GLMRIS – Brandon Road

Appendix L - Monitoring and Adaptive Management Plan

U.S.ARMY

August 2017

US Army Corps of Engineers ®
Rock Island & Chicago Districts

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Planning

Introduction

Adaptive Management as defined in ERDC (Engineering Research and Development Center) TN-EMRRP-EBA-10, April 2012, *"is a process wherein management actions can be changed in response to monitored system response, so as to maximize efficacy or achieve a desired ecological state."* The basic steps and how they are interconnected within an Adaptive Management Plan are outlined in Figure 1.

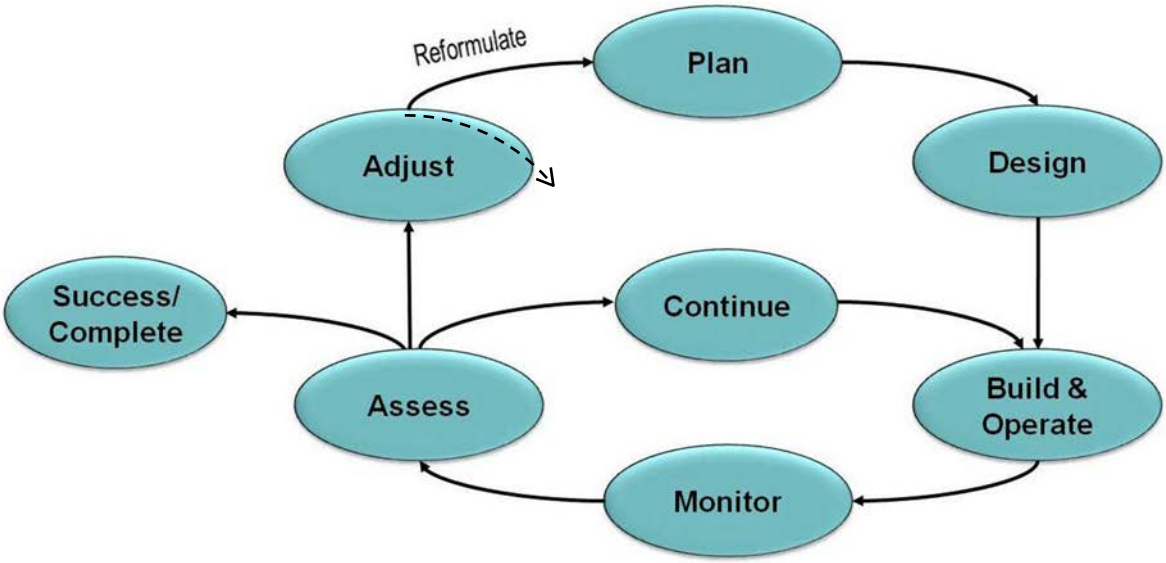

Figure L- 1 Flow Chart depicting the steps within an Adaptive Management Plan.

This appendix will outline the Adaptive Management and associated Monitoring Plan for the Great Lakes and Mississippi River Interbasin Study – Brandon Road (GLMRIS-BR) Draft Integrated Feasibility Study and Environmental Impact Statement. Activities, processes, reporting instructions, and estimated costs will be identified. This plan will be further developed as greater detailed design and specifications are determined during preconstruction engineering design (PED).

Authorization

Section 2039 of the Water Resources Development Act (WRDA) of 2007 directs the Secretary of the Army to ensure, when conducting a feasibility study for a project (or component of a project) for ecosystem restoration and protection, the recommended project includes a plan for monitoring the success of the ecosystem restoration and protection. The implementation guidance for Section 2039, in the form of a CECW-PB Memo dated August 31, 2009, also requires an adaptive management plan be developed for all ecosystem restoration and proteciton projects.

Procedure: Drafting the Plan

The adaptive management plan is closely built around the 2016 Monitoring and Response Plan (MRP) for Asian Carp in the Upper Illinois River and Chicago Area Waterway System which is released annually by the Monitoring and Response Workgroup (MRWG) of the Asian Carp Regional Coordinating Committee

(ACRCC). The MRP is also adaptive in nature. Members of the ACRCC meet on an annual basis and discuss the results of monitoring efforts from previous years. During this meeting, recommendations for changes and improvements are taken into consideration and are implemented in the future monitoring and response plan. The adaptive management plan for GLMRIS-BR will include activities similar to those in the MRP that monitor for Asian carp, as well as monitoring for *A. lacustre*, and monitoring of the technological alternatives. The monitoring plan for the electric barrier component of the Tentatively Selected Plan (TSP) will be similar to protocols conducted at the Chicago Sanitary and Ship Canal Electric Barriers (CSSC-EB) in Romeoville, Illinois. Monitoring of the other components of the TSP are outlined below.

Adaptive Management Team

The Adaptive Management Team for GLMRIS-BR will consist of federal, state, non-governmental agencies, and other stakeholders. The foundation of the team will be based on the ACRCC –MRWG. The MRWG consists of field personnel that conduct the majority of the monitoring activities within the Upper Illinois Waterway. The MRWG reports back to the larger ACRCC, which includes U.S. Army Corps of Engineers (USACE) personnel, to help facilitate the appropriate actions needed to address any issues with the project. While the ACRCC is focused on Asian Carp, the monitoring being conducted will likely be sufficient to detect any new aquatic nuisance fish species that may migrate upstream into the Upper Illinois Waterway. A similar format to the ACRCC can be quickly developed if new aquatic nuisance species enter the project area. Similarly, some of the same agencies within the ACRCC have, and will likely continue monitoring for *A. lacustre.* As GLMRIS-BR moves into the design phase, these details will be worked out with supporting agencies and stakeholders.

The Engineering Adaptive Management Team for this study will consist mostly of USACE personnel. Field personnel working at the project site will maintain the day to day data collection, and design staff at the Chicago and Rock Island Districts will analyze the data for decision making. On an as-needed basis, USACE's research labs will continue to perform larger studies and testing at the site. As GLMRIS-BR moves into the design phase, these details will be worked out with supporting agencies and stakeholders.

Project Adaptive Management Planning

Project Goals and Objectives

The goal of the project is to prevent the transfer of ANS from the Mississippi River Basin to the Great Lakes Basin while balancing the multiple uses/users of the Mississippi River Basin and Great Lakes Basin, shared responsibilities, and authorized purposes of the upper Illinois Waterway. The ultimate effect desired for this goal is the prevention of the transfer and subsequent establishment of new ANS to the Great Lakes Basin from the Mississippi River Basin through aquatic pathways. USACE defines prevent to mean the reduction of risk to the maximum extent possible, because it may not be technologically feasible to achieve an absolute solution. The anticipated consequences of Mississippi River Basin ANS colonization and establishment in the Great Lakes Basin would be assessed. Measures developed to meet this goal need to result in the protection of aquatic resources in the Great Lakes and connected tributaries including habitats and associated environmental, economic, and social resources. Effectiveness of plans developed from ANS control measures will be evaluated. This goal is to identify and evaluate alternative plans to prevent the upstream passage of ANS through Brandon Road Lock and Dam.

