRD. 2008. Description of the Chicago Waterway System for the Use Attainability Analysis. Metropolitan Water Reclamation District of Greater Chicago.

IDNR to increase the diversion from the scheduled 101 cfs, and a hearing is scheduled for October. Depending on the outcome of the hearing, MWRD's allocation for discretionary diversion may change and is likely to change over the long term[9].

## Water Quality

It is assumed that the MWRD's wastewater treatment plants will continue to make up approximately 70% percent of the total annual flow out of the CAWS at Lockport Controlling Works.

### Water Quality Structures on CAWS

Sidestream Elevated Pool Aeration (SEPA) stations implemented by MWRD add oxygen to water in the turbulent cascades, or waterfalls. There are currently five major SEPA stations along the Calumet River and the Calumet-Sag Channel. The aeration process improves water quality, encourages fish populations and prevents unpleasant odors. Underwater aeration stations at Devon Avenue and Webster Avenue also improve water quality in the North Shore Channel and the North Branch of the Chicago River.

### Combined Sewer Overflows

Combined Sewer Overflows (CSOs) occur during intense rain events when Chicago's combined sewers cannot accommodate the additional stormwater flow and untreated sewage-storm runoff is discharged to local waterways. Two hundred forty seven (247) permitted CSO outfalls on the CAWS produce hundreds of discharge events each year. More than 600 CSO outfalls exist throughout the entire combined sewer area, which spans Chicago and 51 other municipalities. MWRD's five pumping stations convey wastewater to the water reclamation plants and help dewater the sewer system during storm events to prevent basement flooding. However when the downstream pipes reach capacity, these pumping stations also release large volumes of combined sewage-stormwater to the CAWS. In cases of especially severe storms, the Chicago River Controlling Works (CRCW) and the T. J. O'Brien Lock and Dam are opened to allow water from the CAWS to flow out to Lake Michigan.

The Tunnel and Reservoir Plan (TARP) was adopted in 1972 in order to minimize the impacts of Combined Sewer Overflows (CSO) on the CAWS and Lake Michigan. Competed in 2006, TARP Phase I delivered significant water quality benefits to the CAWS through the construction of 109 miles of large-diameter stormwater tunnels. Completion of the Phase II reservoirs will provide an additional 17.5 billion gallons of storage, and further reduce water quality impacts caused by untreated stormwater-sewage releases to the waterways.

### Impaired Waters

Section 303(d) of the CWA requires states, territories, and authorized tribes to submit a list of impaired and threatened water bodies to the EPA. "Impaired" waters are defined as those not yet meeting water quality standards (WQS), and "threatened" waters are those not expected to meet WQS by the next listing cycle. The Illinois Environmental Protection Agency (IEPA) has identified that many segments of the CAWS, Lower Des Plaines River (LDPR) and Upper Des Plaines River (UDPR) are not supporting their designated uses, as shown in **Table 2**. High counts of fecal coliform indicator bacteria impair many of the waterways for recreational use, and chemical constituents such as phosphorous, mercury, polychlorinated biphenyls (PCBs), and dissolved oxygen (DO) impair many of the waterways for aquatic

[9] MWRD letter dated September 15, 2015, page 1.

life. To develop the Section 303(d) list, the IEPA Ambient Water Quality Monitoring (AWQM) program monitors 213 locations throughout Illinois, two located on the CAWS.

**Table 2 – Water Impairments from 2014 Illinois 303(d) List**[10]

| Waterway | Non-Supporting Designated Use | Impairment(s) |
|---|---|---|
| **Primary Contact Recreation Use, Indigenous Aquatic Life Use** | | |
| Lower North Shore Channel (NSC) from its confluence with the North Branch Chicago River (NBCR) upstream to the North Side Water Reclamation Plant (WRP) | Fish Consumption | Mercury, PCBs |
| NBCR from its confluence with the NSC to its confluence with the Chicago River | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Iron, Phosphorus (Total), Total Dissolved Solids |
| South Branch of the Chicago River (SBCR) from Wolf Point downstream to South Fork of the South Branch of the Chicago River (Bubbly Creek) | Fish Consumption | PCBs |
| | Indigenous Aquatic Life | DO, Total Dissolved Solids, Phosphorus (Total) |
| Little Calumet River from its confluence with the Calumet River and Grand Calumet River to its confluence with Calumet-Sag Channel (CSC) | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | Aldrin, DO, Iron, Phosphorus (Total), Total Dissolved Solids, Silver |
| Little Calumet River South | Aesthetic Quality | Bottom Deposits, Sludge, Visible Oil |
| | Aquatic LIfe | Chlordane, Chloride, DO, Endrin, Hexachlorobenzene, Phosphorus (Total), Sedimentation/Siltation |
| | Primary Contact Recreation USe | Fecal Coliform |
| Calumet-Sag Channel (CSC) from its confluence with the Chicago Sanitary Ship Canal (CSSC) upstream to its confluence with Stony Creek | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Iron, Oil and Grease, Phosphorus (Total), Total Dissolved Solids, Total Suspended Solids (TSS) |
| CSC from its confluence with Spring Creek upstream to its confluence with the Little Calumet River | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Iron, Total Dissolved Solids |
| **Primary Contact Recreation Use, General Use** | | |



[10]IEPA (Illinois Environmental Protection Agency). 2014. Illinois Integrated Water Quality Report and Section 303(d) List; Water Resource Assessment Information and List of Impaired Waters. Bureau of Water. http://www.epa.state.il.us/water/tmdl/303-appendix/2014/iwq-report-surface-water.pdf

| | | |
|---|---|---|
| Chicago River | Aquatic Life | DO, pH, Phosphorus (Total) |
| | Fish Consumption | Mercury, PCBs |
| | Primary Contact Recreation Use | Fecal Coliform |
| Lake Michigan Nearshore (open water) | Fish Consumption | Mercury, PCBs |
| | Aesthetic Quality | Phosphorus (Total) |
| Upper Des Plaines River (UDPR) from confluence with Salt Creek upstream to Wisconsin border | Primary Contact Recreation Use | Fecal Coliform |
| | Fish Consumption | Mercury, PCBs |
| | Aquatic Life | Arsenic, Chloride, Dissolved Oxygen, Iron, Methoxychlor, pH, Phosphorus (Total), Total Suspended Solids (TSS), Cause Unknown |
| UDPR from confluence with CSSC upstream to confluence with Salt Creek | Aquatic Life | Aldrin, Arsenic, Chloride, Lindane, Methoxychlor, pH, Phosphorus (Total) |
| | Fish Consumption | Mercury, PCBs |
| | Primary Contact Recreation | Fecal Coliform |
| **Incidental Contact Recreation Use, Indigenous Aquatic Life Use** | | |
| South Fork of the SBCR (Bubbly Creek) | Indigenous Aquatic Life | DO, Phosphorus (Total) |
| Chicago Sanitary and Ship from its confluence with the SBCR to its confluence with the CSC | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Phosphorus (Total) |
| Grand Calumet River (GCR) | Indigenous Aquatic Life | Ammonia (Un-ionized), Arsenic, Barium, Cadmium, Chlromium, Copper, DDT, DO, Iron, Lead, Nickel, PCBs, Phosphorus (Total), Sedimentation/Siltation, Silver, Zinc |
| Lower Des Plaines River (LDPR) from the Brandon Road Lock and Dam to Interstate 55 bridge | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Iron, Manganese, Total Dissolved Solids |
| **General Use** | | |
| Upper NSC from the Wilmette Pumping Station to North Side WRP | Aquatic Life | DO, pH, Phosphorus (Total) |
| | Fish Consumption | Mercury, PCBs |
| | Primary Contact Recreation Use | Fecal Coliform |
| Calumet River from Lake Michigan to the T.J. O'Brien Lock and Dam | Fish Consumption | Mercury, PCBs |
| | Primary Contact Recreation Use | Fecal Coliform |

| Secondary Contact Recreation Use, Indigenous Aquatic Life Use | | |
|---|---|---|
| CSSC from its confluence with the CSC to downstream to the Will County line | Fish Consumption | PCBs |
| | Indigenous Aquatic Life | DO, Phosphorus (Total), Total Dissolved Solids |
| CSSC from the Will County line downstream to its confluence with the Des Plaines River | Fish Consumption | PCBs |
| | Indigenous Aquatic Life | DO, Iron, Manganese, Phosphorus (Total), Total Dissolved Solids |
| LDPR from its confluence with the CSSC to the Brandon Road Lock and Dam | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Iron, Manganese, Total Dissolved Solids |

According to USEPA response letter dated September 23, 2015, "Future water quality management activities in the CAWS and LDPR, as guided by implementation of new and/or revised WQS, may include implementation of a total maximum daily load (TMDL), more stringent point source permit limits, better stormwater control, and/or new, holistic strategies to improve aquatic life. To the extent that stricter permit limits, installation of stormwater controls, or improved in-stream habitat are shown to be necessary to remedy aquatic life use impairments in order to meet the applicable designated use for a water body, improvements in treatment technologies and/or habitat may be required. Additional management activities in the CAWS could also include: flow augmentation, aeration, and/or sediment removal in certain reaches"[11].

In addition, the USEPA response letter included the following actions that are anticipated to improve water quality within and downstream of the CAWS: "IEPA issued permits in 2013 for the O'Brien (formerly known as Northside), Calumet and Stickney plants requiring phosphorus removal, with associated lengthy compliance schedules. The 2013 issued permits for O'Brien and Calumet require disinfection by March 31, 2016. The Combined Sewer Overflow (CSO) overflows covered under these permits, which discharge untreated wastewater mixed with stormwater into the CAWS, are primarily controlled by MWRD's construction and operation of their Tunnel and Reservoir Plan (TARP) system. A schedule for completing the TARP by 2029 is included in a proposed Federal Consent Decree that has been lodged in Federal Court. The Federal Consent Decree has not yet been entered by the court and is not in effect. The 2013 issued permits for the O'Brien and Calumet plants reflect the finalized upgrade of WQS for the CAWS, as they now contain fecal coliform limits and construction schedules for disinfecting the discharge from the two plants. The Calumet WRP began chlorintation/dechlorination in July 2015, ahead of its existing disinfection compliance schedule in its 2013 issued permit. The Calumet plant is moving forward per its compliance schedule for phosphorus removal in the 2013 issued permit. The O'Brien WRP construction for disinfection and phosphorus removal is moving forward per the compliance schedule in its 2013 issued permit. The Stickney WRP construction for phosphorus removal is moving forward per the compliance schedule in its 2013 issued permit. The O'Brien, Calumet and Stickney permits all contain a 1 milligram per liter (mg/L) phosphorus limit)"[12].



[11] USEPA letter dated September 23, 2015, page 4.
[12] USEPA letter dated September 23, 2015, page 8.

## Conclusion

The following list is the overall conclusions of the FWOP condition for Asian carp within the IWW and CAWS based on the information presented above:

- Uncertainty exists as to whether the Asian carp population front will move upstream of its current location in Dresden Island Pool (i.e., below Brandon Road Lock and Dam) where it appears to be stalled.
- Uncertainty exists regarding the availability of state and federal funds to support continued monitoring and response actions within the IWW and CAWS.
- It is projected for the 50-year period of analysis that USACE will continue to receive funding to operate at least two electric barriers at Romeoville, Illinois.
- It is expected that 70% of the CAWS total annual flow will continue to be generated by MWRD's wastewater treatment plans; however, based on upstream influences it is anticipated that water quality will improve.

# United States Department of the Interior

**U.S. FISH & WILDLIFE SERVICE**

Carterville Fish & Wildlife Conservation Office
9053 Route 148, Suite A
Marion, IL 62959
Phone: 618-997-6869 Fax: 618-997-9185


**October 30, 2015**

Mark Cornish, Acting Chief, Environmental Planning Branch, RPEDN
Department of the Army
U. S. Corps of Engineers, Rock Island District
P.O. Box 2004 Clock Tower Building
Rock Island, IL 61204-2004

Dear Mr. Cornish,

This Planning Aid Letter (PAL) is submitted by the U.S. Fish and Wildlife Service (Service) to the Rock Island District, U.S. Army Corps of Engineers (Corps), for use in the *GLMRIS-Brandon Road Project*. Information and planning assistance are provided in accordance with the provisions of, and under the authority of, the Fish and Wildlife Coordination Act (48 stat. 401, as amended; 16 U.S.C. 661 et seq.), and the "Agreement between the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers for funding Fish and Wildlife Coordination Activities."

The purpose of this letter is to identify resource values and issues, identify endangered species issues, and propose preliminary changes, mitigation, or enhancement opportunities to facilitate your decision-making as it relates to equal consideration of fish and wildlife resources on the identified project. We submit the following information, comments and suggestions under the Endangered Species Act (ESA), as amended (16 U.S.C. 1531 et seq.), Migratory Bird Treaty Act, (49 Stat. 755 as amended; 16 U.S.C. 702 et seq.), and the FWCA (48 stat. 401, as amended; 16 U.S.C. 661 et seq.). These comments are based on information provided by the Service and the State and Federal Fish and Wildlife Management Agencies from all Great Lakes states that may be affected by an invasion of aquatic invasive species into the Great lakes through the Brandon Road Lock and Dam (BRLD).

State Fish and Wildlife Agencies that were afforded the opportunity to comment on this letter include the Illinois Department of Natural Resources (ILDNR) (where the project site is located), as well as all other Great Lakes States that may be affected by a potential invasion of aquatic invasive species into the Great Lakes through Illinois Waterway System via the BRLD: Indiana Department of Natural Resources (INDNR), Michigan Department of Natural Resources (MIDNR), Minnesota Department of Natural Resources (MNDNR), Ohio Department of Natural Resources (ODNR), Pennsylvania Fish and Boat Commission (PFBC), New York Department of Environmental Conservation (NYDEC), and Wisconsin Department of Natural Resources

(WDNR). The Service will continue to provide additional expertise and information in the form of additional PALs and a subsequent Fish and Wildlife Coordination Act report. This PAL does not constitute the FINAL report of the Secretary of the Interior as required by Section 2(b) of the Fish and Wildlife Coordination Act (FWCA).

## Background and Study Site

The Great Lakes and Mississippi River Interbasin Study (GLMRIS) is a Corps-led evaluation of a range of options and technologies to prevent the transfer of aquatic nuisance species (ANS) by way of identified potential aquatic pathways between the Great Lakes and Mississippi River basins through aquatic pathways. Of numerous alternatives identified in GLMRIS, implementation of actions at BRLD has been identified as being one of the most strategic and rapidly achievable set of options. The BRLD project will assess the efficacy of establishing a single point to control the upstream transfer of ANS from the Mississippi River basin into the Great Lakes basin at the BRLD site.

Construction of one-way ANS controls near BRLD is anticipated to enhance protections for the Great Lakes basin while also providing additional information and technology to inform potential two-way risk reduction solutions. Brandon Road Lock and Dam was identified in the GLMRIS analyses as the only single location that can address upstream transfer of Mississippi River species through all Chicago Area Waterway System (CAWS) pathways.

The physical dimensions and configuration of the Brandon Road Dam prevents the upstream transfer of Mississippi River ANS outside of movement through the lock chamber. There is a minimum 25-foot head differential from the downstream side of the dam to the upstream side, which effectively limits upstream transfer. Operation of the navigation lock at this location currently provides the only known aquatic pathway that allows transfer of Mississippi River ANS to the Great Lakes through the CAWS.

This FWCA effort is focused specifically on addressing on the one way (upstream) transfer of ANS at the BRLD. Additionally the coordination effort focuses on three species: bighead carp (*Hypophthalmichthys nobilis*), Silver Carp (*H. molitrix*), and scud (*Apocorophium lacustre*).

## Planning Aid Letter Objectives

The objectives of this PAL are to:

1) Provide a basic background on current fish and wildlife concerns (including ANS) at the site, adjacent areas, and areas potentially affected by actions (or lack thereof) at the site.
2) Outline the concerns of potentially affected State and Federal fish and wildlife resource agencies: 1) should actions be taken at the site, or 2) should no actions be taken.
3) Provide initial background of, and comments and concerns on, the proposed project alternatives.

The PAL is a first draft formal document for the Corps to consider during future discussions and coordination on the subject project with affected fish and wildlife agencies. A final draft FWCA report will be submitted to the Corps in April of 2016.

## Fish and Wildlife Resource Conditions

### Existing Conditions

Adult Asian carp (specifically bighead and silver carp) are abundant in parts of the Illinois River. Downstream populations are well established in the Alton, LaGrange, and Peoria Pools. While comparatively less than at these downstream locations, Asian carp are still commonly present in the Starved Rock and Marseilles Pools. Adult Asian carp are collected in the Dresden Island Pool (including the Rock Run Rookery backwater in that pool) and Lower Kankakee River, but these captures are relatively rare. One adult Bighead Carp was captured in Lockport Pool in 2009 and there have been two credible sightings in the Brandon Road Pool of Asian carp. Additionally, field tracking information demonstrates that telemetered adult Asian carp have been shown to approach the BRLD.

Small Asian carp (<6”) are more of an invasion concern, compared to large adults, due to their being less susceptible to electricity (control and detection) and the higher potential for them to be inadvertently entrained by moving barges. To date, this smaller cohort has not been found as far upstream as adults. Prior to 2015, small Asian carp collections were confined to Peoria Pool and areas downstream. In 2015 small Asian carp have been captured in Starved Rock Pool, just a few hundred feet downstream from Marseilles Lock and Dam. This represents an upstream increase in the range of detected small Asian carp of 48 miles from 2014 to 2015.

Spawning has been verified as far upstream as Marseilles Lock and Dam.

See Figure 1 for more details on adult and juvenile Asian carp and spawning.  For more information on these sources, please see: http://asiancarp.us/documents/MRP2014-InterimSummary.pdf

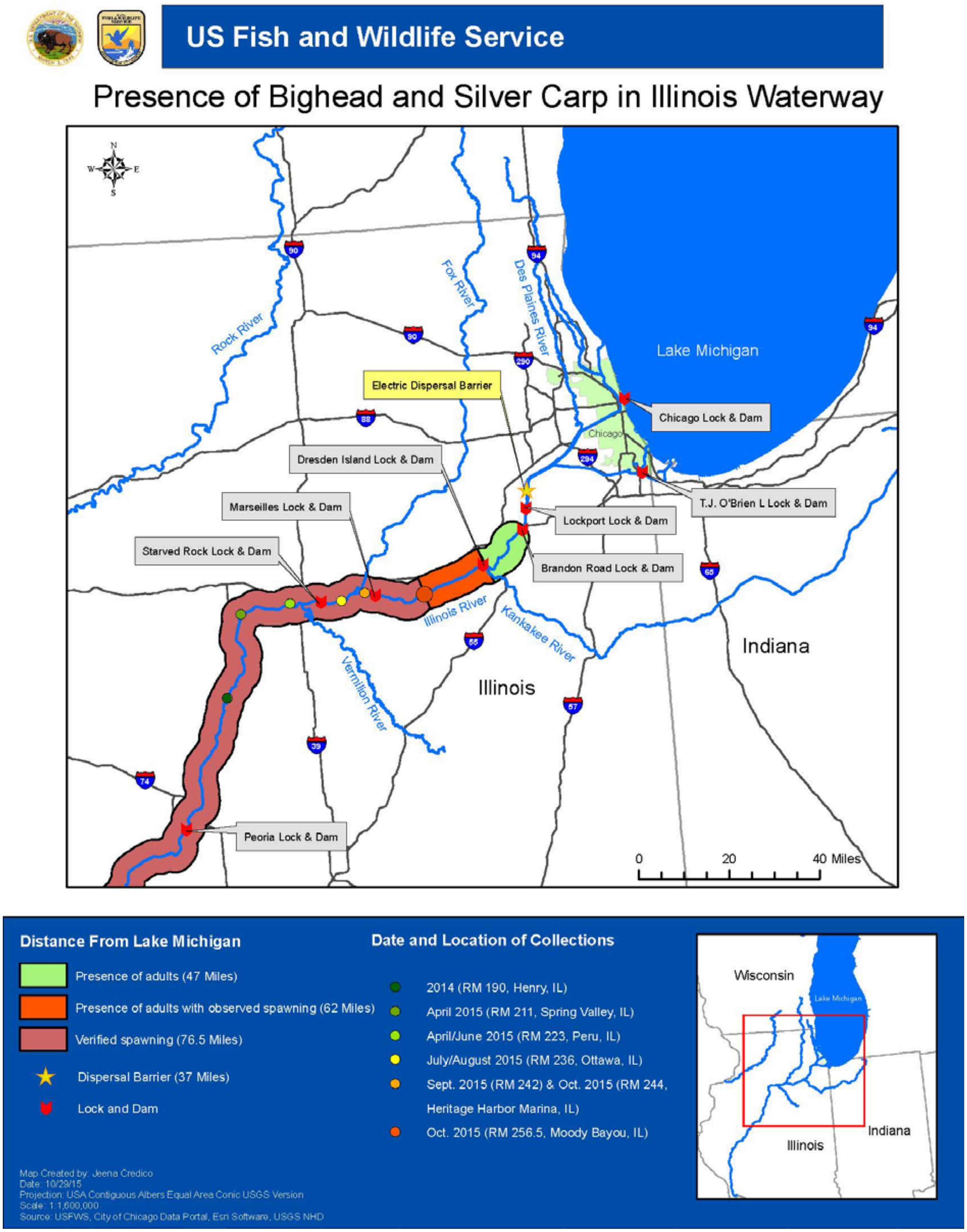



Figure 1- Presence of Asian carp in the Illinois Waterway.

*Apocorophium. lacustre* is an amphipod crustacean found in Ohio and Illinois rivers. It is also found in lower portion of the upper Mississippi River near its confluence with the Ohio River.

The specific BRLD location contains marginal wildlife and fish habitat. The site is heavily impacted and anthropogenic in nature and, therefore, contains little high-quality, intact habitat, save a pathway for aquatic organisms to pass.

**Future without Alternative Implementation**

Currently, intensive management efforts are underway at, below and above the project site to control and contain Asian carp. Extensive harvest controls are underway in Marseilles and Starved Rock pools. Monitoring and removal efforts are underway in Dresden Island Pool, and monitoring efforts are underway in the Brandon Road and Lockport Pools, as well as the Chicago Area Waterways System (CAWS). A redundant series of electrical barriers operates continually in Lockport Pool approximately 5 miles upstream of the Lockport Lock and Dam to prevent upstream Asian carp passage of Asian carp and other fish species. A new barrier is currently under construction at this location and is scheduled for completion in 2017.

Although the Asian carp population front has seemingly demonstrated relatively little upstream movement in recent years, it is not a certainty that this will remain as such in the future. As mentioned, small Asian carp have been collected further upstream with increasing frequency in 2015. Additionally, results from a recently completed study by the Service demonstrate that barge entrainment may serve as a mechanism to inadvertently move small fish further upstream from their current locations. The phenomenon of invasive species halting their invasion progress for long periods of time, only to continue their advancement in future years, is well known. Examples include the rapid expansion of smallmouth bass in the Colorado River and the proliferation of American shad in the Columbia River basin. Both of these examples highlight situations where an introduced fish was present for decades, to later greatly expand its range and abundance. The Service is concerned that the future without alternative implementation could result in the establishment of Asian carps in the Great Lakes. The Corps' No Action alternative should fully assess the risks and likelihood of establishment under current and future conditions.

Currently, other new tools and technologies in the fight against Asian carp are under development that could be implemented in the future. These include, but are not necessarily limited to, more efficient detection and capture methods; the use of dissolved carbon dioxide ($CO_2$) and complex sounds to herd or otherwise deter fish; algal attractant to aggregate fish for control actions; and species-specific piscicides for use against Asian carp.

## Fish and Wildlife Resource Concerns

**Aquatic Nuisance Species Establishment in the Great Lakes Basin**

Of great concern and the primary objective of this project is to prevent the movement of ANS (e.g. Asian carp) from the Mississippi River basin into the Great Lakes by evaluating and potentially establishing control mechanisms at the BRLD. The Great Lakes supports a commercial and recreational fishery valued at over $7 billion annually. Unfortunately, over 180 ANS are already established in the Great Lakes and ANS have caused extensive ecological and economic damage to the entire ecosystem (e.g. sea lamprey, dreissined mussels). Aquatic Nuisance Species that have the potential to invade the Great Lakes from the Mississippi River basin have the potential to do irreparable damage to intact ecosystems through direct competition with and predation on native species, introduction and dispersal of new harmful pathogens and diseases, and ultimately, the alteration of ecosystems functions and services.

**Threatened and Endangered Species**
There are no federally listed species at or near the BRLD location. Therefore, the Service does not have specific concerns about the potential effects of alternatives on federally listed species at BRLD. However, some federal listed species do exist in areas that could be affected by activities that might be implemented at the site (e.g. flow modifications); therefore, consideration should be given to them regarding any impacts that may stem from alternatives under consideration if there are significant alterations in the hydrology of the CAWS or Illinois River.

Species include but are not limited to:

- The Sheepnose Mussel (*Plethobasus cyphyus*), is proposed as endangered and inhabits medium to large rivers and utilizes gravel and mixed sand and gravel substrates.
- The Scaleshell Mussel (*Leptodea leptodon*), is a federally endangered species that occurs in the Mississippi River basin.
- The Hines Emerald Dragonfly (*Somatochlora hineana*) is a federally endangered species that occurs in Illinois, Missouri, Michigan, and Wisconsin.
- The Eastern Prairie Fringed Orchid (*Platanthera leucophaea*) is a federally threatened species that occurs in Illinois, Missouri, Michigan, Iowa, Maine and Wisconsin.
- The Decurrent False Aster (*Boltonia decurrens*) is a federally threatened species that occurs in Illinois along the Illinois River.
- The Leafy Prairie Clover (*Dalea foliosa*) is a federally endangered species that occurs in remnant prairies along the Des Plaines River.

**Fish Passage and Native Fisheries**
Native fisheries have been recovering at and near the study area for several reasons over recent decades. Various legislation (e.g. Clean Water Act) and management actions (e.g. dam removal) have allowed local fisheries in the Upper Illinois River, CAWS, and the Des Plaines River to recover. It has been suggested that these recoveries, particularly in the Des Plaines River, have been assisted and accelerated due to fish passage at Brandon Road. Project activities that would stop or reverse the native fish recovery in the area are of greatest concern to ILDNR.

**Further State and Federal Fish and Wildlife Agency Resource Concerns**
The Service and Corps hosted a FWCA kick-off meeting with the state fish and wildlife agencies on October 7, 2015 to share information about the project and its potential effects, as well as to gather comments and other input from affected states. The meeting was attended, either in person or via webinar, by representatives from the ILDNR, MIDNR, ODNR, and MNDNR. Below is a brief summary of comments received by the states at that meeting.

**ILDNR**

ILDNR supports and recognizes the benefit of stopping the upstream spread of ANS in the Illinois Waterway but has concerns with the lack of detail offered for environmental impacts to date with BRLD planning. ILDNR has stated that there is a lack of concern with other ANS that may establish, and are concerned about additional invaders that may occur over a long time frame.

ILDNR has requested that the Corps needs to give additional consideration into locating further control options at Lockport and would like to discuss long term solutions at Lockport Lock and Dam (Lockport). ILDNR maintains that Lockport is a better location, ecologically and environmentally, for alternative controls and recognizes the potential solutions may be more costly but are more ecologically sustainable. However, BRLD could be considered a short term solution if appropriate long term plans are in place for Lockport or another location. Fish and mussel recovery has shown progress with increased passage efforts in the Des Plaines River and ILDNR has concerns that these recovery efforts may be stopped or reversed. ILDNR would also like to recognize that an existing electrical barrier within the CSSC is being implemented by the Corps and provides a barrier to upstream migration of fishes.

ILDNR would like to consider mitigation measures if passage is restricted at BRLD. Mitigation could include passage, selective sorting, hatcheries, or other measures that would support ecological structure and function and contribute to the continued, positive trend of fish and mussel recovery in the Des Plaines River.

With respect to potential alternatives, ILDNR has general concerns about the level of design at this phase. ILDNR will retain the authority to allow piscicides as a control method as ILDNR deems necessary. Consideration should be given to how $CO_2$ would affect water quality, and downstream impacts would need to be minimized. ILDNR would like to see an impact analysis to fish, mussel, and listed species with each alternative. ILDNR recognizes that economic ramifications of proposed alternatives (i.e. locking time and lock closure) would need to be considered with any future alternative. ILDNR is opposed to any lock closure alternatives and stated that they are unsure that electric barriers are appropriate at BRLD due to considerable concern for human health-safety expressed by USCG and industry. ILDNR supports sustaining current activities, non-structural alternatives, and some additional non-permanent engineering.

Further, ILDNR is concerned about navigation and safety of watercraft operators and barge employees. ILDNR is concerned about the safety of electric barriers. Additional safety measures will need to be taken with the addition of CO2 or electricity at Brandon Road, and ILDNR would like to know what impacts there would be on hydropower development at BRLD if alternatives are implemented.

ILDNR would also like to refer to all the comments specifically mentioned during the public comment period in a letter dated January 16, 2015 (attached).

ILDNR also had these additional considerations:

· Potential impacts to Illinois Natural Areas/Preserves and other flooding impacts for "lock closure" need to be fully identified (ILDNR Nature Preserves recognizes potential terrestrial impacts)

· Weigh sociopolitical and economic consequences of any alternative at BRLD to recreational boating and fishing (not just jumping or just Great Lakes centric)

· This Planning letter should fully recognize fully the challenges for non-federal sponsors and partnerships when developing and selecting alternatives. The Corps should, clearly identify cost/benefits, projects costs, land acquisition, and requirements of the Corps Project Partnership Agreements.

**PFBC**

No verbal or written comments received

**MNDNR**

MNDNR support efforts at BRLD to stop ANS.

MNDNR has no comments on specific control options at this time.

MNDNR has concerns about the expected timeline of project implementation, particularly given their understanding of how the invasion front seems to be advancing. Currently, we have the furthest upstream documented distribution of Asian carp to date.

With respect to predictions of the invasion effects on the Great Lakes that Asian carp pose, MNDNR would like to see near shore aspects are included in future modeling efforts.

MNDNR wants to ensure that the Corps is deploying the most effective barrier to control all life stages and also that continued maintenance costs are assured.

**MIDNR**

Brandon Road Lock and Dam is very important to the state of Michigan, and they view it as a last timely opportunity for their state to stop Asian carp from entering the Great Lakes, given the rate of advancement particularly of the juvenile fish. MIDNR is concerned about the efficacy of control methods if ANS do further invade the Great Lakes. MIDNR is concerned about whitefish, perch, and walleye; as they are near shore spawners their larvae are likely to be consumed in large numbers by bighead and silver carp. Lake trout population recovery in the face of potential further foodweb disruption is also a concern. They are also concerned about walleye and perch populations. MIDNR has seen significant native fish recovery in the Great Lakes, bay, and drowned rivermouths and is concerned about reverses in these recoveries that an ANS invasion may cause. The Corps should also consider effects on mussel populations in Great Lakes and its tributaries in Michigan when considering the no action alternative. Additionally, MIDNR suggests that a representative from the Service's East Lansing Ecological Services Field Office be included in discussions of effects to local threatened and endangered species under the no action alternative.

MIDNR has no specific comments on which barrier alternative is best at this time, but would like to know what alternatives work and what alternatives are available that we can use now. MIDNR suggests an adaptive management framework and supports the proposed alternatives as long as they have proven to be effective. MIDNR feels that electricity is the most effective structural option, and the Corps should also evaluate Alternating Current (AC) as an alternative to Direct Current (DC) with alternative barrier designs to those currently in operation. MIDNR believes there are alternatives with electric barriers that can be safer for people and more effective for fish when combined with a confined channel design. Using electricity is a valuable tool and it can always be turned off if it is no longer necessary or effective. MIDNR is glad to see that lock closure is a part of the proposed alternatives, but understands it is an extraordinary method. However, lock closures may not need to be long term but they may be necessary in urgent situations and emergency lock closure should be considered as an option.

MIDNR made the additional comments that it is important to be successful in preventing fish (mega-swimmers as compared to other taxa) from entering the Great Lakes. There will be serious public concerns, based on perception, for moving forward with control options for smaller organisms such as the floaters or foulers. MIDNR is further concerned over the enormous costs not only to the fishery and tourism economies, but to the agencies responsible for controlling and managing bighead and silver carp if they were to enter the Great Lakes.

**INDNR**

Verbal and written comments received are captured in other parts of the PAL

**ODNR**

ODNR is supportive of ANS controls at BRLD but not in lieu of moving towards an effective two-way ANS barrier. Although potential negative impacts to the Des Plaines River are noted, these impacts should not hinder the proposed efforts to prevent the movement of ANS into the Great Lakes because of the overall greater risk.

ODNR is concerned with the timeline for implementation. The Corps will not have the chiefs' report until 2019 with funding not available until 2021, and another 5-6 years for construction. Every effort should be made to speed up the timeline.

ODNR has no preference as to the proposed alternatives at this time but efforts should be made to focus on technologies that show the greatest promise as an effective ANS barrier and these technologies should be deployed as soon as possible and should not wait for the study completion.

**WDNR**

WIDNR is open to the investigation of the effectiveness of ANS control technologies at the Brandon Road location. Depending upon the results of the investigation WIDNR may be supportive of full implementation of these technologies at the Brandon Road Lock and Dam if it is part of a comprehensive ANS control strategy that will prevent the two way movement of ANS through the CAWS.

**NYDEC**

NYDEC supports pursuit of redundant ANS controls at BRLD but has no specific comments on preferred alternatives at this time. Although the Asian Carp population front has seemingly not advanced in recent years, NYDEC views potential movements of small Asian Carp as particularly worrisome and remains concerned about the timeline for implementing potential additional controls.

**Additional State Comments**

States were afforded to provide further scoping comments under the GLMRIS NEPA scoping process. Please see the attached letters from ILDNR, MIDNR, and ODNR for additional comments.

**U. S. Fish and Wildlife Service**

The Service wants the Corps to select the most effective alternative. The Service recommends that additional high risk species (e.g. Black Carp, Northern Snakehead) be taken into consideration when considering options for preventing passage of ANS at BRLD. Additionally, the Service and other states recommended that all life stages (egg, larvae, juvenile, and adult) of ANS be taken into consideration for any alternatives.

## Description of Alternatives under Consideration

The Corps is currently working on developing alternatives to consider for the BRLD project. These alternatives are being developed with partnering agencies (e.g. U.S. Geological Survey) and in some cases include novel technologies that are in various stages of research and development. Additionally, environmental compliance and permitting issues are still under review. As such, a brief and generalized description of the alternatives is given below. A more detailed description will be forthcoming and taken into consideration in future iterations of the FWCA planning process and given full consideration before the final FWCA report is submitted.

### No New Federal Action

Current actions that are being conducted federal, state and local agencies. This includes the continued operation of the redundant series of electrical barriers in Lockport Pool approximately 5 miles upstream of the Lockport Lock and Dam.

### Non-structural Alternative

Includes the actions included in the No New Federal Action Alternative and additional ANS controls that do not require the construction of permanent structures, best management practices related to navigation within the waterway, and public outreach and education. Controls include actions such as overfishing, piscicides and ballast water discharge. The Nonstructural Alternative includes monitoring to assess whether the alternative achieves its anticipated outcome, and adaptive management promotes flexible decision making that can be adjusted in light of alternative uncertainties.

The following structural alternatives would be sited in the vicinity of the Brandon Road Lock and Dam.

**Technology Alternative 1**
This Alternative includes the Nonstructural Alternative, and barge entrainment options and swimmer controls that will be installed within an engineered channel. This alternative includes monitoring and adaptive management.

**Technology Alternative 2**
This Alternative includes the Nonstructural Alternative, barge entrainment options and swimmer controls that will be installed within an engineered channel, and a flushing lock. This alternative includes monitoring and adaptive management.

**Lock Closure**
Includes the Nonstructural Alternative and removes the upper operational lock gates and replaced them with a permanent concrete wall. This alternative includes monitoring and adaptive management.

## Alternative Evaluation Methods

The U.S. Army Corps of Engineers is convening an expert elicitation panel in Winter/Fall of 2015 to evaluate the effectiveness of options under consideration at BRLD. This evaluation will garner consensus on the range of, and bounds around, the effectiveness on the various options. This panel will consist of biologists, hydrologists, engineers, and other pertinent subject matter experts. The outcome of this panel will be incorporated into FWCA recommendations when it is received and before the final FWCA report is submitted. With regard to the expert elicitation process, State and federal fish and wildlife resource agency personnel in the FWCA process recommend the following:

1. We recommend that the expert panel include experts on invasion theory.
2. We recommend that the appropriate experts on the technologies under consideration for alternative development be a part of this process.
3. We recommend that the Service and state fish and wildlife agencies be given the opportunity to review the results from the expert elicitation process and that the Corps consider our comments relative to the panel recommendations.

With regard to other evaluation methodologies, the Service and State fish and wildlife agencies recommend the following:

4. We recommend that any efforts to weight the significance of an invasion weigh the sociopolitical and economic consequences of fish jumping that may impact recreational boating.
5. Evaluation of electric barriers should consider AC vs DC current.
6. ILDNR recommends that evaluation methods consider impacts to the Des Plaines River ecosystem.
7. We recommend that existing data from ongoing efforts to monitor Asian carp populations and movements, examine fish passage at BRLD, and all studies related to barrier technologies and factors that may impact the efficacy of barrier technologies (e.g. barges) be taken into consideration.

8. We recommend communication and coordiantion with the CAWS Advisory Committee to exchange ideas, updates, and results
9. We recommend that quantitative ecological consequences modeling consider caution about the food web modeling because it may not be appropriate (too conservative). Invasion modeling efforts for the Great Lakes in the past have been pelagic based and need to consider near-shore areas and species as this is where Asian carp are likely to have the most impact.
10. We also recommend that modeling efforts consider riverine habitat impacts.
11. We recommend that the Corps bound the ecological and economic consequences of invasion with lower and upper ranges.
12. We recommend that the sociopolitical consequences include an analysis of the economic consequences of fish jumping that may impact recreational boating.

### Recommendations for Alternatives Development

1. All agencies, with the exception of ILDNR, are in support of the Brandon Road location as a long term ANS control point. ILDNR supports BRLD as a short term AND control point.
2. All agencies, with the exception of ILDNR, support all technologies and redundant controls (e.g. electricity, $CO_2$). Real time monitoring of these technologies is also recommended. ILDNR is adverse to the further use of electricity for safety reasons, and has reservations about the potential effects of other technologies.
3. Great consideration needs to be given on effectiveness of the control measures under consideration.
4. Potential impacts to native fisheries and water quality need to be considered. Alternatives need to be further designed and analyzed before more robust recommendations can be made.
5. A process to fully allow for adaptive management to occur during the alternatives development, testing and evaluation should be established.

Sincerely,

Sam Finney

Sam Finney, Assistant Project Leader/Fish Biologist

cc: Affected states

Attachments: NEPA scoping comments from Illinois, Michigan, and Ohio

# Great Lakes and Mississippi River Interbasin Study – Brandon Road

# Draft December 2015 Factsheets

## Brandon Road Lock & Dam

**Location**

Brandon Road Lock and Dam is located along the Des Plaines River in Joliet, IL. There are two miter gates located at either end of the lock. A miter gate is one pair of canal lock gates that swing out from the side walls and meet at an angle pointing toward the upper level. The dam is located slightly upstream of the lock. Two mooring cells are currently located in the downstream approach channel. An additional feature in the area is a roadway lift bridge over the lock channel for Brandon Road traffic.

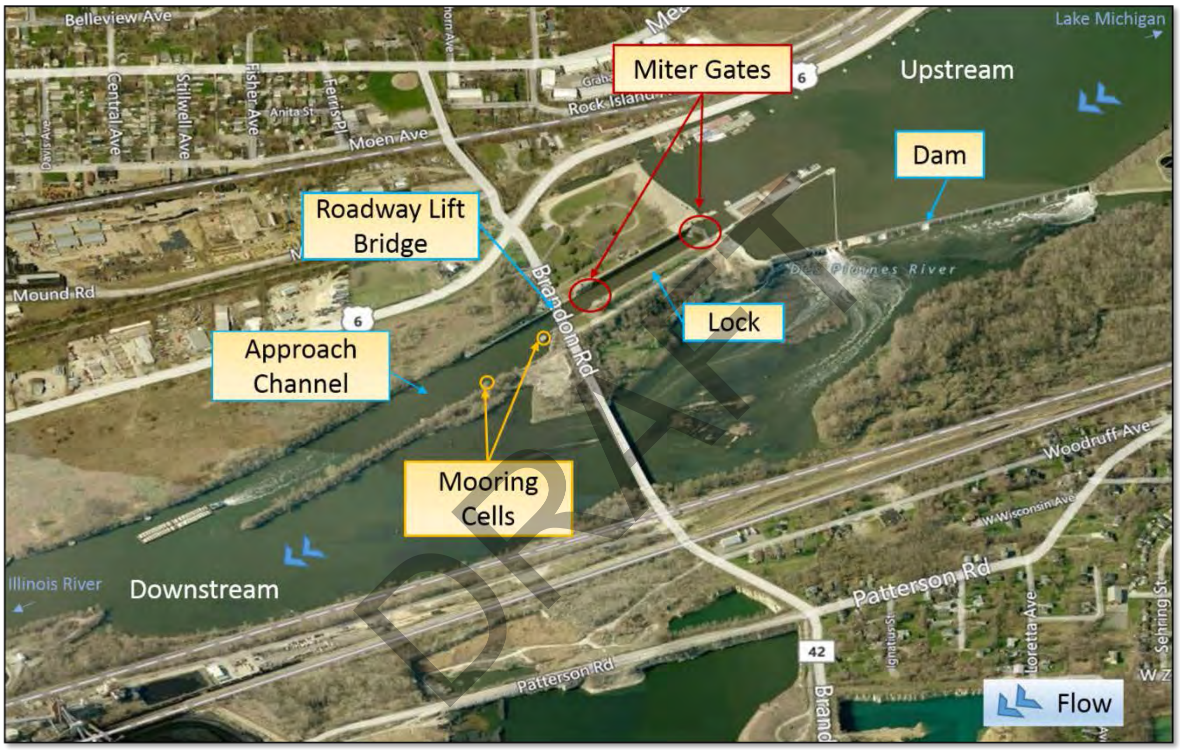



**Figure 1. Brandon Road Lock & Dam Location Map.**

**Brandon Road Lock**

Brandon Rd Lock is unique in that it does not close during high water events, so barges may still lock through during a 500-year storm event. At this frequency, the head difference between the pool and tail is still greater than 20 feet. Navigation stops at 15,000 cubic feet per second (cfs); however, due to traffic constraints (no lockages) upstream and downstream of Brandon Road.

Typical Filling Time: 19 min
Typical Emptying Time: 15 min
Average Inflow while Filling: 1705 cfs

Average Discharge while Emptying: 2159 cfs

**Brandon Road Dam**

This dam contains 21 operable tainter gates (50 ft wide by 2' 3.5" high) and eight operational headgates (15 ft wide by 15.75 ft high) (**Figure 2**). The tainter gates are used to keep the upper pool at elevation 538.5 feet NGVD while passing the river flows. Each tainter gate has a maximum capacity of 550 cfs. During normal flow conditions, all flow is passed through the tainter gates.

If additional capacity is needed during flood conditions, the headgates are used. Three of the gates have permanently mounted electric hoist mechanisms, and the remaining five gates are operated by a mobile electric hoist car on a rail system. The average velocity through the head gates using a conservative water depth (H) of 20 ft is 30 ft/s.

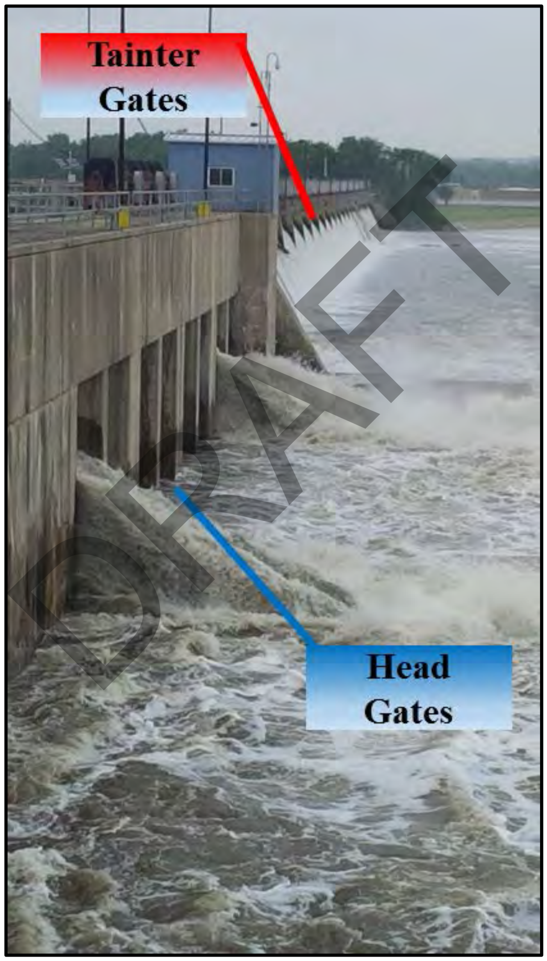



**Figure 2. Brandon Road Dam.**

## Chicago Sanitary and Ship Canal Dispersal Barriers

**Location and Purpose**

The dispersal barriers are located in Romeoville, IL in the Chicago Sanitary and Ship Canal (CSSC), which is a man-made waterway creating the only continuous connection between Lake Michigan and the Mississippi River basin. The dispersal barrier system is operated to deter the movement of invasive fish species between the Mississippi River basin and the Great Lakes (**Figure 1**).

Each barrier is formed of steel electrodes that are secured to the bottom of the canal (**Figure 2 and Figure 3**). A low-voltage, pulsing DC current is generated on land in a control building and sent through the cables, creating an electric field in the water. The electric field is uncomfortable for fish and deters them from swimming across it.

