Asian Carp Regional Coordinating Committee

Monitoring and Response Workgroup

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

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ILLINOIS DEPARTMENT OF NATURAL RESOURCES

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The Asian Carp Monitoring and Response Plan was created by a team of biologists, scientists, managers, and administrators from state and federal agencies and includes technical input from government, university, and the private sector specialists. The original plan released in May 2010 was developed by S. Finney, R. Simmonds, S. Pescitelli, S. Shults, J. Mick, G. Sass, and R. Maher. This and earlier versions of the plan have benefitted from reviews by participants of the Monitoring and Response Work Group, Great Lakes state's natural resource agencies, non-governmental organizations, and staff from the Illinois Department of Natural Resources Division of Fisheries, U.S. Army Corps of Engineers and U.S. Fish and Wildlife Service.

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EXECUTIVE SUMMARY

The 2013 Monitoring and Response Plan (MRP) has been developed by the Monitoring and Response Workgroup (MRWG) and released by the Asian Carp Regional Coordinating Committee (ACRCC). The plan outlines 2013 actions for Asian carp monitoring and removal in the Chicago Area Waterway System (CAWS) and upper Illinois Waterway. In addition, the plan identifies on-going actions to evaluate the effectiveness of barriers (electrical, chemical, and physical) and gears (e.g. electrofishing, gill/trammel netting, and trap netting) used in the effort to keep Asian carp from becoming established in the CAWS and Lake Michigan. This plan builds upon plans developed in 2011 and 2012. This and earlier versions of the plan have benefitted from reviews by technical experts and workgroup members, including, but not limited to Great Lakes state's natural resource agencies and non-governmental organizations. For the purpose of this plan, the term 'Asian carp' refers to Bighead Carp (*Hypophthalmichthys nobilis*) and Silver Carp (*H. molitrix*), exclusive of other Asian carp species such as Grass Carp (*Ctenopharyngodon idella*) and Black Carp (*Mylopharyngodon piceus*).

The MRWG is following an adaptive approach to Asian carp management and has prepared an interim summary report document (MRRWG 2013) containing preliminary results and analysis of actions completed for each of the 18 projects described in the 2012 MRRP. The interim reports document is considered a companion document to this 2013 MRP and includes recommendations for modifications and enhancements to project plans based on past results and experiences. Knowledge gaps also were identified and these informed recommendations for new project plans included in this update. The interim summary report may be found at: www.asiancarp.us.

Highlights of major initiatives in the 2013 MRP include:

- A modified strategy for eDNA monitoring that decouples eDNA as a trigger for response actions. In 2013, eDNA monitoring in the CAWS will include two comprehensive events in the spring and fall, with the addition of monitoring below the electric barrier system. The comprehensive events will include sample collection at multiple sites in the CAWS during a relatively short period of time. The interagency eDNA Calibration Study (ECALS) has released findings to date that suggest that eDNA may exist in the system that may have originated from alternate sources (in addition to a live, free-swimming fish). Until the context of the eDNA positive detections in the CAWS can be further refined by ECALS in the next year, the MRWG has removed eDNA as a trigger for response actions, yet retains it as a monitoring and surveillance tool in the MRP.
- Overall monitoring will be maintained in the CAWS - monitoring will be reduced at the five fixed sites and four random areas upstream of the electric barrier system. Extensive sampling upstream of the electric barrier system has led to the conclusion that Asian carp, if they are present, are likely in extremely low numbers. Monitoring with agency electrofishing in the areas upstream of the electric barrier system will shift from twice per month events to once per month events. Monitoring with contracted commercial netting crews will continue twice monthly above the electric barrier system.

- Initiation of response actions will be maintained within the Framework - The 2013 MRP includes levels of response triggers and a feedback loop that advises for continued monitoring or an end to the action. Final decisions regarding responses remain under action agency authority with endorsement from the MRWG.
- Planned Intensive Surveillance in the CAWS - Planned intensive surveillance actions at selected locations in the CAWS outside the response threshold framework will be conducted. Surveillance events will target areas that have been previously monitored through response actions.
- An increase in fixed site monitoring below the electric barrier system from once/month events to twice/month events with the addition of random electrofishing and contracted netting. Increased effort below the electric barrier system will provide information for a better characterization of the Asian carp population front.
- Tagged fish for acoustic telemetry evaluations of electric barrier system - Additional tagged fish for acoustic telemetry evaluations of electric barrier system effectiveness and movements of Asian carp and surrogate fish species through locks and water control structures at dams.
- Monitoring fish at the electric barrier system - Monitoring fish at the electric barrier system area will continue and protocols for monitoring on a monthly basis between barrier maintenance events with split-beam hydroacoustics, side-scan sonar, and DIDSON imaging technology have been developed.
- Hydroacoustics - New efforts will be undertaken to evaluate the possibility of identifying fish, particularly Asian carp, to species level using multiple hydroacoustic split-beam frequencies.
- Expansion of the Des Plaines River monitoring project - Removal of the Hofmann Dam in 2012 has created opportunity for fish to advance further up the Des Plaines River. In 2013 monitoring will extend upstream to areas with favorable Asian carp habitat.
- Use of Great Lakes trap nets monitoring - The use of Great Lakes trap nets will extend to locations in the LaGrange or Peoria Pools to further test this gear.
- Testing of water guns - Additional testing of water guns will be undertaken to assess the effects of the guns on navigation structures, locks, and associated equipment. In addition, testing to define the distribution of pressure at various pressure settings and with multiple guns and responses by Asian carp in controlled and uncontrolled environments will be undertaken.
- Law enforcement - Law enforcement surveillance and inspections of fish haulers, fish production facilities, and fish markets will be expanded in 2013.

More detailed analyses and justifications for changes to sampling protocols are included in the MRWG 2013 Interim Report. As in the past, individual project plans detail procedures and protocols that will allow us to achieve the overall goal and accomplish strategic objectives developed by the workgroup.

The overarching goal and objectives for the plan remain the same - to prevent Asian carp from establishing self-sustaining populations in the CAWS and Lake Michigan. The five strategic objectives to accomplish the overall goal are:

1) Determination of the distribution and abundance of any Asian carp in the CAWS, and use this information to inform response removal actions;
2) Removal of any Asian carp found in the CAWS to the maximum extent practicable;
3) Identification, assessment, and reaction to any vulnerability in the current system of barriers to prevent Asian carp from moving into the CAWS;
4) Determination of the leading edge of major Asian carp populations in the Illinois River and the reproductive success of those populations; and
5) Improvement of our understanding of factors behind the likelihood that Asian carp could become established in the Great Lakes.

Twenty-one projects are proposed to achieve the overarching goal and objectives of the 2013 MRP. Project plans are included to showcase the full range of work that will be on-going or initiated during the coming year. These projects can be categorized geographically as occurring either upstream or downstream of the electric barrier system and grouped into five categories: Monitoring Projects, Removal Projects and Evaluations, Barrier Effectiveness Evaluations, Gear Effectiveness Evaluations and Development Projects, and Alternative Pathway Surveillance.

MONITORING PROJECTS

Fixed and Random Site Monitoring Upstream of the Barrier (18) – This project includes monthly standardized monitoring with pulsed-DC electrofishing gear and twice-monthly contracted commercial fishers at sites in the CAWS upstream of the electric barrier system. Monitoring also will include five fixed sites with additional random electrofishing transects and net sets per month at locations outside of fixed sites to maintain spatial coverage of the waterway. This project provides information on relative abundance and distribution of Asian carp, if captured or observed, and other fish species that can be compared among sites and across time. Acquired data will inform response actions.

Strategy for eDNA Monitoring in the CAWS (25) – A modified strategy for eDNA monitoring that decouples eDNA as a trigger for response actions. In 2013, eDNA monitoring in the CAWS will include two comprehensive events in the spring and fall, with the addition of monitoring below the electric barrier system. The comprehensive events will include sample collection at multiple sites in the CAWS during a relatively short period of time. The interagency eDNA Calibration Study (ECALS) has released findings to date that suggest that eDNA may exist in the system that may have originated from alternate sources (in addition to a live, free-swimming fish; See Appendix G for ECALS Executive Summary).

Larval Fish and Productivity Monitoring (29) – Sampling for fish eggs, larvae, and Illinois Waterway productivity will occur approximately every two weeks from April-October at 10 sites downstream of the electric barrier system (LaGrange to Brandon Road pools) and 3-4 sites in the CAWS upstream of the electric barrier system. Sampling may occur more frequently when Asian carp eggs or larvae are more likely to be present (e.g., during spring months, a period of rising water levels, and shortly after peak flows). Information may be used to assess timing and extent of Asian carp reproduction in the Illinois River, Des Plaines River, and CAWS, provide

early detection in the CAWS, examine relations between Asian carp and productivity variables, and inform possible control strategies targeting Asian carp spawning and early life history.

Young-of-Year and Juvenile Asian Carp Monitoring (32) – Monitoring for the presence of young-of-year Asian carp in the Illinois River, Des Plaines River, and CAWS will take place through sampling planned by other projects in the MRP (e.g., Larval Fish and Productivity Monitoring, Fixed and Random Site Monitoring Upstream of the Barrier, Fixed Site Monitoring Downstream of the Barrier, Gear Efficiency and Detection Probability Study, Des Plaines River and Overflow Monitoring Project). Sampling targets a segment of the Asian carp population typically missed with adult sampling gears and provides information to help determine where in the waterway Asian carp are successfully recruiting young.

Distribution and Movement of Juvenile Asian Carp in the Illinois Waterway (34) – This project specifically targets sampling of young Asian carp in areas not sampled by standard monitoring and gear evaluation projects in an effort to better understand distribution and habitat use by young Bighead and Silver Carp in the Illinois Waterway. Specific areas include tributaries and shallow backwater habitats known to function as nursery areas for young Asian carp. Movement patterns of young will be determined with acoustic telemetry. Results from this project will contribute to our understanding of young Asian carp movement and habitat use and help assess the risk of these life stages challenging the electric barrier system and gaining access to the CAWS and Lake Michigan.

Fixed and Random Site Monitoring Downstream of the Barrier (39) – This project includes monthly standardized monitoring with pulsed-DC electrofishing gear and contracted commercial fishers at four fixed sites downstream of the electric barrier system (in Lockport Pool and downstream from the Lockport, Brandon Road, and Dresden Island locks and dams). In addition, we have added hoop nets and mini-fyke nets to sampling protocols to enhance monitoring for adult and juvenile Asian carp. Results will provide information on the location of detectable Asian carp populations in the waterway (relative abundance and distribution) and their progression upstream over time. Population data may be compared among sites and across time.

REMOVAL PROJECTS AND EVALUATIONS

Response Actions in the CAWS (45) – This project includes a threshold framework to support decisions for response actions to remove any Asian carp from the CAWS upstream of the electric barrier system with conventional gear. It also allows for targeted response actions at selected locations in the CAWS outside the threshold framework when information gained from such actions may benefit monitoring protocols and Asian carp removal efforts.

Planned Intensive Surveillance in the CAWS (48) - This project represents a modification to response actions in the CAWS and surveillance events will target areas that have been previously monitored through response actions. These efforts will have the benefit of advanced planning and will be in locations where the repeated detection of eDNA in previous years indicates the potential presence of Asian carp in the waterway.

Barrier Maintenance Fish Suppression (52) – This project provides a fish suppression plan to support USACE maintenance operations at the electric barrier system. The plan includes clearing fish from between barriers with water gun technology and evaluating clearing success with split-beam hydroacoustics, side scan SONAR, and DIDSON imaging SONAR.

Barrier Defense Asian Carp Removal Project (62) – This program was established to reduce the numbers of Asian carp downstream of the electric barrier system through targeted and contracted commercial fishing. Reducing Asian carp populations is anticipated to lower propagule pressure and the chances of Asian carp gaining access to waters upstream of the electric barrier system. Primary areas that will be fished include Starved Rock, Marseilles, and Dresden Island Pools, though additional effort is expended in Brandon Road and Lockport Pools.

Monitoring Asian Carp Population Metrics and Control Efforts (64) – This project includes measuring population demographics of Asian carp populations in the Illinois Waterway, including estimates of population abundance with split-beam hydroacoustics and mark-recapture techniques. Work will focus on assessing population response to Asian carp removal by commercial fishers in Starved Rock, Marseilles, and Brandon Road Pools, although down river evaluations also will occur. Effects of emigration and immigration will be determined with acoustic telemetry.

BARRIER EFFECTIVENESS EVALUATIONS

Telemetry Monitoring Plan (71) – This project uses ultrasonically tagged Asian carp and surrogate species to assess if fish are able to challenge and/or penetrate the electric barrier system and pass through navigation locks in the upper Illinois Waterway. An array of stationary acoustic receivers and mobile tracking will be used to collect information on Asian carp and surrogate species movements.

Monitoring Fish Abundance, Behavior, and Fish-Barge Interactions at the Barrier (81) – 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 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.

Evaluating Asian Carp Detection Techniques with SONAR (87) - 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.

Des Plaines River and Overflow Monitoring (89) – This project provides a plan to monitor for Asian carp spawning activity, if any exists, in the upper Des Plaines River. It also will assess efficacy of the Asian carp barrier fence constructed between the Des Plaines River and Chicago Sanitary and Ship Canal (CSSC) by monitoring for any Asian carp eggs, larvae, and juveniles that may be transported to the CSSC via laterally flowing Des Plaines River floodwaters passing through the barrier fence.

GEAR EFFECTIVENESS EVALUATIONS AND DEVELOPMENT PROJECTS

Asian Carp Gear Efficiency and Detection Probability Study (91) – This project will assess efficiency and detection probability of gears currently used for Asian carp monitoring (pulsed-DC electrofishing, gill nets, and trammel nets) by sampling at sites in the Illinois River, lower Des Plaines River, and CAWS that have varying carp population densities. In addition, a variety of alternative sampling gears (hydroacoustics, midwater trawls, purse seines, trap nets, mini-fyke nets, hoop nets, cast nets, and seines) and newly developed gears (6-foot diameter hoop nets, 30-foot deep experimental gill nets, and Lake Michigan style pound nets) will be evaluated to determine their ability to detect juvenile and adult Asian carp. Results will inform decisions on appropriate levels of sampling effort and monitoring regimes, and ultimately improve Asian carp monitoring and control efforts.

Exploratory Gear Development Project (94) – A professional net designer will be consulted to develop and build enhanced purse seines and trawls (e.g., modified paupier push trawl) for more effective harvest of Asian carp. Enhanced gears will be evaluated in areas known to have abundant Asian carp populations.

Unconventional Gear Development Project (96) – 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. Alternative trap and net designs developed during the past years (Great Lakes pound nets, 30-foot deep gill nets, and six-foot hoop nets) will be evaluated as part of the gear efficiency project.

Water Gun Development and Testing (98) – 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 its effects on lock structures in the CAWS (e.g., lock walls and in-water equipment) and as an alternative tool to rotenone for fish suppression in support of electric barrier system maintenance. If proven successful, water guns may be further evaluated for potential use as a permanent tool to defend navigation locks in the CAWS or elsewhere to keep Asian carp from moving into the Great Lakes.

ALTERNATIVE PATHWAY SURVEILLANCE

Alternative Pathway Surveillance in Illinois - Law Enforcement (101) – This project created 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. Inspection and surveillance efforts will take place in the Chicago Metropolitan Area including Cook and the collar counties, with eventual expansion statewide and potentially across state boundaries.

Alternative Pathway Surveillance in Illinois - Urban Pond Monitoring (103) - This project provides monitoring and removal efforts for Asian carp that may have been unintentionally stocked in urban fishing ponds in the Chicago Metropolitan Area. Monitoring with eDNA technology and conventional gears (electrofishing and netting) has previously occurred in local fishing ponds and has detected and removed Asian carp (possibly introduced as contaminants in shipments of stocked sport fish). Revisits of contaminated ponds and further monitoring and surveillance efforts will continue in the Chicago Metropolitan Area including Cook and the collar counties.

A broad range of sampling and removal tools are available to the MRWG action agencies to accomplish the plan objectives outlined above. They include traditional sampling gears (e.g., electrofishing, trammel nets, experimental gill nets, mini fyke or trap nets, larval push nets, trawls, and seines), chemical piscicide (e.g., rotenone), high-tech sonic detection and imaging devices (e.g., ultrasonic telemetry and hydroacoustics, DIDSON, and side-scan SONAR), and newly developed or developing techniques (e.g., eDNA, pneumatic water guns, and attraction pheromones). Whereas many of these gears and techniques are part of on-going monitoring and removal efforts, new tools are continually being added to the MRP as it is periodically revised and new techniques are developed. In many cases, multiple tools are being used to accomplish individual objectives and provide sufficient intelligence to allow for sound management decisions. This strategy of addressing questions from multiple fronts with a combination of gears and techniques has helped to increase the level of confidence in results provided by monitoring and removal projects to date. In addition, gear evaluations have been on-going (see gear development and evaluation projects below) and have been expanded in this revised MRP (e.g., see Monitoring Asian Carp Population Metrics and Control Efforts and Water Gun Development and Testing Project). Research on calibration and further refinement of eDNA monitoring is also being pursued outside of this plan. Upon completion, these assessments should lead to improved Asian carp monitoring and removal outcomes, better understanding of the effectiveness of in-place barriers built to prevent Asian carp from gaining access to the CAWS and Lake Michigan, and improved interpretation of sampling results.

2012 ACCOMPLISHMENTS

- Total area sampled:
  - 200 miles of waterway from Starved Rock Lock and Dam to Lake Michigan including 76 miles of CAWS
- Estimated total effort, capture, and removal upstream of the electric barrier system:
  - 7,518 person-hours; 99,243 fish collected, 63 species plus 2 hybrid groups
  - 192 hours of electrofishing
  - 81.7 miles of trammel/gill nets fished
  - No Bighead or Silver Carp captured or observed upstream of the electric barrier system
- Estimated total effort, capture, and removal downstream of the electric barrier system:
  - 10,401 person-hours; 96,309 fish collected, 68 species plus 2 hybrid groups
  - 36 hours of electrofishing
  - 328 miles of trammel/gill nets fished
  - 196 net nights of hoop/mini fyke nets fished

    - No Bighead or Silver Carp captured or observed in Lockport Pool and Brandon Road Pools
    - 80 Bighead Carp and 13 Silver Carp captured and removed from Dresden Island Pool 15-24 miles downstream of the electric barrier system
    - 16,643 Bighead Carp and 28,773 Silver Carp (>284 tons) removed from Marseilles and Starved Rock pools 24-65 miles downstream of the electric barrier system
- eDNA samples processed upstream of the electric barrier system in 2012
    - 428 estimated person-hours were spent collecting and filtering 1,210 water samples
    - 4 positives for Bighead Carp DNA upstream of the electric barrier system*
    - 153 positives for Silver Carp DNA upstream of the electric barrier system*

* Results of eDNA sampling must be interpreted with care because a relation between the number of positive detections and fish population abundance has not been established to date, or that eDNA indicates the presence of a live fish. See Strategy for eDNA Monitoring in the CAWS (page 25 of 2013 MRP) for more details.

Further details on work conducted and results of the 2012 MRRP are available in the 2013 MRP Interim Summary Report document available at www.asiancarp.us.

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

May 2013

INTRODUCTION AND BACKGROUND

Asian carp were first sampled from the Illinois River during the 1990's and populations have since progressed upstream (Conover et al. 2007; Irons et al. 2009). For the purpose of this plan, the term 'Asian carp' refers to Bighead Carp (*Hypophthalmichthys nobilis*) and Silver Carp (*H. molitrix*), exclusive of other Asian carp species such as Grass Carp (*Ctenopharyngodon idella*) and Black Carp (*Mylopharyngodon piceus*). Monitoring for Bighead and Silver Carp was originally incidental to standard routine sampling by the Illinois Department of Natural Resources (IDNR) and the Illinois Natural History Survey (INHS). Sampling directed toward Asian carp in the upper Illinois Waterway began with the US Fish and Wildlife Service's (USFWS) annual Carp Corral & Goby Roundup. Subsequently, the US Army Corps of Engineers (USACE) adopted a plan specifically to monitor Asian carp downstream of the electric barrier system located near Romeoville, Illinois. This barrier is designed to repel fish using an electric field to prevent fish movement between the Great Lakes and Mississippi River basins. Monitoring efforts and the need to perform maintenance work on the barrier precipitated a rotenone action in Lockport Pool during December 2009. This action resulted in the collection of a Bighead Carp in Lockport Pool downstream of the electric barrier system. Monitoring also resulted in the sighting of a single Silver Carp in Brandon Road Pool and the capture of numerous Bighead Carp in Dresden Island Pool.

Environmental DNA (eDNA) is a new surveillance method for use in aquatic environments that is being used to test for the genetic presence of Bighead and Silver Carp (Jerde et al. 2011). The use of eDNA as an invasive species management tool is currently being refined through ongoing research to reduce the uncertainty surrounding eDNA results (ACRCC 2012). The USACE began using eDNA in cooperation with the UND in August 2009 to monitor for Asian carp DNA in the Chicago Area Waterway System (CAWS). Early eDNA monitoring resulted in the discovery of Asian carp DNA in areas upstream of the electric barrier system and prompted additional monitoring and response actions. The additional monitoring resulted in the discovery of Asian carp DNA at several other locations in the CAWS. Intensive targeted use of conventional capture gear resulted in the capture, through commercial netting, of a single live Bighead Carp in Lake Calumet upstream of the electric barrier system.

An Asian Carp Regional Coordinating Committee (ACRCC) was established to provide coordinated communication and response to accomplish the goal of preventing Asian carp from becoming established in the Great Lakes. To facilitate the accomplishment of the goal, the

ACRCC formed multiple workgroups, including the Monitoring and Response Workgroup (MRRWG). A variety of response actions led to a more precise re-branding of the group as the Monitoring and Response Work Group (MRWG). The MRWG is co-led by the IDNR and the Great Lakes Fishery Commission (GLFC) and is comprised of liaisons from key state and federal agencies as well as independent technical specialists (see Appendix A for membership). The MRRWG 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. Specifically, the group was asked to determine how best to identify the location and abundance of Asian carp in the CAWS, lower Des Plaines River, and upper Illinois River, and to identify appropriate response actions to address such findings. Many of the actions included in this plan were informed by recommendations presented in the National Asian Carp Control Plan (Conover et al. 2007).

The MRP has gone through several annual versions and periodically will be revisited and modified as more information becomes available on Asian carp distribution and abundance and as response needs change. Herein, we review plan development to date, present overarching strategic objectives, identify tools available to complete necessary work, and present 21 specific project plans detailing tactics and protocols that will allow us to accomplish strategic objectives and achieve the overall goal of preventing Asian carp from establishing populations in the CAWS and Lake Michigan.

PLAN DEVELOPMENT PROCESS

The purpose of the MRP is to identify the best strategy for conducting monitoring and response actions that will accomplish the goal of preventing Asian carp from establishing self-sustaining populations in the CAWS and Lake Michigan. The MRRWG initially (2009-2010) considered a multitude of actions and then more fully developed a dual approach that was considered to be the most promising to determine distribution and abundance of Asian carp. The initial approach was: 1) use eDNA testing of waterway samples to identify areas containing Asian carp DNA, and then use conventional sampling gears or rotenone to intensively sample those areas; and 2) use conventional netting and electrofishing gear to intensively sample fixed locations where Asian carp are most expected to be present if any existed, and to less intensively sample wider waterway reaches throughout the CAWS. Taking a conservative approach, the MRWG considered positive eDNA detections as an indicator of the presence of Asian carp in the waterway for purposes of management and response strategies.

Initial sampling with conventional gear was completed in the CAWS upstream of the electric barrier system during February and March 2010. Sampling targeted warm water discharges and backwater habitats where Asian carp were expected to congregate if present, and included reach-wide electrofishing runs along the entire waterway upstream of the electric barrier system. No Asian carp were collected or observed during initial sampling efforts. As a follow-up to the initial sampling, the MRWG was expanded to include the independent technical specialists listed in Appendix A.

The expanded workgroup met in April 2010 to discuss the results of initial monitoring, and the outcome of the meeting was a decision to: 1) proceed initially with eDNA sampling and rotenone

treatments at locations where sufficient evidence of the possible presence of Asian carp existed; and 2) reconsider netting, electrofishing, and other potential monitoring techniques, once information on Asian carp abundance was gathered from rotenone treatments. A consensus on general triggers to initiate response actions was not reached by the workgroup, but specific triggers were developed for the Little Calumet River downstream from O'Brien Lock and Dam and the North Shore Channel downstream from Wilmette Pumping Station. Both sample reaches had multiple positive eDNA detections for Asian carp on one or more sample dates during 2009 and displayed physical characteristics conducive to response actions. The MRWG determined that another positive detection at either location would trigger a conventional gear or rotenone sampling response to determine Asian carp presence and abundance.

Initial eDNA monitoring in 2010 took place from March through May and targeted areas of the CAWS upstream of the electric barrier system that either had positive detections for Asian carp DNA during 2009 or lacked surveillance altogether. Of the 543 water samples analyzed for Bighead and Silver Carp, none contained Bighead Carp DNA and eight contained Silver Carp DNA; one each in the Calumet/Little Calumet River, North Shore Channel, and Chicago River and five in the Chicago Sanitary and Ship Canal (CSSC)/South Branch Chicago River (SBCR) near Bubbly Creek. These results elicited conventional gear response actions at North Shore Channel (May) and CSSC/SBCR (June), and a combined rotenone and conventional gear response at Calumet/Little Calumet River downstream of O'Brien Lock and Dam (May). No Bighead or Silver Carp were captured or observed during any of these response actions.

The MRWG met after the spring 2010 response actions and concluded that whereas eDNA detections suggested Asian carp may be present in the CAWS upstream from the electric barrier system, results of intensive sampling with conventional gear and rotenone indicated that if any Asian carp were present in the waterway, they were present in low numbers. It also was noted that eDNA samples taken within block netted areas of the North Shore Channel and Calumet/Little Calumet River prior to response actions were negative for Bighead and Silver Carp DNA, which was in agreement with conventional gear and rotenone sampling results for these actions. The work group recommended continued monitoring with eDNA and conventional gears and implementation of additional response actions as needed to bolster abundance estimates and remove Asian carp from the system.

One additional response action was initiated after an adult Bighead Carp (mature male 34.6 inches long and 19.6 pounds) was captured by contracted commercial netters in Lake Calumet on 22 June, 2010, which was the first day of sampling at designated fixed sites upstream of the electric barrier system. This capture confirmed the presence of live Asian carp in the CAWS above the barrier and resulted in 11 days of sampling in Lake Calumet, the Calumet River, and Calumet Harbor from 23 June – 9 July. No Asian carp were captured or observed during the response. Additional water samples from Lake Calumet ($N = 114$), Calumet River and Harbor ($N = 95$), and Indiana ports and harbors ($N = 125$) were collected during July and August and analyzed for Asian carp DNA. None of the DNA testing indicated the presence of Bighead or Silver Carp DNA in any of the regions surveyed. Fixed site sampling continued on a twice monthly schedule throughout summer and fall 2010. Sampling resulted in the catch of >40,000 fish and no additional Bighead or Silver Carp.

In addition to sampling in the upper waterway, monitoring and removal of Asian carp took place downstream of the electric barrier system in order to track the upstream progression of the detectable population front and reduce its abundance. The detectable population front is defined as the farthest upstream location where multiple Bighead or Silver Carp have been captured in conventional sampling gears during a single trip or where individuals of either species have been caught in repeated sampling trips to a specific site. Downstream monitoring and removal efforts suggested the location of the detectable population front was in the lower Dresden Island Pool about 55 miles from Lake Michigan. Monitoring also provided preliminary evidence that commercial netting may be useful for reducing Asian carp abundance within localized areas.

The MRWG met again in September 2010 to discuss the results of all monitoring to that point and to modify the plan accordingly. A new plan was developed and reviewed over winter. It incorporated preliminary results of 2010 monitoring and removal efforts, discussions among action agency staff and technical experts at the September meeting, and numerous written comments provided by workgroup members, Great Lakes state's natural resource agencies, and non-governmental organizations. The plan included 18 project plans categorized geographically as occurring either upstream or downstream of the electric barrier system and grouped into five categories: Monitoring Projects, Removal Projects, Barrier Effectiveness Evaluations, Gear Effectiveness Evaluations and Development Projects, and Alternative Pathway Surveillance. The 2011 MRRP was officially released and posted on the Asiancarp.org website in May 2011.

Implementation of the 2011 MRRP resulted in extensive sampling of 200 miles of waterway from Starved Rock Lock and Dam to Lake Michigan, including 76 miles of the CAWS. Further details of 2011 project results can be found in the 2011 MRRP Interim Summary Reports document (MRRWG 2012) prepared by the workgroup and posted on Asiancarp.us.

The workgroup met in January 2012 to review summary information from the past year's monitoring and removal efforts and consider recommendations for projects in the updated plan. A plan for 2012 was developed and reviewed that provided comments by workgroup members, Great Lakes state's natural resource agencies, and non-governmental organizations. The plan 2012 again included 18 project plans categorized geographically as occurring either upstream or downstream of the electric barrier system and grouped into five categories: Monitoring Projects, Removal Projects, Barrier Effectiveness Evaluations, Gear Effectiveness Evaluations and Development Projects, and Alternative Pathway Surveillance. The 2012 MRRP was released and posted on the Asiancarp.org website in May 2012.

The 2012 MRRP again called for a considerable sampling effort covering the Illinois Waterway from Starved Rock Lock and Dam to Lake Michigan, including the CAWS. Monitoring for eDNA upstream of the electric barrier system provided a collection of 1,210 samples resulting in 4 positives for Bighead Carp DNA and 153 positives for Silver Carp DNA. Consecutive eDNA positives triggered two Level I Response actions in Lake Calumet during July and October 2012 and one Level I Response action in the North Shore Channel during October 2012. For the first time in three years, eDNA samples collected prior to response actions returned positive detections for Asian carp DNA, but intensive conventional gear efforts during the actions resulted in no Asian carp observed or captured. An estimated 7,518 person-hours were spent to complete 192 hours of electrofishing and deploy 82 miles of net during 2012 monitoring

upstream of the electric barrier system. The combined catch during these efforts was 99,234 fish representing 63 species; none of which were Bighead or Silver Carp.

An estimated 10,401 person-hours, 36 hours of electrofishing, 328 miles of gill/trammel nets, 128 net-nights of hoop netting, and 68 net nights of mini-fyke netting were expended monitoring and removal downstream of the electric barrier system during 2012. The catch included 96,309 fish representing 68 species. No Bighead or Silver Carp were captured or observed in Lockport or Brandon Road pools. Sampling efforts removed 80 Bighead Carp and 13 Silver Carp from Dresden Island Pool 15-24 miles downstream of the electric barrier system and 16,643 Bighead Carp and 28,773 Silver Carp (>284 tons) from Marseilles and Starved Rock pools 24-65 miles downstream of the electric barrier system. As in previous years, extensive monitoring downstream of the electric barrier system confirmed that the detectable population front was indeed located in the lower Dresden Island Pool about 47 miles from Lake Michigan and that its location had not changed.

Other highlights from 2012 MRRP projects included: the absence of Asian carp eggs, larvae, young-of-year and juveniles <12 inches long from all samples collected upstream of Henry, Illinois (a single Asian carp egg was collected at Henry, but not upstream - over 100 miles from the electric barrier system); higher productivity and zooplankton abundance in Lake Calumet and the Little Calumet River compared to other areas of the CAWS and Illinois Waterway; successful clearings of fish >12 inches long from the electric barrier system and assessment of clearing success with remote sensing gears (split-beam hydroacoustics, DIDSON, and side scan sonar), which allowed barrier maintenance operations to occur without a breach in barrier effectiveness; assessments with telemetry, DIDSON, and other techniques to test effectiveness of barriers designed to keep Asian carp from gaining access to Lake Michigan; evaluation of the effectiveness of established gears used to sample Asian carp and development of new or modified gears (e.g., 6-foot diameter hoop nets, surface-to-bottom experimental gill nets, modified purse seine, customized Lake Michigan style pound (trap) nets, and a modified push trawl called a paupier net); establishment of a law enforcement Invasive Species Unit; and the detection and removal of large adult Bighead carp in urban fishing ponds located in the Chicago area and other parts of Illinois thought to be the result of contaminated shipments of Channel catfish from the late 1990s and early 2000s.

The work group met again in December 2012 and January 2013 to begin preparation of the 2013 MRP. Information from the 2012 monitoring and removal efforts was used to guide recommendations for projects to be conducted in the 2013 plan. Projects for the 2013 MRP were developed and reviewed, with comments provided by workgroup members from Great Lakes state's natural resource agencies and non-governmental organizations. The 2013 MRP includes 21 project plans categorized geographically as occurring either upstream or downstream of the electric barrier system.

The interim reports document is considered a companion document to this updated 2013 MRP and includes recommendations for modifications and enhancements to project plans based on past results and experiences. It contains preliminary results and analysis of actions completed during 2012 (and in some cases 2010 and 2011) for each of the 18 projects described in the 2012 MRRP. Knowledge gaps also were identified and these informed recommendations for new

project plans included in the updated MRP. This compilation of summary reports was intended to foster an adaptive management approach to Asian carp monitoring and removal. Although individual project plans have been designed as standalone plans, they all support one or more of the overarching strategic objectives of the MRP. Because multiple plans have been developed for some objectives, care has been taken to ensure that related plans provide complimentary rather than duplicative information. In many cases, field sampling can be coordinated or data shared to optimize personnel effort and reduce overall project costs.

If and as necessary, near shore areas of Lake Michigan will be addressed in a future version of the plan. However, it should be noted that INHS and IDNR Lake Michigan programs currently have ongoing near shore monitoring projects that could detect any Asian carp that might gain access to the Lake. The INHS samples three Lake Michigan sites with plankton nets and small-mesh gill nets, both of which may provide early detection of Asian carp larvae or juveniles. Sampling sites are located north of Waukegan, north of downtown Chicago, and near Jackson Harbor on the City's south side. These sites are located in the general vicinity of CAWS connections with Lake Michigan (i.e., Wilmette Pumping Station, Chicago Lock, and Calumet Harbor). The IDNR Lake Michigan program samples with gill nets (1- to 6-inch mesh) off of Chicago and Waukegan during spring, and again off Waukegan during fall. Electrofishing samples are made at three harbors, including Calumet Harbor, during summer and fall; the furthest southern harbor sampled in fall is Jackson Harbor. Beach seining for juvenile fish occurs at five sites along the Illinois shoreline from the Wisconsin state line south to Jackson Harbor during summer.

Additional monitoring in Lake Michigan is currently being developed and coordinated by USFWS through a separate project funded, in part, by the Great Lakes Restoration Initiative (GLRI) and outlined in the 2012 Asian Carp Framework (ACRCC 2012).

LOCATION OF PRIMARY TARGET AREAS COVERED BY THE MRP

The area covered by this plan (Figure 1) encompasses over 200 miles of waterways stretching from Starved Rock Lock and Dam to Lake Michigan and includes two target areas: 1) all waterways upstream of the electric barrier system; and 2) waterways downstream of the electric barrier system to Starved Rock Lock and Dam. The area upstream of the barrier includes approximately 76 miles of the Chicago Area Waterway System (CAWS). The downstream limit of the CAWS is the confluence of the Chicago Sanitary and Ship Canal (CSSC) and the Des Plaines River within the Brandon Road Pool (Figure 1). Waterways included in the area upstream of the electric barrier system are: CSSC (18.3 miles); South Branch Chicago River (3.9 miles); Chicago River (1.6 miles); North Branch Chicago River (7.7 miles); North Shore Channel (7.6 miles); Calumet-Sag Channel (16.0 miles); Little Calumet River, including the South Leg (40 miles); Grand Calumet River to sheet pile obstruction (3 miles); Calumet River (7.5 miles); and Lake Calumet. Waterways downstream of the electric barrier system include: CSSC, including the reach of CSSC downstream of Lockport Lock (6.0 miles); lower Des Plaines River (42 miles); and Illinois River (43 miles). Areas upstream of the electric barrier system are a higher priority for monitoring and response actions than areas downstream due to their closer proximity to Lake Michigan.

OVERALL GOAL AND OBJECTIVES OF PLAN

Overall Goal: *Prevent Asian carp from establishing self-sustaining populations in the CAWS and Lake Michigan.*

Five objectives have been identified to accomplish the overall goal. These objectives are:

1) Determination of the distribution and abundance of any Asian carp in the CAWS, and use this information to inform response removal actions;
2) Removal of any Asian carp found in the CAWS to the maximum extent practicable;
3) Identification, assessment, and reaction to any vulnerability in the current system of barriers to prevent Asian carp from moving into the CAWS;
4) Determination of the leading edge of major Asian carp populations in the Illinois River and the reproductive success of those populations; and
5) Improvement of our understanding of factors behind the likelihood that Asian carp could become established in the Great Lakes.

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Objective 1: Determination of the distribution and abundance of any Asian carp in the CAWS, and use this information to inform response removal actions. Knowledge of the distribution of Asian carp in the CAWS will inform decision makers on where and what actions are most needed and appropriate to keep Asian carp from moving into Lake Michigan. Patterns may be identified that would facilitate removal actions (e.g., commercial netters or rotenone), placement of additional barriers (e.g., water gun barrier, chemical barriers, or oxygen depletion zones), and/or other appropriate actions. Projects developed to meet this objective include eDNA, fixed and random site monitoring upstream of the electric barrier system, response actions, and planned intensive surveillance in the CAWS.

Knowledge of the abundance of Asian carp in the CAWS also will guide removal action and barrier placement decisions. In addition, it is a key piece of information required to determine the risk of Asian carp populations becoming established in the CAWS or Lake Michigan. Fixed site monitoring and response actions have provided general information on Asian carp abundance in the CAWS and these standardized sampling efforts will provide for comparisons of relative abundance over time. Owing to the current presumed low numbers and difficulty of catching Asian carp, actual abundance will be quite challenging to determine. On-going gear evaluation projects may provide for enhanced abundance estimates by determining efficiencies of gears used to sample Asian carp and identifying new gears or techniques to enhance capture rates. In addition, several projects have been developed to assist with determination of Asian carp abundance in the CAWS (see larval fish and juvenile Asian carp monitoring projects, and Gear Efficiency and Detection Probability Study).

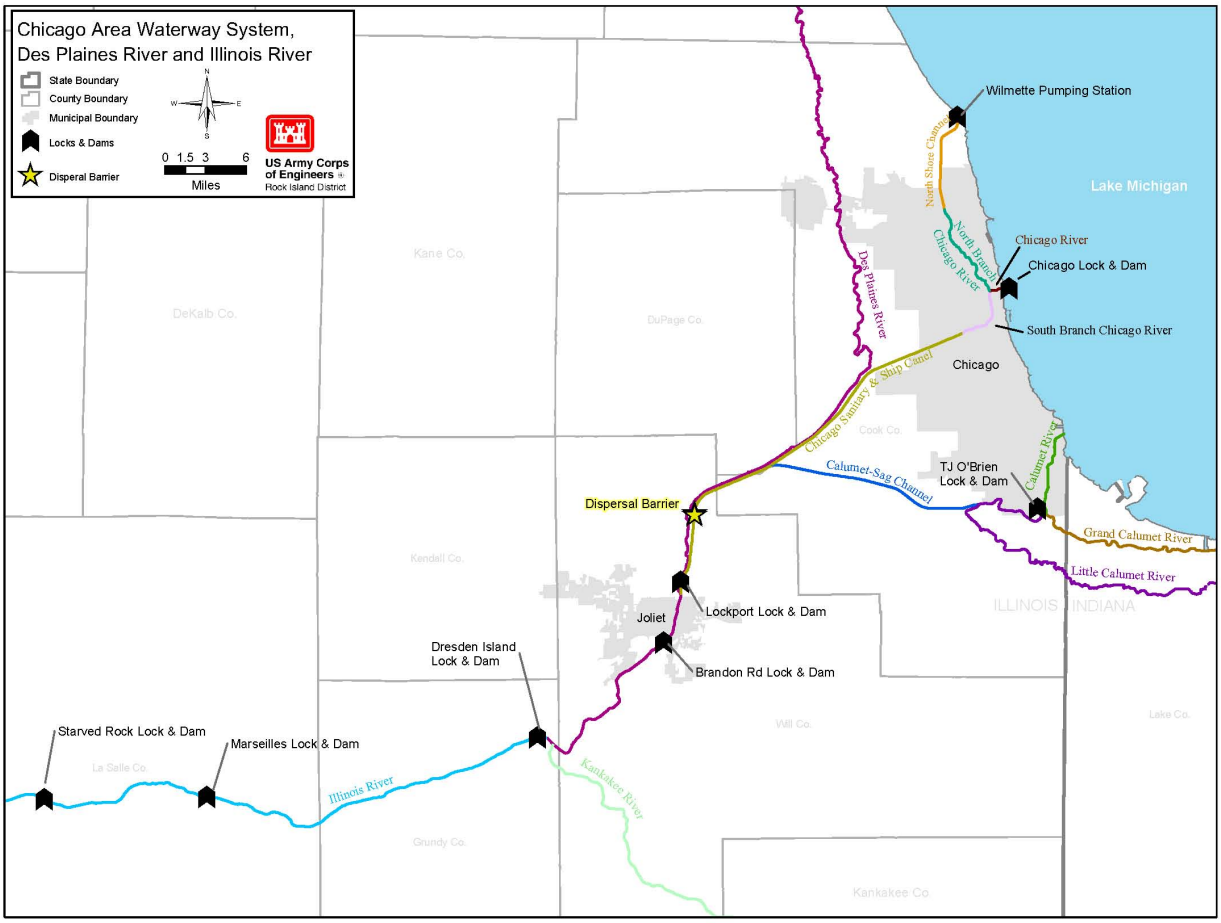


Figure 1. Map of the Chicago Area Waterways System (CAWS), Des Plaines River, and upper Illinois River.

Objective 2: Removal of any Asian carp found in the CAWS to the maximum extent practical. The MRWG is taking a cautious approach by attempting to remove all known Asian carp upstream of the electric barrier system, including those that may be trapped between Barrier 2A and Barrier 2B before completion of barrier maintenance operations (see Barrier Maintenance Fish Suppression). Removal may occur incidentally when Asian carp are captured during routine monitoring or during planned intense surveillance actions targeting specific areas of the CAWS. Response teams will be mobilized when Asian carp have been captured or observed (see Response Actions in the CAWS project plan below for more detailed discussion of response triggers).

Objective 3: Identification, assessment, and reaction to any vulnerability in the current system of barriers to exclude Asian carp from moving into the CAWS. Many measures have been undertaken or are being considered to prevent Asian carp from entering the CAWS and ultimately Lake Michigan. Some of these measures include: improving the electric barrier system in the CSSC by constructing new barriers 2A (operational in 2009) and 2B (operational in early 2011) and operating barriers at appropriate operating parameters (see Holliman 2011) to better repel small and large fish; constructing a rip-rap barrier to isolate the Illinois and Michigan Canal from the CSSC (completed in September 2010); constructing a 13-mile long concrete

barrier/small-mesh fence to prevent the movement of Asian carp from the Des Plaines River to the CSSC upstream of the electric barrier system during extreme flooding events (completed in September 2010). The USACE has been and continues to be the lead agency for most completed and proposed actions. The MRWG will provide necessary monitoring data and coordinate with partners to assist control efforts relative to the electric barrier system and other Asian carp exclusion measures. The following projects have been developed to enhance assessment and reaction to any barrier vulnerabilities: Telemetry Monitoring Plan, Monitoring Abundance, Behavior, and Fish/Barge Interactions at the Barrier, Des Plaines River Monitoring, Barrier Maintenance Fish Suppression, and Water Gun Development and Testing.

Objective 4: Determination of the leading edge of major Asian carp populations in the Illinois River and the reproductive success of those populations. It is critical to gather information on carp densities in the area downstream of the electric barrier system in order to effectively assess the risks of Asian carp passing the electric barrier system, to formulate response actions to reduce fish passage risks, and to implement downstream population control measures. For example, the presence of Asian carp between the electric barrier system and the Lockport Lock may necessitate the use of rotenone to remove fish when barriers are shut down for maintenance or if they experience emergency failures. In addition, harvesting Asian carp downstream of Lockport Lock with contracted commercial fishers should reduce the number of fish attempting to challenge or bypass the electric barrier system. It is also important to know where reproduction is occurring because the greatest overall reduction in numbers of Asian carp can most effectively be accomplished by removing individuals that are members of the breeding population. Projects developed to address this objective include: Fixed Site Monitoring Downstream of the Barrier, Barrier Defense Asian Carp Removal Project, Larval Fish and Productivity Monitoring, Young-of-Year and Juvenile Asian Carp Monitoring, Telemetry Monitoring Plan, Gear Efficiency and Detection Probability, Barrier Maintenance Fish Suppression, and new projects Distribution and Movement of Small Asian Carp and Monitoring Asian Carp Population Metrics and Control Efforts.