In order to meet the project goals and objectives, success criteria will be used to achieve them. These success criteria include:

- zero aquatic nuisance species passage upstream through the Brandon Road Lock and Dam for the project life,
- decrease the average catch per unit effort (CPUE) from 2010 to 2015 from 7.64 Asian carp/ 1000 yards of net by 95% during the life of the project to ensure propagule pressure remains low,
- maintain the current level of *A. lacustre* populations below Brandon Road Lock

Additional success criteria will be developed during PED for the TSP. Some of the specifications for the technological components of the TSP are unknown and since most of the monitoring will be measuring specific outputs of the TSP, these objectives will be defined at that time.

Conceptual Ecological Model

The National Invasive Species Council Management Plan (2016) describes the four stages in the invasion process as prevention, eradication, control, and ecosystem restoration. Prevention aims at keeping a potential invasive species from entering the ecosystem. The next step is eradication. Prior to an invasive species getting established, eradication is possible. Eradication is typically possible only if a small population within a small geographic range is detected quickly. If a species and or population is not detected quickly, eradication may not be possible and then the species needs to be controlled. In this instance, the species is managed to the greatest extent possible to minimize the spread and impacts to the surrounding environment. Finally, it is important to implement ecosystem restoration. The removal of invasive species from an area and the subsequent restoration allows for the protection and management of the environment. Since degraded areas are more susceptible to invasion, restoration can provide a more resilient habitat for native species to thrive and limit the impacts of invasive species.

The purpose of the GLMRIS-BR project is to evaluate structural and nonstructural options and technologies near the Brandon Road Lock and Dam site to prevent the upstream transfer of ANS from the Mississippi River Basin into the Great Lakes Basin, while minimizing impacts to existing waterways uses and users. Figure 2 shows the difference in cost at all four levels of invasion as defined above. While step four is labeled differently in the figure, the two categories are essentially synonymous. In general, the likelihood of spread and establishment increases for an invading species through time. As these species do become established it becomes increasingly more expensive to control as populations grow and invade larger geographic areas. Currently, only a few Asian carp have been found upstream of the study area at Brandon Road Lock and Dam and *A. lacustre* has not been found upstream of the study area. The implementation of the TSP is expected to reduce the risk of Mississippi River Basin ANS establishment in the GLB to the maximum extent possible while minimizing impacts on waterway uses and users.

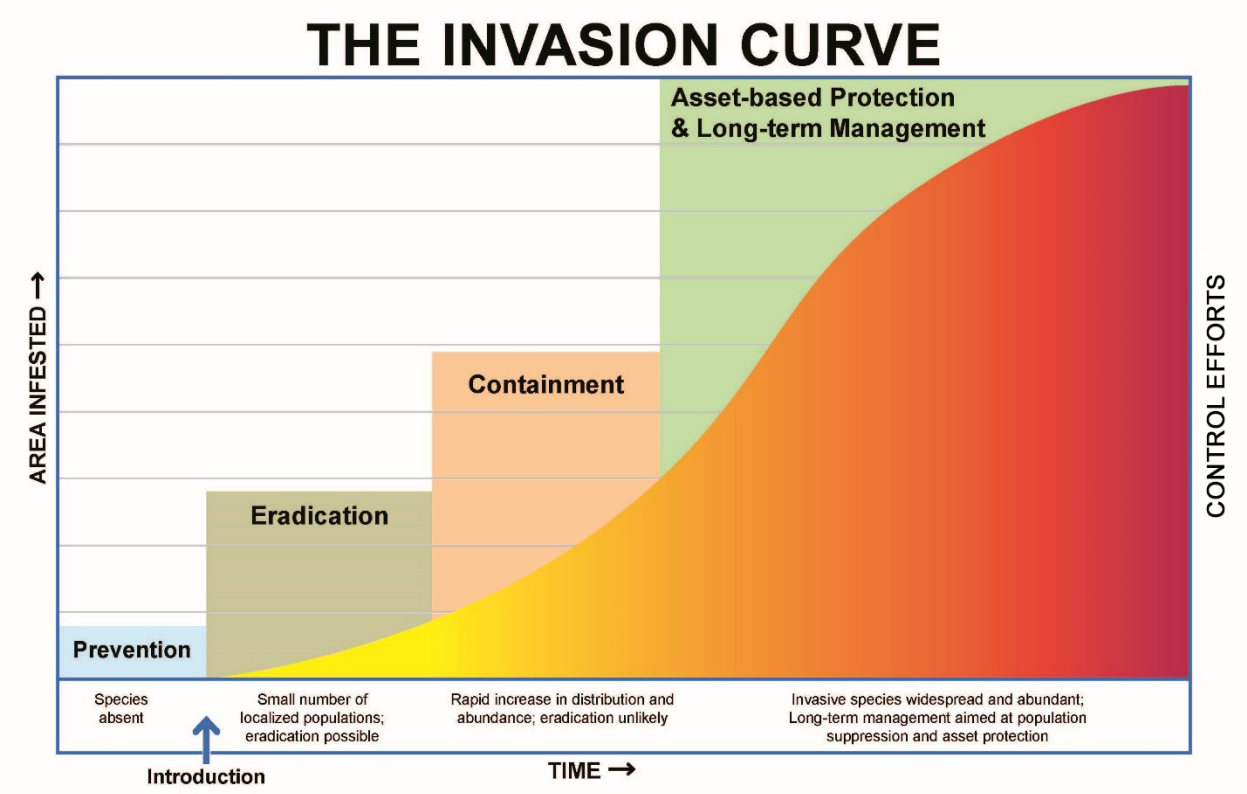

Figure L- 2 Conceptual increases in cost of control of aquatic nuisance species as time and area infested increases.

Sources of Uncertainty

- As always, the availability of funding to implement Adaptive Management activities is uncertain and is based on future appropriations.

- Changes in aquatic nuisance species populations downstream of the GLMRIS-BR Site-Specific Study Area cannot be predicted. The adult Bighead and Silver Carp population front has remained in Dresden Island Pool since 2006 and is believed to have not progressed significantly over the past nine years. The time in which other potential invaders may arrive from the Mississippi River to the GLMRIS-BR Site-Specific Study Area is unknown. Similarly, the types of controls needed and the monitoring techniques for each potential new aquatic nuisance species is not known.