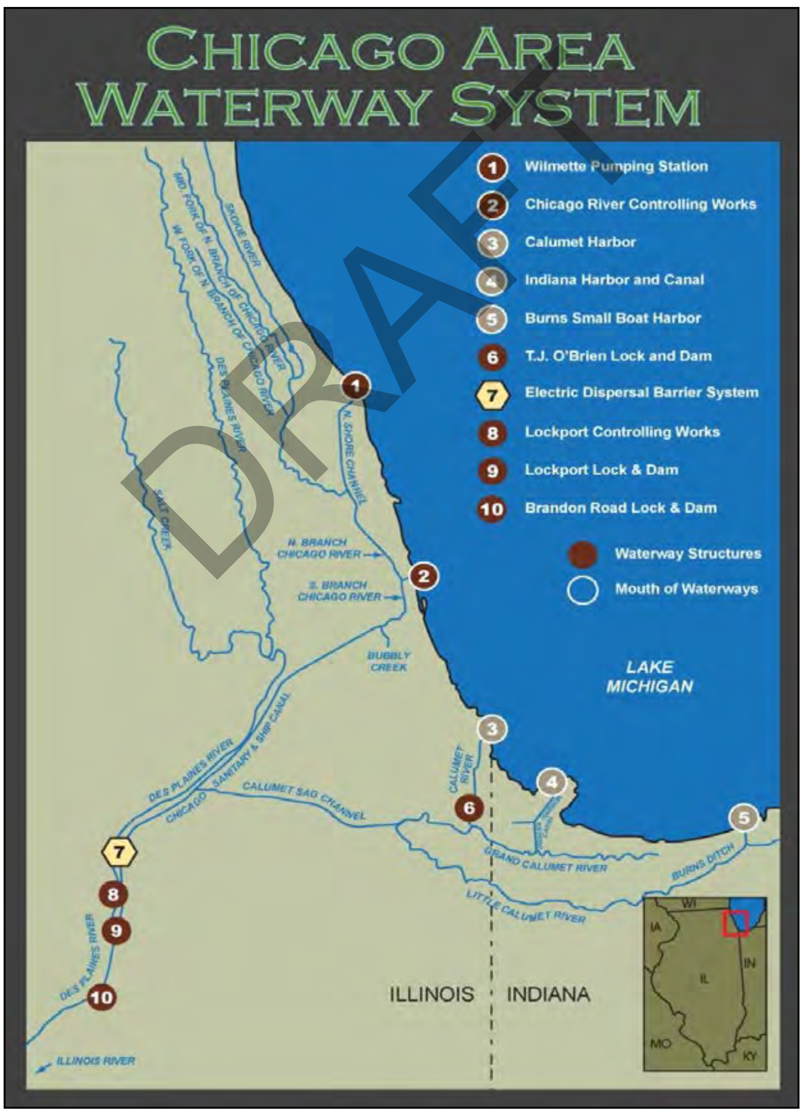



**Figure 1. Location of the Electric Dispersal Barrier within the CAWS**

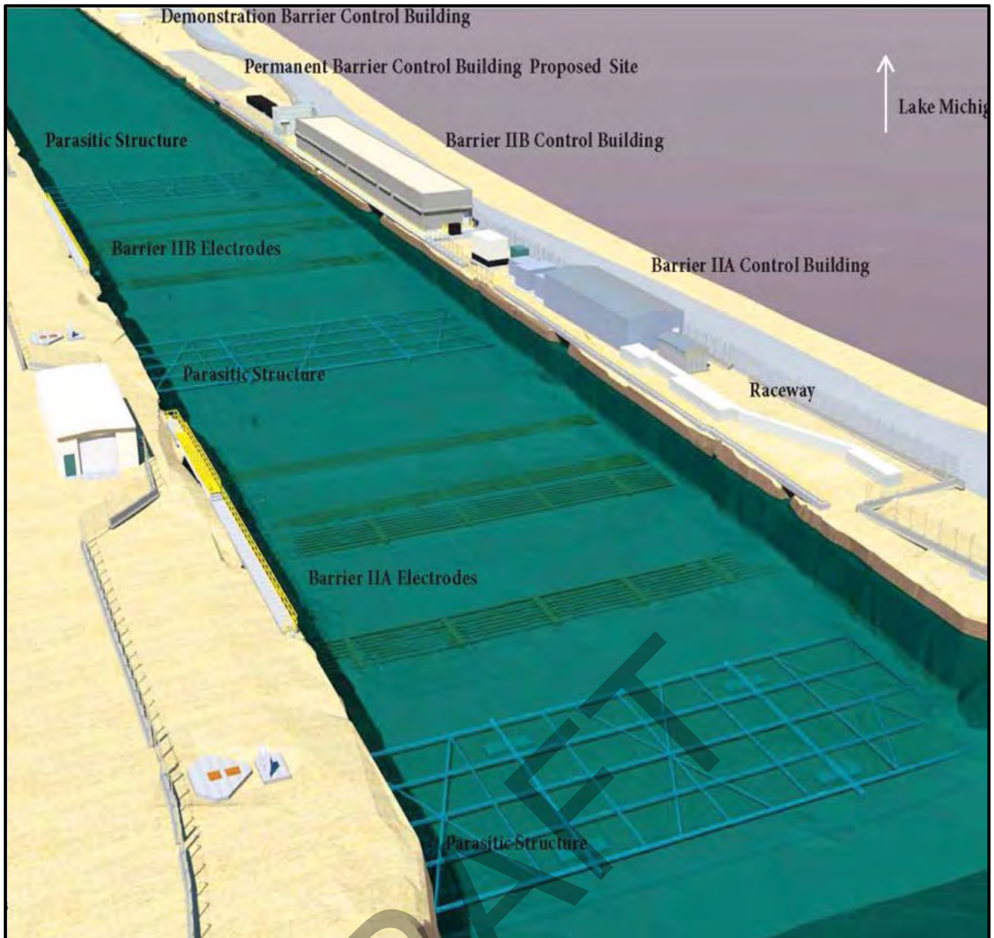



Figure 2. Romeoville Electric Dispersal Barrier schematic


Figure 3. Aerial view of the Romeoville Electric Dispersal Barrier

**History**

**Table 1. History of Barrier Completion.**

| Barrier | Fully Operational (Year) |
|---|---|
| Demonstration Barrier | 2002 |
| Barrier IIA | 2009 |
| Barrier IIB | 2011 |

**Current Status**

All three barriers are kept in continuous operation except when maintenance or construction needs require a barrier to be off for safety reasons. Maintenance and construction are scheduled so that at least one barrier is always operational. Construction of the upgraded permanent Barrier I is underway. Installation of the underwater components was completed in October 2014. Construction of the control building is ongoing. Permanent Barrier I is scheduled for activation in 2017 after completing construction and operational and safety testing. An Interim IV Efficacy Study report has been prepared by LRC and is currently under review at Corps Headquarters. The Interim IV report documents the results of ongoing testing and analysis related to the barriers and includes a systematic risk assessment of identified barrier failure modes.

**Operating Parameters**

The effectiveness of the barriers is dependent on the electric field parameters (field strength, pulse frequency, pulse duration), biological factors (fish species and size), and environmental factors (such as water temperature, conductivity, and depth and presence of conductive objects in the water such as boats or debris). Only the electric field parameters can be directly controlled during operation. The USACE has sponsored an ongoing research program investigating optimal operating parameters for the CSSC Barriers for deterring Bighead and Silver Carp. Several reports have been published[1,2,3,4] and others are under development. Barriers IIA and IIB currently operate at a maximum in-water field strength at the water surface of 2.3 Volts/inch with a pulse frequency of 34 pulses/second and a pulse duration of 2.3 milliseconds. These parameters were found in the laboratory to be effective at immobilizing Bighead and Silver Carp as small as approximately 76.2-127 mm (3-5 in) in total length. Tests on smaller fish are ongoing and initial results indicate some combination of larger field strength and/or higher pulse frequencies is necessary to immobilize Bighead and Silver Carp 25.4-50.8 mm (1-2 in) in total length.



[1] Holliman, FM. 2011. Operational protocols for electric barriers on the Chicago Sanitary and Ship Canal: influence of electrical characteristics, water conductivity, behavior, and water velocity on risk breach by nuisance invasive fishes. Final report submitted to U.S. Army Corps of Engineers, Chicago District. 132 pp.

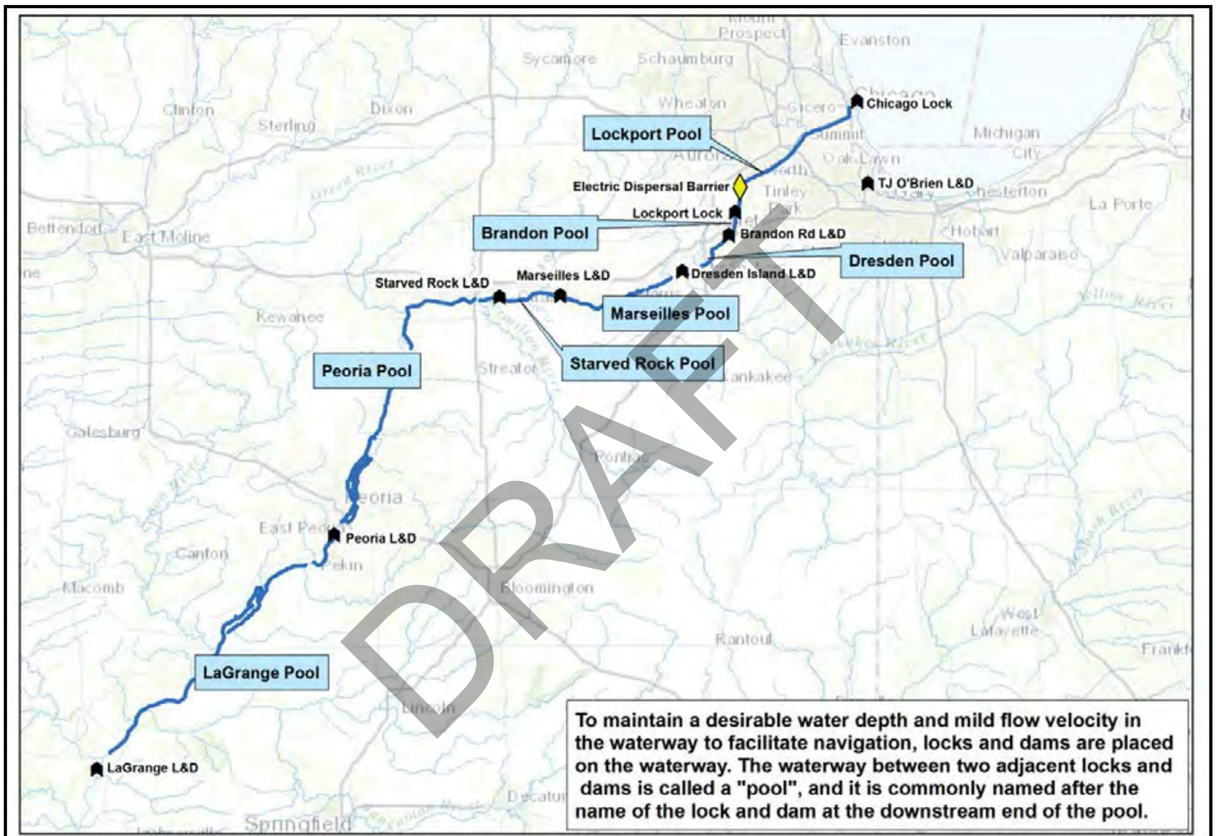
[2] Holliman, FM. 2014. Reliability demonstration testing of electric field parameters for electric field-based aquatic nuisance species dispersal barriers on the Chicago sanitary and ship canal. Fish Research and Development, LLC. 48 pp.

[3] Holliman, FM. 2014. Effects of electrode polarity on risk for breach of electric barriers on the Chicago sanitary and ship canal by small sizes of bighead carp. Fish Research and Development, LLC. 41 pp.

[4] Holliman, FM, Killgore KJ, and Shea C. (2015). "Development of Operational Protocols for Electric Barrier Systems on the Chicago Sanitary and Ship Canal: Induction of Passage-Preventing Behaviors in Small Sizes of Silver Carp," ANSRP-15-1, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

**Effectiveness Studies**

The primary tool used to monitor barrier effectiveness is a telemetry tracking program that uses surrogate species of fish, primarily common carp. The program involves surgically implanting individually coded ultrasonic transmitter tags in the fish and then monitoring movements with a series of stationary and mobile hydrophones. 148 tagged fish have been released in the Lockport Pool (**Figure 4, Table 2**) below the barriers. There have been 4.4 million detections of these fish and no fish have been recorded swimming upstream through any active barrier. There are however two instances of transmitters originally implanted into fish downstream being detected upstream of the barriers. These tags were not detected on receivers at the barriers and were both identified as deceased at their upstream locations[5].




The Electric Dispersal Barrier System located approximately 8 km (5 mi) upstream of the Lockport Lock and Dam.

**Figure 4. "Pools" within the CAWS and Upper Illinois Waterway**

[5] Monitoring and Response Workgroup. 2015. 2014 Asian Carp Monitoring and Response Plan Interim Summary Reports. Monitoring and Response Workgroup, Asian Carp Regional Coordinating. 258 pp.

**Table 2. Pool and Lock & Dam information for the upper IWW and CAWS.**

| Pools of the Upper Illinois River and CAWS | | | Lock and Dams of the Upper Illinois River and CAWS | |
|---|---|---|---|---|
| **Pool** | **River Miles** | **Approximate Length (km/mi)** | **Lock and Dams** | **Approximate Distance from Electric Barrier System (km/mi)** |
| Lockport Pool | | | Chicago Lock | 49.9/31 |
| Electric Barrier System | 296 | -- | T.J. O'Brien L&D | 49.1/30.5 |
| To Chicago Lock | 291-327 | 57.9/36 | Lockport L&D | 8/5 |
| To T.J. O'Brien L&D | 291-326.5 | 57.1/35.5 | Brandon Road L&D | 16.1/10 |
| Brandon Road Pool | 286-291 | 8/5 | Dresden Island L&D | 39.4/24.5 |
| Dresden Island Pool | 271.5-286 | 23.3/14.5 | Marseilles L&D | 78.9/49 |
| Marseilles Pool | 247-271.5 | 39.4/24.5 | Starved Rock L&D | 104.6/65 |
| Starved Rock Pool | 231-247 | 25.7/16 | Peoria L&D | 222.7/138.4 |
| Peoria Pool | 157.6-231 | 118.1/73.4 | LaGrange L&D | 347.3/215.8 |
| LaGrange Pool | 80.2-157.6 | 124.6/77.4 | | |

The Corps has identified five types of failure modes for the CSSC Barriers that could severely reduce the effectiveness of the project: movement and release by people or animals; bypass of the barriers via interbasin connections; inadvertent movement by vessels; failure of the barriers to perform effectively; and other miscellaneous risks. Actions to reduce the risk of movement by people are beyond the authority of the Corps. Movement by animals is possible, but a relatively low risk.

The Interim I Efficacy Study report investigated the potential bypass of the barriers through the Des Plaines River or other neighboring waterways during flood flows. It recommended blockage of the Illinois & Michigan Canal at a natural flow divide and construction of approximately 20.9 km (13 mi) of a combination of concrete barriers and fine-mesh fencing between the Des Plaines and CSSC to minimize the risk of fish bypass during high water events. Construction of these barriers was completed in October 2010.

Three ways that vessels could inadvertently transport fish across the barrier are movement in ballast or bilge water, fish jumping on vessels, and entrainment within water movements created by vessel movement or impingement on the vessel itself. The first two are relatively low risks[6,7]. Field and laboratory studies have been completed on the potential entrainment of fish by moving vessels[8] and in every model or on-site field test completed to date at least some fish were moved across the barriers.



[6] U.S. Coast Guard. 2013. Asian carp survivability experiments and water transport surveys in the Illinois River, Volume I. Acquisition Directorate: Research & Development Center. Report No. CG-D-01-13. 80 pp. Accessed at: http://www.dtic.mil/docs/citations/ADA571454

[7] U.S. Coast Guard. 2013. Asian carp survivability experiments and water transport surveys in the Illinois River, Volume II. Acquisitions Directorate: Research & Development Center. Report No. CG-D-02-13. 79 pp. Accessed at: http://www.dtic.mil/docs/citations/ADA571455

[8] U.S. Fish and Wildlife Service. 2014. Summary of fish-barge interaction research and fixed dual frequency identification. Sonar (DIDSON) sampling at the electric dispersal barrier in Chicago Sanitary and Ship Canal. 15 pp. Accessed at: https://lrc.usace.afpims.mil/Portals/36/docs/projects/ans/docs/Fish-Barge%20Interaction%20and%20DIDSON%20at%20electric%20barriers%20-%2012202013.pdf

Results of a 2011 indoor scaled physical model (1:16.7) study indicated that fish could become entrained within the recesses between barges or trapped in the residual currents and carried past simulated control structures (e.g., electric fish barriers) for a variety of tow configurations, speeds, and directions. In some cases, fish were carried over the scaled up distance of 609.6 meters (2000 feet).

Several studies have been conducted near the Electric Dispersal Barriers by USFWS to determine the efficacy of the barrier. These studies primarily focus on if and how small fish interact with the barrier and in what effect vessel traffic effects these behaviors. In 2013, USFWS deployed fixed DIDSON cameras at the Electric Dispersal Barriers to esonify the entire IIB narrow array where the electrical fields are the strongest. Video footage was collected in 10 minute increments and video was reviewed in the lab to determine if fish were able to penetrate the barrier. All video footage was taken while Barrier IIA was under maintenance and not operational. Results indicated that 44 out of 72 (61%) ten minute videos captured at least one occurrence of a school of fish, estimated to be between 50.8-101.6 mm (2-4 inches) in length, passed through the barrier in an upstream direction. The study was repeated in 2014 however this time Barrier IIA and IIB were operational and fish densities near the barriers were low due to the time of year. No fish were observed passing through the IIB narrow array in the upstream direction.

Additional studies by USFWS investigated how vessel traffic may impact the ability of fish to move through the Electric Dispersal Barriers. Research conducted in 2012 demonstrated that large bodied fish can move through the demonstration barrier when placed into a cage within a barge junction. These data resulted in a follow up study in 2013 using fish tethered to small bobbers by fishing line, USFWS released tethered fish either directly into the various junction wedges of barges to evaluate the likelihood of entrainment when the fish had the ability to leave under its own volition or they were released in advance of an upstream bound barge to assess the likelihood of entrainment into the junction wedges after a barge strike. During the trials, several barge configurations were tested. In total, 340 Gizzard Shad were tethered resulting in 21 breaches of the dispersal barrier after direct placement into a junction and an additional 20 breached after they were deployed in front of the moving barge. These fish ranged from 99 to 247 mm in total length. As a follow up to the 2013 study, USFWS service conducted additional tests in 2015. These tests resulted in releasing fin clipped Golden Shiners into barge junctions while traversing both the Brandon Road Lock and Dam and the Electric Dispersal Barriers. The data demonstrated that Golden Shiners with fin clips were found within the junctions after traversing both Brandon Road Lock and Dam and the Electric Dispersal Barriers. These fish were captured post transit via a cast net. As a pilot study, USFWS then stocked around 2000 fin clipped Golden Shiners into the barge junction and had the tug transit in the upstream direction from the I-80 bridge through Lockport Lock and Dam and finally through the Electric Dispersal Barrier, resulting in a distance of approximately 16.1 km (10 miles). Once the barge stopped, USFWS personnel were still able to capture some of the fin clipped Golden Shiners, demonstrating that small fish may be entrained for long distances. It is important to note that USFWS reported that a strong reverse by the tug captain resulted in the barge junctions to get flushed from the crevices and may be used as a mitigation tool. In a similar study, adult Asian carp were placed into the junctions while the barges were in transit. All adult Asian carp quickly exited the barge junctions on their own volition; therefore, entrainment of adult Asian carp may not be viable since they are stronger swimmers than small fish.

Changes in vessel operations may be able to reduce the probability of fish transfer. Future research on possible measures is ongoing. Additionally, flows created by vessel movement have been found to transport fish. Mitigation measures are currently being investigated to address this entrainment; however, their effectiveness is unknown at this time. Further research on this topic is ongoing.

The barriers can fail to perform effectively due to loss of power; equipment failure, operation at less than optimal operating parameters, fish moving near irregular sidewalls; and variations in the electric field due to metal vessel hulls. Risks due to loss of power or equipment failure are reduced by preventive maintenance and installation of redundant backup systems. The effect of fish size is very significant when evaluating barrier operating parameters. The operating parameters must be selected for the smallest fish size of concern. Environmental factors can also change the effectiveness of a barrier for a given size of fish. For example, initial results of tests of temperature variations indicate the barriers are less effective in warmer water. Small fish may be able to utilize any reduced electric field strength near irregularities in the canal walls to pass through the electric fields. This concern is based on observed behavior during laboratory testing in which fish appeared to prefer to stay in a recess in a flume wall. Field measurement indicate that the electrical field strength temporarily drops when large metal hulls are over the barrier electrodes, providing a potential opening for fish to move across the barrier.

Flow reversals in the CSSC are another way fish can pass through the Electric Barrier System. If a fish is immobilized by a barrier and remains afloat, a relatively low reverse flow at the surface could move it across the barrier.

# Current Activities within the Illinois Waterway and CAWS – Asian Carp

The following overview describes currently operating barriers, monitoring, and control activities occurring within the Illinois Waterway (IWW) and Chicago Area Waterway System (CAWS).

**Electric Dispersal Barrier:** The first dispersal barrier was authorized in 1996 as a demonstration project under Section 1202(i)(3) of the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, P.L. 101-646, as amended by Section 2(e)(3) of the National Invasive Species Act of 1996, P.L. 104-332 (codified at 16 U.S.C. § 4722(i)(3)), and the Demonstration Barrier has been in operation since April 2002. Barrier II is a set of two barriers, Barrier IIA and Barrier IIB. Barrier IIA has been in operation since April 2009, while Barrier IIB has been in operation since April 2011. Section 3061(b)(1)(A) of WRDA 2007 authorized USACE to upgrade and make the Demonstration Barrier permanent, and stated that the barriers should be operated and maintained as a system to optimize effectiveness. Currently, all three barriers are operated simultaneously during normal operations. Please refer to the Chicago Sanitary and Ship Canal Dispersal Barriers Factsheet for additional details regarding the Electric Dispersal Barrier at Romeoville, IL.

**Monitoring Activities in the CAWS:** In 2009, due to heightened concern about Asian carp potentially dispersing into the Great Lakes, the Asian Carp Regional Coordinating Committee (ACRCC) was formed. The ACRCC is comprised of federal and state agencies working collaboratively to bring their particular authorities and knowledge together to reduce the threat of Asian carp establishment in the Great Lakes. The group develops the Asian Carp Control Strategy Framework (Framework) to document actions already undertaken and to identify potential courses of action to be implemented in both the near and short term.



The Monitoring and Response Work Group (MRWG) was established by the ACRCC and is co-led by the Illinois Department of Natural Resources (IDNR) and the Great Lakes Fishery Commission (GLFC). Guided by the ACRCC Framework, the MRWG was assigned the task of developing and implementing a Monitoring and Response Plan (MRP) for Asian carp that were present or could gain access to the CAWS. The MRP has been released annually since the establishment of the MRWG in 2010. For additional information on the ACRCC and MRWG please refer to their website, www.asiancarp.us.

The activities outlined in the MRP, such as ongoing Asian carp monitoring efforts and research by multi-agency partners, provide a partial context for the Future Without Project condition (please refer to the Future Without Project Condition for Asian Carp Factsheet for additional details). Below is the Executive Summary for the 2014 Asian Carp Monitoring and Response Plan Interim Summary Reports, which provides a brief overview and result highlights for the 21 projects carried out under the annual MRP. The following three projects have updated details for 2015 based on information presented in the MRWG "Characterizing Risk: IWW and CAWS" map[1]: (1) Young-of-Year and Juvenile Asian Carp Monitoring, (2) Distribution and Movement of Small Asian Carp in the Illinois Waterway, and (3) Identifying Movement Bottlenecks and Changes in Population Characteristics of Asian Carp in the Illinois River. For more detailed information on each project, please refer to the 2014 Asian Carp MRP Interim Summary Reports[2].

[1] MRWG. 28 October 2015. Characterizing Risk: IWW and CAWS.
[2] Monitoring and Response Workgroup. 2015. 2014 Asian Carp Monitoring and Response Plan Interim Summary Reports. Monitoring and Response Workgroup, Asian Carp Regional Coordinating. 258 pp. http://www.asiancarp.us/documents/MRP2014-InterimSummary.pdf

## Monitoring Projects:

Seasonal Intensive Monitoring in CAWS – This project represents a modification to response actions and Planned Intensive Surveillance in the CAWS and target areas that have been previously monitored through response actions. These efforts have the benefit of advanced planning and are in locations where the repeated detection of e DNA in previous years indicates the potential presence of Asian Carp in the waterway.

- Completed 2-two week SIM events with conventional gears in the CAWS upstream of the electric dispersal barrier in 2014
- Estimated 2,205 person-hours were spent to complete 87.1 hours of electrofishing, set 77.7 km (48.3 mi) of trammel/gill net and 2.2 km (1.4 mi) of commercial seine in 2014
- Across all locations and gears in 2014, sampled 27,678 fish representing 57 species and 2 hybrid groups
- Captured a Spotted Gar in the North Branch of the Chicago River in 2014. It is the first-ever recorded in the CAWS, and the western-most occurrence associated with Lake Michigan
- Since 2010, an estimated 19,388 person-hours were spent to complete 769.4 hours of electrofishing, set 524 km (325.6 mi) of gill/trammel net and 3.7 km (2.3 mi) of commercial seine
- A total of 278,991 fish representing 72 species and 6 hybrid groups were sampled, including 1,106 Banded Killifish (state threatened species) from 2010-2014
- Examined 87,779 YOY Gizzard Shad since 2010 and found no Asian carp
- Since 2010, 17 non-native species have been captured accounting for14% of the total fish caught and 22% of the total species
- No Bighead Carp or Silver Carp have been captured or observed since 2010 (1 Bighead Carp in Lake Calumet in 2010).
- Recommend continued use of SIM in the CAWS upstream of the electric dispersal barrier for localized detection and removal of Asian carp



Strategy for eDNA Monitoring in the CAWS and Upper Des Plaines River – This project continues eDNA monitoring in strategic locations in the CAWS that will be used to inform on the status of Asian carp.

- Two eDNA comprehensive sampling events took place in the CAWS at four regular monitoring sites in 2014, resulting in 456 samples collected and analyzed.
- June event: seven positive detections for Silver Carp DNA, one positive detection for Bighead Carp DNA
- October event: 23 positive detections for Silver Carp DNA, zero positive detections for Bighead Carp DNA
- Comparative analysis of cPCR methods used prior to 2014 with qPCR methods employed in 2014

Larval Fish and Productivity Monitoring – This information will aid in evaluating the potential for Asian carp to further expand their range in the Illinois Waterway, and may also be useful for designing future control strategies that target Asian carp spawning and early life history.

- Over 500 larval fish samples were collected from 11 sites across the length of the Illinois Waterway during April – September, 2014, capturing over 18,000 larval fish, including 5,231 larval Asian carp.

- Larval Asian carp were only collected in the LaGrange and Peoria Pools in 2014. No Asian carp larvae were observed from the upper Illinois Waterway.
- Multiple peaks in larval Asian carp abundance were observed during June and July 2014, coinciding with a period of rising water levels and water temperatures consistently above 20°C. Low numbers of Asian carp larvae continued to be collected into August, indicating that spawning continued to occur during this time, although at much lower levels.
- Over 180 larval fish samples were collected from four Illinois River tributaries (Spoon, Sangamon, Salt Fork of the Sangamon, and Mackinaw Rivers) from April – October, 2014, capturing over 4,700 larval fish. Processing and identification of these samples is ongoing and results will be reported once available.

Young-of-Year and Juvenile Asian Carp Monitoring – Monitoring for the presence of young-of-year Asian carp in the Illinois River, Des Plaines River, and CAWS occurred through sampling planned by other projects in the MRP and targeted a segment of the Asian carp population typically missed with adult sampling gears.

- Sampled for young Asian carp from 2010 to 2014 throughout the CAWS, Des Plaines River, and Illinois River between river miles 83 and 334 by incorporating sampling from several existing monitoring projects.
- Sampled with active gears (pulsed-DC electrofishing, small mesh purse seine, cast net, and beach seine) and passive gears (small mesh gill nets, and mini-fyke nets) in 2014.
- Completed 1,401 hours of electrofishing across all years and sites.
- Examined 127,007 Gizzard Shad <152 mm (6 in) long in the CAWS and Illinois Waterway upstream of Starved Rock Lock and Dam from 2010-2014 and found no young Asian carp.
- High catches of young-of-year Asian carp in 2014 in the LaGrange Pool indicate a high recruitment year despite limited to no recruitment in 2010-2013.
- Farthest upstream catch was a post larval Asian carp in the Peoria pool near Henry, Illinois (river mile 190) in 2012 and 2014, over 100RM downstream from the electric dispersal barrier.
- Recommend continued monitoring for young Asian carp to determine the farthest upstream young fish are recruited into the population.



YEAR-TO-DATE: Prior to 2015 the established Asian carp population, defined as the furthest upstream location where small (approximately <152.4 mm (6 inches) total length) Asian carp and adults are located within the same pool, was located in Peoria Pool near Henry, Illinois. However, two (2) Silver Carp, approximately 165.1 mm (6.5 inches) total length, were captured from the Marseilles Pool in Moody Bayou near Seneca, Illinois in October 2015, approximately 106.2 km (66 miles) upstream of their previous location. Below is detailed capture information regarding juvenile Asian Carp in 2015 taken from the MRWG "Characterizing Risk: IWW and CAWS" map[3].

- April 2015: Juvenile Silver Carp captured at Spring Valley, IL (RM 211)
- April and June 2015: Juvenile Silver Carp captured at Peru, IL (RM 223), 33 Miles upstream of Henry, IL
- July and August 2015: Juvenile Silver Carp captured near Ottawa, IL at Sheehan Island (RM 236) in Starved Rock Pool, 46 miles upstream of Henry, IL
- September 2015: Juvenile Silver Carp captured 2 miles downstream of Marseilles Lock at Heritage Harbor Marina, 52 miles upstream of Henry, IL; 54 miles downstream of Barrier

[3] MRWG. 28 October 2015. Characterizing Risk: IWW and CAWS.

- October 2015: One Juvenile Silver Carp captured 500 Ft below Marseilles Lock RM 244. 54 upstream of Henry, IL and 52 miles downstream of Barrier
- October 2015: Two Juvenile Silver Carp captured in Marseilles Pool, RM 256.5 near Moody Bayou upstream of Seneca, IL. 66.5 miles upstream of Henry, IL and 39.5 miles downstream of Barrier

<u>Distribution and Movement of Small Asian Carp in the Illinois Waterway</u> - The purpose of this study was to establish where young (YOY to age 2) Asian carp occur in the IWW through intensive, directed fish sampling which targets these life stages.

- A total of 39,409 fish specimens were collected and examined.
- Eighty-three species were identified along with two hybrid combinations.
- Two Illinois State threatened species were sampled.
- One Illinois State endangered species was sampled.
- No YOY Asian carp were sampled.
- The lack of YOY Asian carp in our samples suggests that the uppermost limit of these fish is still downstream of the Starved Rock Lock and Dam in the Peoria pool.

YEAR-TO-DATE: Prior to 2015 the established Asian carp population, defined as the furthest upstream location where small (approximately <152.4 mm (6 inches) total length) Asian carp and adults are located within the same pool, was located in Peoria Pool near Henry, Illinois. However, two (2) Silver Carp, approximately 165.1 mm (6.5 inches) total length, were captured from the Marseilles Pool in Moody Bayou near Seneca, Illinois in October 2015, approximately 106.2 km (66 miles) upstream of their previous location. Below is detailed capture information regarding juvenile Asian Carp in 2015 taken from the MRWG "Characterizing Risk: IWW and CAWS" map[4].

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- October 2015: Two Juvenile Silver Carp captured in Marseilles Pool, RM 256.5 near Moody Bayou upstream of Seneca, IL. 66.5 miles upstream of Henry, IL and 39.5 miles downstream of Barrier

<u>Fixed Site Monitoring Downstream of the Dispersal Barrier</u> – This project included monthly standardized monitoring with pulsed-DC electrofishing gear and contracted commercial fishers at four fixed sites downstream of the Dispersal Barrier in Lockport Pool and downstream from the Lockport, Brandon Road, and Dresden Island locks and dams. It provides information on the location of the Asian carp detectable population front and upstream progression of populations over time.

- Estimated 10,224.5 person-hours spent sampling at fixed, random, and additional sites

[4] MRWG. 28 October 2015. Characterizing Risk: IWW and CAWS.

and netting locations downstream of the electric dispersal barrier from 2010-2014.

- 409 hours spent electrofishing and 439 km (273 miles) of trammel/gill net deployed.
- Sampled 146,882 fish, representing 97 species and seven hybrid groups.
- No Bighead or Silver Carp were captured by electrofishing or netting in Lockport and Brandon Road pools.
- Seventy-nine Bighead Carp and 19 Silver Carp were collected in the Dresden Island Pool during, fixed, random, and additional commercial netting from 2010-2014.
- Twenty-nine Bighead Carp were captured in a single hoop net in the Dresden Island Pool.
- One Bighead Carp and no Silver Carp were captured at Dresden Island Pool while electrofishing from 2010-2013, with none being captured in 2014.
- Detectable population front of mostly Bighead Carp located just north of I-55 Bridge at river mile 280 (76 km (47 miles from Lake Michigan)). No appreciable change in upstream location of the population front in past five years.
- Recommend to continue current sampling plan below the electric dispersal barrier with electrofishing, hoop netting, mini-fyke netting, and gill and trammel netting.

**Removal Projects and Evaluations:**

Response Actions in the CAWS – This project uses a threshold framework to support decisions for response actions to remove any Asian carp from the CAWS upstream of the Dispersal Barrier with conventional gear or rotenone.

- Based on the criteria of the Response Matrix there were no rapid response actions utilized in the CAWS in 2014. Alternatively two Seasonal Intensive Monitoring (SIM) events were conducted in 2014 yielding no Bighead Carp or Silver Carp being captured or observed. Refer to the Seasonal Intensive Monitoring Interim report for complete results.
- From 2010-2012, eleven rapid response actions occurred with conventional and experimental gears in the CAWS upstream of the electric dispersal barrier. Eight of the response actions were triggered by positive detections of Asian carp eDNA.
- Estimated 11,330 person-hours were spent to complete 170 hours of electrofishing, set 80.8 km (50.2 mi) of trammel/gill net, treat approximately 4 km (2.5 mi) (70 ha (173 acres)) of river with rotenone, made seven-0.7 km (800 yd) long commercial seine hauls, and deployed six tandem trap nets, 10 hoop nets and two Great Lake pound nets equal to 52.8 net-days of effort.
- Across all response actions and gears, sampled over 137,875 fish representing 57 species and 2 hybrid groups.
- Sampled 398 state threatened Banded Killifish
- No Bighead Carp or Silver Carp were captured or observed during rapid response actions.

Barrier Maintenance Fish Suppression – This project provides a fish suppression plan to support US Army Corps of Engineers maintenance operations at the Dispersal Barrier. The plan includes fish sampling to detect juvenile or adult Asian carp presence in the Lockport Pool downstream of the electric dispersal barriers, surveillance of the barrier zone with split-beam hydroacoustics, side-scan sonar and DIDSON imaging sonar, and operations to clear fish from between barriers by mechanical or chemical means.

- The MRWG agency representatives met and discussed the risk level of Asian carp presence at the electric dispersal barrier system at each primary barrier loss of power to water and supported two clearing actions on 27 May and 9 June 2014.

- A total of 34 fish from 8 species were removed using pulsed DC-electrofishing, with 8 fish > 12 inches in length.
- Split-beam hydroacoustics and side-scan sonar assessed the risk of large fish presence between the barriers on 15 January which precluded the need for further clearing actions.
- **No Asian carp were captured or observed during fish suppression operations**

Barrier Defense Asian Carp Removal Project – This program was established to reduce the numbers of Asian carp downstream of the electric dispersal barrier through controlled commercial fishing. We anticipate that reducing Asian carp populations will lower propagule pressure and the chances of Asian carp gaining access to waters upstream of the barrier. Primary areas fished include Dresden Island, Marseilles, and Starved Rock pools.

- Contracted commercial fishers deployed 2186.9 km (1359.2 miles) of gill/trammel net, 5.0 km (3.1 miles) of commercial seine, and 196 hoop nets set in the upper Illinois Waterway from 2010- 2014.
- A total of 70,882 Bighead Carp, 191,031 Silver Carp, and 1,718 Grass Carp were removed by contracted commercial fisherman from 2010-2014. The total weight of Asian carp removed was 1493.94 tons

Recommend continued targeted harvest of Asian carp in the upper Illinois Waterway with contracted commercial fishers and assisting IDNR biologists. Potential benefits include reduced carp abundance at and near the detectable population front and the possible prevention of further upstream movement of populations toward the electric dispersal barrier and Lake Michigan.

Identifying Movement Bottlenecks and Changes in Population Characteristics of Asian Carp in the Illinois River - This project encompasses multiple studies with the goal of determining estimates of Asian carp abundance, biomass, size structure, demographics (e.g., growth and mortality), natal origin, and rates of hybridization in the Alton, LaGrange, Peoria, Starved Rock, Marseilles, and Dresden Island pools of the Illinois and Des Plaines Rivers.

- Asian carp abundance in the lower river (i.e. below Starved Rock Lock and Dam) appears to have increased compared to 2012 and 2013. Captures of YOY Asian carp also indicate relatively successful recruitment, likely due to high river discharge during the early spawning period in 2014 (compared to 2011–2013).
- Although data processing is ongoing for 2014, upper river hydroacoustic estimates suggest population changes (decreases in abundance, biomass and fish size) between 2012 and 2013.
- Definite separation patterns between the lower and upper river (at Starved Rock Lock and Dam) were observed in 2014. Fish tended to move as far as the Peoria pool, and then return back downstream. Movement in the upper river tended to be in the downstream direction through the Marseilles lock in 2014 and into and out of the HMS pits.
- Continued contract harvest in the upper Illinois River (above Starved Rock) plus intensive commercial harvest in the lower Illinois River may reduce density, potential recruitment, and perhaps immigration of Asian carp towards the electric dispersal barrier.

YEAR-TO-DATE: Prior to 2015 the established Asian carp population, defined as the furthest upstream location where small (approximately <152.4 mm (6 inches) total length) Asian carp and adults are located within the same pool, was located in Peoria Pool near Henry, Illinois. However, two (2) Silver Carp, approximately 165.1 mm (6.5 inches) total length, were captured from the Marseilles Pool in

Moody Bayou near Seneca, Illinois in October 2015, approximately 106.2 km (66 miles) upstream of their previous location. Below is detailed capture information regarding juvenile Asian Carp in 2015 taken from the MRWG "Characterizing Risk: IWW and CAWS" map[5].

- April 2015: Juvenile Silver Carp captured at Spring Valley, IL (RM 211)
- April and June 2015: Juvenile Silver Carp captured at Peru, IL (RM 223), 33 Miles upstream of Henry, IL
- July and August 2015: Juvenile Silver Carp captured near Ottawa, IL at Sheehan Island (RM 236) in Starved Rock Pool, 46 miles upstream of Henry, IL
- September 2015: Juvenile Silver Carp captured 2 miles downstream of Marseilles Lock at Heritage Harbor Marina, 52 miles upstream of Henry, IL; 54 miles downstream of Barrier
- October 2015: One Juvenile Silver Carp captured 500 Ft below Marseilles Lock RM 244. 54 upstream of Henry, IL and 52 miles downstream of Barrier
- October 2015: Two Juvenile Silver Carp captured in Marseilles Pool, RM 256.5 near Moody Bayou upstream of Seneca, IL. 66.5 miles upstream of Henry, IL and 39.5 miles downstream of Barrier

**Barrier Effectiveness Evaluations:**

<u>Telemetry Monitoring Plan</u> – This project uses ultrasonically tagged Asian carp and surrogate species to assess if fish are able to challenge and/or penetrate the electric dispersal barrier system and pass through navigation locks in the upper Illinois Waterway. An array of stationary acoustic receivers and mobile tracking was used to collect information on Asian carp and surrogate species movements.

- 15.1 million detections from 432 tagged fish have been acquired since 2010
- The electric dispersal barriers have been effective at preventing upstream passage of free swimming tagged fish > 300 mm
- Since 2011, two transmitters implanted into Common carp downstream of the Barriers were located upstream although no detections were observed at barrier receivers. The most plausible explanation being assisted passage via barge entrainment; both transmitters were either expelled or the host had expired
- Fish approaching the Dispersal Barriers spend a greater amount of time challenging the barriers with increased discharge rates
- Common Carp over 415 mm in total length are repelled by electric field strengths as low as .1 to .5 V/in
- Inter-pool movement of tagged fish was observed in both directions between all pools within the study area in 2014 (Lockport, Brandon, Dresden Island and Marseilles)
- Asian Carp are consistently using the Kankakee River and Rock Run Rookery with little movement detected surrounding the Brandon Road Lock and Dam
- A probability model for tagged Asian carp presence/absence has been generated for the Rock Run Rookery and the Kankakee River within the Dresden Island Pool based on temperature and discharge rates

<u>Understanding Surrogate Fish Movement with Barriers</u> – This project monitors the movements of tagged surrogate species in Dresden Island, Brandon Road and Lockport Pools and Rock Run Rookery to assess fish movement between barriers structures (i.e. electric dispersal barriers and lock and dams). Obtain

[5] MRWG. 28 October 2015. Characterizing Risk: IWW and CAWS.

information on recapture rates of surrogate species to help verify sampling success using multiple gear types.

- Multiple agencies and stakeholders cooperated in successfully tagging 1,654 fish in Lockport Pool, Brandon Road Pool, Dresden Island Pool and Rock Run Rookery (Between April 1 and December 11)
- A total of 18 fish were recaptured using pulsed DC-electrofishing, gill nets, trammel nets and 6 foot diameter hoop nets.
- A total of 14 recaptures had tags but showed no movement between barrier structures, 3 recaptures where observed due to caudal fin clip but had no tag to show movement and 1 recapture showed movement from Dresden Island Pool downstream through the Dresden Island Lock and Dam into the Marseilles Pool.
- Recommend continued tagging of Common Carp, Bigmouth Buffalo, Smallmouth Buffalo, Black Buffalo and Common Carp x Goldfish hybrid using pulsed DC-electrofishing, gill nets, trammel nets and 6 foot diameter hoop nets to monitor fish movement between barrier structures.

<u>Monitoring Fish Abundance, Behavior, and Fish-Barge Interactions at the Barrier</u> – This project uses split-beam hydroacoustics, side-scan SONAR, Dual-Frequency Identification SONAR (DIDSON), and caged fish experiments to assess fish abundances and behavior at the electric dispersal barrier system designed to prevent fish passage between the Mississippi River and Great Lakes Basins. This is an updated plan that includes protocols for monitoring fish at the electric barrier system area.

- No fish were observed crossing the electric dispersal barrier's IIB narrow array during October 2014.
- Reverse flows in the canal at the electric dispersal barrier site were common and could not be identified from the USGS Lemont IL stream gauge.
- Median size of YOY fish (<150 mm) present in Lower Lockport Pool the week following 2013 DIDSON sampling was 62.2 mm.
- Fish density and congregation directly below the electric dispersal barriers was significantly greater during summer 2013 data collections than during fall 2014 data collections.

<u>Evaluating Asian Carp Detection Techniques with SONAR</u> - This project evaluates the use of multiple hydroacoustic SONAR frequencies in order to assess whether live Asian carp can be specifically identified apart from any other fish species. These identifications could significantly reduce the amount of water targeted for future response efforts.

- There were significantly greater mean total densities of fish observed immediately below the electric dispersal barrier during the summer than in spring or fall.
- During spring both large and small mean fish densities were significantly greater directly below the barrier at night than during daytime or crepuscular periods.
- We observed differences in fish density patterns between study reaches that could be indicative of between reach migrations.
- High relative densities of fish were shown to be present within the Brandon Rd. Lock structure during both summer and fall.
- Acoustic remote sensing was used to communicate the presence of suspect ANS fish targets to state agencies that subsequently successfully captured Asian carp in the area.

Des Plaines River and Overflow Monitoring – This project included periodic monitoring for Asian carp presence and spawning activity, in the upper Des Plaines River downstream of the old Hofmann Dam site. In a second component, efficacy of the Des Plaines Bypass Barrier constructed between the Des Plaines River and CSSC was assessed by monitoring for any Asian carp juveniles that may be transported to the CSSC via laterally flowing Des Plaines River floodwaters passing through the barrier fence.

- Collected 6,656 fish representing 52 species and 3 hybrid groups from 2011-2014 via electrofishing (38.65 hours) and gill netting (111 sets; 10,501 meters).
- IDNR basin survey completed 3.75 hours of electrofishing in 2014.
- No Bighead or Silver Carp have been captured or observed through all years of sampling.
- Two Grass Carp were captured in 2014. Analysis indicated both were triploid. Three Grass Carp tested in 2013 were also triploid. All Grass Carp were captured in the Des Plaines River.

**Gear Effectiveness Evaluations and Development Projects:**

Asian Carp Gear Efficiency and Detection Probability Study – This project assessed efficiency and detection probability of gears currently used for Asian carp monitoring (e.g., DC electrofishing, gill nets, and trammel nets) and others potential gears (e.g., mini-fyke nets, hoop nets, trap nets, seines, and cast nets) by sampling at 10 sites in the Illinois River, lower Des Plaines River, and CAWS that have varying carp population densities. Results will inform decisions on appropriate levels of sampling effort and monitoring regimes, and ultimately improve Asian carp monitoring and control efforts.

- Large numbers of juvenile Asian carp were captured in the LaGrange and Peoria Pools during 2014, but none were captured or observed upstream of the Peoria Pool. All juvenile Asian carp observed during 2014 were silver carp. No juvenile bighead carp were identified.
- Mini-fyke nets captured by far the highest number of juvenile silver carp in 2014. Beach seines and purse seines were also moderately effective. Pulsed-DC electrofishing and cast nets captured smaller numbers of juvenile silver carp. No juvenile Asian carp were captured in gill nets.
- Beach seines captured the smallest sizes of juvenile Asian carp (mean = 38 mm), whereas purse seines captured larger average sizes (mean = 53 mm). Cast nets (mean = 41 mm), pulsed-DC electrofishing (mean = 48 mm), and mini-fyke nets (mean = 49 mm) captured more intermediate sizes. However, electrofishing was the only gear that consistently captured juvenile Asian carp larger than 90 mm.
- Tributary sites were sampled with pulsed-DC electrofishing gear in the Spoon, Sangamon, Salt Fork of the Sangamon, and Mackinaw Rivers during 2014. A total of 796 adult Asian carp (6 bighead carp, 790 silver carp) were captured from tributaries. No juvenile Asian carp were observed in tributaries during electrofishing sampling.

Exploratory Gear Development Project – A professional net designer has been consulted to develop and build enhanced purse seines, trawls, and gill nets for more effective harvest of Asian carp. Enhanced gears will be evaluated in areas known to have abundant Asian carp populations. If effective, gears may be used in place of rotenone for removal actions in the CAWS and for commercial fishing in the lower Illinois River or other Asian carp infested waterways.

- The paupier captures juvenile carp without electricity.
- The surface trawls capture juvenile carp.

- All sizes of Silver Carp were readily captured throughout the year in all habitats sampled.
- Juvenile invasive carp occupy lower reaches of tributary stream habitats of large rivers in the early life stages.
- YOY invasive carps transition to occupy shallow, still water habitats in the fall.

Unconventional Gear Development Project – The goal of this project is to develop an effective trap or netting method capable of capturing low densities of Asian carp in the deep-draft canal and river habitats of the CAWS, lower Des Plaines River, upper Illinois River, and possible Great Lakes spawning rivers.

- Driving fish into surface-to-bottom gill nets resulted in higher catch rates of all fish species and of silver carp than control sets. The highest catch rates were obtained by driving fish using a pulsed-DC electrofishing boat.
- The majority of fish species, including silver carp, were more vulnerable to smaller mesh sizes (6.4 – 7.6 cm) of surface-to-bottom gill nets, whereas bighead carp appear to be more vulnerable to larger mesh sizes (7.6 – 10.2 cm).
- Pound nets captured large numbers of fish, primarily consisting of Asian carp, and produced substantially higher catch rates of Asian carp than traditional entrapment gears in backwater habitats.
- Pound nets captured larger sizes of bighead carp than hoop nets or fyke nets, but sizes of captured silver carp did not differ among these gear types.

Water Gun Development and Testing – Pneumatic water guns that emit high pressure underwater sound waves have potential to deter fishes or kill them if they are in close enough proximity to the wave source. This technology is being evaluated to determine their efficacy as a tool to modify Asian carp behavior and act as a barrier that can support maintenance of the electric dispersal barrier.

- Evaluated two 100in3 water guns firing every ten seconds as a barrier in an open water field setting.
- Behavioral responses of Asian carp and native fishes were observed with sonar and acoustic telemetry under controlled conditions. Initial results indicate fish passed through the water gun barrier during operation.
- Evaluated the behavioral and physiological effects of firing a 100in3 water gun on three species of native mussels
- Results indicate that native mussels did not alter their behavior in response to 100 firing of a 100in3 water gun.
- Results indicated that 100 firing of a 100in3 water gun did not affect the shell of any of the mussels or cause mortality; even the thin-shelled mussels placed near the water gun.

**Alternative Pathway Surveillance:**

Alternate Pathway Surveillance in Illinois – This project creates a more robust and effective enforcement component of IDNR's invasive species program by increasing education and enforcement activities at bait shops, bait and sport fish production/distribution facilities, fish processors, and fish markets/food establishments known to have a preference for live fish for release or food preparation. A second component conducts surveys at urban fishing ponds in the Chicago Metropolitan area included in the IDNR Urban Fishing Program as well as ponds with positive detections for Asian carp eDNA using conventional gears (electrofishing and trammel/gill nets) in an effort to remove potential accidentally stocked Bighead or Silver carp.