Objective 5: Improvement of our understanding of factors behind the likelihood that Asian carp could become established in the Great Lakes. Understanding the combination of environmental and biological variables that could lead to the introduction of Asian carp populations in the Great Lakes is important to the overall project goal and may inform decisions regarding appropriate responses to Asian carp detected or captured in the CAWS. Central to this objective are two questions, both challenging to address: 1) how many Asian carp would it likely take to establish a reproducing population in Lake Michigan; and 2) how many fish are currently in the CAWS and Lake Michigan?

Answers to question 1 above are beyond the scope of this plan, but may be forthcoming upon completion of a bi-national risk assessment convened by the Great Lakes Fishery Commission and designed to assess the risk of establishment and potential effects of Asian carp in the Great Lakes.

Sampling during 2010-2012 has helped to provide an answer to the second question posed above. The capture of only one Bighead Carp in thousands of person-days of sampling effort throughout the CAWS upstream of the electric barrier system (644 hours of electrofishing, 205

miles of trammel/gill net, 173 acres treated with rotenone, and other gears) suggests Asian carp abundance in the waterway currently is low (see MRRWG 2012 for more detailed data summaries). Additional sampling in the lower Des Plaines River and upper Illinois River has placed the detectable Asian carp population front at more than 45 miles and successfully reproducing populations at more than 130 miles from Lake Michigan. Combined, these results suggest the current level of risk of establishment is lower than expected prior to the initiation of sampling in February 2010. However, upstream movements may occur at some point in time so timely and consistent monitoring combined with rapidly deployed removal actions are needed should the level of risk increase.

TOOLS AVAILABLE TO ACCOMPLISH OBJECTIVES

A broad range of sampling and removal tools are available to MRWG action agencies to accomplish the plan objectives outlined above. They include traditional sampling gears (e.g., electrofishing, trammel nets, experimental gill nets, fyke or trap nets, tow nets, and seines), chemical piscicide (e.g., rotenone), high-tech sonic detection and imaging devices (e.g., sonic telemetry and hydroacoustics, DIDSON, and side-scan SONAR), and newly developed or developing techniques (e.g., eDNA, water guns, and attraction pheromones). Whereas many of these gears and techniques are part of on-going monitoring and removal efforts, new tools are continually being added to the MRP as it is periodically revised and new techniques are developed. In many cases, multiple tools are being used to accomplish individual objectives and provide sufficient intelligence to allow for sound management decisions. This strategy of addressing questions from multiple fronts with a combination of gears and techniques has helped to increase the level of confidence in results provided by monitoring and removal projects to date. In addition, gear evaluations have been on-going (see gear development and evaluation projects below) and have been expanded in this revised MRP (e.g., see Monitoring Asian Carp Population Metrics and Control Efforts and Water Gun Development and Testing Project). Research on calibration and further refinement of eDNA monitoring is also being pursued outside of this plan. Upon completion, these assessments should lead to improved Asian carp monitoring and removal outcomes, better understanding of the effectiveness of in-place barriers built to prevent Asian carp from gaining access to the CAWS and Lake Michigan, and improved interpretation of sampling results.

The following are general discussions of the gears and techniques included in this plan and current status of existing or developing techniques. Detailed protocols on the use of each gear are included in the Project Plans section below.

eDNA - The eDNA monitoring project has been used to identify the possible presence of Asian carp DNA throughout the CAWS, Des Plaines River, and near shore waters of Lake Michigan. This technique is potentially useful for early Asian carp DNA detection and to determine distribution patterns of DNA in the waterway because it can presumably detect the presence of DNA in water when fish populations are at very low levels of abundance (Jerde et al. 2011). A positive eDNA sample indicates the presence of Asian carp DNA and the possible presence of live fish. Currently, eDNA evidence cannot verify if live Asian carp are present, whether the DNA may have come from a dead fish, the number of Asian carp in an area, or water containing Asian carp DNA may have been transported from other sources (e.g., translocation by vessel or

birds). Furthermore, eDNA monitoring cannot provide precise, real-time information on where Asian carp might be located due to the requisite two-week sample processing time. Additional research (e.g., the ECALS study; ACRCC 2012) to improve the understanding of eDNA results, and refine eDNA monitoring and processing procedures was conducted in 2012. Results of ECALS relevant to sampling and interpretation of eDNA results are incorporated into this version of the MRP.

The 2013 plan shifts the target area of eDNA monitoring and decouples eDNA positive results as a trigger for response actions. Data from the 2012 ECALS report indicate findings that suggest other sources, in addition to a live Asian carp, may be vectors of Asian carp DNA (ECALS 2012 – see Appendix G). These sources include storm sewers, piscivorous birds, sediments, barges, Asian carp carcasses, and fishing gear (e.g. gill/trammel nets). Additionally, response actions in 2012 yielded no live Asian carp when eDNA samples collected immediately prior to the events indicated genetic material of the fish were present. Persistent positive detections from a single area still offer some indication that a source of DNA occurs, but until probability can be assigned to the source (proposed for ECALS work in FY14); the MRWG has decided to remove eDNA detections as a trigger for response actions. This data continues to have relevance and eDNA monitoring will remain in the MRP as a monitoring tool. When viewed over the long term (e.g. multiple positive hits on consecutive sample dates at the same location), these data will be used to guide decisions on the location and timing of planned response actions.

Monitoring efforts for Asian carp eDNA in the CAWS will continue in 2013, but will be reduced to two comprehensive events - one occurring in summer and one in fall. With the insights from ECALS, as well as a developing record and surveillance of fish in the CAWS, the MRWG believes that excluding eDNA from the trigger for responses is prudent and consistent with our knowledge to date of Asian carp distributions. To maintain the highest vigilance, the MRWG will be scheduling Planned Intensive Surveillance in areas most efficiently sampled and most highly thought of as being areas where Asian carps may linger. With these modifications the MRWG believes surveillance in and around the CAWS is actually higher and more efficient in 2013.

Electrofishing - Electrofishing is an important fish sampling tool incorporated in nearly every sampling action outlined in this plan. We will continue to use electrofishing to monitor for adult, juvenile and young-of-year Asian carp at fixed and random sites throughout the waterway and during response/planned intensive surveillance events and barrier maintenance actions. In addition, electrofishing will be used to salvage sport fish and obtain sentinel fish during rotenone events, and to collect fish for implantation of sonic transmitters, as part of the on-going Telemetry Monitoring Plan, Monitoring Asian Carp Population Metrics and Control Efforts, and Distribution and Movement of Small Asian Carp projects. As an active sampling technique, electrofishing provides coverage of large areas of the waterway with moderate effort. Thus, it can provide information on fish distribution in the waterway, as well as relative estimates of abundance when standardized samples are compared spatially or temporally.

Electrofishing efficiency for capturing Asian carp has come into question, especially in the CAWS where these fish may be present in low numbers and waters are often deeper than 9 feet. However, recent electrofishing in the upper Illinois Waterway (upper Dresden Island and

Brandon Road pools) has resulted in the visual observation of a single Silver Carp (2009) and the capture of a Bighead Carp (2010), both in areas where Asian carp populations are thought to be low. Furthermore, gear evaluation study results have shown electrofishing to be one of the most productive gears for sampling Silver Carp (MRRWG 2012). We incorporate two approaches to maximize the potential usefulness of electrofishing as a sampling tool during standard monitoring and response events. First, we utilize high frequency and duration sampling effort to increase the likelihood of encountering a rare fish; and second, we concentrate effort in areas where the likelihood of capture is greatest (i.e., where multiple eDNA detections occur, below migration barriers, or in areas with shallow water habitats, such as main channel borders, barge slips, or non-navigable portions of the waterway).

This plan includes on-going and proposed studies to enhance our understanding of electrofishing efficacy and the relation between electrofishing catch rates and estimates of Asian carp population size (see Asian Carp Gear Efficiency and Detection Probability Study). Changes to monitoring and response protocols were made in this plan as results from research efforts have become available.

Trammel/Gill Nets - Large-mesh trammel or gill nets (bar mesh = 2.0-5.0 inches) are frequently used in combination with electrofishing during fixed site monitoring and removal actions in the CAWS, lower Des Plaines River, and upper Illinois Waterway. These nets target large juveniles and adult Asian carp and are typically fished in deeper, side channel or offshore habitats not effectively sampled with electrofishing gear. Net dimensions vary depending on need from 6-15 feet high and 100-600 yards long, but are standardized for monitoring at 8-10 feet high, 200 yards long, and mesh sizes of 3.0-4.5 inches. Sets may be of short or long duration. Short duration sets are typically 15-20 minutes long and include driving fish into the nets with electrofishing gear or noise (e.g., plungers on the water surface, pounding on boat hulls, or racing tipped up motors). Short duration sets can take place in main channel habitats during active navigation because nets are not left unattended. Long duration sets range from 3-24 hours and must take place out of the navigation channel or during planned navigation closures because the gear is left unattended. These methods have been shown to be effective at capturing Asian carp, but overnight sets are preferred during response actions in the CAWS to maximize chances of capturing an Asian carp when population abundance is low.

New net designs will be incorporated into sampling programs as they become available. In 2011, tied-down gill nets made of high strength material (e.g., braided nylon, multi-strand monofilament and Dyneema) were included in sampling and removal efforts to improve capture rates for large adults that tend to break through standard monofilament mesh nets, particularly during warm summer months. In 2012, newly developed surface-to bottom experimental gill nets were field tested as part of the gear evaluation study.

Contract Commercial Fishers - The IDNR has contracted with commercial fishers to assist with monitoring and removal actions throughout the waterway upstream and downstream of the electric barrier system. Commercial fishers benefit the program by providing extensive knowledge of Asian carp habits in large Illinois rivers, hands-on experience at capturing Asian carp for commercial harvest, and appropriate-sized boats and specialized equipment to conduct effective netting operations (e.g., large-mesh trammel nets in lengths ≥300 feet, tied-down gill

nets of similar lengths, 800 yard commercial seines, and large diameter hoop nets). Commercial fishers collected the first Asian carp in Illinois waters from the Illinois and Ohio rivers. In addition, commercial fishing is recognized as one of the most effective tools to reduce Asian carp numbers in higher carp density areas in a cost effective manner (Conover et al. 2007), and it produced the only known capture of a live Asian carp upstream of the electric barrier system. Commercial fishers have and will continue to be hired to conduct trammel/gill net sampling during Fixed and Random Site Monitoring Upstream of the Barrier, Fixed and Random Site Monitoring Downstream of the Barrier, Response Actions in the CAWS and Planned Intensive Surveillance in the CAWS, and harvest efforts to reduce population size in the upper Illinois River as part of the Barrier Defense Asian Carp Removal Project. In each instance, IDNR biologists or technicians will be assigned to commercial net boats to monitor netting operations and record data.

Rotenone - Rotenone is a valuable Asian carp eradication tool and it may be the best available sampling technique for determining fish population abundance, especially in the deep waters that comprise much of the CAWS. When applied in confined areas with appropriate water temperatures, most treated fish float to the water surface within 3-4 days where they can be gathered, identified, and enumerated. Unpublished data from the USGS suggests that Asian carp will sink initially after exposure to rotenone, but will float sooner than some other species. Efficacy of individual rotenone actions may be evaluated by employing caged sentinel fish to assess treatment effects and diver transects or lift-nets to estimate recovery rates. Rotenone actions also provide opportunities to assess effectiveness of conventional gears and eDNA when sample data collected from within a treatment zone is compared to rotenone results.

While valuable, recent experience with two rotenone events that sampled 2.6 and 6.7 miles of the CAWS has shown that rotenone actions require extensive planning (1-2 months), labor (>250 workers), and financial expenditures (>$1.5 million). Several factors contributed to the enormity of these rotenone actions, including: logistics in a large urban center; state and federal regulatory requirements (e.g., NEPA, FIFRA, NPDES, and CERP; notice for waterway closures); need to stand up an Incident Command Structure (ICS); State procurement requirements and high costs of chemicals, specialized equipment, and contractual services; and fertile waters with abundant non-target fish populations. Pre-event planning and logistical requirements alone make rotenone ineffective as a response tool. However, the MRWG supports rotenone use for emergency eradication of Asian carp populations in the CAWS and for fish suppression during barrier maintenance operations after other removal options (e.g., electrofishing, commercial netting, and newly developed pneumatic water gun technology) have been implemented and shown to be unsuccessful.

Rotenone applications will be limited to targeted treatment areas within the CAWS. Treating the entire waterway is considered impractical due to costs, logistics, and availability of chemical. The technique also is considered overly aggressive for use in the lower Des Plaines and upper Illinois rivers downstream of the CAWS due to the lower threat of establishment in Lake Michigan, high labor and financial costs, and negative impact on non-target fish communities. A multitude of factors may influence decisions of when and where rotenone actions should occur, including:

a) Nature of available evidence for the presence of Asian carp (e.g., re-occurring eDNA detections, fish in hand, visual observation);
b) Number of lines of evidence identifying Asian carp presence and timeframe that evidence was gathered;
c) Precise location(s) where evidence was collected (e.g., main channel vs. below structural barrier vs. off-channel or backwater);
d) Results of previous rotenone and other sampling methods at a particular location;
e) Water temperature, chemistry, and flow characteristics;
f) Size of necessary treatment area;
g) Disturbance to public stakeholders;
h) Presence of one or more Asian carp species;
i) Season and anticipated weather conditions;
j) Existence of an emergency and the urgency surrounding such an emergency (e.g., loss of power at the electric barrier system); and
k) Need for closure of commercial and/or recreational navigation.

Whereas decisions on use will be based on multiple lines of evidence and best professional judgment of biologists, scientists, and managers from participating action agencies, the ultimate decision to use rotenone will be made by managers within agencies who have jurisdiction over rotenone application (i.e., IDNR for Illinois waters and Indiana DNR for Indiana waters).

Experimental Gill Nets - Experimental gill nets are one of the gears being evaluated by INHS for use in monitoring Asian carp populations. Experimental nets with mesh sizes >2.0 inches have produced limited catches to date. However, nets with panels having mesh sizes from 0.75-2.0 inches have shown promise as a monitoring tool for young-of-year and early juvenile fishes. Poor recruitment years for Asian carp in the Illinois Waterway the past two years has prevented rigorous evaluations of gears targeting young-of-year and juvenile fish. We will continue to assess small mesh experimental nets in Asian carp young-of-year and juvenile monitoring efforts at stations throughout the Illinois Waterway and CAWS. If proven effective, we will use experimental nets to supplement targeted monitoring for young Asian carp by electrofishing that began during summer/fall 2010.

Mini-Fyke Nets - Small frame fyke nets have been used successfully by USFWS and INHS to sample for young-of-year Asian carp in the lower Illinois River and should prove useful in the upper waterway in areas where shallow, near shore habitat can be found. Enhanced monitoring to detect successful Asian carp reproduction or movements of young-of year from the lower river to the CAWS is important because risk of barrier passage and population establishment in Lake Michigan increase if either occurs. Mini-fyke nets were included in gear evaluations at stations in the CAWS and Illinois Waterway during 2011 and were added to monitoring efforts for young Asian carp at downstream fixed sites in 2012.

Larval Push Nets - Over the past three years INHS has used boat-mounted, 0.5-meter diameter larval push nets to sample for Asian carp eggs and larvae at stations located throughout the Illinois Waterway from the LaGrange Pool upstream through the CAWS (including the confluence of the Des Plaines River and CSSC). Asian carp eggs and larvae were only collected from the lower Illinois River downstream from the Peoria Lock and Dam in 2010 and 2011, with

a single egg collected as far as Henry, IL in 2012. Monitoring for fish eggs and larvae will continue at stations throughout the waterway during 2013 and will begin when water temperatures and flow conditions are first suitable for Asian carp spawning. In addition to routine monitoring, additional samples will be taken in the CAWS and Des Plaines River confluence with the CSSC within a week after spring or summer flooding events to monitor Asian carp spawning that may be triggered by high flow conditions.

Trawls and Purse Seines - The INHS and USFWS-Columbia Fish and Wildlife Conservation Office have been evaluating trawls and purse seines as methods to sample and remove Asian carp juveniles and adults from the waterway. Results to date have been largely discouraging, but modifications to gears are being made and evaluations will continue this coming year. These gears will be included in future monitoring and removal plans if and when they are shown to be effective. A modified shrimper's push trawl called a paupier trawl has been developed and tested by USFWS. The trawl shows potential for sampling juvenile Asian and additional field trials will be conducted in 2013.

Ultrasonic Telemetry - The USACE began a telemetry monitoring project during 2010 to determine: 1) if fish are able to challenge and/or penetrate the electric barrier system; 2) if Asian carp are able to navigate through lock structures in the upper Illinois River, lower Des Plaines River, and CAWS; and 3) upstream movement of the leading Asian carp population front. The project includes surgically implanting individually coded ultrasonic transmitters (approximate battery life = 2.5 years) in ~200 fish (Bighead Carp, Silver Carp, and surrogate species) and monitoring tagged fish movements with a series of stationary and mobile hydrophones. A total of 238 tags have been implanted from 2010-2012. To date, 5.5 million detections have been recorded with a 66% detection rate. Results from 2012 monitoring reported the first inter-pool movement by a single Bighead Carp between the Dresden and Marseilles pools and Common Carp continue to navigate through the locks on the upper Illinois Waterway.

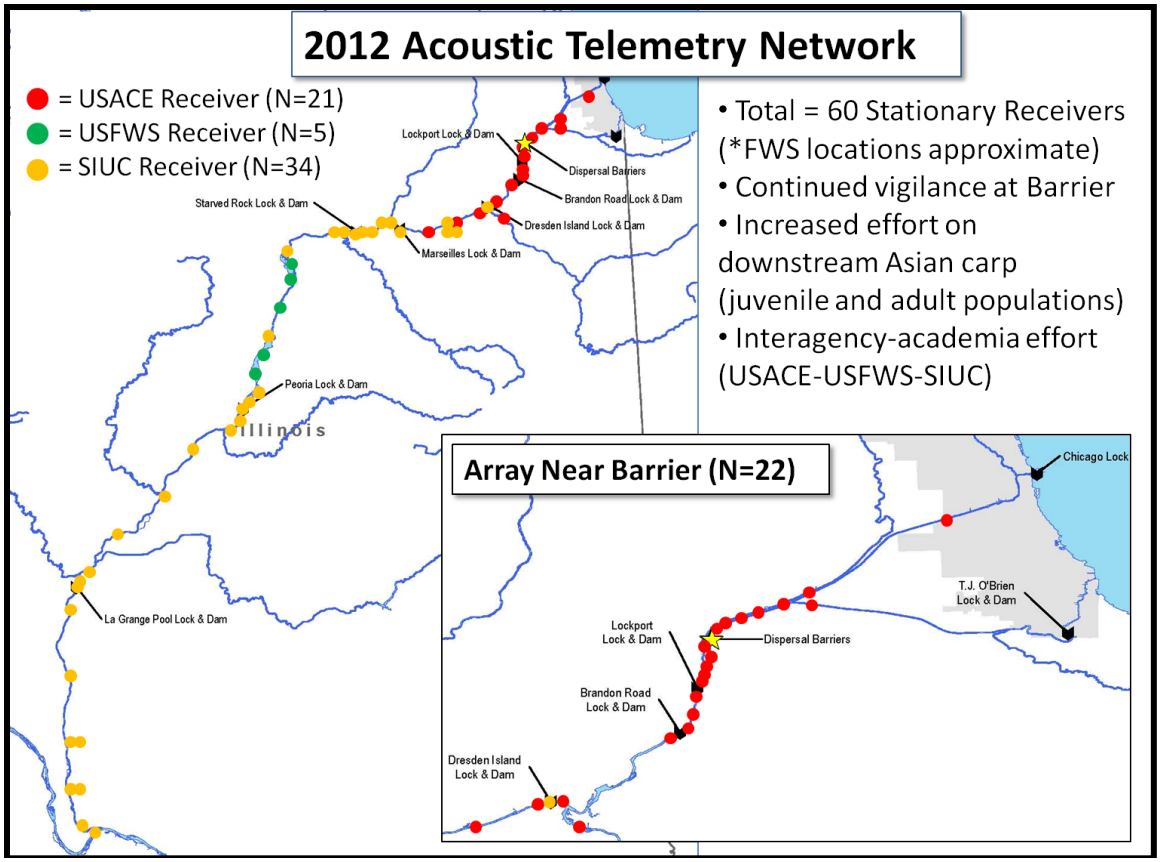


Figure 2. Map of the 2012 acoustic telemetry stationary receiver network in the Illinois Waterway and CAWS.

Dual-Frequency Identification SONAR (DIDSON), Split-Beam Hydroacoustics, and Side-scan SONAR - Several types of SONAR devices are available for locating individuals or groups of fish, monitoring localized fish movements and behavior, and mapping underwater structures and habitat. Each type of SONAR has inherent benefits, but an important limitation of all SONAR devices is the inability to identify marked fishes to species, genus, or even family. None the less, the species of fish being observed with these tools may not be of great consequence; if a fish of a certain size and similar form is penetrating the barrier, it is assumed that an Asian carp could too. Even with the species-specific limitation, SONAR devices have proved useful for locating and enumerating fish near the electrical barrier system, estimating fish population abundance, and verifying success of fish clearing activities in support of barrier maintenance. We continue to evaluate these remote sensing gears as potential monitoring tools or aids to improve effectiveness of other sampling gears.

Imaging SONAR, such as DIDSON, can provide detailed video images of fishes and underwater objects. However, these devices lack vertical resolution because they track in two dimensions and may be range limited under certain conditions. The USACE conducted a survey of the electric barrier system in the CSSC with DIDSON during 2010 and preliminary results showed schools of smaller fish above and below Barrier I and above and below Barrier 2A. Several larger fish also were observed below Barrier 2A. The DIDSON camera was used in 2011 and 2012 to conduct wild fish evaluations at, in, and around the electric barrier system and to view

behavior of fishes in cages dragged through the barriers. The use of DIDSON will be continued for additional fish counts at the electric barrier system and to evaluate presence of fish between barriers after barrier maintenance fish clearing operations (see Monitoring Abundance, Behavior, and Fish/Barge Interactions at the Barrier and Barrier Maintenance Fish Suppression).

Split-beam hydroacoustics has been used to locate fish and collect data on fish abundance, size distribution, and behavior at ranges in excess of 100 meters. Higher-end hydroacoustic devices track in three dimensions, so they have the ability to provide distance, bearing, and vertical locations of objects or fish in the water column within the area surveyed by the transducer beam. This can be particularly useful when a fixed-position monitoring system is used to monitor fish locations and behavior near anthropomorphic structures, such as dams, fishways, navigation locks, or potentially the electric barrier system. The INHS has been evaluating split-beam hydroacoustics as a potential Asian carp monitoring tool over the past two years and this research will continue in the coming field season. The USGS will use a fixed-site hydroacoustics unit to monitor fish movement and response to water gun operations during a field experiment in the Illinois River near Morris, Illinois. Hydroacoustics data in combination with conventional data for species verification has been used to estimate Asian carp abundance in the Illinois River (Garvey et al. 2012). This work will continue in the upper Illinois Waterway during the coming year. In addition, success of fish clearing operations in support of barrier maintenance have and will continue to be evaluated with split beam hydroacoustics, as well as DIDSON and side-scan SONAR.

Multi-beam side-scan SONAR offers wide angle coverage of a water body, but lacks fine scale resolution. These systems are typically used for mapping bottom morphology and detecting underwater objects and bathymetric features. Side scan SONAR was used to determine water depths and survey for bottom obstructions prior to commercial seining in the response action at Lake Calumet in 2010 and likely will be used to obtain similar information in the future. At present, there are no plans to use side-scan SONAR for fish monitoring or to examine fish behavior at the electric barrier system, but it has proved useful in evaluating success of fish clearing operations at the electric barrier system.

PROJECT PLANS

Twenty-one project plans have been prepared for 2013 to achieve the overarching goal and objectives of the MRP. These plans are in various stages of development due to the continuing expansion of efforts to control Asian carp. Several plans were prepared and implemented during 2010, others were newly developed in 2011 and 2012, and still others are newly proposed and only recently scoped out. We included in this MRP project plans from various stages of development to showcase the full range of work that will be on-going or initiated during the coming year. Consequently, the type and amount of information included in the project plans below will vary with the level of plan development to date. Work to improve existing plans and create new projects will be on-going throughout the year. Projects and schedules are included as a guideline for implementation; however actual plans may vary depending upon logistics and funding.

Fixed and Random Site Monitoring Upstream of the Barrier

Participating Agencies: IDNR (lead); USFWS – Columbia, Carterville, and La Crosse Fish and Wildlife Conservation Offices (field support)

Location: Monitoring will take place in the CAWS at the CSSC, Chicago River, South Branch Chicago River, North Branch Chicago River, North Shore Channel, Calumet River, Little Calumet River, Calumet-Sag Channel, Lake Calumet Connecting Channel, and Lake Calumet.

Introduction and Need: Frequent and standardized sampling can provide useful information to managers tracking population growth and range expansion of aquatic invasive species. Information gained from regular monitoring (e.g., presence, distribution, and population abundance of target species) is essential to understanding the threat of invasion and informs management decisions and actions to reduce the risk of population establishment. Detections of Asian carp DNA upstream of the electric barrier system during 2009 initiated the development of a monitoring plan that uses pulsed-DC electrofishing and contracted commercial fishers to sample for Asian carp at five fixed sites upstream of the electric barrier system. Fish community analysis comparing 2010 data from fixed and reach electrofishing samples indicated that the chosen fixed site locations supported fish communities with more fish, higher species richness, and higher diversity (MRRWG 2012). Random area sampling, including electrofishing and gill/trammel netting, began in 2012 in order to increase the chance of encountering Asian carp in the CAWS and provide useful information on distribution patterns of target and non-target fish species beyond the designated fixed sites.

Sampling results from 2010-2012 contributed to our understanding of Asian carp abundance in the CAWS. Based on the extensive sampling performed upstream of the electric barrier system from 2010-2012, and only one Bighead Carp being collected in 2010, fixed site and random area electrofishing efforts will be reduced upstream of the electric barrier system in order to allow an increase in fixed and random site electrofishing downstream of the electric barrier system. The increase in sampling downstream of the electric barrier system in 2013 will better focus efforts on the leading edge of the Asian carp populations. Furthermore, better understanding of Asian carp populations downstream of the electric barrier system should prove to be valuable for reducing their numbers, thus mitigating the risk of individuals moving upstream to Lake Michigan through the CAWS. Monitoring results upstream of the electric barrier system will continue to contribute to our understanding of Asian carp abundances in the CAWS and guide conventional gear or rotenone response actions designed to remove fish from areas where Asian carp have been captured or observed.

Objectives: We will use standardized pulsed-DC electrofishing and contracted commercial netters to:

1) Monitor for the presence of Asian carp in the CAWS upstream of the electric barrier system;
2) Determine relative abundance of Asian carp in locations and habitats where they are likely to congregate;
3) Determine Asian carp distribution in the CAWS; and

4) Obtain information on the non-target fish community to help verify sampling success, guide modifications to sample locations, and assist with detection probability modeling and gear evaluation studies.

Status: This project began in 2010 and is on-going. During 2010, electrofishing and trammel/gill netting samples were taken at the five fixed sites twice monthly, from June through November and June through September, respectively. In 2011 and 2012, fixed sites were sampled twice monthly from April through November and once each month during March and December. Over 9,600 estimated person-hours were spent electrofishing and netting fixed sites upstream of the dispersal barrier during 2010 – 2012. Over three years, approximately 475 hours of electrofishing was completed and 139 miles of trammel/gill net was deployed. Random site sampling in 2012 accounted for an additional 3,805 person-hours, 57 hours of electrofishing and 26.5 miles of trammel/gill netting. A total of 192,763 fish representing 67 species and two hybrid groups were collected during electrofishing and trammel/gill netting at fixed sites in 2010 – 2012 and random sites in 2012. No Bighead or Silver Carp were captured or observed during electrofishing in 2010 – 2012. Likewise, no Silver Carp were captured or seen during contracted commercial netting in 2010 – 2012, nor were any Bighead Carp caught in 2011 – 2012. One adult Bighead Carp (mature male, 34.6 inches in length and 19.6 pounds) was captured by netters in Lake Calumet on 22 June 2010. This fish is the only verified live Bighead or Silver Carp known from the CAWS upstream of the electric barrier system to date. For more detailed results see the 2012 interim summary report document (MRRWG 2013).

Methods: The sampling design includes intensive electrofishing and netting at five fixed sites where we anticipate catching Asian carp if they are present in the waterway, and at four random site sampling areas (Figure 3). Electrofishing will take place monthly, March through December (weather permitting). This is a reduction from bi-weekly electrofishing April-November in previous years. Netting will continue to take place monthly, March and December and twice monthly April through November. No sampling at fixed sites is planned for January and February because several of the sites are typically ice covered during these months. To maximize the potential usefulness of netting and electrofishing, particularly given the apparent low densities of Asian carp in the generally deep-water habitat of the CAWS, stations were located in areas where the likelihood of capture is greatest (i.e., where eDNA has been detected, below migration barriers, or both). The five fixed sites are mostly located at the upstream-most areas of the CAWS near Lake Michigan. These areas were identified for intensive sampling under the assumption that Asian carp upstream of the electric barrier system would swim upstream and congregate below the next existing barriers, namely the T.J. O'Brien and Chicago Locks and the Wilmette Pumping Station. Habitat and collection conditions were taken into consideration in the selection of the locations and boundaries of the fixed sites. For example, Lake Calumet (Site 1) was included because it possesses backwater-like conditions favored by Asian carp and is known to contain Bigmouth Buffalo, a species thought to favor habitat similar to Asian carp. The Little Calumet River (Site 2) was extended downstream to include favorable habitat near the Acme Bend. Finally, Site 3 was shifted downstream of the Chicago Lock in order to include more favorable habitat and collection conditions (e.g., less boat traffic and resulting wave action).

The entire CAWS upstream of the electric barrier system has been divided into four random site sampling areas that will be sampled once monthly with pulsed-DC electrofishing gear and twice per month with commercial trammel/gill nets (Figure 3). Random area sampling will exclude areas of the waterway designated as fixed sites, because these areas are sampled monthly by electrofishing and twice monthly by netting as part of fixed site monitoring. Random sites will be generated with GIS software from shape files of designated random site areas and will be labeled with Lat-Lon coordinates in decimal degrees. A list of random sites will be generated for the entire year for each random site sampling area and assigned for each sample day, after which sampled sites will be eliminated from the list to prevent duplicate sampling. Fixed and random area sampling will provide intense sampling in areas thought to be the most likely places to catch Asian carp, if they are in the waterway, and somewhat less intense broad coverage of the entire CAWS.

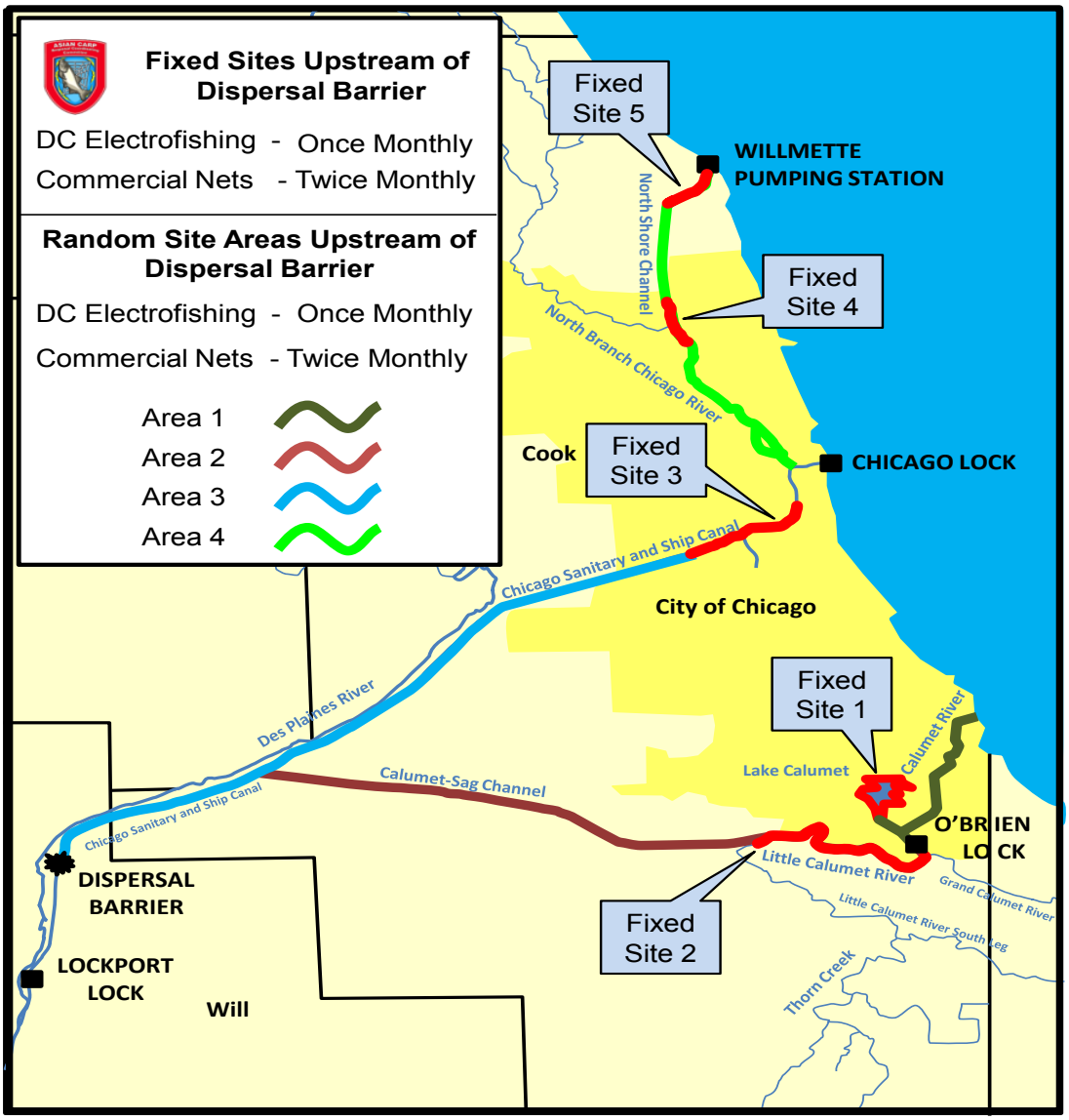


Figure 3. Fixed sites and random site sampling areas for electrofishing and commercial netting upstream of the electric barrier system.

Upstream Fixed Site Descriptions and Effort - A description of fixed site locations and sampling effort targets is summarized below. The duration of each electrofishing run will be 15 minutes and lengths of each net set will be 200 yards. See Appendix B for detailed maps of each site.

Site 1 – Lake Calumet. Sampling will be limited to shallower areas north of the Connecting Channel (this avoids deep draft areas with steep walls but includes channel drop off areas that exist north of the Connecting Channel).

- six (6) electrofishing runs
- 2,000 yards of trammel or gill net

Site 2 – Calumet/Little Calumet River O'Brien Lock to its confluence with the Little Calumet River South Leg (~7 miles)

- eight (8) electrofishing runs
- 1,600 yards of trammel or gill net

Site 3 – CSSC and South Branch Chicago River from Western Avenue upstream to Harrison Street (~4 miles).

- eight (8) electrofishing runs
- 1,000 yards of trammel or gill net

Site 4 – North Branch Chicago River and North Shore Channel from Montrose Avenue north to Peterson Avenue (~2 miles).

- four (4) electrofishing runs
- 400 yards of trammel or gill net

Site 5 – North Shore Channel from Golf Road north to Wilmette Pumping Station (~2 miles).

- Four (4) electrofishing runs
- 400 yards of trammel or gill net

Upstream Random Site Sampling Area Descriptions and Effort - A description of random sampling areas and sampling effort targets is summarized below. As with fixed sites, the duration of each electrofishing run will be 15 minutes and lengths of each net set will be 200 yards. Four random areas have been identified to facilitate coordination with fixed site sampling.

Area 1 – Lake Calumet Connecting Channel and Calumet River from O'Brien Lock and Dam to Calumet Harbor.
Area 2 – Calumet-Sag Channel from its confluence with the CSSC to Little Calumet River.
Area 3 – CSSC from Western Avenue downstream to the Dispersal Barrier.
Area 4 – North Shore Channel (between Fixed Site 4 and 5), North Branch Chicago River, and Chicago River.

Electrofishing at random areas will take place concurrent with fixed site monitoring once per month. Netting at random areas will take place twice per month concurrent with fixed site sampling. A description of the effort at each random area is shown in the table below.

	Number of 15-min. electrofishing transects per trip	Number of 200-yard trammel/gill net sets per trip
Random Areas	Fixed site days (once monthly)	Fixed site days (twice monthly)
Area 1	4	3
Area 2	4	5
Area 3	4	6
Area 4	4	5
Total	16	19

Electrofishing Protocol - All electrofishing will use pulsed-DC current and include 1-2 netters (two netters preferred). Locations for each electrofishing transect for both fixed sites and random sites will be identified with GPS coordinates. For fixed sites, transects were selected from 2010 and 2011 data and represent transects with the highest mean catch-per-unit-effort and species richness. Random site coordinates will be randomly generated, as described above. Electrofishing transects should begin at each coordinate and continue for 15 minutes in a downstream direction in waterway main channels (including following shoreline into off-channel areas) or in a counter-clockwise direction in Lake Calumet. Fixed site sampling locations will remain the same throughout the year and should be sampled with each site visit. This represents a change from past years when exact sampling areas within the sites were left to the discretion of field crews and should lead to more consistent monitoring results.

Electrofishing boat operators may switch the safety pedal on and off at times to prevent pushing fish in front of the boat, increasing the chances of catching an Asian carp. Common Carp will be counted without capture and **all other fish will be netted** and placed in a tank where they will be identified and counted, after which they will be returned live to the water. Periodically, a subsample of 10 fish of each species per site will be measured in total length and weighed to provide length-frequency data for gear evaluations. Schools of young-of-year Gizzard Shad <6 inches long will be subsampled by netting a portion of each school encountered and placing them in a holding tank along with other captured fish. Young-of-year Gizzard Shad will be examined closely for the presence of Asian carp and counted to provide an assessment of young Asian carp in the waterway. We will count all captured Asian carp, as well as those observed but not netted. We may observe more Asian carp than we net because of the difficulty in capturing these fish with electrofishing gear. Refer to Appendix C for detailed protocols on reporting, handling, and chain-of-custody for captured Asian carp. Fish species codes can be found in Appendix E and sample data sheets are included in Appendix F. Crew leaders should fill in as much information on the data sheets as possible for each station/transect and record the location for the start of each run either with GPS coordinates (decimal degrees preferred) or by marking on attached maps.

Netting Protocol – Contracted commercial fishers will be used for net sampling at fixed and random sites and nets used will be large mesh (3.0-4.0 inches) trammel or gill nets 8-10 feet high and in lengths of 200 yards. Locations for each net set for both fixed sites and random sites will be identified with GPS coordinates. For fixed sites, locations were selected from 2010 and 2011 data and represent net sets with the highest mean catch-per-unit-effort and species richness.

Random site coordinates will be randomly generated, as described above. Net sets will take place within 500 yards of a designated coordinate at a specific location agreed upon by the commercial fisher and attending IDNR biologist. Sets will be of short duration and include driving fish into the nets with noise (e.g., plungers on the water surface, pounding on boat hulls, or racing tipped up motors). In an effort to standardize netting effort, sets will be 15- to 20-minutes long and "pounding" will extend no further than 150 yards from the net. Nets will be attended at all times. Captured fish will be identified to species and tallied on standard data sheets. Periodically, a subsample of 10 fish of each species per site will be measured in total length and weighed. Locations of net sets should be recorded with GPS coordinates (decimal degrees preferred) or by marking on attached maps. An IDNR biologist or technician will be assigned to each commercial net boat to monitor operations and record data. All Grass Carp sampled will be stored on ice and the heads will be removed and shipped to SIUC for ploidy analysis (see protocols in Appendix D).

Decontamination Protocol - The potential for Asian carp genetic material contamination in eDNA samples exists as a result of residual material on sampling equipment (boats, netting gear, etc.) consistent with findings from the 2013 ECALS. Efforts will be taken in 2013 monitoring above the electric barrier system to minimize the potential for eDNA contamination and the MRWG will develop a Hazard Analysis and Critical Control Points (HACCP) plan to address the transport of eDNA and unwanted aquatic nuisance species. The initial 2013 decontamination protocol will implement the use of hot water pressure washing and chlorine washing (10% solution) of boats and potentially contaminated equipment. Additionally, IDNR and contracted commercial netters will use netting gear that is site-specific to the CAWS and will only be used in for monitoring efforts above the electric barrier system. Once the full HACCP plan is developed it will be added to the MRP.

Suggested boat launches for fixed and random site sampling.

Fixed Site 1 and Random Area 1 – O'Brien Lock Launch – Contact the Lockmaster for permission.

Fixed Site 2 – Launch at O'Brien Lock and lock through to sample below or pay at marina on east side of river downstream of the dam.

Fixed Site 3, 4, and 5 and Random Area 4 – Western Avenue Launch – No contact necessary. Limited number of parking passes available (State and Federal trucks exempt).

Random Area 2 - Launch at O'Brien Lock and lock through to sample below or pay at marina on east side of river downstream of the dam; Worth Launch (RM 311) – No contact necessary during summer.

Random Area 3 – Western Avenue Launch; Summit Launch (RM 313) – No contact necessary during summer; Cargill Launch – Inform Martin Castro at MWRD, will need to pass through barrier zone to access sampling area.

Sampling Schedules: A tentative 2013 electrofishing schedule with the agency responsible is shown in the table below.

Week of	Agency
25-Mar	IDNR
22-Apr	USFWS
20-May	USFWS
24-Jun	USFWS
29-Jul	IDNR
26-Aug	USFWS
23-Sep	USFWS
21-Oct	USFWS
25-Nov	IDNR
9-Dec	USFWS

A tentative schedule for 2013 netting with contracted commercial fishers is shown in the table below.

Week of	Agency	Week of	Agency
18-Mar	IDNR	5-Aug	IDNR
1-Apr	IDNR	19-Aug	IDNR
15-Apr	IDNR	3-Sep	IDNR
29-Apr	IDNR	16-Sep	IDNR
13-May	IDNR	30-Sep	IDNR
28-May	IDNR	14-Oct	IDNR
10-Jun	IDNR	4-Nov	IDNR
8-Jul	IDNR	18-Nov	IDNR
22-Jul	IDNR	2-Dec	IDNR

Deliverables: Results of each sampling event will be reported in monthly sampling summaries. Data will be summarized for an annual interim report and project plans updated for annual revisions of the MRP.

Strategy for eDNA Monitoring in the CAWS

Participating Agencies: USFWS (lead) and IDNR (field support)

Location: Two monitoring events will take place in the CAWS upstream of Lockport Lock and Power Station, once in June and once in October.

Introduction and Need: Monitoring has been essential to determine the effectiveness of efforts to prevent self-sustaining populations of Asian carp from establishing in the Great Lakes. In the past, traditional fishery techniques have been used to detect the presence of Asian carp in the Upper Illinois Waterway. The application of environmental DNA (eDNA) has been used as a sensitive monitoring tool used to detect the genetic presence of Bighead and Silver Carp in the CAWS since 2009, under the leadership of USACE. The results of eDNA sampling in conjunction with traditional fishery techniques has guided response actions designed to remove Asian carp from the waterway. However, new in 2013, results of eDNA sampling will not be used to trigger response actions, and the lead for sampling and processing will shift to USFWS. The MRWG believes this to be the most appropriate use of resources in light of the ECALS interim report findings.

At present, the capacity to process eDNA is 120 samples per week. The sampling strategy for the 2013 field season takes into account the current level of sample processing, but the number of samples required was determined based on sampling regime and results from prior years (i.e., 2009-2012), individual site characteristics, and the need to gather information from several strategically important reaches of the waterway.