- The success of the measures for the TSP are also not known. Research at the CSSC-EB have shown certain vulnerabilities of the technology. Current vulnerabilities include preventing small fish transfer, barge entrainment and field warping of electric field when vessels move through, reverse flows, loss of power in a waterway that has no control structure, and flood bypass. In addition, complex noise is still in development and the effectiveness is still unknown.

- Future prevention technologies that may become available for implementation at the GLMRIS-BR Site-Specific Study Area are also unknown. Several technologies including CO_2, Ozone, hot water, alternating current (AC) electrical current, species specific piscicides, and hydroacoustics are all under development.

- The USACE in coordination with the U.S. Coast Guard, would conduct safety testing of the ANS control measures in the TSP. The safety testing will inform whether the electric barrier can be operated continuously, or whether it would have to be operated intermittently or at reduced parameters while vessels transit the engineered channel; it will also inform the operational consideration for the remaining ANS control measures. Depending on the operating parameters of the ANS control measures, there may be an increased chance of ANS passage through Brandon Road Lock and Dam.

- The status and funding of other potential future studies to prevent the transfer of ANS between the Mississippi River and Great Lakes Basins.

- While testing has shown that complex noise can be effective against Asian carp, the best way to design and deploy a system within the lock or the engineered channel requires further development. There may be a significant amount of trial and error in field implementation of this measure, as each location provides its own unique variables.

- The duration of lock flushing required to provide assurance of Mississippi River Basin ANS-free water in the lock is still an estimate. The suggested duration will be better defined following physical modeling during PED. The actual requirements for flushing however will not be known until the flushing lock is in continued operation. It is assumed therefore that the operating parameters at the lock will need to be revised over time through adaptive management to improve the effectiveness of the control while maintaining navigation.

The actual changes in operation by users of the lock have been estimated based on informed assumptions, but are unknown. Depending on the implementation and safety restrictions of installed measures, operators may change their habits or stop using the lock altogether.

Action Criteria

Biological

Potential action criteria may fluctuate and evolve through time. In general, the confirmed presence of a new aquatic nuisance species may result in various forms of monitoring/response actions to determine the extent and abundance of the species within the GLMRIS-BR Site-Specific Study Area. Similarly, new technology alternatives could be implemented into the engineered channel. Currently, the ANS of Concern in the area are Asian carp and *A. lacustre*. If an increased population of Asian carp occurred downstream or a capture was confirmed upstream of the GLMRIS-BR Site-Specific Study Area, adaptive management may be applied. An adaptive approach to changes in Asian carp populations are already outlined in the 2016 ACRCC Monitoring and Response Plan, Appendix J, Upper Illinois Waterway Contingency Response Plan. The pool, abundance, and life history traits of the confirmed capture will help determine the exact responses. The responses in the Upper Illinois Waterway Contingency Response Plan range from increased sampling to potential temporary lock closure to support additional response activities.

Technological

Many of the action criteria for engineering adaptive management will be the same used in the biological adaptive management plan. Changes in the location, number and movements of ANS, may prompt changes to the operation of one or more engineering technologies.

Additional action criteria for engineering are the development of new technologies, or improvements to the already installed technologies at Brandon Road. The design team should keep up to date on the latest research and development, and assess whether any new data is ready or appropriate to be implemented at the GLMRIS-BR project site.

An important action criteria on the engineering side is safety. The procedures set up by the USCG will include action criteria to address times when safety concerns may be elevated. This may be due to personnel working in or near the water, barges and other watercraft traveling in the vicinity of the barrier, and other issues. Additional action criteria will address active safety concerns, such as person-in-water or an active shock hazard.

Potential Management Actions

Engineering management actions vary by technology. For the existing technologies, actions may include varying the operating parameters (e.g. higher voltages, increased decibel levels, etc.) or varying the standard operation of the technology (e.g. keep the electric barrier running longer, use the flushing lock with only every other barge flotilla, etc).

For technologies not included in the TSP, management actions may include a test of the technology at Brandon Road, or to implement a new full project feature.

Management actions to address safety concerns may be temporary or permanent. Operating parameters may be changed, or the time of operations may be changed (e.g. only running the electric barrier after vessels have cleared the lock).

Monitoring

Rational for Monitoring

Adaptive Management hinges on the outcomes of monitoring. Without monitoring, it is impossible to determine if the implemented ANS control measures are effective. The TSP includes nonstructural measures which consist of monitoring upstream and downstream of Brandon Road Lock and Dam. Nonstructural measures were built upon the annual MRWG Monitoring and Response Plan that has been implemented since 2010 and includes the lessons learned from each prior year. In order to ensure the TSP is meeting the appropriate objectives, monitoring must continue to ensure that the upstream spread of Mississippi River Basin ANS into the Great Lakes Basin does not occur.

Several of the technologies proposed as a part of the TSP are relatively new and are still being developed, understood and refined. For example, electric barriers have been used for over a decade for repelling fish but the operational parameters, effectiveness, and limitations of this technology are continually being refined. Continual monitoring of the GLMRIS-BR electric field will allow improvements to the project to be made as the implementation of the electric barrier technology at this particular location is further understood.

- In addition, safety is a critical issue for the use of these ANS control technologies in an area of active navigation, particularly the electric barrier. Prior to use of the electric barrier, the USACE in coordination with the USCG, would conduct safety testing of the ANS control measures in the TSP. The safety testing will inform whether the electric barrier can be operated continuously, or whether it would have to be operated intermittently or at reduced parameters while vessels transit the engineered channel; it will also inform the operational consideration for the remaining ANS control measures. Safety testing and rulemaking will determine what operating procedures will be required to keep personnel on and off the water safe.

Project Monitoring Plan

Biological

Under the TSP, the nonstructural measures of the plan will provide much of the monitoring efforts and data needed to adaptively manage the GLMRIS-BR project if implemented. The nonstructural measures are similar to the current monitoring efforts outlined in the 2016 Monitoring and Response Plan for Asian Carp in the Upper Illinois River and Chicago Area Waterway System. These activities consist of electrofishing, netting, and telemetry within reaches of the CAWS and upper Illinois Waterway. Intensive monitoring upstream of the CSSC-EB was reduced in 2014 to two seasonal intensive monitoring events. Monitoring downstream of the CSSC-EB generally occurs twice per month for electrofishing and once per month for netting between the months of March and November in Lockport, Brandon Road, and Dresden Island Pools. Objectives of ongoing monitoring efforts are to (1) determine the distribution and abundance of any Asian carp in the CAWS and upper Illinois Waterway, and use this information to inform response removal actions, (2) remove any Asian carp if found in the CAWS to the maximum extent practicable, (3) identify, assess, and react to any vulnerability in the current system of barriers to prevent Asian carp from moving into the CAWS, (4) determine the leading edge of Asian carp populations in the Illinois River and the reproductive success of those populations, and (5) improve understanding of factors behind the likelihood that Asian carp could become established in the Great Lakes and their connected tributaries.