*Law Enforcement*:

- January 2014 - Sweetwater Spring Fish Company and owner each pled guilty to importing live VHS susceptible species without permits and paid a fine of $25,400.00 which was deposited in the Illinois Conservation Police Operations Assistance Fund.
- In August 2014, an Indiana bait dealer arrested for selling minnows and grass carp in Illinois without an aquatic life dealer's license, VHS permits, or a restricted species permit pled guilty and paid a $4000 fine which was deposited in the Illinois Conservation Police Operations Assistance Fund.
- November 2014 – A commercial fisherman targeted in an ISU investigation was arrested for the unlawful sale of 1,800 pounds of Bighead and Silver Carp – Class 3 Felony. His brother was arrested for possession of live Bighead and Silver Carp – Class A Misdemeanor.
- On December 01, 2014, Farm Cat Fish Transportation Company and the owner pled guilty to importing VHS susceptible species w/o permits and paid a $2,500 fine and $22,500 to the Illinois Conservation Police Operations Assistance Fund. They were also arrested for selling aquatic life without a license.
- Operation JabberJaw in Chinatown identified retail markets illegally selling shark fin. The operation resulted in the issuance of 8 citations for selling aquatic life without a license and 12 citations for illegally selling shark fin. A total of 80 shark fin violations were documented and 33 shark fin items seized. $3700 was awarded to the Illinois Conservation Police Operations Assistance Fund.
- A Commercial Fisherwoman was charged by ISU with 11 counts of falsifying roe harvester reports, 5 counts of fraudulently obtaining commercial device tags, 2 counts of fraudulently obtaining resident roe harvester permits, 2 counts of fraudulently obtaining resident commercial fishing licenses, 57 counts of unlawful commercialization of sturgeon roe, and 1 count of fraudulently obtaining a resident sport fishing license. On December 2014, she pled
- Guilty to 3 counts falsifying records, paid $5000 to the Illinois Conservation Police Operations Assistance Fund and a $300 fine.

*Urban Fishing Pond Surveys*:

- Thirty-two Bighead Carp have been removed from five Chicago area ponds using electrofishing and trammel/gill nets since 2011.
- Sampled four ponds with electrofishing and trammel/gill nets during 2013.
- Estimated 165 person-hours were spent sampling Chicago area ponds in 2013.
- Sampled 179 fish representing 5 species and 1 hybrid group.
- Six Bighead Carp were removed from Humboldt Park and Flatfoot Lake; a replica of the carp from Flatfoot Lake has been made for outreach and educational events.
- Recommend additional sampling of ponds from which Bighead Carp have been removed, as well as repeat sampling of ponds yielding positive results for Asian carp eDNA.

## Current Activities within the Illinois Waterway and CAWS – *A. lacustre*

The following overview describes currently operating barriers, monitoring, and control activities occurring within the Illinois Waterway (IWW) and Chicago Area Waterway System (CAWS).

## Electric Dispersal Barrier

The first dispersal barrier was authorized in 1996 as a demonstration project under Section 1202(i)(3) of the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, P.L. 101-646, as amended by Section 2(e)(3) of the National Invasive Species Act of 1996, P.L. 104-332 (codified at 16 U.S.C. § 4722(i)(3)), and the Demonstration Barrier has been in operation since April 2002. Barrier II is a set of two barriers, Barrier IIA and Barrier IIB. Barrier IIA has been in operation since April 2009, while Barrier IIB has been in operation since April 2011. Section 3061(b)(1)(A) of WRDA 2007 authorized USACE to upgrade and make the Demonstration Barrier permanent, and stated that the barriers should be operated and maintained as a system to optimize effectiveness. Currently, all three barriers are operated simultaneously during normal operations. Please refer to the Chicago Sanitary and Ship Canal Dispersal Barriers Factsheet for additional details regarding the Electric Dispersal Barrier at Romeoville, IL.

## Monitoring Activities in the CAWS

*Apocorophium lacustre* is native to the Atlantic coast of North America[1]. Within the Mississippi River Basin, the scud has been reported from the Mississippi River, Ohio River, and Illinois River[2]. The scud was first reported from the lower Mississippi River in 1987 and spread north to the Ohio River by 1996[3]. By 2003, *A. lacustre* had invaded the Illinois River[4]. Surveys for this species in multiple river basins conducted in 2008 found that the scud was present just above the Dresden Lock and Dam, less than 20 miles from the Brandon Road Lock and Dam[5]. In surveys conducted in 2015, *A. lacustre* was again found as far north as Dresden Island Pool[6]. In the Illinois River, *A. lacustre* can be locally abundant, but overall, it its numbers are highly variable over space and time[7].

*Apocorophium lacustre* is readily transported on boat hulls and is thought to have moved rapidly up the Mississippi River basin by attaching to the hulls of ships[8]. There is heavy upbound boat traffic through the CAWS. Although its potential impacts have not been well studied, it is believed that it could outcompete other benthic filter feeders, such as native mussels. In other regions where the species is established these impacts have spread throughout foodwebs.

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[1] USGS (U.S. Geological Survey). 2011. NAS–Nonindigenous Aquatic Species. *Apocorophium lacustre*. http://nas.er.usgs.gov/queries/SpecimenViewer.aspx?SpecimenID=237724.
[2] Grigorovich, I.A., T.R. Angradi, E.B. Emery & M.S. Wooten. 2008. Invasion of the upper Mississippi River system by saltwater amphipods. *Fundamental and Applied Limnology/Archiv für Hydrobiologie*, vol. 173(1), pp. 67-77.
[3] See 2.
[4] See 1.
[5] See 2.
[6] Personal communication Reuben Keller, Institute of Environmental Sustainability, Loyola University Chicago, September 3, 2015.
[7] See 6.
[8] See 2.

There are currently no known routine monitoring activities in the CAWS for *A. lacustre*. During summer 2015, the Illinois Department of Natural Resources contracted with Loyola University Chicago to conduct a distribution survey for the species within the upper Illinois Waterway (e.g., Dresden Island Pool and areas upstream), CAWS, and harbors of Lake Michigan. Hester-Dendy samplers along with kick nets and wood snag scrapes were used to sample for the species within 50 designated reaches. All of the collected samples have been sorted for *A. lacustre*, and a draft final report is expected in mid-December 2015.

# Future Without Project Condition – Asian Carp

The following overview is the anticipated Future Without Project (FWOP) condition for Asian carp within the Illinois Waterway (IWW) and Chicago Area Waterway System (CAWS) (**Figure 1**). The FWOP condition is the basis for comparing alternative plans for the GLMRIS-Brandon Road study. Conditions are reviewed for a 'period of analysis' which usually extends for 50 years or for the duration that significant impacts are expected, but not to exceed 100 years. The 'period of analysis' for the GLMRIS-Brandon Road Study extends for 50 years, from 2021 to 2071. The year 2021 is assumed to be when the U.S. Army Corps of Engineers (USACE) would have authorization and funding to construct the recommended plan. This FWOP condition forecast is intended to provide information regarding the uncertainty associated with (1) the U.S. Fish and Wildlife Service's (USFWS) considerations concerning the Asian carp population front, (2) Asian carp control activities, and (3) water quality upstream of the Brandon Road Lock and Dam (BRLD) which could impact Asian carps' desire to move upstream.



**Figure 1. Location of the Electric Dispersal Barrier within the CAWS.**

**Asian Carp Populations**

The current distribution of Asian carp populations within the IWW is discussed below. On October 28, 2015, the following updated risk map (**Figure 3**) was published on the Asian Carp Regional Coordinating Committee (ACRCC) website: [www.asiancarp.us](www.asiancarp.us).

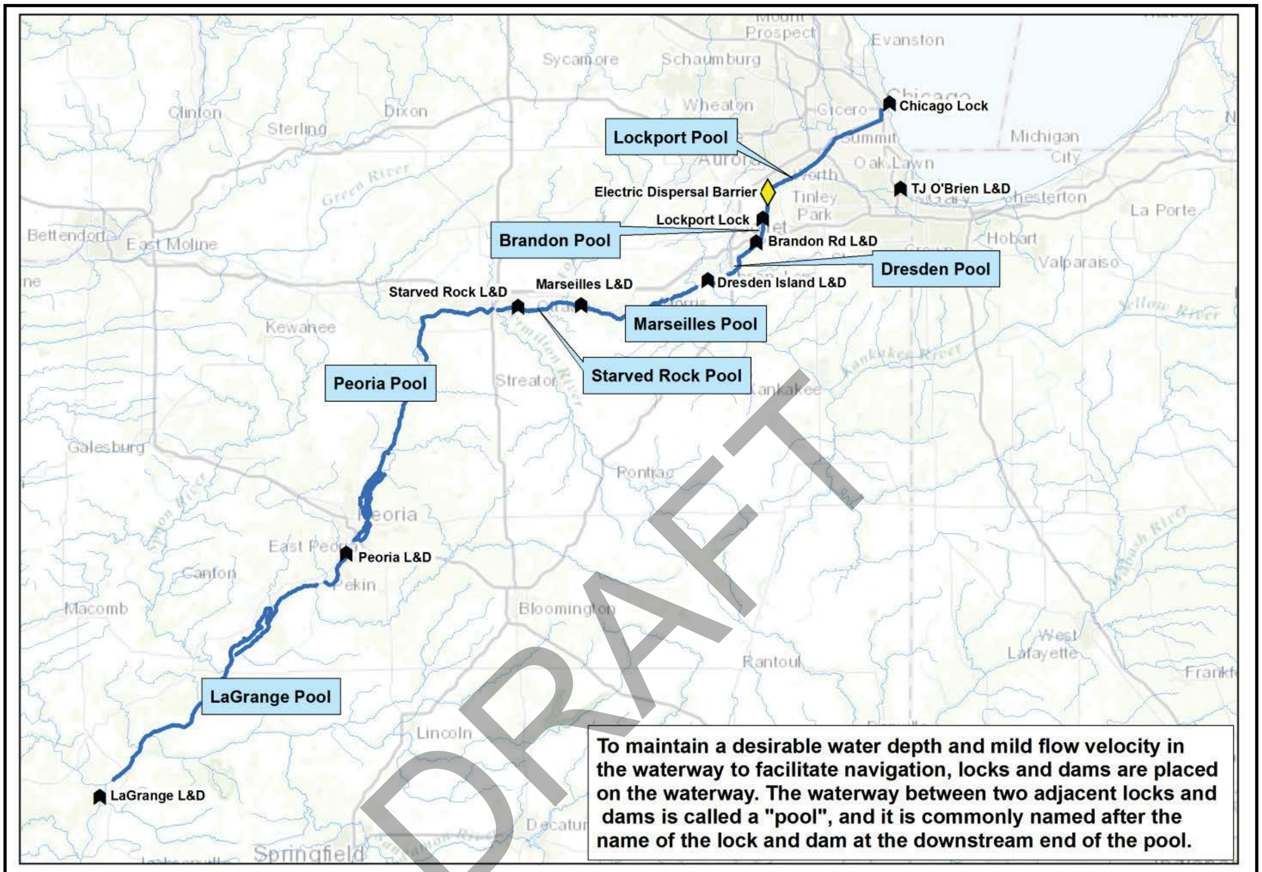


**Figure 2. "Pools" within the CAWS and Upper Illinois Waterway.**

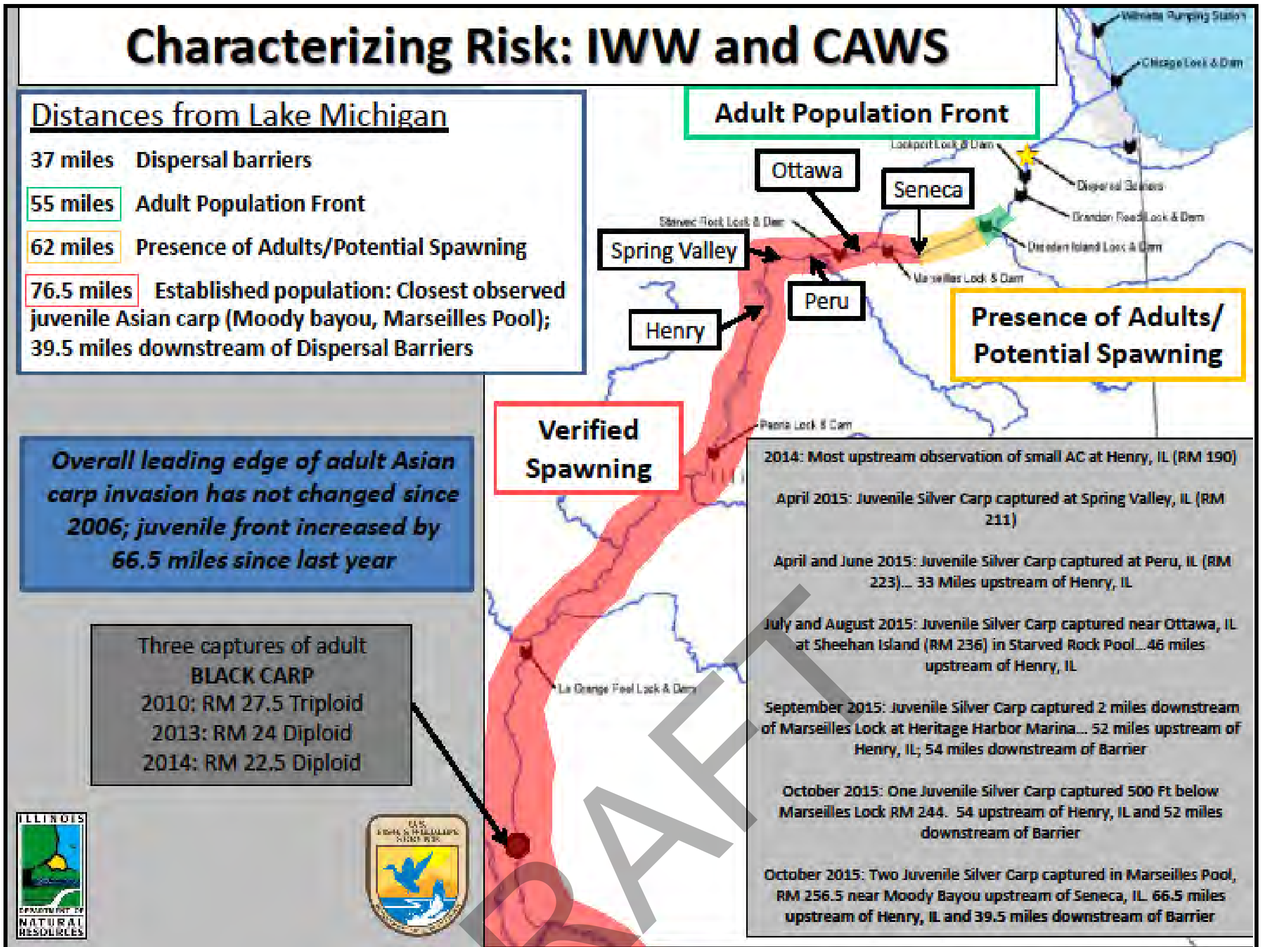


**Figure 3. MRWG risk map depicting distribution of Asian carp populations within the CAWS and IWW[1].**



The established Asian carp population, defined as the furthest upstream location where small (approximately < 152.4 mm total length; 6 in) Asian carp and adults are located within the same pool, is in Marseilles Pool. Prior to 2015, the established population was located in Peoria pool near Henry, Illinois but two (2) Silver Carp, approximately 165.1 mm (6.5 in) total length, were captured from the Marseilles Pool in Moody Bayou near Seneca, Illinois in October 2015 (**Figure 2**), approximately 106.2 km (66 miles) upstream of their previous location[2]. However, the adult population front, defined as the furthest upstream location of adult Asian carp, is in Dresden Island Pool and (**Figure 3**) has not progressed upstream over the past nine (9) years even after two (2) nearly historic spawns were recorded in 2007 and 2008[3]. More specifically, the leading adult population is located in Dresden Island Pool, 88.5 km (55 miles) downstream of Lake Michigan (**Figure 3**) at Rock Run Rookery. Rock Run Rookery is a backwater to the Des Plaines River approximately 6.4 km (4 miles) south of the Brandon Road Lock and Dam where adult Asian carp are consistently captured via commercial fishing efforts. Telemetry results indicate that very few fish move upstream of Rock Run Rookery with only two

[1] MRWG. 28 October 2015. Characterizing Risk: IWW and CAWS.
[2] ACRCC. October 30, 2015. Update: Small Asian carp found in Marseilles Pool of Illinois River. Accessed at: http://www.asiancarp.us/news/Map103015.htm
[3] Kevin Irons, Illinois Department of Natural Resources, personal communication, November 16, 2015.

detections near Brandon Road Lock and Dam. Both detections came from the same tagged fish which occurred on the same day and the fish quickly returned downstream. However, it is important to note that two (2) Bighead Carp have been captured upstream of Brandon Road Lock and Dam. One was captured in Lockport Pool below the Electric Dispersal Barriers during the 2009 clearing event using rotenone. The second was captured in 2010 via contract fishing in Lake Calumet, which is located between T.J. O'Brien Lock and Dam and Lake Michigan, upstream of the Electric Dispersal Barriers.

The FWOP condition related to the location of the established Asian carp population in the upper Illinois Waterway and CAWS is uncertain.

**ANS Control Efforts**

Current efforts such as control through contracted fishing and removal as well as focused monitoring activities are being conducted within the IWW and CAWS by the ACRCC's Monitoring and Response Work Group (MRWG) as well as the USACE operated Electric Dispersal Barriers in Romeoville, Illinois. These efforts are briefly discussed below; for additional details please refer to the Current Activities and Chicago Sanitary and Ship Canal Dispersal Barriers Factsheets. For additional information on the ACRCC and MRWG please refer to their website, www.asiancarp.us.

**Monitoring Activities**

Following is a list of monitoring activities currently being carried out within the IWW and CAWS by the ACRCC's Monitoring and Response Work Group.

- Seasonal intensive monitoring upstream of the Electric Dispersal Barriers.
- Strategy for eDNA monitoring in the CAWS and temporal eDNA quantification below the Electric Dispersal Barriers.
- Larval fish and productivity monitoring in the CAWS and IWW both above and below the Electric Dispersal Barriers.
- Young-of-year and juvenile Asian carp monitoring with traditional and novel gears to characterize distribution and movement of small Asian carp in the IWW.
- Fixed and random site monitoring downstream of the Electric Dispersal Barriers using hoopnets, minifyke nets, electrofishing, and contract fishing effort using gill/trammel nets.
- Directing response actions in the CAWS using the 2015 MRP threshold framework.
- Providing Electric Dispersal Barrier maintenance fish evaluation and suppression as necessary.
- Electric Dispersal Barrier defense Asian carp removal project in the form of contracting commercial fishermen to maximize removal of Asian carp from the IWW, currently with 3.6 M lbs. removed.
- Identifying movement bottlenecks and changes in population characteristics of Asian carp in the Illinois River with goal of determining estimates of Asian carp abundance, biomass, size structure, demographics (e.g., growth and mortality), natal origin, and rate of hybridization.
- Telemetry monitoring of tagged Asian carp and surrogate species to assess ability of fish to challenge and/or penetrate the Electric Dispersal Barriers in the IWW and CAWS.
- Monitoring tagged surrogate fish to understand movements between barrier structures (i.e., Electric Dispersal Barriers, locks and dams).

- Monitoring fish abundance, behavior, identification, and fish-barge interactions at the Electric Dispersal Barriers using split-beam hydroacoustics, side-scan SONAR, Dual-Frequency Identification SONAR (DIDSON), and caged fish experiments.
- Evaluating Asian carp detection techniques using multiple hydroacoustic SONAR frequencies to assess whether Asian carp can be specifically identified apart from other fish species.
- Periodic Des Plaines River monitoring for Asian carp presence and spawning activity; efficacy of Des Plaines Bypass Barrier between Des Plaines River and CSSC.
- Asian carp gear efficiency and detection probability study to assess gears currently used for Asian carp monitoring and other potential gears in the Illinois River, lower Des Plaines River, and CAWS.
- Exploratory gear development project where professional net designer has been consulted to develop and build enhanced purse seines, trawls, and gill nets for more effective harvest of Asian carp.
- Unconventional gear development project to develop effective trap or netting method capable of capturing low densities of Asian carp.
- Water gun development and testing to determine efficacy as a tool to modify Asian carp behavior and act as barrier to support maintenance of Electric Dispersal Barriers.
- Alternate pathway surveillance in Illinois (law enforcement and urban fishing pond surveys) creates more robust and effective enforcement component of IDNR's invasive species program; second component conducts surveys at urban fishing ponds in Chicago area for Asian carp.

Since 2010, annual monitoring and response work as well as project plans, like those listed above inform the annual MRP[4], have been funded primarily through the U.S. Environmental Protection Agency (USEPA) funds for Great Lakes Restoration Initiative (GLRI). The GLRI was launched in 2010 to accelerate efforts to protect and restore the Great Lakes as well as to provide additional resources to make progress toward the most critical long-term goals for this important ecosystem. During the first five years of the GLRI, federal agencies and their partners engaged in an unprecedented level of activity to prevent new introductions of invasive species in the Great Lakes ecosystem.

During FY15-19, federal agencies plan to continue to use GLRI resources to strategically target the biggest threats to the Great Lakes ecosystem and to accelerate progress toward long term goals – by combining GLRI resources with agency base budgets and by using these resources to work with nonfederal partners to implement protection and restoration projects. To guide this work, federal agencies have drafted GLRI Action Plan II[5], which summarizes the actions that federal agencies plan to implement during FY15-19 using GLRI funding. Under GLRI Action Plan II, federal agencies and their partners will continue to prevent new invasive species from establishing self-sustaining populations in the Great Lakes ecosystem. Table 1 shows the FY15-19 GLRI Action Plan Summary for Invasive Species.

[4] Monitoring and Response Workgroup. 2015. Monitoring and Response Plan for Asian Carp in the Upper Illinois River and Chicago Area Waterway System. Monitoring and Response Workgroup, Asian Carp Regional Coordinating Committee, Council on Environmental Quality, Washington. 128 pp.

[5] Great Lakes Interagency Task Force. 2014. Great Lakes Restoration Initiative Action Plan II. 30 pp.

**Table 1 – FY15-19 GLRI Action Plan Summary for Invasive Species[6].**

| Focus Area | Objectives | Commitments |
|---|---|---|
| Invasive Species | Prevent new introductions of invasive species | ▪ Block pathways through which aquatic invasive species can be introduced to the Great Lakes ecosystem<br>▪ Conduct early detection monitoring activities<br>▪ Work with Great Lakes states to conduct rapid response actions or exercises |
| | Control established invasive species | ▪ Implement control projects for GLRI-targeted invasive species |
| | Develop invasive species control technologies and refine management techniques | ▪ Develop/enhance technologies and methods to prevent the introduction and to control the spread of invasive species<br>▪ Develop/enhance invasive species specific collaborative to support rapid responses and communicate the latest control and management techniques |

For the GLMRIS-Brandon Road Study, USACE is utilizing a 50-year period of analysis (i.e., through 2071). The GLRI Action Plan II only projects funding for invasive species programs through FY19, after that time it is unknown whether funding will continue or be phased out. USACE sent letter requests to agencies whose invasive species monitoring and response activities are part of the annual MRP and/or receive funds from GLRI. Respondents to information requests provided the following regarding future funding of invasive species programs and projects:



- The Illinois Department of Natural Resources (IDNR) responded that their agency is operating under significant fiscal constraints. Currently, the majority of funding for Aquatic Nuisance Species (ANS) research, controls, and monitoring is funded by Federal funds, which originate within USFWS to support Illinois' Statewide Aquatic Nuisance Species (ANS) Comprehensive Management Plan. Additionally, USEPA funds for GLRI through the USFWS are necessary to support ACRCC actions, including monitoring and response work. There are no current alternative funding strategies for Asian carp work near Chicago. However, prior to ACRCC formation and under near emergency conditions, the State of Illinois was able to facilitate a multi-million dollar response by coordinating with local, state, and federal partners[7].

- The U.S. Environmental Protection Agency (USEPA) responded that they anticipate, "continued funding of various Asian carp activities as part of the Asian Carp Control Strategy Framework via the Great Lakes Restoration Initiative for local, state, and federal partners involved in this effort to prevent Asian carp from migrating upstream of the Corps of Engineers' electric barriers. The Framework presents a multi-tiered strategy to combat the spread of Asian carp into the Great Lakes and to ensure coordination and the most effective response across all levels of government. It represents a comprehensive Asian carp prevention plan that includes chemical, structural, monitoring, biological, management and operational strategies. The Framework complements the broader national approach to the management and control Asian carp as

[6] Great Lakes Interagency Task Force. 2014. Great Lakes Restoration Initiative Action Plan II. 30 pp.
[7] IDNR letter dated September 8, 2015, page 2.

presented in the Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States (National Carp Plan), approved by the National Aquatic Nuisance Species Task Force in November 2007[8].” Future funding of Asian carp activities is subject to appropriations.

- The U.S. Fish and Wildlife Service responded that starting in FY2015 they received an additional $2 million in their base funds to support ANS monitoring and control activities outside of the Great Lakes Basin (e.g., Ohio River Basin and Mississippi River Basin). If GLRI funding is not continued past FY19 (current end date for GLRI Action II), then the USFWS is permitted to use a portion of these additional funds to supplement high priority work, such as that in the CAWS and upper Illinois Waterway. However, if GLRI funding does cease after FY2019, then the ability of the USFWS to continue funding ANS control/monitoring projects within the CAWS and upper Illinois Waterway at the level they are currently being funded decreases significantly. At this time, the USFWS expects to continue to carry out its mission objectives at a minimum at current FY16 base levels through the 50-year period of analysis (i.e., 2071). Per WRRDA 2014, Section 1039 Invasive Species, the USFWS in coordination with the Corps of Engineers, the National Park Service, and the U.S. Geological Survey is tasked with leading a multiagency effort to slow the spread of Asian carp in the Upper Mississippi and Ohio River basins and tributaries through technical assistance, coordination, best practices, and support to state and local governments in carrying out activities designed to slow the threat posed by Asian carp. In FY2015 the USFWS provided a combined $800,000 in base appropriations to implement priority projects in support of the “Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States”, the “Ohio River Basin Asian Carp Control Strategy Framework”, the “Minnesota Asian Carp Action Plan”, the draft “Action Plan for Management of Asian Carp in the Upper Mississippi River Basin”, and other basin-wide partnership plans. The USFWS also supports actions to provide benefits to the Upper Mississippi River Basin, as described in the ACRCC’s annual prevention strategy the “Asian Carp Control Strategy Framework”. The USFWS will continue to work with partners to implement actions in support of these strategies, based on availability of resources. Future funding for Asian carp activities is subject to appropriations.



Currently, other new tools and technologies in the fight against Asian carp are under development that could be implemented in the future. These include, but are not necessarily limited to, more efficient detection and capture methods; the use of dissolved carbon dioxide ($CO_2$) and complex sound to herd or otherwise deter fish; attractants to aggregate fish for control actions; and species-specific piscicides for use against Asian carp. In addition, the Illinois Department of Natural Resources (IDNR) has a contract in place for the construction of a mobile electric barrier which is expected to be delivered Spring 2016 with field testing beginning upon delivery. The design of the electric barrier is still in the preliminary stages; however, it is anticipated that it would be effective to a depth of 30 feet and potentially adaptable to shallower habitats. The mobile electric barrier could be used to restrict movement of Asian carp and assist in contract harvest activities conducted by IDNR, deter fish from sensitive or uninvaded areas, or support the existing dispersal barrier when practicable as a barrier or sweeping fish from between active barriers. When the mobile barrier is in use it is not expected to allow commercial or recreational navigation where deployed.

On November 5, 2015 a meeting was held between members of the MRWG to discuss level of response to changes in the population front of Asian carp within the IWW and CAWS. The goal of the

[8] USEPA letter dated September 23, 2015, page 11.

meeting will be to develop a framework describing actions that could be included as part of a low, medium, or high level of response.

**Electric Dispersal Barriers**

The Electric Dispersal Barriers includes three (3) barriers (i.e., Demonstration Barrier, Barrier IIA, Barrier IIB) in operation in the Chicago Sanitary and Ship Canal at Romeoville, IL. The Demonstration Barrier is being upgraded to a more powerful barrier (Permanent Barrier I) and construction is currently underway with installation of underwater components having been completed in October 2014. Permanent Barrier I is scheduled for activation in 2017 after completing construction and operational and safety testing. Barrier I is designed to operate at higher voltages than Barriers IIA and IIB; and therefore, may have an increased ability to deter small fish. Barriers IIA and IIB currently operate at a maximum in-water field strength at the water surface of 2.3 Volts/inch with a pulse frequency of 34 pulses/second and a pulse duration of 2.3 milliseconds. These parameters were found in the laboratory to be effective at immobilizing Bighead and Silver Carp as small as approximately 76.2-127 mm (3-5 inches in) in total length[9,10,11,12]. It is projected that through the duration of the period of analysis (i.e., 2071) at least two barriers, potentially all three, will be in operation under normal circumstances (excluding maintenance, etc.) with operating parameters no lower than the current parameters of Barriers IIA and IIB.



Several studies have been conducted near the Electric Dispersal Barriers by USFWS to determine the efficacy of the barrier. These studies primarily focus on if and how small fish interact with the barrier and in what effect vessel traffic effects these behaviors. In 2013, USFWS deployed fixed DIDSON cameras at the Electric Dispersal Barriers to esonify the entire IIB narrow array where the electrical fields are the strongest. Video footage was collected in 10 minute increments and video was reviewed in the lab to determine if fish were able to penetrate the barrier. All video footage was taken while Barrier IIA was under maintenance and not operational. Results indicated that 44 out of 72 (61%) ten minute videos captured at least one occurrence of a school of fish, estimated to be between 50.8-101.6 mm (2-4 inches) in length, passing through the barrier in an upstream direction. The study was repeated in 2014 however this time Barrier IIA and IIB were operational and fish densities near the barriers were low due to the time of year. No fish were observed passing through the IIB narrow array in the upstream direction.

Additional studies by USFWS investigated how vessel traffic may impact the ability of fish to move through the Electric Dispersal Barriers by effecting the electrical field strength. Research conducted in 2012 demonstrated that caged Common Carp, Gizzard Shad, and Freshwater Drum may be either incapacitated or unaffected when moved through the Electric Dispersal Barriers depending on barge configuration. These data resulted in a follow up study in 2013 using fish tethered to small bobbers by

[9] Holliman, FM. 2011. Operational protocols for electric barriers on the Chicago Sanitary and Ship Canal: influence of electrical characteristics, water conductivity, behavior, and water velocity on risk breach by nuisance invasive fishes. Final report submitted to U.S. Army Corps of Engineers, Chicago District. 132 pp.
[10] Holliman, FM. 2014. Reliability demonstration testing of electric field parameters for electric field-based aquatic nuisance species dispersal barriers on the Chicago sanitary and ship canal. Fish Research and Development, LLC. 48 pp.
[11] Holliman, FM. 2014. Effects of electrode polarity on risk for breach of electric barriers on the Chicago sanitary and ship canal by small sizes of bighead carp. Fish Research and Development, LLC. 41 pp.
[12] Holliman, FM, Killgore KJ, and Shea C. (2015). “Development of Operational Protocols for Electric Barrier Systems on the Chicago Sanitary and Ship Canal: Induction of Passage-Preventing Behaviors in Small Sizes of Silver Carp,” ANSRP-15-1, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

fishing line. The USFWS released tethered fish either directly into the various junction wedges of barges to evaluate the likelihood of entrainment when the fish had the ability to leave under its own volition, or they were released in advance of an upstream bound barge to assess the likelihood of entrainment into the junction wedges after a barge strike. During the trials, several barge configurations were tested. In total, 340 Gizzard Shad were tethered resulting in 21 breaches of the dispersal barrier after direct placement into a junction and an additional 20 breached after they were deployed in front of the moving barge. These fish ranged from 99 to 247 mm (3.9-9.7 in) in total length. As a follow up to the 2013 study, USFWS conducted additional tests in 2015. These tests resulted in releasing fin clipped Golden Shiners into barge junctions while traversing both the Brandon Road Lock and Dam and the Electric Dispersal Barriers. The data demonstrated that Golden Shiners with fin clips were found within the junctions after traversing both Brandon Road Lock and Dam and the Electric Dispersal Barriers. These fish were captured post transit via a cast net. As a pilot study, USFWS then stocked approximately 2,000 fin clipped Golden Shiners into the barge junction and had the tug transit in the upstream direction from the I-80 bridge through Lockport Lock and Dam and finally through the Electric Dispersal Barriers, resulting in a distance of approximately 16.1 km (10 miles). Once the barge stopped, USFWS personnel were still able to capture some of the fin clipped Golden Shiners, demonstrating that small fish may be entrained for long distances. It is important to note that USFWS reported that a strong reverse by the tug captain resulted in the barge junctions to get flushed from the crevices and may be used as a mitigation tool. In a similar study, adult Asian carp were placed into the junctions while the barges were in transit. All adult Asian carp quickly exited the barge junctions on their own volition; therefore, entrainment of adult Asian carp may not be viable since they are stronger swimmers than small fish[13].



To inform mitigation measures to address fish entrainment between and around barges and tugs, USACE has initiated a scaled physical model study at the USACE Engineering and Research Development Center. The study will test water jet designs and configurations to dislodge trapped fish. These experiments will be conducted under different vessel speeds and drafts to examine a range of flow and entrainment conditions typical of full scale vessels navigating the Chicago Sanitary and Ship Canal. These experiments will determine minimum discharge, nozzle diameter and pump requirements to remove fish as well as optimal configurations for water jet placement within the channel cross-section. The model study will also evaluate tow speeds in the canal to determine optimal speed requirement to minimize return current (current opposite to vessel movement) of tows.

Informed by the physical model study, USACE's goal is to complete a field study later in FY 2016 of the mitigation measures that are most promising. If the field-tested mitigation measures are found to be effective, then USACE would consider implementing these measures at the Electric Dispersal Barriers.

**Upstream of Lockport Lock and Controlling Works and Des Plaines River**

**Upstream of Lockport Lock and Controlling Works**

The Chicago Waterway is comprised of 125.5 km (78 mi) of canals, which are used for conveyance of storm water runoff and treated municipal wastewater, commercial navigation, and flood control. The

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[13] U.S. Fish and Wildlife Service. 2014. Summary of fish-barge interaction research and fixed dual frequency identification. Sonar (DIDSON) sampling at the electric dispersal barrier in Chicago Sanitary and Ship Canal. 15 pp. Accessed at: https://lrc.usace.afpims.mil/Portals/36/docs/projects/ans/docs/Fish-Barge%20Interaction%20and%20DIDSON%20at%20electric%20barriers%20-%2012202013.pdf

Chicago Waterway includes two river systems, the Chicago River (88.7 km/55.1 mi) and the Calumet River (37.2 km/23.1 mi). Approximately 75% of the length of the Chicago Waterway is man-made canals where no waterway previously existed, while the remaining length is natural streams which have been dredged, realigned, widened, and straightened. The absence of gradual sloping banks, shallow littoral zone habitat, and bends result in a limited habitat for aquatic biota. Homogenous silt sediments that restrict macroinvertebrate and fish populations are deposited throughout much of the Chicago Waterway due to the unnatural stream flow dynamics[14].

Flow in the Chicago Waterway is managed by the Metropolitan Water Reclamation District of Greater Chicago (MWRD), but is subject to regulation under U.S. Supreme Court Decrees and Title 33 of the Code of Federal Regulations (CFR), Sections 207.420 and 207.425. The CFR provides for the maintenance of navigable depths to support commercial navigation and to prevent unintentional reversal into Lake Michigan.

The U. S. Supreme Court Decrees govern the quantity of water from Lake Michigan that is diverted out of the Great Lakes Basin into the Mississippi River Basin by the State of Illinois. Within Illinois, this quantity is subject to regulation by the Illinois Department of Natural Resources (IDNR), Division of Water Resources (DWR). The IDNR issues allocation orders for annual average quantities of diversion which is allocated to municipalities for domestic consumption.

MWRD also has an order allowing it to divert Lake Michigan water into the Chicago Waterway to improve water quality. This diversion is called “discretionary diversion,” and it is seasonal and is scheduled such that most flow is during the warm weather months of June through October. In a response letter dated September 15, 2015, the MWRD stated, “the current diversion allocation is 270 cfs but is scheduled to decrease to 101 cfs in water year 2015. MWRD has petitioned IDNR to increase the diversion from the scheduled 101 cfs, and a hearing was scheduled for October 2015. Depending on the outcome of the hearing, MWRD’s allocation for discretionary diversion may change and is likely to change over the long term[15]. The hearing was held, and IDNR is still considering possible adjustments.



Flow of water within is artificially controlled by hydraulic structures, with the single control outlet for the Chicago Waterway being the Lockport Powerhouse and Lock (LP&L) located in Romeoville, IL. Over 70% of the annual flow in the system as measured at Lockport Powerhouse and Lock and Lockport Controlling Works is from the discharge of treated municipal wastewater effluent from MWRD’s Water Reclamation Plants (WRP). During the winter months, virtually 100% of the flow is from these WRPs; during the summer months, about 50% of the flow is from the WRPs[16].

**Des Plaines River**

In addition to the Chicago Waterway described above, the GLMRIS-Brandon Road Study also encompasses a portion of the Des Plaines River. The Des Plaines River flows from Union Grove, Wisconsin southwest 241.4 km (150 mi) to its confluence with the Kankakee River. The Des Plaines River is typically broken into two separate segments, the Upper and Lower Des Plaines River. The Upper Des

[14]MWRD. 2008. Description of the Chicago Waterway System for the Use Attainability Analysis. Metropolitan Water Reclamation District of Greater Chicago. Report No. 08-15R. 29 pp.
[15] MWRD letter dated September 15, 2015, page 1.
[16]MWRD. 2008. Description of the Chicago Waterway System for the Use Attainability Analysis. Metropolitan Water Reclamation District of Greater Chicago. Report No. 08-15R. 29 pp.

Plaines River (UDPR) extends from the headwaters in Wisconsin downstream to its confluence with Salt Creek near Lyons, IL. The Lower Des Plaines River (LDPR) extends from its confluence with Salt Creek downstream to its confluence with the Kankakee River where it forms the Illinois River. Habitats in the Des Plaines vary, with some reaches having lower gradients and exhibiting abundant backwaters and side stream wetland habitats; while some reaches have higher gradients where the channel braids and exhibits swift currents over bedrock, thus forming many riffles (near Lockport and Romeoville). The Des Plaines joins the Brandon Road Pool 1.8 km (1.1 mi) downstream of the LP&L. The Brandon Road Pool extends from Brandon Road Lock and Dam upstream to LP&L and is approximately 8 km (5 mi) in length. This portion of the Des Plaines River below LP&L is deeper and wider, a result of modification for commercial navigation. For convenience, the Chicago Area Waterway, Brandon Road Pool and portion of the Des Plaines River that flows into Brandon Road Pool will be referred to as the Chicago Area Waterway System (CAWS) from here on. The CAWS consists of 206 km (128 mi) of waterways throughout the Chicago Metropolitan area. In summation, the CAWS is a highly regulated waterway system that is an integral component to the Chicago areas flood risk management and where Lake Michigan water is used to improve water quality.

**Water Quality Structures on Chicago Waterway**

Sidestream Elevated Pool Aeration (SEPA) stations implemented by MWRD add oxygen to water in the turbulent cascades, or waterfalls. There are currently five major SEPA stations along the Calumet River and the Calumet-Sag Channel. The aeration process improves water quality, encourages fish populations and prevents unpleasant odors. Underwater aeration stations at Devon Avenue and Webster Avenue also improve water quality in the North Shore Channel and the North Branch of the Chicago River.



**Combined Sewer Overflows**

Combined Sewer Overflows (CSOs) occur during intense rain events when Chicago's combined sewers cannot accommodate the additional storm water flow and untreated sewage-storm runoff is discharged to local waterways. Two hundred fifteen (215) permitted CSO outfalls, with a total of 394 within the MWRD boundaries, on the CAWS produce hundreds of discharge events each year. More than 600 CSO outfalls[17] exist throughout the entire combined sewer area, which spans Chicago and 51 other municipalities. MWRD's five pumping stations convey wastewater to the water reclamation plants and help dewater the sewer system during storm events to prevent basement flooding. However when the downstream pipes reach capacity, these pumping stations also release large volumes of combined sewage-storm water to the CAWS. In cases of especially severe storms, the Wilmette Pump Station, Chicago River Controlling Works (CRCW) and the T.J. O'Brien Lock and Dam are opened to allow water from the CAWS to flow out to Lake Michigan.

The Tunnel and Reservoir Plan (TARP) was adopted in 1972 in order to minimize the impacts of Combined Sewer Overflows (CSO) on the CAWS and Lake Michigan. Competed in 2006, TARP Phase I delivered significant water quality benefits to the CAWS through the construction of 175.4 km (109 mi) of large-diameter storm water tunnels. Completion of the Phase II reservoirs will provide an additional

[17] USACE. 2014. The Great Lakes and Mississippi River Interbasin Study Report: Appendix B – Affected Environment. U.S. Army Corps of Engineers. 130 pp.

17.5 billion gallons of storage, and further reduce water quality impacts caused by untreated storm water-sewage releases to the waterways.

**Water Quality**

**Impaired Waters**

Section 303(d) of the CWA requires states, territories, and authorized tribes to submit a list of impaired and threatened water bodies to the EPA. "Impaired" waters are defined as those not yet meeting water quality standards (WQS), and "threatened" waters are those not expected to meet WQS by the next listing cycle. The Illinois Environmental Protection Agency (IEPA) has identified that many segments of the CAWS, Lower Des Plaines River (LDPR) and Upper Des Plaines River (UDPR) are not supporting their designated uses, as shown in **Table 2**. High counts of fecal coliform indicator bacteria impair many of the waterways for recreational use, and chemical constituents such as phosphorous, mercury, polychlorinated biphenyls (PCBs), and dissolved oxygen (DO) impair many of the waterways for aquatic life. To develop the Section 303(d) list, the IEPA Ambient Water Quality Monitoring (AWQM) program monitors 213 locations throughout Illinois, two located on the CAWS.

**Table 2 – Water Impairments from 2014 Illinois 303(d) List**[18]

| Waterway | Non-Supporting Designated Use | Impairment(s) |
|---|---|---|
| **Primary Contact Recreation Use, Indigenous Aquatic Life Use** | | |
| Lower North Shore Channel (NSC) from its confluence with the North Branch Chicago River (NBCR) upstream to the North Side Water Reclamation Plant (WRP) | Fish Consumption | Mercury, PCBs |
| NBCR from its confluence with the NSC to its confluence with the Chicago River | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Iron, Phosphorus (Total), Total Dissolved Solids |
| South Branch of the Chicago River (SBCR) from Wolf Point downstream to South Fork of the South Branch of the Chicago River (Bubbly Creek) | Fish Consumption | PCBs |
| | Indigenous Aquatic Life | DO, Total Dissolved Solids, Phosphorus (Total) |
| Little Calumet River from its confluence with the Calumet River and Grand Calumet River to its confluence with Calumet-Sag Channel (CSC) | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | Aldrin, DO, Iron, Phosphorus (Total), Total Dissolved Solids, Silver |
| Little Calumet River South | Aesthetic Quality | Bottom Deposits, Sludge, Visible Oil |

[18]IEPA (Illinois Environmental Protection Agency). 2014. Illinois Integrated Water Quality Report and Section 303(d) List; Water Resource Assessment Information and List of Impaired Waters. Bureau of Water. http://www.epa.state.il.us/water/tmdl/303-appendix/2014/iwq-report-surface-water.pdf

| Waterway | Non-Supporting Designated Use | Impairment(s) |
|---|---|---|
| | Aquatic LIfe | Chlordane, Chloride, DO, Endrin, Hexachlorobenzene, Phosphorus (Total), Sedimentation/Siltation |
| | Primary Contact Recreation USe | Fecal Coliform |
| Calumet-Sag Channel (CSC) from its confluence with the Chicago Sanitary Ship Canal (CSSC) upstream to its confluence with Stony Creek | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Iron, Oil and Grease, Phosphorus (Total), Total Dissolved Solids, Total Suspended Solids (TSS) |
| CSC from its confluence with Spring Creek upstream to its confluence with the Little Calumet River | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Iron, Total Dissolved Solids |
| **Primary Contact Recreation Use, General Use** | | |
| Chicago River | Aquatic Life | DO, pH, Phosphorus (Total) |
| | Fish Consumption | Mercury, PCBs |
| | Primary Contact Recreation Use | Fecal Coliform |
| Lake Michigan Nearshore (open water) | Fish Consumption | Mercury, PCBs |
| | Aesthetic Quality | Phosphorus (Total) |
| Upper Des Plaines River (UDPR) from confluence with Salt Creek upstream to Wisconsin border | Primary Contact Recreation Use | Fecal Coliform |
| | Fish Consumption | Mercury, PCBs |
| | Aquatic Life | Arsenic, Chloride, Dissolved Oxygen, Iron, Methoxychlor, pH, Phosphorus (Total), Total Suspended Solids (TSS), Cause Unknown |
| UDPR from confluence with CSSC upstream to confluence with Salt Creek | Aquatic Life | Aldrin, Arsenic, Chloride, Lindane, Methoxychlor, pH, Phosphorus (Total) |
| | Fish Consumption | Mercury, PCBs |
| | Primary Contact Recreation | Fecal Coliform |
| **Incidental Contact Recreation Use, Indigenous Aquatic Life Use** | | |
| South Fork of the SBCR (Bubbly Creek) | Indigenous Aquatic Life | DO, Phosphorus (Total) |

| Waterway | Non-Supporting Designated Use | Impairment(s) |
|---|---|---|
| Chicago Sanitary and Ship from its confluence with the SBCR to its confluence with the CSC | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Phosphorus (Total) |
| Grand Calumet River (GCR) | Indigenous Aquatic Life | Ammonia (Un-ionized), Arsenic, Barium, Cadmium, Chlromium, Copper, DDT, DO, Iron, Lead, Nickel, PCBs, Phosphorus (Total), Sedimentation/Siltation, Silver, Zinc |
| Lower Des Plaines River (LDPR) from the Brandon Road Lock and Dam to Interstate 55 bridge | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Iron, Manganese, Total Dissolved Solids |
| **General Use** | | |
| Upper NSC from the Wilmette Pumping Station to O'Brien WRP | Aquatic Life | DO, pH, Phosphorus (Total) |
| | Fish Consumption | Mercury, PCBs |
| | Primary Contact Recreation Use | Fecal Coliform |
| Calumet River from Lake Michigan to the T.J. O'Brien Lock and Dam | Fish Consumption | Mercury, PCBs |
| | Primary Contact Recreation Use | Fecal Coliform |
| **Secondary Contact Recreation Use, Indigenous Aquatic Life Use** | | |
| CSSC from its confluence with the CSC to downstream to the Will County line | Fish Consumption | PCBs |
| | Indigenous Aquatic Life | DO, Phosphorus (Total), Total Dissolved Solids |
| CSSC from the Will County line downstream to its confluence with the Des Plaines River | Fish Consumption | PCBs |
| | Indigenous Aquatic Life | DO, Iron, Manganese, Phosphorus (Total), Total Dissolved Solids |
| LDPR from its confluence with the CSSC to the Brandon Road Lock and Dam | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Iron, Manganese, Total Dissolved Solids |



According to USEPA response letter dated September 23, 2015, "Future water quality management activities in the CAWS and LDPR, as guided by implementation of new and/or revised WQS, may include implementation of a total maximum daily load (TMDL), more stringent point source permit limits, better storm water control, and/or new, holistic strategies to improve aquatic life. To the extent that stricter permit limits, installation of storm water controls, or improved in-stream habitat are shown to be necessary to remedy aquatic life use impairments in order to meet the applicable designated use for a water body, improvements in treatment technologies and/or habitat may be required. Additional management activities in the CAWS could also include: flow augmentation, aeration, and/or sediment removal in certain reaches" [19].