Objectives: eDNA sampling will be used to:

1) Determine whether Asian carp DNA is present in strategic locations in the CAWS to inform status of Asian carp.
2) Detect Asian carp DNA in areas that have been monitored since 2009 to maintain annual data collection which may inform future work in the CAWS.

Status: Sampling for Asian carp DNA began during June 2009 in the upper Illinois River and continued through August 2010 at other locations, including the Des Plaines River, CAWS, and near shore areas of Lake Michigan. In the summer of 2010, Federal agencies assumed the lead for eDNA monitoring. The USACE became responsible for coordinating sampling, processing samples, and posting results; while the U.S. Fish and Wildlife Service (FWS) and Illinois Department of Natural Resources became responsible for sample collection. In 2013, the FWS will assume responsibility of coordinating sampling and filtering in the field to meet objectives one and two within the scope of this plan (Fish and Wildlife Conservation Offices; FWCO) and laboratory analysis (Whitney Genetics Lab; WGL). Detailed results from the 2012 season are available in the 2012 interim summary report document (MRRWG 2013).

To date, no relationship between the number of positive detections and Asian carp population abundance has been established; therefore, eDNA results should be interpreted with caution. Additional research on the calibration of the eDNA method has been occurring since 2010; however, the full results of this multi-agency study will not be known until 2014. Until

completion of this additional research to calibrate eDNA results and assess potential alternative sources of DNA in the waterway, the MRWG views positive eDNA results as an indicator of the possible presence of live Asian carp. When viewed over the long term (e.g., multiple positive hits on consecutive sample dates at the same location), these data will be used to guide decisions on response actions.

In 2013, the FWS will also coordinate field sampling and laboratory analysis of eDNA samples collected along an Asian carp-infestation gradient below the electric barrier system, which will investigate eDNA probability of detection in relation to known densities of Asian carp. Detailed methods and sampling locations are outside the scope of this work plan and will be covered within an internal FWS document.

Methods: Standard operating procedures have been outlined in the eDNA Quality Assurance Project Plan (USACE 2012) and were reviewed and agreed upon by all partnering agencies (e.g. USACE, FWS and IDNR). In general, FWCO will collect 60 water samples twice at four specified reaches. Samples will be filtered by FWCO personnel in the FWCO filtering trailer and shipped overnight to the WGL in La Crosse, WI on dry ice. WGL will analyze the samples according to the updated 2013 QAPP, and results will be posted on a FWS web site after analysis of each sampling event is complete (analysis priority TBD by ACRCC). A general description of the eDNA sample collection method is given below. Detailed field, laboratory, and reporting protocols are available in the eDNA Quality Assurance Project Plan (FWS 2013).

Locations - Comprehensive sampling in the CAWS will occur in June and October (weather permitting). Sample locations were selected based on habitat thought to be preferred by Asian carp (Lake Calumet) and entry points to Lake Michigan (North Shore Channel downstream from Wilmette Pumping Station, Chicago River downstream from Chicago Lock, and Little Calumet River downstream from T. J. O'Brien Lock and Dam. Sampling is complementary to fixed site sampling conducted with conventional gears in the locations listed below.
North Shore Channel (60 samples); South Branch Chicago River to the Chicago Lock (60 samples); Little Calumet River downstream of O'Brien Lock (60 samples); Lake Calumet (60 samples).

Sampling locations will be similar to prior years at the above fixed site monitoring locations. Coolers with complete collection kits containing sample vessels, labels, data sheets, COC form, centrifuge tubes, filters, and zip loc bags will be supplied to each sampling crew by the WGL. FWCOs will supply their own nitrile gloves, handheld depth SONAR, GPS units, water quality probes and sprayers with 10% bleach solution. FWCOs will filter samples in the mobile FWS filtering trailer.

The proposed strategy allows for eDNA sampling to take place in order to continue collecting data at the regularly monitored sites in the CAWS. FWCO staff has already been trained and have sampled in the CAWS in previous seasons.

Reduced sampling frequency is consistent with the removing of eDNA as a trigger for response actions, yet retaining the surveillance data by conducting the comprehensive sampling events

twice during the sampling season to inform the MRRWG on spatial and temporal trends of Bighead and Silver Carp DNA presence. (see ECALS Appendix G for more information).

eDNA Sample Collection Protocol.

1) Sampling will be cancelled or postponed due to contamination concerns if a combined sewer overflow (CSO) occurs four days prior to sampling and/or if observed precipitation exceeds 1.5 inches in 24 hours five days prior to sampling. Sample crews will be notified as soon as possible of a cancellation.
2) The sampling boat and transport trailer must be disinfected prior to launching by spraying the outer surfaces (i.e. hull, motor, etc.) with a hand-held sprayer containing a prepared 10% bleach/water solution.
3) Prior to launch, crew members will be given their specific duties for the sampling trip. One crew member will be designated as the boat operator and will be in charge of driving the vessel to sample locations. A second crew member will be designated as the lead sampler and will be in charge of collecting all water samples and measuring water depth and temperature. A third crew member will record GPS location (decimal degrees) and habitat measurements for each water sample on a datasheet.
4) Sampling will begin at the first transect located at the DOWNSTREAM end of the reach to be sampled and will proceed in an UPSTREAM direction.
5) When arriving at a sample site, the lead sampler will put on sterile exam gloves (powderless latex or nitrile).
6) Going in consecutive order, the lead sampler will remove a labeled 2L sample bottle from the sample cooler.
7) Just prior to collecting the sample, the lead sampler will unscrew and remove the lid from the sample bottle.
8) The lead sampler will then reach over the upstream side or the bow of the boat with the 2L sample bottle and fill the bottle by skimming the water surface. The sample bottle should not be submerged or dipped beyond the upper 2 inches of the surface water for sample collection.
9) Once the sample bottle is completely filled (approximately 1 inch of space should be left within the sample bottle) the lead sampler will screw the lid back on to the bottle until it is tight. The closed bottle should then be returned to the sample cooler from which it was removed.
10) The lead sampler will take a surface water temperature and depth measurement at the sample site. The data recorder will record the bottle ID number, GPS location (decimal degrees), time of sample, water temperature, and water depth on the data sheet.
11) If the lead sampler pulls a transport blank (2L of DI water filled prior to trip) from the cooler, the sampler will unscrew and remove the lid to expose the bottles contents to the atmosphere for 5 seconds, reseal the bottle, fully submerge the bottle in the field water, and return the bottle to the cooler from which it was removed. The lead sampler should relay to the data recorder that the sample was a blank, so that it can be recorded on the data sheet next to the appropriate ID number. BLANKS ARE TAKEN IN TANDEM WITH THE NEXT ACTUAL SAMPLE AND DO NOT REPLACE A SAMPLE IN THAT LOCATION. If a blank was collected, the boat will remain at the same location and an actual sample will be taken.

12) Duplicate samples are collected as part of quality control. Duplicate sample locations are designated as red stars on the aerial location map. Duplicate samples will be collected the same a regular sample; however, the lead sampler should relay to the data recorder that the sample is a duplicate, so that it can be recorded on the data sheet next to the appropriate sample ID. DUPLICATE SAMPLES ARE TO BE TAKEN IN TANDEM WITH THE NEXT REGULAR SAMPLE. If a duplicate sample is designated, this sample should be taken concurrently with the regular sample, side-by-side, to best replicate the regular sample collection. If a blank sample is pulled from the cooler at a designated duplicate location on the aerial map, take the duplicate sample at the NEXT DESIGNATED REGULAR SAMPLE LOCATION.
13) Steps 5 through 12 should be repeated until sampling has been completed for the targeted reach.
14) Once sampling is complete, ice will be added to the sample coolers as soon as possible. Enough ice should be added to each cooler to completely surround each sample bottle and maintain an inside temperature of 40ºF. If at any time during transport the inside temperature of the cooler(s) rises above 40ºF, additional ice should be added.
15) Chain-of-custody (COC) forms will be completed for every sample. All samples, including blanks, will be logged onto COC forms. The forms will be collected and signed whenever the coolers are transferred between parties.

Sampling Schedule: CAWS eDNA samples will be collected during two events, June 17-21 and October 21-25, weather permitting.

Deliverables: Results of each sampling event will be reported for sampling summaries. Data will be summarized for an annual interim report and project plans updated for annual revisions of the MRP.

Larval Fish and Productivity Monitoring in the Illinois Waterway

Participating Agencies: INHS (lead), Western Illinois University and Eastern Illinois University (field and lab support)

Location: Larval fish and productivity sampling will take place at 14 sites in the Illinois and Des Plaines River downstream of the electric barrier system (LaGrange, Peoria, Starved Rock, Marseilles, Dresden, and Brandon Road Pools), and at four sites in the CAWS upstream of the electric barrier system (Figure 1). Sites may be dropped, or additional sites added as needed in order to complete study objectives.

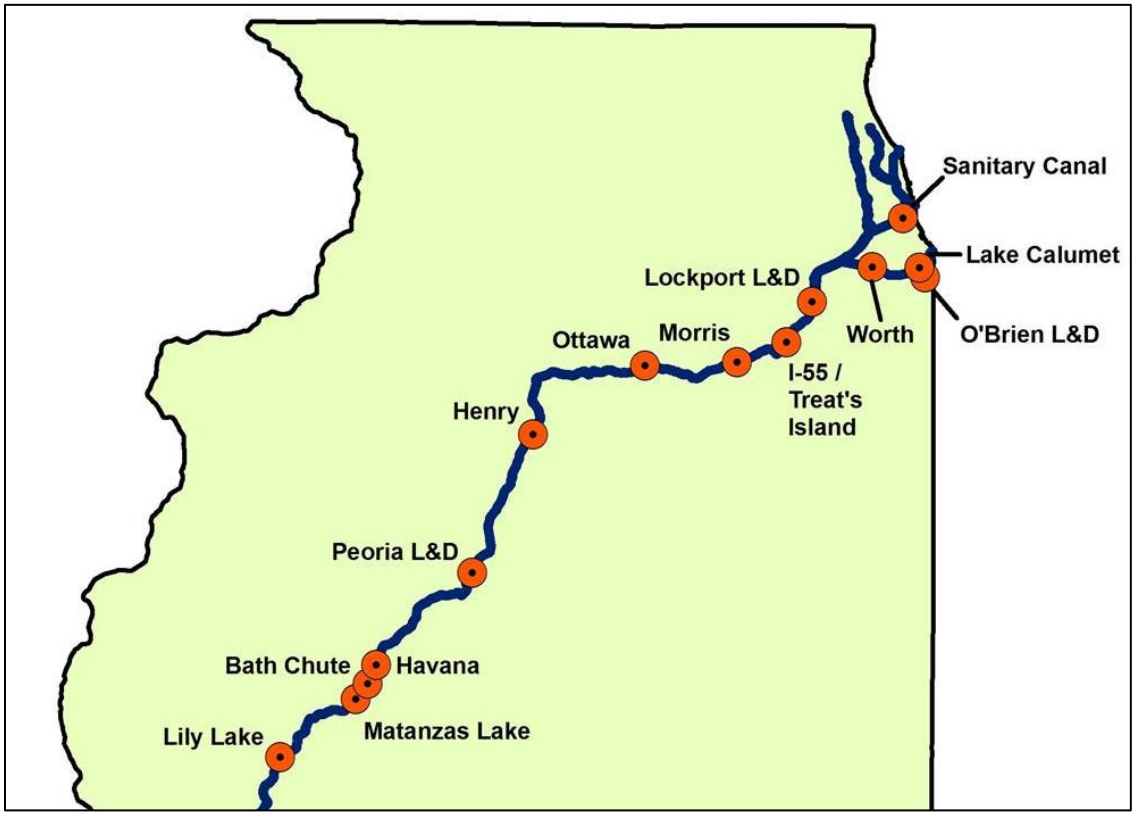


Figure 1. Map of larval fish and productivity sampling sites in the Illinois Waterway.

Introduction and Need: Factors affecting the early life stages of fish strongly influence recruitment to adult populations. An evaluation of Asian carp reproduction and recruitment in different sections of the Illinois Waterway is needed to better understand Asian carp population dynamics in this system and potentially develop management strategies targeting early life stages. Larval Asian carp have previously been collected in the Alton and LaGrange Pools of the Illinois River, and juveniles have been captured in the Alton, LaGrange, and Peoria Pools, but the potential for Asian carp reproduction in upstream reaches of the Illinois Waterway is unknown. Additionally, reproduction and recruitment are known to be highly variable among years in the lower Illinois River, with consistently poor recruitment observed in recent years. Information on the spatial and temporal distribution of Asian carp eggs and larvae will help to

identify adult spawning areas, determine reproductive cues, and characterize relationships between environmental variables and survival of young Asian carp. Larval fish monitoring will aid in evaluating the potential for these species to further expand their range in this system and may prove to be an early detection method in the CAWS.

Asian carp are filter-feeding planktivores that have the ability to deplete plankton densities and alter zooplankton community composition. Because Asian carp require sufficient food resources to optimize feeding and sustain their growth, they may associate with areas of higher productivity. Phytoplankton and zooplankton densities are expected to vary considerably both across the longitudinal gradient of a large river and among habitats within river segments. Therefore, identifying patterns in nutrient concentrations, phytoplankton densities, and zooplankton abundance may indicate locations where Asian carp are most likely to be located. Examining relationships between the abundance of Asian carp, other planktivorous fishes, and productivity variables will provide information on Asian carp foraging ecology and will help focus sampling and removal efforts. This information will also be useful for examining relationships among nutrients, phytoplankton, and zooplankton abundance in a large river system.

Objectives: We are sampling fish eggs and larvae in the Illinois Waterway to:

1) Identify the spatial extent of Asian carp reproduction;
2) Determine the timing of Asian carp spawning in this system;
3) Determine the detectability of larval fish in standard ichthyoplankton sampling gear; and
4) Examine relationships between environmental variables (e.g., temperature, discharge, habitat type) and Asian carp reproduction and recruitment.

Productivity variables are being measured to:

1) Identify high-productivity areas where Asian carp may be most likely to be located;
2) Determine relationships between productivity and the abundance of Asian carp and other planktivorous fishes; and
3) Examine relationships among nutrients, phytoplankton, and zooplankton density in the Illinois Waterway.

Status: Over 600 ichthyoplankton samples were collected from May – October 2012, capturing over 25,000 larval fish. Larval and early-juvenile Asian carp (n = 396) were collected from multiple sites in the LaGrange Reach in May and June. Additionally, a single Asian carp egg was collected in a larval fish sample from Henry (Peoria Pool) in May. No Asian carp eggs or larvae were collected upstream of the Peoria Pool. Clupeids, primarily Gizzard Shad, were the most abundant larval fish taxa captured. Cyprinids (excluding Asian carp) were common at most sites, and centrarchid larvae were abundant in the upper Illinois River.

Productivity sampling largely coincided with larval fish sampling during 2012, and sample processing from 2012 is ongoing. Analysis of previous years' data reveals that total phosphorus concentrations increase with increasing distance upriver and are highest in the Des Plaines River and in the lower CAWS, but phosphorus concentrations decline to their lowest observed levels at sites closest to Lake Michigan. Phosphorus and chlorophyll concentrations appear to be negatively correlated, with the highest chlorophyll concentrations occurring in the lower Illinois

River. Crustacean zooplankton densities vary little among sites in the Illinois River, but increase in abundance in the Des Plaines River and are highest in the CAWS. Dreissenid veligers occur in low densities in the Illinois River, but increase substantially in the Des Plaines River and are abundant the CAWS. Rotifer densities are relatively high in the lower Illinois River, decline in the upper Illinois and Des Plaines River, but increase again to their highest level in the CAWS. Densities of all zooplankton groups appear to be highest in the Little Calumet River and in Lake Calumet.

Methods: Larval fish samples will be collected using a 0.5 m-diameter ichthyoplankton push net with 500 μm mesh. Sampling transects will be located on either side of the river channel, parallel to the bank, at both upstream and downstream locations within each study site. To obtain each sample, the net will be pushed upstream using an aluminum frame mounted to the front of the boat. Boat speed will be adjusted to obtain 1.0-1.5 m/s water velocity through the net. Flow will be measured using a flow meter mounted in the center of the net mouth and will be used to calculate the volume of water sampled. Fish eggs and larvae will be collected in a meshed tube at the tail end of the net, transferred to sample jars, and preserved in 90% ethanol. The presence of any fish eggs will be noted and all eggs will be retained for future analyses. Larval fish will be identified to the lowest possible taxonomic unit in the laboratory. Larval fish densities will be calculated as the number of individuals per m^3 of water sampled. Productivity patterns will be evaluated by measuring total phosphorus and chlorophyll *a* concentrations, as well as zooplankton abundance at all 14 sampling locations. Water samples will be collected at upstream and downstream locations at each site using an integrated tube sampler lowered to twice the Secchi depth. Whole water samples (40 mL) will be being collected for phosphorus analysis, whereas chlorophyll *a* samples will be collected by filtering 100 mL of water through glass microfiber filters. Two of each sample type will be collected at each location (4 each per site). Chlorophyll *a* concentrations will be estimated fluorometrically with an acetone extraction, and total phosphorus concentrations will be determined by measuring sample absorbance with a spectrophotometer after an acid molybdate extraction. Zooplankton will be collected by obtaining vertically-integrated water samples using a diaphragmatic pump. At each site, 90 L of water will be filtered through a 63 μm mesh to obtain crustacean zooplankton, whereas 10 L of water will be filtered through a 20 μm mesh to obtain rotifers. Organisms will be transferred to sample jars and preserved in either Lugols solution (4%; macrozooplankton) or buffered formalin (10%; rotifers). In the laboratory, individual organisms will be separated into major taxonomic groups, counted, and measured using a digitizing pad. Zooplankton densities will be calculated as the number of individuals per liter of water sampled.

Sampling Schedule: In 2013, sampling will occur at approximately bi-weekly intervals at all sites from April to October. Larval fish sampling may occur more frequently during periods when Asian carp eggs and larvae are likely to be present (e.g., during spring months, during periods of rising water levels, or shortly after peak flows).

Deliverables: Results of each sampling event will be reported in monthly sampling summaries. Data will be summarized and project plans updated for annual revisions of the MRP.

Young-of-Year and Juvenile Asian Carp Monitoring

Participating Agencies: IDNR (lead); INHS, USFWS, and USACE (field support)

Location: Sampling will take place in the Illinois River, Des Plaines River, and CAWS.

Introduction and Need: Bighead and Silver Carp are known to spawn successfully in larger river systems where continuous flow and moderate current velocities transport their semi-buoyant eggs during early incubation and development. Spawning typically occurs at water temperatures between 18°C and 30ºC during periods of rising water levels. Environmental conditions suitable for Asian carp spawning may be available in the CAWS and nearby Des Plaines River, particularly during increasingly frequent flooding events.

Successful reproduction is considered an important factor in the establishment and long term viability of Asian carp populations. The risk Asian carp will establish viable populations in Lake Michigan increases if either species is able to successfully spawn in the CAWS. Successful spawning in the upper Des Plaines River also could pose a threat because larval fish may be washed into the CSSC upstream of the electric barrier system during extreme flooding. The transport of larvae to the CSSC can occur despite the installation of concrete barrier and fencing between the waterways because larval fish are small enough to pass through the 0.25-inch mesh fencing used for the separation project. Whereas larvae washed into the CSSC likely would be transported downstream past the electric barrier system during flooding, these fish might become established in the lower Lockport Pool and recruit to the juvenile life stage. This poses a threat because small fish <3.0 inches long might be capable of swimming upstream past the electric barrier system at the current settings (Holliman 2011). An additional threat may occur if juvenile Asian carp from spawning events in downstream pools migrate to the Lockport Pool via navigation locks. Even though there has been no evidence of successful Asian carp reproduction in the CAWS, Des Plaines River, or upper Illinois River, targeting young-of-year and juvenile Asian carp in monitoring efforts is needed because these life stages may not be detected in conventional sampling geared toward adults.

Objectives: We will use multiple gears suitable for sampling small fish to:

1) Determine whether Asian carp young are present in the CAWS, lower Des Plaines River, and Illinois River; and
2) Determine the uppermost waterway reaches where young Asian carp are successfully recruiting.

Status: Sampling for young Asian carp as part of standard monitoring began in late summer 2010 and continued through 2012. Electrofishing protocols for fixed site monitoring upstream and downstream of the electric barrier system were modified to include small fish sampling. Small mesh experimental gill nets (mesh sizes = 0.75-2.0 inches) and mini-fyke nets were added to the gear evaluation study and fished at several stations in the Illinois River, Des Plaines River, and CAWS. In addition, we used mini-fyke nets in combination with electrofishing and experimental gill nets during two fall sampling events in the Lockport Pool downstream of the electric barrier system. No young Asian carp were captured with any sampling gears upstream

of Starved Rock Lock and Dam. For more detailed results see 2012 interim summary report document (MRRWG 2013).

Methods: As in the past, 2013 sampling for young-of-year and juvenile Asian carp will take place through other projects of the MRP. Projects included are Larval Fish and Productivity Monitoring, Fixed and Random Site Monitoring Upstream of the Barrier, Fixed and Random Site Monitoring Downstream of the Barrier, Distribution and Movement of Small Asian Carp in the Illinois Waterway, Gear Efficiency and Detection Probability Study, Response Actions in the CAWS, Barrier Maintenance Fish Suppression Project, and the Des Plaines River and Overflow Monitoring Project. Electrofishing protocols will include sub-sampling schools of small fish <6 inches long (typically Gizzard Shad) by netting a portion of each school encountered during each electrofishing transect. Netted small fish will be held in a holding tank and examined individually for the presence of Asian carp before being returned to the waterway. Keeping small fish tallies separate from larger fish will provide an estimate of the relative abundance of young Asian carp in each sample of small fish.

In addition to electrofishing, mini-fyke nets and small mesh experimental gill nets will be fished at several stations in the Illinois Waterway and CAWS (see Exploratory Gear Development Project) and mini-fyke nets will be fished at fixed sites downstream of the electric barrier system (see Fixed and Random Site Monitoring Downstream of the Barrier). These gears will be set in shallower habitats off of the main navigation channel and fished for 1-2 net-nights. Mini-fyke nets will be incorporated into monitoring plans upstream of the electric barrier system if successful spawning and recruitment of young Asian carp progresses up the waterway closer to Lake Michigan.

Additional sampling gears that target small fish, such as midwater trawls, purse seines, cast nets, beach seine, and push trawls are currently being evaluated. We will add new gears to our arsenal of sampling tools pending results and recommendations of current researchers. Some of these gears (push trawl and beach seine) will be used in targeted monitoring of Asian carp in tributaries and backwater habitats of the Illinois Waterway downstream of the Brandon Road Lock and Dam as part of a study evaluating distribution and movement of small Asian carp (see Distribution and Movement of Small Asian Carp in the Illinois Waterway plan).

Sampling Schedule: Small fish sampling will take place from March through December 2013, as part of other monitoring projects in the MRP.

Deliverables: Results of each sampling event will be reported in monthly sampling summaries. Data will be summarized for an annual interim report and project plans updated for annual revisions of the MRP.

Distribution and Movement of Small Asian Carp in the Illinois Waterway

Participating Agencies: USFWS Carterville Fish and Wildlife Conservation Office (lead); USFWS Columbia, MO and La Crosse, WI FWCOs (field support).

Location: Areas sampled will be within the Peoria, Starved Rock, Marseilles, and Dresden Island pools. Known populations of adult Asian carp exist in all pools of the Illinois River Waterway (IWW) from Dresden Island downstream. To date, the farthest upstream extent of small (≤ 300 mm TL) Asian carp recorded in the Illinois River has been near the town of Henry, Illinois (Peoria County) at river mile 194 where young of year Silver Carp were collected in June 2012 (USFWS unpublished data).

Introduction and Need: Asian carp include the Silver Carp (*Hypophthalmichthys molitrix)* and Bighead Carp (*H. nobilis)* as well as hybrids between these species. Populations of these two introduced exotic species are spreading throughout the Mississippi River Basin (Conover et al. 2007; Chapman and Hoff 2011; O'Connell et al. 2011). Kolar et al. (2007) rated the probability of Silver and Bighead Carp spreading to previously uncolonized areas as "high" and assigned this rating as "very certain". Asian carp are highly invasive species that have been expanding their range in the U.S. since the early 1980's when they first began to appear in public waters (Freeze and Henderson 1982; Burr et al 1996). Populations of Asian carp have grown exponentially because of their rapid growth rates, short generation times, and dispersal capabilities (DeGrandchamp 2003; Peters et al. 2006; DeGrandchamp et al. 2008). Asian carp have been shown to exhibit very high reproductive potential with high fecundity and the potential for a protracted spawning period (Garvey et al. 2006). Garvey et al. (2006) stated that high reproductive capacity of both species, in particular Silver Carp ensure that attempts to exclude or remove individuals will require a massive undertaking that targets young small-bodied fish as well as adults.

Populations of Asian carp have become well established in the lower and middle reaches of the Illinois River. Because of the connection of the upper IWW to Lake Michigan, natural resource managers are concerned about the potential invasion of Asian carps into the Great Lakes (Conover et al. 2007). If Asian carp gain entry into Lake Michigan they could pose a significant threat to fisheries by competing with established, economically and recreationally important species for limited plankton resources (Sparks et al. 2011). Kolar et al. (2007) noted that the most probable pathway for gaining access to the Great Lakes is through the Chicago Sanitary and Shipping Canal (CSSC). Therefore, the CSSC is also the key to stopping large numbers of Asian carp from expanding their range into Lake Michigan and the Great Lakes (Conover et al. 2007).

At present an electric barrier system operated by the U.S. Army Corps of Engineers (USACE) is intended to block the upstream passage of Asian carp through the CSSC. Laboratory testing has shown that the operational parameters currently in use at the electric barrier system are sufficient to stop large bodied fish from passing through (Holliman 2009). However, recent testing of operational parameters using small Bighead Carp (51 to 76 mm total length) revealed that operational parameters may be inadequate for blocking small fish passage (Holliman 2011). For this reason, there exists some concern that small sized Asian carp, if present, might represent a

threat to breach the electric barrier system. This highlights the need to better define the distribution and demographic characteristics of small Asian carp in the middle and upper IWW allowing us to fully characterize and assess the risk they may pose to the barriers. Additionally, there is an ongoing need to understand the reproduction of these species in the IWW so that managers might better target small sized fish for eradication or other management actions in the future.

The purpose of this study is to establish where young (young of year to age 2) Asian carp occur in the IWW through intensive, directed fish sampling which targets these life stages. For the purposes of this study, fish specimens less than 300 mm total length will be considered "small fish" based on previously published estimates of age-one and age-two Bighead Carp (Shrank and Guy 2002) and Silver Carp (Williamson and Garvey 2005). Sampling will employ the best known methods for detection and collection of Asian carp (Irons et al. 2011). Gears used will include small-mesh fyke nets and pulsed-DC electrofishing. In isolated off channel backwater areas seines may be used when appropriate. The use of small-mesh fyke nets and electrofishing has been shown to provide complimentary information when employed in shallow water areas (Ruetz et al. 2007).

Status: This is a continued project for 2013. In 2012 a total of 458 sites distributed among the Peoria, Starved Rock, Marseilles, and Dresden Island Pools of the Illinois Waterway were sampled for small fishes during the months of June through October 2012. Samples included 209 - 15 minute electrofishing runs (52.25 hours shock time); 88 experimental push trawl runs; 184 net nights of mini-fyke nets fished, and 52 net nights with large frame, small meshed fyke nets fished.

Results include a total of 72,015 fish specimens collected and examined. Eighty species and three hybrid groups were identified. Nine species and three hybrid groups were non-natives. A total of four post-larval Asian carp (*Hypophthalmichthys* spp.) young-of-the-year specimens were identified from three collections made 4 and 5 June 2012. All three collections were made in the Peoria Pool, one in the vicinity of Henry, Illinois and two near Chillicothe, Illinois.

Objectives:

1) Determine the distribution, abundance, and age structure of small Asian carp in the middle and upper IWW.
2) Determine the movements of small Asian carp in the middle and upper IWW.
3) Combine distribution, abundance, and movement data to characterize the risk that small Asian carp pose to the Great Lakes via the Chicago Area Waterway System.

Methods: **Fish Capture**

Site/Habitat Selection - Sites selected will be in areas off of the navigation channel. These areas may include backwaters, isolated pools, side channels, side channel borders, and/or tributary mouths. Efforts will be made to sample areas inaccessible to traditional fisheries boats (traditional fisheries boats are already collecting small fishes on other projects in the area). Shallow backwaters and isolated pools disconnected from the main channel, except during flooding events, are areas that small Asian carp likely occupy but are rarely, if ever sampled.

Sample sites will be determined from analysis of LTRMP GIS data. Final in-field site selection will be left ultimately to the discretion of the biologist in the field subject to on-site realities (e.g. a given site may be dry so an alternative nearby site would be chosen instead).

Netting – Nets will consist of mini-fyke nets and large frame, small meshed fyke nets. Nets will be set and fished overnight. In areas with wade-able depths and sufficiently firm substrate for seining, small meshed seines may be used. Examples of habitats to be sampled by seining include isolated pools, or other areas inaccessible to boats. Seines will include 4.6m x 1.8m, 4.8mm mesh straight seine, and a 9.1m x 1.8m, 4.8mm mesh bag seine.

Electrofishing – Fifteen-minute pulsed-DC electrofishing samples will be conducted. All fish will be collected and processed at the end of each 15-minute run. Common Carp will be counted but not netted.

Push-trawl and/or Mini-mamou Trawl Sampling - Push-trawl and/or Mini-mamou Sampling surface/mid-water will be conducted concurrently with netting and electrofishing sampling. Trawl runs will be made in shallow water (0.5 m to 2.0 m water depth habitats). Sampling effort will be quantified by length of trawl haul and number of hauls. Quantification of catch per unit effort (CPUE) will be the number of individuals per species per square meter trawled. Target lengths of trawl hauls will be between 25 and 100 meters but will vary with the amount of fishable habitat present at a given location. The push-trawl employed has a skate balloon trawl net of 4 mm mesh, 1.8 m body length, 0.76 x 0.38 m otter boards, 2.4 m foot rope, and an effective net fishing width 1.8 m across. The Mini-mamou net is a 8 m wide, .75 m deep, 38 mm stretch mesh, with a 6 mm mesh liner and mullet doors. Gear selection will depend on habitat characteristics.

Surface/mid-water trawl Sampling – surface/mid-water will be employed concurrently with netting and electrofishing sampling. The trawl is an Aluette Combination trawl employed by the Missouri Department of Conservation, Open Rivers & Wetlands Field Station. Trawls will be made in open waters of the IWW. The Aluette Trawl Model 12 is a pelagic trawl with a 12 m head rope, 12.5 m foot rope, 9 m depth, an overall length of 19 m, and a 12 mm inner liner.

Fish identification and archiving - All fish other than Asian carp collected will be identified to species, counted, and native fish will be released. Some Asian carp captured will be implanted with ultrasonic transmitters. Large collections of small bodied fishes will necessarily be preserved and returned to the laboratory for identification and enumeration. Asian carp not used for telemetry will be identified, measured for total length (mm), weighed to the nearest gram, and destroyed or given to researchers for ageing, or other life history data collection. A subsample of small Asian carp specimens captured will be preserved as vouchers and retained to provide a permanent record. Vouchers of any additional exotic species collected will be preserved for archiving. Exotic fish species not preserved for voucher specimens will be destroyed. Any preserved voucher specimens will be deposited into one or more fish collections (SIUC, INHS, FMNH). Any Illinois state threatened or endangered species incidentally taken will be deposited at Southern Illinois University (SIUC). Element Occurrence and Sighting Report Forms for all T&E species collected will be submitted to the Illinois Natural Heritage Program.

Asian Carp Aging and Natal Water Determination - Lapillus otoliths, or other aging structures, will be removed from a subsample of Asian carp collected from each site. Structures from up to 30 fish will be removed, placed in individually marked envelopes and returned to the lab for ageing. Asian carp less than 300 mm TL will be aged. Lapilli will be processed and aged according to procedures described in Maceina and Sammons (2006). Two independent readers will make annuli counts and a third reader will resolve disagreements between readers. In addition to ageing, a subset of otoliths will be provided with all collection data to Dr. Gregory Whitledge at SIUC for stable isotope analysis of fish natal origin.

Habitat Measurements – Macro habitat information will be recorded for each sampling location (e.g. backwater, side channel border, tributary mouth). Physical and chemical habitat measurements will be made at each collection site. Habitat measurements will be recorded at the time of each net retrieval, electrofishing run, or seine haul. Global Positioning System (GPS) coordinates will be recorded for all net sets, beginning and end of electrofishing runs, and locations of seine hauls. Physical measurements will include: depth, Secchi depth, and substrate composition (i.e. mud, sand, silt, vegetation, gravel, etc.). Water quality measurements will include: temperature, salinity, specific conductance, dissolved oxygen, and pH. Water quality measurements will be taken with an analytical instrument (YSI Professional Series multi-meter).

Fish Sampling Frequency and Effort – The onset of fish sampling will be determined by monitoring the hydrographs generated by the USGS Water Resources gaging stations along the IWW. Sampling will occur during May through October 2013 and will be initiated approximately three weeks following a substantial increase in stream discharge following spring or summer rains (flood pulse) with water temperatures above 18^{o} C. Four weeks during May to July will be spent sampling areas which are inaccessible to traditional fisheries boats but can be sampled with our shallow drive (mud motor) boat. In addition to boat accessible areas, two weeks will be devoted to sampling five isolated areas which are disconnected from the main channel of the river except in times of overtopping floods. This sampling will take place between May and the end of October and will be initiated after a flood pulse event. One week of push-trawl and surface/mid-water trawl sampling will also be conducted during the four weeks of sampling between May and July concurrent with netting and electrofishing.

Methods: Telemetry

Ultrasonic Transmitter Tagging - During the course of fish sampling, all equipment necessary to implant fish with ultrasonic transmitters will be maintained in a ready state with the field crew. If small Asian carp of appropriate size are captured they will be surgically implanted with ultrasonic transmitters (Vemco, Model V7-4L; 69 kHz, 7 mm diameter, 22.5 mm long) for remote individual identification. Each transmitter will be tested for recognition prior to its use with a portable hydrophone and receiver (Vemco Model VH110-10M and Vemco Model VR100, respectively). Fish to be tagged will be held in a holding tank with fresh oxygenated water, then anesthetized with carbon dioxide gas and implanted with transmitters according to surgical procedures described by Summerfelt and Smith (1990). Following surgery, fish will be measured for total length (mm) and weight (g), placed in a container of fresh, oxygenated water and allowed to revive before release at or near the site of capture.

Stationary and Mobile Telemetry – If small Asian carp are captured and implanted with transmitters, mobile telemetry will be performed in order to determine gross habitat usage by tagged fish. Tagged fish will be located as closely as possible using mobile telemetry and GPS coordinates. Physicochemical habitat measurements will be taken at sites where tagged fish are located. Data will also be available from the existing array of stationary receivers currently being used by other researchers in the IWW including Southern Illinois University at Carbondale and U.S. Army Corps of Engineers. Data gleaned from stationary receivers will provide information on gross movements of tagged fish including detection of any movements through lock and dam facilities.

Methods: Data Analyses

Descriptive statistics such as presence/absence and mean counts from fish capture data will be presented. Graphs of raw numbers of Asian carp caught using the different gear types will be used to determine which method is most effective at capturing small fish. Chemical/physical variables will be summarized at each site using principal components analysis (PCA). The PC scores will be plotted on a PCA bi-plot and the scores labeled by pre-assigned categories related to Asian carp (zero Asian carp, low Asian carp, med Asian carp, and high Asian carp). Fish capture data will be used to determine if certain environmental conditions are associated with their presence/absence or relative abundance. Fish age data will be presented graphically.

Non-metric multidimensional scaling (NMDS) will be used to examine variation in adult fish assemblage structure (i.e., species abundance) among sites with and without Asian carp using Primer-E LTD software (Clarke and Gorley, 2001). The NMDS technique is used to analyze assemblages by producing an ordination plot that shows the relative differences in assemblage structure between sample pairs, where pairs with a larger dissimilarity are further apart on the ordination diagram (Minchin 1987, Clarke 1993). Analysis of Similarity (ANOSIM) will be used to test for significant differences in assemblage structure among sites with and without Asian Carp. Global R is the test statistic for ANOSIM, which ranges from 0-1, where values of zero indicate overlapping assemblages that do not differ, while values of one indicate differing structure and assemblages that can be distinguished from one another (Clarke and Gorley 2001).

Sampling Schedule:

February - April 2013: Gear preparation, field logistics planning, crew scheduling
May - June 2013: Initiation of field sampling following a rise in the hydrograph
May - October 2013:Fish sampling, fish identification in lab, aging, data entry, fish data analysis
November 2013: Complete fish identification and aging, data entry
December 2013 - January 2014: Final data analyses and draft annual report generation

Deliverables: Any findings of small carp in areas significantly upstream towards the electric barrier system will be reported immediately to Todd Turner, USFWS Assistant Regional Director-Fisheries or Charlie Wooley, USFWS Deputy Regional Director - Region 3 and the MRRWG. A final report will be given to the MRRRWG upon completion of this work, pending future year funding.

Fixed and Random Site Monitoring Downstream of the Barrier

Participating Agency: IDNR (lead); USACE and USFWS (field support)

Location: Monitoring will take place in the CSSC, lower Des Plaines River and upper Illinois River. Specifically, we will sample the Lockport Pool downstream of the electric barrier system and the Brandon Road, Dresden Island, and Marseilles Pools.

Introduction and Need: Standardized sampling can provide useful information to managers tracking population growth and range expansion of aquatic invasive species. Information gained from regular monitoring (e.g., presence, distribution, and population abundance of target species) is essential to understanding the threat of possible invasion upstream of the electric barrier system. For this project, we use pulsed-DC electrofishing, hoop and minnow fyke netting, and contracted commercial netters to sample for Asian carp in the four pools below the electric barrier system. A goal of this monitoring effort is to identify the location of the detectable population front of advancing Asian carp in the Illinois Waterway and track changes in distribution and relative abundance of leading populations over time. The detectable population front is defined as the farthest upstream location where multiple Bighead or Silver Carp have been captured in conventional sampling gears during a single trip or where individuals of either species have been caught in repeated sampling trips to a specific site. Monitoring data from 2010-2012 has contributed to our understanding of Asian carp abundance and distribution downstream of the electric barrier system and the potential threat of upstream movement toward the CAWS. Based on data collections from 2010-2012, sampling efforts upstream of the electric barrier system will be reduced in order to allow an increase in sampling efforts downstream of the electric barrier system. This shift in effort will allow the opportunity to better assess Asian carp abundances and distributions downstream of the electric barrier system.

Objectives: Standardized sampling will consist of pulsed-DC electrofishing, hoop and mini-fyke netting, and contracted commercial netting to:

1) Monitor for the presence of Asian carp in the four pools below the electric barrier system;
2) Determine relative abundance of Asian carp in locations and habitats where they are likely to congregate;
3) Supplement Asian carp distribution data obtained through other projects (e.g., Barrier Defense Asian Carp Removal Project); and
4) Obtain information on the non-target fish community to help verify sampling success, guide modifications to sample locations, and assist with detection probability modeling and gear evaluation studies.

Status: This project began in 2010 and is on-going. Samples were taken at four fixed sites in each of the four pools once monthly from April through November 2010 and March through November 2011 and 2012 with pulsed-DC electrofishing gear and from July through September 2010, April through November 2011, and March through November 2012 with trammel and gill nets. In total, 5,267 estimated person-hours of labor were expended to complete 94.5 hours of electrofishing and deploy 81.1 miles of trammel/gill net over the three years. A total of 64 hoop and 64 mini-fyke nets were set in the four downstream pools from August through December 2012. No Bighead or Silver Carp have been captured by electrofishing or netting in Lockport

and Brandon Road pools, although one adult Asian carp was observed in Brandon Road Pool by a net crew in October 2011. Monitoring indicated higher abundance of Bighead and Silver Carp in Marseilles Pool than Dresden Pool. For more detailed results see the 2012 interim summary report document (MRRWG 2013).

Methods: The sample design includes intensive electrofishing and netting at four fixed sites and four random sites in each of the four pools below the electric barrier system (Figure 6). Fixed and random site electrofishing will take place bi-weekly, rather than monthly, from March through November. Contracted commercial netting will take place bi-weekly from March through December and will include four fixed sites and four random sites within each pool. Fixed and random contracted netting below will occur during the same weeks as fixed and random contracted netting above. The fixed sites in each of the four pools are located primarily in the upper ends below lock and dams structures, and in habitats where Asian carp are likely to be located (backwaters and side-channels). Random electrofishing and contracted commercial fishing sites could occur anywhere within each pool, including the lower portion of each pool. The Kankakee River, from the Des Plaines Fish and Wildlife Area boat launch downstream to the confluence with the Des Plaines River, will be added to the Dresden Island pool random sites. Hoop and minnow fyke netting will take place at four fixed sites in each pool on a monthly schedule from March through December. No sampling at fixed sites is planned for January or February because several of the sites are typically ice covered during these months.

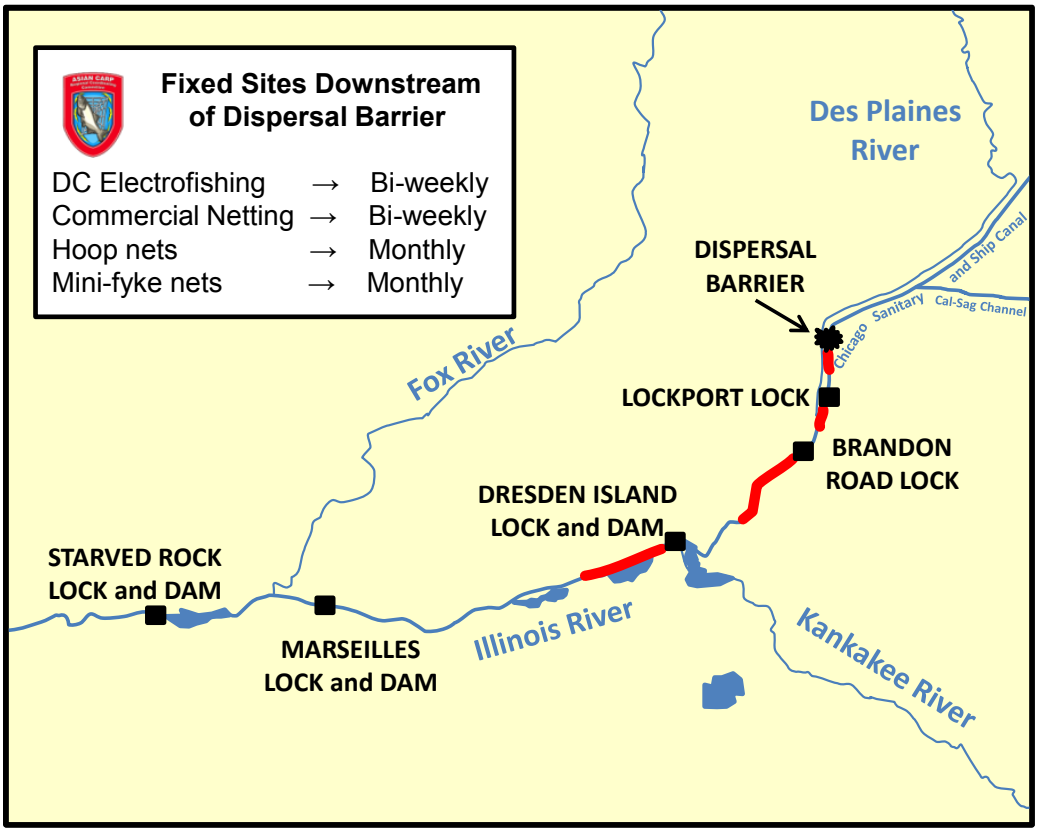


Figure 6. Map of fixed sites for electrofishing and commercial net sampling for Asian carp downstream of the electric barrier system.

Fixed and Random Sites Downstream of the Barrier Description and Effort: A description of fixed site locations and sampling effort targets is summarized below. There are four (4) 15-minute electrofishing runs, four (4) 200-yard trammel/gill net sets, eight (8) hoop net nights with 6-foot diameter hoop nets, and four (4) mini-fyke net nights planned for each of the four pools. Hoop and mini-fyke nets will be deployed at or near trammel/gill net sites. Four (4) 15 minute random electrofishing runs and four (4) 200-yard random trammel/gill net sets will be sampled in each pool concurrent with fixed site monitoring. See Appendix B for detailed maps of each fixed site.