Electrofishing and netting will continue under the current protocols to help detect any potential changes with the Asian carp population. Detection of live Asian carp in new areas may be indicative of potential population changes or could help guide contingency planning to gain a better understanding of the potential change. Electrofishing may help detect fish that may have passed through the Brandon Road Lock and Dam after the project is implemented. Finally, the ancillary catch data may help with early detection of additional aquatic invasive species and guide eradication efforts before additional species become established.

Telemetry monitoring is a multi-agency effort. USACE, Southern Illinois University, Western Illinois University, U.S. Fish and Wildlife Service, and U.S. Geological Survey have all been working on tracking Asian carp and surrogates within the upper Illinois River System for several years. An extensive network currently exists throughout the Illinois River but a high concentration of USACE receivers are located within Dresden Island and Brandon Road Pools

(Figure 3). Additional receivers will be placed within and around the GLMRIS-BR Site-Specific Study Area to determine whether or not tagged fish can make it through Brandon Road Lock and Dam if the project is implemented.

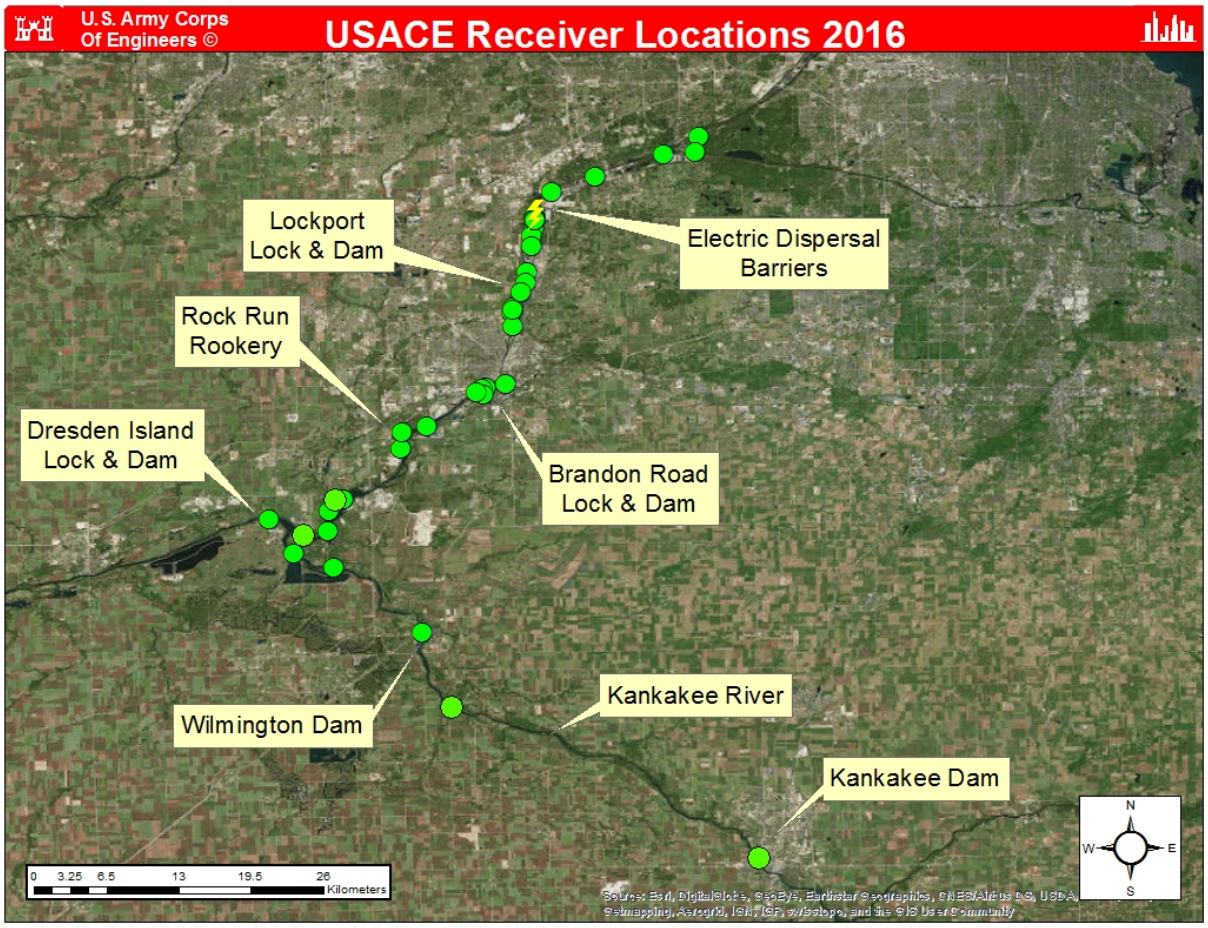

Figure L- 3 Aerial map of USACE receiver locations in Dresden Island, Brandon Road, and Lockport Pools as well as the Kankakee River. Receiver placement is demarcated by a green circle. The yellow lightning bolt represents the location of the current Electric Dispersal Barrier in Romeoville, Illinois.

In addition to the aforementioned, between five and six contracted fishing crews use various nets (e.g., gill, trammel, modified hoop nets) and seines to remove Asian carp from Dresden Island, Marseilles, and Starved Rock Pools. The areas fished by the contracted fishermen are closed to commercial fishing by Illinois Administrative Rule: Part 830 Commercial Fishing and Musseling in certain waters of the state; Section 830.10(b) Waters open to commercial harvest of fish; therefore, a biologist from Illinois Department of Natural Resources is required to accompany contracted fishing crews when they are in these portions of the waterway. Contracted fishing crews generally fish every other week between March and December. The goal of these activities is to maintain low propagule pressure and therefore decrease the probability of Asian carp passing the Brandon Road Lock and Dam and the CSSC-EB. These efforts will also help with

early detection of additional aquatic nuisance fish species in the future and guide eradication efforts.