Additionally, the Illinois Environmental Protection Agency (IEPA) provided the following information in regards to the UDPR, "Future water quality management activities in the UDPR, may include implementation of a total maximum daily load (TMDL), better storm water control, removal of dams, and/or new, holistic strategies to improve aquatic life. To the extent that stricter permit limits, installation of storm water controls, or improved in-stream habitat are shown to be necessary to remedy aquatic life use impairments in order to meet the applicable designated use for a water body, improvements in treatment technologies and/or habitat may be required.[20]"

Finally, the USEPA response letter also included the following actions that are anticipated to improve water quality within and downstream of the CAWS: "IEPA issued permits in 2013 for the O'Brien (formerly known as Northside), Calumet and Stickney plants requiring phosphorus removal, with associated lengthy compliance schedules. The 2013 issued permits for O'Brien and Calumet require disinfection by March 31, 2016. The Combined Sewer Overflow (CSO) overflows covered under these permits, which discharge untreated wastewater mixed with storm water into the CAWS, are primarily controlled by MWRD's construction and operation of their Tunnel and Reservoir Plan (TARP) system. A schedule for completing the TARP by 2029 is included in a Federal Consent Decree that was entered in Federal Court. The 2013 issued permits for the O'Brien and Calumet plants reflect the finalized upgrade of WQS for the CAWS, as they now contain fecal coliform limits and construction schedules for disinfecting the discharge from the two plants. The Calumet WRP began chlorintation/dechlorination in July 2015, ahead of its existing disinfection compliance schedule in its 2013 issued permit. The Calumet plant is moving forward per its compliance schedule for phosphorus removal in the 2013 issued permit. The O'Brien WRP construction for disinfection and phosphorus removal is moving forward per the compliance schedule in its 2013 issued permit. The Stickney WRP construction for phosphorus removal is moving forward per the compliance schedule in its 2013 issued permit. The O'Brien, Calumet and Stickney permits all contain a 1 milligram per liter (mg/L) phosphorus limit)"[21].



**Conclusion**

The following list is the overall conclusions of the FWOP condition for Asian carp within the IWW and CAWS based on the information presented above:

- Uncertainty exists as to whether the Asian carp adult population will move upstream of its current location in Dresden Island Pool (i.e., below Brandon Road Lock and Dam).
- Uncertainty exists regarding the availability of state and federal funds to support continued monitoring and response actions within the IWW and CAWS.
- It is projected for the 50-year period of analysis that USACE will continue to receive funding to operate at least two electric barriers, potentially all three, at Romeoville, Illinois under normal circumstances (excluding maintenance, etc.) with operating parameters no lower than the current parameters of Barriers IIA and IIB.

[19] USEPA letter dated September 23, 2015, page 4.
[20] IEPA email dated November 16, 2015.
[21] USEPA letter dated September 23, 2015, page 8.

- Uncertainty exists regarding the ability to design a solution to effectively address the barge entrainment and small fish issues with the Electric Dispersal Barriers.
- It is expected that approximately 70% of the Chicago Waterway (waterway upstream of Lockport Lock and Controlling Works) total annual flow will continue to be generated by MWRD's water reclamation plants; however, based on upstream influences it is anticipated that water quality will improve.

**Future Without Project Condition – *A. lacustre***

The following overview is the anticipated Future Without Project (FWOP) condition for *Apocorophium lacustre* within the Illinois Waterway (IWW) and Chicago Area Waterway System (CAWS) (**Figure 1 and Figure 2**). The FWOP condition is the basis for comparing alternative plans for the GLMRIS-Brandon Road study. Conditions are reviewed for a 'period of analysis' which usually extends for 50 years or for the duration that significant impacts are expected, but not to exceed 100 years. The 'period of analysis' for the GLMRIS-Brandon Road Study extends for 50 years, from 2021 to 2071. The year 2021 is assumed to be when the U.S. Army Corps of Engineers (USACE) would have authorization and funding to construct the recommended plan. This FWOP condition forecast is intended to provide information regarding the uncertainty associated with (1) current distribution of *A. lacustre*, (2) *A. lacustre* control activities, and (3) water quality upstream of the Brandon Road Lock and Dam (BRLD) which could impact *A. lacustre* survival upstream.

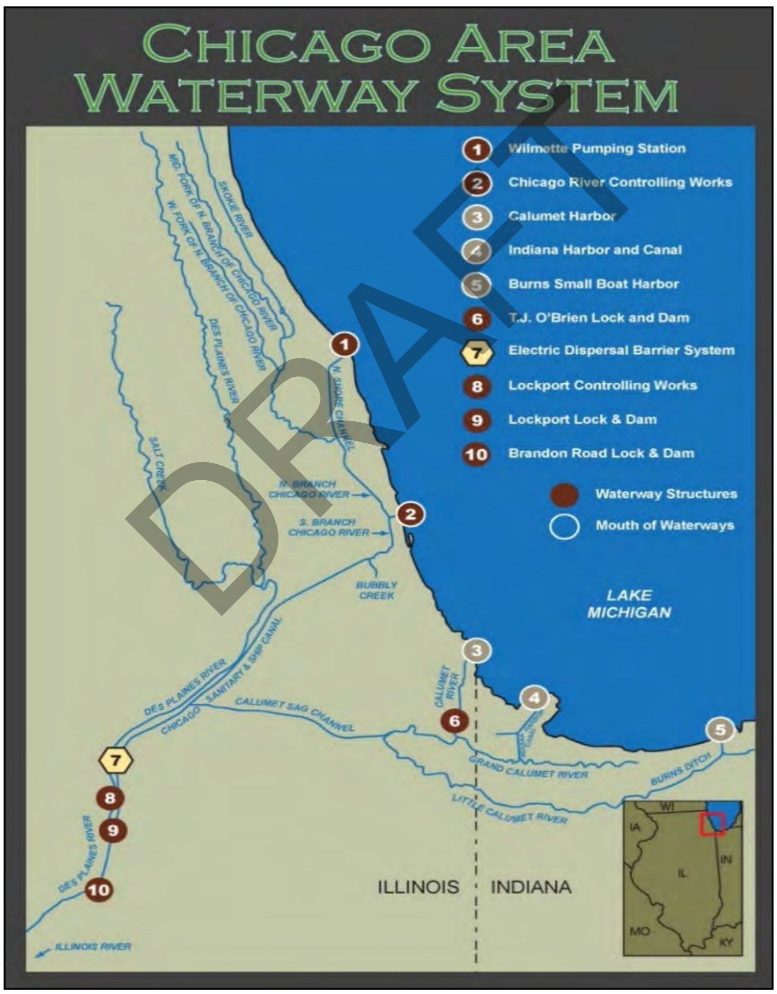


**Figure 1. Location of the Electric Dispersal Barrier within the CAWS.**

***Apocorophium lacustre* Current Distribution**

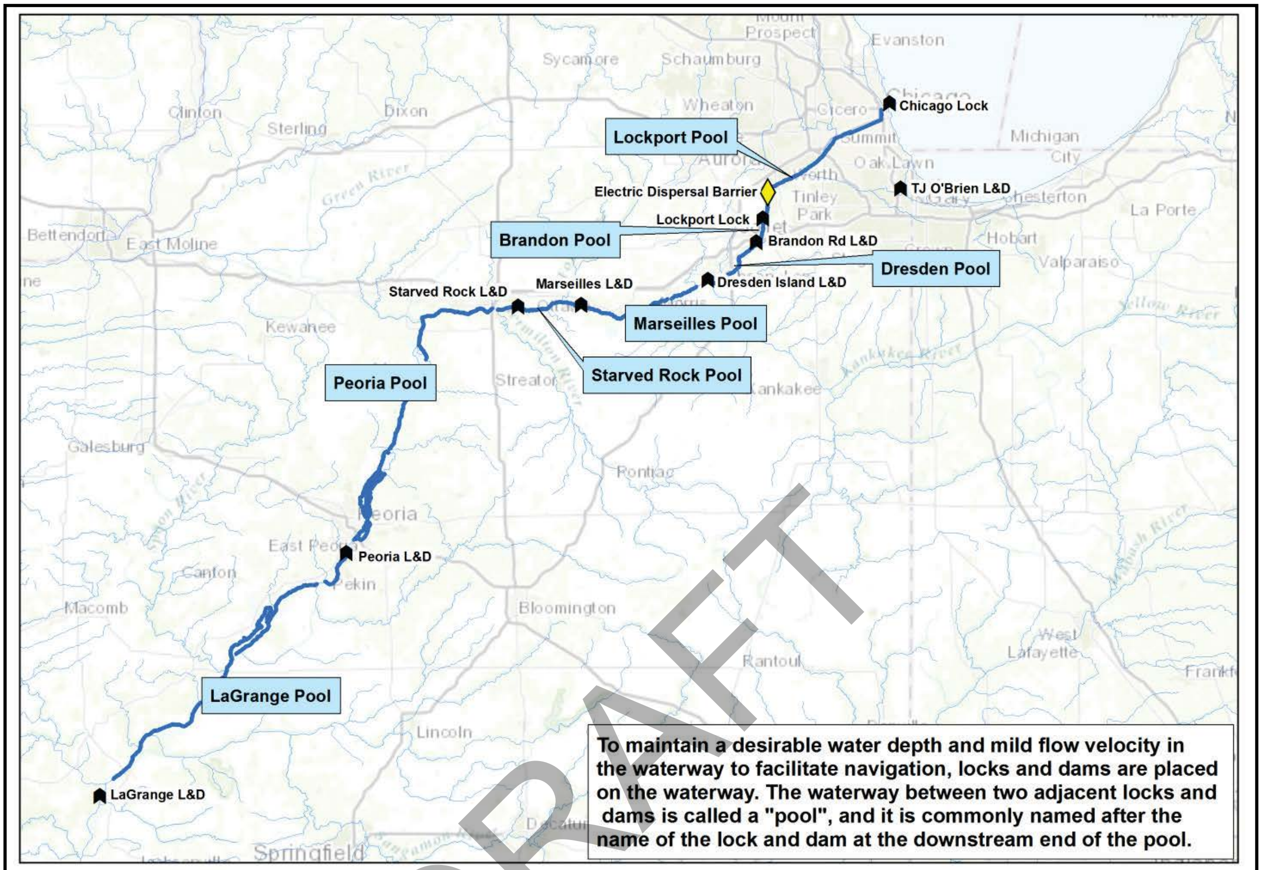


**Figure 2. "Pools" within the CAWS and Upper Illinois Waterway.**



The current distribution of *A. lacustre* within the IWW is discussed below. **Figure 3** shows the current distribution, per the USGS NAS Factsheet, of *A. lacustre* within the Illinois Waterway[1]. *Apocorophium lacustre* is native to the Atlantic coast of North America[2]. Within the Mississippi River Basin, the scud has been reported from the Mississippi River, Ohio River, and Illinois River[3]. The scud was first reported from the lower Mississippi River in 1987 and spread north to the Ohio River by 1996 [4]. By 2003, *A. lacustre* had invaded the Illinois River. Surveys for this species in multiple river basins conducted in 2008 found that the scud was present just above the Dresden Lock and Dam, less than 20 miles from the Brandon Road Lock and Dam[5]. In surveys conducted in 2015, *A. lacustre* was again found

[1]USGS (U.S. Geological Survey). 2011. NAS–Nonindigenous Aquatic Species. *Apocorophium lacustre*. http://nas.er.usgs.gov/queries/SpecimenViewer.aspx?SpecimenID=237724.
[2]See 1.
[3]Grigorovich, I.A., T.R. Angradi, E.B. Emery & M.S. Wooten. 2008. Invasion of the upper Mississippi River system by saltwater amphipods. *Fundamental and Applied Limnology/Archiv für Hydrobiologie*, vol. 173(1), pp. 67-77.
[4]See 3.
[5]See 3.

as far north as Dresden Island Pool[6]. In the Illinois River, *A. lacustre* can be locally abundant, but overall, it its numbers are highly variable over space and time[7].

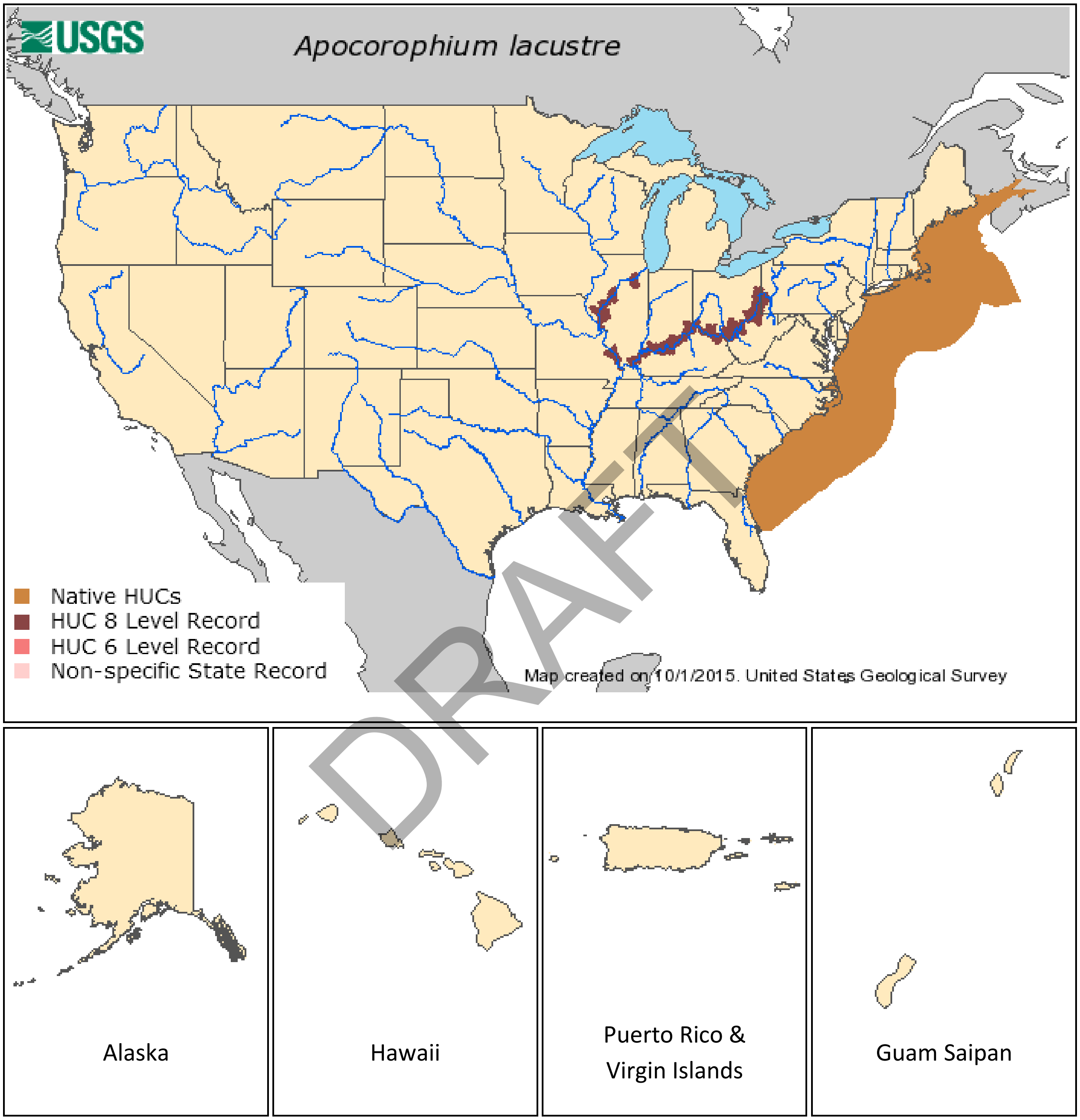


**Figure 3. *A. lacustre* point distribution map within the United States[8].**

[6]Personal communication Reuben Keller, Institute of Environmental Sustainability, Loyola University Chicago, September 3, 2015.

[7]See 6.

[8] United States Geological Survey (USGS). 2015. *Apocorophium lacustre*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. http://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=2315 Revision Date: 6/15/2015

The FWOP condition related to the location of the established *A. lacustre* population in the upper Illinois Waterway and CAWS is uncertain.

**ANS Control Efforts**

There are currently no known activities in regards to monitoring and control efforts for *A. lacustre* within the Illinois Waterway and CAWS.

Potential funding for monitoring or control efforts for *A. lacustre* might come from the Great Lakes Restoration Initiative (GLRI). The GLRI was launched in 2010 to accelerate efforts to protect and restore the Great Lakes as well as to provide additional resources to make progress toward the most critical long-term goals for this important ecosystem. During the first five years of the GLRI, federal agencies and their partners engaged in an unprecedented level of activity to prevent new introductions of invasive species in the Great Lakes ecosystem.

During FY15-19, federal agencies plan to continue to use GLRI resources to strategically target the biggest threats to the Great Lakes ecosystem and to accelerate progress toward long term goals – by combining GLRI resources with agency base budgets and by using these resources to work with nonfederal partners to implement protection and restoration projects. To guide this work, federal agencies have drafted GLRI Action Plan II[9], which summarizes the actions that federal agencies plan to implement during FY15-19 using GLRI funding. Under GLRI Action Plan II, federal agencies and their partners will continue to prevent new invasive species from establishing self-sustaining populations in the Great Lakes ecosystem. Table 1 shows the FY15-19 GLRI Action Plan Summary for Invasive Species.



**Table 1 – FY15-19 GLRI Action Plan Summary for Invasive Species[10].**

| Focus Area | Objectives | Commitments |
|---|---|---|
| Invasive Species | Prevent new introductions of invasive species | ▪ Block pathways through which aquatic invasive species can be introduced to the Great Lakes ecosystem<br>▪ Conduct early detection monitoring activities<br>▪ Work with Great Lakes states to conduct rapid response actions or exercises |
| | Control established invasive species | ▪ Implement control projects for GLRI-targeted invasive species |
| | Develop invasive species control technologies and refine management techniques | ▪ Develop/enhance technologies and methods to prevent the introduction and to control the spread of invasive species<br>▪ Develop/enhance invasive species specific collaborative to support rapid responses and communicate the latest control and management techniques |

[9] Great Lakes Interagency Task Force. 2014. Great Lakes Restoration Initiative Action Plan II. 30 pp.
[10] Great Lakes Interagency Task Force. 2014. Great Lakes Restoration Initiative Action Plan II. 30 pp.

For the GLMRIS-Brandon Road Study, USACE is utilizing a 50-year period of analysis (i.e., through 2071). The GLRI Action Plan II only projects funding for invasive species programs through FY19, after that time it is unknown whether funding will continue or be phased out. USACE sent letter requests to agencies whose invasive species monitoring and response activities are part of the annual MRP and/or receive funds from GLRI. Respondents to information requests provided the following regarding future funding of invasive species programs and projects:

- The Illinois Department of Natural Resources (IDNR) responded that their agency is operating under significant fiscal constraints. Currently, the majority of funding for Aquatic Nuisance Species (ANS) research, controls, and monitoring is funded by Federal funds, which originate within USFWS to support Illinois' Statewide Aquatic Nuisance Species (ANS) Comprehensive Management Plan.

- The U.S. Fish and Wildlife Service responded that starting in FY2015 they received an additional $2 million in their base funds to support ANS monitoring and control activities outside of the Great Lakes Basin (e.g., Ohio River Basin and Mississippi River Basin). If GLRI funding is not continued past FY19 (current end date for GLRI Action II), then the USFWS is permitted to use a portion of these additional funds to supplement high priority work, such as that in the CAWS and upper Illinois Waterway. However, if GLRI funding does cease after FY2019, then the ability of the USFWS to continue funding ANS control/monitoring projects within the CAWS and upper Illinois Waterway at the level they are currently being funded decreases significantly. At this time, the USFWS expects to continue to carry out its mission objectives at a minimum at current FY16 base levels through the 50-year period of analysis (i.e., 2071). The USFWS will continue to work with partners to implement actions in support of these strategies, based on availability of resources. Future funding for ANS activities is subject to appropriations.



**Electric Dispersal Barriers**

The Electric Dispersal Barriers includes three (3) barriers (i.e., Demonstration Barrier, Barrier IIA, Barrier IIB) in operation in the Chicago Sanitary and Ship Canal at Romeoville, IL. The Demonstration Barrier is being upgraded to a more powerful barrier (Permanent Barrier I) and construction is currently underway with installation of underwater components having been completed in October 2014. Permanent Barrier I is scheduled for activation in 2017 after completing construction and operational and safety testing. Barrier I is designed to operate at higher voltages than Barriers IIA and IIB; and therefore, may have an increased ability to deter small fish. Barriers IIA and IIB currently operate at a maximum in-water field strength at the water surface of 2.3 Volts/inch with a pulse frequency of 34 pulses/second and a pulse duration of 2.3 milliseconds. These parameters were found in the laboratory to be effective at immobilizing Bighead and Silver Carp as small as approximately 76.2-127 mm (3-5 inches in) in total length[11,12,13,14]. It is projected that through the duration of the period of analysis (i.e., 2071) at least two barriers, potentially all three, will be in operation under normal circumstances (excluding maintenance, etc.) with operating parameters no lower than the current parameters of Barriers IIA and IIB.

Several studies have been conducted near the Electric Dispersal Barriers by USFWS to determine the efficacy of the barrier. These studies primarily focus on if and how small fish interact with the barrier and in what effect vessel traffic effects these behaviors. No studies have been conducted to determine the effect the Electric Dispersal Barriers may have on *A. lacustre*.

**Upstream of Lockport Lock and Controlling Works and Des Plaines River**

**Upstream of Lockport Lock and Controlling Works**

The Chicago Waterway is comprised of 125.5 km (78 mi) of canals, which are used for conveyance of storm water runoff and treated municipal wastewater, commercial navigation, and flood control. The Chicago Waterway includes two river systems, the Chicago River (88.7 km/55.1 mi) and the Calumet River (37.2 km/23.1 mi). Approximately 75% of the length of the Chicago Waterway is man-made canals where no waterway previously existed, while the remaining length is natural streams which have been dredged, realigned, widened, and straightened. The absence of gradual sloping banks, shallow littoral zone habitat, and bends result in a limited habitat for aquatic biota. Homogenous silt sediments that restrict macroinvertebrate and fish populations are deposited throughout much of the Chicago Waterway due to the unnatural stream flow dynamics[15].

Flow in the Chicago Waterway is managed by the Metropolitan Water Reclamation District of Greater Chicago (MWRD), but is subject to regulation under U.S. Supreme Court Decrees and Title 33 of the Code of Federal Regulations (CFR), Sections 207.420 and 207.425. The CFR provides for the maintenance of navigable depths to support commercial navigation and to prevent unintentional reversal into Lake Michigan.

The U. S. Supreme Court Decrees govern the quantity of water from Lake Michigan that is diverted out of the Great Lakes Basin into the Mississippi River Basin by the State of Illinois. Within Illinois, this quantity is subject to regulation by the Illinois Department of Natural Resources (IDNR), Division of



[11] Holliman, FM. 2011. Operational protocols for electric barriers on the Chicago Sanitary and Ship Canal: influence of electrical characteristics, water conductivity, behavior, and water velocity on risk breach by nuisance invasive fishes. Final report submitted to U.S. Army Corps of Engineers, Chicago District. 132 pp.
[12] Holliman, FM. 2014. Reliability demonstration testing of electric field parameters for electric field-based aquatic nuisance species dispersal barriers on the Chicago sanitary and ship canal. Fish Research and Development, LLC. 48 pp.
[13] Holliman, FM. 2014. Effects of electrode polarity on risk for breach of electric barriers on the Chicago sanitary and ship canal by small sizes of bighead carp. Fish Research and Development, LLC. 41 pp.
[14] Holliman, FM, Killgore KJ, and Shea C. (2015). "Development of Operational Protocols for Electric Barrier Systems on the Chicago Sanitary and Ship Canal: Induction of Passage-Preventing Behaviors in Small Sizes of Silver Carp," ANSRP-15-1, U.S. Army Engineer Research and Development Center, Vicksburg, MS.
[15] MWRD. 2008. Description of the Chicago Waterway System for the Use Attainability Analysis. Metropolitan Water Reclamation District of Greater Chicago. Report No. 08-15R. 29 pp.

Water Resources (DWR). The IDNR issues allocation orders for annual average quantities of diversion which is allocated to municipalities for domestic consumption.

MWRD also has an order allowing it to divert Lake Michigan water into the Chicago Waterway to improve water quality. This diversion is called "discretionary diversion," and it is seasonal and is scheduled such that most flow is during the warm weather months of June through October. In a response letter dated September 15, 2015, the MWRD stated, "the current diversion allocation is 270 cfs but is scheduled to decrease to 101 cfs in water year 2015. MWRD has petitioned IDNR to increase the diversion from the scheduled 101 cfs, and a hearing was scheduled for October 2015. Depending on the outcome of the hearing, MWRD's allocation for discretionary diversion may change and is likely to change over the long term[16]. The hearing was held, and IDNR is still considering possible adjustments.

Flow of water within is artificially controlled by hydraulic structures, with the single control outlet for the Chicago Waterway being the Lockport Powerhouse and Lock (LP&L) located in Romeoville, IL. Over 70% of the annual flow in the system as measured at Lockport Powerhouse and Lock and Lockport Controlling Works is from the discharge of treated municipal wastewater effluent from MWRD's Water Reclamation Plants (WRP). During the winter months, virtually 100% of the flow is from these WRPs; during the summer months, about 50% of the flow is from the WRPs[17].

**Des Plaines River**

In addition to the Chicago Waterway described above, the GLMRIS-Brandon Road Study also encompasses a portion of the Des Plaines River. The Des Plaines River flows from Union Grove, Wisconsin southwest 241.4 km (150 mi) to its confluence with the Kankakee River. The Des Plaines River is typically broken into two separate segments, the Upper and Lower Des Plaines River. The Upper Des Plaines River (UDPR) extends from the headwaters in Wisconsin downstream to its confluence with Salt Creek near Lyons, IL. The Lower Des Plaines River (LDPR) extends from its confluence with Salt Creek downstream to its confluence with the Kankakee River where it forms the Illinois River. Habitats in the Des Plaines vary, with some reaches having lower gradients and exhibiting abundant backwaters and side stream wetland habitats; while some reaches have higher gradients where the channel braids and exhibits swift currents over bedrock, thus forming many riffles (near Lockport and Romeoville). The Des Plaines joins the Brandon Road Pool 1.8 km (1.1 mi) downstream of the LP&L. The Brandon Road Pool extends from Brandon Road Lock and Dam upstream to LP&L and is approximately 8 km (5 mi) in length. This portion of the Des Plaines River below LP&L is deeper and wider, a result of modification for commercial navigation. For convenience, the Chicago Area Waterway, Brandon Road Pool and portion of the Des Plaines River that flows into Brandon Road Pool will be referred to as the Chicago Area Waterway System (CAWS) from here on. The CAWS consists of 206 km (128 mi) of waterways throughout the Chicago Metropolitan area. In summation, the CAWS is a highly regulated waterway system that is an integral component to the Chicago areas flood risk management and where Lake Michigan water is used to improve water quality.



[16]MWRD letter dated September 15, 2015, page 1.
[17]MWRD. 2008. Description of the Chicago Waterway System for the Use Attainability Analysis. Metropolitan Water Reclamation District of Greater Chicago. Report No. 08-15R. 29 pp.

**Water Quality Structures on Chicago Waterway**

Sidestream Elevated Pool Aeration (SEPA) stations implemented by MWRD add oxygen to water in the turbulent cascades, or waterfalls. There are currently five major SEPA stations along the Calumet River and the Calumet-Sag Channel. The aeration process improves water quality, encourages fish populations and prevents unpleasant odors. Underwater aeration stations at Devon Avenue and Webster Avenue also improve water quality in the North Shore Channel and the North Branch of the Chicago River.

**Combined Sewer Overflows**

Combined Sewer Overflows (CSOs) occur during intense rain events when Chicago's combined sewers cannot accommodate the additional storm water flow and untreated sewage-storm runoff is discharged to local waterways. Two hundred fifteen (215) permitted CSO outfalls, with a total of 394 within the MWRD boundaries, on the CAWS produce hundreds of discharge events each year. More than 600 CSO outfalls[18] exist throughout the entire combined sewer area, which spans Chicago and 51 other municipalities. MWRD's five pumping stations convey wastewater to the water reclamation plants and help dewater the sewer system during storm events to prevent basement flooding. However when the downstream pipes reach capacity, these pumping stations also release large volumes of combined sewage-storm water to the CAWS. In cases of especially severe storms, the Wilmette Pump Station, Chicago River Controlling Works (CRCW) and the T.J. O'Brien Lock and Dam are opened to allow water from the CAWS to flow out to Lake Michigan.

The Tunnel and Reservoir Plan (TARP) was adopted in 1972 in order to minimize the impacts of Combined Sewer Overflows (CSO) on the CAWS and Lake Michigan. Competed in 2006, TARP Phase I delivered significant water quality benefits to the CAWS through the construction of 175.4 km (109 mi) of large-diameter storm water tunnels. Completion of the Phase II reservoirs will provide an additional 17.5 billion gallons of storage, and further reduce water quality impacts caused by untreated storm water-sewage releases to the waterways.

**Water Quality**

**Impaired Waters**

Section 303(d) of the CWA requires states, territories, and authorized tribes to submit a list of impaired and threatened water bodies to the EPA. "Impaired" waters are defined as those not yet meeting water quality standards (WQS), and "threatened" waters are those not expected to meet WQS by the next listing cycle. The Illinois Environmental Protection Agency (IEPA) has identified that many segments of the CAWS, Lower Des Plaines River (LDPR) and Upper Des Plaines River (UDPR) are not supporting their designated uses, as shown in **Table 2**. High counts of fecal coliform indicator bacteria impair many of the waterways for recreational use, and chemical constituents such as phosphorous, mercury, polychlorinated biphenyls (PCBs), and dissolved oxygen (DO) impair many of the waterways for

[18]USACE. 2014. The Great Lakes and Mississippi River Interbasin Study Report: Appendix B – Affected Environment. U.S. Army Corps of Engineers. 130 pp.

aquatic life. To develop the Section 303(d) list, the IEPA Ambient Water Quality Monitoring (AWQM) program monitors 213 locations throughout Illinois, two located on the CAWS.

**Table 2 – Water Impairments from 2014 Illinois 303(d) List[19]**

| Waterway | Non-Supporting Designated Use | Impairment(s) |
|---|---|---|
| **Primary Contact Recreation Use, Indigenous Aquatic Life Use** | | |
| Lower North Shore Channel (NSC) from its confluence with the North Branch Chicago River (NBCR) upstream to the North Side Water Reclamation Plant (WRP) | Fish Consumption | Mercury, PCBs |
| NBCR from its confluence with the NSC to its confluence with the Chicago River | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Iron, Phosphorus (Total), Total Dissolved Solids |
| South Branch of the Chicago River (SBCR) from Wolf Point downstream to South Fork of the South Branch of the Chicago River (Bubbly Creek) | Fish Consumption | PCBs |
| | Indigenous Aquatic Life | DO, Total Dissolved Solids, Phosphorus (Total) |
| Little Calumet River from its confluence with the Calumet River and Grand Calumet River to its confluence with Calumet-Sag Channel (CSC) | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | Aldrin, DO, Iron, Phosphorus (Total), Total Dissolved Solids, Silver |
| Little Calumet River South | Aesthetic Quality | Bottom Deposits, Sludge, Visible Oil |
| | Aquatic LIfe | Chlordane, Chloride, DO, Endrin, Hexachlorobenzene, Phosphorus (Total), Sedimentation/Siltation |
| | Primary Contact Recreation USe | Fecal Coliform |
| Calumet-Sag Channel (CSC) from its confluence with the Chicago Sanitary Ship Canal (CSSC) upstream to its confluence with Stony Creek | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Iron, Oil and Grease, Phosphorus (Total), Total Dissolved Solids, Total Suspended Solids (TSS) |



[19]IEPA (Illinois Environmental Protection Agency). 2014. Illinois Integrated Water Quality Report and Section 303(d) List; Water Resource Assessment Information and List of Impaired Waters. Bureau of Water. http://www.epa.state.il.us/water/tmdl/303-appendix/2014/iwq-report-surface-water.pdf

| Waterway | Non-Supporting Designated Use | Impairment(s) |
|---|---|---|
| CSC from its confluence with Spring Creek upstream to its confluence with the Little Calumet River | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Iron, Total Dissolved Solids |
| **Primary Contact Recreation Use, General Use** | | |
| Chicago River | Aquatic Life | DO, pH, Phosphorus (Total) |
| | Fish Consumption | Mercury, PCBs |
| | Primary Contact Recreation Use | Fecal Coliform |
| Lake Michigan Nearshore (open water) | Fish Consumption | Mercury, PCBs |
| | Aesthetic Quality | Phosphorus (Total) |
| Upper Des Plaines River (UDPR) from confluence with Salt Creek upstream to Wisconsin border | Primary Contact Recreation Use | Fecal Coliform |
| | Fish Consumption | Mercury, PCBs |
| | Aquatic Life | Arsenic, Chloride, Dissolved Oxygen, Iron, Methoxychlor, pH, Phosphorus (Total), Total Suspended Solids (TSS), Cause Unknown |
| UDPR from confluence with CSSC upstream to confluence with Salt Creek | Aquatic Life | Aldrin, Arsenic, Chloride, Lindane, Methoxychlor, pH, Phosphorus (Total) |
| | Fish Consumption | Mercury, PCBs |
| | Primary Contact Recreation | Fecal Coliform |
| **Incidental Contact Recreation Use, Indigenous Aquatic Life Use** | | |
| South Fork of the SBCR (Bubbly Creek) | Indigenous Aquatic Life | DO, Phosphorus (Total) |
| Chicago Sanitary and Ship from its confluence with the SBCR to its confluence with the CSC | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Phosphorus (Total) |
| Grand Calumet River (GCR) | Indigenous Aquatic Life | Ammonia (Un-ionized), Arsenic, Barium, Cadmium, Chlromium, Copper, DDT, DO, Iron, Lead, Nickel, PCBs, Phosphorus (Total), Sedimentation/Siltation, Silver, Zinc |
| Lower Des Plaines River (LDPR) from the Brandon Road Lock and Dam to Interstate 55 bridge | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Iron, Manganese, Total Dissolved Solids |
| **General Use** | | |

| Waterway | Non-Supporting Designated Use | Impairment(s) |
|---|---|---|
| Upper NSC from the Wilmette Pumping Station to O'Brien WRP | Aquatic Life | DO, pH, Phosphorus (Total) |
| | Fish Consumption | Mercury, PCBs |
| | Primary Contact Recreation Use | Fecal Coliform |
| Calumet River from Lake Michigan to the T.J. O'Brien Lock and Dam | Fish Consumption | Mercury, PCBs |
| | Primary Contact Recreation Use | Fecal Coliform |
| **Secondary Contact Recreation Use, Indigenous Aquatic Life Use** | | |
| CSSC from its confluence with the CSC to downstream to the Will County line | Fish Consumption | PCBs |
| | Indigenous Aquatic Life | DO, Phosphorus (Total), Total Dissolved Solids |
| CSSC from the Will County line downstream to its confluence with the Des Plaines River | Fish Consumption | PCBs |
| | Indigenous Aquatic Life | DO, Iron, Manganese, Phosphorus (Total), Total Dissolved Solids |
| LDPR from its confluence with the CSSC to the Brandon Road Lock and Dam | Fish Consumption | Mercury, PCBs |
| | Indigenous Aquatic Life | DO, Iron, Manganese, Total Dissolved Solids |



According to USEPA response letter dated September 23, 2015, "Future water quality management activities in the CAWS and LDPR, as guided by implementation of new and/or revised WQS, may include implementation of a total maximum daily load (TMDL), more stringent point source permit limits, better storm water control, and/or new, holistic strategies to improve aquatic life. To the extent that stricter permit limits, installation of storm water controls, or improved in-stream habitat are shown to be necessary to remedy aquatic life use impairments in order to meet the applicable designated use for a water body, improvements in treatment technologies and/or habitat may be required. Additional management activities in the CAWS could also include: flow augmentation, aeration, and/or sediment removal in certain reaches" [20].

Additionally, the Illinois Environmental Protection Agency (IEPA) provided the following information in regards to the UDPR, "Future water quality management activities in the UDPR, may include implementation of a total maximum daily load (TMDL), better storm water control, removal of dams, and/or new, holistic strategies to improve aquatic life. To the extent that stricter permit limits, installation of storm water controls, or improved in-stream habitat are shown to be necessary to remedy aquatic life use impairments in order to meet the applicable designated use for a water body, improvements in treatment technologies and/or habitat may be required.[21]"

[20]USEPA letter dated September 23, 2015, page 4.
[21]IEPA email dated November 16, 2015.

Finally, the USEPA response letter also included the following actions that are anticipated to improve water quality within and downstream of the CAWS: "IEPA issued permits in 2013 for the O'Brien (formerly known as Northside), Calumet and Stickney plants requiring phosphorus removal, with associated lengthy compliance schedules. The 2013 issued permits for O'Brien and Calumet require disinfection by March 31, 2016. The Combined Sewer Overflow (CSO) overflows covered under these permits, which discharge untreated wastewater mixed with storm water into the CAWS, are primarily controlled by MWRD's construction and operation of their Tunnel and Reservoir Plan (TARP) system. A schedule for completing the TARP by 2029 is included in a Federal Consent Decree that was entered in Federal Court. The 2013 issued permits for the O'Brien and Calumet plants reflect the finalized upgrade of WQS for the CAWS, as they now contain fecal coliform limits and construction schedules for disinfecting the discharge from the two plants. The Calumet WRP began chlorintation/dechlorination in July 2015, ahead of its existing disinfection compliance schedule in its 2013 issued permit. The Calumet plant is moving forward per its compliance schedule for phosphorus removal in the 2013 issued permit. The O'Brien WRP construction for disinfection and phosphorus removal is moving forward per the compliance schedule in its 2013 issued permit. The Stickney WRP construction for phosphorus removal is moving forward per the compliance schedule in its 2013 issued permit. The O'Brien, Calumet and Stickney permits all contain a 1 milligram per liter (mg/L) phosphorus limit)"[22].

**Conclusion**

The following list is the overall conclusions of the FWOP condition for *A. lacustre* within the IWW and CAWS based on the information presented above:

- Uncertainty exists as to whether *A. lacustre* have moved upstream of their last known location in Dresden Island Pool (i.e., below Brandon Road Lock and Dam).
- Uncertainty exists regarding the availability of state and federal funds to support potential monitoring and/or control efforts of ANS within the upper IWW and CAWS.
- It is projected for the 50-year period of analysis that USACE will continue to receive funding to operate at least two electric barriers, potentially all three, at Romeoville, Illinois under normal circumstances (excluding maintenance, etc.) with operating parameters no lower than the current parameters of Barriers IIA and IIB. It is unknown whether or not the Electric Dispersal Barriers have any effect on *A. lacustre*.
- It is expected that approximately 70% of the Chicago Waterway (waterway upstream of Lockport Lock and Controlling Works) total annual flow will continue to be generated by MWRD's water reclamation plants; however, based on upstream influences it is anticipated that water quality will improve.

[22]USEPA letter dated September 23, 2015, page 8.

**Nonstructural Alternative – Asian Carp**

Several nonstructural measures could potentially be applied to control the upstream dispersal of Asian carp through the Illinois Waterway (IWW) and the Chicago Area Waterway System (CAWS). **Table 1** summarizes the potential effectiveness of the various categories of nonstructural approaches. The Nonstructural Alternative consists of implementing all of the applicable nonstructural measures in **Table 1** because they represent actions that may reduce the probability of Asian carp becoming established in the CAWS and Lake Michigan. The following is an overview of the Nonstructural Alternative in which nonstructural measures including expanded controlled harvest are described.

**Nonstructural Measures**

**Table 1. Categories of nonstructural measures and their potential effectiveness controlling various life stages of Asian carp.**

| Target | Nonstructural Measure | Description |
|---|---|---|
| **Asian Carp** | Education and Outreach | For all life stages, educating the public to not spread aquatic invasive species from an infested waterway to another by properly disposing of unused bait, not transferring bait between basins, emptying bilge and live wells, and inspecting/cleaning outside of vessels before leaving a waterway to reduce likelihood of accidental introduction. |
| | Ballast and Bilge Management | For adult life stage, the importance of transfer via ballast or bilge water is unknown and may be very limited.<br>For larvae, they can be entrained in ballast water tanks and survive containment; however, very high mortality results when larvae are passed once through a ballast water pump[1].<br>Similar to larvae, it is likely that eggs could become entrained in ballast water tanks and have high mortality when passed through a ballast water pump; however, this has not been tested.<br>Since Asian carp may be transferred in ballast water tanks, upbound vessels would be required to remove ballast and bilge water prior to passing through the Dresden Island Lock and Dam. |
| | Monitoring | For all life stages, monitoring would provide early identification of spread but not likely affect transfer. Monitoring would include the involvement of agencies that are members of the ACRCC. Early identification of new populations, if linked with aggressive response action, may limit spread and transfer. Measures include |

[1] United States Coast Guard. 2012. Survivability of Asian carp in barge tanks in the Illinois River. USCG Acquisition Directorate, Research and Development Center, Department of Homeland Security.

| Target | Nonstructural Measure | Description |
|---|---|---|
| | | targeted and fixed site netting as well as random and fixed site electrofishing. |
| | Threat Assessment | For all life stages, presence studies, location studies (i.e., telemetry), and modeling may be used to identify the species current distribution, where the species could likely disperse to and become established, and potential impacts on ecological resources. |
| | Romeoville Electric Dispersal Barriers | For adult life stage, the electric barriers are important for reducing spread.<br>For larvae and eggs, electric barriers are ineffective at reducing spread at current operational settings. |
| | Adaptive Management | For all life stages, measures such as rapid response actions (i.e., targeted intensive fishing efforts using multiple gears (e.g., electrofishing, gill/trammel nets, minifyke nets, etc.)) could be used in localized areas. |
| | Piscicides | For adults and larvae, piscicides may be effective in localized areas, but maintaining needed concentrations in large or flowing water bodies limits effectiveness. Additionally, most piscicides are non-target controls which will impact non-target species. An additional requirement that limits application is Illinois Admin Rule 890, which states piscicides (e.g., rotenone, antimycin a) can only be received, possessed, and applied by a Division of Fisheries Biologist.<br>For eggs, piscicides may not be effective. Some piscicides may target eggs (e.g., antimycin a); however, Asian carp may be insensitive to these piscicides. |
| | Manual or Mechanical Removal | For adult life stage, controlled harvest and overfishing may be effective in maintaining low numbers of large fish in localized areas, potentially slowing the advance into new areas. Overfishing would occur in areas where Asian carp are abundant within the Illinois Waterway (**Figure 1**). Harvest techniques would utilize large mesh gill and trammel nets to reduce bycatch of native fish species; however, these nets are ineffective for harvesting juvenile and larval fish, and eggs. All manual or mechanical removal would require the involvement of the designated natural resource agency. |
| | Habitat Alteration | For all life stages, habitat alteration has limited applicability in localized areas within the IWW and CAWS. |
| | Laws and Regulations | For all life stages, it is unknown if new legislation would be effective. Uncertain how quickly new laws and regulations could be passed and implemented, or how |

| Target | Nonstructural Measure | Description |
| --- | --- | --- |
| | | quickly amendments could be made to the Lacey Act if deemed necessary. |

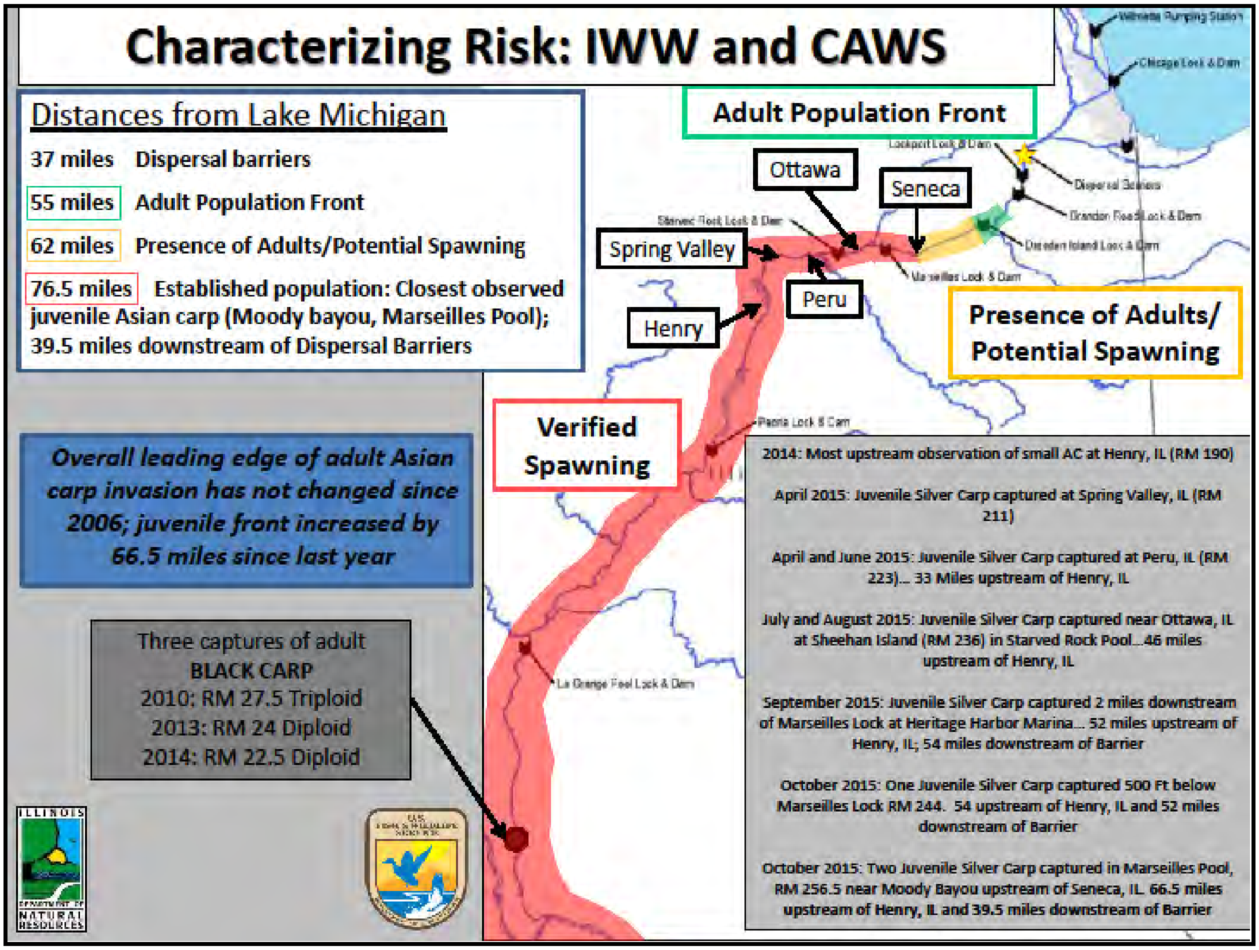


**Figure 1. MRWG risk map depicting distribution of Asian carp population front within the CAWS and IWW[2].**

**Expanded Controlled Harvest**

Currently, Asian carp are removed from the Illinois River through a variety of programs and projects with goals including monitoring, research and harvesting. Asian carp are removed from the river during monitoring and research focused efforts although the goals of these projects are not to reduce the population of Asian carp. The quantity of this incidental harvest in the upper Illinois River (upstream of Starved Rock Lock & Dam to the Brandon Road Lock & Dam) is low in comparison to population reduction based programs (less than 1% of total). Harvesting efforts which focus on population reduction of Asian carp in the upper river are led by the Illinois Department of Natural Resources (IDNR)

[2] ACRCC. 28 October 2015. Characterizing Risk: IWW and CAWS.

and include the contracting of commercial fishermen to remove Asian carp. Commercial harvest of fishes is prohibited by state law from the Route 89 Highway Bridge upstream to Starved Rock Lock and Dam and requires an IDNR biologist to accompany the contracted fisherman. Commercial harvest for profit is currently ongoing downstream of the Route 89 Highway Bridge within the Peoria, Alton and LaGrange pools of the Illinois River. These various programs have been reviewed and were used to develop a conceptual harvest program in proximity to the Brandon Road Lock and Dam to be a stand-alone alternative and to further bolster the efficacy of any recommended structural alternative from the GLMRIS-Brandon Road Study.