Lockport Pool

- 1E1 starts at the Romeo Road Bridge on the east side of the canal and goes downstream
- 1E2 starts at the north end of the large haul slip of Hanson Material Services on the west side of the canal and goes downstream
- 1E3 starts at the upstream end of the MWRD Controlling Works and goes downstream
- 1E4 starts at the Rt. 7 Bridge on the west shore and goes downstream

- 1G1 is in the big haul slip of Hanson Material Services.
- 1G2 is upstream of Rt. 7 Bridge on the west side of the canal
- 1G3 is just downstream of the Rt. 7 Bridge on the west side of the canal
- 1G4 is just downstream of Cargill Grain Elevator on the west side of the canal

Brandon Pool

- 2E1 is in the bay below the Lockport Hydropower Plant
- 2E2 starts just above the confluence of the CSSC and Des Plaines River and goes downstream
- 2E3 starts just above the confluence of the Des Plaines River and the Illinois Michigan Canal and goes up the canal
- 2E4 starts at the I-80 Bridge and goes downstream along the east shore

- 2G1 just downstream of the confluence of the Des Plaines River
- 2G2 at the confluence of the Illinois Michigan Canal
- 2G3 just downstream of I-80 on the east shoreline
- 2G4 between I-80 and the Brandon Road Lock & Dam

Dresden Island Pool

- 3E1 in the bay on east side of river below the Brandon Road Dam
- 3E2 starts at the lower end of Treats Island and goes up into the side channel
- 3E3 is in Mobil Oil Corporation Cove
- 3E4 starts at I-55 Bridge on southeast shoreline and goes downstream

- 3G1 is in the bay on east side of river below the Brandon Road Dam
- 3G2 downstream of the casino on the west side of the river
- 3G3 in the lower end of the Treats Island side channel
- 3G4 is in Mobil Oil Corporation Cove
-

Marseilles Pool

- 4E1 along the north side of Big Dresden Island
- 4E2 along the north shoreline across from Big Dresden Island
- 4E3 at the back end of the north portion of Peacock Slough
- 4E4 is the south portion of Peacock Slough

- 4G1 is just upstream of the mouth of Aux Sable Creek
- 4G2 is at the mouth of the Commonwealth Edison Co. Cove
- 4G3 is just inside the north portion of Peacock Slough
- 4G4 is in the back of the south portion of Peacock Slough

Electrofishing Protocol - All electrofishing will use pulsed-DC current and include 1-2 netters (two netters preferred). Locations for each electrofishing transect will be identified with GPS coordinates. Electrofishing transects should begin at each coordinate and continue for 15 minutes in a downstream direction in waterway channels (including following shoreline into off channel areas) or in a clockwise direction in backwater sloughs. Fixed site sampling locations will remain the same throughout the year and should be sampled with each site visit. This represents a change from past years when exact sampling areas within the sites were left to the discretion of the field crews and should lead to more consistent monitoring results.

While electrofishing, operators may switch the safety pedal on and off at times to prevent pushing fish in front of the boat and increasing the chances of catching an Asian carp. Common Carp will be counted without capture and all other fish will be netted and placed in a tank where they will be identified and counted, after which they will be returned live to the water. Periodically (usually in the fall), a subsample of 10 fish of each species per site will be measured in total length and weighed to provide length-frequency data for gear evaluations. Schools of young-of-year Gizzard Shad <6 inches long will be subsampled by netting a portion of each school encountered and placing them in a holding tank along with other captured fish. Young-of-year Gizzard Shad will be examined closely for the presence of Asian carp and counted to provide an assessment of young Asian carp in the waterway. We will count all captured Asian carp, as well as those observed but not netted. We may observe more Asian carp than we net because of the difficulty in capturing these fish with electrofishing gear. Sample data sheets are included in Appendix F. Crew leaders should fill in as much information on the data sheets as possible for each station/transect and record the location for the start of each run either with GPS coordinates (decimal degrees preferred) or by marking on attached maps.

Netting Protocol – Contracted commercial fishers will be used for net sampling at fixed sites and nets used will be large mesh (3.0-4.0 inches) trammel or gill nets 8-10 feet high and in lengths of 200 yards. Locations for each net set will be identified with GPS coordinates. Net sets will take place within 500 yards of a designated coordinate at a specific location agreed upon by the commercial fisher and attending IDNR biologist. Sets will be of short duration and include driving fish into the nets with noise (e.g., plungers on the water surface, pounding on boat hulls, or racing tipped up motors). In an effort to standardize netting effort, sets will be 15-20 minutes long and "pounding" will extend no further than 150 yards from the net. Nets will be attended at all times. Captured fish will be identified to species and tallied on standard data sheets. Periodically (usually in the fall), a subsample of 10 fish of each species per site will be measured

in total length and weighed. Locations of net sets should be recorded with GPS coordinates (decimal degrees preferred) or by marking on attached maps. An IDNR biologist or technician will be assigned to each commercial net boat to monitor operations and record data.

Single hoop nets will be deployed by IDNR biologists at four locations in each pool, where they will be fished for two days each month. Specific set locations will vary, but nets typically will be set offshore, in current, and parallel to the navigation channel. Four mini-fyke nets will be set at four locations in each pool and fished for one net-night per month. Mini-fyke nets will be set in shallow off-channel areas with leads affixed to the shoreline and running perpendicular to shore. Though hoop and mini-fyke nets will be left unattended, care will be taken to set them in locations that will not interfere with commercial navigation or recreational boat traffic.

Suggested boat launches for sampling.
Lockport Pool – Cargill Launch – Inform Martin Castro of MWRD.
Brandon Road Pool –Ruby Street Launch in Joliet on the west side of the river.
Dresden Island Pool – Big Basin Marina under the I-55 Bridge on north side of the river. Contact Russ to get let in without paying. If you have to pay you can take the receipt to Office to get reimbursed.
Marseilles Pool – Stratton State Park Launch in Morris on the north side of the river.

Sampling Schedule: A tentative sampling schedule for electrofishing and netting for 2013 is shown in the tables below. Hoop and mini-fyke netting will occur monthly either the week before or after the week of scheduled electrofishing and netting.

Electrofishing Downstream of Barrier

Week	Agency
18-Mar	IDNR/USACE
1-Apr	USFWS/USACE
15-Apr	IDNR/USACE
29-Apr	USFWS/USACE
13-May	IDNR/USACE
28-May	USFWS/USACE
10-Jun	IDNR/USACE
8-Jul	USFWS/USACE
22-Jul	IDNR/USACE
5-Aug	USFWS/USACE
19-Aug	IDNR/USACE
3-Sep	USFWS/USACE
16-Sep	IDNR/USACE
30-Sep	USFWS/USACE
14-Oct	IDNR/USACE
4-Nov	USFWS/USACE
18-Nov	IDNR/USACE

Contracted Netting Above and Below Barrier

Week	Agency	Week	Agency
18-Mar	IDNR	5-Aug	IDNR
1-Apr	IDNR	19-Aug	IDNR
15-Apr	IDNR	3-Sep	IDNR
29-Apr	IDNR	16-Sep	IDNR
13-May	IDNR	30-Sep	IDNR
28-May	IDNR	14-Oct	IDNR
10-Jun	IDNR	4-Nov	IDNR
8-Jul	IDNR	18-Nov	IDNR
22-Jul	IDNR	2-Dec	IDNR

Fixed Site Hoop and Mini-Fyke Netting Below Barrier

Week	Agency
22-Apr	IDNR
20-May	IDNR
24-Jun	IDNR
15-Jul	IDNR
26-Aug	IDNR
23-Sep	IDNR
28-Oct	IDNR
2-Dec	IDNR

Deliverables: Results of each sampling event will be reported in monthly sampling summaries. Data will be summarized for an annual interim report and project plans updated for annual revisions of the MRP.

Response Actions in the CAWS

Participating Agencies: IDNR (lead); INHS, USFWS, and USACE (field support), USCG (waterway closures when needed), USGS (flow monitoring and dye tracking when needed), MWRD (waterway flow management and access), USEPA and GLFC (project support)

Location: Response removal actions will take place in the CAWS upstream of Lockport Lock and Power Station.

Introduction and Need: Preventing Asian carp from gaining access to Lake Michigan via the CAWS requires monitoring to detect and locate potential invaders and removal efforts to reduce population abundance and the immediate risk of invasion. Removal actions that capture or kill Asian carp once their location is known may include the use of conventional gears (e.g., electrofishing, nets, and commercial fishers), experimental gears (e.g., Great Lake pound nets, and deep water gill nets), and chemical piscicides (e.g., rotenone), or all strategies. Decisions to commence removal actions, particularly rotenone actions, often are difficult due to high labor, equipment, and supply costs. Furthermore, a one-size-fits-all formula for response actions is not possible in the CAWS because characteristics of the waterway (e.g., depth, temperature, water quality, morphology, and habitat) are highly variable. A threshold framework for response actions with conventional gear or rotenone was developed in the 2011 MRRP. Proposed thresholds were meant to invoke consideration of removal actions by the MRRWG, and were not intended to be rigid triggers requiring immediate action. Final decisions to initiate response actions and the type and extent of each action were ultimately based on the best professional judgment of representatives from involved action agencies.

Objectives: The plan objectives are:

1) Remove Asian carp from the CAWS upstream of Lockport Lock and Power Station when warranted; and
2) Determine Asian carp population abundance through intense targeted sampling efforts at locations deemed likely to hold fish.

Status: Actions to capture and remove Asian carp from the CAWS began in February 2010 and will continue as needed. This past year, we completed five response actions: North Shore Channel, Chicago River/South Branch Chicago River and three response actions in Lake Calumet. Three of the actions were triggered by three consecutive positive eDNA detections for Bighead and/or Silver Carp in the same location. Sampling effort combined across all responses in 2012 included 1,630 person-hours to complete 59 hours of electrofishing (250 transects), 18.4 miles of trammel/gill net (180 sets), 1.4 miles of commercial seining (3 hauls), 7.6 trap net-days, 19.1 hoop net-days, and 3.6 pound net-days. Rotenone was not used during 2012 response actions. For more detailed results see 2012 interim summary report document (MRRWG 2013).

Methods: We will use conventional gears, experimental gears and/or rotenone to capture and remove Asian carp from the CAWS upstream of Lockport Lock and Power Station. Each response action will be unique to location, perceived severity of the threat, and likelihood of successfully capturing an Asian carp. For example, observation of a live Asian carp from a credible source at the shallow North Shore Channel might elicit a 2- to 3-day conventional gear

response with two electrofishing and netting crews. Capture of a live Asian carp at the same location might initiate a 2-week response with 5-10 sampling crews and additional types of gear. Furthermore, capture or credible observations of multiple Asian carp in a deep-draft channel, such as the Little Calumet River below O'Brien Lock, might call for an emergency rotenone action to eradicate the local population. In general, small-scale removal actions will require fewer sampling crews and gear types than larger events, although all events will include multiple gears for more than one day of sampling and participation by commercial fishers, if available.

New methods to drive, capture, and kill Asian carp are constantly being developed and evaluated as part of the ACRCC Framework (see water gun, gear evaluation, and alternative gear projects in this plan and pheromone research outlined in the 2012 Framework). Such techniques may allow biologists to drive or attract Asian carp to barge slips or other backwater areas where they can be captured more easily or killed. We will incorporate new technologies in response actions when they have been sufficiently vetted and shown to be of practical use.

Threshold Framework-
Data from ECALS has revealed the uncertainty of eDNA positive detections originating from a live, free swimming fish, and several vectors have been identified as potential sources in addition to a live fish. Intensive sampling over the past two years, including response actions triggered by detection of Asian carp DNA, has resulted in no Asian carp being observed or captured. At present, the detection of eDNA evidence within a sampled reach cannot verify whether live Asian carp are present, whether the DNA may have come from a dead fish, or whether water containing Asian carp DNA may have been transported from other sources such as boat hulls, storm sewers, sediment, piscivorous birds or nets used by contracted commercial fishers. It is also not fully understood how environmental variables (e.g. temperature, conductivity, pH, etc.) impact the detection rate, degradation rate, or persistence of DNA in the environment. In light of this information, the MRWG proposes a new framework to guide management decisions on response actions in the CAWS where eDNA is no longer a response trigger. Therefore, the observation or capture of a live Asian carp by a credible source would be the lone trigger for initiating a response.

The proposed thresholds for response actions with conventional gears and rotenone apply to monitoring efforts in the CAWS upstream of Lockport Lock and Power Station. Again, this threshold framework is meant to inform decisions to initiate response actions and guide the level of sampling effort put forth during such actions. Actual decisions to respond and the type, duration, and extent of response actions will be made by agency representatives with input from the MRWG. Action agencies also may conduct targeted response actions at selected locations in the CAWS outside the response threshold framework when information gained from such actions may benefit monitoring protocols, research efforts, or Asian carp removal and control efforts.

The threshold framework includes three levels of response triggers and a feedback loop that advises for continued sampling or an end to the action (Figure 1). The first threshold level (Level 1) includes the observation of live Asian carp by a credible source (i.e., fisheries biologist or field technician). A suggested response for Level 1 might include 2-4 electrofishing boats and crews and 1-2 commercial fishing boats and crews sampling for 2-3 days. A Level 2 threshold

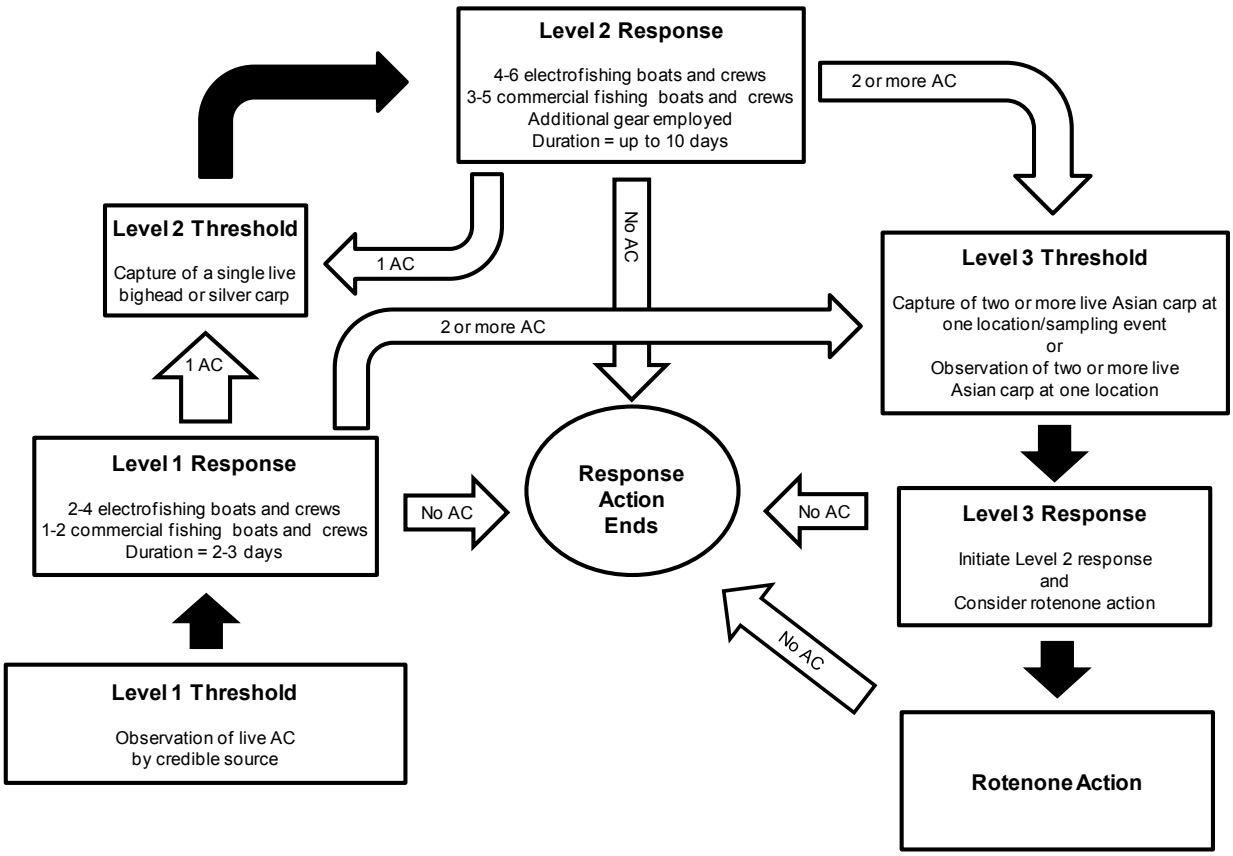


Figure 1. Thresholds for Asian carp (AC) response actions with conventional gears and rotenone.

would include the capture of a single live Bighead or Silver Carp. A Level 2 response might employ 4-6 electrofishing boats and crews, 3-5 commercial fishing boats and crews, and additional gears (e.g., hydroacoustics, commercial seines, and trap or fyke nets). Level 2 events might last up to 10 days. The capture of two or more Asian carp from a single sampling event-location or the credible observation of two or more Asian carp at one location would signify a Level 3 threshold. Crossing the Level 3 threshold would trigger an immediate Level 2 conventional gear response action and consideration of a rotenone response. Where feasible (e.g., non-navigation reaches, barge slips, backwater areas), block nets will be used in an attempt to keep Asian carp in the area being sampled. The final decision to terminate a response will rely on best professional judgment of participating biologists, managers, and agency administrators.

Sampling Schedule: Response actions will be dependent upon results of conventional gear monitoring and recommendations from the MRWG.

Deliverables: Results for each removal action will be reported daily during events and compiled in monthly sampling summaries. Data will be summarized for an annual interim report and project plans updated for annual revisions of the MRP.

Planned Intensive Surveillance in the CAWS

Participating Agencies: IDNR (lead); INHS, USFWS, and USACE (field support), USCG (waterway closures when needed), USGS (flow monitoring and dye tracking when needed), MWRD (waterway flow management and access), USEPA and GLFC (project support)

Location: Planned intensive surveillance will take place in the CAWS upstream of Lockport Lock and Power Station.

Introduction and Need: To date, intensive sampling during response actions triggered by detection of Asian carp DNA has resulted in no Asian carp being observed or captured. At present, the detection of eDNA evidence cannot discern the source of the eDNA or the characteristics of the fish, verify whether live Asian carp are present, the number of Asian carp in an area, or whether a viable population of Asian carp exists. As further calibration of the eDNA method is completed the MRWG has proposed suspending the use of eDNA as a trigger for responses, instead using this information to establish planned intensive surveillance at key locations where Asian carp eDNA has been found to accumulate. These efforts will have the benefit of advanced planning, greater sampling intensity over a shorter time period than fixed site and random sampling, and will be in locations where the repeated detection of eDNA in previous years indicates the potential presence of Asian carp in the waterway. All planned surveillance activities will be preceded by eDNA sampling events. This coordination of monitoring for Asian carp using eDNA and traditional fishery sampling techniques (electrofishing and netting) will enhance the eDNA Calibration Study (ECALS) which aims to reduce the uncertainty surrounding eDNA results. Information gained from such actions may also benefit monitoring protocols, research efforts, or Asian carp removal and control efforts.

Objectives: The plan objectives are:

1) Remove Asian carp from the CAWS upstream of Lockport Lock and Power Station when warranted; and
2) Determine Asian carp population abundance through intense targeted sampling efforts at locations deemed likely to hold fish.

Status: Planned intensive surveillance is a modified continuation of response actions.

Methods: A variety of gears will be used during planned intensive surveillance activities, including pulsed-DC electrofishing, trammel and gill nets, deep water gill nets, a commercial seine, trap nets, hoop nets and Great Lake pound nets to capture and remove any Asian carp present in areas where eDNA has been found to accumulate. Each planned intensive surveillance event will be unique to location:

North Shore Channel - Sampling will occur between the Argyle Street Bridge, located just downstream from the North Shore Channel and North Branch Chicago River confluence, and the Wilmette Pumping Station (Figure 1). Teams will begin at the upper and lowermost site boundaries and work toward the middle. Each team of two electrofishing boats and a net boat will work together to set nets across the channel and drive fish to nets with noise and electrofishing gear. Three nets will be set at 500- to 800-yard intervals apart, after which

electrofishing and noise to drive fish will occur between the nets. The net closest to the outer site boundary will then be pulled and reset 500 to 800 yards closer to the site center and the process repeated. To maximize sampling time, electrofishing will begin in the area between the remaining nets while the outer net is being moved. The idea is to leapfrog the nets after each electrofishing and fish driving episode so that each team gradually moves toward the site midpoint, where we will trap any possible rogue silver carp that keeps shedding DNA in the channel.

Chicago River and South Branch Chicago River/Bubbly Creek - Electrofishing will occur around the entire shoreline of the basin between Lake Shore Drive and Chicago Lock and near Wolf Point (confluence of the North Branch Chicago River and Chicago River) for 2-3 hours (Figure 1). During this time net boats will set deep water gill nets (IDNR will provide one 30-foot deep gill net for each net boat) in areas off of the main navigation channel. Nets will be set for short duration and attended at all times. Noise from "pounding" on the hull of boats and racing trimmed up motors will be used to drive fish into the nets. Electrofishing boats will also be used to drive fish into the nets. When sampling in these areas is complete crews will travel down river and sample eight barge slips and backwater areas in the South Branch Chicago River near Bubbly Creek (Figure 1). Barge slip sampling will have a net boat block off the entrance to the slip and electrofishing boats will shock from the back of the slip out driving fish into the net and collecting fish along the way. A second net may be set midway within longer slips to sample them more effectively.

Lake Calumet - Prior to sampling, INHS crews will set Great Lake pound nets at the entrance to Lake Calumet to prevent fish immigration/emigration (Figure 2). A commercial beach seine will be fished by a commercial crew once per day. Commercial seining will occur in the North section for two days, then in the South section for one day. Commercial gill/trammel net and trap/hoop net operations within Lake Calumet will be performed by two commercial crews on day 1, three commercial crews on day 2, and one commercial crew on the final day. One commercial crew will actively fish designated areas all three days with gill/trammel nets and trap/hoop nets in the South section. One fixed site commercial crew will fish scheduled fixed site locations in Lake Calumet on day 1 (10 sites x 200 yards each, plus 3 random sites in the Calumet Connecting Channel). Two fixed site commercial crews will fish designated areas in the North and South sections away from the commercial seine on day 2. Trammel nets will be set for short duration and will have fish driven into the nets with noise as described above. Nets will be well marked with buoys when left unattended, with IDNR law enforcement officers securing the area. Agency electrofishing crews will operate (one crew in each section) on day 1 and day 2 of the sample operation. Samples will be collected 15 minutes at a time, then enumerating catches of fish netted. Electrofishing may also be used in conjunction with commercial fishers to move fish into nets.

For all planned intensive surveillance events accurate time fishing (net soak/electrofishing time) will be recorded with all fish recorded to species. GPS coordinates will be taken at all net sets and at the beginning of electrofishing runs. Grass Carp will be kept and put on ice for transfer to SIU Dr. Greg Whitledge for ploidy analysis. Any Bighead or Silver Carp collected will immediately be reported to the Operations Coordinator and/or Law Enforcement who will bring a cooler to secure fish. GPS location, time, and specific gear (mesh size, type, depth) will be

recorded as accurately as possible. Any Asian carp will be transferred to Dr. John Epifanio, with tissues shared among research agencies as per the 2012 MRRP. Capture of a Bighead or Silver Carp would initiate a level 2 response upon conferring with MRRWG members, additional effort or time frame could change.

Sampling Schedule: Planned intensive surveillance is scheduled for June 25-28 at Lake Calumet and October 29-November 1 at North Shore Channel, Chicago River and South Branch Chicago River.

Deliverables: Results for planned intensive surveillance activities will be reported daily during events and compiled in monthly sampling summaries. Data will be summarized for an annual interim report and project plans updated for annual revisions of the MRP.

Figure 1. Sampling locations in the North Shore Channel, Chicago River and South Branch Chicago River/Bubbly Creek area.

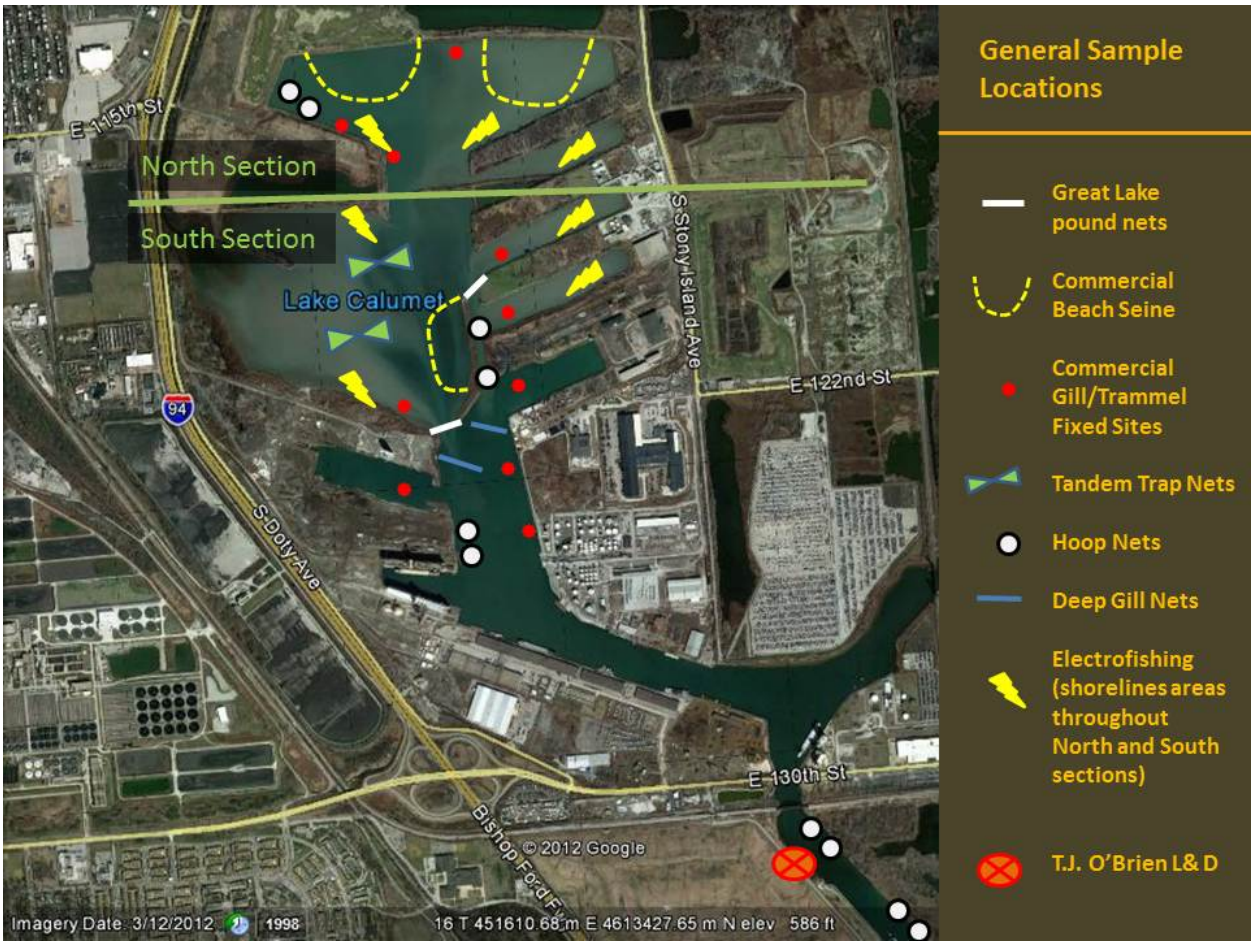


Figure 2. Sampling locations in Lake Calumet.

Barrier Maintenance Fish Suppression

Participating Agencies: IDNR (lead); SIUC, WIU, INHS, USFWS, USACE and USGS (field support); USCG, USEPA and MWRD (project support)

Location: Sampling to assess abundance of Asian carp may take place in the Lockport Pool of the CSSC between Lockport Lock and Power Station and the electric barrier system (RM 291.0-296.1). Fish clearing with surface to bottom gill nets, pulsed-DC electrofishing, and deep-water AC electrofishing and surveillance with split-beam hydroacoustics, side scan SONAR, and DIDSON will occur within the electric barrier system. The work area will be extended about 0.25 miles in both upstream and downstream directions if a backup rotenone action is necessary to allow for chemical application and detoxification stations.

Introduction and Need: The USACE operates three electric aquatic invasive species barriers (Demonstration Barrier, 2A and 2B) in the CSSC at approximate river mile 296.1 near Romeoville, Illinois. The Demonstration Barrier is located farthest upstream (about 800 feet above Barrier 2B) and is operated at a setting that has been shown to repel adult fish. Barrier 2A is located 220 feet downstream of Barrier 2B and both of these barriers now operate at parameters that have been shown to repel fish as small as 3.0 inches long in the laboratory (Holliman 2011). Barriers 2A and 2B must be shut down for maintenance approximately every 6 months and the IDNR has agreed to support maintenance operations by providing fish suppression at the barrier site. Fish suppression can vary widely in scope and may include application of piscicide (rotenone) to keep fish from moving upstream past the barriers when they are down. This was the scenario for a December 2009 rotenone operation completed in support of Barrier 2A maintenance and before Barrier 2B was constructed. With Barrier 2A and 2B now operational, fish suppression actions will be smaller in scope because one barrier can remain on while the other is taken down for maintenance.

Barrier 2B has been designated the primary barrier in the electrical barrier system and it is the primary barrier in operation. In contrast, Barrier 2A is typically held in warm standby mode until needed. With this barrier operation protocol, IDNR will lead fish surveillance and suppression at the electric barrier system whenever Barrier 2B is scheduled for maintenance or if Barrier 2B shuts down unexpectedly due to mechanical or electrical problems. Fish suppression is necessary because, based on 2 years of conventional fish sampling and eDNA monitoring in the CAWS upstream and downstream of the electric barrier system, there is a strong possibility that Asian carp could be present in this reach of the waterway, potentially even immediately below Barrier 2B. If this is the case, when Barrier 2B is powered down for maintenance or loses power, any Asian carp immediately below Barrier 2B could move upstream with only the original demonstration barrier between the fish and Lake Michigan. This creates an unacceptable level of risk that Asian carp could gain access to the upper CAWS and Lake Michigan, and reduces the redundancy that is considered an essential feature of the entire electric barrier system. The intent is to drive fish below Barrier 2A, which would then be brought online and would serve as the primary barrier until Barrier 2B maintenance activities are completed and it resumes normal operations.

Following is a generalized plan to provide fish suppression at the electric barrier system in support of Barrier 2B maintenance. Operations to clear fish may take from 1-5 days and will include physical fish netting, collecting and driving techniques and, if necessary, a small-scale rotenone action. We also include a plan for intensive fish sampling to detect presence and assess abundance of any Asian carp juveniles and adults that may be in the canal immediately downstream of the barrier.

Objectives: The IDNR will work with federal and local partners to:

1. Assess the need for fish suppression actions at the electric barrier system through surveillance with split-beam hydroacoustics, side scan SONAR, and DIDSON imaging SONAR;
2. Eliminate fish from the electric barrier system prior to maintenance operations or after an unintentional shutdown of Barrier 2B by blocking off the canal with a surface to bottom gill net and driving fish to the net or from the area with pulsed-DC and deep-water AC electrofishing gears, flow in the canal will be decreased for optimal netting conditions, or if needed, a small-scale rotenone action; and
3. Conduct intensive sampling to assess abundance of Asian carp juveniles and adults in the CSSC between the electric barrier system and Lockport Lock and Power Station, when standard monitoring detects their presence in the Lockport Pool downstream of the electric barrier system.

Status: Fish suppression in support of barrier maintenance began in 2009 and is on-going. Three multi-agency fish clearing action occurred in 2012. An estimated 420 person-hours were spent sampling in the electric barrier system during barrier maintenance events. The May 12 water gun clearing effort was considered unsuccessful due to sensing surveys that indicated only one fish >12 inches was cleared from the electric barrier system and seven fish >12 inches remained. As a result, the June barrier maintenance event was executed using surface pulsed-DC electrofishing, deep-water AC electrofishing and surface to bottom 30 ft gill nets. Pulsed-DC electrofishing and deep-water AC electrofishing were used to drive fish to the surface to bottom 30 ft gill net set across the canal. The November 14th operation included two electrofishing boats (one surface and one deep-water shocker) and a stationary surface-to-bottom gill net which caught five Common Carp >12 inches long. Lockport Pool sampling effort consisted of pulsed-DC electrofishing, trammel nets, experimental gill nets, surface to bottom 30 ft gill nets, mini-fyke nets, mid-water trawl, purse seine, tandem trap nets and hydroacoustics imaging. No adult or juvenile Bighead or Silver Carp were captured or observed during either event. For more detailed results of fish clearing and sampling relative to barrier maintenance see the 2012 interim summary report document (MRRWG 2013) and the Monitoring Asian Carp Population Metrics and Control Efforts plan.

Methods:

Project Overview – Our current approach to fish suppression at the electric barrier system is to first survey the area with remote sensing gears to assess the need for fish clearing operations either to support barrier maintenance or after an unplanned power loss at Barrier 2B. If fish of a certain size are present (currently >12 inches long although this could change with perceived risk of juvenile presence), then we will use a surface to bottom 30 ft gill net set across the canal in the designated safety zone area and pulsed-DC and deep-water AC electrofishing boats to drive fish

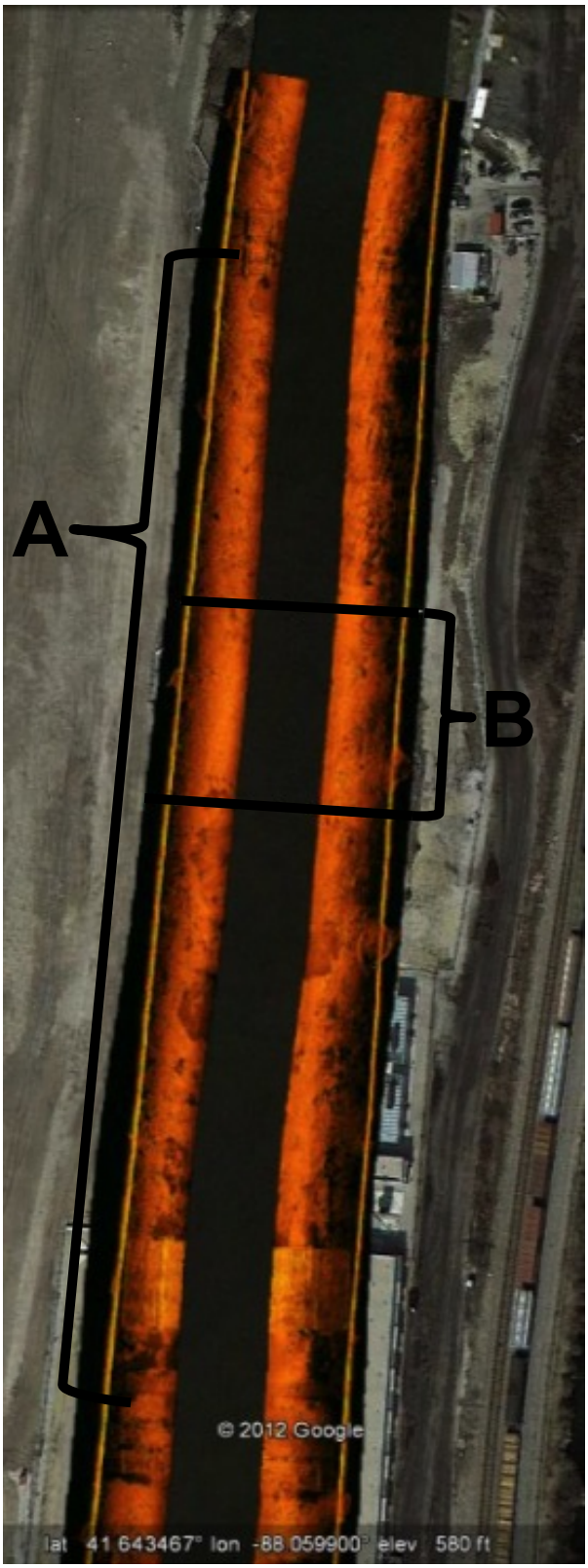
into the net or downstream out of the target area. A request for no flow conditions will be made to MWRDGC for a 2-hour period during netting operations. If mechanical clearing fails, we will invoke a small-scale rotenone to clear fish from the area. Finally, we include a plan for intensive sampling in the Lockport Pool downstream of the electric barrier system as a measure of the risk that Asian carp might pass the barrier during maintenance and a gauge of the level of fish suppression activities needed to eliminate the possibility of upstream fish passage.

Remote Sensing and Mechanical Clearing Operations- Surveys will be conducted with split beam hydroacoustics, side scan SONAR, and DIDSON imaging to determine if fish are present in the target area and to evaluate the success of physical fish clearing actions. Clearing will be considered successful when no fish larger than 300 mm (12 inches) are observed between the barriers, after which Barrier 2B can be taken down for maintenance. By selecting a cut-off of 300 mm, we will be targeting sub adult and adult Asian carp, and excluding young-of-year fish. Excluding young-of-year Asian carp from the assessment is appropriate because there is no indication of their presence in the Lockport Pool based on 2+ years of sampling and the known location of spawning adults (i.e., downstream of Starved Rock Lock and Dam; see 2011 interim report document for more detailed information). Additionally, eggs, larvae, or young-of-year have not been observed upstream of Starved Rock Lock and Dam in the past decade. Our approach may be considered conservative because sub adult and younger Asian carp have never been captured upstream of the Marseilles Pool.

Multiple surveys are necessary to enhance confidence in results that fish are either present or absent from the electric barrier system. The principal remote sensing tools are split-beam hydroacoustics and side scan SONAR. These gears are operated simultaneously and provide about 98% coverage of the waterway with just three passes of the barrier area (10- to 15-minute survey duration; see 2012 Barrier Maintenance Fish Suppression final report in MRRWG 2013). Portions of the water column not viewed with these gears (e.g., immediately below water surface and against canal walls and areas where the canal wall is broken and eroded away) will be surveyed with DIDSON imaging SONAR The DIDSON imaging also will be used to verify that images identified on other SONAR are actually fish and not stationary objects or interference. Total time required to complete a single set of surveys and process the data is about 60-75 minutes.

During a typical maintenance shutdown, we will first ask USACE to power up Barrier 2A so that both barriers are operating simultaneously and then conduct the first surveys with all three remote sensing gears. The detection of fish >12 inches long in the target area will initiate mechanical suppression actions. Mechanical suppression will include a surface to bottom 30 ft gill net set across the canal in the designated safety zone area and pulsed-DC and deep-water AC electrofishing boats to drive fish into the net or downstream out of the target area. Figure 1 provides a map and description of a mechanical fish clearing operation at the electric barrier system.

A second set of surveys will occur after mechanical removal operations have taken place with both barriers operational to assess the effectiveness of mechanical removal efforts. It is beneficial to have low flow conditions during remote sensing surveys to reduce interference to hydroacoustics scans caused by air bubbles entrained in the water column. Operators at MWRD



Barrier Outage Electrofishing and Netting Fish Clearing Methods Site Map

A Electrofishing Area

- **The electrofishing area is located from Barrier 1 to the Barrier 2B narrow array.**
- **Two electrofishing boats will be used: one deep water shocker (USFWS) and one standard shocker (USACE).**
- **Fish will be initially located with hydroacoustics and side-scan sonar (SIUC boat) and tracked with DIDSON imaging sonar (USFWS boat).**
- **Electrofishing boats will target located fish and response of fish will be observed with the DIDSON. Stunned fish will be captured with non-conductive long handled dip nets and removed.**

B Gill Netting Area

- **The gill netting area is located about 300 feet downstream from Barrier 1 and 300 feet upstream from the uppermost parasitic structure in a section of the canal with little debris as indicated by side-scan imagery (courtesy of Dave Glover at SIUC).**
- **A request for no flow conditions will be made to MWRDGC for a 2-hour period during netting operations.**
- **One 100-yard long x 30-foot deep tied-down gill net will be dead set from an IDNR net boat in the netting area and fish will be driven into the net with noise by pounding on boats and revving motors. The net will be pulled and captured fish will be removed. The net may be reset several times.**

Safety Procedures

- **Standard safety procedures for working in the barrier area will be followed.**
- **Two spotters will be located on the east and west bank of the canal, a safety boat with AED will be located below the Romeo Road Bridge, and work will occur during an existing USACE requested canal closure date and time.**

Figure 1. Map and descriptions of a fish clearing operation at the electric barrier system.

have been helpful in modifying flows to assist with fish clearing operations. A third set of surveys will take place before recommendations are given to shut down Barrier 2B. The presence of any large juveniles or adult fish (>12 inches long) between the barriers signifies that a rotenone action likely will be necessary to eliminate fish from the area. In contrast, a pre-planned rotenone action may be cancelled if mechanical suppression is shown to be successful.

Canal closures may not be necessary for remote sensing surveys when one barrier is operating (2A or 2B); however, they will be needed for mechanical fish suppression activities or whenever both barriers are operating simultaneously. Typically, IDNR will make a request to USCG for safety zone closures to navigation in the vicinity of the barriers for 5 hours each morning (7:00 a.m. to 12:00 p.m.) on 4-5 days during the week of barrier maintenance fish clearing. A contingency week should also be planned in case equipment failure or inclement weather precludes operations. All closure requests will be made 45 days prior to a planned event.

Small Scale Rotenone Action - Rotenone is considered the fallback method for fish suppression should other clearing efforts prove to be unsuccessful. If necessary, rotenone will be applied from boats at a location just upstream of the arched overhead pipe that designates the upstream boundary of the barrier Regulated Navigation Area (RNA) Safety Zone enforced by the USCG (Figure 2). This will create a rotenone slug that will travel downstream and mix throughout the water column driving fish from the target area between the barriers or killing them. The rotenone slug will be detoxified with liquid sodium permanganate pumped from boats at a location south of the Romeo Road Bridge. Unlike fish clearing methods discussed above, the effect of rotenone on fish is well known and has been documented often, precluding the need for on-site evaluation. Barrier 2B will be turned down for maintenance once stable operation of Barrier 2A has been confirmed.

Although rotenone is an effective technique for controlling fish populations, there are several reasons for attempting physical removal of fish prior to rotenone application. Even the proposed small-scale rotenone action will be costly (estimated 150-250K), require extensive labor and permitting (minimum 40-50 persons; NEPA, NPDES, IDNR CERP, and Special Local Needs labeling), and require a longer duration canal closure than physical fish clearing (estimated 8-10 hours vs. 0-5 hours). In addition, barrier maintenance must occur regularly at approximately 6 month intervals. Developing methods that are less expensive and disruptive to canal users is beneficial to all involved stakeholders. In contrast to rotenone, physical clearing methods will not pollute waters or kill many fish. Fish killed with rotenone must be collected and disposed of in an EPA approved toxic waste landfill. Perceptions that rotenone actions “poison” the water have been expressed by potential purchasers of commercially harvested Asian carp from down river locations. These perceptions may adversely affect the success of Asian carp commercial market development projects. Furthermore, while rotenone is used and neutralized successfully in most cases, there is the possibility that mechanical or environmental factors could allow rotenone to travel outside of the treatment area where additional aquatic resources could be unintentionally harmed. And finally, the USACE telemetry program to assess effectiveness of the barriers will be adversely impacted should tagged fish in the vicinity of the barriers be eradicated by rotenone.