The TSP will involve a few technologies that have not been tested in the field, yet may provide promising results. Specifically, these include the flushing lock and complex noise. Complex noise has been studied, but the results have been diverse. Lab studies and microcosm studies have shown sound to be effective, but fish may have the ability to acclimate to the barrier. Sound is currently implemented at Lock and Dam 8 on the Mississippi River but no monitoring is being done to determine its effectiveness. Similarly, the concept of a flushing lock has not been implemented before to prevent the movement of ANS. The design of the flushing lock will allow for water, as the lock is draining, to push floating or buoyant ANS back downstream. The strength of the flushing water may also help keep smaller fish, which are more susceptible to pass through an electric barrier, away from the control point at Brandon Road Lock and Dam. This integrated system of an electric barrier, complex noise, and flushing lock will need to be monitored closely to determine the effectiveness. To an extent, the telemetry work outlined above will help provide some information on the effectiveness of the integrated technologies. However, the exact methodologies to be implemented for monitoring are not fully understood at this time. It is likely that some type of hydroacoustic technology may be used to determine fish abundances before and after lock flushing. Hydroacoustics may also be able to quantify the number of fish challenging the integrated barrier, moving downstream through the lock, and determine if fish are able to swim through the barrier on their own volition or with assistance from navigation traffic. The exact protocol for monitoring the integrated barrier will be further detailed in PED.

Additional monitoring within the nonstructural measures will include hitchhiking species such as *A. lacustre*. The species has been located within the Dresden Island Pool, but it has not been detected further upstream. Monitoring for *A. lacustre* will entail setting Hester-Dendy macroinvertebrate samplers throughout the Brandon Road, Dresden Island, and Marseilles Pool. It will be important to monitor the downstream population in Dresden Island Pool to determine if the population is growing and therefore increasing the risk of upstream transfer. Dresden Island sampling will make sure the species is not moving upstream within the pool and Brandon Road to ensure that the species does not make it past the control point at Brandon Road Lock and Dam. These data will also help identify additional invasive macroinvertebrate species prior to establishment.

In addition to the nonstructural monitoring outlined above, project performance monitoring will focus on the effectiveness of the control point at Brandon Road Lock and Dam. It is important to note that much of the nonstructural monitoring will likely assist with the project performance monitoring. For instance, the telemetry monitoring occurring throughout the CAWS can very easily be used to answer several research questions within the area. The specifics of the project performance monitoring will be addressed and finalized during PED.

Technological

Electric Barrier: Monitoring includes daily equipment and facility inspections, daily in-water measurement, quarterly/annual maintenance, periodic inspections of in water structures, and

routine maintenance on non-pulse generating equipment. In addition, periodic lab and field studies and field observations are completed to ensure power in the water and effectiveness of the barrier.

Flushing Lock: Monitoring for the flushing lock feature will include continued testing for the percentage of upstream water present in the lock after each flush. The frequency and nature of the field testing will be determined once the project is constructed, and will use the results of the physical model testing as a starting point.

Complex Noise: Through intermittent testing and using monitoring systems and cameras built into the complex noise system, the effectiveness of the current system against ANS will be monitored. Continued research at other installation locations of this technology will be used to inform the operating procedures at Brandon Road.

Water Jets: Monitoring for water jets may involve the use of temporary or permanent underwater cameras to observe the effect of the technology on entrained ANS.

Any of the three listed control technologies may need to be turned off temporarily for routine maintenance. During this time, lock doors will likely be kept closed and techniques may be used to clear fish from the approach channel to prevent passage of ANS species. This technique is currently done with the use of electrofishing boats and surface to bottom gill nets at the CSSC-EB. The process entails the use of hydroacoustics to assess the number of fish within the area to be cleared prior to any work. Then, net boats, electrofishing boats, and other gears are deployed in the area. The goal is to either drive the fish from the area by using electricity or to capture and release them outside of the electric barrier area. Once the clearing event is complete, an additional scan by the hydroacoustics boat is conducted to determine effectiveness of the clearing event. These events may also be conducted if any barrier loses power or fails unexpectedly. These approaches will likely be more adaptive in manner as these events cannot be planned for.

Down-bound Tows: Methods to mitigate upstream fish movement 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 includes 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 modified vessel operations are found to reduce fish entrainment, they would be explored during the adaptive management phase of the project in conjunction with USCG and the navigation community.

Engineered Channel: The channel will be monitored using standard inspection procedures for USACE Lock and Dams. This includes Periodic Inspection Reports, Periodic Assessment Reports, and Operational Condition Assessments.

Analysis and Use of Monitoring Results

Biological

The monitoring plan requires coordination between numerous State, Federal, and Institutional agencies with each responsible for their own activities. As a result, analysis of results will be the responsibility of the cooperating agency for the inclusion in the end of year report. A majority of the monitoring activities focus on the most immediate threat; Asian carp. Therefore, the analysis of monitoring activities will be shared and made public through the ACRCC Monitoring and Response Plan Interim Summary Reports that are released in the spring of each year. These results are often used to make improvements or changes to the plan to ensure we are maximizing efforts. While much of the monitoring efforts focused on the Asian carp, the proposed monitoring activities are anticipated to help detect the presence of other nuisance fish species. Any new documented nuisance fish species will be required to be reported to USACE and should be documented in section of the Monitoring and Response Plan Interim Summary Report.

The responsible agency for monitoring for the *A. lacustre* will provide an annual report of their findings to USACE for further review and potential needs for adaptive management. These monitoring techniques may also provide early detection of new macroinvertebrate/hitchhiking invaders. Similar to the above, the responsible agency will be required to report any documented new ANS to USACE immediately.

Project performance monitoring data will be summarized in an annual report to ensure the control point is working effective and to address any adaptive management changes that may be required.

In general, the use of monitoring results will be used to make appropriate changes to plans to maximize effectiveness for ANS. This may result in increased operating parameters at the GLMRIS-BR electric barrier, implementation of new technologies currently under development, increase or decrease in monitoring activities, and implementation of new monitoring techniques.

Technological

Electric Barrier: Based on the results of the monitoring the equipment is cleaned, repaired, and/or replaced as required to maintain power in the water. Results of the studies and observations are utilized to optimize the effectiveness of the electrical field.

Flushing Lock: Based on the results of the physical model during design, the frequency and length of flushing will be set for normal lock operations. As the constructed feature operates,

continued testing will allow lock operators to refine the procedures, using the flushing more or less often, and lengthening or shortening the flushing time as necessary.

Complex Noise: The number and placement of speakers and decibel levels of noise will be determined during PED. As the installed project and its effect on ANS swimmers is monitored, additional speakers may be installed or the placement of the speakers changed. Continual testing regarding the effectiveness of various decibel levels will also inform and potentially change the operating parameters of the complex noise system.

Water Jets: Based on observation of ANS within the water jets and on continued testing by ERDC, operators may change the velocity of the jets, install additional jets or turn off some existing jets, or revise the length of time during which jets are turned on during barge passage.

Down-bound Tows: Results from the current study will be used to determine if this mitigation technique is effective.

Engineered Channel: Based on the periodic reports completed, repairs and maintenance will be performed as recommended.