Tsehaye et al.[3] produced a model to assess removal strategies for Asian carp with the goal of forcing a collapse of their populations. The model suggests 70% exploitation of each species is needed to reduce populations to the point of collapse and that all size classes of Asian carp should be targeted.

Current efforts utilize large mesh gill and trammel nets to reduce bycatch of native sport and non-sport species but are also size and species selective for adult Asian carp populations. Specialized gear and methods would be required to target small fish. The level of fishing effort should change by season to maximize harvest. Harvesting populations of Asian carp in the fall and winter when movements are lowest may increase exploitation rates as would targeting aggregations during spawning. New strategies such as setting nets under the ice could maximize harvest of fish in the winter. Specific fishing locations and methods would be chosen with the best available information from commercial fishermen, IDNR biologists and from ongoing research and monitoring activities.

Information collected through monitoring and adaptive management would be used to refine models and establish target harvest rates in the Dresden, Marseilles, and Starved Rock Pools. Gear selection would be chosen to maximize capture of all lengths of Asian carp. Experimental gill nets with varying mesh sizes, paupier nets and other new or emerging harvest technologies could be added to the gear currently being used to improve the capture of smaller fish. Bi-weekly harvest events would continue in the upper IWW to remove fish from the system and to collect the data needed to inform future decisions on harvest.

**Conclusion**

The Nonstructural Alternative includes activities that would require action by other federal and state agencies. For the GLMRIS-Brandon Road Study, it is assumed that these measures would be fully implemented by other federal and state stakeholders in collaboration with the USACE. Because the Federal Government cannot direct the activities of state or local entities, further evaluation would be required to determine responsibility for implementing these measures. The GLMRIS-Brandon Road Study assumes that funding for Nonstructural Alternative activities would continue through the period of analysis regardless of the responsible agency.

New techniques and measures would be implemented using an adaptive management process associated with the Nonstructural Alternative.

[3] Tsehaye, I., M. Catalano, G. Sass, D. Glover, and B. Roth. 2013. Prospects for fishery-induced collapse of invasive Asian carp in the Illinois River. Fisheries 38(10):445-454. **DOI**: 10.1080/03632415.2013.836501.

**Nonstructural Alternative – *A. lacustre***

Several nonstructural measures could potentially be applied to control the upstream dispersal of *Apocorophium lacustre* through the Illinois Waterway (IWW) and the Chicago Area Waterway System (CAWS). **Table 1** summarizes the potential effectiveness of the various categories of nonstructural approaches. The Nonstructural Alternative consists of implementing all of the applicable nonstructural measures in **Table 1** because they represent actions that may reduce the probability of *A. lacustre* becoming established in the CAWS and Lake Michigan. The following is an overview of the Nonstructural Alternative in which nonstructural measures are described.

**Nonstructural Measures**

**Table 1. Categories of nonstructural measures and their potential effectiveness controlling *A. lacustre*.**

| Target | Nonstructural Measure | Description |
|---|---|---|
| ***A. lacustre*** | Education and Outreach | Educating the public to not spread aquatic invasive species from an infested waterway to another by properly disposing of unused bait, not transferring bait between basins, emptying bilge and live wells, and inspecting/cleaning outside of vessels before leaving a waterway to reduce likelihood of accidental introduction. |
| | Ballast and Bilge Management | May reduce passage via this vector, but effectiveness unknown. |
| | Monitoring | Monitoring would provide early identification of spread but not likely affect transfer. Monitoring would include the involvement of local, state and federal agencies. |
| | Threat Assessment | Presence studies and modeling may be used to identify the species current distribution, where the species could likely disperse to and become established, and impacts it may have on ecological resources. |
| | Romeoville Electric Dispersal Barriers | It is unknown whether or not the Electric Dispersal Barriers would have an effect on *A. lacustre*. |
| | Adaptive Management | Measures such as rapid response actions (i.e., targeted intensified monitoring efforts) could be used in localized areas. |
| | Pesticides | Pesticides may be effective in localized areas, but maintaining needed concentrations in large or flowing water bodies limits effectiveness. Disinfection of boat hulls and other recreational equipment may slow spread via this vector. Concerns regarding impacts to non-target species. |
| | Habitat Alteration | The application of chemical compounds to alter water quality may limit or prevent movement of the species. |
| | Laws and Regulations | Mandatory disinfection of watercraft and ballast and bilge water management may slow spread. Uncertain |

| | | |
|---|---|---|
| | | how quickly new laws and regulations could be passed and implemented, or how quickly amendments could be made to the Lacey Act if deemed necessary. |

## Technology Alternative – Electric Barrier

The following is an overview of Technology Alternative – Electric Barrier (**Figure 1**) which includes the following measures: (1) nonstructural activities, (2) electric dispersal barrier, (2) fish entrainment, (3) engineered channel, (4) flushing lock, and (5) physical barrier blocking the Illinois and Michigan (I&M) Canal.

**Table 1. Technology Alternative – Electric Barrier**

| Technology Alternative – Electric Barrier | | |
|---|---|---|
| **Location** | **Measure** | **Implementation** |
| Downstream Approach Channel | Fish Entrainment Mitigation | $T_{10}$ (2031) |
| | Engineered Channel | |
| | Electric Barrier | |
| Within Lock | Flushing Lock | |
| Mouth of Illinois & Michigan Canal | Physical Barrier | |
| Romeoville, IL | Electric Barriers | Ongoing |
| The Starved Rock Pool to Lake Michigan | Nonstructural | $T_0$ (2021) |


**Figure 1. Aerial view of Brandon Road Lock and Dam with Potential Layout of Technology Alternative – Electric Barrier.**

**Electric Dispersal Barrier**

An electric dispersal barrier would be located within the approach channel downstream of Brandon Road Lock and Dam (**Figure 2**). The electric dispersal barrier would likely be located at the southernmost end of the approach channel to minimize safety concerns for tow and barge personnel, as well as lock personnel, and influence of the electric dispersal barrier on the lock structure. Based on safety concerns, as a vessel approaches the electric barrier, the barrier may need to either be turned off, or the power turned down to minimize the field strength in the water.

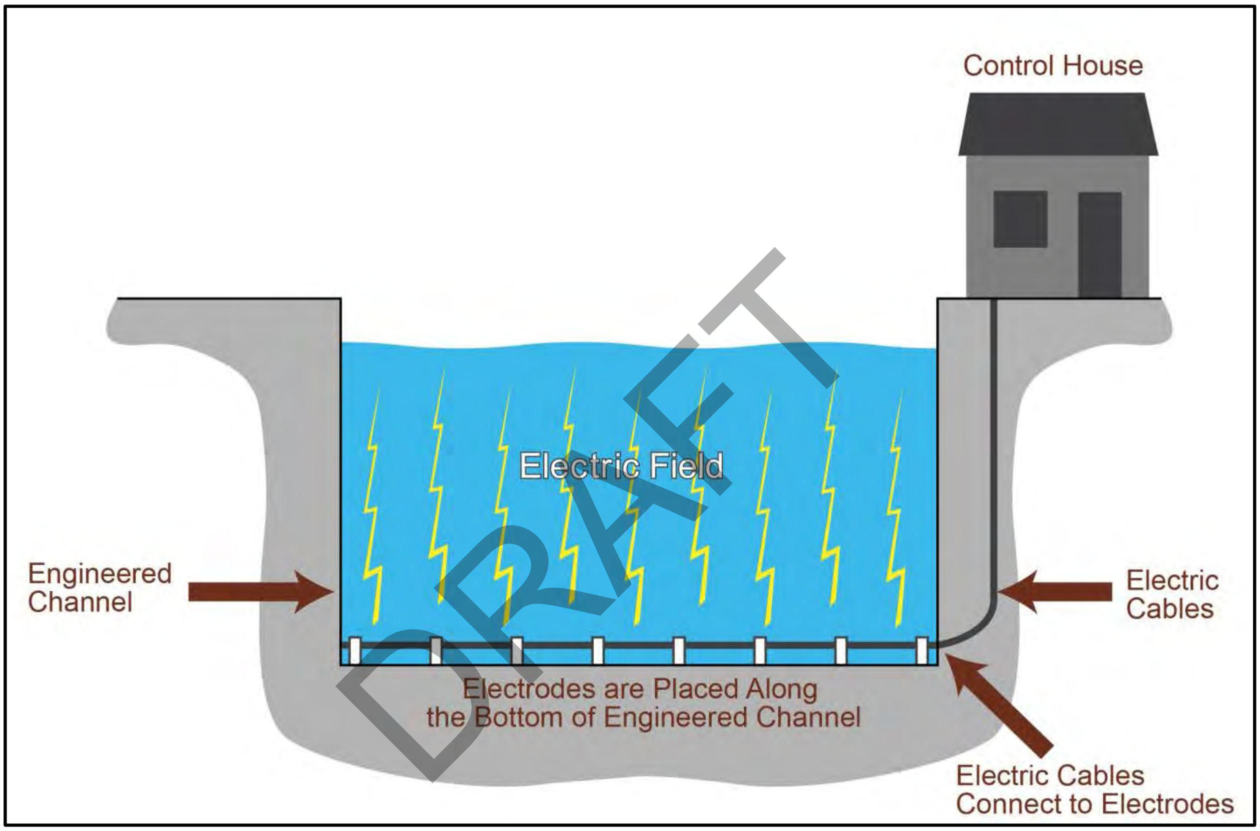


**Figure 2. Electric Barrier within an engineered channel.**

It is expected that the Electric Dispersal Barrier at Brandon Road Lock and Dam would have similar operating parameters as the current electric barriers at Romeoville. See the Chicago Sanitary and Ship Canal Electric Barrier fact sheet for more information regarding electric barrier effectiveness, small fish passage, vessel-assisted transport through the electric barrier system and other factors that may impact barrier effectiveness. With operating parameters similar to the current electric barrier, it is possible for small fish (< 101.6 mm (< 4 in)) to penetrate the field that would be produced by this alternative. Further research on the optimal operating parameters to stop all sizes of fish would be conducted, but it is unknown at this time if a set of parameters will successfully address very small fish and whether these operating conditions would result in stray current issues that would require lowering of the optimal parameters. Fish Entrainment section for a description of the mitigation feature proposed by this alternative to address vessel-induced entrainment.

This alternative includes an engineered channel (at least in the area surrounding the electric barrier – see the Engineered Channel section of this factsheet) in order to minimize the probability that small fish will utilize any reduced electric field strength near irregularities in the channel walls to pass through the electric fields, this alternative includes an engineered channel at least in the area surrounding the electric barrier. Please refer to the engineered channel section of this fact sheet for more information. Flow reversals in the BR L&D approach channel may transport a stunned fish through the barrier. If a fish is immobilized by the electric barrier and remains afloat, a relatively low reverse flow at the surface could move it across the barrier.

**Engineered Channel**

Prior to construction of the electric barrier and fish entrainment measures, an engineered channel would be constructed within the approach channel of Brandon Road Lock and Dam. The physical extent (length) of the engineered channel is unknown at this time. The GLMRIS-BR project delivery team (PDT) is assessing the cost of constructing the channel and the potential impacts to navigation during construction of this feature within the navigation channel. The cost and identified impacts may limit its extent; however, at a minimum, the engineered channel would be constructed to contain the electric barrier, its parasitic and extend some distance upstream and downstream of the electric barrier. Some of the benefits of constructing the engineered channel for this alternative include but are not limited to: limits available refugia (e.g., crevices, outcroppings, debris, etc.) for Asian carp within the channel, ease of applying monitoring techniques within the channel (e.g., electrofishing, DIDSON, hydroacoustics), simplifies clearing of fish within the channel (e.g., piscicide application, hydroguns, etc.), could minimize stray current created by the electric barrier, and provide a location where ANS controls that are in research and development could be tested.

The approach channel would have a trapezoidal cross-section with an approximate width of 232 feet. The normal water depth in the channel would be approximately 13 to 14 feet deep. If water from the main channel were to overtop the walls of the engineered channel, the ANS control point would be bypassed. Consequently, the walls of the engineered channel would be high enough to address overtopping during the 0.2% frequency event (500 year storm event). If an engineered channel is not constructed through the entire approach channel, then the banks on either side of the approach channel would be raised to meet the design requirement.



**Fish Entrainment**

Fish may become entrained in recesses of barges as well as currents created by up-bound and down-bound tows. (Up-bound tow means the tow is traveling upstream; down-bound tow means the tow is traveling downstream.) As an up-bound tow traverses the downstream extent of the electric barrier, it can entrain fish and carry them across the barrier and possibly farther upstream. If fish are at the downstream extent of the electric barrier, a down-bound tow’s return current could transport these fish into and across the electric barrier (the opposite direction of the tow) and toward the lock. Depending on the size and speed of the tow, the return current may transport fish through the electric barrier. The following are potential measures to address fish entrainment for up-bound and down-bound tows.

<u>Up-bound Tows</u>

Methods to remove or dislodge fish from up-bound tows must contend with vessel-induced motion that transports fish along with the vessel. Water jets would be installed within the downstream approach channel of Brandon Road Lock and Dam to address fish entrainment in up-bound tows.

Pending physical modeling results, field studies may be warranted to inform the flow rate needed to maximize effectiveness of water jets at dislodging entrained organisms. The goal of the design would be water jets would be of sufficient strength to dislodge fish from the recesses and eddies formed by the moving tow. As the tow passes, jets would deliver water to the hull to remove fish and force them downward or laterally away from the near-field region.

A physical model study is being conducted to inform the design of possible mitigation measures for fish entrainment at the Romeoville Electric Barriers. The study will examine multiple jet configurations to determine optimal placement within the approach channel to reduce fish entrainment between barges due to vessel induced currents. The experiments will include altering the jet discharge velocity, the placement of the jets in the channel in relation to vessels, nozzle orientation, number of jets and other factors and evaluate these design considerations in terms of efficiency and effectiveness.

One potential configuration is to place water jets in the path of the tow. Jets would be arranged in a low angle lateral array on the bottom and across the channel (**Figure 3 and 4**). The goal would be for the jets to displace fish from the tow's path, thereby reducing the likelihood of entrainment. As the tow passes, the goal would also be to dislodge fish that are already entrained by pushing them away from the vessel's influence. While this approach removes fish from the tow's path, it may induce a surface eddy, which would cause flow in the direction of the tow at the channel boundaries. Dislodged fish may become trapped in the eddy, carried towards the side of the channel, and then transported in the direction of the tow. A secondary array could be installed near the channel sides to counter the eddy and reduce the likelihood of fish being forced in the direction of the tow (**Figure 4**).

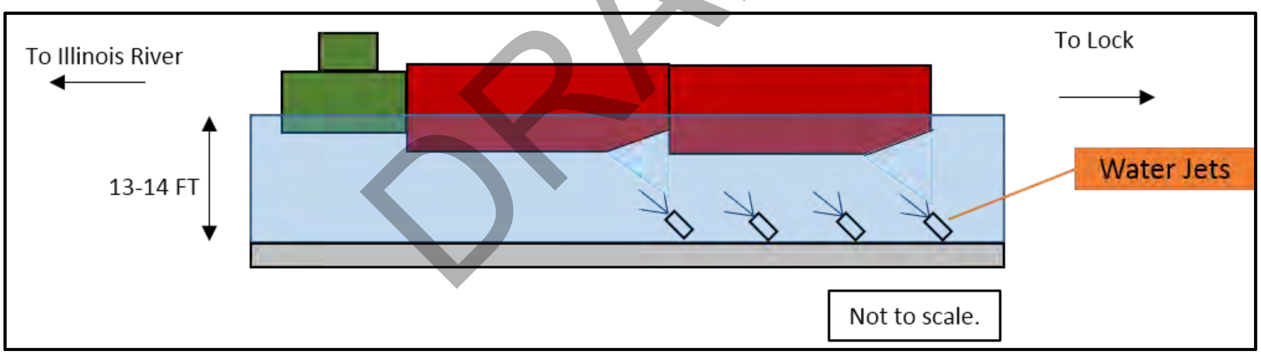


**Figure 3. One potential water jet flushing array includes staging the jets along the canal bottom and sides. Note, the number of jets is arbitrary, and the drawing is not to scale.**

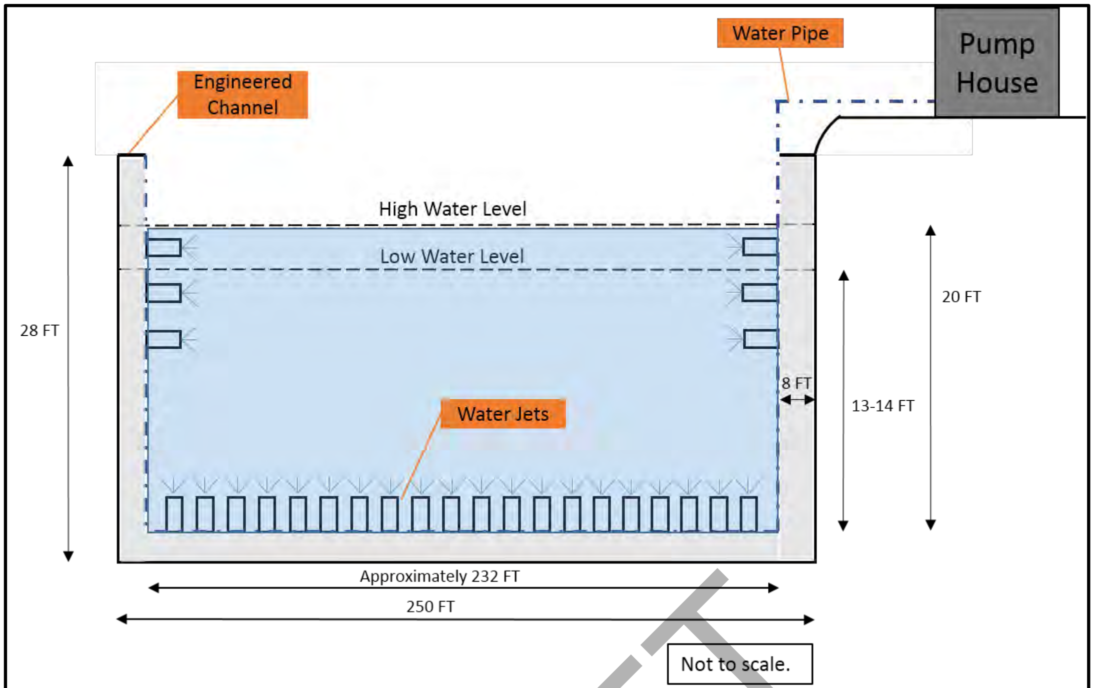


**Figure 4. The water jets would be positioned so the jets would be directed away from the lock. Note, the number of jets is arbitrary, and the drawing is not to scale.**



Another water jet configuration under consideration in the model study is the placement of an array of vertical jets placed on the channel bottom. The goal of this configuration would be to remove fish from the tow as it passes overhead. A vertical jet array also produces an eddy but it is in the vertical plane and acts to force water towards the sides of the channel as opposed to along the channel. Even with this potential configuration, the jet will produce some velocities along the channel axis as it disperses. Additional jets could be configured to counter this effect.

Though the current model study will inform the final design of the water jet system, the team has developed a conceptual layout of this measure that will be refined throughout the study as additional analyses are completed. A water jet array would be placed at the downstream extent of the electric barrier system, and a second water jet would be placed within the electric barrier. The first water jet system would remove entrained fish and the second water jet system provides redundancy and also can push stunned fish downstream and away from the lock. The current scaled model study will inform the best layout, exiting water velocity, and number of jets required to maximize this measure's effectiveness; however, it is unknown how effective the water jet system will be on removing entrained fish. If the water jet system is found to be ineffective at addressing fish entrainment, then additional physical model studies would evaluate the effectiveness of other mitigation measures and changes to vessel approaching BR L&D.

Down-bound Tows

Methods to remove or dislodge fish from down-bound tows must contend with vessel-induced motions that transport fish in the opposite direction of the vessel. Vessel operations may be a potential measure to address return current from down-bound tows. Vessel maneuvers involve reducing speed and possibly reversing the tow prior to passing a control point. Temporarily arresting the tow's forward motion will stop the return current allowing the ambient flow to transport fish downstream. The fish entrainment study currently underway will include experiments where a range of speeds (including reversing the tow) will be explored to determine the rate and degree at which the return current and associated fish transport responds. If these management measures are found to reduce fish entrainment, the goal would be to have vessel traffic implement these actions in the approach channel for this alternative.

**Flushing Lock**

The flushing of the Brandon Road Lock and Dam is a measure for Technology Alternative – Electric Barrier **(Figure 5)**. The purpose of the flushing lock is to flush floating organisms from within the lock when the lock is at the lower pool elevation and could act as an added defense to address small fish that become entrained within a barge and are transported through the fish entrainment measures as well as small fish that pass through the electric barrier. The water used to flush the lock is diverted from the upper pool water (BR L&D pool) through the lock filling and emptying culverts and through open downstream miter gates. Pending availability of water, the flushing lock may not necessarily operate for every lockage or the flushing duration may be shortened during low flow months. July through December is typically low flow months for the BR L&D pool except during rain and flood events. Flushing operations would be linked with physical monitoring of the upstream pool to optimize the use of this feature.

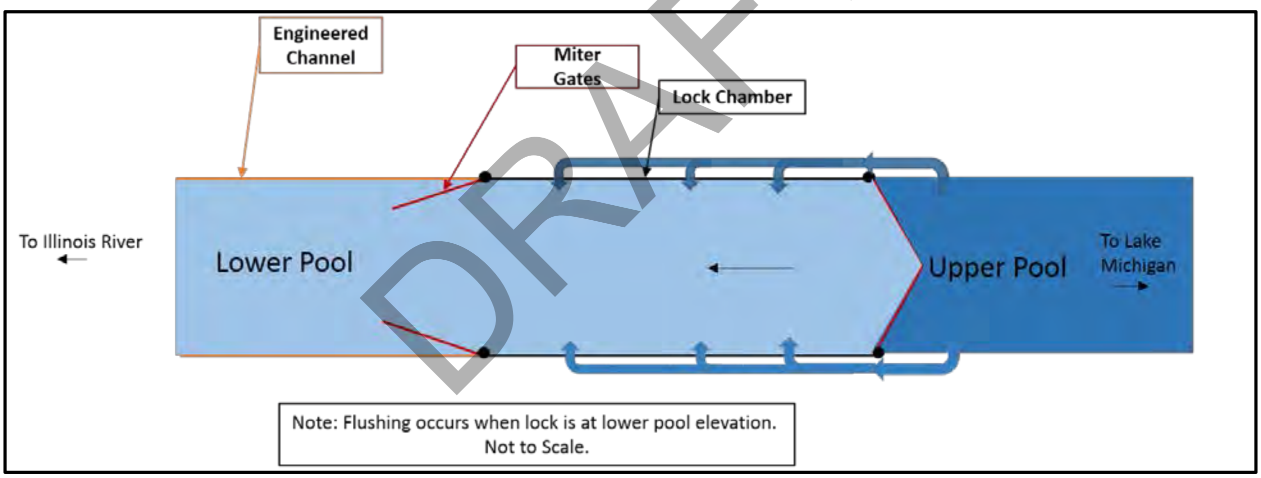


**Figure 5. Schematic of flushing lock at Brandon Road Lock and Dam.**

**Physical Barrier on Illinois & Michigan Canal**

Future investigation is needed to confirm whether the abandoned lock on the Illinois and Michigan Canal (no longer in use) at the Brandon Road Lock and Dam is permanently sealed off and could contain the 0.2% annual chance of exceedance (AED) event without overtopping. All features are being designed to contain the 0.2% AED event. If the abandoned lock, does not meet this design requirement, tieback measures will be developed.

**Romeoville Electric Dispersal Barriers**

The Electric Dispersal Barriers includes three (3) barriers (i.e., Demonstration Barrier, Barrier IIA, Barrier IIB) in operation in the Chicago Sanitary and Ship Canal at Romeoville, IL. The Demonstration Barrier is being upgraded to a more powerful barrier (Permanent Barrier I) and construction is currently underway with installation of underwater components having been completed in October 2014. Permanent Barrier I is scheduled for activation in 2017 after completing construction and operational and safety testing. Barrier I is designed to operate at higher voltages than Barriers IIA and IIB; and therefore, may have an increased ability to deter small fish. Barriers IIA and IIB currently operate at a maximum in-water field strength at the water surface of 2.3 Volts/inch with a pulse frequency of 34 pulses/second and a pulse duration of 2.3 milliseconds. These parameters were found in the laboratory to be effective at immobilizing Bighead and Silver Carp as small as approximately 76.2-127 mm (3-5 in) in total length[1,2,3,4]. It is projected that through the duration of the period of analysis (i.e., 2071) at least two barriers, potentially all three, will be in operation under normal circumstances (excluding maintenance, etc.) with operating parameters no lower than the current parameters of Barriers IIA and IIB. For more information related to the Electric Barrier's effectiveness, please refer to the Chicago Sanitary and Ship Canal Dispersal Barriers Factsheet and the "Electric Barrier" Section of the Future Without Project Condition Factsheets for Asian carp and *Apocorophium lacustre*.

To inform mitigation measures to address fish entrainment between and around barges and tugs, USACE has initiated a scaled physical model study at the USACE Engineering and Research Development Center. The study will test water jet designs and configurations to dislodge trapped fish. These experiments will be conducted under different vessel speeds and drafts to examine a range of flow and entrainment conditions typical of full scale vessels navigating the Chicago Sanitary and Ship Canal. These experiments will determine minimum discharge, nozzle diameter and pump requirements to remove fish as well as optimal configurations for water jet placement within the channel cross-section. The model study will also evaluate tow speeds in the canal to determine optimal speed requirement to minimize return current (current opposite to vessel movement) of tows.

Informed by the physical model study, USACE's goal is to complete a field study later in FY 2016 of the mitigation measures that are most promising. If the field-tested mitigation measures are found to be effective, then USACE would consider implementing these measures at the Electric Dispersal Barriers.



**Nonstructural Activities**

Nonstructural measures would be implemented as part of the Technology Alternative 1. The nonstructural component of this alternative requires vessels moving upbound through the Dresden Island Lock to release their ballast and bilge water prior to entering the BR L&D pool and thereby minimize the probability that fish in any of its life stages and *A. lacustre* pass through the barrier in the bilge and ballast. Please refer to the Nonstructural Alternative Factsheets for Asian carp and *A. lacustre* for details on the measures that would be implemented.

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[1] Holliman, FM. 2011. Operational protocols for electric barriers on the Chicago Sanitary and Ship Canal: influence of electrical characteristics, water conductivity, behavior, and water velocity on risk breach by nuisance invasive fishes. Final report submitted to U.S. Army Corps of Engineers, Chicago District. 132 pp.

[2] Holliman, FM. 2014. Reliability demonstration testing of electric field parameters for electric field-based aquatic nuisance species dispersal barriers on the Chicago sanitary and ship canal. Fish Research and Development, LLC. 48 pp.

[3] Holliman, FM. 2014. Effects of electrode polarity on risk for breach of electric barriers on the Chicago sanitary and ship canal by small sizes of bighead carp. Fish Research and Development, LLC. 41 pp.

[4] Holliman, FM, Killgore KJ, and Shea C. (2015). "Development of Operational Protocols for Electric Barrier Systems on the Chicago Sanitary and Ship Canal: Induction of Passage-Preventing Behaviors in Small Sizes of Silver Carp," ANSRP-15-1, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

# Technology Alternative – Complex Noise

The following is an overview of Technology Alternative – Complex Noise (**Figure 1**) which includes the following measures: (1) nonstructural activities, (2) complex noise, (3) fish entrainment, (4) engineered channel (5) flushing lock, and (6) physical barrier blocking the Illinois and Michigan Canal.

**Alternative Measures**

**Table 1. Technology Alternative – Complex Noise**

| Technology Alternative – Complex Noise | | |
|---|---|---|
| **Location** | **Measure** | **Implementation** |
| Downstream Approach Channel | Complex Noise | $T_{10}$ (2031) |
| | Fish Entrainment Mitigation | |
| | Engineered Channel | |
| Within Lock | Flushing Lock | |
| Illinois and Michigan Canal | Physical Barrier | |
| Romeoville, IL | Electric Barriers | Ongoing |
| The Starved Rock Pool to Lake Michigan | Nonstructural | $T_0$ (2021) |

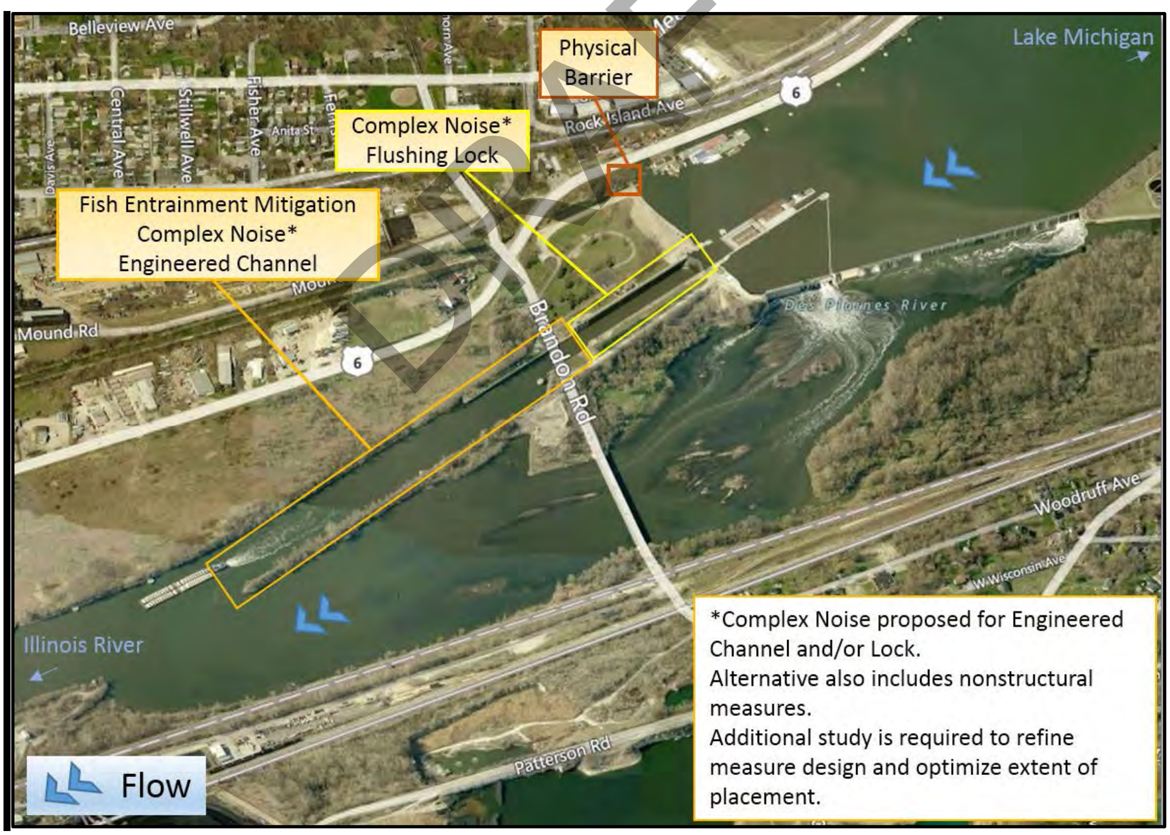


**Figure 1. Aerial view of Brandon Road Lock and Dam with Potential Layout of Technology Alternative – Complex Noise.**

**Complex Noise**

Speakers for the complex noise barrier would be installed within the downstream approach channel and/or the lock (**Figure 1**). It is expected that the complex noise barrier would not be operated continuously, so as to reduce the potential for acclimation to the sound by Asian carp. Instead, the complex noise would likely operate when a vessel is moving toward the approach channel to enter or exit the lock chamber. Except when a vessel is entering or exiting the lock, the downstream lock doors would remain shut to prevent ANS from passing upstream through the lock.

Additional development of the alternative will occur as the study progresses. Steps include but are not limited to the following: (1) map existing ambient sound conditions within the approach channel and lock under various scenarios (e.g., opening/closing of miter gates, vessels traversing, and vehicle bridge operations), (2) establish audiogram for Asian carp, (3) identify the target frequencies needed to elicit behavioral avoidance response in Asian carp, (4) model the channel to inform the design of the speaker array, (5) assess the time required to clear fish from the channel downstream of the lock gate and (6) assess the compatibility of complex noise with the other control features in this alternative.

**Engineered Channel**

Prior to construction of the complex noise and fish entrainment measures, an engineered channel would be constructed within the approach channel of Brandon Road Lock and Dam. The physical extent (length) of the engineered channel is unknown at this time. The GLMRIS-BR project delivery team (PDT) is assessing the cost of constructing the channel and the potential impacts to navigation during construction of this feature within the navigation channel. The cost and identified impacts may limit the extent of the engineered channel. Some of the benefits of constructing the engineered channel for this alternative include but are not limited to: limits available refugia (e.g., crevices, outcroppings, debris, etc.) for Asian carp within the channel, ease of applying monitoring techniques within the channel (e.g., electrofishing, DIDSON, hydroacoustics), reduces shielding of sound waves, simplifies clearing of fish within the channel (e.g., piscicide application, hydroguns, etc.), and provides a location where ANS controls that are in research and development could be tested.



The approach channel would have a trapezoidal cross-section with an approximate width of 232 feet. The normal water depth in the channel would be approximately 13 to 14 feet deep. If water from the main channel were to overtop the walls of the engineered channel, the ANS control point would be bypassed. Consequently, the walls of the engineered channel would be high enough to address overtopping during the 0.2% frequency event (500 year storm event). If an engineered channel is not constructed through the entire approach channel, then the banks on either side of the approach channel would be raised to meet the design requirement.

**Fish Entrainment**

Fish may become entrained in recesses of barges as well as currents created by up-bound and down-bound tows. (Up-bound tow means the tow is traveling upstream; down-bound tow means the tow is traveling downstream.) As an up-bound tow traverses the downstream extent of the complex noise area, it can entrain fish and carry them into the area where complex noise is played and possibly farther upstream. If fish are at the downstream extent of the complex noise area, a down-bound tow's return current, as the tow crosses through the complex noise area, could transport these fish into the complex noise area (the opposite direction of the tow) and toward the lock. Depending on the size and speed of the tow and the length of the complex noise area, the return current may transport fish through the complex noise area. The following are potential measures to address fish entrainment for up-bound and down-bound tows.

Up-bound Tows

Methods to remove or dislodge fish from up-bound tows must contend with vessel-induced motion that transports fish along with the vessel. Water jets would be installed within the downstream approach channel of Brandon Road Lock and Dam to address fish entrainment in up-bound tows. Pending physical modeling results, field studies may be warranted to inform the flow rate needed to maximize effectiveness of water jets at dislodging entrained organisms. The goal of the design would be water jets would be of sufficient strength to dislodge fish from the recesses and eddies formed by the moving tow. As the tow passes, jets would deliver water to the hull to remove fish and force them downward or laterally away from the near-field region.

A physical model study is being conducted to inform the design of possible mitigation measures for fish entrainment at the Romeoville Electric Barriers. The study will examine multiple jet configurations to determine optimal placement within the approach channel to reduce fish entrainment between barges due to vessel induced currents. The experiments will include altering the jet discharge velocity, the placement of the jets in the channel in relation to vessels, nozzle orientation, number of jets and other factors and evaluate these design considerations in terms of efficiency and effectiveness.

One potential configuration is to place water jets in the path of the tow. Jets would be arranged in a low angle lateral array along and across the bottom of the channel (**Figure 2 and 3**). The goal would be for the jets to displace fish from the tow's path, thereby reducing the likelihood of entrainment. As the tow passes, the goal would also be to dislodge fish that are already entrained by pushing them away from the vessel's influence. While this approach removes fish from the tow's path, it may induce a surface eddy, which would cause flow in the direction of the tow at the channel boundaries. Dislodged fish may become trapped in the eddy, carried towards the side of the channel, and then transported in the direction of the tow. A secondary array could be installed near the channel sides to counter the eddy and reduce the likelihood of fish being forced in the direction of the tow (**Figure 3**).

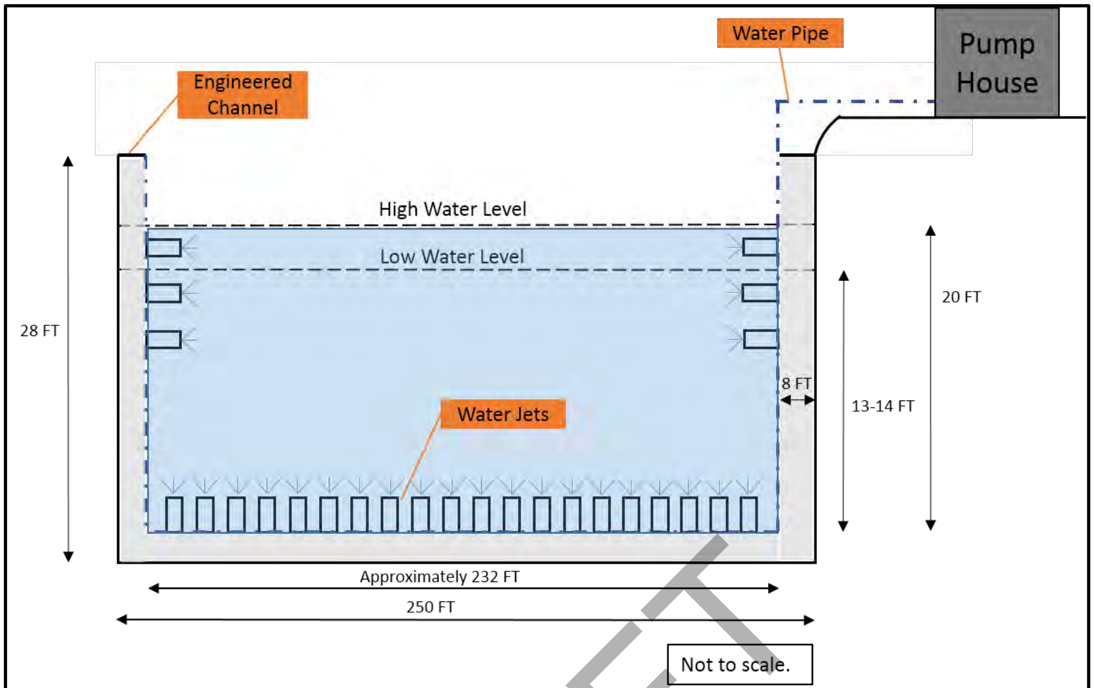


**Figure 2. One potential water jet flushing array includes staging the jectsalong the canal bottom and sides. Note, the number of jets is arbitrary, and the drawing is not to scale.**

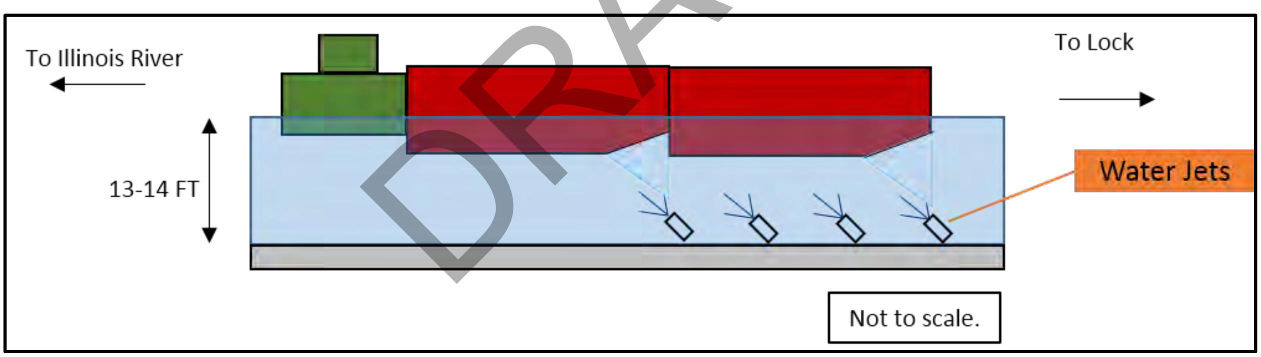


**Figure 3. The water jets would be positioned so the jets would be directed away from the lock. Note, the number of jets is arbitrary, and the drawing is not to scale.**

Another water jet configuration under consideration in the model study is the placement of an array of vertical jets placed on the channel bottom. The goal of this configuration would be to remove fish from the tow as it passes overhead. A vertical jet array also produces an eddy but it is in the vertical plane and acts to force water towards the sides of the channel as opposed to along the channel. Even with this potential configuration, the jet will produce some velocities along the channel axis as it disperses. Additional jets could be configured to counter this effect.

Though the current model study will inform the final design of the water jet system, the team has developed a conceptual layout of this measure that will be refined throughout the study as additional analyses are completed. A water jet array would be placed at the downstream extent of the complex noise area, and a second water jet would be placed upstream of the first. The first water jets would remove entrained fish and the second water jet system provides redundancy. The current scaled model study will inform the best layout, exiting water velocity, and number of jets required to maximize this measure's effectiveness; however, it is unknown how effective the water jet system will be on removing entrained fish. If the water jet system is found to be ineffective at addressing fish entrainment, then additional physical model studies would evaluate the effectiveness of other mitigation measures and changes to vessel approaching BR L&D.

Down-bound Tows

Methods to remove or dislodge fish from down-bound tows must contend with vessel-induced motions that transport fish in the opposite direction of the vessel. Vessel operations may be a potential measure to address return current from down-bound tows. Vessel maneuvers involve reducing speed and possibly reversing the tow prior to passing a control point. Temporarily arresting the tow's forward motion will stop the return current allowing the ambient flow to transport fish downstream. The fish entrainment study currently underway will include experiments where a range of speeds (including reversing the tow) will be explored to determine the rate and degree at which the return current and associated fish transport responds. If these management measures are found to reduce fish entrainment, the goal would be to have vessel traffic implement these actions in the approach channel for this alternative.

**Flushing Lock**

The flushing of the Brandon Road Lock and Dam is a measure for Technology Alternative – Complex Noise **(Figure 4**). The purpose of the flushing lock is to flush floating organisms from within the lock when the lock is at the lower pool elevation and could act as an added defense to address small fish that become entrained within a barge and are transported through the fish entrainment measures as well as small fish that pass through complex noise area. The water used to flush the lock is diverted from the upper pool water (BR L&D pool) through the lock filling and emptying culverts and through open downstream miter gates. Pending availability of water, the flushing lock may not necessarily operate for every lockage or the flushing duration may be shortened during low flow months. July through December are typically low flow months for the BR L&D pool except during rain and flood events. Flushing operations would be linked with physical monitoring of the upstream pool to optimize the use of this feature.

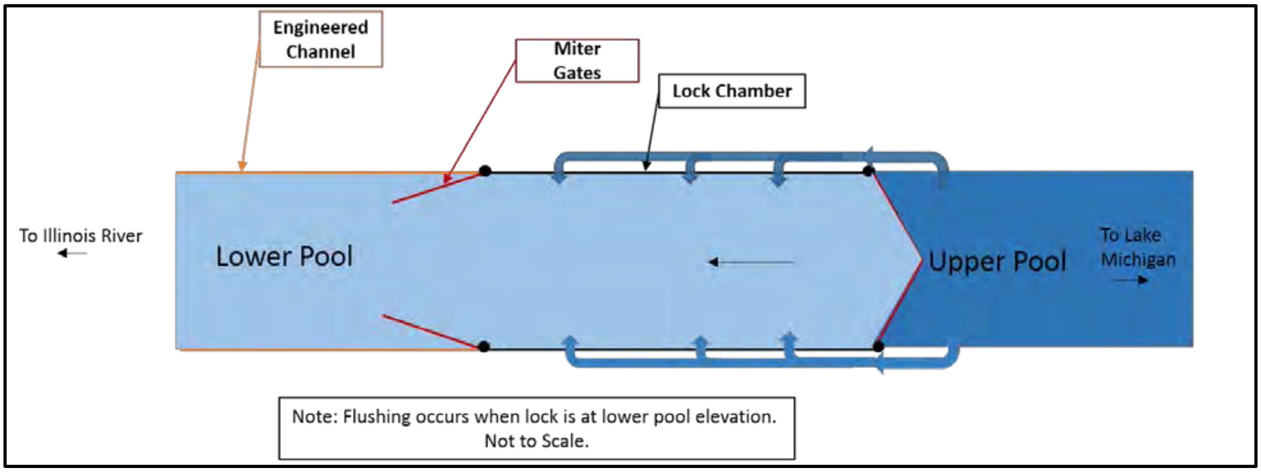


**Figure 4. Schematic of flushing lock at Brandon Road Lock and Dam.**

**Physical Barrier on Illinois and Michigan Canal**

Future investigation is needed to confirm whether the abandoned lock on the Illinois and Michigan Canal (no longer in use) at the Brandon Road Lock and Dam is permanently sealed off and could contain the 0.2% annual chance of exceedance (AED) event without overtopping. All features are being designed to contain the 0.2% AED event. If the abandoned lock, does not meet this design requirement, tieback measures will be developed.

**Romeoville Electric Dispersal Barriers**

The Electric Dispersal Barriers includes three (3) barriers (i.e., Demonstration Barrier, Barrier IIA, Barrier IIB) in operation in the Chicago Sanitary and Ship Canal at Romeoville, IL. The Demonstration Barrier is being upgraded to a more powerful barrier (Permanent Barrier I) and construction is currently underway with installation of underwater components having been completed in October 2014. Permanent Barrier I is scheduled for activation in 2017 after completing construction and operational and safety testing. Barrier I is designed to operate at higher voltages than Barriers IIA and IIB; and therefore, may have an increased ability to deter small fish. Barriers IIA and IIB currently operate at a maximum in-water field strength at the water surface of 2.3 Volts/inch with a pulse frequency of 34 pulses/second and a pulse duration of 2.3 milliseconds. These parameters were found in the laboratory to be effective at immobilizing Bighead and Silver Carp as small as approximately 76.2-127 mm (3-5 in) in total length[1,2,3,4]. It is projected that through the duration of the period of analysis (i.e., 2071) at least

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[2] Holliman, FM. 2014. Reliability demonstration testing of electric field parameters for electric field-based aquatic nuisance species dispersal barriers on the Chicago sanitary and ship canal. Fish Research and Development, LLC. 48 pp.
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[4] Holliman, FM, Killgore KJ, and Shea C. (2015). "Development of Operational Protocols for Electric Barrier Systems on the Chicago Sanitary and Ship Canal: Induction of Passage-Preventing Behaviors in Small Sizes of Silver Carp," ANSRP-15-1, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

two barriers, potentially all three, will be in operation under normal circumstances (excluding maintenance, etc.) with operating parameters no lower than the current parameters of Barriers IIA and IIB. For more information related to the Electric Barrier's effectiveness, please refer to the Chicago Sanitary and Ship Canal Dispersal Barriers Factsheet and the "Electric Barrier" Section of the Future Without Project Condition Factsheets for Asian carp and *Apocorophium lacustre*.

To inform mitigation measures to address fish entrainment between and around barges and tugs, USACE has initiated a scaled physical model study at the USACE Engineering and Research Development Center. The study will test water jet designs and configurations to dislodge trapped fish. These experiments will be conducted under different vessel speeds and drafts to examine a range of flow and entrainment conditions typical of full scale vessels navigating the Chicago Sanitary and Ship Canal. These experiments will determine minimum discharge, nozzle diameter and pump requirements to remove fish as well as optimal configurations for water jet placement within the channel cross-section. The model study will also evaluate tow speeds in the canal to determine optimal speed requirement to minimize return current (current opposite to vessel movement) of tows.

Informed by the physical model study, USACE's goal is to complete a field study later in FY 2016 of the mitigation measures that are most promising. If the field-tested mitigation measures are found to be effective, then USACE would consider implementing these measures at the Electric Dispersal Barriers.

**Nonstructural Activities**

Nonstructural measures would be implemented as part of the Technology Alternative – Complex Noise. The nonstructural component of this alternative requires vessels moving upbound through the Dresden Island Lock to release their ballast and bilge water prior to entering the BR L&D pool and thereby minimize the probability that fish in any of its life stages and *A. lacustre* pass through the barrier in the bilge and ballast. Please refer to the Nonstructural Alternative Factsheets for Asian carp and *A. lacustre* for details on the measures that would be implemented.