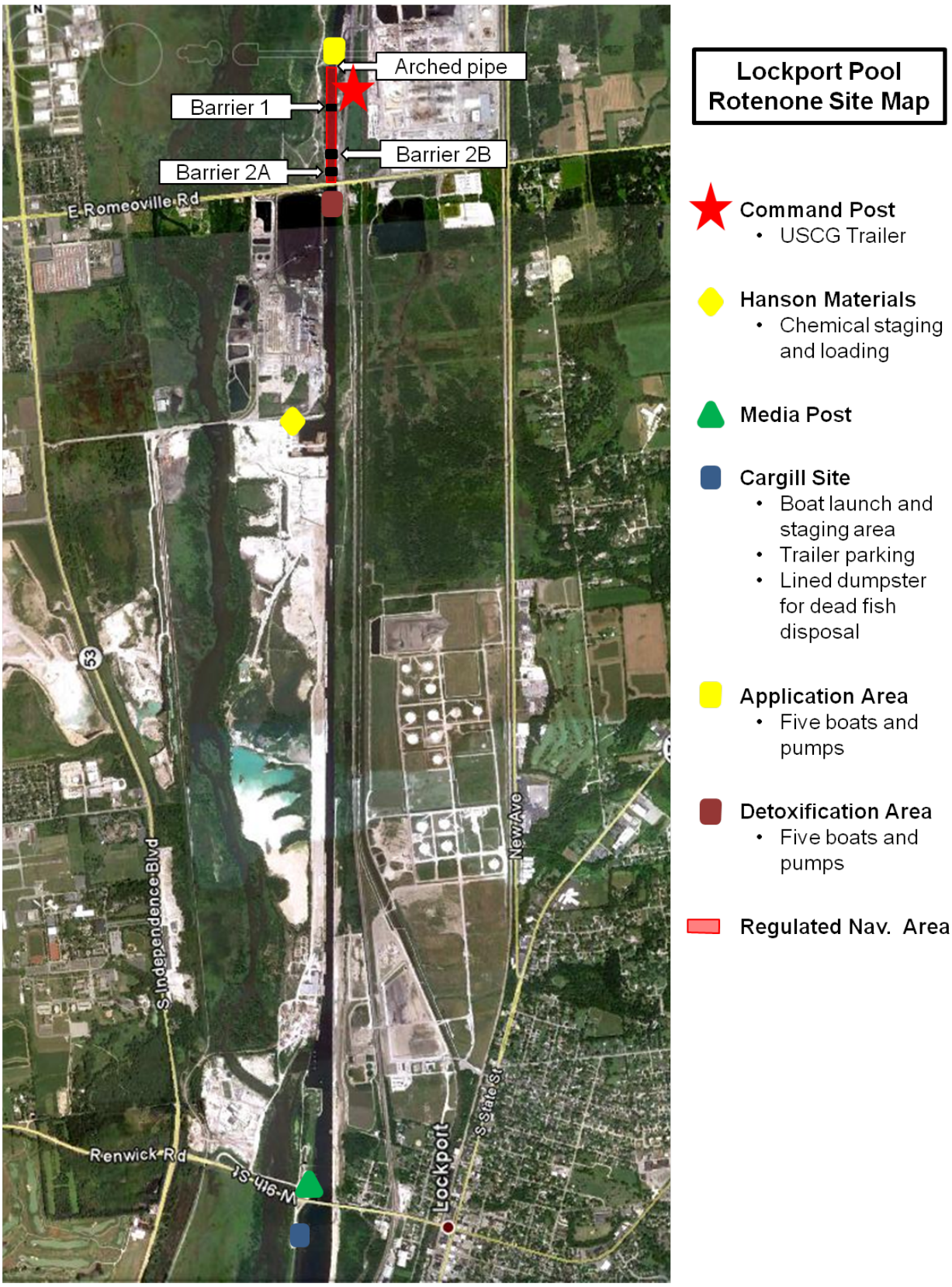


Figure 2. A map of a small-scale rotenone operation to clear from the electric barrier system.

A small-scale rotenone action will take place if remote sensing surveys indicate fish >12 inches long may be present in the electric barrier system and mechanical suppression measures fail to collect or drive fish from the area. All operations will occur between Hanson Material Service's large barge slip (~RM 295.2) and a point about 0.25 miles upstream of the arched pipeline (up to RM 297). No work is planned in the designated RNA, although it will be necessary for some boats to pass through the RNA to get to upstream chemical application stations (see Safety and Communication section below for RNA restrictions). IDNR will stand up an Incident Commend Structure (ICS) for a rotenone action and will work closely with USCG and USACE (possibly in Unified Command) during all phases of project planning and implementation to ensure a safe and successful event. Detailed plans for a rotenone action will be prepared by IC staff, but a general overview of possible operations is presented here. In all, we anticipate a 3-4 day operation with 12-15 boats, 45-50 field crew, and 15-20 IC staff and support crew. This estimate does not include security and safety zone enforcement boats and crews. Day 1 will include travel to the site, gear preparation, and the collection of sentinel fish for detoxification monitoring.

The bulk of the work will occur on the second day of operations and a 10-hour daytime canal closure will be necessary on this day. During Day 2, we will apply approximately 125 gallons of rotenone from boats ($N = 5$) located at a station upstream of the RNA. The chemical will be allowed to mix and flow downstream over the barriers killing fish or forcing them out of the area. Dye will be used to track the leading and trailing boundaries of the rotenone slug. Reactivation of Barrier 2A must be synchronized with the passing of the tail end of the rotenone slug through the barrier area to prevent movement of fish back into the treatment zone. Detoxification with approximately 750 gallons of sodium permanganate applied from boats (N = 3-4) will take place downstream of the barrier RNA. The exact location of the detoxification station will be based on consultations with personnel from the Midwest Generation power plant and their level of concern over permanganate entrainment through the plant cooling system. Cages with sentinel fish will be placed at several downstream locations in the Lockport Pool to ensure that detoxification was successful. Although a large kill is not anticipated, we will have 2-3 recovery boats and crews and one dumpster on hand for the collection and disposal of dead fish. Fish recovery will continue on the third and fourth day of the event, as needed.

Lockport Pool Sampling - Fish sampling may take place in the CSSC from Lockport Lock and Power Station to the downstream boundary of the barrier RNA (Figure 10) when deemed necessary by the MRRWG. Sampling has been shown to be effective without waterway closures, but closures can be requested if sampling is to take place in the main navigation channel for extended periods of time. An example of sampling gears and anticipated effort from a fall 2010 multi-gear operation is included in the following table and text. All captured fish will be identified to species, counted, and a subsample of 20 fish per species per gear will be measured (mm total length). Except for Asian carp, all captured fish will be returned live to the waterway. Any captured Asian carp will be held and immediately reported to the operations coordinator.

Methods	Boat/crew	Number of sets, runs, or samples	Duration
eDNA sampling	1 boat; 3 crew	120 samples total; 60 upstream and 60 downstream of barrier	5-6 hours collection time
Pulsed-DC electrofishing	2 boats; 6 crew**	6 hours total; 12 runs @ 30 min. per run	2 partial days; three 30-min. runs/boat/day
Commercial fishers - trammel/gill nets @ 8' x 600'; 3-5 in. mesh	2 boats; 4 crew, and 2 IDNR observers	1,000 yards of net set and run/boat/day	2 nights; 13-14 hour set
Experimental gill nets 6 @ 6' x 300'; 0.75-5.0 in. mesh 3 @ 10' x 150'; 0.75-2.0 in. mesh	1 boat, 3 crew*	6 nets set overnight in off channel areas	1-2 nights; 13-14 hour set
Mini fyke nets (10)	1 IDNR boat, 3 crew**	10 nets set overnight	2 partial days; 13-14 hour set
Telemetry	2 boats, 4 crew	NA	1-2 days

*Same boat doing different sampling.

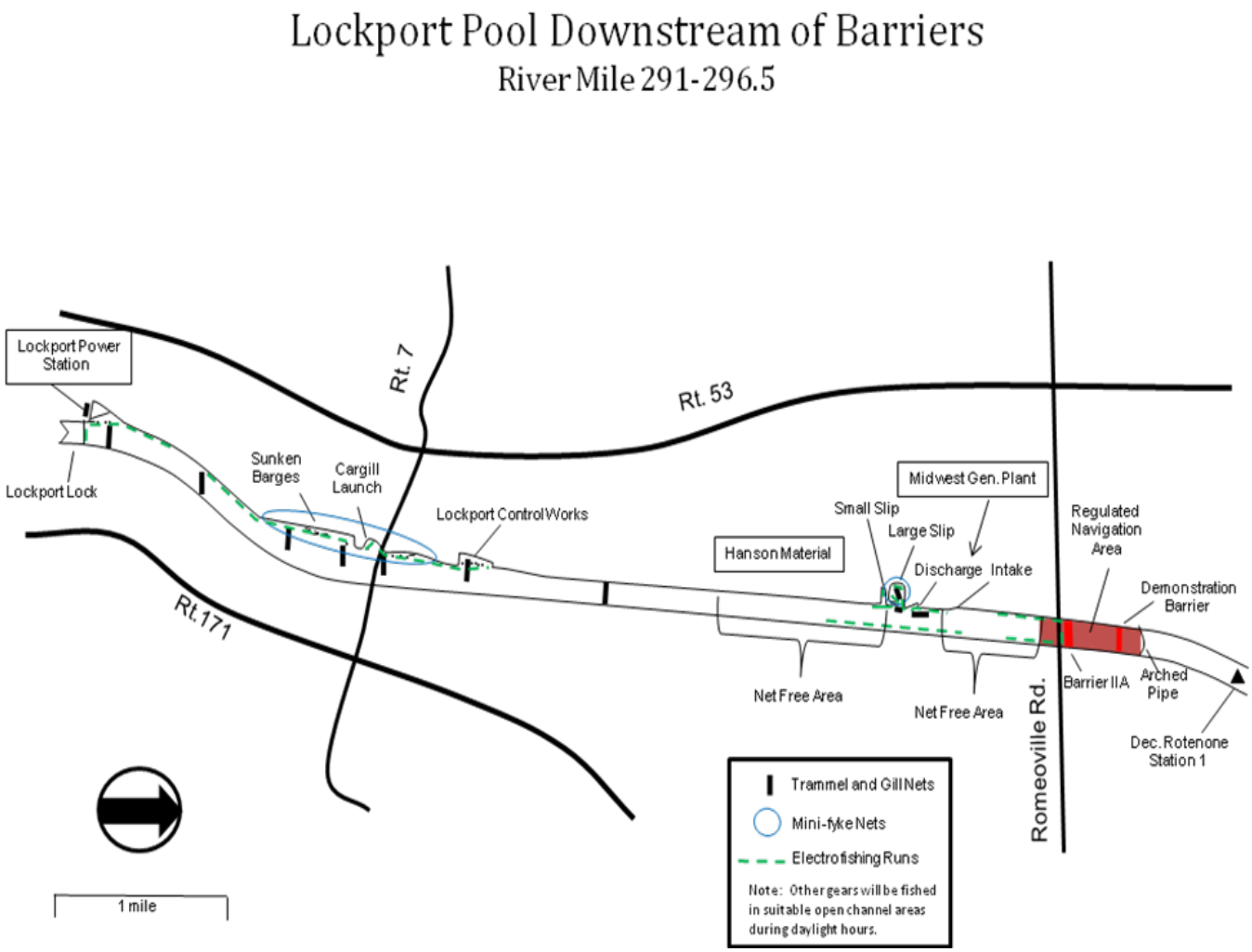


Figure 10. Lockport Pool downstream of the electric barrier system showing target areas for fish sampling operations.

Sampling will require eight open deck aluminum boats that range in size from 18-24 feet long. The staging, boat launch, and overnight boat storage area will be located at the Cargill Launch site on the west bank of the canal just south of the Route 7 (9th Avenue) Bridge (a.k.a. Carp Camp 1). Mini-fyke nets and experimental gill nets will be fished in shallower near shore areas away from the navigation channel and in a portion of Hanson Material Services large slip during day and night hours. Daytime trammel net sets will be of short duration (15-20 minutes) and will have fish driven into the nets by "pounding," a method commonly used by commercial netters. Short term sets will always be attended by a net boat and crew and target areas throughout the reach known to hold concentrations of fish. Trammel nets may be set overnight in backwater and off channel areas to increase chances of catching fish.

Safety and Communication - Safety is a primary objective when operating in the electric field created by the barrier. Boats will be equipped with required safety equipment and floatation devices. Operators and crews will wear personal flotation devices while working on the water. For fish sampling operations, no work is scheduled to take place in or upstream of the electric barrier system RNA. However, all requirements of the RNA will be adhered to should a crossing be necessary. The RNA extends from the arched pipe downstream to a point 450 feet below the Romeo Road Bridge (designated by Sampson post #2 on the west bank).

First, any vessel crossing the electric barrier system or entering the RNA will provide advance notification to the Coast Guard Captain of the Port Representative on scene at (630) 336-0296 or VHF-16. Additional RNA requirements include:

a. The vessel cannot be less in than 20 feet in length.

b. The vessel must proceed directly through the RNA, and may not conduct any fishing operations, loiter, or moor within the RNA boundaries. Special permits will be requested for remote sensing surveys and mechanical fish suppression operations planned to take place within the RNA (see below).

c. All personnel must remain inside the cabin, or as far inboard as practicable. If personnel must be on open decks, they must wear a Coast Guard approved Type I personal floatation device.

The CSSC is a working ship canal and sampling crews should be aware of potential hazards in the waterway. Note that no boats should operate near barges that are being loaded. In addition to the hazard of being hit by material that misses the target, there are cables that move barges along the wall during loading. These cables may be under the water surface when slack, but can rapidly rise 4-5 feet above the water when tightened. A rising cable could cause severe bodily injury or catch and easily flip a sampling boat. Crews should be aware of their surroundings and avoid potential safety hazards while sampling.

Communication among boats, staff, security, and shore command will be by marine radio or cell phone. A briefing before any crew enters the water will be held and will include a handout of crew leaders and cell phone numbers for each participating boat/crew. This handout will include a map of the sample reach. All boats will be equipped with numbered flags for identification on the water and hand-held marine radios operating on Channel 12 for the operation, unless

emergency communication with USCG or Lockmaster is necessary (Channel 16, 14). Emergency contact numbers (local ambulance, fire/rescue service, Lockmaster, USGC contact information, and MWRD) will be included on the handout if needed for unforeseen reasons, yet the primary communicator to these services will be the operations coordinator or Incident Commander.

Sampling Schedule: Barrier maintenance may be required every six months to a year. The USACE determines the need for barrier maintenance and when maintenance will occur. The IDNR has requested that USACE provide a notice of maintenance dates 60 days in advance to allow time for planning and preparation. The USCG requires that Safety Zone applications be submitted 45 days prior to requested canal closure dates. By law, mariners must be informed about any non-emergency canal closures 30 days before the closure is to occur. Canal closures are required for the safety of mariners and operation crews and whenever both Barrier 2A and 2B are operating simultaneously.

Deliverables: Results of fish sampling events will be compiled in monthly sampling summaries. Fish suppression updates will be provided daily during operations. Data will be summarized for an annual interim report and project plans updated for annual revisions of the MRP.

Barrier Defense Asian Carp Removal Project

Participating Agencies: IDNR (lead)

Location: The Barrier Defense Project will target the area between the Starved Rock Lock and Dam up to the electric barrier system at Romeoville. The primary focus area will include Starved Rock, Marseilles and Dresden Island pools, though effort will be expended in Brandon Road, Lockport pools, occasionally.

Introduction and Need: This project uses contracted commercial fishing to reduce the numbers of Asian carp in the upper Illinois and lower Des Plaines rivers downstream of the electric barrier system. By decreasing Asian carp numbers, we anticipate decreased migration pressure towards the electric barrier system and reduced chances of carp gaining access to upstream waters in the CAWS and Lake Michigan. Trends in harvest data over time may also contribute to our understanding of Asian carp population abundance and movement between pools of the Illinois Waterway. The project was initiated in 2010 and has continued through 2012 using ten contracted commercial fishing crews to remove Asian carp with large mesh (3.0 - 4.0 inch) trammel nets, gill nets and other gears on occasion (e.g., seines and hoop nets).

Objectives: Ten commercial fishers will be employed to:

1) Harvest as many Asian carp as possible in the area between the Starved Rock Lock and Dam and the electric barrier system. Harvested fish will be picked up and utilized by private industry for purposes other than human consumption; and
2) Gather information on Asian carp population abundance and movement in the Illinois Waterway downstream of the electric barrier system as a supplement to fixed site monitoring.

Status: Contracted commercial fishers and assisting IDNR biologists deployed 643.3 miles of net in the upper Illinois Waterway since 2010. A total of 44,658 Bighead Carp, 47,474 Silver Carp, and 496 Grass Carp were removed by contracted netting. The total weight of Asian carp removed was 698.7 tons (62.4 tons in 2010, 351.8 tons in 2011 and 284.5 tons in 2012). For more detailed results see the 2012 interim summary report document (MRRWG 2013).

Methods: Contracted commercial fishing will take place from March through December 2013. Contracted commercial fishing will occur in the target area of Dresden Island, Marseilles, and Starved Rock pools. This target area is closed to commercial fishing by Illinois Administrative Rule; therefore an IDNR biologist will be required to accompany commercial fishing crews working in this portion of the river. Five commercial fishing crews per week with assisting IDNR biologists will fish Tuesday through Friday of each week, 1-2 weeks each month of the field season. Due to fishing pressure driving fish out of areas and greatly reducing catches, harvest events will be scheduled at every-other week intervals to allow fish to repopulate preferred habitats in between events. Fishing will occur in backwater areas known to hold Asian carp, main channel, and side channel habitats. Specific netting locations will be at the discretion of the commercial fishing crew with input from the IDNR biologist assigned to each boat. Large mesh (3.0 – 4.0) trammel and gill net will be used and typically set 20-30 minutes with fish being driven to the nets with noise (e.g., pounding on boat hulls, hitting the water surface with

plungers, running with motors tipped up). Nets will be occasionally set overnight off the main channel, in non-public backwaters with no boat traffic. Biologists will enumerate and record the catch of Asian carp and identify the by-catch to species. Asian carp and Common Carp will be checked for ultrasonic tags and ultrasonic tagged fish and by-catch will be returned live to the water. All harvested Asian carp will be removed and transferred to a refrigerated truck and taken to a processing plant where they will be used for non-consumptive purposes (e.g., converted to liquid fertilizer). Each harvest event a representative sample of up to 30 of each Asian carp species (Bighead, Silver, and Grass Carp) from each pool will be measured in total length and weighed in grams to provide estimates of total weight harvested.

Suggested Boat Launches for Barrier Defense Harvesting:
Lockport Pool – Cargill Launch – Inform Martin Castro of MWRD.

Brandon Road Pool –Ruby Street Launch in Joliet on the west side of the river.

Dresden Island Pool – Big Basin Marina under the I-55 Bridge on north side of the river. Contact Russ to get let in without paying. Take the receipt to marina office to get reimbursed.

Marseilles Pool – Stratton State Park Launch in Morris on the north side of the river.

Starved Rock Pool – Allen Park Launch in Ottawa off Route 71 on the south side of the river or Starved Rock Marina off of Dee Bennett Road on the north side of the river.

Sampling Schedule: A tentative sampling schedule for 2013 is shown in the table below.

Week of	Agency	Week of	Agency	Week of	Agency
Mar 11	IDNR	Jun 3	IDNR	Oct 21	IDNR
Mar 25	IDNR	Jun 17	IDNR	Nov 4	IDNR
Apr 8	IDNR	Jul 8	IDNR	Nov 18	IDNR
Apr 22	IDNR	Aug 5	IDNR	Dec 2*	IDNR
May 6	IDNR	Sep 9	IDNR		
May 20	IDNR	Oct 7	IDNR		

* Weather permitting.

Deliverables: Results of each sampling event will be reported in monthly sampling summaries. Data will be summarized for an annual interim report and project plans updated for annual revisions of the MRP.

Monitoring Asian Carp Population Metrics and Control Efforts: Preventing Upstream Movement in the Illinois River

Participating Agencies: SIUC (lead); INHS, IDNR, USACE, USFWS, and WIU (field support and coordination)

Location: Estimates of Asian carp abundance, biomass, size structure, demographics (e.g., growth and mortality), natal origin, and rates of hybridization will take place in the Alton, La Grange, Peoria, Starved Rock, Marseilles, and Dresden Island Pools of the Illinois and Des Plaines Rivers. Although estimation of these Asian carp population metrics are not currently scheduled to occur north of the Dresden Island Pool, we will incorporate upstream areas barring the discovery of Asian carp populations as indicated by workgroup sampling and monitoring. Immigration and movement will be monitored by SIUC in the Alton, La Grange, Peoria, Starved Rock, and Marseilles Pools of the Illinois River; coordination with the USACE, USFWS, and INHS will allow for assessment of upstream movement in the Dresden, Lockport, and Brandon Road Pools of the Illinois and Des Plaines Rivers via an extensive VR2/VR4 stationary receiver network. In support of barrier maintenance operations, evaluation of fish suppression methods with remote sensing technology will take place in the CSSC.

Introduction and Need: Bighead Carp and Silver Carp (hereafter, Asian carp) invaded the Illinois River waterway over a decade ago. Populations of these fishes have grown dense in the lower and middle Illinois River and both species are approaching the Chicago Area Waterway System (CAWS) and the electric barrier system. Control efforts of Asian carp are underway in the Illinois River (> 350 tons removed in 2011 alone). Removal should affect density, size, biomass, age structure, and movement of Asian carp throughout the river. As such, a consistent estimate of Asian carp abundance, biomass, size structure, species composition, demographics (e.g., growth and mortality), and propensity for upstream movement needs to be determined past the edge of the invasion wave (e.g., in CAWS and Brandon Road Reach) reaching down to the purported "source" of Asian carp near the confluence of the Mississippi River to evaluate the success of ongoing removal efforts.

Abundance, biomass, size structure, demographics, and hybridization
During 2010-2011, SIUC and its partners successfully completed a survey of Asian carp abundance, biomass, size structure, and demographics (e.g., growth and mortality) in the Illinois River below Starved Rock Lock and Dam to the confluence with the Mississippi River as well as in a portion of Marseilles Reach (i.e., the east pit of the Hanson Material Service Corporation). The results indicated that Asian carp dominated fish biomass in the three lower reaches, yet abundance and biomass estimates were conservative given the sampling limitations of using down-looking hydroacoustic surveys. Therefore, in 2011-2012 we refined the methodology established in 2010-2011 by incorporating side-looking split-beam hydroacoustics to sample near-surface Asian carp in both main channel and backwater habitats. Analyses of these data is ongoing, but will provide a more accurate depiction of Asian carp standing stock and allow us to determine correction factors for the 2010-2011 estimates. These estimates along with typical demographic information of Asian carp (e.g., growth, mortality, condition, size structure) will assist in evaluating how these populations are responding to removal efforts.

During last-year's effort Asian carp were identified as Bighead or Silver Carp, although some of the fish were likely intermediates (hybrids). Hybridization may influence the movement, spawning, and feeding ecology of fish, with implications for invasibility in the CAWS and the Great Lakes. As such, the rate of hybridization baseline information regarding population demographics needs to be determined along the entire Illinois River.

Immigration and movement

Immigration and upstream movement of Asian carp was quantified with telemetry in 2010-2011, which indicated that 30% of Asian carp immigrated into the Illinois River from the Mississippi River and subsequently made long distance trips up the Illinois River, but did not extend past Starved Rock Lock and Dam. Additional Asian carp were implanted with acoustic transmitters and tracked in 2012, and early analyses suggest no movement of fish from the lower Illinois River have moved past the Starved Rock pool. Immigration and upstream movement corresponded with elevated flow in the river during spring through summer. However, Asian carp (from 2010-2011) that moved upstream returned to downstream locations as water levels dropped in late summer. Examining how immigration and movement rates of Asian carp change in relation to seasonal and annual changes in river flow as well as determining how changes in Asian carp density affect these rates are important considerations for forecasting population responses to removal efforts and predicting how this will affect the probability of movement toward or away from the CAWS. Lastly, determining how Asian carp interact with the locks and dams of the Illinois River is an important consideration for parameterizing spatially explicit models, as the type of dam (e.g., wicket dams on the lower Illinois River compared to the gated lock and dams at Brandon Road) may affect the probability for successful passage.

Survival and use of backwater habitat

During spring 2012, SIUC initiated a mark-recapture study within the HMSC east and west pits to estimate population size, movement patterns, and exploitation rates for Asian carp. Tag reporting by contracted fishermen is thought to be high, but tag retention (of both acoustic transmitters and jaw tags) in these fish is currently unknown. In addition, initial data analyses indicate that Asian carp continue to move into and out of this backwater area on a regular basis, but to what extent is unknown. We also assumed that tag loss was negligible for these analyses and could therefore have affected these results. Given that estimates of emigration appeared to be exceptionally high due to the declining proportions of marked individuals harvested, determining tag loss is needed. We recommend the use of an additional mark, either using a PIT tag, Carlin Dangler tags, or a non-invasive fin clip to keep mortality at a minimum. To further refine the population and survival estimates from 2012, and to determine tag retention in these fish, additional Asian carp will be need to be tagged in the HMSC pits and other backwater habitat in 2013.

Natal origin

Asian carp are known to be reproducing in the Illinois, middle Mississippi, and lower Missouri rivers. During 2010-2011 and 2011-2012 sampling, we have generated initial estimates of the extent to which the Asian carp stocks in the Illinois River are derived from recruits from within the Illinois River vs. immigrants from the Mississippi and Missouri Rivers. We have also estimated the contribution of floodplain lake habitats to Asian carp recruitment in the Illinois River. Continued monitoring of the relative importance of different environments as recruitment

sources that support Asian carp stocks in the Illinois River will provide valuable information regarding: 1) whether removal in the upper Illinois River and enhanced commercial harvest of Asian carps in the lower Illinois River are effectively reducing recruitment of these species within the upper Illinois River (as indicated by a decrease in the relative abundance of Illinois River-origin fish near CAWS), 2) the degree to which Asian carp stocks in the Illinois River may be replenished by immigrants from other rivers (immigration rates are an important component of population models) and the potential need to expand the geographic scope of enhanced commercial harvest efforts (e.g., are CAWS fish being replenished by Asian carp produced in the lower Illinois River or the Mississippi River?) and 3) to direct commercial fishing and other control efforts to target locations that are supporting Asian carp populations that threaten the CAWS.

Efficacy of contracted removal efforts
SIUC estimated total fish abundance via hydroacoustics and Asian carp abundance via mark-recapture methods in the east pit of the Hanson Material Services Corporation, near Morris, IL to assess the efficacy of contracted removal efforts in this area. The results indicated that changes in harvest catch rates may be partly due to seasonal trends in movement in and out of this area. Therefore, there is a need to quantify both changes in abundance as it relates to not only harvest, but also immigration and emigration rates to determine the efficacy of these removal efforts. A better understanding of where emigrating Asian carp move to is also important for determining whether these "holding areas" actually represent "stepping stones" that Asian carp use for creeping further upstream toward the CAWS.

Electric barrier system maintenance remote sensing surveys
Given the increased potential threat of inter-basin transfer of ANS during maintenance of the electric barrier system, the Illinois Department of Natural Resources (IDNR) supports maintenance operations by providing fish suppression at the electric barrier system site. Fish suppression can vary widely in scope and may include application of piscicide (rotenone) to keep fish from moving upstream past the electric barrier system when they are down. However, the efficacy of these fish suppression efforts needs to be evaluated. In October 2011, SIUC crews showed that remote sensing technology (i.e., side-looking split-beam hydroacoustic and side-scan SONAR) is an effective evaluation method for scanning the barrier channel for the presence of fish. As such, there is a need to continue evaluations of fish suppression efforts using remote sensing technology in support of barrier maintenance operations to reduce the potential of Asian carp gaining access through the CSSC.

Objectives:

1) Determine the efficacy of Asian carp removal efforts in the upper river at the detectable population front near the CAWS (i.e., Starved Rock, Marseilles, and Dresden Island Pools);
2) Determine whether complementary removal efforts in the remainder of the river (i.e., Alton, La Grange, and Peoria Pools) are having an impact on population densities and reducing the number of fish moving toward CAWS;

3) Examine whether removal efforts are linked to changes in Asian carp population structure and their propensity to move toward the CAWS to determine whether there are benchmark control pressures (e.g., harvest) that managers might set to quantify success;
4) Determine whether removal efforts encourage downstream movement toward the Mississippi River away from CAWS;
5) Determine whether Asian carp movement is related to lock and dam structures, leading to a partially isolated population in the upper Illinois River;
6) Determine the relative density of Asian carp in the Dresden Island Pool down to the confluence with the Mississippi River along the main channel of the Illinois Waterway and shallow, off-channel areas;
7) Determine how hybridization rates between Silver Carp and Bighead Carp change with removal efforts and affect population dynamics;
8) Evaluate the efficacy of fish suppression efforts during barrier maintenance.

Status: This was a new MRRP project in 2012, although similar efforts have been ongoing in the lower Illinois River as part of a separate ACRCC Framework research project (ACRCC 2012, Garvey et al. 2011).

In preparation for the April 2012 electric barrier system maintenance, we conducted two remote sensing surveys between the high field array of Barrier 2A and the Demonstration Barrier on 21 March 2012. No fish ≥ 30 cm TL were detected within this area. As of January 2013, down-looking and side-looking hydroacoustic transects were completed in the river, comprising 2,306 miles of data collection. Analysis is ongoing. Habitat covered included 82.6% main channel, 5.2% backwater lakes, 5.1 % contiguous lakes, 4.9% side channels, 1.5% tributaries, and 0.4% harbors. Side-scan SONAR plus split-beam hydroacoustics was effective for evaluating the presence of fish > 12 inches in length in the electrical barrier system. This monitoring system was deployed nine times in 2012.

In Marseilles Pool, 279 Bighead Carp and 34 Silver Carp were tagged externally for a mark-recapture study. Forty-nine percent of these fish were recaptured in 2012. Retrieval of tagged Asian carp showed us that contracted harvest caused 79% mortality in the quarry adjacent to Marseilles Pool. Frequency of the decline of tagged fish relative to untagged fish showed that immigration into the quarry offset removal of harvested fish during summer.

We have also deployed 30 Vemco VR2W stationary receivers and HOBO temperature loggers along the Illinois River from the confluence with the Mississippi River to Dresden Lock and Dam, including three VR2 receivers within Hansen's Material Service Corporation near Morris, IL. In December 2012, we deployed additional VR2W receivers in each of the lock chambers from La Grange to Dresden in addition to receivers in Sheehan Island backwater and in the Fox River. As of January 2013, 372 Asian carp were implanted with acoustic transmitters. Of the Asian carp tagged, we have relocated 150.

Samples of fish putatively identified as "pure" Silver Carp, "pure" Bighead Carp, and hybrids were sent to Western Illinois University for genetic analysis. Of the 394 fish tested, 49.24% were hybrids (50.76% "pure").

Methods:

Abundance, biomass, size structure, demographics, and hybridization

During both years, we will use methods developed in 2010-2011 to quantify Asian carp density and biomass throughout the entire Illinois River system. To quantify targets in the main river, we will use the same echosounding technique used to quantify main-channel densities within the Alton, La Grange, and Peoria Pools. This involved running eight down-looking parallel transects through the entire channel with a 200 kHz Biosonics DTX system. Coverage was limited to water > 1.5 m, potentially missing fish in shallow-water areas as well as channel borders, side channels, backwater lakes, and tributaries.

Using distributions of fish quantified in our comprehensive survey in 2010-2011, during summer 2012 and summer 2013, we will randomly stratify sampling across main channel habitats at 30-kilometer intervals throughout the river starting in the Peoria Pool down to the confluence of the Mississippi River; the smaller Starved Rock, Marseilles, and Dresden Pools will be sampled in their entirety. We also will sample the main channel, shallow water tributaries, side channels, and connected backwater lakes using side-looking hydroacoustics (70-kHz BioSonics DTX). This system has rotators that will allow us to precisely quantify the angle of the beam and assess target density and volume of water sampled. These data combined with down-looking, split-beam hydroacoustics will give us a complete, comprehensive estimate of density and size distribution to evaluate the efficacy of removal efforts in the entire river. At each sampling site, no less than eight transects will be conducted to ensure complete coverage of the area. To determine the relative species composition and size distribution of Asian carp and other species at the sampling sites, standardized electrofishing and trammel netting will be conducted at each site in collaboration with the IDNR/USACE removal effort. These data will be combined with multi-gear data being deployed and tested in the upper Illinois River (D. Wahl unpublished) as well as ongoing long-term monitoring programs being conducted by the INHS (i.e., LTRMP and LTEF).

A subsample (at least N=150 per species if possible) of Asian carp from each reach of the Illinois River will be returned to SIUC and used for estimation of sex ratio, gonadal condition, body condition (lipid content), and age (with sectioned post-cleithra). A subset of ages will be compared to sectioned vertebrae for older fish. A subset of Asian carp will also be vouchered and tissue samples sent to Western Illinois University where genetic tests will be used to determine the rate of hybridization. The project involves identification, quantification, and maternal contribution of parental Bighead Carp, Silver Carp, and their hybrids through DNA extraction, genotyping, and data processing. We will be using a 60 SNP nuclear DNA assay for parental and hybrid assignment and one mitochondrial SNP to determine maternal contribution to the hybrids. All genotypes will be assigned by posterior probabilities computed by NewHybrids hybrid assignment algorithm. Resulting products will be genetic identities, allele frequencies, and maternal contribution of 400 Asian carp per year, for two years, from the Illinois River covering the CAWS down to the confluence with the Mississippi River. These fish will be obtained from many ongoing efforts in the river (e.g., contracted removal upstream and commercial harvest downstream as well as our own sampling).

Immigration and movement
During spring of 2012 we will implant Silver Carp and Bighead Carp with Vemco acoustic transmitters in Pool 26 of the Mississippi River and in Lower Starved Rock Reach/Upper Peoria Pool of the Illinois River. In both locations, we will tag 105 adult Silver Carp and 70 Bighead Carp (total of 175 fish in the north and 175 in the south reaches; tag life about 2 years). An additional 50 fish will be tagged in the upper river reaches extending to Dresden Lock and Dam. In 2013, 300 acoustic transmitters will be implanted in Bighead and Silver Carp spread throughout the river reaches. Fifty fish will be tagged in Pool 26 of the Mississippi River, 50 in the Alton reach, 50 in the La Grange Reach, 50 in the Peoria reach, 50 in the Starved Rock Reach, 70 in the Marseilles reach (30 in the HMSC pits and 40 in the main channel), and 50 (if possible) in the Dresden Reach.

Movement of these fish along with those surviving fish tagged in 2010 will be quantified during each year with stationary VR2W receivers emplaced at roughly 20-km intervals throughout the river reaching up past Dresden Lock and Dam (in collaboration with US Army Corps efforts). VR2W receivers have also been placed in all lock chambers from LaGrange to Dresden. Four VR2Ws have been placed above and below the dams to evaluate the frequency of passage, based on our experience in the Upper Mississippi River. Whole-channel discharge will continue to be quantified twice each month at three fixed locations (Starved Rock Reach, Alton Reach, and Pool 26 of the Mississippi River below the confluence) using an acoustic current Doppler profiler (ADCP). This will allow us to determine how flow conditions in the two rivers influence movement of the fish through the river. These data will be compared to gage data collected by the Army Corps of Engineers and USGS at Hardin, IL, Pool 26, and Starved Rock L&D. Temperatures also will be logged with stationary loggers at 10 locations throughout the river.

Survival and use of backwater
During the spring of 2013, an additional mark-recapture study will be conducted in one backwater area in the Starved Rock reach and one backwater area of the Marseilles reach. Five hundred fish will be jaw-tagged in the east pit of the HMSC backwater area (Marseilles), and 500 fish will be tagged in the Sheehan Island backwater area (Starved Rock Reach). All fish will be tagged with $5 reward jaw-tags to encourage reporting of tag collections. Data will be analyzed using mark-recapture models in program MARK to further refine survival and population estimates of Asian carp in each reach.

Natal origin
Bighead and Silver Carp will be collected from each of four reaches of the Illinois River (Alton, LaGrange, Peoria, and upper river). Both lapilli otoliths will be extracted from each fish; one otolith per fish will be sectioned and analyzed for strontium:calcium ratio (Sr:Ca) using laser ablation-ICPMS and the second otolith will be analyzed for stable oxygen and carbon isotope ratios (δ18O and δ13C) using a micromill to obtain subsamples of from the otolith core. Sr:Ca, δ18O and δ13C of the otolith core (which reflects early life history) will be used to infer natal environment for individual fish; changes in Sr:Ca across sectioned otoliths will be used to assess timing and long-term patterns of inter-river movement.

Efficacy of contracted removal efforts
As was completed in 2011, we will conduct another mark-recapture in the Marseilles Reach in 2012 and 2013 in conjunction with the Illinois DNR removal effort. We will quantify movement through the channel connecting this quarry to the river with 24-hour echosounding surveys at least three times each year (spring, summer, and fall). The expectation is that overall movement should be greater during periods when densities in the east pit of Hansen's Material Services Corp. decline. In addition to the VR2 network described above, additional fixed station receivers will be placed near the entrance of the east pit within the main channel of the Illinois River in the Marseilles Reach, within the east pit, and within the west pit to examine immigration and emigration. We will implant an additional 30 Asian carp with acoustic tags during spring 2013 to quantify movement with VR2Ws placed in the river channel and the pit. These immigration and emigration data will be combined with telemetry and harvest data to assess the efficacy of removal efforts there.

Electric barrier system maintenance remote sensing surveys
Sampling will include regular remote sensing monitoring of the area within the electrical barrier system as part of the regular barrier maintenance effort. This effort will include a combination of side-looking split-beam hydroacoustic surveys and side-scan SONAR surveys, which have been shown to be effective in identifying the presence/absence of fish. Each survey will consist of three transects, which will provide an estimated 97.6% water column coverage. Hydroacoustics will be carried out using two multiplexed BioSonics, Inc. side-looking split-beam transducers (either 200 kHz or 70 kHz transducers, depending on availability of the newly purchased 70 kHz system) set at 15 cm below the surface; each transducer will be set to 5 pings/s with a 0.40-ms pulse duration and data will be collected from 0 to 50 m. Acoustic transducers will be off-set in angle to maximize coverage across the CSSC. A Marine Sonics 1200 kHz HDS side-scan SONAR tow fish will be towed at 1-m depth to detect and measure potential fish targets as well as to provide detailed imagery of the electric barrier system.

Forecasting changes in propagule pressure on the CAWS
A stage-structured population model was developed for Asian carp in the Illinois River as a function of control by harvest. This model had many important assumptions about factors such as recruitment and immigration. We will refine this model with demographics and movement data collected from the river during 2012-2013. In addition, a spatially explicit model where movement as a function of density and food availability needs to be developed to inform risk assessments for the Illinois River and other similar systems.

Sampling Schedule: Effort will occur from March 2011 to December 2013. Specific sampling dates are yet to be determined, but will be made available for weekly scheduling reports posted on Asiancarp.us.

Deliverables: Summaries of each sampling event will be reported as conducted and progress reports will be provided as needed. Data will be summarized and project plans updated for annual interim summary reports and revisions of the MRP.

Telemetry Monitoring Plan

Participating agencies: US Army Corps of Engineers - Chicago District (lead).

Introduction: Telemetry has been identified by the MRRWG as one of the primary tools to assess the efficacy of the electric barrier system. In mid-summer 2010, an acoustic telemetry sampling strategy was initiated using a network of acoustic receivers supplemented by mobile surveillance to track the movement of tagged Bighead Carp (*Hypophthalmichthys nobilis*), Silver Carp (*H. molitrix*), and surrogate fish species in the area around the electric barrier system in the Chicago Sanitary and Ship Canal (CSSC) and Upper IWW. This network has been maintained to date through a partnership between the U.S. Army Corps of Engineers (USACE), the U.S. Fish and Wildlife Service (USFWS), the Metropolitan Water Reclamation District of Greater Chicago (MWRD), Southern Illinois University of Carbondale (SIUC) and the Illinois Department of Natural Resources (ILDNR) as part of the MRRWG's monitoring plan. Although the telemetry monitoring plan is scheduled as a five year program, it is important to note that a certain level of monitoring should be maintained throughout the life of the electric barrier system project. This work plan will outline the major goals of the telemetry program and identify key objectives for the 2013 sampling season.

The telemetry monitoring plan includes the tagging of fish with individually coded ultrasonic transmitters in the Upper IWW. The acoustic network proposed is comprised of stationary receivers and supplemented by a mobile hydrophone unit to collect information from acoustic transmitters (tags) implanted into free-swimming Asian carp (Bighead carp and Silver Carp) and surrogate species. Acoustic receiver coverage within the Upper IWW will remain constant from the 2012 season with primary focus at the electric barrier system and secondary coverage surrounding lock and dams and emigration routes such as tributaries and backwater areas. There will be 30 stationary receivers that will remain at their respective 2012 locations, sites shown in green in Figure 1, with an additional five receivers reserved for deployment at the leading edge of the invasion front.

Since 2010, a limited number of Asian carp have been collected and tagged from the Dresden Island Pool in the IWW while a larger number of surrogate species have been collected and tagged from the Lockport and Brandon Road Pools closer to the electric barrier system. A total of 177 large fish have been implanted with ultrasonic transmitters from as far south as the Marseilles pool below the electric barrier system and as far north as the Bubbly Creek turning basin above the electric barrier system. Tagged surrogate fish have been released above and below the electric barrier system; however, no tagged Asian carp have been released above the electric barrier system. In 2011 and 2012 a total of 45 juvenile and/or small bodied surrogate fish species have been tagged and released within the vicinity of the electric barrier system. This

project has recorded no occurrences of tagged fish moving upstream through the electric barrier system to date.

Goals and Objectives: The overall goal of this telemetry monitoring plan is to assess the effect and efficacy of the electric barrier system on tagged fish in the Chicago Area Waterways (CAWS) and Upper IWW using ultrasonic telemetry. The goals and objectives for the 2013 season have been identified as:

Goal 1: Determine if fish are able to approach and/or penetrate the electric barrier system (Barrier Efficacy);

- **Objective** Monitor the movements of tagged fish (large and small) in the vicinity of the electric barrier system using receivers (N=8) placed immediately upstream, within, and immediately downstream of the electric barrier system, in addition to mobile tracking. (Figure 2)
- **Objective** Determine if there is adequate detection coverage to effectively assess efficacy of the electric barrier system.

Goal 2: Determine if and how Asian carp pass through navigation locks in the Upper IWW;

- **Objective** Monitor the movements of tagged fish at Marseilles, Dresden Island, Brandon Road, and Lockport Locks and Dams using stationary receivers (N=8) placed above and below each dam.

Goal 3: Determine the leading edge of the Asian carp range expansion;

- **Objective** Determine detectable population front of Asian carp invasion; currently, Dresden Pool is the leading edge of the Asian carp population.
- **Objective** Describe habitat use and movement in the areas of the Upper IWW and tributaries where Asian carp have been located and relay that information to the population reduction program undertaken by IDNR and commercial fishermen.

Additional objectives of the telemetry monitoring plan:

- **Objective** Integrate information between related acoustic telemetry studies.
- **Objective** Download, analyze and post telemetry data for information sharing.
- **Objective** Maintain existing acoustic network and rapidly expand to areas of interest in response to new information.

Work Plan: *Sample size and distribution* – Sample size was selected through review of similar studies, past catch data and expert opinion from the MRWG. In 2010, the MRWG recommended that 200 tags be implanted for large fish telemetry monitoring. An existing resource of 110 tags was implanted in 2010; and another 90 tags were procured to enhance monitoring capability in 2011. This recommendation however did not account for a report

published later (Holliman, 2010), suggesting small bodied fish may have a greater chance of penetrating the electric barrier system. In response to this report, USACE procured an additional 30 tags for implantation into small fish that were released in the vicinity of the electric barrier system in 2011. An additional 15 small fish were tagged and monitored within the vicinity of the electric barrier system in 2012 with another 15 small fish planned for implementation in spring 2013 for data comparison.

Additional tagging is required to sustain recommended levels of the large fish sampling size as battery life expires in previously tagged fish. At the conclusion of the 2012 sampling season, 172 tags remained active in the study area. This number will be drastically reduced to 66 active tags as battery life continues to expire through mid-March 2013. It is recommended that 134 tags be implanted into surrogate fishes and Asian carp throughout the study area in order to maintain a consistent level of surveillance as in previous year's effort. Table 1 below displays the location and number of tags recommended for implantation in various fish species in the spring of 2013.

Table 1: Recommended telemetry tag implementation for the 2013 sampling season.

Release Pool/Location	Species	Number of tags
Upper Lockport/RM300	Surrogate species	40
Lower Lockport/RM292.7	Surrogate species	34
Brandon Road/RM286.5	Surrogate species	20
Dresden Island/RM276	Bighead / Silver Carp	15 / 15
Marseilles/RM264.5	Bighead / Silver Carp	5 / 5

The proposed distribution is influenced by several factors including the carrying capacity for the receiver network array per pool, the small number of previously tagged Asian carp and available source populations of the target species. All tags previously implanted into surrogate fish species upstream of the electric barrier system will be expiring in late winter 2013 and will need to be replaced. Previously, these tags were released in two batches split between Bubbly Creek on the CSSC and the Cal-Sag Channel near Worth, IL. Because none of these previous tags were observed to reach the electric barrier system in the past, a large portion of the new tags will be released further downstream, approximately 6 miles above the electric barrier system. This will increase the chance of approaches to the electrified barrier environment from the upstream direction. Surrogate species will be tagged and released into the Lower Lockport and Brandon Road pools to replace fish determined dead or tags that have expired. Likewise, Asian carp will be tagged and released within the Marseilles and Dresden Island pools to account for fish lost to commercial netting operations or expired tag batteries. No Asian carp will be released upstream

of the known population front in order to reduce the risk of assisting any upstream advance of the invasive species.