Database Management

Description and Location

Biological

The large coordination that is required during the monitoring makes the catch data from all the different agencies difficult to maintain and manage. The advantage is that the current monitoring plan expands upon an already adaptive plan that has been implemented for several years. Protocols for data management and sharing have been in place for several years as well, which can be used as a template for future data management. In general, the data consists of catch data separated out by gear types and project types. For instance, the electrofishing data is split by pool and then further split by location to ensure it can be easily queried or displayed on a GIS platform. This template is used for contracted commercial fishing removal efforts and all other netting and collection methods deployed. While several agencies are involved with the collection of this data, one agency manages and maintains the database. While this is true with most of the data, current protocols for some of the telemetry data management are different. Several agencies are involved with the telemetry program and each agency maintains their own at this time. In an attempt to maximize data sharing and maintenance, the group of agencies have quarterly to bi-annual meetings to share data, discuss weaknesses in the network, and other needs. With so much data collection it is recommended that a lead agency for database management be appointed for all or portions of monitoring activities.

Technological

Each ANS control system installed will have a database of monitoring and operational information collected, maintained by USACE. Data from daily monitoring activities will be entered into a database held on the USACE "P Drive" and will be attainable by USACE personnel with appropriate permissions.

Data Storage and Retrieval

Biological

Similar to how individual agencies are responsible for data analysis, each agency will be responsible for storing data they collect in accordance with their respective data storage guidelines. These data should be backed-up in case of data loss. In addition, the agency given the duty to collect and maintain all of the data or portions of the data should maintain several back up databases on appropriate storage media. Each agency tasked with maintaining all or parts of the data collected will provide a point of contact for data inquiries.

Technological

Data will be centrally stored by USACE for retrieval by both Rock Island or Chicago Districts. It will be available for review by district and ERDC personnel, as well as other participating agencies upon request.

Analysis, Summarization, and Reporting

Biological

As previously described above, monitoring data will be analyzed by the responsible agency. Data collected through the ACRCC Monitoring and Response Plan will be summarized and published in the ACRCC Monitoring and Response Plan Interim Summary. This report is made public every spring following each sampling season. As part of an iterative process, an annual meeting is used to present data and discuss changes to the plan each year. This plan, while it focuses on Asian carp, should help detect additional nuisance fish species as they enter the GLMRIS-BR Site-Specific Study Area.

Monitoring data for *A. lacustre* will be analyzed and provided to USACE in an annual report format. The data and results will be made public via the USACE website. Any potential new ANS should be reported to USACE immediately.

Project performance monitoring data will be summarized and provided in an annual report to direct any adaptive management needs for the Brandon Road Lock and Dam control point.

Technological

Data will be analyzed by USACE and summarized into annual reports for each ANS control system. Reports for the engineered channel will follow standard procedures for USACE construction projects. Reports for other systems will be analyzed by the appropriate group for each technology. For example, researchers at ERDC who've completed testing on water jets will analyze the results of that system. The electric barrier will be monitored by personnel at USACE Chicago District experienced in barrier operation from the CSSC-EB, along with ERDC-CERL (Construction Engineering Research Laboratory).

Costs for Adaptive Management

Adaptive Management Costs

The planning costs for adaptive management for the TSP are difficult to estimate. The types of future technology that may be implemented are unknown at this time. Several potential ANS deterrents are currently under research and development. The engineered channel will allow the spiraling in of new technologies and the amount of planning and design work are unknown. If new technologies are determined to be effective at preventing the upstream transfer of ANS during PED, estimated planning costs will be included. In general, adaptive management and monitoring costs will not exceed 10% of the total project cost. Table 1 provides an estimated breakdown of biological and technological monitoring and adaptive management costs across 10 years. It is anticipated that the adaptive management costs will be front end loaded with 60% of the total cost being implemented in the first 4 years. An additional 30% of the costs are estimated to be implemented in years 5 through 8 with the final 10% allocated for adaptive management to be implemented in the final 2 years.

Table L- 1 Cost breakdown for project performance monitoring for technological (ie. electric barrier operational monitoring/stray current/other structural ANS control features) and biological monitoring. The remaining costs are the allocated amounts for adaptive management.

	Allocation to Fiscal Years										
Activities	**2026***	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**Subtotal**
Technological Monitoring	$900,000	$900,000	$900,000	$900,000	$900,000	$900,000	$900,000	$900,000	$900,000	$900,000	$9,000,000
Biological Monitoring	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$200,000	$2,000,000
Adaptive Management	$1,826,070	$1,826,070	$1,826,070	$1,826,070	$913,035	$913,035	$913,035	$913,035	$608,690	$608,690	$12,173,800
Total Costs											**$23,173,800**

*construction ends July 2025 and assume USCG safety testing is completed by Oct. 1, 2026.

Monitoring Costs

Biological

Project performance monitoring will occur to test how well the alternatives are working. Costs for these activities are estimated within Table L-1. Project performance monitoring will occur up to 10 after project construction and are cost-shared. After the monitoring period is over, all costs associated costs associated with project performance monitoring will be covered by the non-federal sponsor.

Additional monitoring costs are built into the TSP through the nonstructural measures. The estimated average annual cost of the nonstructural measures is approximately $12,300,000. The plan includes several categories outside of monitoring such as Public Education and Outreach, Integrative Pest Management, and Research and Development. A breakdown of average annual costs of monitoring within the nonstructural measure is located in Table L-2.

Table L- 2 Cost breakdown of the non-structural components built into the tentatively selected plan.

Category	General Project Description	Agency	Estimated Cost
Public Education and Outreach	Outreach	USFWS-ILDNR	$500,000
	Asian Carp Website Operation and Maintenance	USFWS	$50,000
Monitoring	Fixed and Random Site Monitoring Downstream of the Electric Barrier	USFWS-IDNR	$1,950,000
	Monitoring Downstream of the Electric Barrier	USACE	$200,000
	Fixed and Random Site Monitoring Downstream of the Electric Barrier	USFWS	$1,120,000
	Grat Lakes Asian Carp Monitoring Program – Comprehensive Sampling Regimen for Early Detection of ANS in Great Lakes	USFWS	$350,000
	Mass Removal and Monitoring of Juvenile Asian Carp	USFWS	$100,000
	Black Carp Assessment: CAWS and UMRB	USFWS	$200,000
	Advanced Telemetry Techniques for Real-Time Tracking of Asian Carp	USGS	$200,000
	Monitoring for *A. lacustre* Upstream and Downstream of the Electric Barrier	USFWS-ILDNR	$100,000
Piscicides	-	-	-
Integrative Pest Management	Integrative Pest Management Program	USGS-USACE	$1,459,000
Manual or Mechanical Removal	Contract Fishing for Asian Carp Detection and Removal	USFWS-ILDNR	$1,500,000
	Additional Contract Fishing for Asian Carp Detection and Removal	USFWS-ILDNR	Varied between $1,500,000 - $3,000,000
	Illinois River Stock Assessment/Management Alternatives	USFWS-ILDNR	$300,000
Research and Development	Use of Improved Gear and Novel Designs at Brandon Road	USFWS-ILDNR	$350,000
	Barrier Defense Removal of Asian Carp Using Novel Gear	USFWS	$80,000
	Barge Entrainment and Interaction Studies	USFWS	$750,000
	Hydro-acoustic Assessment of Lock Mediated Fish Passage in the Upper Illinois River	USFWS	$160,000
	Assessment of Hydraulic Water Quality Influences on Waterways to Develop Control Options	USGS	$315,000