## Technology Alternative – Complex Noise & Electric Barrier

**Table 1. Technology Alternative – Complex Noise & Electric Barrier**

| Technology Alternative – Complex Noise & Electric Barrier | | |
|---|---|---|
| **Location** | **Measure** | **Implementation** |
| Downstream Approach Channel | Engineered Channel | $T_{10}$ (2031) |
| | Electric Barrier | |
| | Complex Noise | |
| | Fish Entrainment Mitigation | |
| Within Lock | Flushing Lock | |
| | Complex Noise | |
| Mouth of Illinois & Michigan Canal | Physical Barrier | |
| Romeoville, IL | Electric Barriers | Ongoing |
| The Starved Rock Pool to Lake Michigan | Nonstructural | $T_0$ (2021) |


**Figure 1. Aerial view of Brandon Road Lock and Dam with Potential Layout of Technology Alternative - Electric Barrier and Complex Noise.**

**Electric Dispersal Barrier**

An electric dispersal barrier would be located within the approach channel downstream of Brandon Road Lock and Dam (BR L&D) (**Figure 2**). The electric dispersal barrier would likely be located at the southernmost end of the approach channel to minimize safety concerns for tow and barge personnel, as well as lock personnel, and influence of the electric dispersal barrier on the lock structure. In this alternative, the electric barrier would remain on except when vessels are approaching the BR L&D. As a vessel approaches the electric barrier, the barrier would either be turned off, or the power turned down to minimize the field strength in the water. At the same time, the complex noise system would be turned on to control fish from entering the engineered channel while the electric field was minimized. See the complex noise section of this fact sheet for more information.

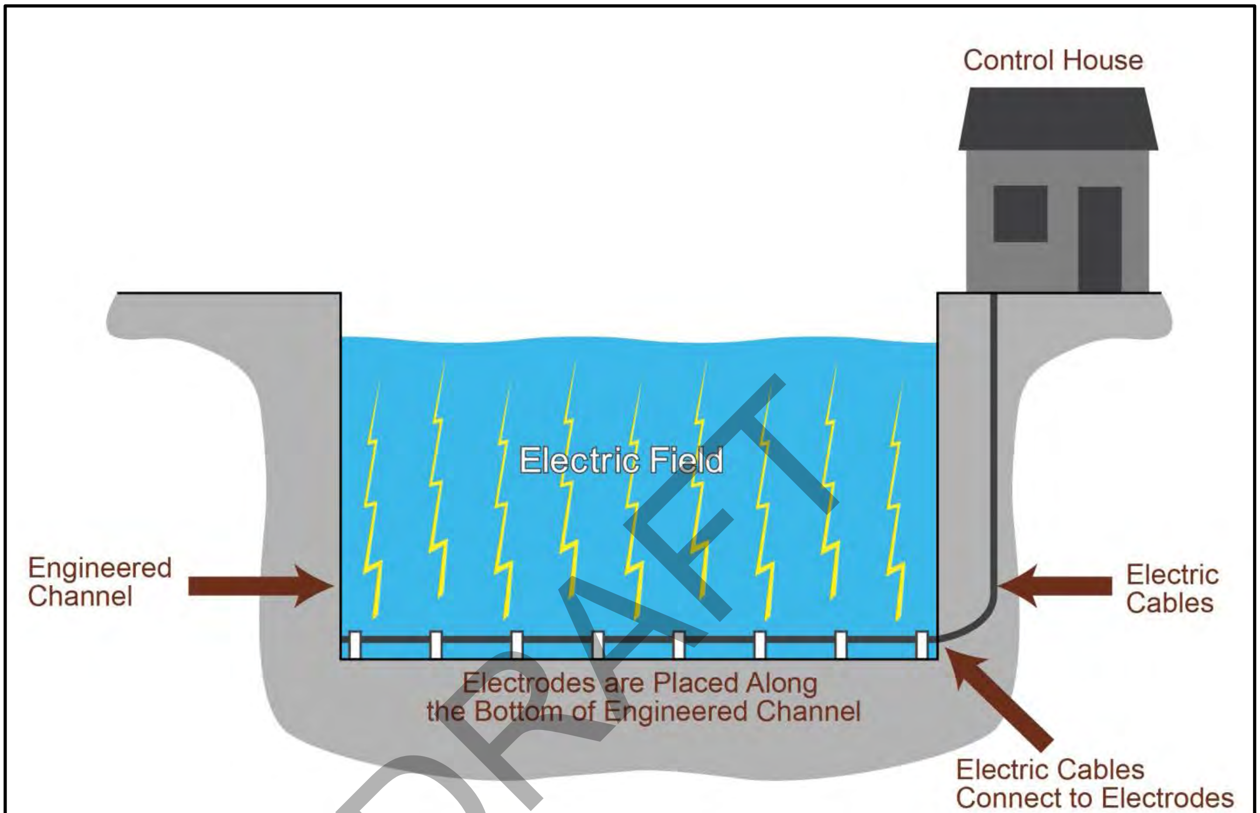




**Figure 2. Electric Barrier within an engineered channel.**

It is expected that the Electric Dispersal Barrier at Brandon Road Lock and Dam would have similar operating parameters as the current electric barriers at Romeoville. See the Chicago Sanitary and Ship Canal Electric Barrier fact sheet for more information regarding electric barrier effectiveness, small fish passage, vessel assisted transport through electric barrier system and other factors that may impact barrier effectiveness. With operating parameters similar to the current electric barrier, it is possible for small fish (< 101.6 mm (< 4 in)) to penetrate the field that would be produced by this alternative. Further research on the optimal operating parameters to stop all sizes of fish would be conducted, but it is unknown at this time if a set of parameters will successfully address very small fish and whether these operating conditions would result in stray current issues that would require lowering of the optimal parameters. See the Fish Entrainment section for a description of the mitigation feature proposed by this alternative to address vessel-induced entrainment.

This alternative includes an engineered channel (at least in the area surrounding the electric barrier - see the Engineered Channel section of this fact sheet) in order to minimize the probability that small fish will utilize any reduced electric field strength near irregularities in the channel walls to pass through the electric fields. Please refer to the engineered channel section of this fact sheet for more information. Flow reversals in the BR L&D approach channel may transport a stunned fish through the barrier. If a fish is immobilized by the electric barrier and remains afloat, a relatively low reverse flow at the surface could move it across the barrier.

**Complex Noise**

Speakers for the complex noise barrier would be installed within the downstream approach channel and/or the lock (**Figure 1**). As a vessel approaches the electric barrier, the barrier would either be turned off, or the power turned down to minimize the field strength in the water. At the same time, the complex noise system would be turned on. Except when a vessel was entering or exiting the lock, the downstream lock doors would remain shut to prevent ANS from passing upstream through the lock.

Additional development of the alternative will occur as the study progresses. Steps include but are not limited to the following: (1) map existing ambient sound conditions within the approach channel and lock under various scenarios (e.g., opening/closing of miter gates, vessels traversing, and vehicle bridge operations), (2) establish audiogram for Asian carp, (3) identify the target frequencies needed to elicit a behavioral avoidance response in Asian carp, (4) model the channel to inform the design of the speaker array, and (5) assess how to best coordinate electric barrier and complex noise operation with vessel movement through the channel.

**Engineered Channel**

Prior to construction of the complex noise and fish entrainment measures, an engineered channel would be constructed within the approach channel of Brandon Road Lock and Dam. The physical extent (length) of the engineered channel is unknown at this time. The GLMRIS-BR project delivery team (PDT) is assessing the cost of constructing the channel and the potential impacts to navigation during construction of this feature within the navigation channel; however, at a minimum, the engineered channel would be constructed to contain the electric barrier, its parasitic and extend some distance upstream and downstream of the electric barrier. The cost and identified impacts may limit the extent of the engineered channel. Some of the benefits of constructing the engineered channel for this alternative include but are not limited to: limits available refugia (e.g., crevices, outcroppings, debris, etc.) for Asian carp within the channel, ease of applying monitoring techniques within the channel (e.g., electrofishing, DIDSON, hydroacoustics), reduces shielding of sound waves, simplifies clearing of fish within the channel (e.g., piscicide application, hydroguns, etc.), and provides a location where ANS controls that are in research and development could be tested.

The approach channel would have a typical trapezoidal cross-section with an approximate width of 232 feet. The normal water depth in the channel would be approximately 13 to 14 feet deep. If water from the main channel were to overtop the walls of the engineered channel, the ANS control point would be bypassed. Consequently, the walls of the engineered channel would be high enough to address overtopping during the 0.2% frequency event (500 year storm event). If an engineered channel is not constructed through the entire approach channel, then the banks on either side of the approach channel would be raised to meet the design requirement.

**Fish Entrainment**

Fish may become entrained in recesses of barges as well as currents created by up-bound and down-bound tows. (Up-bound tow means the tow is traveling upstream; down-bound tow means the tow is traveling downstream.) As an up-bound tow traverses the downstream extent of the complex noise area or electric barrier system, it can entrain fish and carry them into the area where complex noise is played or past the electric barrier and possibly farther upstream. If fish are at the downstream extent of the complex noise area or electric barrier, a down-bound tow's return current could transport these fish into the complex noise area (the opposite direction of the tow) or over the electric barrier and toward the lock. Depending on the size and speed of the tow and the length of the controlled area, the return current may transport fish through the controlled area. The following are potential measures to address fish entrainment for up-bound and down-bound tows.

Up-bound Tows

Methods to remove or dislodge fish from up-bound tows must contend with vessel-induced motion that transports fish along with the vessel. Water jets would be installed within the downstream approach channel of Brandon Road Lock and Dam to address fish entrainment in up-bound tows. Pending physical modeling results, field studies may be warranted to inform the flow rate needed to maximize effectiveness of water jets at dislodging entrained organisms. The goal of the design would be water jets would be of sufficient strength to dislodge fish from the recesses and eddies formed by the moving tow. As the tow passes, jets would deliver water to the hull to remove fish and force them downward or laterally away from the near-field region.

A physical model study is being conducted to inform the design of possible mitigation measures for fish entrainment at the Romeoville Electric Barriers. The study will examine multiple jet configurations to determine optimal placement within the approach channel to reduce fish entrainment between barges due to vessel induced currents. The experiments will include altering the jet discharge velocity, the placement of the jets in the channel in relation to vessels, nozzle orientation, number of jets and other factors and evaluate these design considerations in terms of efficiency and effectiveness.

One potential configuration is to place water jets in the path of the tow. Jets would be arranged in a low angle lateral array across and along the bottom of the channel (**Figure 3 and 4**). The goal would be for the jets to displace fish from the tow's path, thereby reducing the likelihood of entrainment. As the tow passes, the goal would also be to dislodge fish that are already entrained by pushing them away from the vessel's influence. While this approach removes fish from the tow's path, it may induce a surface eddy, which would cause flow in the direction of the tow at the channel boundaries. Dislodged fish may become trapped in the eddy, carried towards the side of the channel, and then transported in the direction of the tow. A secondary array could be installed near the channel sides to counter the eddy and reduce the likelihood of fish being forced in the direction of the tow (**Figure 4**).

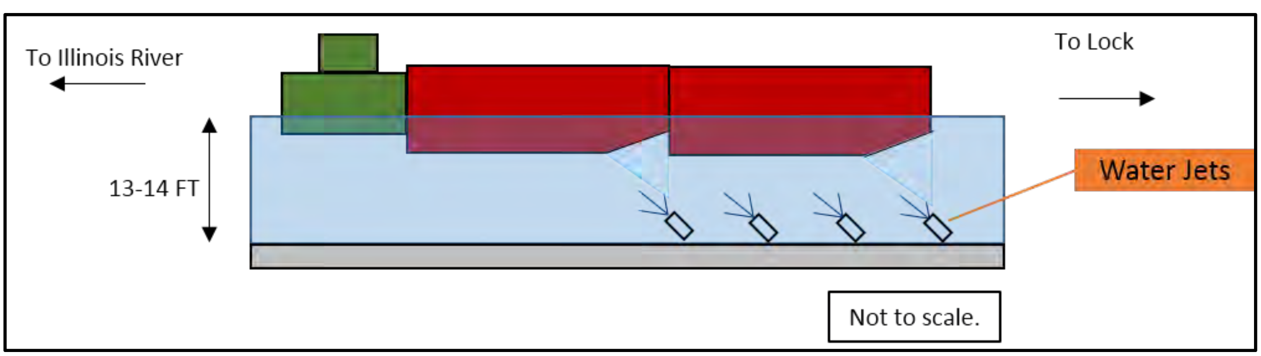


**Figure 3. The water jets would be positioned so the jets would be directed away from the lock. Note, the number of jets is arbitrary, and the drawing is not to scale.**

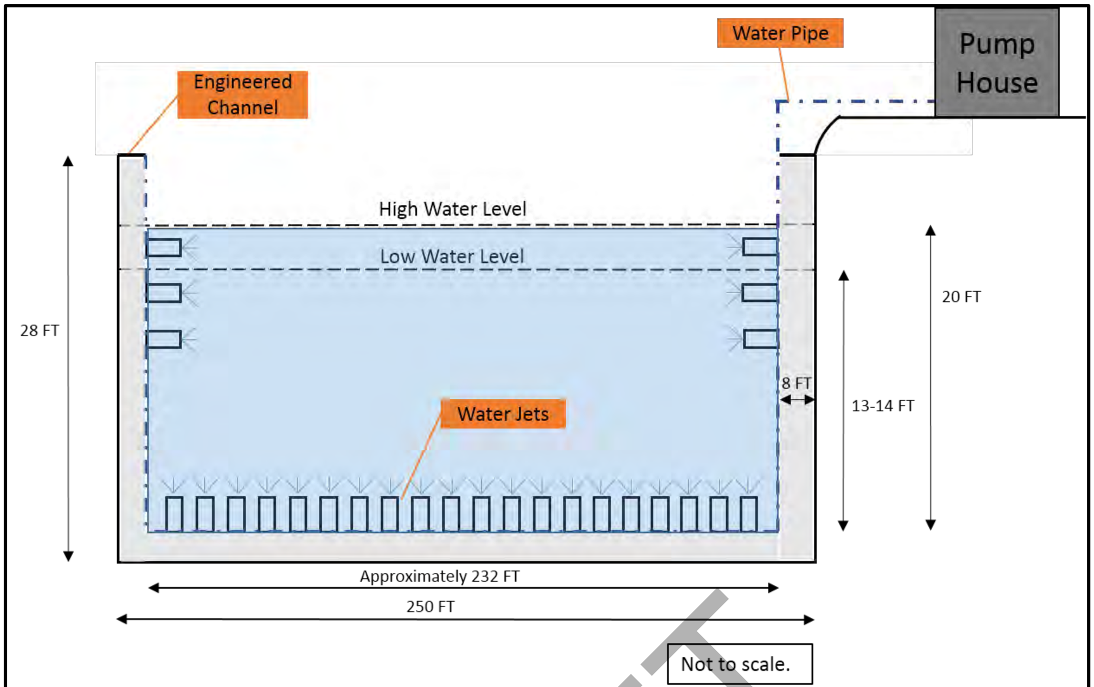


**Figure 4. One potential water jet flushing array includes staging the jets along the canal bottom and sides. Note, the number of jets is arbitrary, and the drawing is not to scale.**

Another water jet configuration under consideration in the model study is the placement of an array of vertical jets placed on the channel bottom. The goal of this configuration would be to remove fish from the tow as it passes overhead. A vertical jet array also produces an eddy but it is in the vertical plane and acts to force water towards the sides of the channel as opposed to along the channel. Even with this potential configuration, the jet will produce some velocities along the channel axis as it disperses. Additional jets could be configured to counter this effect.

Though the current model study will inform the final design of the water jet system, the team has developed a conceptual layout of this measure that will be refined throughout the study as additional analyses are completed. A water jet array would be placed at the downstream extent of the complex noise area and electric barrier system, and a second water jet would be placed upstream of the first and within the electric barrier. The first water jet system would remove entrained fish and the second water jet system provides redundancy and also can push stunned fish downstream and away from the lock. The current scaled model study will inform the best layout, exiting water velocity, and number of jets required to maximize this measure's effectiveness; however, it is unknown how effective the water jet system will be on removing entrained fish. If the water jet system is found to be ineffective at addressing fish entrainment, then additional physical model studies would evaluate the effectiveness of other mitigation measures and changes to vessel approaching BR L&D.

Down-bound Tows

Methods to remove or dislodge fish from down-bound tows must contend with vessel-induced motions that transport fish in the opposite direction of the vessel. Vessel operations may be a potential measure to address return current from down-bound tows. Vessel maneuvers involve reducing speed and possibly reversing the tow prior to passing a control point. Temporarily arresting the tow's forward motion will stop the return current allowing the ambient flow to transport fish downstream. The fish entrainment study currently underway will include experiments where a range of speeds (including reversing the tow) will be explored to determine the rate and degree at which the return current and associated fish transport responds. If these management measures are found to reduce fish entrainment, the goal would be to have vessel traffic implement these actions in the approach channel for this alternative.

**Flushing Lock**

The flushing of the Brandon Road Lock and Dam is a measure for Technology Alternative – Complex Noise **(Figure 5**). The purpose of the flushing lock is to flush floating organisms from within the lock when the lock is at the lower pool elevation and could act as an added defense to address small fish that become entrained within a barge and are transported through the fish entrainment measures as well as small fish that pass through the electric barrier and complex noise area. The water used to flush the lock is diverted from the upper pool water (BR L&D pool) through the lock filling and emptying culverts and through open downstream miter gates. Pending availability of water, the flushing lock may not necessarily operate for every lockage or the flushing duration may be shortened during low flow months. July through December are typically low flow months for the BR L&D pool except during rain and flood events. Flushing operations would be linked with physical monitoring of the upstream pool to optimize the use of this feature.

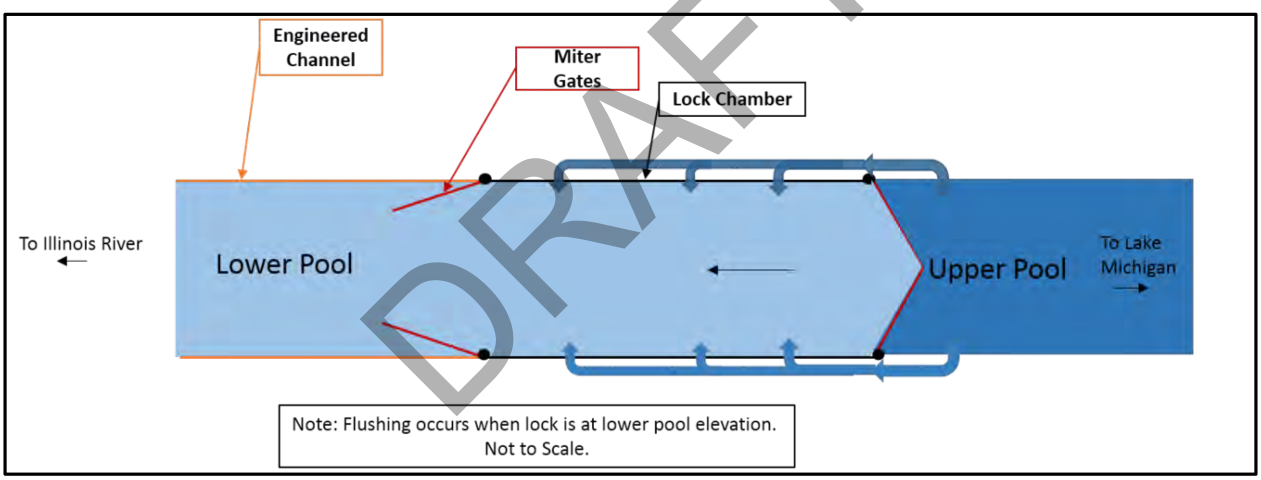




**Figure 5. Schematic of flushing lock at Brandon Road Lock and Dam.**

**Physical Barrier on Illinois & Michigan Canal**

Future investigation is needed to confirm whether the abandoned lock on the Illinois and Michigan Canal (no longer in use) at the Brandon Road Lock and Dam is permanently sealed off and could contain the 0.2% annual chance of exceedance (AED) event without overtopping. All features are being designed to contain the 0.2% AED event. If the abandoned lock, does not meet this design requirement, tieback measures will be developed.

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The Electric Dispersal Barriers includes three (3) barriers (i.e., Demonstration Barrier, Barrier IIA, Barrier IIB) in operation in the Chicago Sanitary and Ship Canal at Romeoville, IL. The Demonstration Barrier is being upgraded to a more powerful barrier (Permanent Barrier I) and construction is currently underway with installation of underwater components having been completed in October 2014. Permanent Barrier I is scheduled for activation in 2017 after completing construction and operational and safety testing. Barrier I is designed to operate at higher voltages than Barriers IIA and IIB; and therefore, may have an increased ability to deter small fish. Barriers IIA and IIB currently operate at a maximum in-water field strength at the water surface of 2.3 Volts/inch with a pulse frequency of 34 pulses/second and a pulse duration of 2.3 milliseconds. These parameters were found in the laboratory to be effective at immobilizing Bighead and Silver Carp as small as approximately 76.2-127 mm (3-5 in) in total length[1,2,3,4]. It is projected that through the duration of the period of analysis (i.e., 2071) at least two barriers, potentially all three, will be in operation under normal circumstances (excluding maintenance, etc.) with operating parameters no lower than the current parameters of Barriers IIA and IIB. For more information related to the Electric Barrier's effectiveness, please refer to the Chicago Sanitary and Ship Canal Dispersal Barriers Factsheet and the "Electric Barrier" Section of the Future Without Project Condition Factsheets for Asian carp and *Apocorophium lacustre*.

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Informed by the physical model study, USACE's goal is to complete a field study later in FY 2016 of the mitigation measures that are most promising. If the field-tested mitigation measures are found to be effective, then USACE would consider implementing these measures at the Electric Dispersal Barriers.



**Nonstructural Activities**

Nonstructural measures would be implemented as part of the Technology Alternative 1. The nonstructural component of this alternative requires vessels moving upbound through the Dresden Island Lock to release their ballast and bilge water prior to entering the BR L&D pool and thereby minimize the probability that fish in any of its life stages and *A. lacustre* pass through the barrier in the bilge and ballast. Please refer to the Nonstructural Alternative Factsheets for Asian carp and *A. lacustre* for details on the measures that would be implemented.

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## Lock Closure

**Table 1. Lock Closure**

| Lock Closure | | |
|---|---|---|
| **Location** | **Measure** | **Implementation** |
| Lock Culvert Intake | Concrete Plug | $T_0$ (2021) |
| Lock Upstream Miter Gate | Permanent Concrete Wall | |
| Illinois and Michigan Canal | Existing Physical Barrier | |
| Romeoville, IL | Electric Barriers | Ongoing |
| The Starved Rock Pool to Lake Michigan | Nonstructural | $T_0$ (2021) |

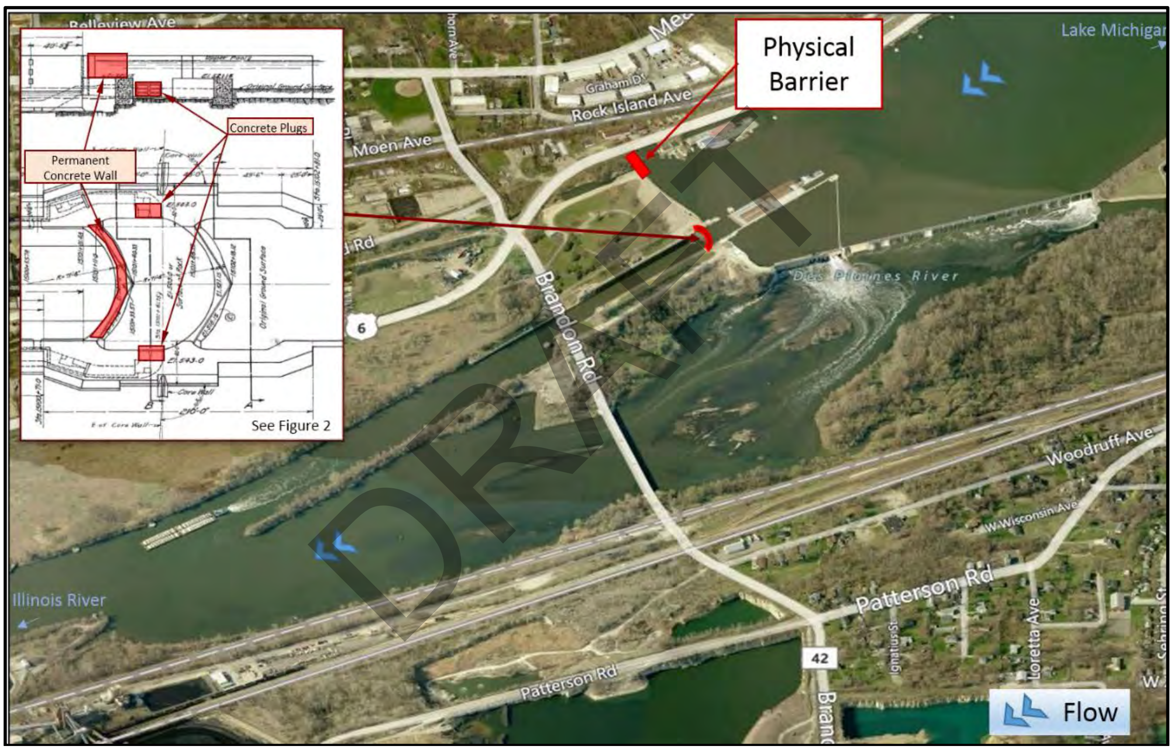


**Figure 1. Aerial view of Brandon Road Lock and Dam with potential layout of Lock Closure.**

**Lock Closure**

This measure removes the upper operational gates from the Brandon Road Lock and replaces them with a permanent concrete wall that ties into the existing concrete gate sill and existing lock walls to structurally separate the upper pool from the lower pool (**Table 1 and Figure 1**). The concrete wall spans the total lock width of 33.5 meters (110 feet) and is 6.7 meters (22 feet) in height in order to match into the height of the existing lock walls. The existing lock walls level of flood protection are well above the 0.2% exceedence event. In addition, concrete plugs are placed in each upstream lock culvert intake to permanently close the water pathways through the filling and emptying culverts. Each lock culvert intake is 2.4 meters (8 feet-4 inches) in width and 3.7 meters (12 feet) in height at the opening and are paired together to create side by side openings 5.5 meters (18 feet) in total width on each lock wall (**Figure 2**).

The separation terminates navigation access to and from Lake Michigan and the City of Chicago to the inland waterways located below Brandon Road to include access to and from the Gulf of Mexico. River flow through the Brandon Road Dam continues per the current operational plan. Head gates, sluice gates, and a tainter gate spillway provide controlled flow through the dam.

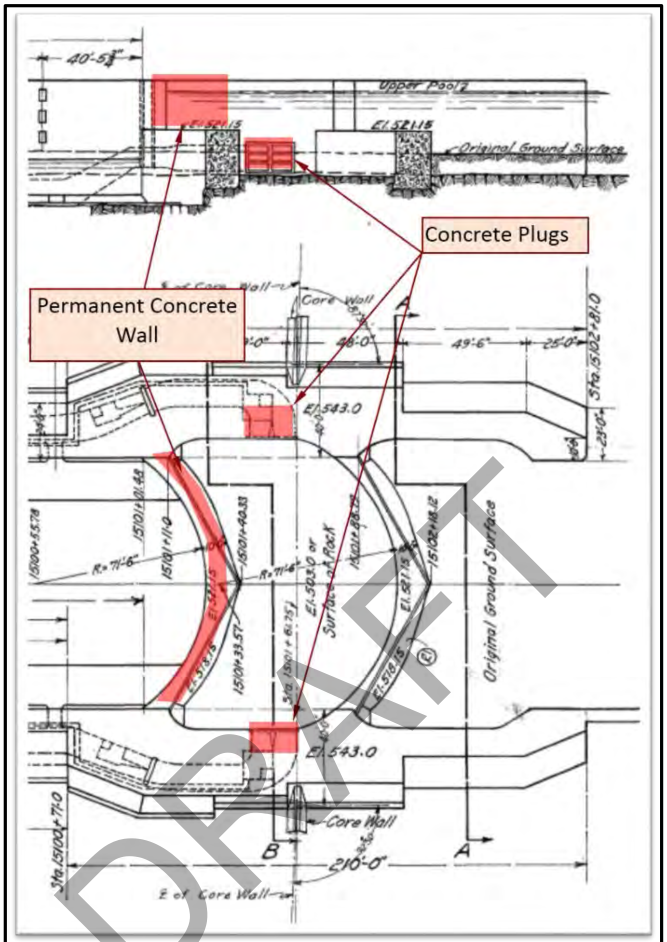


**Figure 2. Lock Features and Potential Permanent Physical Structures.**

**Physical Barrier for Illinois and Michigan Channel**

The lock on the I&M Canal (no longer in use) at the Brandon Road Lock and Dam, would be permanently sealed off to the same elevation as the Brandon Road Dam. Potential methods include filling in with earthen material or sealing off the abandoned I&M lock.

**Nonstructural Activities**

Nonstructural measures would be implemented as part of the Lock Closure Alternative. Please refer to the Nonstructural Alternative Factsheet for details on the measures that would be implemented.

# United States Department of the Interior

**U.S. FISH & WILDLIFE SERVICE**

Midwest Regional Fisheries
1511 47th Ave
Moline, IL 61265
Phone: 309-757-5800 Fax: 309-757-5807


**March 31, 2016**

Mark Cornish, Acting Chief, Environmental Planning Branch, RPEDN
Department of the Army
U. S. Corps of Engineers, Rock Island District
P.O. Box 2004 Clock Tower Building
Rock Island, IL 61204-2004

Dear Mr. Cornish,

This Planning Aid Letter (PAL) is submitted by the U.S. Fish and Wildlife Service (Service) to the Rock Island District, U.S. Army Corps of Engineers (Corps), by your request for use in the *GLMRIS- Brandon Road Project*. Information and planning assistance are provided in accordance with the provisions and under the authority of the Fish and Wildlife Coordination Act (48 stat. 401, as amended; 16 U.S.C. 661 et seq.) (FWCA); and the "Agreement between the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers for funding Fish and Wildlife Coordination Activities." The purpose of this PAL is to summarize our current consultation efforts under the FWCA for the Brandon Road Project. This PAL does not constitute the final report of the Secretary of the Interior for this project, as required by Section 2(b) of the FWCA.

This FWCA effort is focused specifically on addressing the potential one-way (upstream) transfer of Aquatic Nuisance Species (ANS) at the Brandon Road Lock and Dam (BRLD), specifically Bighead Carp (*Hypophthalmichthys nobilis*), Silver Carp (*H. molitrix*), and scud (*Apocorophium lacustre*). We previously provided a PAL to the Corps on October 30, 2015, and the information it contains is still timely and relevant. Also, we will provide additional informed analysis and relevant information in our draft FWCA Report (FWCAR), which we anticipate submitting to the Corps on April 30, 2016. Although our previous PAL was reviewed by the fish and wildlife resource management agencies of the Great Lakes States, we were unable to coordinate a similar review of this PAL with the states due to the short timeline requested by the Corps. We have provided the Great Lakes States a copy of this PAL and asked that they submit any additional comments they may have directly to you.

**Significance of the Great Lakes and Asian Carp Establishment**

The Service is well aware of the potential threat posed to the Great Lakes ecosystem in the event of the introduction and establishment of an Asian carp population. As Chair of the Asian Carp Regional Coordinating Committee (ACRCC), the Service, along with the USEPA as Co-chair, works directly with all 23 member agencies to protect the Great Lakes basin, with a focus on implementing Asian carp prevention, detection, and control actions in the Chicago Area Waterway System (CAWS) and Illinois Waterway (IW). The ACRCC, formed in 2009, is bi-national partnership of U.S and Canadian Federal, State, Provincial, and local agencies with the mission of preventing the introduction, establishment and spread of Asian carp into the Great Lakes. While primarily focused on Asian carp, the ACRCC also seeks prevention and control solutions that may also address other ANS that could potentially migrate between the Great Lakes and Mississippi River watersheds. The ACRCC develops an annual Action Plan (formerly titled the Control Strategy Framework), which coordinates planning for member agencies to execute relevant priority projects in support of the ACRCC mission.

Objectives of the ACRCC include the following:

- Promote the collection of biological information on Asian carp, their impacts, preferred habitats, and biological and ecological requirements;
- Identify additional research, technology, and data needed to effectively inform and support Asian carp management strategies;
- Support the development of technologies and methods that will result in the control and management of Asian carp; and the transferability of these new tools for use in the control of other invasive species, where possible;
- Use the Incident Command System (ICS) for response purposes as well as coordination of events to best deploy resources as needed;
- Encourage the exchange of information between member agencies and stakeholders, and seek opportunities to transfer and further leverage control technologies developed as part of the Action Plan to other areas of the United States and Canada. Work under this objective by the ACRCC fulfills the coordination and notification requirements of the United States-Canada Great Lakes Water Quality Agreement;
- Develop a comprehensive Action Plan, and annually coordinate the development of potential projects for inclusion in the Action Plan. Recommendations on funding decisions shall be sought from ACRCC members, with final decisions being made by the funding agencies. Coordination and collaboration will be encouraged for all projects, as appropriate; and
- Coordinate implementation and evaluate the effectiveness of collaborative Asian carp assessment, prevention and control measures, as described in the Action Plan.

Additionally, the Service has been identified in the Water Resources Reform and Development Act of 2014 (WRRDA), Public Law 113-121, Section 1039 (b) which authorizes the Director of the U.S. Fish and Wildlife Service to coordinate with the Secretary of the Army, the Director of the National Park Service, and the Director of the U.S. Geological Survey to lead a multiagency effort to address the spread of Asian carp in the Upper Mississippi River Basin (UMRB) and the Ohio River Basin (ORB) and tributaries. Since 2014, the Service has increased its interagency coordination as directed by Congress in in WRRDA, including production of an annual Report to Congress describing all actions and expenditures to prevent the expansion of Asian carp range in the UMRB and ORB. The Service continues to seek opportunities to leverage the lessons-learned and advancements in detection, prevention, and control technology made in Asian carp efforts in the Great Lakes, UMRB, and/or ORB across all basins to maximize return-on-investment and facilitate the implementation of holistic basinwide strategies.

The actions and management plans to prevent Asian carp establishment, both under the ACRCC and through WRRDA authorization, emphasize the scale and importance of concern regarding Asian carp invasion to a significant natural resource such as the Great Lakes.

As stated in our previous PAL, the primary objective of the Brandon Road Project is to prevent the movement of Asian carp from the Mississippi River basin into the Great Lakes by evaluating and potentially implementing control mechanisms at the BRLD. The Great Lakes supports a traditional and long-standing commercial and recreational fishery valued at over $7 billion annually. Unfortunately, over 180 ANS are already established in the Great Lakes and ANS have caused extensive ecological and economic damage to the entire ecosystem (e.g. sea lamprey, dreissined mussels). Aquatic Nuisance Species that have the potential to invade the Great Lakes from the Mississippi River basin have the potential to do irreparable damage to intact ecosystems through direct competition with and predation on native species, introduction and dispersal of new harmful pathogens and diseases, and ultimately, the alteration of ecosystems functions and services. The Service also recognizes that although two species of Asian Carp (Bighead Carp and Silver Carp) are specifically addressed in the Brandon Road project, we recommend evaluating impacts of Black Carp since their population in the Upper Mississippi River has recently been determined to be naturally reproducing and this species could also be problematic for already imperiled native mussel fauna of North America.

Lastly, we recommend you consider the recently published study by NOAA: *Forecasting the Impacts of Silver and Bighead Carp on the Lake Erie Food Web* (Zhang et al. 2016), which predicts Asian carp as eventually accounting for about a third of the total weight in fish biomass of Lake Erie if they were to successfully invade, causing significant declines in prized sport and commercial fish species, such as Walleye.

**Status of the FWCA Consultation**

On January 19, 2016, a meeting with the state fish and wildlife agencies and the Corps was convened. The purpose was to review and discuss the Corps' alternatives and to receive an update on the control technologies under development and testing by the USGS. The meeting was attended, either in person or via webinar, by representatives from the Illinois Department of Natural Resources (ILDNR), Michigan Department of Natural Resources (MIDNR), Indiana Department of Natural Resources (INDNR), Corps, USGS, and the Environmental Protection Agency (EPA).

It is our understanding from the January meeting that the Corps is currently developing and evaluating the following six alternatives:

1. **No New Federal Action**
   This alternative assumes that the monitoring and fishing response actions, currently being conducted by federal, state and local agencies, will continue to be funded through 2019. This alternative does not include any new actions against Asian carp or scud except the potential use of the ILDNR mobile electric barrier. This alternative also includes the continued operation of the redundant series of electrical barriers in Lockport Pool approximately 5 miles upstream of the Lockport Lock and Dam.

2. **Non-structural Alternative**
   Includes the actions included in the No New Federal Action Alternative and additional ANS controls that do not require the construction of permanent structures, best management practices related to navigation within the waterway, and public outreach and education. Controls include actions such as overfishing, piscicides and ballast water discharge. The Non-structural Alternative includes monitoring to assess whether the alternative achieves its anticipated outcome, and adaptive management promotes flexible decision making that can be adjusted in light of alternative uncertainties.

   The following structural alternatives would be sited in the vicinity of the Brandon Road Lock and Dam.

3. **Technology Alternative 1**
   This alternative involves the installation of a new electric barrier at BRLD within a newly engineered channel at BRLD. This alternative also includes the continued operation of at least two of the three Romeoville barriers, the activities outlined in the Non-Structural Alternative, fish entrainment mitigation and swimmer controls, a flushing lock, and a physical barrier blocking the I&M canal. This alternative will include monitoring and adaptive management. The non-structural activities would begin in 2021 and the implementation of new structural features would be completed by 2031.

4. **Technology Alternative 2**
   This alternative involves the use of complex noise which would be installed within a newly engineered channel at BRLD. This alternative includes continued operation of at least two of the three Romeoville electric barriers, the activities outlined in the Non-structural Alternative, fish entrainment mitigation and swimmer controls, a flushing lock, and a physical barrier blocking the I&M canal. This alternative will include monitoring and adaptive management. The nonstructural activities would begin in 2021 and the barriers and implementation of new structural features would be completed in 2031.

5. **Technology Alternative 3**
   This alternative involves the installation of both an electric barrier and complex noise within a newly engineered channel at BRLD. This alternative combines Technology Alternatives 1 and 2. The electric barrier would operate when no vessels are present and complex noise would operate at least when the electric

barrier is not in use. This alternative includes continued operation of at least two of the three Romeoville electric barriers, the activities outlined in the Non-structural Alternative, fish entrainment mitigation and swimmer controls, a flushing lock, and a physical barrier blocking the I&M canal. This alternative will include monitoring and adaptive management. The nonstructural activities would begin in 2021 and the implementation of new structural features would be completed in 2031.

6. **Lock Closure**
   This alternative would remove the upper operational lock gates and replace them with a permanent concrete wall closing the lock. This alternative includes monitoring and adaptive management, as well as, the continued operation of at least two of the three Romeoville electric barriers and the activities outlined in the Non-structural Alternative. The lock would be closed in 2021 and the nonstructural activities would begin in 2021.

Please let us know if any of these alternatives have changed. As an outcome of that meeting, the Service committed to send the states follow-up email correspondence detailing the six alternatives and asked for written feedback on the Corps' alternatives with regard to significant fish and wildlife resources. Specifically, we asked that the States focus on these items: (1) are there additional technologies or alternatives that the Corps should evaluate; (2) would you recommend any changes to these alternatives; (3) could any of these alternatives result in significant impacts to fish and wildlife resources; and (4) do you have preference for any of these alternatives at this point and why. The following agencies submitted these comments on the alternatives.

**INDNR**

The INDNR is supportive of alternative techniques; however, it will take too long to evaluate new technologies that are still in their infancy stage. INDNR noted that the time frame to complete implementation is already far too long, and they are not in favor of additional delays that may result from evaluating new technologies.

The INDNR understands the ILDNR's concerns that BRLD alternatives could hamper Des Plaines River recovery efforts. The INDNR wants to know if the Corps has fully investigated moving control options to Lockport. The INDNR feels that if it is possible to achieve watershed separation between the Chicago Sanitary and Ship Canal (CSSC) and the Des Plaines River, then Lockport could be considered; however, the current separation involving screens and jersey barriers is not sufficient. The INDNR does not feel that all of the BRLD alternatives would have equally negative impacts on native species recovery. For instance, an electric barrier, especially a constantly functioning electric barrier, may limit native fish recovery since nearly all species of fish are likely to react to an electrical field, while sound trials have shown that Asian carp react to particular sounds but most native species do not. Sound, therefore, may not have significant impacts on fish and wildlife as electricity.

The INDNR supports the continued used of the current electric barriers; however, they are concerned that these barriers alone are not protective of the Great Lakes. Further, INDNR feels that non-structural alternatives should be pursued, but this alternative should also not stand alone. While harvest should be encouraged, increased harvest rates between 2014 and 2015 indicate that harvest cannot be the only control. Likewise other non-structural alternatives are encouraged but will not be protective enough.

The INDNR supports Technology Alternative 2 - the installation of a complex sound barrier. This will provide far less exclusion for native species movement than an electric barrier and will better allow Illinois to achieve their desired Des Plaines River recovery. INDNR is concerned that because electrical barriers are extremely non-selective, technology alternatives with electric barriers may stall the Illinois effort to restore the native fishery of the Des Plaines River. In addition, the INDNR does not support Technology Alternative 3 because they are concerned that the electricity alternative will add little additional benefit than sound alone and that the additional expensive may not be worth the cost. Finally, the INDNR does not support lock closure because the two Indiana ports on Lake Michigan rely on barge traffic utilizing CSSC.

The INDNR insists that alternatives should go live in stages rather than waiting the protected 15 years before implementation of the GLRMIS BRLD project. For example, if sound is selected as part of an alternative, then INDNR recommends that the Corps start implementing sound controls in the lock chamber immediately and then work on establishing the engineered approach channel with sound.

**NYSDEC**

The NYSDEC supports the alternative that would use complex noise in conjunction with an electric barrier within an engineered channel.

**MIDNR**

The MIDNR understands that while tremendous effort is being put forth for management and control under the current sustained activities, the No New Federal Action alternative does not address the noted risk at the current electric barriers or barge entrainment. The barriers are continually challenged by environmental conditions and the "warping" of the electric field as barges move through the area. There is an inability to maintain a vertical electric field that is effective for all size classes of invasive carp.

The MIDNR believes that all of the additional measures put forth as part of the Non-structural Alternative are actions that should occur even if a structural alternative is chosen. Given the concern regarding ballast and bilge management that is noted, this seems like an activity to implement immediately to reduce risk. The MIDNR recommends that the Corps does not wait until 2021 to implement any of these measures. The MIDNR understands that Rotenone treatments are a tool that should not be used lightly given the concern regarding the fish community in the upper waterway. However, there may be times and places for this consideration when the risks are low to the majority of the fish community and the success would be high for carp eradication in some areas, especially where gear efficiencies may be less than desired.

The MIDNR believes that the Technology Alternative 1 would provide the redundancy desired for prevention in the pathway but suggest that alternative approaches may yield greater effectiveness for fish and increase safety for people. An engineered channel would provide for the maximum efficiency of any new barrier, but also allow for any other types of controls to be used in concert or in place of an electric barrier as they may become available.

The MIDNR agrees that the issue of fish entrainment by barges needs to be addressed for an investment to be fully realized, but it also should be mandatory for the nonstructural alternatives as well and implemented as soon as possible without waiting until 2021. The flushing lock concept is highly desired to address “floaters” and “foulers” in addition to “swimmers”.

The MIDNR understands the concern for fish passage of other species necessary to the Des Plaines River, a trap and transfer project to move desired fish could be developed to assist with the restoration goals of the Des Plaines River.

Although the Complex Sound approach seems like a “silver” bullet in its promise, the reality is that few nuisance species (native and invasive and birds, mammals, or fish) have been successfully deterred through noise applications. The MIDNR believes that if investigations are promising, this could be deployed with other measures until certainty in effectiveness is demonstrated.

The MIDNR believes that a Lock Closure would reduce risk by the greatest amount when compared with all of the other alternatives and likely be the most cost-effective for addressing the biological risk to the Great Lakes from invasive species in all forms of swimmers, floaters, and foulers. A trap and transfer program for continued rehabilitation of the Des Plaines River could be employed as necessary.

The MIDNR does not have alternative suggestions for additional technologies or alternatives. They do recommend, to the extent possible, that any outcomes or direction from the study allows for adapting through time as proposed methodologies become more certain in their application.

It is unclear to the MIDNR as to why a 500 year flood design would need to be used for the engineered channel if the purpose of the Brandon Road location is to prevent upstream movement. At high flows, the lock would likely be closed; it is unlikely that any technology would be effective at those flows. The MIDNR requests that the Corps explain why they have designed a channel that is outside of operational range.

At this time, MIDNR’s preferred alternative is Technology Alternative 3, but it should be implemented with the flexibility to take advantage of the methodology that is most effective at reducing risk, even if it is not currently identified today.

**U. S. Fish and Wildlife Service**

The Service does not believe there are any additional technologies or alternatives that the Corps should evaluate at this time, nor do we recommend any changes to these alternatives. However, we recognize timeframe to implementation and ongoing technology development as two interrelated parts of the implementation scenarios of interest to planning efforts. All of the alternatives presented are in various stages of development. The efficacy of complex sound is not fully understood and vetted. Other facets of proposed deterrent technologies (e.g. electric barriers) are better understood, however ongoing research is still identifying potential shortcomings of this technology. Still yet, other technologies may be brought to bear that are unforeseen at this time. Given the time frame to implementation, and ongoing research into deterrent technologies, we recommend flexibility in planning and final decision making as implementation moves forward. In an effort to remain flexible as research into deterrent technologies moves forward, we do recommend that the Corps strongly consider selecting an alternative that includes an engineered channel because it could serve as platform for future control technologies that may be developed, and provide a more flexible platform should research in the future identify technologies as being more or less applicable at the implementation location.

At this time, we are unable to evaluate whether there could be any significant impacts to fish and wildlife resources because we need access to the results of your expert elicitation process. The Service intends to use the expert elicitation process as the basis of our alternative evaluation methods. We are concerned that we will not be able to meet your April 30, 2016 deadline for the draft FWCAR without the results of the expert elicitation. We request that you provide these results no later than April 7, 2016. We are also unable to advise the Corps of our preference for any alternative at this point.

Thank you for considering our comments, and we look forward to working with you on the draft FWCAR. If you have any questions, please contact me or Karen Herrington (850-348-6495).