Species selection (primary and surrogate) - Asian carp are the primary species of concern, and their behavioral response to the electrical barrier system is of the greatest importance. However, as mentioned previously, populations of both species vary and are considered rare to absent near the electrical barrier system. Therefore, in order to test the direct response of fish, surrogate species have been tagged and monitored within the Dresden Island, Brandon Road and Lockport pools. Dettmers and Creque (2004) cited the use of Common Carp (*Cyprinus carpio*) as a surrogate species for use in telemetry in the CSSC because "Common Carp are naturalized and widespread throughout the CSSC and Illinois water bodies in general. Common Carp are known to migrate relatively long distances and they grow to large sizes that approximate those achieved by invasive carps. Based on these characteristics, tracking of Common Carp should provide a good indicator of how Asian carp would respond to the dispersal barrier if they were in close proximity to this deterrent." These characteristics could also justify the use of other species such as Buffalo spp. (Smallmouth and Black), Grass Carp (another species of Asian carp), and Freshwater Drum.

Recent testing of voltage parameters by ERDC indicated voltage settings may not be as effective on smaller fish (Holliman 2011). To investigate this in the field setting, 45 small bodied fish (TL 4 to 7 inches) were tagged in the vicinity of the Barrier in 2011 and 2012 and their movement monitored. Due to the constraints associated with tagging smaller fish, tagging took place in the spring and fall to ensure compatible sizes and reduce stress by waiting for cooler water temperatures. Additionally, battery life of tags is sacrificed (smaller tags to accommodate smaller fish have less battery life), so it may be prudent to implement continuous mobile tracking for 12 hours (from time of release) on these fish. Small fish species selected have largely been dependent on available populations within the lower Lockport and upper Brandon Road pools. Species tagged included Largemouth Bass, Crappie spp., sunfish spp., Common Carp and Skipjack Herring. A total of 15 additional small fish tags to be implanted in spring 2013 will concentrate efforts on young of year Common Carp but will again rely on the resources available in the field.

Tag specifications and Implantation procedure – Tagging efforts will be focused May-June and October-November and will follow the surgical and recovery procedures outlined in *Telemetry Master Plan Summary of Findings* by Baerwaldt and Shanks (2012). Adult Asian carp will be collected from the IWW; in the Marseilles (RM 247 to 271.5) and Dresden Island (RM 271.5 to 286) pools. Surrogate species for the small fish study will be collected from the Lockport Pool below the electric barrier system (RM 291 to 296). The primary method of capture will be electrofishing; although supplemental gear such as fyke and trammel nets may also be used to harvest fish for tagging. Fish collected will be weighed, measured, and sex will be identified if

possible. Water quality parameters such as dissolved oxygen, pH, and conductivity will be taken at each release site using a water quality probe (Pro Plus Instrument, Yellow Springs Inc.)

In an attempt to reduce the amount of tagged fish losses due to harvesting, all Asian carp undergoing surgery will also be fitted with a single jaw tag (provided by SIUC). Commercial fishermen and action agencies working with the MRRWG will be made aware of the project and will be requested to release any jaw tagged Asian carp if they are suitable for release, otherwise they will be requested to save the fish and return it to USACE so we can save the transmitter and tag a replacement fish.

No Asian carp caught in Lockport pool will be tagged and returned as this may result in the distortion of eDNA surveillance. Any Asian carp captured in Lockport or Brandon Road will be turned over to IDNR for species voucher.

Acoustic Network Array: *Stationary Receivers* – A system of passive, stationary receivers (Vemco VR2W and VR4 Receivers) were placed throughout the IWW in order to monitor movement of tagged fishes. The receivers log data from tagged fish when they swim within the detection range of the receiver (typically at least one quarter mile from the receiver). The detection limits of each receiver were tested with a test tag. VR2W's were placed from the Marseilles Lock and Dam (RM 245 of Marseilles Pool, Illinois Waterway) to above the electric barrier system in the CAWS. In some areas, two VR2W's were placed to increase the detection capability in high noise or wider riverine settings, or to duplicate monitoring efforts in high risk environments (where receivers may be subject to damage or loss). VR2W's were deployed using a variety of methods: stationary deployment using a lead line or marked buoy, or deployment on fixed structures (canal walls, mooring cells, lock guide walls), and will use steel cable to eliminate loss due to vandalism. In the immediate vicinity of the electric barrier system, receivers were placed inside the canal walls in manhole covers constructed for previous telemetry studies for protection against barge traffic. For the 2013 field season, 5 additional VR2W's will be held in reserve for rapid deployment near the leading edge of the invasion front to identify habitat utilized by the principal population of Asian carp. These new receiver deployments will be closely linked with mobile tracking data and physical captures of Asian carp by commercial fishermen as the season progresses. Deploying these five receivers with input from up-to-date data will help identify new areas of interest and achieve a better understanding of residence times in previously known areas of Asian carp habitat.

Emergence of a new technology enabled USACE to deploy Vemco VR4 model receivers at the electric barrier system site. These receivers work together as a Vemco Positioning System (VPS) to triangulate the position of the fish in the water to give precise location and movement data. They are submersible for at least 5 years and data is downloaded via wireless modem, thus eliminating the need for manual retrieval (improving safety for the workers in the electrical field

environment created by the electric barrier system). These receivers are deployed to the bottom of the canal using a specialized float collar to keep them upright and protected from passing vessels. Currently, we have 8 VR4 receivers covering the areas around barriers 2A and 2B. VR4 data is sent to Vemco for processing. Data processing typically takes about 3-4 weeks for full analysis.

Figure 1 shows the general strategy of VR2W placement for 2013 (N=21 receivers). Figure 2 depicts a close up view of VR2W and VR4 receivers at the electric barrier system. The priority is to achieve the most coverage (detection capacity) in the immediate vicinity of the electric barrier system, where most fish will be tagged, to determine if fish are challenging or passing through (upstream or downstream directional movement) the electric barrier system. The network will expand throughout the system to track overall movement, and to determine what type of movement occurs from fish negotiating lock structures. Receivers will also be deployed at possible escape routes from the telemetry network such as tributary confluences. Movement through lock structures will be compared to USACE lockage data from Marseilles, Dresden Island, Brandon Road, and Lockport. Leading edge movements will be monitored by the downstream receivers. Other significant movement patterns will also be compared to river stage and temperature data.

Receivers will be downloaded monthly to retrieve data for analysis, and for maintenance of the acoustic network (i.e. decrease risk of vandalism, ensure operation of device, check battery life, replacement if necessary). Receivers may be downloaded more frequently if needed. Monthly field visits will also allow for flexibility in receiver position adjustments near the leading edge of the invasion front. All receivers can be downloaded with either a serial port and/or Bluetooth-USB capability. The software is available free online from the Vemco website (http://www.vemco.com/support/vue_dload_form.php). Water quality parameters (DO, pH, conductivity, and temperature) will be recorded at each station during downloads.

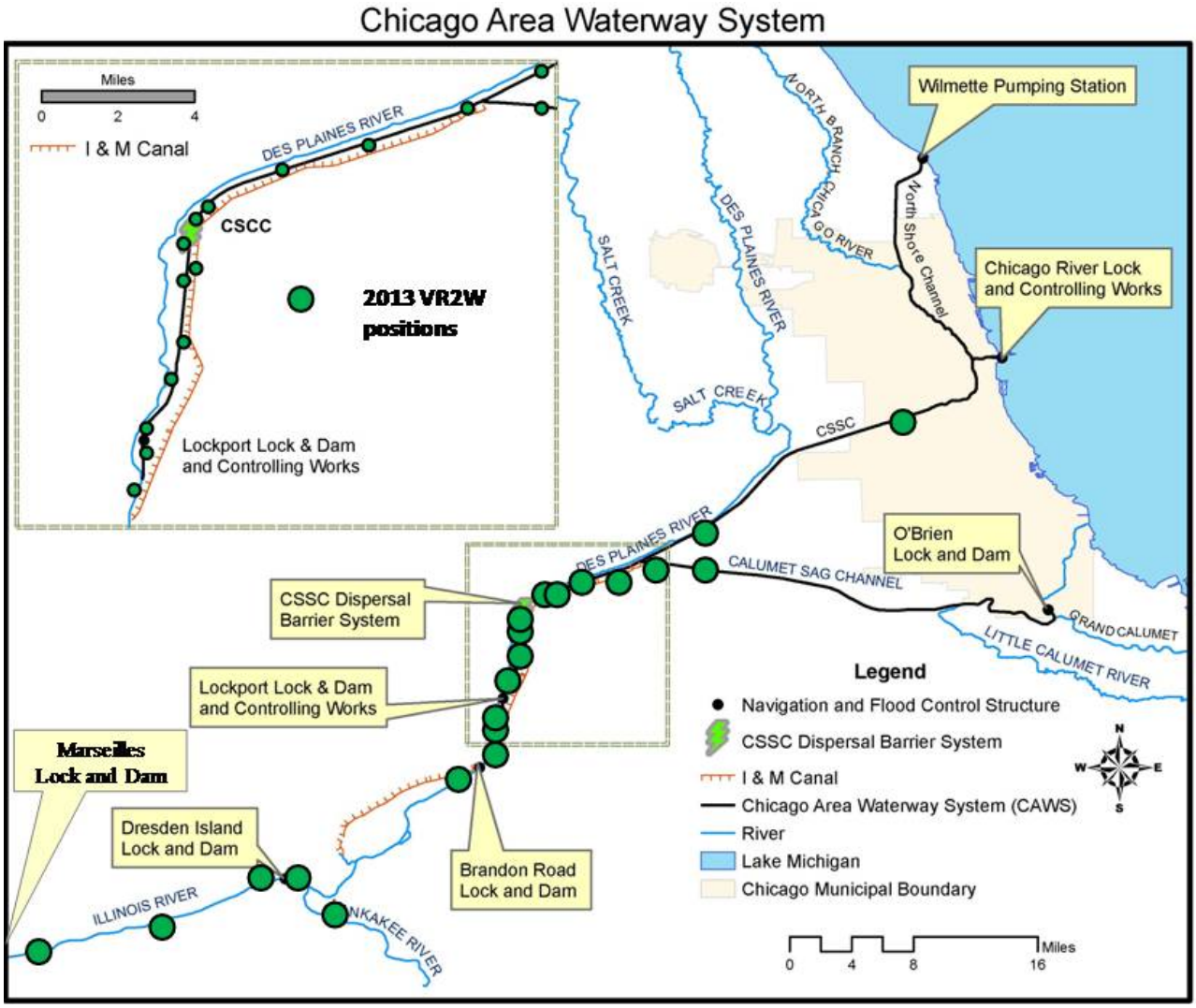


Figure 1: VR2W receiver network within the Upper IWW and CAWS

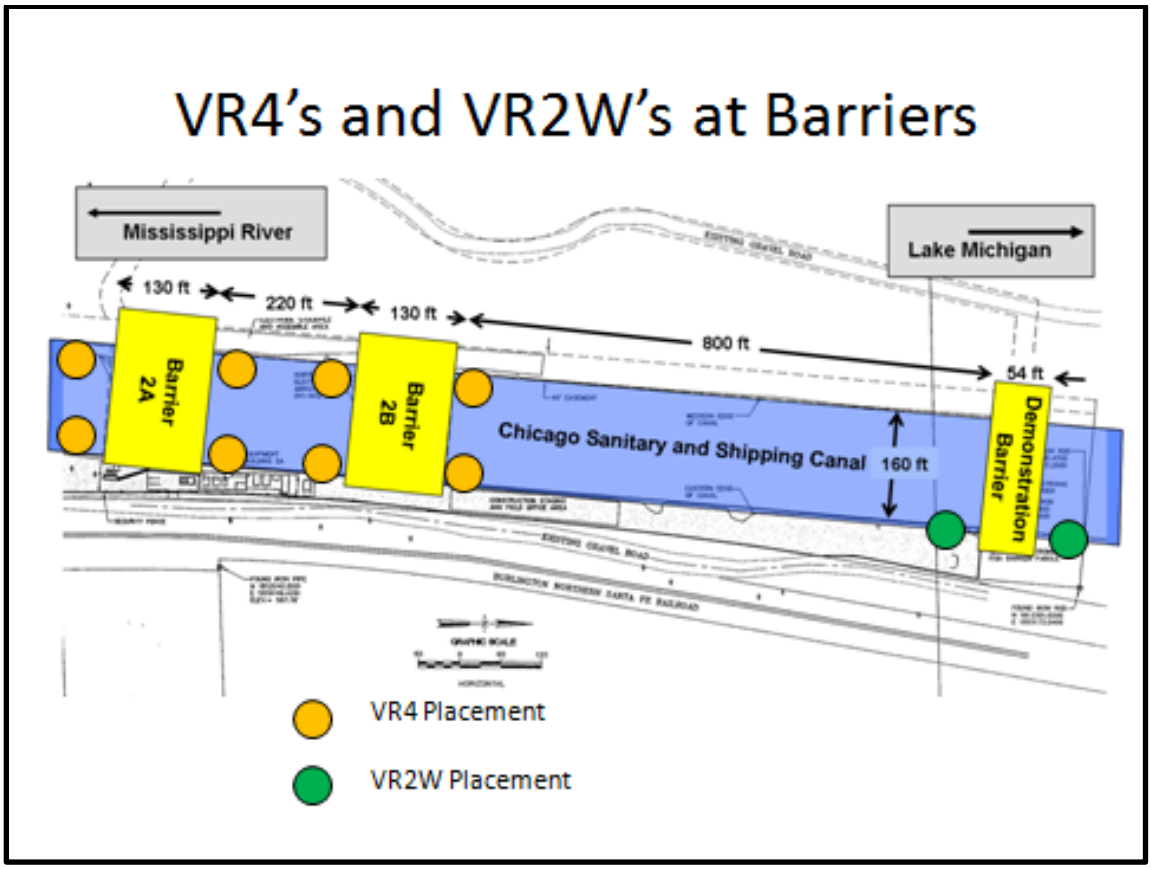


Figure 2: VR2W and VR4 receiver network at the electric barrier system.

Mobile Tracking – The use of a mobile unit (Vemco VR-100 unit with a portable directional and omni-directional hydrophone operated out of a boat) enables a crew to manually locate any tagged fish using the signal emitted from the transmitter inside the fish. The mobile unit will be used to occasionally locate all fish in the study area to ensure an adequate number of active tags in the system are being monitored. Since the stationary receivers give an approximation of where a tagged fish is, the mobile unit can identify the exact location of any fish. This is useful if the stationary receiver data indicate a tagged fish has crossed the barrier, or to locate a fish the receivers have not been able to detect (can confirm viability of fish). The mobile unit will also be used when tagging small fish with the decreased battery life tags, and to monitor fine scale movements. The mobile unit may also be used to locate fish in an area where other monitoring tools (commercial harvest, sonic barriers, etc) are planned to be used that may impact a tagged fish.

Contingency Measures: *Tagged fish crossing barrier* – As described above, any suspicion (indicated by stationary receiver data) of a tagged fish crossing the electric barrier system can be confirmed by the mobile tracking unit. This will enable crews to locate the exact location of a fish, instead of the approximation detected by a stationary receiver. All agency leads involved

with the telemetry plan, as well as the MRWG, will be notified immediately of any suspected barrier breach. In some cases, it may be necessary to implement a 24-hr track to confirm if the fish of interest is indeed viable.

Other Relevant Studies: An ancillary benefit of this project will be the enhancement of the regional capability of fish tracking at a basin scale. This project will complete the IWW basin acoustic receiver network which extends from the Mississippi River to Lake Michigan and will enable cooperating researchers to document large scale movements of Asian carp and other fish species within the system. The information gathered from this system will enhance the understanding of systemic movement in the basin. Additionally, any fish tagged from this effort that disperse outside of the USACE telemetry network detection area have the probability of being detected on another researcher or agencies network. A list of tagged fish and receiver locations will be available to other researchers, and will be registered with the Great Lakes Acoustic Telemetry Observation System.

Points of contact for other studies in the region using the Vemco acoustic telemetry system include:

- Dr. Jim Garvey, David Glover and Marybeth Brey, Southern Illinois University. Species tagged in Illinois and Mississippi Rivers include: Silver Carp, Paddlefish, Shovelnose Sturgeon, Blue Catfish, White Bass, Walleye, Sauger, and hybrid Striped Bass.
- Doug Bradley, LimnoTech, Tom Minarik, MWRD, Dr. Dave Wahl, University of Illinois. Species tagged in CAWS: Largemouth Bass. This study has immediately enhanced the acoustic network by deploying 14 VR2W receivers in the CSSC/Chicago River near Chicago Lock. The study was completed in 2011 but researchers continue to support USACE by leaving hardware in place for deployment of government receivers.
- Jeff Stewart and Sam Finney, USFWS Region 5, Carterville Field Office. Species to be tagged in middle IWW include: Silver Carp and Bighead Carp. This study is scheduled to start in early summer of 2012 and will focus on the early life stages of Asian carp (year-0 and year-1 age classes).
- Dr. Reuben Goforth and Alison Coulter, Purdue University. Species tagged in Wabash River: Silver Carp. The study is ongoing and tracks Silver Carp movements in the Wabash River, a tributary to the Ohio River.

Sampling Schedule: A tentative work schedule is presented below.

April 2013	VR2W network inspected and new receivers installed and tested
April & May 2013	Tagging efforts of Asian carp in the Dresden Island and Marseilles Pools and surrogate fish replacement in Lockport and Brandon Road pools at Barriers
May 2013	Tagging efforts of remaining 15 small fish at the Barrier
ONGOING	VR2W network maintenance, downloads and mobile tracking
December 2013	Prepare receiver array within the IWW and CAWS for winter months

Deliverables: All agency leads involved with the telemetry plan, as well as the MRWG, will be notified immediately of any suspected barrier breach. Periodic updates will be given to the MRRWG in the form of briefings at regular meetings, and the year end summary report will be compiled after the 2013 sampling season.

Monitoring Fish Abundance, Behavior, and Fish-Barge Interactions at the Barrier

Participating Agencies: U.S. Fish and Wildlife Service, Carterville Fish and Wildlife Conservation Office, Marion, Illinois (lead), USACE-Chicago District (field support), USACE-CERL-Champaign (field support), USFWS Columbia, MO and La Crosse, WI FWCOs (field support), Southern Illinois University (statistical and field support).

Location: All work will take place in a 5.4 mile section of the Chicago Sanitary and Ship Canal between the Lockport Lock, near Lemont, IL and the electric barrier system near Romeoville, IL.

Introduction and Need: The electric barrier system in the Chicago Sanitary and Ship Canal (CSSC) operates with the purpose of preventing upstream fish migration from the Mississippi River Basin to Lake Michigan. A demonstration barrier has been operational since April 2002 and currently operates at 4 ms, 5 Hz, 1 V/in. Sparks et al. (2010) and Dettmers et al. (2005) were the first to directly test the effectiveness of the Demonstration Barrier. Sparks et al. (2010) recorded a radio-tagged Common Carp (*Cyprinus carpio*) breaching the Demonstration Barrier in April 2003. This breach was later determined to have coincided with the passage of a barge. During November 2003, Dettmers et al. (2005) passed encaged fish alongside a barge through the Demonstration Barrier. Dettmers et al. (2005) found that the effects of the electrical field were delayed when fish swam alongside the conductive (steel) barge hulls and some fish were never incapacitated as they swam through the Demonstration Barrier. Dettmers et al. (2005) attributed the delayed and non-incapacitations to a distortion of the electrical field by the barges.

Following the Dettmers et al. (2005) study, design modifications were made to two additional electrical barriers that were constructed, Barriers 2A and 2B, to account for the barge-induced electrical warping. Barriers 2A and 2B were implemented in 2009 and 2011, respectively. The newer barriers cover a much larger area than the Demonstration Barrier and are capable of generating electrical fields of much higher intensity. Initially, Barrier 2A had the same operating parameters as the Demonstration Barrier. However, the operating parameters of Barrier 2A were increased to 6.5 ms, 15 Hz, 2.0 V/in (referred to as 2.0 V/in hereafter) in August, 2009 as a result of a pilot laboratory study performed by Holliman (2011) on Silver Carp ranging in size from 5.4-11 in TL. Holliman (2011) found that at those parameters, 100% of Silver Carp specimens were incapacitated. Barrier 2B began operation in April 2011 at 2.0 V/in. Typically only one of the larger barriers (2A or 2B) operates at one time along with the Demonstration Barrier. Barrier 2B was operated at 2.0 V/in until 11/29/2011, when parameters were increased to 2.5 ms, 30 Hz, 2.3 V/in (referred to as 2.3 V/in hereafter), which is what operating parameters remain at for Barriers 2A and 2B. The increase to 2.3 V/in was in response to intensive laboratory work done by Holliman (2011) on Bighead Carp that were 1.8-3.2 in TL. Holliman (2011) found that those parameters incapacitated 100% of small Bighead Carp that were exposed to gradual increases in voltage in a Brett swim tunnel. Those parameters were about 90% effective at preventing fish from swimming through a simulated barrier that small Bighead Carp were allowed to challenge. Results from the past year-and-a-half of our fish monitoring at the electric barrier system have revealed that fish abundances in that area fluctuate throughout the year and that at times, fish were able to swim up to the highest electrical field before upstream progress was inhibited (described in further detail below in status section). The accumulation of feral fish immediately

below the operating barrier has raised concerns about the fish opportunistically moving upstream during a planned or unplanned barrier outage, swimming upstream during a barge passage, or involuntarily being moved upstream by a passing barge vessel. Specifically, our objectives for this year's studies are to:

1) Determine the abundance of fish between the Lockport Pool and the electric barrier system throughout the year.
2) Evaluate the diel abundances of fish around and within the electric barrier system.
3) Determine fish abundances immediately below Barrier 2B and between Barrier 2B and the Demonstration Barrier before and after required monthly barrier maintenance shutdowns.
4) Evaluate fish behavior during monthly shutdowns to see if feral fish opportunistically swim upstream during the planned outages.
5) Evaluate fish behavior between the narrow arrays where the highest-voltage electrical field is located.
6) Evaluate behavior of fish that are placed within moving barge vessel junctions and that are immediately below the barrier as a barge traverses the barrier both upstream and downstream.

Status: The Carterville Fish and Wildlife Conservation Office began performing field work within the electric barrier system in June 2011 when operating parameters were at 2.0 V/in and continued to work there following the change in operating parameters in November 2011 to 2.3 V/in. Specifically, we recorded underwater footage of areas within and around the electric barrier system using a duel-frequency identification SONAR (DIDSON) unit and evaluated fish behavior and abundances. In 2012, our office recorded DIDSON footage in and around the electric barrier system during 12 separate weeks and recorded 9,260 minutes of footage. We also performed eight weeks of caged-fish work in and around the electric barrier system. Seven weeks consisted of moving encaged fish through Barrier 2A or 2B for 20 separate runs and ten control runs in non-electrified water. One week focused on the Demonstration Barrier; nine caged-fish runs were performed. Two weeks were dedicated to caged-fish work with fish placed adjacent to various parts of a barge vessel and in small wedges of water between barge vessels. In July 2012, 12 control runs were performed using a fiberglass-hull boat and the cage was placed in the following barge locations: side of barge (four runs), on the stern of a barge that was in a two-wide configuration (three runs), within the rake (or sloped portion) of a barge with no other barge lashed to the rake (two runs), and within the rake of a barge, but with the square end of another barge lashed to the rake (five runs). In October, barge-fish interaction work focused solely on barge junctions and the cage was placed within the rake in the following barge configurations: rake-to-tow vessel (four runs), rake-to-rake (nine runs), and rake-to-square end (five runs). In addition to the caged-fish work, 15 runs were also performed in which un-caged fish that were externally tagged with brightly-colored floats were placed into the water between rake-to-square-end barge junctions. A full analysis of the barge-fish behavioral data is not available at this time.

During the fall of 2011, when operating parameters were at 2.0 V/in, DIDSON recordings revealed that feral fish appeared to accumulate in large numbers below the highest-voltage area of the electric barrier system. We also observed the highest amounts of both hovering and

probing behavior both below the barrier arrays and within the barrier arrays where the in-water voltage was highest. We also found that the larger fish accumulated further downstream from the highest concentration of electricity, whereas smaller fish (2.1 – 13.3 in TL) were able to penetrate further into the barrier system, including just below the highest electrical field between the narrow arrays, an area about two meters wide. During 2012, when operating parameters were at 2.3 V/in, we found very few fish near the electric barrier system in the winter and spring, and the fish that we did record were generally further from the electric arrays than in the fall of 2011 when operating parameters were at 2.0 V/in. During the 2012 summer months, more fish appeared and accumulated below the barriers, and fish began to penetrate further upstream into the electric barrier system than in the winter and spring. During the fall of 2012, we observed the most fish in and around the electric barrier system. Similar to the fall of 2011, at 2.0 V/in, fish accumulated below the barriers and were able to penetrate the furthest upstream into the electric barrier system, including immediately below the highest electrical field between the narrow arrays. The fish that we recorded immediately below the highest electrical field ranged in size from 3.6 - 4.9 in TL. No fish were observed breaching the electric barrier system, both when operating parameters were at 2.0 V/in and 2.3 V/in.

During the fall of 2011, at the previous barrier operating parameters of 2.0 V/in, 270 Gizzard Shad were moved through the electric barrier system in cages. Of those fish, eight did not become incapacitated (size range 3.3 – 3.8 in TL) when moved upstream next to an aluminum-hull boat. However, since the barrier operating parameters have increased to 2.3 V/in, all of the fish that we moved through Barriers 2A or 2B, along aluminum and fiberglass-hull boats, were incapacitated. Six out of 11 Common Carp that were moved through the Demonstration Barrier were not incapacitated; however, they did exhibit behavior indicative of attempting to avoid moving through the barrier, such as rapid circling movements and efforts to swim downstream. The sizes of the non-incapacitated common carp were 15.6 – 25.7 in TL. The two freshwater drum (14.6 and 15.1 in TL) that were moved through the Demonstration Barrier were not incapacitated and did not exhibit any readily discernible avoidance behavior comparable to the Common Carp.

Methods: Fish abundances from Lockport Pool through the electric barrier system (Figure 1) will be estimated using hydroacoustic sampling following Garvey et al. (2011). Split-beam hydroacoustics and side-scan SONAR will be used to survey fish. Past work using hydroacoustics within the electric barrier system found that 98% of the water column can be covered when simultaneously operating the SONAR equipment (ACRCC 2012).

Figure 1. 5.4 mile stretch of the CSSC where SONAR sampling will take place.

Six scans of the electric barrier system will coincide with planned barrier maintenance shutdowns that are required for monthly testing of the back-up generator system. The first three independent scans will take place shortly before the planned shutdown. After the scans, two DIDSON units will be mounted to the side of our boat and the boat will be positioned between the narrow arrays. DIDSON units will record footage along the west wall during the temporary barrier shutdown. Following the shutdown, a second set of three scans of the electric barrier system will be performed. DIDSON footage will be reviewed later in order to directly assess whether fish moved upstream along the west canal wall during the temporary shutdown. Counts of fish within the electric barrier system that are obtained via hydroacoustic sampling, particularly between Barrier 2B and the Demonstration Barrier, will be averaged and compared before and after the temporary barrier shutdown in order to indirectly assess whether fish opportunistically moved upstream during the shutdown.

Scans of the CSSC from Lockport Pool to the electric barrier system will take place monthly in order to assess spatio-temporal patterns of fish abundance below the electric barrier system. Finally, diel sampling will take place, in which barrier scans will occur once every three hours, in order to assess fish distribution patterns near the electric barrier system throughout a 24-hour period. This information will be especially useful given that some evidence exists that Bighead Carp move more in the evening hours than during daylight hours (Schultz 2006).

Fixed DIDSON recordings during times of normal barrier operation will take place solely between the narrow arrays of the operating barrier, where the strongest electrical field is located. DIDSON footage will focus on the water surface along the western canal wall. In order to ensonify the entire 8 m of canal wall between the narrow arrays, two DIDSON units will be used simultaneously while both are synced up to a single laptop computer. The DIDSON units will either be mounted off of a boat, as has been done in the past, or off of a fixed crane unit extending into the canal (pending safety review underway). If a fixed crane arm can be retracted close enough to the wall, so as not to interrupt barge navigation, the DIDSON units will record footage of passing barge vessels and any potential fish-barge interactions.

Controlled fish-barge interaction evaluations will focus on placing on untagged and externally-tagged Gizzard Shad within the wedges of water between various barge junctions. For each run, 10 Gizzard Shad will be used; five untagged and five tagged. The five tagged Gizzard Shad will be tethered to highly-visible floats with one-pound tensile strength fishing line (Hasler et al. 1958; Sass and Ruebush 2010). Fish will be placed into the following barge junction locations: 1) within the wedge of water between a rake-to-square end barge junction, 2) within the wedge of water between a rake-to-rake junction, 3) within the wedge of water between a rake-to-towboat junction, and 4) within the wake flow behind the stern of one barge that is in a two-wide configuration. Other, un-tagged, Gizzard Shad may be immersed in a fish sedative and also placed within the wake flow to try to track entrainment. Finally, tagged fish will be placed immediately below various parts of the electric barrier system, where wild fish have been previously observed with our DIDSON, and the barge vessel will then be instructed to traverse the electric barrier system either downstream or upstream. We propose that half of these runs, in each different configuration, be performed with only Barrier 2B operating, and the other half with both Barriers 2A and 2B operating.

Fish behavior will be recorded within the wedge using a DIDSON unit that will be mounted of of the barge deck and aimed inside the wedge and the locations and movements of tagged fish will be recorded with camcorders. Workers will be placed in the following locations: one on each bank and one on the 135th ST bridge with a hand-held camcorder to record the locations where fish are swept out of the barge junctions. One worker will be on the barge vessel to place fish in the water and operate the DIDSON (if used), and two workers will be in a USFWS boat to collect fish, transfer tagged fish to the barge, and collect water quality measurements. Highly-visible markers, such as bright-colored buckets, will be suspended along the canal walls, above the water, to denote the upstream extents of the Barrier 2A and 2B narrow arrays and serve as reference points for whether or not fish were moved upstream of the electric barrier system.

Sampling Schedule: Hydroacoustic SONAR scans before and after barrier maintenance events will take place monthly, typically during the first Tuesday of each month, from April to October. Fixed DIDSON sampling will take place during two weeks in the summer season and two weeks in the fall season. One week in May will be dedicated to evaluations of barge-fish interactions at the electric barrier system. If field crews should make any observations that would indicate that fish are not being deterred by the electric barrier system, these observations will be reported immediately to MRP agencies, Todd Turner, USFWS Assistant Regional Director-Fisheries, and Charlie Wooley, USFWS Deputy Regional Director - Region 3.

Deliverables: A report on our findings will be completed by approximately summer 2014 and distributed to interested parties.

Evaluating Asian Carp Detection Techniques with SONAR

Participating Agencies: U.S. Fish and Wildlife Service, Carterville Fish and Wildlife Conservation Office, Marion, Illinois and Southern Illinois University – Carbondale, Center for Fisheries, Aquaculture, and Aquatic Sciences (CFAAS).

Location: Wild fish will be collected in the Big Muddy River in Jackson County, Illinois. All experimental work will take place at the CFAAS Touch of Nature Experimental Lake in Makanda, Illinois.

Introduction and Need: Currently, both intensive systematic and response sampling programs target the capture of live Asian carp upstream of the electric barrier system. Additionally, water samples are taken throughout the Chicago Area Waterways System (CAWS) and tested for the presence of Asian carp environmental DNA (eDNA). The eDNA sampling has yielded numerous positive detections of Bighead and Silver Carp DNA throughout the CAWS while traditional fish sampling has yielded only one Bighead Carp above the electric barrier system. However, capturing a live Asian carp in a low abundance population using traditional fish sampling gear, and without timely knowledge of the specific location in the water body where a fish may be present, can be difficult.

The use of hydroacoustics to assess fish stocks has become increasingly common in open water environments (Parker-Stetter 2009; Simmonds and MacLennon 2005) and more recently in riverine environments including the Illinois River (Garvey et al. 2011). A limitation in the use of hydroacoustics for fish stock estimation though is that detected fish cannot be readily identified to species. Therefore, hydroacoustic fish stock sampling is typically accompanied by traditional fish sampling in order to verify species identifications (Brandt 1996).

Given the above needs for Asian carp-specific hydroacoustic signatures, we are going to perform an experiment using 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.

Objectives: Explore the possibility of identifying fish, particularly Asian carp, to species using multiple hydroacoustic split beam frequencies.

Status: New project.

Method: At the CFAAS Touch of Nature Experimental Lake, we will collect data on multiple sizes of Asian carp and other large-bodied fish species that are common to the CAWS including Buffalo spp., Largemouth Bass, Common Carp, and Gizzard Shad. A combination of 38, 70, 120, and 200 kHz transducers will be tested with each fish positioned at different aspects relative to the beam, including dorsal and side-looking, by tethering recently euthanized fish in front of the acoustic beams at a distance far enough away to allow the entire fish to be within the beam. Other transducer frequencies will be included if they are available. The angle of the fish body to the transducer will affect both the peak target strength (in –dB) as well as the shape of the sound packet returning to the transducer. This is important because the angle of the beams used in the

CAWS surveys will not be fixed. Beam angle will be quantified for each transducer using an integrated heading-pitch-roll sensor. Target data collected will include target strength, width, shape, and incidental angle. These data will be incorporated into a multivariate (e.g., discriminant function) analysis to determine whether we can distinguish species with the gear. These data will also be used to quantify the frequency specific peak target strength to body size relationships for each species and to determine the uncertainty in these relationships.

Sampling schedule: Experimental work will take place in the spring of 2013 and take approximately one month.

Deliverables: Data will be summarized for the annual interim report and project plan updated for annual revisions of the MRP.

Monitoring for Asian Carp in the Upper Des Plaines River and Upper Des Plaines River Overflow

Participating Agencies: USFWS – La Crosse Fish and Wildlife Conservation Office (lead): IDNR and MWRD (as needed field support)

Introduction and Need: Fish can freely move into and out of the upper Des Plaines River via the confluence with the CSSC, and Asian carp have been observed in the Brandon Road Pool near the confluence. Asian carp eDNA has been detected in the Des Plaines River above the confluence. There is potential risk that Asian carp could gain access to the CSSC upstream of the electric barrier system during certain high-water events when water from the upper Des Plaines River flows laterally into the CSSC, although that possibility has been reduced by the construction of a physical barrier described below.

A physical barrier made of concrete and small-meshed fencing was erected by USACE along 13.5 miles of the upper Des Plaines River to prevent Asian carp from infiltrating the CSSC and then Lake Michigan. The barrier/fence was designed to prevent adult and juvenile Asian carp from moving between waterways, but eggs and fry could pass through the 0.25 in mesh fencing with flood waters. During a July 2011 flooding event, the fence was breached and small fish (about 30 mm TL) moved under the fence and were collected on the CSSC side of the fence. Knowing the population status of Asian carp and if they are spawning in this reach of the Des Plaines River, and determining the effectiveness of the physical barrier, will inform management decisions and direct fish removal actions.

Objectives: There are two major objectives for this study plan:

1) Monitor Bighead and Silver Carp and their spawning activities in the upper Des Plaines River above the confluence with the CSSC; and
2) Monitor Bighead and Silver Carp around the physical barrier when water moves over land laterally from the upper Des Plaines River into the CSSC during high flows.

Status: This project was proposed in 2010 and initiated in 2011, and was reviewed and accepted by the MRRWG. Sampling in 2011 on the upper Des Plaines River included 10.4 hours of electrofishing and 40.3 hours of trammel netting (1,452 yards) and captured 1,178 fish. Sampling in 2012 included 12.6 hours of electrofishing and 24.2 hours of trammel netting (2,066 yards). No Asian carp were captured or observed during sampling. For more detailed results see the 2012 interim summary report document (MRRWG 2013).

Methods: For Objective 1, there were previously three sites on the Des Plaines River that were monitored: downstream from the Hofmann Dam; the Columbia Woods Forest Preserve area; and in the vicinity of the Lemont Railroad Bridge landing. Sampling in 2013 will expand to adjacent areas with favorable Asian carp habitat. Monitoring will include electrofishing and short-term sets of gill and trammel nets.

For Objective 2, critical USGS and USACE gauges will be remotely monitored to help determine pending high flow events, as well as coordination with USACE personnel. The barrier itself will be utilized as a sampling device by serving as a hardened gill net. Staff will walk along

the barrier after the water has receded to collect and identify impinged fish and also sample on the CSSC side of the fence if the fence has been breached.

Sampling Schedule: Monitoring for Asian carp will be initiated in the upper Des Plaines River in April and continue throughout the sampling season, coinciding with increased flows. Additional sampling will be conducted if: Asian carp eggs are collected at the confluence of the upper Des Plaines River and CSSC; or if tagged fish are tracked in this reach of the Des Plaines River. All over-topping events will be monitored.

Deliverables: Results of each sampling event will be reported in monthly sampling summaries. Data will be summarized for an annual interim report and project plans updated for annual revisions of the MRP.

Evaluation of Gear Efficiency and Detectability of Asian Carp

Participating Agencies: INHS (lead), Western Illinois University and Eastern Illinois University (field and lab support)

Location: Evaluation of sampling gears will take place in three segments of the Illinois River and Chicago Area Waterway System (CAWS). Five sites in the middle Illinois River (LaGrange and Peoria Pools), three sites in the upper Illinois/Des Plaines River (Starved Rock, Marseilles, and Dresden Pools), and two sites in the CAWS upstream of the electric barrier system will be sampled as part of this evaluation. In the next phase of this project, select sites on Illinois River tributaries (Sangamon, Spoon, Mackinaw, and Kankakee Rivers) will also be sampled with a subset of gears. Sites may be dropped, or additional sites added as needed in order to complete study objectives.

Site	Waterbody	Navigation Pool
Lily Lake	Illinois River backwater	LaGrange
Matanzas Lake	Illinois River backwater	LaGrange
Havana	Illinois River	LaGrange
Peoria Lock & Dam Tailwater	Illinois River	LaGrange
Henry	Illinois River	Peoria
Ottawa	Illinois River	Starved Rock
Morris / Material Service Pit	Illinois River backwater	Marseilles
I-55 / Treat's Island	Des Plaines River	Dresden Island
Western Ave.	Chicago Sanitary and Ship Canal	Lockport
O'Brien Lock & Dam Tailwater	Calumet / Little Calumet River	Lockport

Introduction and Need: Multi-agency sampling and removal efforts, using a variety of sampling gears, are currently ongoing in the Illinois River and the CAWS to monitor and control the spread of Asian carp. Different sampling gears may vary widely in their ability to capture fish in proportion to their abundance, and may select for different sizes of fish. Evaluating the relative ability of traditional and alternative sampling gears to capture both juvenile and adult Asian carp will help improve the efficiency of monitoring programs and allow managers to more effectively assess Asian carp relative abundance. Data gathered from gear evaluations can also be used to calculate detection probabilities and occupancy rates for Asian carp, which would allow for determination of appropriate levels of sampling effort and help improve the design of existing monitoring regimes. Results of this study will help improve Asian carp monitoring and control efforts in the Illinois River and the CAWS, and will contribute to a better understanding of the biology of these invasive species in North America.

Objectives: We will use a variety of sampling gears to

1) Evaluate the effectiveness of traditional and alternative sampling gears at capturing both juvenile and adult Asian carp;
2) Determine site characteristics and sampling gears that are likely to maximize the probability of capturing Asian carp;
3) Estimate the amount of effort required to detect Asian carp at varying densities with each gear;

4) Supplement Asian carp sampling data being collected by other agencies; and
5) Gather data on abundances of other fish species found in the Illinois River and CAWS to further assess gear efficiency, and examine potential associations between Asian carp and native fishes.

Status: In 2012, each site was sampled three times with all sampling gears. A total of 2,042 Asian carp were captured, comprising 1,712 Silver Carp, 142 Bighead Carp, and 185 hybrid Asian carp. Electrofishing was the most effective gear for sampling Silver Carp (77% of Silver Carp), followed by hoop nets (7%) and large mesh purse seines (6%). Hybrid Asian carp were also most effectively captured by electrofishing (66%), followed by hoop nets (15%), fyke nets (8%), and trammel nets (6%). Bighead Carp were most effectively captured using hoop nets (57%), trammel nets (21%), and fyke nets (9%). No Asian carp were observed or captured above the electric barrier system in the CAWS. The furthest upstream site where Asian carp were captured was at Morris, IL (Marseilles Pool). The highest abundance of Silver Carp was at Henry, IL (Peoria Pool), the highest abundance of Bighead Carp was at Havana, IL (LaGrange Pool), and the highest abundance of hybrid Asian carp was at Matanzas Lake (LaGrange Pool). One age-0 (140 mm) Silver Carp was captured at Peoria Lock & Dam during fall sampling. No age-0 Bighead Carp or hybrid Asian carp were captured in 2012.

Methods: The design of this project involves evaluating sampling gears at multiple sites in three segments of the Illinois River and the CAWS: the middle Illinois River (where Asian carp are present in high densities), the upper Illinois/Des Plaines River (where Asian carp are present in low to moderate densities), and the CAWS (where Asian carp are either absent or present in very low densities). Sampling gears will be employed seasonally at each site, and gears will be evaluated for their ability to detect both juvenile and adult Asian carp.

- Six 15-minute electrofishing transects will be conducted at each site on each sampling date using a pulsed-DC electrofishing boat. A video camera mounted to the front of the boat will be used to record leaping Silver Carp, and the number of individuals observed with the camera will be compared with the number of individuals physically captured during electrofishing transects.
- Both surface (45.8 m long x 3.05 m deep, 1.9, 2.5, 3.2, 3.8, and 5.1 cm mesh panels) and bottom experimental gill nets (45.8 m long x 1.8 m deep, 6.4, 7.6, 8.9, 10.2, and 12.7 cm mesh panels) will be used at all sites, with a minimum of four sets with each net type at each site on each sampling trip (4 hour sets). These standard gill nets will also be used to evaluate the effectiveness of surface-to-bottom gill nets (see Unconventional Gear Development plan).
- Trammel nets (91.4 m length, 10.2 cm mesh with 0.46 m walling #139 twine) will be deployed to supplement IDNR efforts. Four sets will be conducted at each site on each sampling trip, and Asian carp and other fish will be driven towards the net using the boat motor (100-150 m distance, 10-15 minutes effort).
- Hoop nets (1.2 m x 4.8 m, 3.7 cm mesh) will be deployed for twelve net-nights at each site on each sampling trip. Standard hoop nets will also be used to evaluate the effectiveness of large (2 m diameter) hoop nets (see Unconventional Gear Development plan).

- Hydroacoustic surveys will be conducted during each season at each site. A 200 kHz split-beam transducer will be mounted to the front of the boat and connected to a computer with acquisition software. Multiple 15-minute transects will be driven with the river current, and the entire width of the river will be surveyed.
- Wisconsin-type mini-fyke nets (4.5 m x 0.6 m lead, 0.6 m x 1.2 m trap, 3 mm mesh) and beach seines (various lengths, 3 mm mesh) will continue to be used to sample for juvenile Asian carp near shorelines and in other shallow-water habitats. Mini-fyke nets will be deployed for a minimum of eight net-nights, and a minimum of four seine hauls will be pulled at each site on each sampling trip.
- Additional gears (purse seines, cast nets) will also be utilized if any juvenile Asian carp are observed in 2013.

All captured fish will be identified to species, and measured for total length and weight. Sex and reproductive condition of Asian carp will be determined by removal of gonads in the field. Patterns in species richness, fish assemblage structure, and the relative abundance, size structure, and condition of Asian carp across the length of the Illinois Waterway will be examined. Comparisons of normalized catch-per-unit-effort data will be used to evaluate relative gear efficiency. Detection probability and occupancy modeling will also be a focus of data analyses.