	Monitoring, Biomass Estimation, and Correlation with Live Fish	USGS	$110,000
	eDNA Genetic Marker Development for Future ANS	USFWS	$300,000

Technological

The costs for monitoring the systems will be included in the operation and maintenance costs for the project (Table L-1). Analyzing and reporting on the data, as well as any changes that come out of this reporting, will be an additional yearly cost on top of the operation and maintenance (O&M). Most of the costs will be labor, for both on-site inspections and work to analyze the data and produce reports.

Implementation Costs

The TSP includes the construction of an engineered channel. The engineered channel allows for the spiraling in of new deterrent technologies. Currently, these potential technologies are unknown but several research and development projects currently ongoing may provide some clarification within the near future. Since the future technologies are unknown, the agencies responsible and the cost for implementation are also unknown. If a new technology during PED is thought to be effective and can be implemented at the project location, estimated implementation costs will be added.

Implementation

A conceptual model of how implementation for an adaptive management plan works was provided in ERDC TN-EMRRP-EBA-10, April 2012 and can be seen in Figure L-4. In general, information, both previously known and acquired through assessments/monitoring, drive the decision for implementation. Monitoring results are assessed to determine if the decision criteria are being met. If not, the model allows for re-evaluation by either adjusting the decision criteria based on new found knowledge or applying additional management actions through the convening of the adaptive management review team. If additional management actions are not needed, then monitoring continues and are re-assessed in the future to determine if decision criteria are being met. If new actions are taken, revision to monitoring methodologies may be needed to ensure that the appropriate data are acquired to determine if the actions were successful. This feedback loop can occur in multiple iterations to ensure the success of the project.

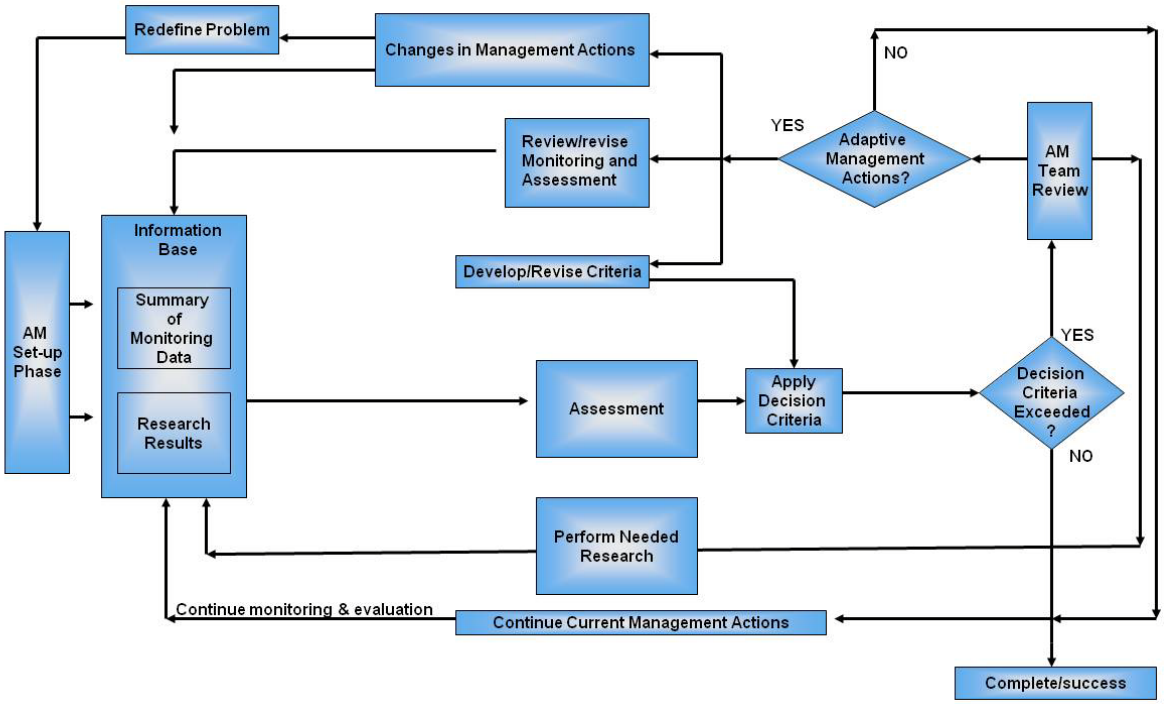

Figure L- 4 Model of the implementation phase for an adaptive management plan.

Assessment

Assessment Process and Frequency

An assessment will occur on an annual basis for all the data collected via monitoring through the nonstructural measure. This assessment will come from the collected Asian Carp Monitoring and Response Work Group Interim Summary Reports that are released every spring. The interim summary report provides a synopsis of all the data collected the previous sampling season and provides recommendations and changes for the following year's response plan. These recommendations are discussed during an annual meeting held in Springfield, Illinois. While the Asian Carp MRWG makes recommendations and changes to the plan on their own volition, additional and potentially larger management actions may be made under this proposed adaptive management plan. The annual results from the monitoring for *A. lacustre* and project performance monitoring will also be assessed on an annual basis for potential adaptive management options. The adaptive management team will review the results and determine if, when and where additional actions are needed to prevent the spread haul fowling aquatic nuisance species.

Variances and Success

The most important success criteria for the tentatively selected plan is to prevent movement of ANS upstream through the Brandon Road Lock and Dam. The aim is to have no upstream movement and that leaves no room for any variance. Variance with the CPUE for catches within the Dresden Island Pool will likely occur as populations naturally fluctuate based on recruitment.

Once the goal for CPUE is reached, continued fishing will be needed and the variance should not fluctuate by more than 15% over a 2 year span. Any further increase could be a result of changing population conditions and require additional management actions to account for them. The success of the project will occur if no ANS move upstream through the Brandon Road Lock and Dam. The success of keeping propagule pressure low may be difficult to reach. The unpredictability of invasive species expansion can occur unexpectedly. Even with the action criteria met, stopping removal efforts may allow the population to rebound and potentially expand very quickly. Even when the CPUE is reached, removal efforts will be needed to ensure that the population does not rebound.