Sincerely,

Kelly Baerwaldt
Asian Carp/eDNA Coordinator
US Fish and Wildlife Service Midwest Region
Kelly_baerwaldt@fws.gov

cc: Affected states
Chicago Ecological Services Field Office, Chicago, IL
Rock Island Ecological Services Field Office, Rock Island, IL

**Appendix V.** List of the fishes of the Great Lakes and their Federal/State listing statuses. List only includes those established fishes using the lakes for at least part of their life histories and those found in rivers and bodies of water connected to the lakes. E= Endangered, T= Threatened, Special Concern= SC. X= Great Lakes migratory fishes that utilize the lakes' tributaries and connected habitats for at least part of their life histories.

| Common Name | Scientific Name | Status | Migratory |
|---|---|---|---|
| Alewife | *Alosa pseudoharengus* | | |
| American Brook Lamprey | *Lampetra appendix* | T | |
| American Eel | *Anguilla rostrate* | T | X |
| Atlantic Salmon | *Salmo salar* | | X |
| Banded Killifish | *Fundulus diaphanus* | T | |
| Bigmouth Buffalo | *Ictiobus cyprinellus* | E | X |
| Bigmouth Shiner | *Notropis dorsalis* | T/SC | |
| Black Buffalo | *Ictiobus niger* | T | X |
| Black Bullhead | *Ameiurus melas* | E/T | |
| Black Crappie | *Pomoxis nigromaculatus* | | |
| Black Redhorse | *Moxostoma duquesneii* | E/T | |
| Blackchin Shiner | *Notropis heterodon* | E/T | |
| Blacknose Dace | *Rhinichthys atratulus* | | |
| Blacknose Shiner | *Notropis heterolepis* | E/T | |
| Blackside Darter | *Percina maculata* | | |
| Blackstripe Topminnow | *Fundulus notatus* | | |
| Bloater | *Coregonus hoyi* | | |
| Bluegill | *Lepomis macrochirus* | | |
| Bluntnose Minnow | *Pimephales notatus* | | |
| Bowfin | *Amia calva* | SC | X |
| Brassy Minnow | *Hybognathus hankinsoni* | T | |
| Bridle Shiner | *Notropis bifrenatus* | E | |
| Brindled Madtom | *Noturus miurus* | T/SC | |
| Brook Silverside | *Labidesthes sicculus* | | |
| Brook Stickleback | *Culaea inconstans* | SC | |
| Brook Trout | *Salvelinus fontinalis* | T | X |
| Brown Bullhead | *Ameiurus nebulosus* | | |
| Brown Trout | *Salmo trutta* | | X |
| Burbot | *Lota lota* | SC | X |
| Central Mudminnow | *Umbra limi* | SC | |
| Central Stoneroller | *Campostoma anomalum* | | |
| Chain Pickerel | *Esox niger* | | |
| Channel Catfish | *Ictalurus punctatus* | | X |
| Channel Darter | *Percina copelandi* | E/T | X |
| Chestnut Lamprey | *Ichthyomyzon castaneus* | T | X |
| Chinook Salmon | *Oncorhynchus tshawytscha* | | X |
| Coho Salmon | *Oncorhynchus kisutch* | | X |
| Common Carp | *Cyprinus carpio* | | X |
| Common Shiner | *Luxilus cornutus* | | X |
| Creek Chub | *Semotilus atromaculatus* | | |
| Creek Chubsucker | *Erimyzon oblongus* | | |
| Deepwater Sculpin | *Myoxocephalus thompsonii* | E | |
| Eastern Sand Darter | *Ammocrypta pellucida* | E/T/SC | |
| Emerald Shiner | *Notropis atherinoides* | | X |

| Common Name | Scientific Name | Status | Migratory |
|---|---|---|---|
| Fallfish | *Semotilus corporalis* | | |
| Fantail Darter | *Etheostoma flabellare* | | |
| Fathead Minnow | *Pimephales promelas* | | |
| Finescale Dace | *Phoxinus neogaeus* | | |
| Flathead Catfish | *Pylodictis olivaris* | | |
| Fourspine Stickleback | *Apeltes quadracus* | | |
| Freshwater Drum | *Aplodinotus grunniens* | | X |
| Ghost Shiner | *Notropis buchanani* | E | |
| Gizzard Shad | *Dorosoma cepedianum* | | |
| Golden Redhorse | *Moxostoma erythrurum* | | |
| Golden Shiner | *Notemigonus crysoleucas* | | |
| Goldfish | *Carassius auratus* | | |
| Grass Pickerel | *Esox americanus vermiculatus* | T | |
| Gravel Chub | *Erimystax x-punctatus* | E/T | |
| Greater Redhorse | *Moxostoma valenciennesi* | E/T | X |
| Green Sunfish | *Lepomis cyanellus* | | |
| Greenside Darter | *Etheostoma blennioides* | | |
| Hornyhead Chub | *Nocomis biguttatus* | SC | |
| Iowa Darter | *Etheostoma exile* | E/T | |
| Johnny Darter | *Etheostoma nigrum* | | |
| Kiyi | *Coregonus kiyi* | SC | |
| Lake Chub | *Couesius plumbeus* | | X |
| Lake Chubsucker | *Erimyzon sucetta* | T | |
| Lake Herring | *Coregonus artedi* | E/T/SC | X |
| Lake Sturgeon | *Acipenser fulvescens* | T/E | X |
| Lake Trout | *Salvelinus namaycush* | SC | X |
| Lake Whitefish | *Coregonus clupeaformis* | SC | X |
| Largemouth Bass | *Micropterus salmoides* | | |
| Least Darter | *Etheostoma microperca* | E/SC | |
| Logperch | *Percina caprodes* | | X |
| Longear Sunfish | *Lepomis megalotis* | E/T | |
| Longnose Dace | *Rhinichthys cataractae* | SC | X |
| Longnose Gar | *Lepisosteus osseus* | | X |
| Longnose Sucker | *Catostomus catostomus* | E/T/SC | X |
| Mimic Shiner | *Notropis volucellus* | | |
| Mooneye | *Hiodon tergisus* | T | X |
| Mottled Sculpin | *Cottus bairdii* | | |
| Muskellunge | *Esox masquinongy* | SC | X |
| Ninespine Stickleback | *Pungitius pungitius* | | |
| Northern Brook Lamprey | *Ichthyomyzon fossor* | E | |
| Northern Hog Sucker | *Hypentelium nigricans* | | |
| Northern Madtom | *Noturus stigmosus* | E/SC | |
| Northern Pike | *Esox lucius* | | X |
| Northern Redbelly Dace | *Phoxinus eos* | E | |
| Orangespotted Sunfish | *Lepomis humilis* | | |
| Pearl Dace | *Margariscus margarita* | E | |
| Pink Salmon | *Oncorhynchus gorbuscha* | | X |
| Pirate Perch | *Aphredoderus sayanus* | T | |
| Pugnose Minnow | *Opsopoeodus emiliae* | E/T | |
| Pugnose Shiner | *Notropis anogenus* | E/T/SC | |

| Common Name | Scientific Name | Status | Migratory |
|---|---|---|---|
| Pumpkinseed | *Lepomis gibbosus* | | |
| Pygmy Whitefish | *Prosopium coulterii* | SC | X |
| Quillback | *Carpiodes cyprinus* | | X |
| Rainbow Darter | *Etheostoma caeruleum* | | |
| Rainbow Smelt | *Osmerus mordax* | | X |
| Rainbow Trout | *Oncorhynchus mykiss* | | X |
| Red Shiner | *Cyprinella lutrensis* | | |
| Redfin Shiner | *Lythrurus umbratilis* | E/T/SC | |
| Redside Dace | *Clinostomus elongatus* | E | |
| River Chub | *Nocomis micropogon* | E | |
| River Darter | *Percina shumardi* | E | X |
| River Shiner | *Notropis blennius* | E | |
| Rock Bass | *Ambloplites rupestris* | | |
| Rosyface Shiner | *Notropis rubellus* | | |
| Round Goby | *Neogobius melanostomus* | | X |
| Round Whitefish | *Prosopium cylindraceum* | E | X |
| Rudd | *Scardinius erythrophthalmus* | | |
| Ruffe | *Gymnocephalus cernuus* | | X |
| Sand Shiner | *Notropis ludibundus* | | |
| Sauger | *Sander canadense* | T | X |
| Sea Lamprey | *Petromyzon marinus* | | X |
| Shorthead Redhorse | *Moxostoma macrolepidotum* | | X |
| Shortjaw Cisco | *Coregonus zenithicus* | T | |
| Shortnose Gar | *Lepisosteus platostomus* | E | X |
| Silver Chub | *Macrhybopsis storeriana* | E/SC | |
| Silver Lamprey | *Ichthyomyzon unicuspis* | | X |
| Silver Redhorse | *Moxostoma anisurum* | | X |
| Silver Shiner | *Notropis photogenis* | E | |
| Silverjaw Minnow | *Notropis buccatus* | | |
| Skipjack Herring | *Alosa chrysochloris* | E | |
| Slimy Sculpin | *Cottus cognatus* | SC | |
| Smallmouth Bass | *Micropterus dolomieu* | | X |
| Smallmouth Buffalo | *Ictiobus babalus* | | |
| Spoonhead Sculpin | *Cottus ricei* | E/SC | |
| Spotfin Shiner | *Cyprinella spiloptera* | | |
| Spottail Shiner | *Notropis hudsonius* | | X |
| Spotted Gar | *Lepisosteus oculatus* | E/SC | |
| Spotted Sucker | *Minytrema melanops* | T | X |
| Stonecat | *Noturus flavus* | | |
| Striped Shiner | *Luxilus chrysocephalus* | E | |
| Tadpole Madtom | *Noturus gyrinus* | E | |
| Tessellated Darter | *Etheostoma olmstedi* | | |
| Threespine Stickleback | *Gasterosteus aculeatus* | E | |
| Trout-perch | *Percopsis omiscomaycus* | SC | X |
| Tubenose Goby | *Proterorhinus marmoratus* | | |
| Walleye | *Sander vitreum* | | X |
| Warmouth | *Chaenobryttus gulosus* | E | |
| White Bass | *Morone chrysops* | | X |
| White Crappie | *Pomoxis annularis* | | |
| White Perch | *Morone americana* | | X |

| Common Name | Scientific Name | Status | Migratory |
|---|---|---|---|
| White Sucker | *Catostomus commersonii* | | X |
| Yellow Bullhead | *Ameiurus natalis* | | |
| Yellow Perch | *Perca flavescens* | | X |

**Appendix VI.** List of the fishes of the Des Plaines River including tributaries. These fish were collected during the basin wide survey conducted by the Illinois DNR in 2013. (Table is copied from the 2013 Basin Survey)

| Common Name | Scientific Name | Total |
|---|---|---|
| Longnose Gar | *Lepisosteus osseus* | 11 |
| Bowfin | *Amia calva* | 11 |
| Gizzard Shad | *Dorosoma cepedianum* | 211 |
| Grass Pickerel | *Esox americanus* | 3 |
| Northern Pike | *Esox lucius* | 40 |
| Muskellunge | *Esox masquinongy* | 1 |
| Goldfish* | *Carassius auratus* | 19 |
| Carp* | *Cyprinus carpio* | 198 |
| Carp x Goldfish hybrid | *Cyprinus carpio x Carassius auratus* | 5 |
| Golden Shiner | *Notemigonus crysoleucas* | 27 |
| Creek Chub | *Semotilus atromaculatus* | 527 |
| Hornyhead Chub | *Nocomis biguttatus* | 452 |
| Central Stoneroller | *Campostoma anomalum* | 1840 |
| Suckermouth Minnow | *Phenacobius mirabilis* | 3 |
| Striped Shiner | *Luxilus chrysocephalus* | 91 |
| Common Shiner | *Luxilius cornutus* | 2 |
| Redfin Shiner | *Lythrurus umbratilus* | 235 |
| Spotfin Shiner | *Cyprinella spiloptera* | 1807 |
| Fathead Minnow | *Pimephales promelas* | 69 |
| Bluntnose Minnow | *Pimephales notatus* | 6240 |
| Emerald Shiner | *Notropis atherinoides* | 2 |
| Rosyface Shiner | *Notropis rubellus* | 50 |
| Bigmouth Shiner | *Notropis dorsalis* | 10 |
| Sand Shiner | *Notropis ludibundus* | 983 |
| Mimic Shiner | *Notropis volucellus* | 16 |
| Spottail Shiner | *Notropis hudsonius* | 6 |
| Smallmouth Buffalo | *Ictiobus bubalus* | 50 |
| Black Buffalo | *Ictiobus niger* | 1 |
| Quillback | *Carpiodes cyprinus* | 8 |
| River Carpsucker | *Carpiodes carpio* | 4 |
| White Sucker | *Catostomus commersoni* | 589 |
| Spotted Sucker | *Minytrema melanops* | 57 |
| Northern Hogsucker | *Hypentelium nigricans* | 16 |
| Shorthead Redhorse | *Moxostoma macrolepidotum* | 18 |
| Golden Redhorse | *Moxostoma erythrurum* | 27 |
| Silver Redhorse | *Moxostoma anisurum* | 1 |
| Channel Catfish | *Ictalurus punctatus* | 117 |

| Common Name | Scientific Name | Total |
|---|---|---|
| Yellow Bullhead | *Ameiurus natalis* | 130 |
| Black Bullhead | *Ameiurus melas* | 21 |
| Flathead Catfish | *Pylodictis olivaris* | 2 |
| Stonecat | *Noturus flavus* | 11 |
| Tadpole Madtom | *Noturus gyrinus* | 36 |
| Banded Killifish** | *Fundulus diaphanus* | 1 |
| Blackstripe Topminnow | *Fundulus notatus* | 1598 |
| Mosquitofish | *Gambusia affinis* | 23 |
| Brook Silverside | *Labidesthes sicculus* | 3 |
| White Bass | *Morone chrysops* | 3 |
| Yellow Bass | *Morone mississippiensis* | 18 |
| Black Crappie | *Pomoxis nigromaculatus* | 57 |
| Rock Bass | *Ambloplites rupestris* | 259 |
| Largemouth Bass | *Micropterus salmoides* | 350 |
| Smallmouth Bass | *Micropterus dolomieu* | 267 |
| Warmouth | *Lepomis gulosus* | 10 |
| Green Sunfish | *Lepomis cyanellus* | 640 |
| Bluegill x Green hybrid | *Lepomis macrochirus x L. cyanellus* | 67 |
| Bluegill | *Lepomis macrochirus* | 1275 |
| Redear Sunfish | *Lepomis microlophus* | 23 |
| Pumpkinseed | *Lepomis gibbosus* | 49 |
| Northern Sunfish | *Lepomis megalotis* | 150 |
| Orangespotted Sunfish | *Lepomis humilis* | 106 |
| Walleye | *Stizostedion vitreum* | 4 |
| Sauger | *Stizostedion canadense* | 3 |
| Yellow Perch | *Perca flavescens* | 1 |
| Blackside Darter | *Percina maculata* | 46 |
| Logperch | *Percina caprodes* | 13 |
| Johnny Darter | *Etheostoma nigrum* | 501 |
| Banded Darter | *Etheostoma zonale* | 2 |
| Orangethroat Darter | *Etheostoma spectabile* | 16 |
| Fantail Darter | *Etheostoma flabellare* | 55 |
| Iowa Darter** | *Etheostoma exile* | 1 |
| Freshwater Drum | *Aplodinotus grunniens* | 7 |
| Round Goby* | *Neogobius melanostomus* | 170 |
| *Non-native fish species | Total number of fish species | 70 |
| **State threatened fish species | Total number of native species | 67 |
| | Total fish | 19,665 |

**Appendix VII.** List of the fishes of the Des Plaines River collected by the US Fish and Wildlife Service during Asian Carp sampling events from 2011-2015.

| Species | Electrofishing | Gill Netting | Total |
|---|---|---|---|
| Common Carp | 1,319 | 980 | 2,299 |
| Bluegill | 857 | 2 | 859 |
| Spotfin Shiner | 757 | | 757 |
| Gizzard Shad | 624 | 8 | 632 |
| Largemouth Bass | 571 | 5 | 576 |
| Bluntnose Minnow | 465 | | 465 |
| Channel Catfish | 318 | 31 | 349 |
| Black Crappie | 274 | 2 | 276 |
| White Sucker | 267 | 7 | 274 |
| Green Sunfish | 156 | | 156 |
| Spottail Shiner | 148 | | 148 |
| Northern Pike | 116 | 31 | 147 |
| Sand Shiner | 141 | | 141 |
| Orangespotted Sunfish | 101 | | 101 |
| Golden Shiner | 95 | | 95 |
| Bowfin | 68 | 2 | 70 |
| Sauger | 56 | 2 | 58 |
| Longnose Gar | 45 | 4 | 49 |
| Emerald Shiner | 44 | | 44 |
| Blackstripe Topminnow | 41 | | 41 |
| Fathead Minnow | 40 | | 40 |
| Pumpkinseed | 37 | | 37 |
| Smallmouth Bass | 30 | 1 | 31 |
| Yellow Bullhead | 29 | | 29 |
| Round Goby | 26 | | 26 |
| Spotted Sucker | 24 | 2 | 26 |
| Goldfish | 19 | 2 | 21 |
| Bigmouth Buffalo | 2 | 18 | 20 |
| Rock Bass | 17 | 1 | 18 |
| GoldfishXCarp Hybrid | | 16 | 16 |
| Quillback | 9 | 6 | 15 |
| Smallmouth Buffalo | 1 | 14 | 15 |
| Blackside Darter | 14 | | 14 |
| River Carpsucker | 8 | 2 | 10 |
| Black Bullhead | 9 | | 9 |
| Walleye | 7 | 1 | 8 |
| Grass Carp | 1 | 6 | 7 |

| | | | |
|---|---|---|---|
| Warmouth | 6 | | 6 |
| Hornyhead Chub | 6 | | 6 |
| Creek Chub | 6 | | 6 |
| Freshwater Drum | 4 | | 4 |
| Central Stoneroller | 3 | | 3 |
| Grass Pickerel | 3 | | 3 |
| Western Mosquitofish | 2 | | 2 |
| Yellow Perch | 2 | | 2 |
| Oriental Weatherfish | 2 | | 2 |
| Johnny Darter | 2 | | 2 |
| Logperch | 2 | | 2 |
| Central Mudminnow | 2 | | 2 |
| Longear Sunfish | 1 | | 1 |
| Hybrid Sunfish | 1 | | 1 |
| White Crappie | 1 | | 1 |
| White Perch | 1 | | 1 |
| Muskellunge | 1 | | 1 |
| StripedXWhite Bass Hybrid | 1 | | 1 |
| Yellow Perch | 1 | | 1 |
| Totals | 6,783 | 1,143 | 7,926 |

Thank you for your comment, Nathan Grider.

The comment tracking number that has been assigned to your comment is GLMRISBRS50006.

Comment Date: January 16, 2015 13:11:06PM
GLMRIS Brandon Road Scoping
Comment ID: GLMRISBRS50006

First Name: Nathan
Middle Initial: T
Last Name: Grider
Organization: Illinois Department of Natural Resources
Address:
Address 2:
Address 3:
City:
State:
Zip: 62702
Country:
Attachment: IDNR GLMRIS Scoping Comments.pdf

Comment Submitted:

IDNR Scoping Comments, GLMRIS - Brandon Road Project

Illinois Department of
**Natural Resources**

One Natural Resources Way Springfield, Illinois 62702-1271
http://dnr.state.il.us

Pat Quinn, Governor
Marc Miller, Director

January 16, 2014

Dave Wethington P.E.
GLMRIS Project Manager
U.S. Army Corps of Engineers - Chicago District
231 S. LaSalle Street, Suite 1500
Chicago, IL 60604

**RE: Proposed GLMRIS - Brandon Road Project, Scoping Comments**
**County: Will**

Dear Mr. Wethington:

The Illinois Department of Natural Resources has received your request for comments for the NEPA scoping process regarding a project near the Bandon Road Lock and Dam proposed as part of the Great Lakes and Mississippi River Interbasin Study (GLMRIS). The objective of the project is to control Aquatic Nuisance Species (ANS) transfer upstream from the Mississippi River basins to the Great Lakes. Structural control methods considered for implementation at this site may include a GLMRIS Lock, electric barriers, ANS treatments, and physical barriers.

The Department is concerned about potential negative impacts to uses and users of the Chicago Area Waterway System (CAWS) as identified in the GLMRIS Report. Of special interest to the Department is the ability of watercraft to navigate through the proposed project without unnecessary delay or exposure to risks. Other potential concerns worth investigating are the risks to workers during project construction and staff during project operation. Short and long-ternm exposures to specific aspects of the project, such as $CO_2$ infused zones, should be studied. The best alternatives and mitigation should be chosen to prevent negative impacts to uses and users at the Brandon Road project site.

As you are likely aware, the Department has been reviewing a proposed hydropower facility by Northern Illinois Hydropower (NIH), LLC at the Brandon Road Lock and Dam since 2009 (FERC # 12717). The Department is interested in how the proposed GLMRIS project will affect this proposal and if the hydropower project may still be developed in cooperation between NIH and USACE. If so, the cumulative environmental impacts of both hydropower operation and the GLMRIS project at the Brandon Road site should be studied.

Another significant concern of the Department is potential negative impacts on the ability of native aquatic organisms to traverse the proposed project at this location and continue to facilitate the ecological recovery of the Upper Des Plaines River (UDPR, upstream of Brandon Lock and Dam) and CAWS that has been observed in recent decades. The following concerns are validated with survey data and published reports collected from our Fisheries Division, Impact Assessment Section, and freshwater mussel experts with the Illinois Natural History Survey serving an advisory role to the Department. The Department requests this information be evaluated in the environmental impact statement (EIS) with alternatives and mitigation measures identified that best address these issues.

**Native Fishes:**

- The primary targets for the GLMRIS – Brandon Road project are Bighead and Silver carps. While it is widely agreed that preventing upstream movement of these species into the Great Lakes Basin is an important goal, curtailing movement of these ANS fish species will also impact movement of desirable native fish species.

- Connectivity within river systems is critical to maintaining and/or restoring sustainable fisheries and native fish diversity. This is particularly true in systems such as the UDPR and the CAWS, which have experienced a long history of water quality degradation. While water quality problems remain and habitat is limited in many areas of the CAWS, conditions have improved markedly over the past 40 years, prompting review of water quality regulations and use attainment goals. On the UDPR there are many areas which retain natural habitat features and where improved water quality has resulted in restoration of sustainable sport fisheries and an increase in fish species richness. The recruitment source for many of the "new" species in the UDPR appears to be the Lower Des Plaines and Illinois rivers. The improvements in water quality in the CAWS and UDPR have stimulated expanded public investment in ecosystem improvements.

- In 1975 there were very few fish of any species present in the many areas of the CAWS, including the Chicago Sanitary and Ship Canal (CSSC; MWRD 1998). In 2012, there were 26 fish species collected in the CSSC during Asian carp monitoring efforts (Asian Carp MRWG 2013). Similar improvements have been observed in most areas of the CAWS. Recruitment sources for new fish species in the CAWS include: refugia within the system, Lake Michigan, and the lower Des Plaines/Illinois River. Among these sources, the lower Des Plaines/Illinois River has the most diverse assemblage of native riverine fish species.

- Since 1983, fish species richness and sport fish abundances have increased in the UDPR (upstream of Brandon Road Lock and Dam) in response to improved water quality conditions. Temporal changes in fish assemblages in the UDPR have been documented in fish surveys conducted by IDNR. A total of 100 fish collections were conducted at 24 locations from 1974 to 2014 (See Appendices, Table 1; Figure 1). Basin Surveys conducted in 1983, 1997, 2003, 2008, and 2013 comprise the majority of the collection data. Very few surveys were done prior to 1983, or between 1983 and 1997. Results of 1983 Des Plaines River Basin Survey are found in Bertrand (1984), and Pescitelli and Rung (2005, 2010).

- Seven of 15 stations sampled in the 1983 Basin Survey were resampled in 1997, 2003, 2008 and 2013. In 1983, these seven locations yielded 21 native fish species in 300 minutes of AC-electrofishing, an average of nine species per station. The AC-electrofishing surveys conducted at the same seven locations in 1997 with similar effort (323 minutes) yielded 37 native fish species for a mean of 16 species per location (Table 2). The number of fish species per station was similar for these seven stations in the subsequent surveys 2003 to 2013;

however, overall species richness has continued to increase over the period from 1997 to 2013(Table 2).

- For all 15 UDPR stations sampled by electrofishing and seining in 1983 there were 28 native fish species collected, including only one intolerant species- a single smallmouth bass collected at the Wisconsin State Line (Appendices, Table 3). No channel catfish were collected in the entire survey, and white sucker was the only sucker species found (Table 2). Twelve additional species were found in 1997 at only seven mainstem sampling stations. Additional new fish species were found in subsequent Basin Survey surveys (Table 3). The 2013 collection included five intolerant fish species, 86 channel catfish and three sucker species. For all surveys combined, 61 native species have been collected.

- Until 2012, the Hofmann Dam located at River Mile 44.5 (Des Plaines River) at Riverside presented a barrier to upstream fish movement. Species appearing since 1983 upstream of the dam would have likely come from refugia within the watershed, for example tributary streams within Illinois or from the Wisconsin portion of the river system. Tributary stations upstream of Hofmann Dam in 1983 included several fish species which appeared in the mainstem in more recent surveys (hornyhead chub, bigmouth shiner, central stoneroller, Johnny darter, and blackside darter; Table 4).

- Over the Basin Survey sampling period from 1997 to 2008, prior to removal of the Hofmann Dam, a number of large-bodied riverine species which were not observed in 1983 were found in the UDPR downstream of the Hoffman Dam, including: quillback, river carpsucker, silver redhorse, smallmouth buffalo, freshwater drum, and flathead catfish. The USFWS also recently collected bigmouth buffalo and black buffalo downstream of the Hofmann Dam (Asian Carp Monitoring Report 2014). Longnose gar, an additional “new” fish species, was captured in the area downstream of the former Hofmann Dam (Table 3; this species was also collected by USFWS, Asian Carp MRWG 2014).

- These large-bodied riverine species are relatively vulnerable to capture by electrofishing, therefore it is unlikely they originated from refugia within the UDPR, since they were absent in the 1983 Basin Survey at 15 locations. The most likely source for these species is the Lower Des Plaines/Illinois River populations where these species are present and common (Asian Carp Monitoring Report 2014). The migration route from the Lower Des Plaines River to the UDPR is through the Brandon Lock. The only other potential recruitment source for large-bodied riverine species is via downstream movement through CSSC (Asian Carp Monitoring Area A), where their presence is rare or undocumented (Asian Carp MRWG 2014). However, the pathway from Lake Michigan through the CAWS appears to be the source for the non-native fish species round goby, and the native species banded killifish (state-threatened), which is becoming more widespread throughout the system in recent years and seems to be advancing downstream in the Illinois River.

- In addition to potential movement of the large-bodied migrants, the appearance of several minnow species downstream of the Hoffman Dam suggests that the Brandon Lock may be used by smaller-bodied fishes as well. In particular, the appearance of rosyface shiner in 2013 indicates potential upstream movement into the UDPR. This species is listed as intolerant by

Illinois EPA and is typically found only in higher quality stream systems. Prior to 2013, there were no records for this species anywhere in the UDPR Watershed upstream of the Brandon Lock (Smogor 2004). Since 2013, rosyface shiner has also been found seven miles upstream of the former Hofmann Dam at Irving Park Road (G-30). Three other fish species found only downstream of Hofmann Dam - suckermouth minnow, striped shiner, and grass pickerel, are potential small-bodied migrants from the Lower Des Plaines River. Longear sunfish were documented for the first time in the UDPR in 2012 (Asian Carp MRWG 2013). The freckled madtom was discovered in the lower Des Plaines River near the confluence with the CSSC in 2005. This fish had not been collected in the Chicago region in 100 years. The most likely source population for this fish is 22 miles downstream, below the Brandon Road Lock and Dam. (Willink *et al.* 2006)

- There are only two tributaries to the Des Plaines River between the former Hofmann Dam and Brandon Lock, Flagg and Sawmill Creeks. In the 1983 Basin Survey, only seven species were collected from these tributaries, suggesting that Flagg and Sawmill Creeks did not serve as refugia for recently documented small-bodied species in the downstream area of UDPR (Table 5).

- In addition to the five Des Plaines River Basin Surveys conducted from 1983 to 2013, samples were collected during intervening years at selected stations. One location at Riverside (G-39, 32 miles upstream of the Brandon Road Dam) was sampled routinely during the period from 1997 to 2013 as part of the Hoffman Dam removal evaluation. This site was also sampled during the 1983 Basin Survey. Results at this location show an increase in species richness over time, similar to the results found for the basin surveys, with more frequent sampling events (Table 6). Another very likely migrant from the Lower Des Plaines River - skipjack herring, was found at this UDPR location in 2001.

- Bertrand (1984) described the Des Plaines River sport fishery as "insufficient to support even moderate angler use" based on the 1983 Basin Survey. Since the early 1990's, selected areas of the UDPR have become heavily used for sport fishing. The IDNR Fisheries Division has worked closely with local angler groups since 1995 to establish species harvest regulations, develop a successful sauger stocking program, reintroduce native aquatic plants, and remove dams to restore connectivity and riverine habitat. Electrofishing data indicates healthy populations for multiple fish species. For example, a survey conducted in 2014 downstream of the former Hofmann Dam site in Riverside yielded 25 native species and a diverse sport fishery including 10 walleye (15-20"), 10 sauger (three year classes, 8-17"), 15 smallmouth bass, 42 largemouth bass, seven northern pike, 25 channel catfish, and seven rock bass.

- Improvements in the sport fishery and in native fish species diversity observed for the UDPR in the past 40 years demonstrate the resiliency of fish and aquatic systems. However, an important component of the restoration equation is connection to diverse downstream recruitment sources. The sportfishery appears to have recovered to sustainable levels and can be supplemented by stocking. Although native fish species richness has increased and some species have become established, many others are represented by very few individuals. Even in un-modified, natural stream systems, local extirpations can occur due to natural perturbations (eg. flood and drought). In urban streams, this risk is greater due to modified flow regimes and there is an increased potential for pollution caused fish kills.

- The UDPR will likely continue to rely on a downstream connection to the Lower Des Plaines/Illinois River to maintain and expand current fish assemblages. Moreover, there are additional species present in the lower Des Plaines River which would be potential candidates for migration into the UDPR through the Brandon Lock, most notably, the redhorse species. Silver redhorse has been collected in the UDPR, represented by only two individuals to date. All five redhorse species occur in the lower Des Plaines and Illinois Rivers, including the Illinois State listed species, river and greater redhorse.

- In addition, a significant amount of restoration effort has been implemented to improve the UPDR. The IDNR and the Army Corps of Engineers completed an Ecosystem Restoration project on the Des Plaines River in 2012 which included the removal of the Hofmann Dam and two other dams (Armitage Avenue and Fairbanks Road). Lake County removed the Ryerson Dam in 2011. During 2014, Dam #1 and Dam #2 were removed as a part of IL DNR Dam Removal Initiative. The five remaining dams on the Des Plaines River are currently in the design phase for removal. After completion of the Dam Removal Initiative work, the Des Plaines River will be free flowing from the Wisconsin State Line to Brandon Road.

- Injuries and mortality of fishes occur at pumping stations, dams, and other man-made structures in rivers due to impingement on trashracks and screens, entrainment into pumps and pipes, and barotrauma during sudden pressure changes. An analysis should be completed on injury and mortality rates of fishes from equipment installed at the project site that is capable of causing these issues. The study should consider all species potentially occurring at the project site, different size classes, and loss of fish hosting mussel larvae (called glochidia). The best alternatives and mitigation measures should be chosen to address these concerns.

**Native Mussels:**

- Freshwater mussels have a complex and unique reproductive cycle (Williams *et al.* 1993). The glochidia need fish to transform and complete the mussel life cycle. Some mussel species can use several species of fish as hosts, whereas others require a particular species or family of fish. Therefore, the freshwater mussel assemblage can be tightly correlated with the fish assemblage.

- Freshwater mussels are the most imperiled group of organisms in North America. Nearly 75% of the approximately 300 North American mussel taxa are extinct, federally-listed as endangered or threatened, or in need of conservation status (Williams *et al.* 1993). In Illinois, 25 of the 62 extant species (44%) are listed as threatened or endangered (Illinois Endangered Species Protection Board 2011). Impoundments are major factors affecting freshwater mussel populations (Vaughn and Taylor 1999; Watters 2000; Tiemann et al 2007b).

- Dams not only change physicochemical parameters (e.g., modified flow patterns and increased sedimentation), but also alter host fish assemblages and restrict host fish movement (Tiemann et al. 2004; Santucci et al. 2005; Slawski et al. 2008). The resulting effects for mussels include restricted distributions, blockage of gene flow, fragmented and declining populations, and altered community composition (Vaughn and Taylor 1999; Watters 1996; Tiemann et al 2007b). These effects occur upstream and downstream of impoundments, and are exacerbated by the presence of multiple impoundments or impoundments on tributaries (Watters 1996; Tiemann et al 2007b). Also, a dam near the river's mouth can hinder the (re)colonization of mussels into a basin because the dam prohibits the dispersal of host fishes.

- The Des Plaines River basin historically supported 38 species of freshwater mussels, but only 13 species have been found alive since 1969 (Tiemann et al. 2007a; Price et al. 2012a). The Kankakee River historically supported 40 species and 30 are still considered extant (Tiemann et al. 2007a; Price et al. 2012b). The upper Illinois River, long considered a wasteland and devoid of freshwater mussels (Starrett 1971), is recovering and now has 24 species inhabiting its waters (Sietman et al. 2001; INHS Mollusk Collection database, Champaign). The species from the lower Kankakee and upper Illinois River, which include the federally-endangered scaleshell (*Leptoda leptodon*), the federally-endangered sheepnose (*Plethobasus cyphyus*), the state-threatened purple wartyback (*Cyclonaias tuberculata*), and the state-threatened black sandshell (*Ligumia recta*), likely will not have the opportunity to recolonize the Des Plaines River and CAWS if their host fishes are not able to pass through the proposed project at Brandon Road Lock and Dam.

**State-Threatened, Endangered, and Species Proposed for Listing:**

- Numerous state-listed species, and species proposed for listing, are known to occur in the upper Illinois River, lower Kankakee River, and CAWS that may be negatively impacted by the proposed GLMRIS project at Brandon Road Lock and Dam. A list of these species is included in Table 7. Impediments in the river systems will cause challenges for successful recovery of these species in the state. Some of these species, such as the state-listed greater and river redhorses as described on Page 5, are known to occur downstream of the Brandon Road lock and Dam and possible range expansion upstream into the CAWS would be eliminated with project implementation. An investigation of the effects of the proposed project on recovery of these species in their historic ranges in Illinois should be completed. The study should include an estimate of the number of individuals expected to be lost due to mortality when the proposed facility is encountered. The best alternatives and mitigation measures should be chosen to address these concerns.

- American eel population declines are mostly attributed to dams and other river obstacles preventing access to habitats and migration routes. Many projects, such as hydropower development, have included eel ladders in design plans to provide a safe route for eel's to traverse barriers (U.S. Fish and Wildlife Service 2011). American eels are observed on occasion in the Illinois River and CAWS river systems. For example, an individual was caught recently (2014) by a fisherman in Tampier Lake, Cook County. It is suspected this fish likely migrated to this location from the Mississippi River basin or possibly from the Great Lakes basin. Pending publication in the Illinois Register, the American eel will be listed as a state-threatened species. Project design should consider installing safe passage specific to the American eel at this location.

**Gene Flow, Migration, and Range Shifts:**

- Construction of the proposed project may cause fish and mussel populations to become disjunct in the CAWS and Illinois River basin with restricted gene flow. Gene flow and genetic variability is important to the well-being and future existence of a species, and perhaps even more so in modern times with anthropogenic climate change likely driving evolutionary responses (Parmesan 2006; Crozier and Hutchings 2014). The effects of the proposed project on gene flow should be investigated not only for state-listed fish and mussel species, but also ecologically and economically important aquatic species as well. The best alternatives and mitigation measures should be chosen to address this issue.

- Interference of migration and species range shifts as they respond to climate change is another issue that should be investigated. Many studies in recent years have documented range shifts attributed to climate change in freshwater, marine, and terrestrial ecosystems as species pursue optimal abiotic and biotic resource availability (Walther et al. 2002; Parmesan 2006). While range shifts may be difficult to predict for individual species, the ability of individuals to track optimal environmental conditions will increase in importance, and obstructions in travel corridors will pose significant challenges to future conservation strategies (Pearson and Dawson 2005). The effects the proposed project will have on range shifts of aquatic species in response to climate change should be investigated and the best alternatives and mitigation chosen to address these concerns.

Thank you for the opportunity to provide comments on the proposed GLMRIS project at Brandon Road Lock and Dam. Please contact Steve Pescitelli, Kevin Irons, or myself if you have further questions regarding these comments.

Nathan Grider

Nathan Grider
Impact Assessment Section
217-785-5500

cc: Steve Pescitelli – IDNR, Fisheries
Kevin Irons – IDNR, Fisheries
Jeremy Tiemann – INHS, Field Biologist
Shawn Cirton – USFWS, Chicago Illinois Field Office
Peter Bullock – USACE, Chicago District
Frank Veraldi - USACE, Chicago District

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## Appendices

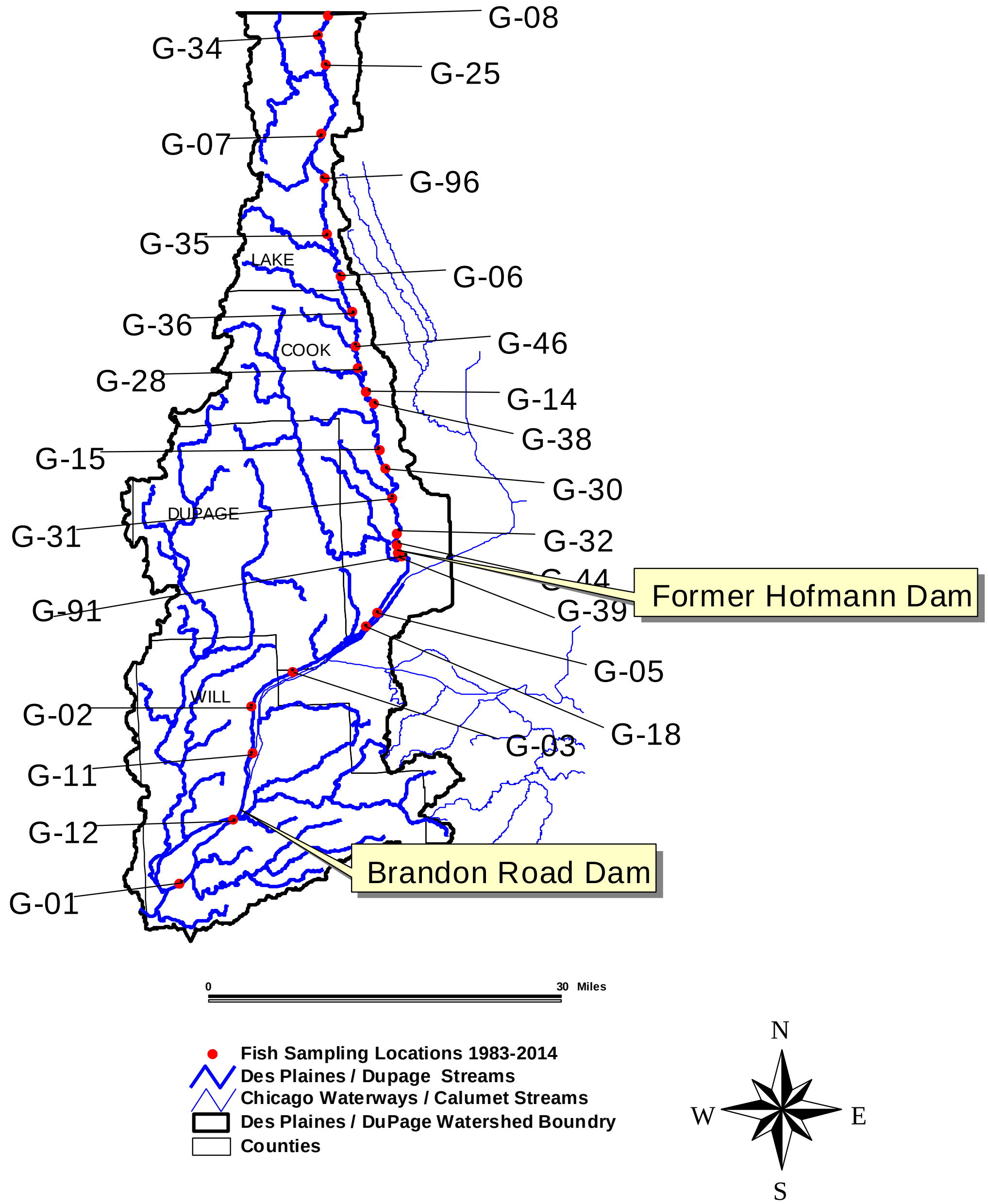



Figure 1. Location of Illinois Department of Natural Resources fish sampling locations on the mainstem of the Des Plaines River, 1983 - 2014.

Table 1. Illinios Department of Natural Resources sampling locations on the mainstem of the Des Plaines River, 1979-2014.

| Location | IEPA CODE | 1979 | 1980 | 1982 | 1983 | 1985 | 1987 | 1989 | 1990 | 1991 | 1993 | 1995 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2007 | 2008 | 2010 | 2012 | 2013 | 2014 | Total No. Stations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Russel Rd | G-08 | X | X | X | X | X | X | X | | | X | | X | | | | | | X | | | | X | | | X | | 12 |
| Rt. 173 | G-34 | | | | X | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Wadsworth Rd | G-25 | | | | X | | | | X | X | | | X | | | | | | X | | | | X | | | X | | 7 |
| Rt 120 Belvidere Rd | G-07 | | | | X | | | | | | | X | X | | | | | | X | | | | X | | | X | | 6 |
| Oak Springs Rd | G-96 | | | | X | | | | | | | | | | | | | | | | | | | | | X | | 2 |
| Danl Wright Woods | G-35 | | | | X | | | | | | | | X | | | | | | X | | | | X | | | X | | 5 |
| Deerfield Road - Ryerson | G-06 | | | | | | | | | | | | | | | | | | X | | | | | | | X | | 2 |
| Dam #1 Dwnstrm | G-36 | | | | X | | | | | | | | | | | | | | | | | | | | | X | | 2 |
| DAM #2 Dwnstrm | G-46 | | | | | | | | | | | | | | | | | | X | | | | | | | | | 1 |
| Golf Rd | G-28 | | | | X | | | | | | | | X | | | | | | | | | | | | | | | 2 |
| Oakton St US Touhy | G-14 | | | | | | | | | | | | | | | | | | X | | | | | | | X | | 2 |
| Touhy Ave | G-38 | | | | | | | | | | | | | | | | | | X | | | | | | | X | | 2 |
| Irving Park Rd | G-15 | | | | | | | | | | | | | | | | X | | X | | | | | | | X | X | 4 |
| Grand Ave (Armitage) | G-30 | | | | X | | | | | | | | | | | | | | X | | | | | | | X | X | 4 |
| Chicago Ave | G-31 | | | | | | | | | | | | | | | | | | | | | | | X | | | | 1 |
| Cermak Rd | G-32 | | | | X | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Forest Ave US Hofmann | G-44 | | | | | | | | | | | X | | X | | | X | | | | | | | | X | X | | 5 |
| Upstream Hofmann Salt Ck | G-91 | | | | | | | | | | | | | | | | | | X | | | | | | | | X | 2 |
| Swan Pond DS Hoff. | G-39 | | | | X | | | | | | | | X | X | X | X | X | | X | X | X | X | X | X | | X | X | 14 |
| Sante Fe Prairie Rt. 45 | G-05 | | | | | | | | | | | | | | | | | X | X | X | | | | | | | | 3 |
| Wentworth Ave Willow Spgs | G-18 | | | | X | | | | | | | | X | | | | | | X | | | X | X | | | X | | 6 |
| Lemont Rd | G-03 | | | | X | | | | | | | | | | | | | | | | | | X | | | X | | 3 |
| 135th St Romeoville | G-02 | | | | | | | | | | | | | | | | | | | | X | | X | | | X | | 3 |
| Division St. Lockport | G-11 | | | | X | | | | | | | | X | | | | | | X | | | | X | | | X | | 5 |
| DS Brandon Rd. Dam | G-12 | | | | X | | | | | | | | | | | | | | | | | | X | | | X | | 3 |
| I-55 Bridge | G-01 | | | | | | | | | | | | | | | | | | | | | | X | | | X | | 2 |
| Total No. Stations | | 1 | 1 | 1 | 15 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 8 | 2 | 1 | 1 | 3 | 1 | 15 | 2 | 2 | 2 | 11 | 2 | 1 | 19 | 4 | 100 |

Table 2. Mean number of species collected and mean electrofishing (EF) period at common stations sampled in all IDNR Basin Surveys, 1983 - 2013

| | 1983 | 1997 | 2003 | 2008 | 2013 |
|---|---|---|---|---|---|
| No. Stations | 7 | 7 | 7 | 7 | 7 |
| Mean No. Fish Species/Station | 8 | 16 | 16 | 15 | 18 |
| Mean EF Period (min.) | 46 | 44 | 53 | 57 | 56 |

Table 3. Native fish species collected at all locations for each IDNR Basin Survey on the mainstem of the Des Plaines River.

| Common name | Scientific name | 1983 | 1997 | 2003 | 2008 | 2013 |
|---|---|---|---|---|---|---|
| Bowfin | Amia calva | X | X | X | X | X |
| Gizzard shad | Dorosoma cepedianum | X | X | X | X | X |
| Central mudminnow | Umbra limi | X | X | | X | |
| Northern pike | Esox lucius | X | X | X | X | X |
| Golden shiner | Notemigonus crysoleucas | X | X | X | X | X |
| Creek chub | Semotilus atromaculatus | X | X | X | X | X |
| Common shiner | Luxilius cornutus | X | X | X | | |
| Spotfin shiner | Cyprinella spiloptera | X | X | X | X | X |
| Red shiner* | Cyprinella lutrensis | X | | | | |
| Fathead minnow | Pimephales promelas | X | X | X | X | X |
| Bluntnose minnow | Pimephales notatus | X | X | X | X | X |
| Emerald shiner | Notropis atherinoides | X | X | X | X | X |
| Sand shiner | Notropis ludibundus | X | X | X | X | X |
| White sucker | Catostomus commersoni | X | X | X | X | X |
| Yellow bullhead | Ameiurus natalis | X | X | X | X | X |
| Black bullhead | Ameiurus melas | X | X | X | X | X |
| Blackstripe topminnow | Fundulus notatus | X | X | X | X | X |
| Black crappie | Pomoxis nigromaculatus | X | X | X | X | X |
| White crappie | Pomoxis annularis | X | | X | X | |
| Rock bass | Ambloplites rupestris | X | X | X | X | X |
| Largemouth bass | Micropterus salmoides | X | X | X | X | X |
| Smallmouth bass | Micropterus dolomieu | X | X | X | X | X |
| Green sunfish | Lepomis cyanellus | X | X | X | X | X |
| Bluegill | Lepomis macrochirus | X | X | X | X | X |
| Pumpkinseed | Lepomis gibbosus | X | X | X | X | X |
| Yellow perch | Perca flavescens | X | | X | X | X |
| Blackside darter | Percina maculata | X | X | X | X | X |
| Johnny darter | Etheostoma nigrum | X | X | X | X | X |
| Hornyhead chub | Nocomis biguttatus | | X | X | X | X |
| Bigmouth shiner | Notropis dorsalis | | X | X | X | X |
| Quillback* | Carpiodes cyprinus | | X | X | X | X |
| Spotted sucker | Minytrema melanops | | X | X | X | X |
| Silver redhorse* | Moxostoma anisurum | | X | | | |
| Channel catfish | Ictalurus punctatus | | X | X | X | X |
| Tadpole madtom | Noturus gyrinus | | X | X | X | X |
| Brook silverside | Labidesthes sicculus | | X | | | X |
| Yellow bass | Morone mississippiensis | | X | | X | X |
| Orangespotted sunfish | Lepomis humilis | | X | X | X | X |
| Walleye | Stizostedion vitreum | | X | X | X | X |
| Freshwater drum* | Aplodinotus grunniens | | X | X | X | X |
| Central stoneroller | Campostoma anomalum | | | X | X | |
| Redfin shiner | Lythrurus umbratilus | | | X | | |
| Blackchin shiner | Notropis heterodon | | | X | | |
| Mimic shiner | Notropis volucellus | | | X | | |
| Spottail shiner | Notropis hudsonius | | | X | X | X |
| Smallmouth buffalo* | Ictiobus bubalus | | | X | X | X |
| Stonecat | Noturus flavus | | | X | X | X |
| Mosquitofish | Gambusia affinis | | | X | X | X |
| Warmouth | Lepomis gulosus | | | X | X | X |
| Sauger | Stizostedion canadense | | | X | X | X |
| Striped shiner* | Luxilus chrysocephalus | | | | X | |
| River carpsucker* | Carpiodes carpio | | | | X | X |
| Flathead catfish* | Pylodictis olivaris | | | | X | |
| Logperch | Percina caprodes | | | | X | X |
| Longnose gar* | Lepisosteus osseus | | | | | X |
| Grass pickerel* | Esox americanus | | | | | X |
| Muskellunge | Esox masquinongy | | | | | X |
| Suckermouth minnow* | Phenacobius mirabilis | | | | | X |
| Rosyface shiner** | Notropis rubellus | | | | | X |
| Banded killifish* | Fundulus diaphanus | | | | | X |
| Redear sunfish | Lepomis microlophus | | | | | X |
| | Total Native Species | 28 | 37 | 45 | 47 | 50 |
| | Cummulative Species Total | 28 | 40 | 50 | 54 | 61 |
| | No. Stations | 15 | 8 | 19 | 8 | 17 |