Sampling Schedule: In 2013, gear evaluation sampling will occur seasonally (2-3 times per year) at all sites. Additional sampling may occur on an as-needed basis in cooperation with other sampling and monitoring efforts.

Deliverables: Preliminary results will be reported in monthly sampling summaries. Data will be summarized and project plans updated for annual revisions of the MRP.

Exploratory Gear Development Project

Participating Agencies: USFWS (lead)

Location: Missouri River tributaries, Illinois River and backwaters

Introduction and Need: New gears are needed to assess the risk of young Asian carp that potentially could challenge the electrical barrier system to the Great Lakes. New gears are needed to assess Asian carp escapement into the Great Lakes as well as aid in removal. Additional gears are needed for population reduction, commercial fishing and scientific sampling.

Objectives: Gear development will expand on previous year's efforts to:

1) Develop gears that can target smaller Asian carp from fry to juvenile sizes
2) Develop gears that could assist in adult Asian carp removal

Status: Gear development to date has experimented with a purse seine, electrofishing and a butterfly trap net (mechanized active trap net).

Electrofishing: Using a contract physicist, FWS electrofishing instructor and manufacturer of the Infinity Control Box, we found effective settings that could be used to create taxis with much better success than previously used techniques.

Purse seine: This net was used with poor initial results. Problems encountered were the fish's strong ability to find gaps, dive under or jump over the net before encirclement could occur. Asian carp are not likely to herd before fright occurs. The net is being modified to a Danish seine design that will include a bottom and a hood which will be more easily handled by a typical fishing crew.

The butterfly trap net (paupier) was modified eight times but is now highly successful at capturing juvenile Asian carp and has shown moderate success for adult Asian carp in colder temperatures. It is suspected that an adaptation to a smaller mesh size will yield a primary tool for sampling age-zero to age-one Asian carp in any habitat.

A Missouri River push trawl was used to capture several post-hatch larval Asian carp in 2012 and that net will be modified to more effectively fish the habitats encountered in the Illinois River for age-zero Asian carp.

Consultation with a net designer is taking place to expand on the behavioral patterns observed through underwater DIDSON camera usage during paupier trials. We seek to develop two additional surface fishing trawls for sampling small fish below the electric barrier system.

Methods: The paupier will be deployed in Missouri River tributaries and Illinois River backwaters throughout the year on a bi-monthly basis to assess its effectiveness on different sizes

of Asian carp at varying temperatures. Two additional pairs of nets of different sizes will be built with a smaller mesh size and be deployed during an intensive effort to locate age-zero Asian carp in the Illinois River below the electric barrier system.

The purse seine will be modified and deployed later in the year where high concentrations of Asian carp exist. Depending on the success of the net, additional efforts to modify may be abandoned in favor of traditional entanglement gears.

The push trawl will be deployed during summer efforts to detect the leading edge of age-zero Asian carp, particularly in harder to sample tributaries.

The floating trawls (mamou) nets will be deployed in backwaters of the Illinois River to determine their effectiveness compared to traditional small mesh gears.

Deliverables: Results of each sampling event will be reported in monthly sampling summaries. Data will be summarized for an annual interim report and project plans updated for annual revisions of the MRP.

Unconventional Gear Development

Participating Agencies: INHS (lead), IDNR (project support)

Location: Large hoop nets and surface-to-bottom gill nets will be set at Havana (LaGrange Pool), Peoria Lock and Dam Tailwater (LaGrange Pool), Hanson Material Services (HMS) pits (Marseilles Pool), and at Western Ave. (CAWS; Lockport Pool). Great Lakes trap (pound) nets will be deployed at Lake Calumet (CAWS; O'Brien Pool), HMS-East Pit, and potentially at a downstream site in the LaGrange or Peoria Pools. Additional new gears or combination systems will be evaluated at appropriate sites as they become available. Sites may be dropped, or additional sites added as needed in order to complete study objectives.

Introduction and Need: Traditional sampling gears vary widely in their ability to capture Asian carp, and many are far more successful at capturing non-target species. Additionally, the ability of some of these gears to capture Asian carp in the conditions found in the CAWS is questionable. A working group composed of fisheries scientists and commercial fishers was convened in 2011 to discuss development of gears specifically targeting Asian carp in areas of low density and in the deep-draft channels of the CAWS. This committee decided to pursue purchase and conduct an evaluation of three new sampling gears: large (2 m) hoop nets, deep (10 m) tied-down gill nets, and Great Lakes style trap (pound) nets. A pilot study was also recommended for assessing the effectiveness of corn or soybean meal/chaff as a surface attractant for Asian carp. Evaluating these and other gears/methods alongside traditional sampling gears (see Asian Carp Gear Efficiency and Detection Probability Study) is necessary for understanding the potential utility of these new techniques as tools for monitoring and controlling Asian carp in the upper Illinois/Des Plaines River and the CAWS.

Objectives: To enhance sampling success for low density Asian carp populations, we will:

1) Investigate alternative techniques to enhance capture of rare Asian carp in deep-draft canals, such as in the CAWS; and
2) Evaluate gear and combination system prototypes in areas with low to moderate Asian carp population densities.

Status: In 2012, two Great Lakes trap (pound) nets were set for 107 net-days at Lake Calumet, resulting in the capture of 1,051 fish (10 fish/net-day). One of these nets was vandalized on three separate occasions, highlighting the need for greater education, public relations, and law enforcement with the use of this gear type. No Asian carp were captured from Lake Calumet during these efforts. Two pound nets were also set for 70 net-days at the HMS-East Pit. These efforts proved extremely effective, capturing 4,341 fish (62 fish/net-day), including 705 Asian carp (512 Bighead Carp, 85 Silver Carp, 108 hybrids).

Large hoop nets were set overnight at four sites on three occasions during 2012, in conjunction with small (standard) hoop nets. Small hoop nets caught more Asian carp (120 net-nights; 0.83 Asian carp per net-night) than the large hoop nets (80 net-nights; 0.34 Asian carp per net-night) in 2012.

Surface-to-bottom gill nets were tested at four sites on three occasions during 2012, in conjunction with other, traditional gill net types. Surface-to-bottom gill nets were more effective at capturing Asian carp (2.8 Asian carp per 4-hour set) than large mesh sinking gill nets (0.45 per set), small mesh floating gill nets (0.3 per set), or small mesh sinking gill nets (0.05 per set). We found similar catch rates per unit area for surface-to-bottom (5.0 Asian carp per 1,000 m^2 of net) and large mesh sinking gill nets (5.5 per 1,000 m^2). Small mesh floating gill nets (2.2 per 1,000 m^2) and small mesh sinking gill nets (0.6 per 1,000 m^2) had lower catch rates per unit area.

In July – August 2012, the use of soybean meal as a surface attractant for Asian carp was tested at two sites (Lily Lake, Peoria Lock and Dam Tailwater) in the LaGrange Pool. On each of four occasions, approximately 5.7 kg of soybean meal was spread across the water's surface and allowed to drift freely until dissipated (approximately 30 minutes). No Asian carp or other fish were observed feeding on the soybean meal during these time periods.

Methods: In 2013, unconventional gears will be evaluated at multiple sites in order to evaluate their effectiveness across a range of Asian carp densities. All gears will be evaluated for the numbers and sizes of Asian carp and other fishes they are able to capture in comparison with traditional sampling gears. All captured fish will be identified to species, and measured for total length and weight. Sex and reproductive condition of Asian carp will be determined by removal of gonads in the field.

- Large hoop nets (2 m diameter, 6.4 cm square mesh) will be set overnight for a minimum of 8 net-nights on each sampling trip for comparison with standard (1.2 m diameter) hoop nets.
- Surface-to-bottom gill nets (91.4 m long x 8.5 m tied down to 6.1 m depth; 6.4, 7.6, 8.9, and 10.2 cm mesh panels) will deployed for a minimum of 4 four-hour sets during each season at each site. They will be compared with small mesh floating gill nets (45.7 m x 3.0 m; 1.9, 2.5, 3.2, 3.8, 5.1 cm mesh) and large mesh sinking gill nets (4.57 m x 1.8 m; 6.4, 7.6, 8.9, 10.2, 12.7 cm mesh).
- Great Lakes trap (pound) nets (100 m lead, 6.1 x 3.0 x 3.0 m pot, 7.6-9.1 m wings, 3.8-7.6 cm mesh) will be set for extended periods (1-3 weeks) at each site during at least 2 seasons. Pound nets will be checked periodically (1-7 day intervals, based on catch rates) during each set, at which times all captured fish will be removed from the pots for identification and measurement.

Additional new gears and gear combinations may also be incorporated into sampling efforts as they become available.

Sampling Schedule: In 2013, sampling with unconventional gears will occur seasonally (2-3 times per year) at each site. Additional sampling may occur on an as-needed basis in cooperation with other sampling and monitoring efforts.

Deliverables: Preliminary results will be reported in monthly sampling summaries. Data will be summarized and project plans updated for annual revisions of the MRP.

Water Gun Development and Testing

Participating Agencies: USGS (lead); IDNR (field support); USACE, USCG, and MWRD (project coordination)

Location: Water guns are being considered for use in fish suppression activities in the CSSC associated with maintenance of the electric barrier system. Evaluations of the technology were completed at Hanson Material Services on the Illinois River near Morris, IL and at the U.S. Geological Survey Upper Midwest Environmental Sciences Center in La Crosse, WI.

Introduction and Need: There is an immediate need to develop and implement control strategies to prevent Asian carp from entering the Great Lakes Ecosystem from the Mississippi River. Seismic technology may have potential as a physical deterrent to carp movement through the emission of high pressure underwater sound waves. These sound waves are produced by a pneumatic water gun that compresses water with a piston traveling through a cylinder. The resulting burst of compressed water induces cavitation in the water which generates a pulsed sound-pressure wave as these cavities collapse. The sound-pressure wave may deter or kill fish depending on proximity to the wave source. The pulsed sound-pressure wave generated by water gun discharge is likely to be a non-selective tool, meaning that both invasive (e.g. Asian carp) and native fishes (e.g. Gizzard Shad) will be affected. The water gun may be operated in either fixed or mobile deployments to create a barrier to deter the movement of fish. In addition to the need to assess physiological and behavioral effects of the water gun on fishes, its potential impacts on structures (e.g. canal walls) needed to be evaluated.

Status: The capacity of water gun discharge to alter the behavior of Asian carp was assessed in field trials in 2010 and 2012 at the Hanson Material Services backwater near Morris, IL. Though previous studies had not definitively characterized the response of fish to water gun discharge, the water guns were deployed in October 2011 near the electric barrier system to clear fish during barrier maintenance and considered to be successful in causing fish to move out of the electric barrier system. Preliminary pressure monitoring was completed before and during water gun operation in the CSSC near the electric barrier system. Pressure monitoring during water gun operation suggests that seismic energy transferred by the water gun was about an order of magnitude greater than that of background noise in the CSSC. Video surveillance indicated no alteration of the canal wall (i.e., no visible scalloping or removal of rock from the canal wall) nor was any disturbance to green vegetative growth on the wall visible. For more detailed results see the 2011 interim summary report document (MRRWG 2012). Additional studies were completed under controlled field conditions at the USGS Upper Midwest Environmental Sciences Center 0.5 acre earthen test pond to evaluate the response of Silver Carp to water gun discharge and to describe the pressure gradient resulting from water gun discharge. For more detailed results see the 2012 interim summary report document (MRRWG 2013).

Objectives:

1) Further Assess Structural Effects of Water Guns: Recognizing potential concerns of the USACE about possible structural impacts from water gun operation near operating waterway structures, USGS will complete additional analyses of the existing data, further develop pressure gradient maps, and plan to demonstrate the safety of water guns at a "surrogate" site that approximates the conditions at the O'Brien Lock and Dam. Potential

sites are being evaluated with testing planned during summer 2013. Pressure gradient mapping will seek to refine previously developed pressure gradient maps for the operation of the 1- and 120-in^3 water gun. Maps developed will evaluate use over the gun operational pressure range and characterize the gradient generated during single or multiple gun operation (synchronous or asynchronous operation).

2) Provide Electric Barrier System Shutdown Support: Though a potential tool to remove fish from the area between Barriers 2A and 2B and to keep fish from moving upstream past the electric barrier system during barrier maintenance, water guns are not expected to be used during barrier maintenance unless the concerns regarding potential structural impacts have been addressed. The water guns can be strategically deployed to repel all fish in the canal between Barriers 2A and 2B in a downstream direction. Methods for verifying the effectiveness of the water guns in removing fish from between barriers 2A and 2B have been developed and may include the use of split-beam hydroacoustics, side-scan SONAR, and DIDSON technology to view fish movement under the water and acoustic tagging of fish to track movement.

3) Behavioral response of fish to water gun discharge: Experiments to assess the behavioral response of Silver Carp and Bighead Carp and native fishes to water gun operation (1- and 120in^3 water guns) will be completed under controlled field conditions in the USGS UMESC experimental pond. Trials in the UMESC pond will be conducted in low-light conditions and behavioral responses will be monitored using telemetry and hydroacoustic monitoring. Field trials will be conducted in selected locations in the Illinois River near Morris or Havana, IL to assess to the response of Bighead Carp and Silver Carp and other fishes. Field trials will be designed to require minimum handling of fish, i.e. behavioral response will be evaluated using hydroacoustice monitoring of fish movement in response to stationary or mobile single or multiple gun deployments.

Questions to be addressed include:

- Does water gun operation alter (1) the relative/spatial occupancy rate (number of fish contained within known distances of the water gun / total number of fish within the system [experimental pond]) or (2) the direction of movement of fish within lentic or lotic systems.
- What is the minimum pressure gradient that deters fish from occupying a certain portion of the water column?
- Does the response of Silver Carp and Bighead Carp to water gun operation differ between species and from native species?

Sampling Schedule: Experimental pond trials will begin as soon as weather conditions allow operation of the air compressor and for filling/draining of the research pond (expected April 2013). Fish behavioral response experiments in the research pond are expected to occur from May through June 2013. Field trials in the Illinois River for behavioral response and structural effects are expected to occur between July and September 2013. Coordination with USACE, IL DNR and others is required. Water gun monitoring support during any barrier maintenance shutdowns will be scheduled in collaboration with IDNR and other partners. Adequate advance notice is required to establish contracts and prepare boats and equipment.

Deliverables: Data will be summarized for an annual interim report and project plans updated for annual revisions of the MRP. A final report of experimental results will be prepared and submitted to the MRRWG.

Long Term Objectives (1-3 years)

1) Calibrate fish behavioral responses to water gun operation: Develop deployment guidelines for use in permanent (fixed) or temporary (mobile) water gun arrays. Permanent arrays, for example, could be used to defend locks in the CSSC to keep Asian carp from moving into the Great Lakes.
2) Examination and documentation of physiological impacts of water guns on fish and aquatic invertebrates to address NEPA and other environmental impact concerns
3) Consider application to other invasive species such as zebra mussels, Round Goby, and other invasive fish and invertebrate species.
4) Conduct engineering studies of acoustic energy on navigation and other in-water structures.

Alternative Pathway Surveillance in Illinois – Law Enforcement

Participating Agencies: IDNR (lead);

Location: Surveillance and enforcement efforts will focus in the Chicago Metropolitan area and will ultimately expand throughout Illinois and additional states.

Introduction and Need: The Lacey Act prohibits the interstate movement of live organisms that are on a list of injurious species. Currently, three species of Asian carp—Silver, Bighead, and Black Carp - are on that list. Although the Lacey Act prohibits movement of live Asian carp across state lines, it does not prohibit Asian carp aquaculture or the possession of live Asian carp in many states. Each of the Great Lakes states and the Province of Ontario has made it illegal to possess live Asian carp within its jurisdiction. Despite the Lacey Act and state laws, the movement of live Asian carp persists. Several recent arrests at the U.S./Canadian border illustrate this disconnect between the law and observed practice. In one instance, a shipper's tanks contained live Asian carp in water. In another instance, the shipper's dewatered tanks contained Asian carp on ice; upon seizure, law enforcement officers observed moving Asian carp and placed these fish in water, where they quickly righted themselves and began swimming. In all instances, the carps originated from American fish farms outside of the Great Lakes basin. Enforcement of U.S. and Canadian laws regulating the movement of live fish is essential to prevent establishment of invasive species which includes Asian carp in the Great Lakes basin.

In 2012, operations in the Chicago area gained preliminary intelligence into illegal fish importation and invasive species trade. Expanding upon this intelligence, the IDNR Invasive Species Unit conducted numerous surveillance operations resulting in many citations written for illegal activities.

Objectives: Continue to build on the newly formed IDNR Invasive Species Unit activities. Also collaborate with other agencies with intelligence gathering and enforcement on invasive species along with illegal fish importation we propose to:

- Invasive Species Unit (ISU) along with USFWS will provide training, a power point presentation, quick reference guides, and standardized inspection procedures to Illinois State Police personnel and Conservation Police Officers throughout the State to maximize efforts to detect and interdict the illegal transportation of aquatic life.
- Design and recommend the implementation of a fish transportation inspection form to be completed by the primary law enforcement officer coming into contact with a fish hauler. The carbon copied form would be a guideline on what documentation is required and it could provide data for future investigations.
- ISU attend and represent Illinois at the 2013 multi-agency invasive species task force conference in Arkansas. ISU members will provide a presentation relating to invasive species issues and laws in Illinois. Task Force members will tour fish farms and interact with the Asian carp business community to get an inside look into the industry.
- Conduct surveillance and enforcement operations within the commercial fishing industry.

- Step up surveillance of fish haulers, area fish production facilities, and live fish markets and food establishments.
- Continue enforcement efforts focusing on the illegal bait trade in Chicago metropolitan area.
- Use intelligence previously gathered from surveillance to conduct operations and continue ongoing operations in efforts to apprehend violators of federal and state laws dealing with invasive species.
- Organize details to be implemented at boat launches throughout the State by uniformed CPOs which will focus on enforcing laws and educating fishermen on regulations established to prevent the spread of invasive species by them. The details will document violations and enforcement actions.
- ISU members will continue to attend training opportunities to remain updated on the enforcement of invasive species.
- Network with members of the multi-agency invasive species task force for the sharing of intelligence, resources, and strategies related to preventing the spread of Asian Carp.

Status: This project is on-going and has been expanded for 2013. Preliminary intelligence has been gathered and leads are being formed. Being sensitive in nature, surveillance activities, operations and arrests cannot be discussed in this document.

Methods:
Intelligence gathering and Surveillance - In 2012 inspections of Chicago area fish markets gained much of the initial intelligence to illegal fish importation and invasive species trade. The ISU will continue these impromptu inspections to gain further intelligence and to educate market owner on the current laws. GPS trackers will be utilized to follow suspected illegal fish haulers as they transport fish within Illinois. Additional surveillance equipment and methods will be utilized as investigations become more involved.

Sampling Schedule: Surveillance activities will take place at yet to be determined times throughout the year.

Deliverables: Results of inspections and enforcement activities will be summarized and reported to the MRWG, as they become available. Data will be summarized for an annual interim report and project plans updated for annual revisions of the MRP.

Alternative Pathway Surveillance in Illinois – Urban Pond Monitoring

Participating Agencies: Illinois Department of Natural Resources (lead).

Location: Monitoring will occur in Chicago area fishing ponds supported by the IDNR Urban Fishing Program.

Introduction and Need: The Illinois Department of Natural Resources (IDNR) fields many public reports of observed or captured Asian carp. All reports are taken seriously and investigated through phone/email correspondence with individuals making a report, requesting and viewing pictures of suspect fish, and visiting locations where fish are being held or reported to have been observed in the wild. In most instances, reports of Asian carp prove to be native Gizzard Shad or stocked non-natives, such as salmonids or Grass Carp. Reports of Bighead or Silver Carp from valid sources and locations where these species are not known to previously exist elicit a sampling response with boat electrofishing gear and trammel or gill nets. Typically, no Bighead or Silver Carp are captured during sampling responses. However, this pattern changed in 2011 when 20 large Bighead Carp (>48 pounds) were captured by electrofishing and netting in Flatfoot Lake and Schiller pond, both urban fishing ponds located in Cook County once supported by the IDNR Urban Fishing Program (See report: Bighead Carp in Illinois Urban Fishing Ponds 2011).

The source of Bighead Carp in urban fishing ponds has not been confirmed to date and identifying a specific source may prove impossible. However, there is building evidence that young Bighead Carp may have been unintentionally stocked in urban fishing ponds with shipments of desirable fish species. The fact that all Bighead Carp obtained from Chicago area ponds to date have been large fish of similar size and age also points towards stocking as a potential source. These demographics indicate that stocking probably occurred during a limited number of events sometime before 2005 and likely before the State of Illinois banned transport of live Bighead Carp in 2002-2003.

As a further response to the Bighead Carp in Flatfoot Lake and Schiller Pond, IDNR reviewed Asian carp captures in all fishing lakes included in the IDNR Urban Fishing Program located in the Chicago Metropolitan area. Of the 21 urban fishing lakes in the program, six have verified captures of Bighead Carp either from sampling, pond rehabilitation with piscicide, or natural seasonal die offs; two had reported sightings of Asian carp that were not confirmed by sampling (Table 1). The distance from urban fishing ponds to Lake Michigan ranged from 0.1 to 25.7 miles. The distance from ponds to Chicago Area Waterway System (CAWS) waterways upstream of the electric barrier system ranged from 0.01 to 5.1 miles. Although some ponds are located near Lake Michigan or CAWS waterways, most are isolated and have no surface water connection to the Lake or CAWS upstream of the electric barrier system (Table 1). Lagoons in Gompers Park, Jackson Park, and Lincoln Park are the exceptions. The Lincoln Park South Lagoon is no longer a potential source of Asian carp because the fish population was rehabilitated in 2008, after which it was dropped as a Chicago urban stocking site. Gompers Park Lagoon and Jackson Park Lagoon have never had a report of Asian carp, nor have any been captured or observed during several past sampling events. Nevertheless, examining all urban fishing ponds close to CAWS

Table 1. A list of Chicago area urban fishing ponds, reported and verified occurrence of Bighead Carp, proximity to Lake Michigan (LM) and the Chicago Area Waterway System (CAWS), and surface water connection to LM and CAWS. NR indicates none reported or observed/captured during routine electrofishing samples. DCEL is DC electrofishing and TN/GN is trammel/gill net. Waterways are: LM=Lake Michigan; CALSC = Cal-Sag Channel; CALR = Calumet River; CSSC = Chicago Sanitary and Ship Canal; NBCR = North Branch Chicago River; LCALR = Little Calumet River; BUBCR = Bubbly Creek; NSC = North Shore Channel; DH = Diversey Harbor; and JH = Jackson Harbor.

Urban Fishing Pond	County	Town	Presence of bighead carp (number-year)	Distance to LM (miles)	Distance to CAWS (miles-waterway)	Surface water connection to LM and CAWS
Commissioner's Park Pond	Cook	Alsip	NR	9.7	0.9-CALSC	None
Auburn Park Lagoon	Cook	Chicago	NR	3.7	5.1-CALR	None
Columbus Park Lagoon	Cook	Chicago	3 winterkill-2011	7.8	4.1-CSSC	None
Douglas Park Lagoon	Cook	Chicago	NR	4.2	1.8-CSSC	None
Garfield Park Lagoon	Cook	Chicago	1 summerkill-2010 2 TN/GN-2012	5.0	3.2-NBCR	None
Gompers Park Lagoon	Cook	Chicago	NR	4.1	0.01-NBCR	Overflow to NBCR
Humboldt Park Lagoon	Cook	Chicago	3 TN/GN-2012	3.8	2.2-NBCR	None
Jackson Park Lagoon	Cook	Chicago	NR	0.1	4.7-CALR	Overflow to JH
Lincoln Park South Lagoon	Cook	Chicago	3 pond rehab-2008	0.1	1.3-NBCR	Overflow to DH
Marquette Park Lagoon	Cook	Chicago	NR	6.3	4.2-CSSC	None
McKinley Park Lagoon	Cook	Chicago	Reported, none sampled	3.8	0.9-CSSC	None
Sherman Park Lagoon	Cook	Chicago	NR	3.6	1.9-BUBCR	None
Washington Park Lagoon	Cook	Chicago	NR	1.7	3.3-BUBCR	None
Riis Park Lagoon	Cook	Chicago	NR	7.7	4.8-NBCR	None
Flatfoot Lake	Cook	Dolton	15 DCEL-2011 2 TN/GN-2011	5.0	0.2-LCALR	None
Lake Owens	Cook	Hazelcrest	NR	12.2	4.8-LCALR	None
Cermak Quarry	Cook	Lyons	NR	10.7	1.3-CSSC	None
Lake Shermerville	Cook	Northbrook	NR	6.6	4.8-NBCR	None
Schiller Pond	Cook	Schiller Park	3 DCEL-2011	10.1	7.1-NBCR	None
Elliot Lake	DuPage	Wheaton	NR	25.7	14.5-CSSC	None
Community Park Pond	Lake	Mundelein	NR	9.2	22.7-NSC	None

waterways or Lake Michigan is of importance due to the increased likelihood of human transfers of fish between waters within close proximity to one another.

In addition to ponds once supported by the IDNR Urban Fishing Program, ponds that yielded positive detections for Asian carp eDNA were also reviewed. A total of eight ponds had positive detections for Asian carp eDNA, two of which were IDNR urban fishing ponds (Jackson Park and Flatfoot Lake; Table 2). The distance from these ponds to Lake Michigan ranged from three to 19.5 miles. The distance from ponds to Chicago Area Waterway System (CAWS) waterways

upstream of the electric barrier system ranged from 0.03 to 2.7 miles. Though positive eDNA detections do not necessarily represent the presence of a live fish (e.g., do positive detections represent live or dead fish, or result from sources other than live fish, such as DNA from the guano of piscivorous birds?), they should be examined for the presence of live Asian carp given their proximity to CAWS waterways.

Table 2. A list of Chicago area ponds with positive detections for Asian carp eDNA, verified occurrence of Bighead Carp, proximity to Lake Michigan (LM) and the Chicago Area Waterway System (CAWS), and surface water connection to LM and CAWS. NR indicates none reported or observed/captured during routine electrofishing samples. DCEL is DC electrofishing and TN/GN is trammel/gill net. Waterways are: LM=Lake Michigan; CALSC = Cal-Sag Channel; CALR = Calumet River; GCALR = Grand Calumet River; LCAL = Lake Calumet; LCALR = Little Calumet River; JH = Jackson Harbor. (*) denotes IDNR urban fishing ponds.

Pond	County	Town	Presence of Bighead carp (number-year)	Distance to LM (miles)	Distance to CAWS (miles-waterway)	Surface water connection to LM and CAWS
Jackson Park*	Cook	Chicago	NR	0.1	4.7-CALR	Overflow to JH
Powderhorn Lake	Cook	Chicago	NR	3.5	0.5-GCALR	None
Harborside Lake	Cook	Chicago	NR	3.0	0.03-LCAL	Overflow to LCAL
Flatfoot Lake*	Cook	Dolton	15 DCEL-2011 2 TN/GN-2011	5.0	0.2-LCALR	None
Sag Quarry West	Cook	Lemont	NR	19.5	0.06-CALSC	None
Horsetail Lake	Cook	Palos Park	NR	18.0	1.2-CALSC	None
Tampier Lake	Cook	Palos Park	NR	19.5	2.7-CALSC	None
Joe's Pond	Cook	Willow Springs	1 TN/GN-2012	17.0	0.9-CALSC	None

Objectives:

1) Monitor for the presence of Asian carp in Chicago area fishing ponds supported by the urban fishing program;
2) Obtain life history, age and otolith microchemistry information from captured Asian carp;

Status: This project began in 2011 and is on-going. In 2011, four Chicago area ponds were sampled. Seventeen large Bighead Carp were removed from Flatfoot Lake and three Bighead Carp were removed from Schiller pond using pulsed-DC electrofishing and trammel or gill nets. Nineteen Chicago area ponds were sampled in 2012. A total of six Bighead Carp were removed from three ponds (Humboldt Park, Garfield Park, and Joe's Pond). Three Bighead Carp were removed from Humboldt Park with weights of 62, 34 and 46 pounds. Two Bighead Carp were captured and removed from Garfield Park weighing 53 and 46 pounds. One Bighead Carp was removed from Joe's Pond with a weight of 34 pounds. The three Bighead Carp from Humboldt Park are currently on exhibit at the John G. Shedd Aquarium. For more detailed results see Bighead Carp in Illinois Urban Fishing Ponds Report, Illinois Department of Natural Resources, Division of Fisheries, Aquatic Nuisance Species Program (2011) at http/asiancarp.us.

Methods: The sample design includes intensive electrofishing and netting at all ponds in the urban fishing program that Bighead Carp were collected from in 2012 to ensure that no more Bighead Carp remain. We also recommend repeat sampling of ponds that had positive detections for Asian carp DNA with Powderhorn Lake being the highest priority as it was not sampled in 2012. Sampling will take place in the spring and fall of 2013.

Electrofishing Protocol - All electrofishing will use pulsed-DC current and include 1-2 netters (two netters preferred). The operator may switch the pedal on and off at times to prevent pushing fish in front of the boat and increasing the chances of catching an Asian carp.

Netting Protocol –Nets used will be large mesh (3.5-4.5 inches) trammel or gill nets 10 feet high and in lengths of 100 or 200 yards. Sets will include driving fish into the nets with noise (e.g., plungers on the water surface, pounding on boat hulls, or racing tipped up motors).

Otolith Microanalysis and Aging- Asian carp captured in urban fishing ponds will have head, vertebrae, and post-cleithra removed and sent to SIUC for otolith microchemistry analysis and aging.

Deliverables: Results of each sampling event will be reported for monthly sampling summaries. An annual report summarizing sampling results will be provided to the MRWG, agency partners, and any other interested parties.

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Appendix A. Participants of the Monitoring and Response Workgroup, including their roles and affiliations.

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Jeff Stewart, USFWS
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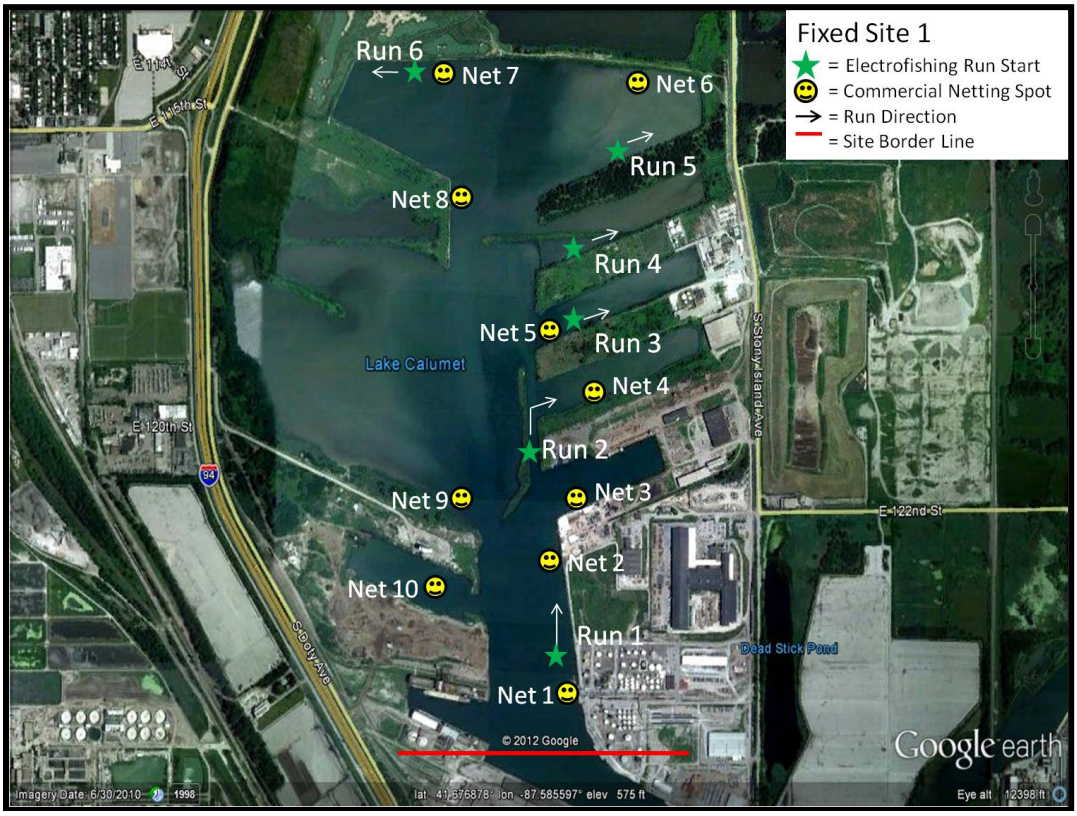
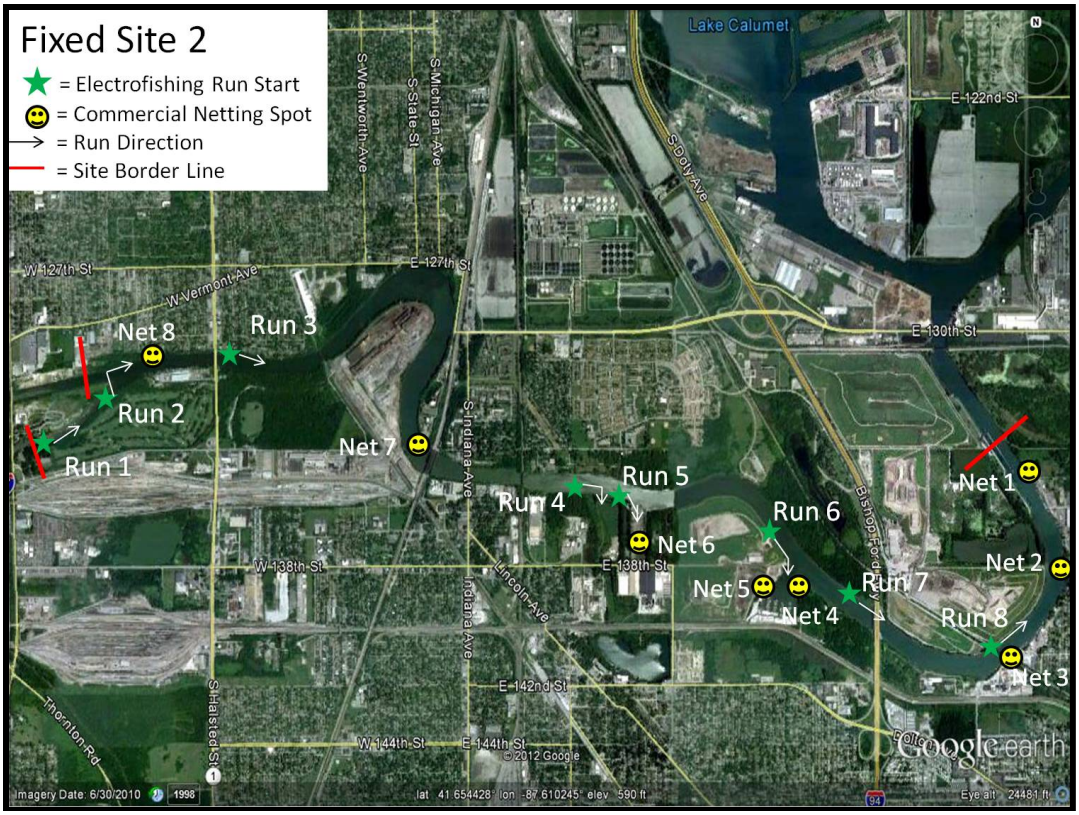
Appendix B. Detailed Maps of Fixed and Random Site Sampling Locations.

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= Commercial Netting Spot
= Run Direction
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S Wentworth Ave
S State St
S Michigan Ave
S Doty Ave
W 127th St
E 127th St
W Vermont Ave
Net 8
Run 3
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Run 1
Net 7
S Indiana Ave
E 130th St
Net 1
Run 5
Run 4
Run 6
Net 6
W 138th St
E 138th St
Lincoln Ave
Net 5
Net 4
Bishop Ford Fwy
Run 7
Net 2
Run 8
Net 3
E 142nd St
Thornton Rd
S Halsted St
W 144th St
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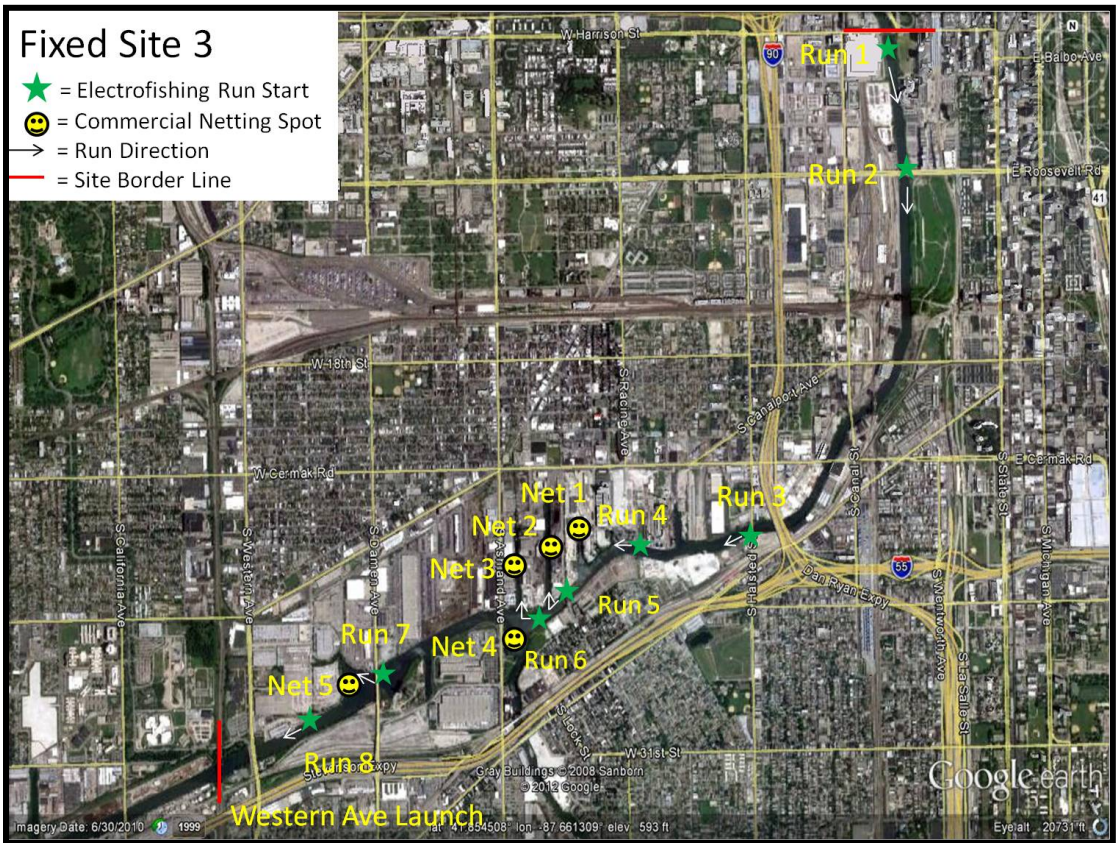
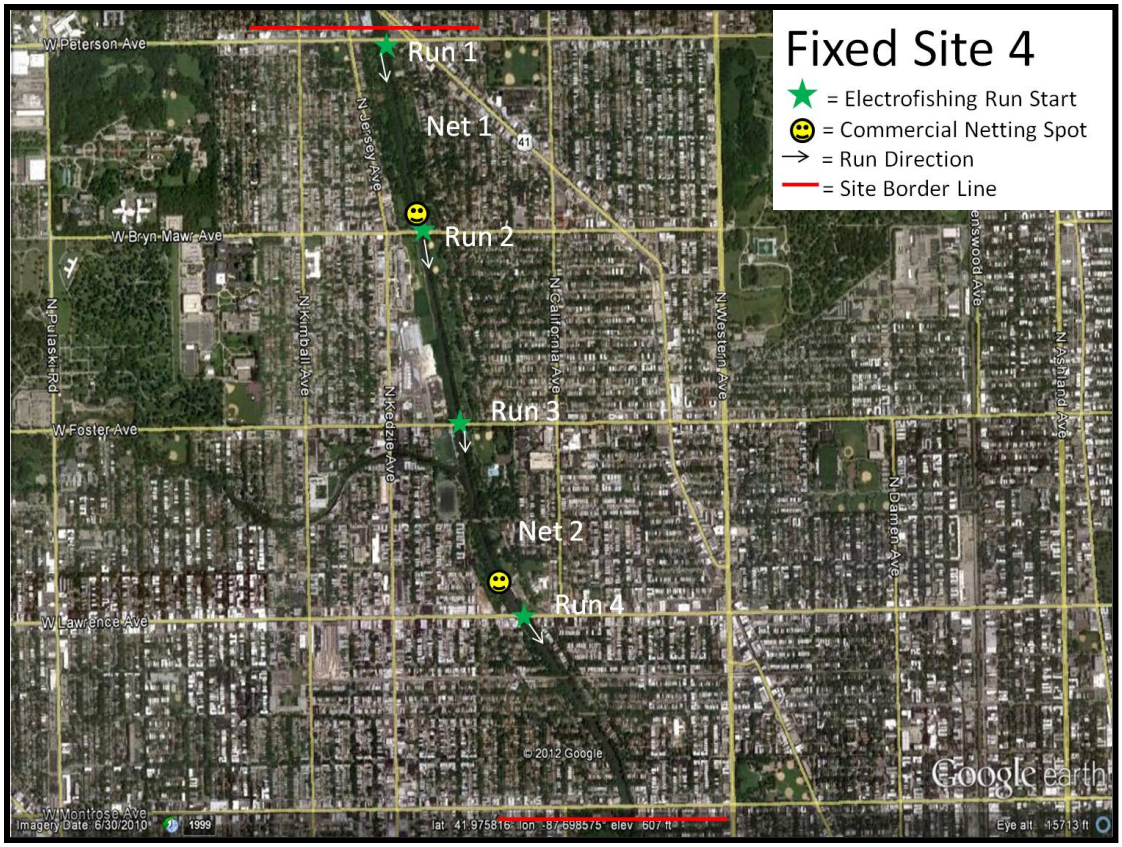
Eye alt 24481 ft