Documentation and Reporting

Assessment results from monitoring will be documented into the annual Asian Carp Monitoring and Response Workgroup Interim Summary Report released every spring. The report is very comprehensive and detailed. It provides recommendations to improve monitoring for the following year, making it an adaptive process. The monitoring results for *A. lacustre* should be documented in an annual report provided to the Adaptive Management Team. The report should outline all the results, indicate any changes in capture locations, any new ANS captured, and the implication (in any) of the results. Project performance monitoring results should also be provided in an annual report. The report should outline the results, the implications of the results and any recommended adaptive management actions.

If a new ANS is captured during monitoring, a brief write-up documenting the capture location, species, and potential concerns associated with the species will be developed. The Adaptive Management Team will then use the write-up to discuss any potential adaptive management options to mitigate the concerns.

Decision-Making

Decision Process

If monitoring results suggest an adaptive management action is needed, the Adaptive Management Team will convene to discuss the potential actions. The actions will be discussed and detailed notes of the meeting with the recommended action will be taken to account for opposing sides of the discussion. Once a decision is made, the team will present their options to the responsible Federal and/or State agencies to implement the necessary adaptive management actions.

Action Criteria

The specific action criteria to be used in the decision making process are not fully understood at this stage. However, the goal of the TSP is to prevent the upstream transfer of ANS from the Mississippi River Basin to the Great Lakes Basin through the Brandon Road Lock and Dam. If new ANS are found upstream of the Brandon Road Lock and Dam, the adaptive management team should convene immediately to discuss the potential implications and determine if any additional actions are needed.

Potential Adaptive Management Decisions

While it is impossible to predict all the potential adaptive management decisions during feasibility level planning, a few potential options are outlined below.

- Additional effort may be needed for removal to maintain low populations of aquatic nuisance fish species in the upper Illinois River.
- If new aquatic nuisance species become present within the upper Illinois River, new types of gear may be needed to effectively control for the species. For instance, if a new fish species that prefers benthic habitat were to enter the study area, new gear types may need to be deployed to improve efficiencies.
- If populations of aquatic nuisance species rapidly increase, the use of piscicides, under direction of the Illinois Department of Natural Resources may be required.
- New deterrent technologies may be applied as we learn more about them. One example may be the use of CO_2 if it becomes safe and applicable within the engineered channel.

The above are just a few of the potential actions that may take place in response to changing populations of ANS. While this plan aims to provide adaptive management actions and the appropriate criteria, it is important to note that the nonstructural measure will be conducted through the Asian Carp Monitoring and Response Work Group is adaptive in nature. Besides the fact that the plan changes on an annual basis due to new information and recommendations from members of the Asian Carp Regional Coordinating Committee, the 2016 plan has a contingency plan built in with great detail. The contingency plan can be found in Appendix J of the 2016 Monitoring and Response Plan for Asian Carp in the Upper Illinois River and Chicago Area Waterway System. The plan outlines potential monitoring and response actions based the changes to the Asian carp populations in respect to life stages, adundance, and pool location.

Project Close Out

Close-out of the GLMRIS-BR Project would occur when it is determined that the Project has successfully met the criteria described above. Success would be considered to have been achieved when the Project objectives have been met, or when it is clear that they will be met based upon the trends for the site conditions and processes.

Documentation

Once an adaptive management action is implemented, the Adaptive Management Team will document the changes to the project. The report will include what action was implemented, how it aims to correct the issue, costs, new success criteria, any new monitoring needed to assess for success, and any additional pertinent information.

Communications structure for Implementation

Communication for implementation will occur through the GLMRIS Brandon Road Interagency Committee (GBRIC) shown in Figure L-5. The committee will meet annually or as needed to

discuss potential adaptive management activities needed at Brandon Road Lock and Dam. The GLMRIS-BR Interagency Coordination Committee would also consider establishing a science subcommittee. As the study moves into PED, a more formal communication structure will be developed.

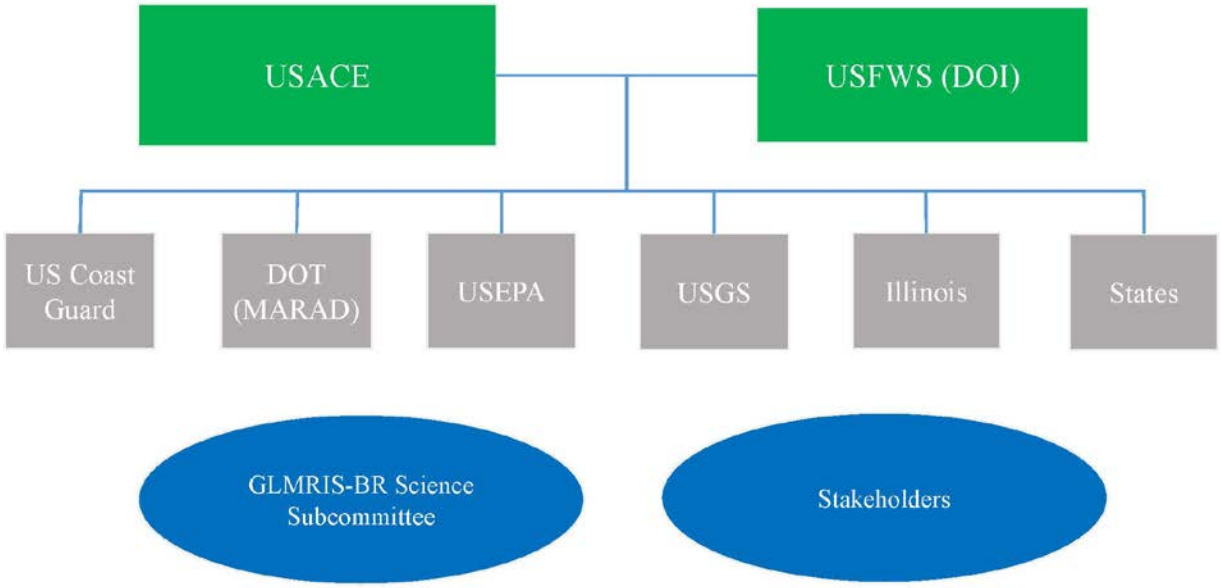

Figure L- 5 Draft of the GLMRIS Brandon Road Interagency Coordination Committee

Literature Cited

Monitoring and Response Plan for Asian Carp in the Upper Illinois River and Chicago Area Waterway System, 2016.

National Invasive Species Council. Management Plan: 2016-2018. Washington, DC, 2016.