*collected only downstream of former Hofmann Dam

Table 4. Fish species found in Des Plaines River tributaries, upstream of the Hofmann Dam in 1983. Streams include Mill Creek, Indian Creek, Bull Creek, Willow Creek, Salt Creek, and Addison Creek.

| Common name | Scientific name |
|---|---|
| Goldfish | Carassius auratus |
| Carp | Cyprinus carpio |
| Golden shiner | Notemigonus crysoleucas |
| Creek chub | Semotilus atromaculatus |
| Hornyhead chub | Nocomis biguttatus |
| Unidentified Stoneroller | Campostoma sp. |
| Common shiner | Luxilius cornutus |
| Spotfin shiner | Cyprinella spiloptera |
| Fathead minnow | Pimephales promelas |
| Bluntnose minnow | Pimephales notatus |
| White sucker | Catostomus commersoni |
| Brown bullhead | Ameiurus nebulosus |
| Stonecat | Noturus flavus |
| Blackstripe topminnow | Fundulus notatus |
| Brook silverside | Labidesthes sicculus |
| Black crappie | Pomoxis nigromaculatus |
| Largemouth bass | Micropterus salmoides |
| Green sunfish | Lepomis cyanellus |
| Bluegill | Lepomis macrochirus |
| Pumpkinseed | Lepomis gibbosus |
| Blackside darter | Percina maculata |
| Johnny darter | Etheostoma nigrum |
| Fantail darter | Etheostoma flabellare |

Table 5. Fish species found in Des Plaines River tributaries, downstream of Hofmann Dam in 1983. Streams include Flagg Creek and Sawmill Creek.

| Common name | Scientific name |
|---|---|
| Golden shiner | Notemigonus crysoleucas |
| Creek chub | Semotilus atromaculatus |
| Fathead minnow | Pimephales promelas |
| White sucker | Catostomus commersoni |
| Largemouth bass | Micropterus salmoides |
| Green sunfish | Lepomis cyanellus |
| Bluegill | Lepomis macrochirus |

Table 6. ILDNR sampling results downstream of the former Hofmann Dam (Removed 2012) at Station G-39 on the Des Plaines River mainstem, 32 miles upstream of Brandon Lock, 1983 - 2014.

| Common name | Scientific name | 1983 | 1996 | 1997 | 1998 | 1998 | 1999 | 2000 | 2001 | 2003 | 2005 | 2008 | 2010 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Black bullhead | Ameiurus melas | X | | | X | X | | | | | | | | | |
| Black crappie | Pomoxis nigromaculatus | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Bluegill | Lepomis macrochirus | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Bluntnose minnow | Pimephales notatus | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Carp | Cyprinus carpio | X | X | X | X | X | X | X | X | X | X | X | X | | X |
| Creek chub | Semotilus atromaculatus | X | | X | | | | | | | | | | X | X |
| Gizzard shad | Dorosoma cepedianum | X | X | X | X | X | X | | X | X | X | X | X | X | X |
| Goldfish | Carassius auratus | X | X | X | X | X | X | | | X | | X | X | | X |
| Green sunfish | Lepomis cyanellus | X | X | X | X | X | X | X | | X | X | X | X | X | X |
| Largemouth bass | Micropterus salmoides | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Pumpkinseed | Lepomis gibbosus | X | X | | X | X | X | | | X | | | | | X |
| Red shiner | Cyprinella lutrensis | X | | | | | | | | | | | | | |
| White sucker | Catostomus commersoni | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Bowfin | Amia calva | | X | X | | | | | | | X | X | | | X |
| Channel catfish | Ictalurus punctatus | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Golden shiner | Notemigonus crysoleucas | | X | X | | | X | | X | | | X | | | |
| Orangespotted sunfish | Lepomis humilis | | X | X | X | X | X | X | | X | X | X | X | X | |
| Sand shiner | Notropis ludibundus | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Smallmouth bass | Micropterus dolomieu | | X | X | X | X | X | X | X | X | | | | X | X |
| Smallmouth buffalo | Ictiobus bubalus | | X | | | | | | | | X | | | | X |
| Spotfin shiner | Cyprinella spiloptera | | X | X | | X | X | X | X | X | X | X | X | X | X |
| Walleye | Stizostedion vitreum | | X | X | | X | X | X | X | X | X | X | X | | X |
| Bigmouth shiner | Notropis dorsalis | | | X | X | X | X | | | X | | X | | X | |
| Fathead minnow | Pimephales promelas | | | X | | | X | | | | | X | | X | |
| Northern pike | Esox lucius | | | X | X | X | X | X | X | X | X | X | | X | X |
| Silver redhorse | Moxostoma anisurum | | | X | | | | | | | | | | | X |
| Yellow bass | Morone mississippiensis | | | | X | X | X | | | | | | | | |
| Yellow bullhead | Ameiurus natalis | | | | X | X | X | | | X | | X | X | | |
| Emerald shiner | Notropis atherinoides | | | | | | X | | | | X | | | | |
| Rock bass | Ambloplites rupestris | | | | | | X | | | X | X | X | X | X | X |
| Spottail shiner | Notropis hudsonius | | | | | | X | | X | X | X | | | | X |
| White crappie | Pomoxis annularis | | | | | | X | | | | | X | | | |
| Yellow perch | Perca flavescens | | | | | | X | | | | X | | | | |
| Spotted sucker | Minytrema melanops | | | | | | | X | X | | | | X | | X |
| Tadpole madtom | Noturus gyrinus | | | | | | | X | X | | | | | | |
| Johnny darter | Etheostoma nigrum | | | | | | | X | X | X | | X | | X | |
| Sauger | Stizostedion canadense | | | | | | | | X | X | X | X | X | | X |
| Skipjack herring | Alosa chrysochloris | | | | | | | | X | | | | | | |
| Suckermouth minnow | Phenacobius mirabilis | | | | | | | | X | | | | | X | |
| Blackstripe topminnow | Fundulus notatus | | | | | | | | | X | | X | | X | |
| Common shiner | Luxilius cornutus | | | | | | | | | X | | | | | |
| Freshwater drum | Aplodinotus grunniens | | | | | | | | | X | | X | | | X |
| Hornyhead chub | Nocomis biguttatus | | | | | | | | | X | X | X | X | X | X |
| Blackside darter | Percina maculata | | | | | | | | | | X | | | | |
| Striped shiner | Luxilus chrysocephalus | | | | | | | | | | X | X | | | |
| Round goby | Neogobius melanostomus | | | | | | | | | | | X | X | X | X |
| Logperch | Percina caprodes | | | | | | | | | | | | | X | |
| Mosquitofish | Gambusia affinis | | | | | | | | | | | | | X | |
| Quillback | Carpiodes cyprinus | | | | | | | | | | | | | X | |
| River carpsucker | Carpiodes carpio | | | | | | | | | | | | | X | X |
| Rosyface shiner | Notropis rubellus | | | | | | | | | | | | | X | X |
| | Native Fish Species | 11 | 17 | 20 | 17 | 18 | 25 | 16 | 20 | 25 | 23 | 26 | 17 | 26 | 26 |
| | Cummulative Species Total | 11 | 20 | 24 | 26 | 26 | 31 | 34 | 37 | 41 | 43 | 43 | 43 | 49 | 49 |
| | Electrofishing minutes | 30 | 38 | 60 | 30 | 60 | 60 | 50 | 30 | 53 | 60 | 60 | 60 | 60 | 45 |

Table 7: List of state-threatened, endangered and species proposed for listing which may be negatively impacted by implementation of the proposed GLMRIS project at Bandon Road Lock and Dam.

| Common Name | Scientific Name | State Status |
|---|---|---|
| American eel | *Anguilla rostrata* | Proposed as threatened |
| American brook lampray | *Lethenteron appendix* | Proposed as threatened |
| Banded killifish | *Fundulus diaphanus* | Threatened |
| Black sandshell | *Ligumia recta* | Threatened |
| Blacknose shiner | *Notropis heterolepis* | Endangered |
| Brassy minnow | *Hybognathus hankinsoni* | Proposed as threatened |
| Greater redhorse | *Moxostoma valenciennesi* | Endangered |
| Iowa Darter | *Etheostoma exile* | Threatened |
| Longnose sucker | *Catostomus catostomus* | Threatened |
| Mudpuppy | *Necturus maculosus* | Threatened |
| Purple wartyback | *Cyclonaias tuberculata* | Threatened |
| River redhorse | *Moxostoma carinatum* | Threatened |
| Pallid shiner | *Hybopis amnis* | Endangered |
| *Scaleshell | *Leptoda leptodon* | Proposed as endangered |
| *Sheepnose | *Plethobasus cyphyus* | Endangered |

*****Federally listed species

Doug Keller
Indiana Division of Fish and Wildlife
402 W. Washington St., Rm W273
Indianapolis, IN 46204
dkeller@dnr.in.gov

U.S. Fish and Wildlife Service
Midwest Region
Bloomington, MN

RE: FWCAR – Brandon Road Project

September 6, 2016

The Indiana Department of Natural Resources appreciates having been given the opportunity to comment at multiple times throughout the process of developing the Fish and Wildlife Coordination Act Report for the U.S. Army Corps of Engineers GLMRIS – Brandon Road Project. Some relatively minor edits and comments are "tracked" in the attached draft September 2016 document. There are three additional comments that were not addressed in the document that I would like to raise here.

Indiana strongly supports adding black carp as a species to be addressed at Brandon Road due to the expansion of the black carp population. In fact, we feel that all management plans addressing species of Asian carp along the Mississippi River or Ohio River should consider options to address black carp.

Indiana agrees that the two options supported in the document (Continuous Electric Barrier and Complex Noise with Continuous Electric Barrier) would be the most effective in preventing the expansion of Asian carp populations and would still allow shipping. Continuous electricity however will create a barrier to not only invasive fish species but also to native species. While sound technology may not be fully developed at this time, additional research may reveal effective sounds that completely block Asian carp but allow other native species to pass. For this reason, it is the desire of Indiana DNR that the option that combines the sound barrier with the electric barrier be constructed at Brandon Road lock and dam. Including sound now will speed the process should effective sound technology be discovered in the future.

Finally, Indiana DNR urges the Army Corps of Engineers to continue to investigate methods that may eliminate or reduce the two-way transfer of aquatic invasive species at Brandon Road. There are still a number of invasive species in the Great Lakes that are not yet established in the Mississippi basin

Thank you again for allowing Indiana to be a part of the process for determining a barrier solution at Brandon Road.

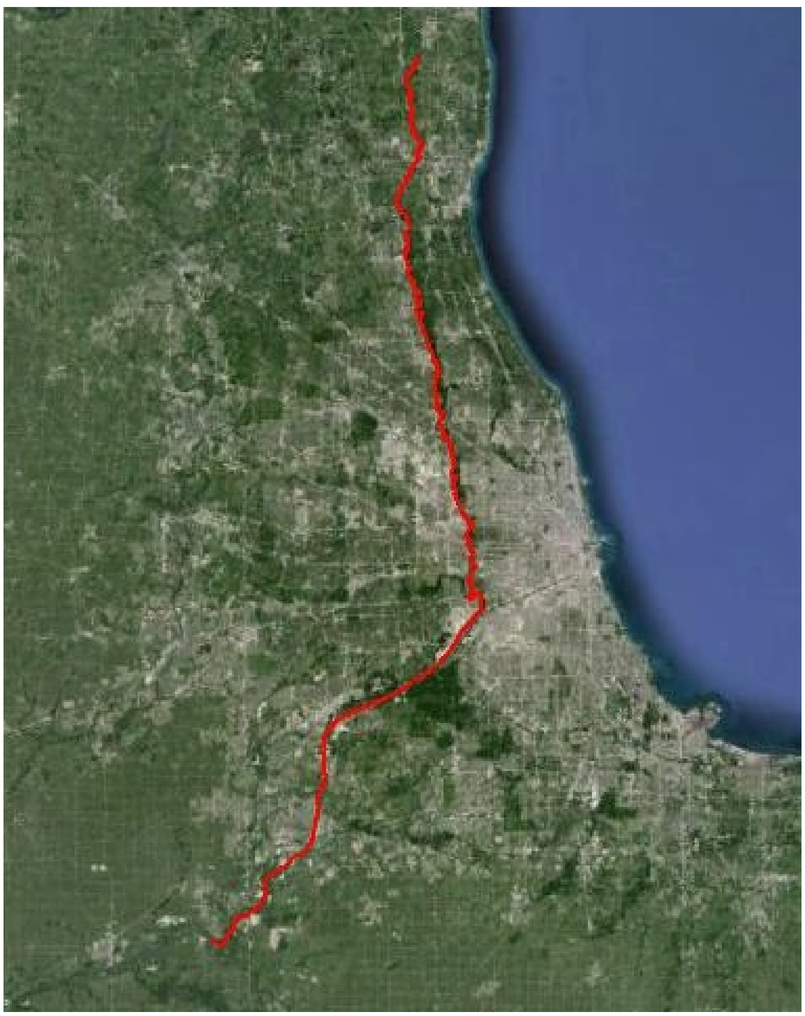
Sincerely,

Douglas C. Keller

Doug Keller
Aquatic Habitat Program Manager

Office of Resource Conservation
Division of Fisheries
Area A Streams Program
5931 Fox River Drive
Plano, IL 60548

# Des Plaines River Fishery Management Plan
# June 2016



# Table of Contents

## Contents

## Introduction

The Des Plaines River is a valuable natural resource providing abundant recreational opportunities for urban residents in Northeastern Illinois. Much of the River corridor is in public ownership with extensive miles of Forest Preserve Land in Lake, Cook, DuPage and Will County. The entire River is also part of the Northeastern Illinois Water Trail System. Although once highly degraded, the river now supports areas of diverse and sustainable fisheries. There have been extensive restoration efforts including dam removals and habitat restoration, as well as watershed-based planning and remediation efforts. To date, six dams on the mainstem of the Des Plaines River has been removed. As part of the Illinois Department of Natural Resources (IDNR) Dam Removal Initiative, all remaining mainstem dams upstream of the Brandon Lock and Dam are slated for removal, creating over 110 miles of free flowing river, one of the longest in Northern Illinois.

Although water quality conditions have improved over the past 30 years, most of the Des Plaines River remains impaired for Aquatic Life, Recreation, and Fish Consumption (IEPA 2016). Recently, the Des Plaines River Watershed Group was formed to address water quality impairments and to develop a watershed plan for the Lake County portion of the system with financial support from Illinois Environmental Protection Agency (IEPA).

IDNR Division of Fisheries has been actively involved in Des Plaines River management including fish monitoring, stocking and regulation of sportfish populations, habitat improvement including dam removals and emergent plant reintroductions as well as working with local partners in restoration planning and outreach efforts. This Management Plan describes current conditions on the Des Plaines River, reviews past and ongoing management activities, summarizes factors currently limiting fish assemblages, and presents management recommendations for maintain and improving the status of game and non-game fishes in the Des Plaines River .

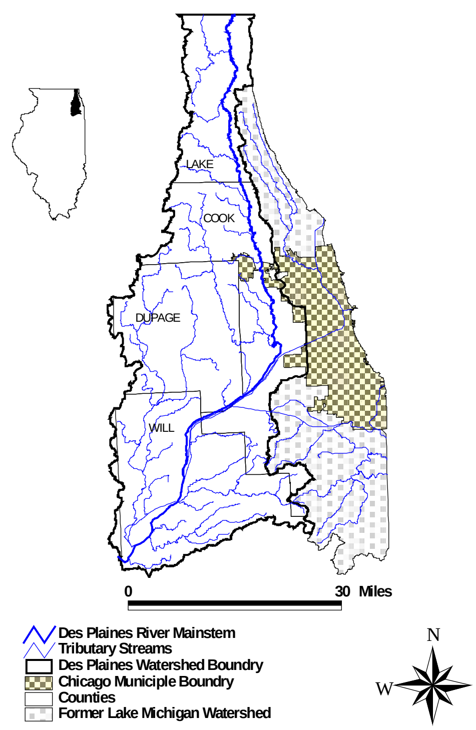


**Figure 1. Des Plaines River Mainstem with tributary streams and watershed boundaries.**

## Description of Management Area

The Des Plaines River originates near Racine, Wisconsin in Kenosha County, entering Illinois two miles north of the town of Rosecrans in Lake County. The river flows primarily south for 110 miles in Illinois where it joins the Kankakee River to form the Illinois River near Channahon (Figure 1). Total watershed area includes approximately 2,110 square miles, 1,231 of which are in Illinois (Healy 1979). The drainage area was increased by 673 square miles after diversion of Lake Michigan water through the Chicago Sanitary and Ship Canal (CSSC) and the Cal Sag Channel in the early 1900's. The CSSC joins the Des Plaines River at river mile 17, just north of Joliet. A 16 mile section of the Des Plaines River, from approximately Romeoville to 47$^{th}$ Street was channelized as part of the CSSC Construction.

The Des Plaines River is a low gradient stream falling 120 feet in elevation over its 110 mile length in Illinois, with an average slope of 1.2 feet/mile. Higher gradient areas are found in a short segment near Riverside and from Romeoville to CSSC, where the gradient increases to nearly seven feet/mile.

The DuPage River is the largest tributary to the Des Plaines River, with a watershed covering 353 square miles (Healy 1979), including urbanized areas of DuPage County. Other larger tributaries include Salt Creek with a watershed area of 150 square miles, Hickory Creek (107 square miles), Jackson Creek (52 square miles) and Mill Creek (31 square miles). The watershed includes parts of Lake, Cook, DuPage, Grundy, and Will Counties in Northeastern Illinois (Figure 1). With over 6 million people residing in the watershed, landuse is 58.7% urban development, with only 33.2% of the surface area in agriculture. By comparison, urban land use in the Fox Basin is 17.5% and only 3.5% statewide.

The Des Plaines/DuPage Watershed has a large number of municipal wastewater treatment plants (n=85) and other industrial treatment facilities (n=66), which discharge 1,221 million gallons of wastewater per day into the stream systems (IEPA 2014). Much of that flow comes into the lower watershed through the CSSC as municipal wastewater, originating from Lake Michigan. Mean discharge at Romeoville, downstream of the CSSC, is 3,536 cubic feet per second (cfs) for 739 square miles of watershed area, compared to mean discharge at Riverside of 535 cfs for 630 square miles (USGS 2004).

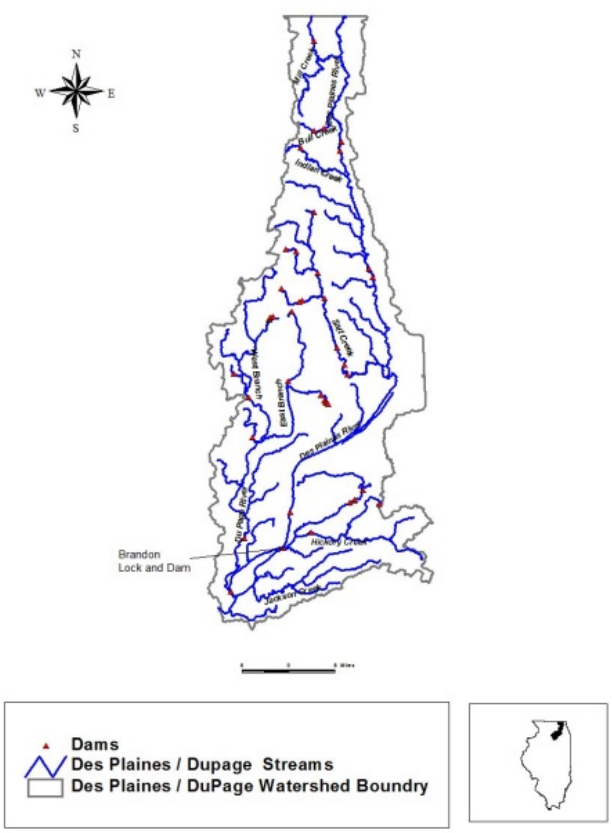



Figure 2. Location of dams in the Des Plaines River watershed.

A total of 44 dams are listed for the Des Plaines River Watershed (Figure 2, USACOE 2013). The Brandon Road Lock and Dam in Rockdale is 2,391 wide and 35 feet tall, located 13 miles upstream from the Illinois River confluence in Rockdale, IL (Figure 2). During 2014, nearly 12 million tons of freight was moved through the lock (USACE 2015). Despite presenting a “bottle neck” to upstream passage, fish are able to pass through the lock. It appears that the Lock structure has been the major conduit for movement of native fishes from the lower Des Plaines and Illinois Rivers, back into the upper Des Plaines River (upstream of the CSSC), which was formerly highly degraded due to water pollution (Pescitelli 2016). In 2014, the Great Lakes Mississippi Interbasin Study (GLMRIS 2014) identified the Brandon Lock as a potential control point to prevent one-way, upstream transfer of aquatic nuisance species (ANS) from the Mississippi River basin to the Great Lakes basin. Controlling passage of non-native ANS may also impact upstream movement of native fishes and affect restoration efforts in the upper Des Plaines River. Upstream of Brandon Road, there were 12 low head dams on the mainstem, six of which have been removed since 2011 (*see* Dam Removal Section below).

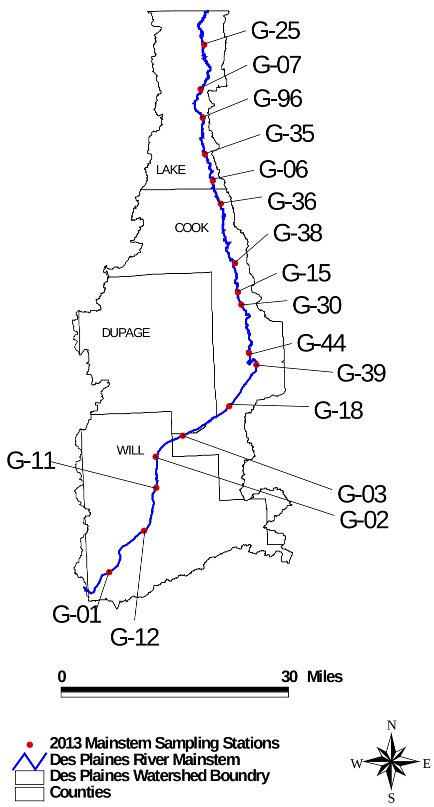



**Figure 3. Location of IL DNR fish sampling stations on the Des Plaines River**

## Current Status of Fish Assemblages and Sportfishery

IL DNR conducts intensive fish surveys in the Des Plaines River Basin every five years. The most recent survey in 2013 included 17 locations on the mainstem (Figure 3; Pescitelli 2016). A total 6,124 fish were collected, representing 57 native species. Two State Threatened fish species were collected, Banded Killifish and Iowa darter, each represented by one individual. Three non-native fish species were also found: Common Carp, Goldfish, and Round Goby (Table 4). One Grass Carp was captured below the Brandon Lock and Dam in 2008 (Pescitelli and Rung 2008). No other Asian Carp species were collected or observed in 2013, or in any previous surveys. Another species of interest, Rosyface Shiner, was collected at four mid-river stations between Riverside (G-39) and Irving Park Road (G-15). A total of 39 individuals were captured. This minnow species is considered to be intolerant (Smogor 2004), and has not been collected in previous basin surveys at any locations upstream of Brandon Lock and Dam. The only record for Rosyface Shiner in the upper Des Plaines Basin is from Mill Creek in 1976 (Heidinger 1989).

The number of fish species at each station ranged from 19 to 27, with highest number collected at G-39 in Riverside, downstream of the former Hofmann Dam. Channel gradient, proximity to the Illinois River and lower Des Plaines River, and presence of dams appeared to influence the composition and distribution of fish species. Rock Bass and Northern Pike were found predominately at stations in the lower gradient area above upstream of station G-39. Channel catfish and Smallmouth Bass were more abundant in the area downstream of G-44, especially in the higher gradient segments. A total of 15 fish species were found only in the lower river, downstream of G-44, including larger bodied, migratory fishes, which generally prefer larger riverine habitats (e.g., Longnose Gar, Smallmouth Buffalo, River Carpsucker, and Quillback Carpsucker). Upstream movement may have been blocked by the Hofmann Dam which was removed in 2012. Seven fish species were found only downstream of the Brandon Lock and Dam including Longer Sunfish, Redear Sunfish, White Bass, Golden Redhorse, Silver Redhorse, Black Buffalo, and Flathead Catfish. Non-metric multidimensional Scaling (NMDS; Primer 5) analysis indicated that stations downstream of Brandon Lock (G-01 and G-12) were unique compared to other upstream stations, which segregated roughly by river segment (Figure 4).

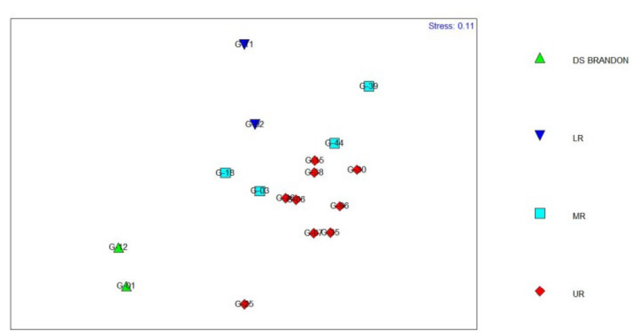



**Figure 4. Non-metric Multidimensional Scaling plot (log(X+1) transformed catch per effort, Bray Curtis Similarity) by river segment: DS=downstream Brandon Lock; LR = lower river; MR = middle river; UR = upper river.**

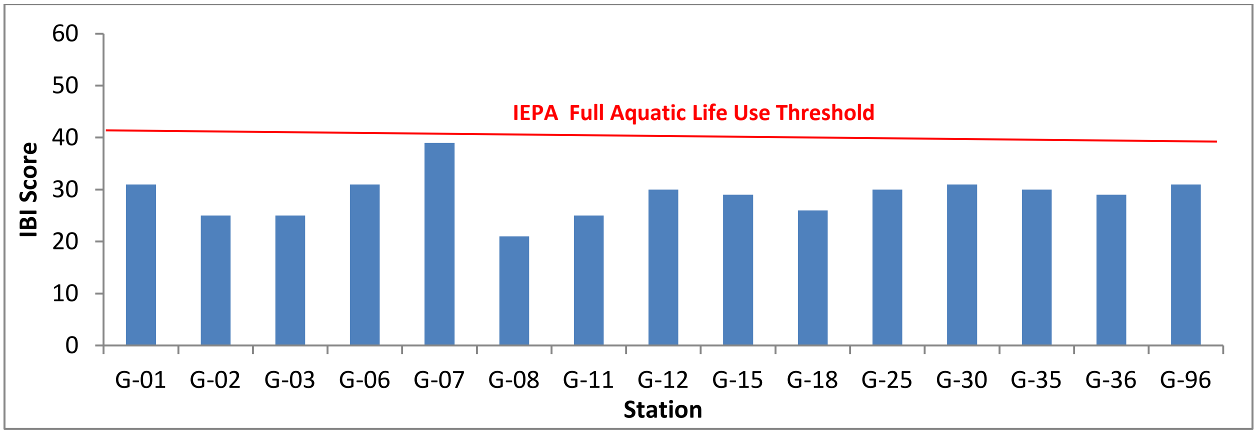



**Figure 5. Index of Biotic Integrity Scores (IBI) for Des Plaines River stations sampled in 2013. Total IBI range is 0 to 60, with higher scores indicating better stream quality.**

Index of Biotic Integrity scores ranged from 25 to 39, indicating moderate to low stream. The mean IBI for the Des Plaines River was 30, compared to a mean of 48 for the Kankakee River (13 stations). For the Des Plaines River in 2013, four of the ten IBI metric scores were particularly low (range 1 – 3 out of 6 possible points) for "Number sucker species", "Number intolerant species", "Proportion benthic invertivore species", and "Proportion mineral substrate spawners". All of the 2013 mainstem stations were below the threshold for "Good Resource Quality/Fully Supportive" Aquatic Life Use Rating (fish IBI ≥ 41), rating instead in the category, "Poor Resource Quality/Not supportive" (IEPA, 2014). Ratings based IBI ratings (IEPA 2014). Five of six stations received the highest rating "Good Resource Quality/Fully Supportive" based on the macroinvertebrate IBI (mIBI).

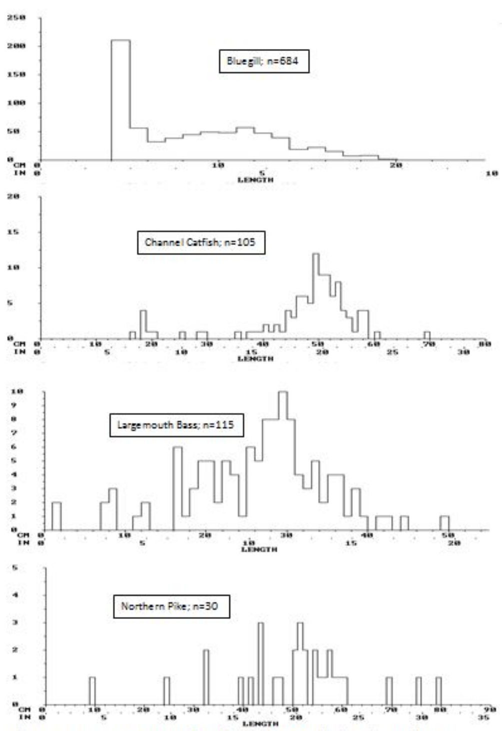



**Figure 6. Length-frequency distributions for selected Des Plaines River sportfish species from 2013 basin survey.**

Bluegill was the most abundant sportfish species in 2013 with a total of 684 collected by seining and electrofishing. Individuals in the one to three inch range were very abundant, while fish over six inches were rare (Figure 6). Bluegill were widespread throughout the mainstem, but were generally more abundant at the upstream, lower gradient locations. A total of 106 Channel Catfish were collected in 2013, with most individuals in the 15 to 20 inch size range (Figure 6). They were more abundant in the lower river segments where riffle habitat was present. Catch rates of Largemouth Bass were low upstream of the Brandon Lock with mean catch rate of less than three fish/hour. For the two stations downstream of Brandon Lock (G-12 and G-10), catch rates were much higher with a mean of 39 fish/hour. Most Largemouth Bass were in the 10 to 12 inch range. A total of 29 Northern Pike were collected in 2013 at nine of the 17 mainstem locations. Pike were more abundant at the upper river stations. The largest Northern Pike was 31 inches in length, although most fish were in the 20 to 25 inch range (Figure 6). Smallmouth Bass were found only downstream of G-44 (Table 5), whereas Rock Bass were collected primarily in the upstream areas. Larger sized Rock Bass (>8 inches) and

Smallmouth Bass (>12 inches) were present, but abundance was low. Overall, catch rates for most sportfish was lower in 2013 compared to recent surveys but were within the range found in previous surveys (Pescitelli and Rung 2010). One exception was Largemouth Bass, which were in low abundance in 2013 compared to all previous years. Higher catch rates of most sportfish species have been observed during fall surveys at G-39 in Riverside (Pescitelli 2015).

Previous basin surveys were conducted on the Des Plaines River in 1983, 1997, 2003, and 2008. In 1983, only 28 fish species were found at 15 stations upstream of the Brandon Lock and Dam (Bertrand 1984), compared 50 fish species at 15 mainstem stations in the same river segment in 2013. Two stations downstream of the Brandon Lock and Dam yielded 15 species in 1983 (Bertrand 1984). In 2013, we collected 30 species at two stations in the same area. For basin surveys between 1997 and 2013, a total of 33 fishes have been collected upstream of the Brandon Lock and Dam which were not found in 1983 in the same area of the mainstem. The presence of degraded water quality conditions in 1983 led to the local extirpation of fish species in the Des Plaines River (Bertrand 1984; IEPA 1988; Pescitelli 2015). Many of the additional fishes found since 1983, especially the larger riverine fishes, most likely migrated upstream through the Brandon Lock from the Lower Des Plaines and Illinois Rivers. Other potential sources include refugia within the upper Des Plaines River watershed, and migration from Lake Michigan and the CAWS (Pescitelli 2015). Round Goby and Banded Killifish appear to have originated from Lake Michigan, entering the Des Plaines River through the CSSC (*see* Figure 1).

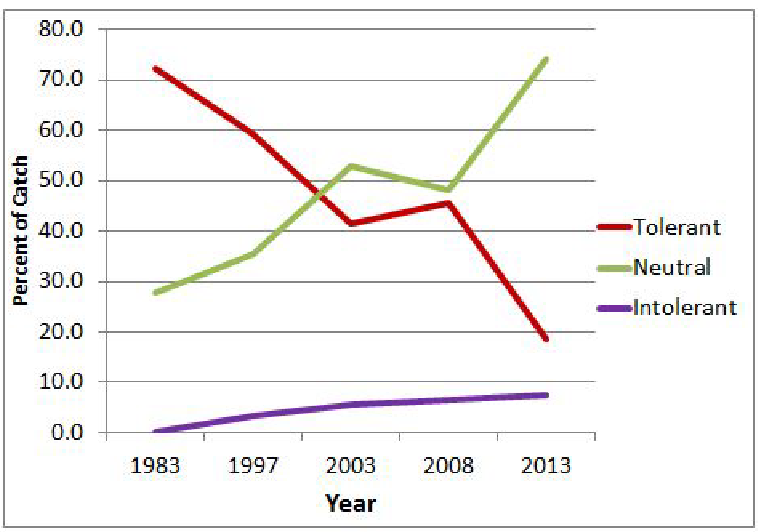



**Figure 7. Percentage of tolerant, neutral, and intolerant fish (Smogor 2004) for six stations sampled in all Des Plaines River Basin Surveys 1983-2013.**

In addition to the increase in fish species richness observed for the Des Plaines River from 1983 to 2013, overall species composition changed, with a notable decrease in percentage of tolerant fishes. For the six stations common to all basin surveys, fish species listed by Smogor (2004) as tolerant, composed 72% of the total in 1983 and only 18% of the total in the 2013 survey (Figure 7), with a substantial decrease since 2008. Although the percentage of tolerant species decreased over the sampling period from 1983 to 2013, there has been very little increase of intolerant fish species in recent years (Figure 6). In 2013 there were only five intolerant species collected on the Des Plaines River, making up a small percentage of the total catch. In contrast, there were 11 intolerant fish species at 13 stations on the Kankakee River, which is considered to be one of the higher quality rivers in Illinois (Pescitelli and Rung 2012). The appearance of Rosyface Shiner on the Des Plaines River in 2013 and other species such as Silver Redhorse in 2014 surveys (Pescitelli 2015), suggests that water quality conditions may be adequate to support additional species, including minnow and sucker fish species which currently occur only downstream in the Lower Des Plaines, Kankakee and Illinois Rivers below the Brandon Lock and Dam. Data from IEPA macroinvertebrate sampling indicate water quality is adequate for full support of aquatic life use at all but one Des Plaines River mainstem stations.

While there have been notable improvements on the Des Plaines River since 1983, IBI scores remain in the range indicating low to moderate stream quality. All 2013 mainstem stations were below the threshold for

"Good Resource Quality/Fully Supportive" Aquatic Life Use Rating (fish IBI ≥ 41), rating instead in the category, "Poor Resource Quality/Not supportive" (fish IBI <41 and >20; IEPA, 2014). Increases in fish species richness, including the appearance of more sensitive species, along with the decrease in tolerant fishes, suggests that current conditions in the Des Plaines River could support additional fish species groups such as suckers, intolerant fishes, specialist benthic invertivores, and mineral substrate spawners which are needed to improve fish IBI scores. The primary source for recruitment of these fish species groups for the upper Des Plaines River is the Lower Des Plaines, Kankakee and Illinois Rivers via the Brandon Lock and Dam.

## On Going and Past Management IL DNR Management Activities

***Fish Monitoring.***

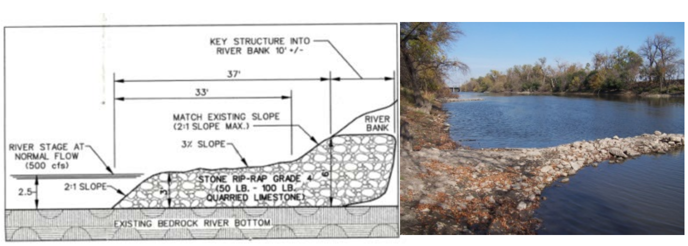
IL DNR conducts intensive fish surveys in the Des Plaines River Basin every five years as part of a Statewide program with IEPA. Fish are sampled at 17 mainstem and 17 tributary locations. IEPA samples water and sediment quality, macroinvertebrates, and conducts qualitative habitat evaluation (wadeable sites only). In addition to the basin survey sampling, routine sportfish monitoring is conducted every fall at selected locations.

***Sportfish Management.***

**Des Plaines River Sauger**

Stocking. IDNR Division of Fisheries has stocked, Sauger in the Des Plaines River since 2000, with an average of 19,000 two-inch fingerlings released per year at Riverside and two locations downstream. Typical electrofishing catch rates for Sauger were 10-15 per hour during fall surveys, with fish ranging from 6 to 19 inches in length. Four- inch Smallmouth Bass were stocked from 1997 to 2002 near Riverside to supplement low natural reproduction.

Management Zones. The higher gradient river segment near Riverside is very productive for sportfish and receives high fishing pressure due to the urbanized surroundings. A management zone was established to limit harvest for popular gamefish species including: Channel Catfish, Black Bass, Walleye, Sauger, White Crappie and Black Crappie.




**Rock Bar Habitat**

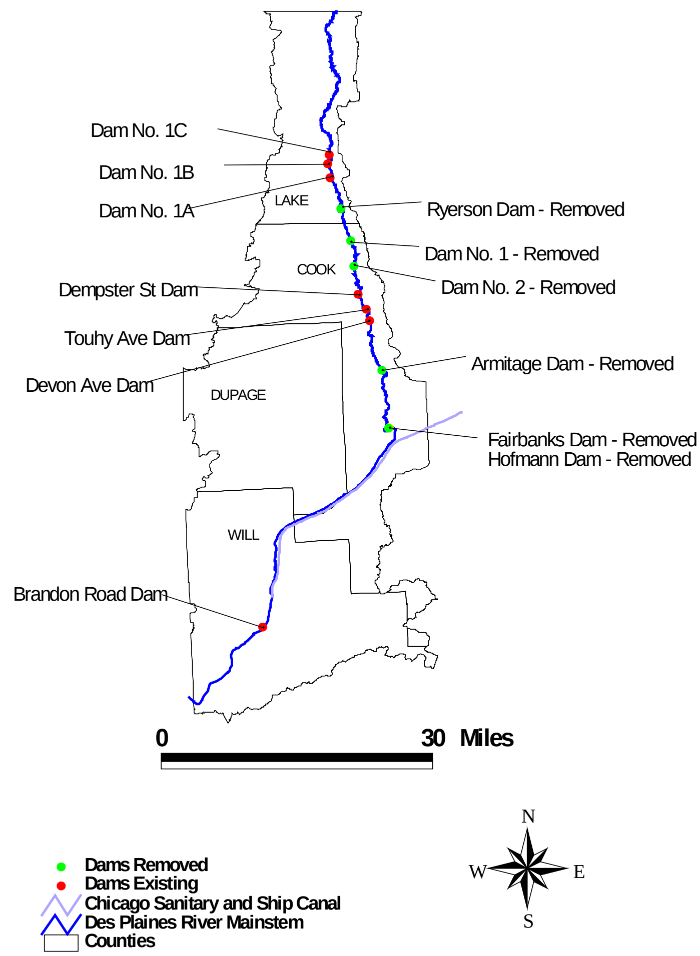
***Habitat Improvement.***

Rock Bars and Islands. A seventeen mile segment of the Des Plaines River between Romeoville and 47th Street was channelized during construction of the CSSC. In order to improve habitat in this section, IL DNR installed five rock bars and three small islands.

Emergent Plant Reintroduction.

Beginning in 1998, IL DNR Fisheries initiated an Emergent Plant Reintroduction Program with a local fishing group, the Hoffmann Dam River Rats. Several large projects were executed over the next few years with over 1000 Water Willow (*Justicea americana*) plugs planted throughout the Riverside/Lyons area. Since 2012 the Hofmann Dam River Rats have planted about 300 Water Willow per year in the area of upstream of the Hoffman Dam removal site. These plants provide habitat for fish and macroinvertebrates and help stabilize the shoreline areas as they become dense colonies.

Dam Removal. The Hoffman Dam was targeted for removal by IL DNR Region II Streams Program together with the Hoffman Dam River Rats in 1996. The 12 ft. high structure was impassable by fish and paddlecraft and had claimed the lives of several people. Due to past water quality problems, key native fish species were absent from the area upstream of the dam, including Smallmouth Bass, Channel Catfish and many sucker and minnow species. An Ecosystem Restoration Project was initiated with the Army Corps of Engineers in 1997. After many public meetings and budget issues, the dam was finally removed in 2012 along with the Fairbanks and Armitage Dams. The Hoffman Dam removal was the first large dam removal in Illinois. The success of this project helped initiate a statewide Dam Removal Program which resulted in the removal of two additional structures in 2014, Dam No. 1 and Dam No. 2. Ryerson Dam was removed in 2011 by Lake County Forest Preserve District. All remaining dams are slated for removal which will create 110 miles of free-flowing river.




**Location of existing dams and dam removals on the Des Plaines River**

## Summary and Recommendations

Like many rivers and streams in Illinois and across the country, the Des Plaines River system has benefitted from improved water quality conditions following passage of the Clean Water Act in 1972. These improvements did not occur rapidly in the Des Plaines River as indicated by fish collections reported here. Moreover, unlike other Basins in Northeastern Illinois which have seen little change since 1994 (Pescitelli and Rung 2010, 2012), the Des Plaines River has experienced continued improvements in recent years with the appearance of new fish species and a decline in tolerant fishes as seen in the 2013 collections. Further restoration of stream fish assemblages in the upper Des Plaines River will rely on recruitment from the lower Des Plaines and Illinois Rivers, which holds a diverse source of riverine fishes (McClelland et al. 2004). The Brandon Lock and Dam is apparently passable by fish, but presents an obvious impediment to migration. This impediment may account for the relatively slow return of fishes to the upper Des Plaines River following water quality improvements and may account in part for currently surpressed IBI scores. In addition to natural events such as floods and droughts, the Des Plaines River upstream of the Brandon Lock and Dam remains vulnerable to local extirpations due to human perturbations such as pollution cause fish kills, especially given the high extent of urbanization in the watershed.

Although water quality conditions have improved over the past 30 years, most of the Des Plaines River remains impaired for Aquatic Life, Recreation, and Fish Consumption (IEPA 2016). Fecal coliform was listed as the cause of impairment for Recreational Use at 12 of 17 locations tested. All locations were impaired for fish consumption due to Mercury and PCBs. The primary causes listed for Aquatic Life Impairment were Phosphorus (11 out of 17 sites) and dissolved oxygen (8 out of 17 sites). Other more limited causes included Chloride, metals, and pesticides. Water quality problems remain as suggested by these impairments. Implementing Phosphorus standards could improve dissolved oxygen conditions by reducing algae. However, it should be noted that the fish IBI one of the criteria used to determine status of Aquatic Life Use. Absence of key sensitive and specialist fishes due to the lack of a direct connection of the upper Des Plaines River to a species rich recruitment source, could impact Aquatic Life evaluation due to the reliance on the IBI as a main criterion. Interestingly, the macroinvertebrate IBI (mIBI) consistently rates higher than the fish IBI for the Des Plaines River (Pescitelli 2015). Apparently, there have been no detailed studies of the relationship between the mIBI and the fish IBI (Roy Smogor, IEPA 2016, pers. comm.).

There has been extensive public investment in The Des Plaines River Watershed. To date, six dams on the Des Plaines River has been removed and all remaining mainstem dams upstream of the Brandon Lock and Dam are slated for removal. Recently, the Des Plaines River Watershed Group was formed to address water quality impairments and is developing a watershed plan with financial support from IEPA as part the TMDL process required by the Clean Water Act. Success of these projects will be measured in part by response of fish assemblages and improvement in the IBI. Further improvements in IBI ratings will be difficult without increased recruitment of key fish species and functional groups. Continued connection to downstream fish recruitment sources will also be critical to restoration of mussel communities in the Upper Des Plaines River, which are currently severely degraded (Price et al. 2012).

Management recommendations:

- Continue fish assemblage monitoring as part of IEPA Cooperative Basin Surveys. Identify gaps in coverage and add or relocate sampling stations as needed.
- Expand annual sportfish monitoring to provide information for anglers and management activities.
- Support on-going dam removal projects by IL DNR Office of Water Resources and County Forest Preserves. Evaluate fishery response when feasible.
- Increase current sauger stocking program to include additional free-flowing areas resulting from dam removals. Examine potential for expanding stocking program to other species.
- Work with local fishing groups to obtain information on angling activities and to assist with habitat enhancement projects (e.g. water willow and other plantings).
- Routinely evaluate fishing regulations, propose additional regulation or modify existing regulations based on fishing pressure and sportfish population surveys.
- Investigate potential research projects for funding by Federal Sportfish Restoration (F-190-R) Funds. Stable Isotope studies would help identify the source of new migrants in the upper Des Plaines River.
- Maintain connectivity to downstream fish recruitment sources in the lower Des Plaines and Illinois Rivers. Identify a list of potential candidate fish species for future migration.

- Maintain connectivity to downstream fish recruitment sources in the lower Des Plaines and Illinois Rivers for recruitment of mussels into the upper Des Plaines Rivers. List common host fishes.
- Support establishment of Phosphorus Standards for waste water effluent.
- Participate in discussions regarding proposed ANS fish barrier at Brandon Lock and Dam; provide information regarding importance of maintaining pathways for native fishes and mussels

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**State of Wisconsin**
**DEPARTMENT OF NATURAL RESOURCES**
**101 S. Webster Street**
**Box 7921**
**Madison WI 53707-7921**

**Scott Walker, Governor**
**Cathy Stepp, Secretary**
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711

WISCONSIN
DEPT. OF NATURAL RESOURCES

September 12, 2016

Kelly Baerwaldt
US Fish and Wildlife Service Midwest Region, Fisheries
555 Lester Ave, Onalaska, WI 54650

Dear Ms. Baerwaldt,

Thank you for the opportunity to comment on the Draft Fish and Wildlife Coordination Act Report On U.S. Army Corps of Engineers GLMRIS – Brandon Road Project. I have the following comments;

1. Wisconsin supports the recommendation of the US Fish and Wildlife Service to include the Black carp as a species of concern in the evaluation of alternatives considered for Bighead and Silver Carp at the Brandon Road site (Page 11).
2. On page 27 of the report it is recommended that the discussion on barrier removal in the Great Lakes basin be put in context with the reports intended purpose to install a barrier for ANS prevention.
3. Page 28 of the report mentions "…the government…" this should be made clear to be the federal government.
4. Define IWW on page 41 of the report.
5. Page 42, Wisconsin would support an evaluation of the need to supplement movement of native species through the electric barrier to support the Des Plaines River ecosystem.
6. Page 47, typos; first and second sentences.
7. Page 45, requesting assistance with barrier removal on the Des Plaines River seems a bit out of place in this document unless tied to improving the overall resistance of the system to future invasions.
8. Page 45-46, include the full description of the alternative to the final recommendation.
9. There is no discussion in the report regarding the preference to AC current at the electrical barrier. Some discussion should be presented to support this recommendation.

I am wondering if this report was shared with stakeholder representatives from outside of the state partner family. There are a number of parties that I think would be interested in the report and would likely provide valuable comments. It may prove to be beneficial for this to receive a broader review.

Wisconsin agrees with the findings and recommendations of the draft report, with the identified changes.

If you have any questions concerning my comments please feel free to contact me at (262) 574 – 2149. Again I appreciate the opportunity to comment.

Sincerely,

Bob Wakeman
Aquatic Invasive Species Coordinator
Wisconsin Department of Natural Resources

Cc: Carroll Schaal, WY/4
Justine Hasz, FM/4
Steve Galarneau, OGL/3