Fixed Site 3
= Electrofishing Run Start
= Commercial Netting Spot
= Run Direction
= Site Border Line
W Harrison St
E Balbo Ave
Run 1
Run 2
E Roosevelt Rd
W 18th St
S Racine Ave
S Canalport Ave
S Canal St
W Cermak Rd
E Cermak Rd
S State St
S Wentworth Ave
S Michigan Ave
S California Ave
S Western Ave
S Oakley Ave
Net 1
Net 2
Run 4
Run 3
Net 3
S Ashland Ave
S Damen Ave
Dan Ryan Expy
Run 5
Run 7
Net 4
Run 6
Net 5
S Loomis St
W 31st St
Run 8
Gray Buildings © 2008 Sanborn
© 2012 Google
Western Ave Launch
Google earth
imagery Date: 6/30/2010
1999
lat 41.834508° lon -87.661309° elev 593 ft
Eye alt 20731 ft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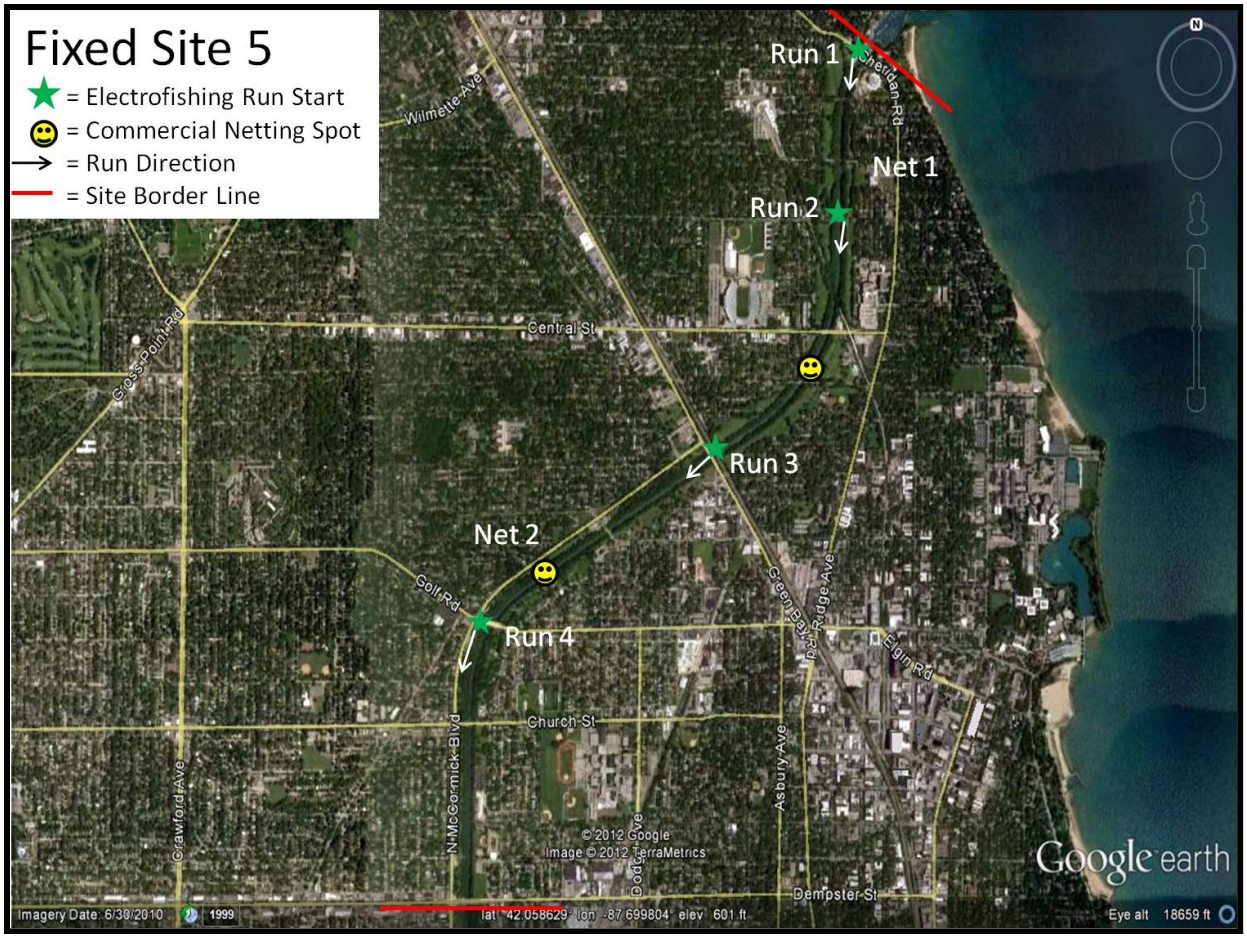
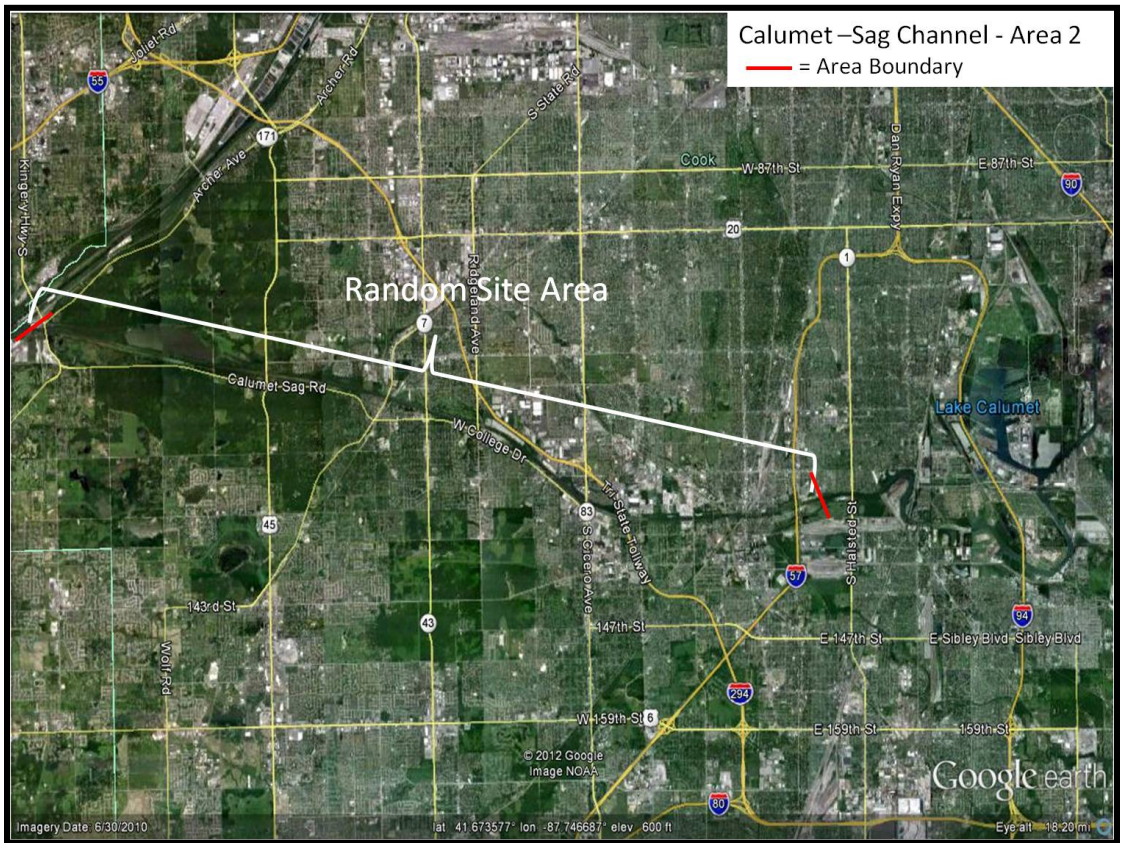
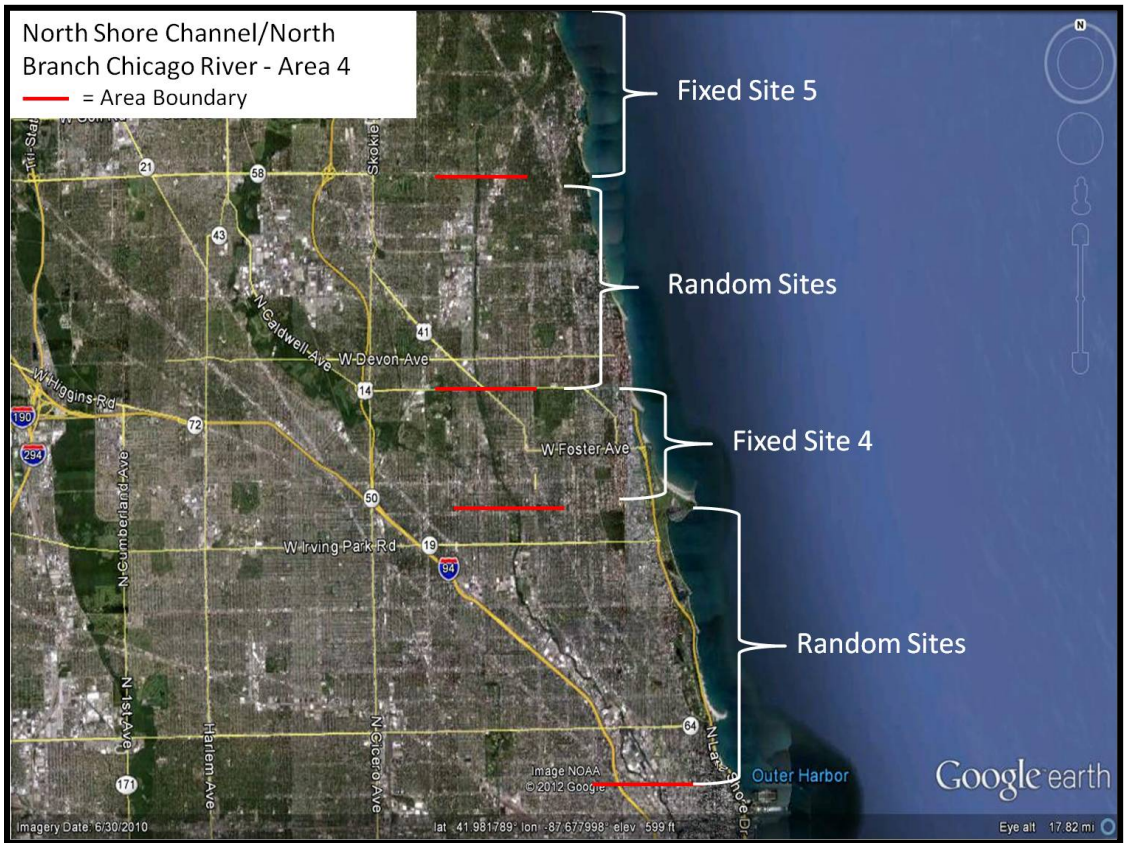
= Site Border Line
Run 1
Net 1
Run 2
Run 3
Net 2
Run 4
W Peterson Ave
W Bryn Mawr Ave
W Foster Ave
W Lawrence Ave
W Montrose Ave
N Jersey Ave
N Kimball Ave
N Kedzie Ave
N California Ave
N Western Ave
N Damen Ave
N Pulaski Rd
© 2012 Google
Google earth


Fixed Site 5
= Electrofishing Run Start
= Commercial Netting Spot
= Run Direction
= Site Border Line
Run 1
Net 1
Run 2
Run 3
Net 2
Run 4
Wilmette Ave
Sheridan Rd
Central St
Gross Point Rd
Golf Rd
Green Bay Rd
Ridge Ave
Elgin Rd
Church St
Crawford Ave
N McCormick Blvd
Asbury Ave
Dodge Ave
Dempster St
© 2012 Google
Image © 2012 TerraMetrics
Google earth
Imagery Date: 6/30/2010
1999
lat 42.058629 lon -87.699804 elev 601 ft
Eye alt 18659 ft

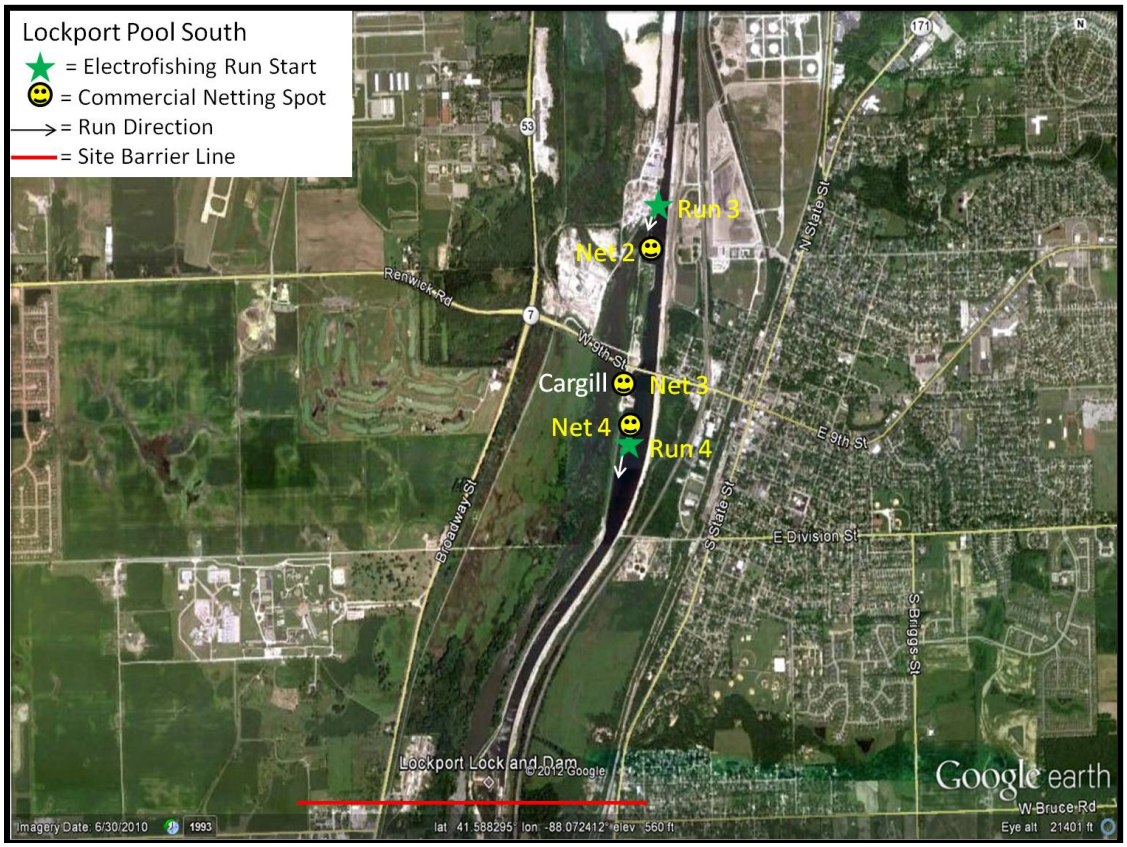

Calumet River - Area 1
= Area Boundary
E 87th St
Chicago Skyway
Highway 12
Bishop Ford Fwy
S Halsted St
Random Site Area
Lake Calumet
Wolf Lake
Calumet Ave
© 2012 Google
Image © 2012 TerraMetrics
Google earth
Imagery Date: 6/30/2010
lat 41.697566° lon -87.564513° elev 586 ft
Eye alt 39389 ft

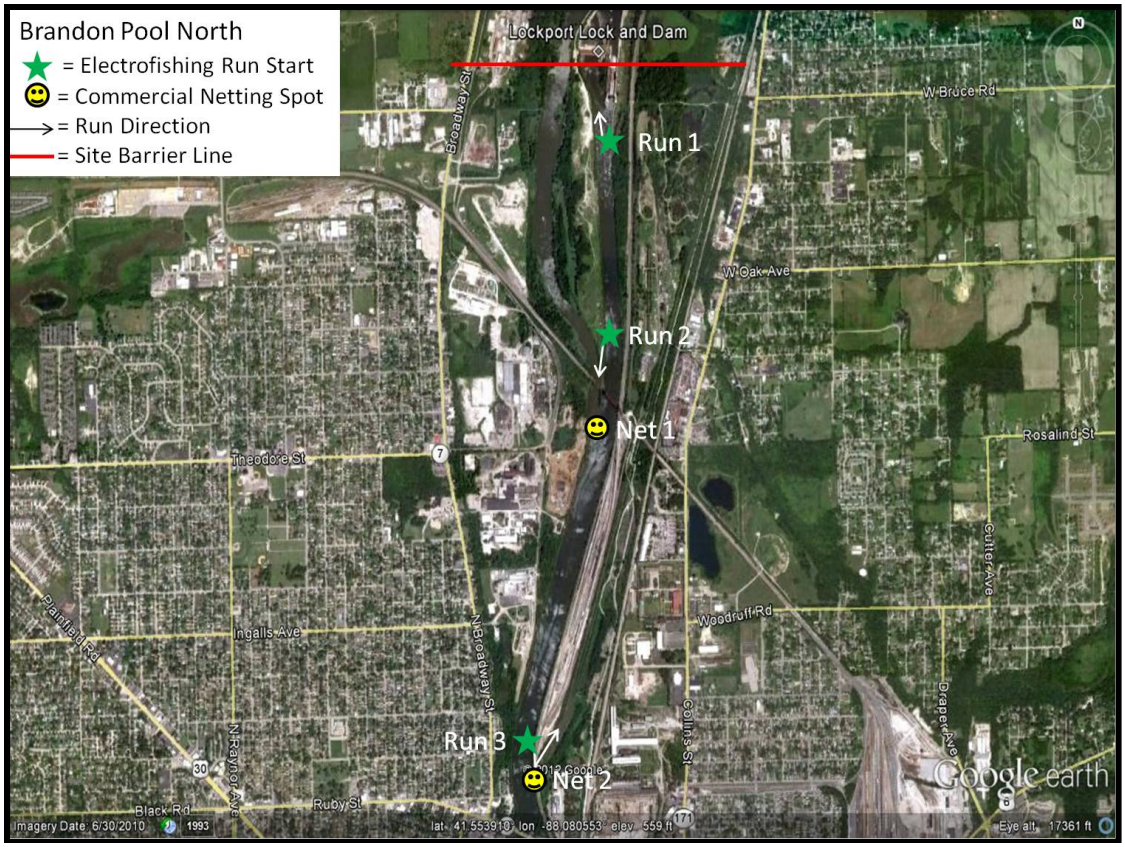

Calumet –Sag Channel - Area 2
= Area Boundary
Joliet Rd
Archer Rd
S State Rd
Archer Ave
Kingery Hwy S
Cook
W 87th St
E 87th St
Dan Ryan Expy
Random Site Area
Ridgeland Ave
Calumet Sag Rd
W College Dr
Lake Calumet
Thornton Transitway
Torrence Ave
S Halsted St
143rd St
147th St
E 147th St
E Sibley Blvd
Sibley Blvd
Wolf Rd
W 159th St
E 159th St
159th St
© 2012 Google
Image NOAA
Google earth
Imagery Date: 6/30/2010
lat 41.673577° lon -87.746687° elev 600 ft
Eye alt 18.20 mi

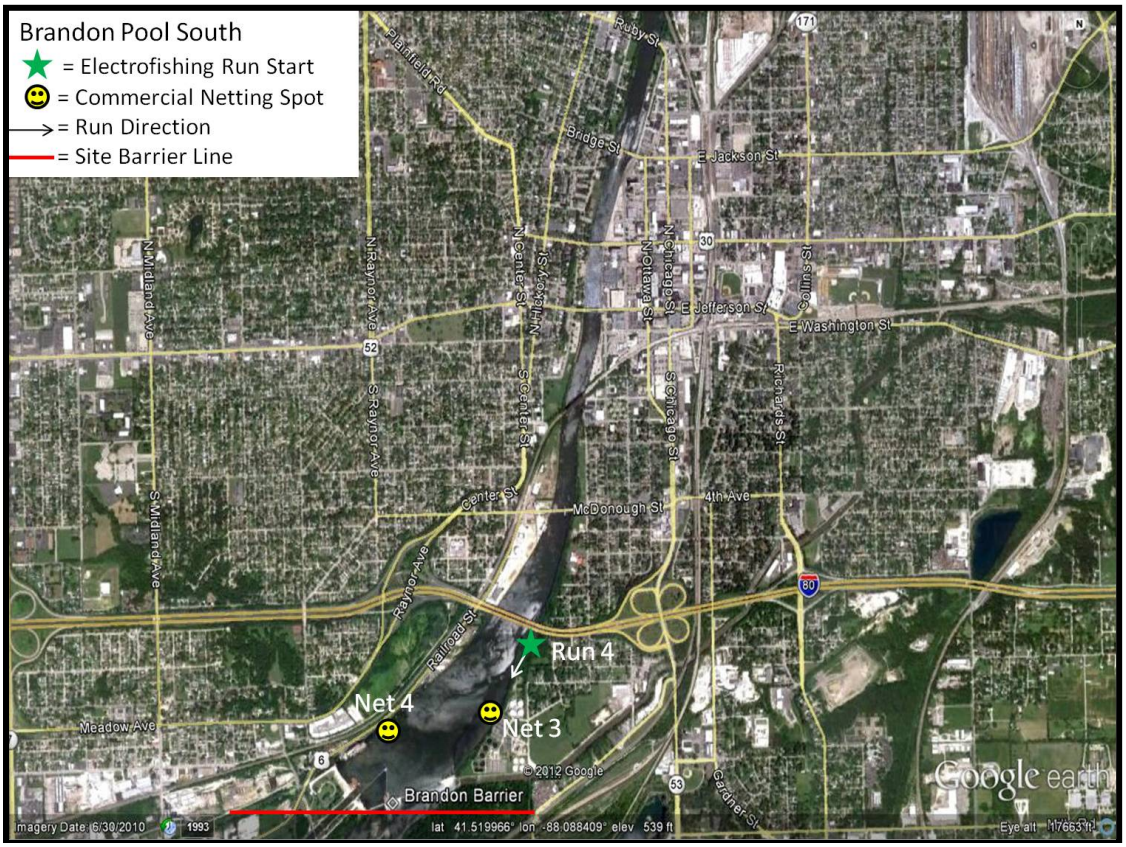

CSSC - Area 3
= Area Boundary
Random Sample Area
Roosevelt Rd
Butterfield Rd
DuPage
E Ogden Ave
W Ogden Ave
Stevenson Expy
Archer Rd
State Rd
W 87th St
Highway 12
Cook
Main St
Lincoln Ave
Bolingbrook Dr
Veterans Memorial Tollway S
Lemont Rd
Archer Ave
South La Grange Road
S Harlem Ave
Ridgeland Ave
S Cicero Ave
S Halsted St
© 2012 Google
Google earth
Imagery Date: 6/30/2010
lat 41.776242° lon -87.857290° elev 631 ft
Eye alt 22.58 mi


North Shore Channel/North Branch Chicago River - Area 4
= Area Boundary
Fixed Site 5
Random Sites
Fixed Site 4
Random Sites
W Devon Ave
W Higgins Rd
W Foster Ave
W Irving Park Rd
N Caldwell Ave
N Cumberland Ave
N 1st Ave
Harlem Ave
N Cicero Ave
Skokie
Outer Harbor
Image NOAA
© 2012 Google
Google earth
Imagery Date: 6/30/2010
lat 41.981789° lon -87.677998° elev 599 ft
Eye alt 17.82 mi


Lockport Pool North
= Electrofishing Run Start
= Commercial Netting Spot
= Run Direction
= Site Barrier Line
Dispersal Barrier
E Romeoville Rd
Run 1
W 135th St
Run 2
Net 1
S Independence Blvd
Archer Ave
W 151st St
N Weber Rd
Google earth
Imagery Date: 6/30/2010
1993
Eye alt 18091 ft


Lockport Pool South
= Electrofishing Run Start
= Commercial Netting Spot
= Run Direction
= Site Barrier Line
Run 3
Net 2
N State St
Renwick Rd
W 9th St
Cargill
Net 3
Net 4
Run 4
E 9th St
Broadway St
S State St
E Division St
S Briggs St
Lockport Lock and Dam
W Bruce Rd
Google earth
Imagery Date: 6/30/2010
1993
Eye alt 21401 ft


Brandon Pool North
= Electrofishing Run Start
= Commercial Netting Spot
= Run Direction
= Site Barrier Line
Lockport Lock and Dam
Run 1
Run 2
Net 1
Run 3
Net 2
Broadway St
W Bruce Rd
W Oak Ave
Rosalind St
Carter Ave
Draper Ave
Collins St
Woodruff Rd
Theodore St
Ingalls Ave
Plainfield Rd
N Broadway St
N Raynor Ave
Black Rd
Ruby St
Google earth


Brandon Pool South
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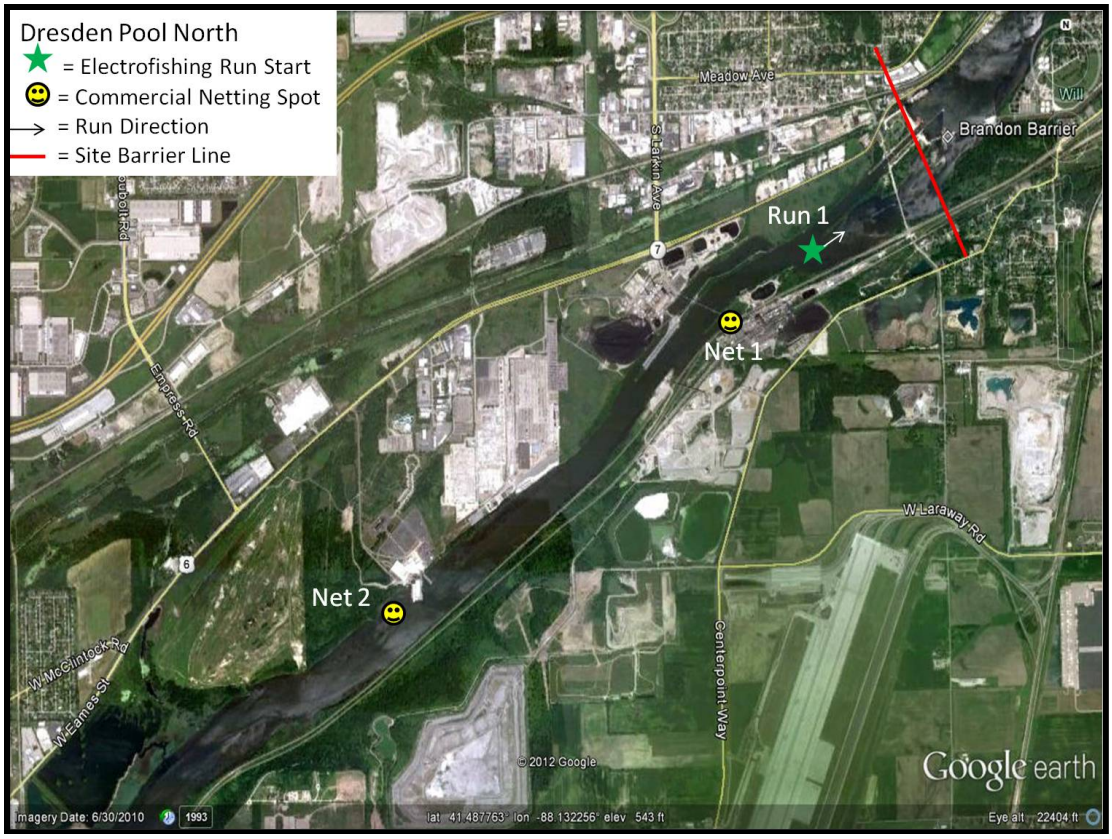
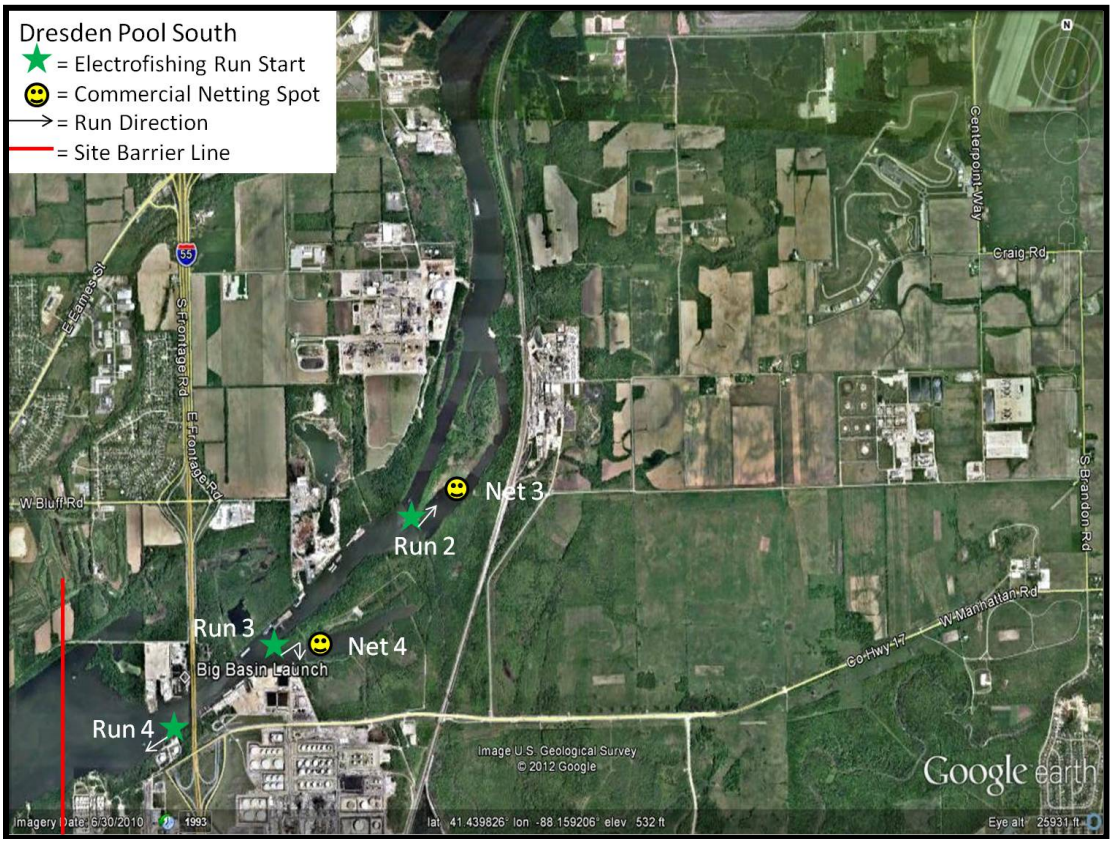
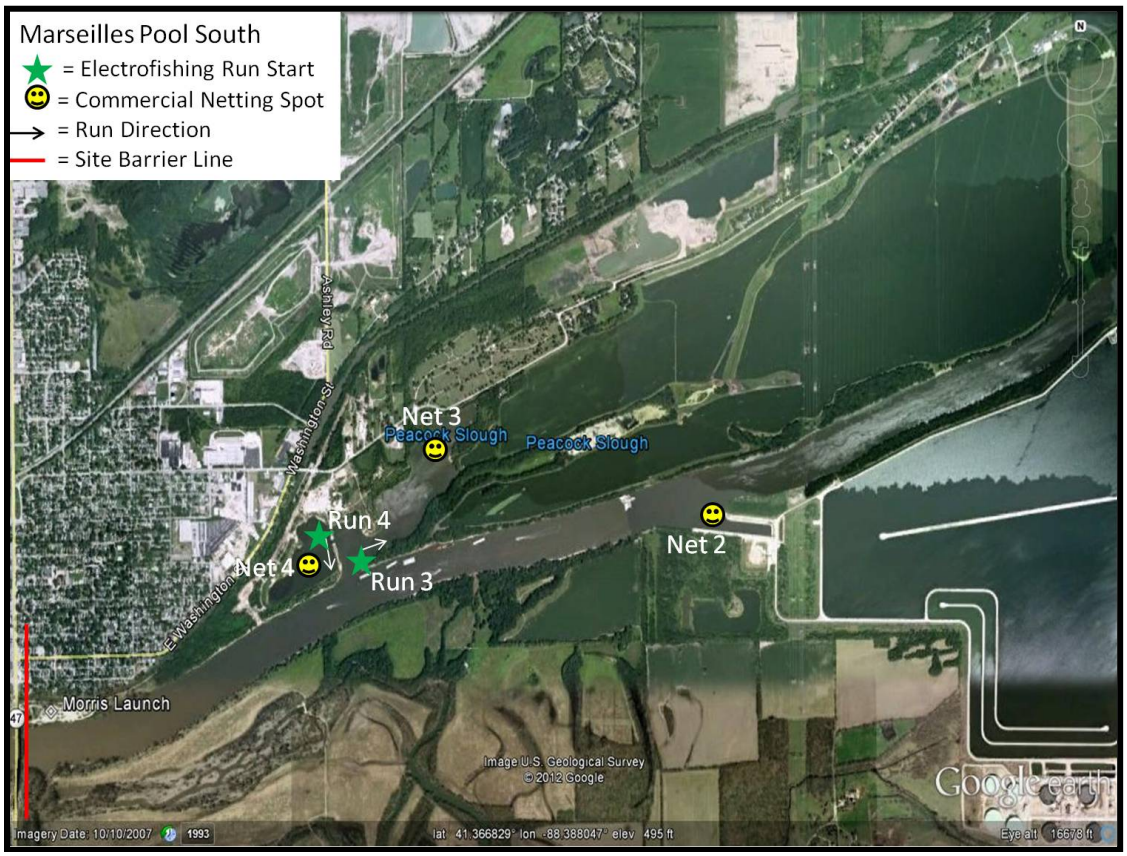
= Commercial Netting Spot
= Run Direction
= Site Barrier Line
Run 4
Net 4
Net 3
Brandon Barrier
Ruby St
Plainfield Rd
Bridge St
E Jackson St
E Jefferson St
E Washington St
N Center St
S Center St
N Chicago St
S Chicago St
N Ottawa St
S Gouin St
Richards St
N Midland Ave
S Midland Ave
N Raynor Ave
S Raynor Ave
Center St
McDonough St
4th Ave
Raynor Ave
Railroad St
Meadow Ave
Gardner St
Google earth


Dresden Pool North
= Electrofishing Run Start
= Commercial Netting Spot
= Run Direction
= Site Barrier Line
Meadow Ave
S Larkin Ave
Brandon Barrier
Run 1
Net 1
Empress Rd
W Laraway Rd
Net 2
W McClintock Rd
W E Ames St
Centerpoint Way
© 2012 Google
Google earth
Imagery Date: 6/30/2010
1993
lat 41.487763 lon -88.132256 elev 543 ft
Eye alt 22404 ft


Dresden Pool South
= Electrofishing Run Start
= Commercial Netting Spot
= Run Direction
= Site Barrier Line
Centerpoint Way
Craig Rd
E Ames St
S Frontage Rd
E Frontage Rd
W Bluff Rd
Net 3
Run 2
Run 3
Net 4
Big Basin Launch
Run 4
S Brandon Rd
W Manhattan Rd
Go-Hwy-17
Image U.S. Geological Survey
© 2012 Google
Google earth
Imagery Date: 6/30/2010
1993
lat 41.439826 lon -88.159206 elev 532 ft
Eye alt 25931 ft


Marseilles Pool North
= Electrofishing Run Start
= Commercial Netting Spot
= Run Direction
= Site Barrier Line
Run 2
Run 1
Negro Slough
Net 1
Image U.S. Geological Survey
© 2012 Google
Google earth


Marseilles Pool South
= Electrofishing Run Start
= Commercial Netting Spot
= Run Direction
= Site Barrier Line
Net 3
Peacock Slough
Peacock Slough
Run 4
Net 4
Run 3
Net 2
Morris Launch
Image U.S. Geological Survey
© 2012 Google
Google earth

Appendix C. Handling Captured Asian Carp and Maintaining Chain-of-Custody Records

Chain-of-custody is a legal term that refers to the ability to guarantee the identity and integrity of a sample from collection through reporting of the test results. The following are general guidelines to keep chain-of-custody intact throughout the fish collection process.

These procedures should be followed when any Bighead or Silver carp is collected in the Chicago Area Waterway (from Lockport Lock and Dam to Lake Michigan, but also areas where they have not previously been collected (e.g. Brandon Road Pool, Des Plaines River, or Lake Michigan).

1. Keep the number of people involved in collecting and handling samples and data to a minimum.

2. Only allow authorized people associated with the project to handle samples and data. Always document the transfer of samples and data from one person to another on chain-of-custody forms. No one who has signed the chain-of-custody form shall relinquish custody without first having the chain-of-custody form signed by the next recipient.

3. Always accompany samples and data with their chain-of-custody forms. The chain-of -custody form must accompany the sample.

4. Ensure that sample identification and data collected are legible and written with permanent ink.

Specific Instructions for Handling Asian Carp:

1. A. If the boat crew believes they have collected an Asian carp, they should cease further collection and take a GPS reading of the location at which the Asian carp was found or mark the location on a map provided.

   B. The boat crew leader should immediately notify a lead operations coordinator or chief, who will immediately notify the Incident Commander and the Conservation Police Commander, if present. If a command structure is not in place, then immediately contact an Illinois Conservation Police Officer (CPO) by contacting the IDNR Region 2 law office at 847-608-3100 x 2056.

   C. The boat crew will then take the fish to a staging area for identification by the fish biologist stationed at the site. If a staging area has not been designated, the boat crew should proceed to a predetermined meeting location and await the arrival of the CPO. The boat crew will not leave until the CPO arrives and they have recorded the GPS reading on a chain-of-custody form and signed the form over to the CPO. The CPO is to remain with the fish at all times.

D. Once a fish biologist at the staging area makes a positive visual identification, he/she will identify the fish with a fish tag; take pictures of the tagged fish (See spawn patch preservation and analysis appendix for photo request, Appendix H); measure its total length (mm) and weight (g); determine the fish's gender; identify reproductive status and gonad development as immature, mature – green, mature – ripe, mature - running ripe, and mature – spent; place the fish in a plastic bag; and seal the fish in a cooler with wet ice. The fish biologist at the staging area will place evidence tape across the opening of the cooler and initial it. The fish biologist at the staging area or when no staging area has been designated, the boat crew leader will give the sealed cooler to the IDNR CPO. The fish is to remain under IDNR control at all times.

E. The CPO will then deliver the sealed fish and chain-of-custody form to the sampling laboratory on site or make arrangements for transport to the genetics laboratory at the University of Illinois (contact: Dr. John Epifanio). Soft tissue for genetic testing and hard tissue for aging and/or chemical analysis will be removed at the UIUC laboratory. Additional soft tissue samples will be collected for other cooperating genetics laboratories (e.g., ERDC), as needed. Hard tissue will be transported to SIUC for analysis (contact: Dr. Jim Garvey). Chain-of-custody will be maintained when transporting hard tissue between university laboratories.

2. Only authorized IDNR tissue samplers or persons designated by an operations coordinator or chief will unseal the fish and remove the tissue samples from the fish for preservation and delivery to the lab. The lab samples will maintain the same sample ID as the subject fish but will also include an additional sequential letter (AC 001a, AC001b, AC002a, AC002b, etc) for multiple tissue samples from one fish. While sampling is occurring, the fish and samples will remain under supervision of the IDNR CPO who will maintain the chain-of-custody form.

3. All Asian carp captured during response actions should be treated with care, handled minimally (no photo ops prior to tissue sampling), and transported to the staging area where they will be stored on ice in a cooler (no plastic bags). Captured fish cannot be frozen or preserved with chemicals, as these techniques distort the DNA. The USACE Engineer Research and Development Center (ERDC) has been designated to obtain a tissue sample from any Bighead Carp or Silver Carp collected during a response action. The preferred tissue for DNA analysis is a pectoral fin (the entire fin) removed with a deep cut in order to include flesh and tissue of the fin base. The fin and tissue sample will be stored in a vial containing ethanol preservative (USACE will provide vials and preservative). Samples will be transported to ERDC for sequencing and comparison to the eDNA found in the pool.

	CHAIN OF CUSTODY RECORD	File No. Inv.

Date and Time of Collection:	**River Reach:**	**Collected By:**

Notes:

Collection No.	**Description of Collection (include river reach, river mileage (if known), and any serial numbers):**

Collection No.	**From: (Print Name, Agency)** **To: (Print Name, Agency)**	**Release Signature:**	**Release Date:**	**Delivered Via:** □ **U.S. Mail** □ **In Person** □ **Other:**
Collection No.	**From: (Print Name, Agency)** **To: (Print Name, Agency)**	**Release Signature:**	**Release Date:**	**Delivered Via:** □ **U.S. Mail** □ **In Person** □ **Other:**
Collection No.	**From: (Print Name, Agency)** **To: (Print Name, Agency)**	**Release Signature:**	**Release Date:**	**Delivered Via:** □ **U.S. Mail** □ **In Person** □ **Other:**
Collection No.	**From: (Print Name, Agency)** **To: (Print Name, Agency)**	**Release Signature:**	**Release Date:**	**Delivered Via:** □ **U.S. Mail** □ **In Person** □ **Other:**
Collection No.	**From: (Print Name, Agency)** **To: (Print Name, Agency)**	**Release Signature:**	**Release Date:**	**Delivered Via:** □ **U.S. Mail** □ **In Person** □ **Other:**
Collection No.	**From: (Print Name, Agency)** **To: (Print Name, Agency)**	**Release Signature:**	**Release Date:**	**Delivered Via:** □ **U.S. Mail** □ **In Person** □ **Other:**

Appendix D. Shipping, Handling, and Data Protocols for Wild Captured Black Carp and Grass Carp.

Any suspect black carp collected in the wild in the United States and grass carp collected in the Great Lakes Basin, or other novel locations in the U.S., should be immediately reported to the appropriate resource management agency in the state where the fish was collected. Do ***not*** release suspect black or grass carp unless required by state laws or instructed to do so by the resource management agency.

Differentiating black carp from grass carp using diagnostic external characteristics can be very challenging, especially when the two species are not being compared side-by-side. An identification fact sheet is attached for your reference. Careful attention should be given in waters where grass carp are known to occur to confirm that captured individuals are indeed grass carp and not black carp. If you are not positive of the species identification you should report the collection to the appropriate resource management agency to get assistance and further instructions.

Collection information, basic biological data, and digital images should be collected for any suspect black or grass carp as soon as possible after capture. In addition to collection and basic biological data, we are interested in collecting multiple structures and organs from each fish for management and research purposes. Protocols are provided for 1) collection information, basic biological data, and digital images; 2) removal, preparation, and shipment of eyes for ploidy analysis; and 3) preparation and shipment of black and grass carp carcasses.
These protocols are intended to provide resource management agencies, or authorized personnel, with streamlined instructions for the proper collection, preparation, and shipping of data, samples, and carcasses. It is important that all collections of black and grass carp (from the identified locations above) are immediately reported to the appropriate resource management agency in the state where the fish was collected before collecting more than collection information, basic biological data, and digital images.

Step 1: Data Collection

1. Record GPS Location (if available, otherwise a description of collection location);
2. Record date and time of capture, method of capture, and collecting individual or agency;
3. Record fish weight, girth (Figure 1), total and fork lengths, and species (number samples if necessary);
4. Take high resolution digital pictures:
   a. Lateral view of fish's entire left side (Figure 1),
   b. Close-up lateral view of head (Figure 2),
   c. Dorsal view of head with mouth ***fully*** closed (taken from directly above the fish's head; Figure 3).
5. Record name, telephone number, and/or email address for point of contact;
6. E-mail data and digital images to Sam Finney at sam_finney@fws.gov.
7. Proceed to Step 2.

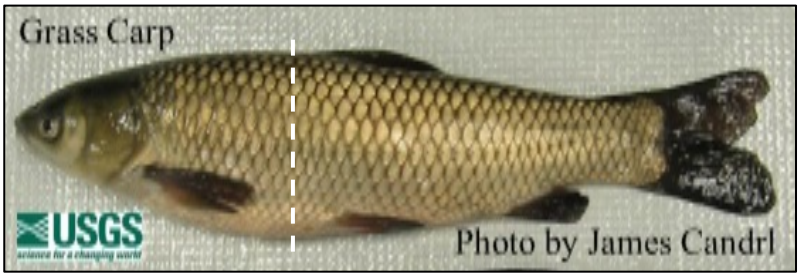


Figure 1. Example of step 4.a: Lateral view of fish's entire left side. Dashed white line indicates location for girth measurement.

Figure 2. Example of step 4.b: Close-up lateral view of head.

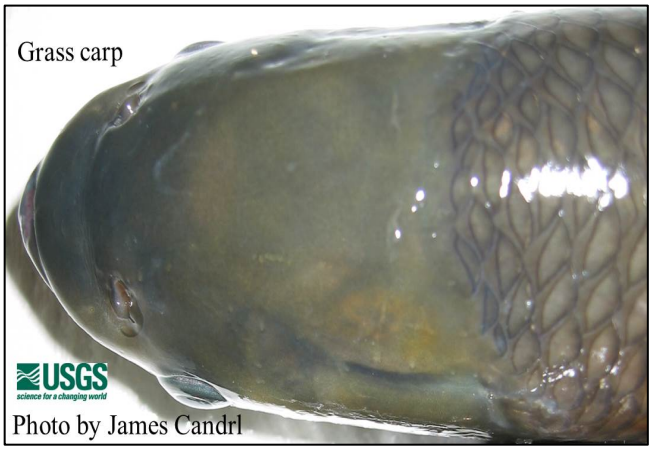


Figure 3. Example of step 4.c: Dorsal view of head with mouth fully closed.

Step 2: Eyeball Removal, Sample Preparation, and Shipping Procedures for Ploidy Analysis

Materials:

- Forceps; scalpel; blunt or curved scissors
- 50-100 ml plastic containers with leak-proof screw top cap
- Sealable plastic bags to fit several 50-100 ml containers
- Contact lens solution or saline (0.8-1.0% NaCl in DI water)
- Permanent marking pen
- Cooler or insulated container with ice packs, packing tape to seal cooler
- Optional: methanol if freezing and storing samples longer than 8 days.

Procedure for Removing Carp Eyeballs**:**

1. Euthanize fish with an overdose of tricaine methanesulfonate (MS-222) or sharp blow to head.
2. Label a small, plastic container with collection date, species, and sample number if applicable (e.g. 25MAR13, black carp, #12).
3. Taking care not to puncture the eyeball, insert scalpel blade between the eyeball and socket wall. You may use forceps to hold the eyeball steady. Keep the blade pointed toward the socket wall while cutting around the circumference of the eyeball. The eye will move around freely when you have cut the tissue.
4. Use the blunt or curved scissors to reach behind the eyeball and cut the optic nerve. Once the optic nerve is cut, you should be able to pop the eye out and trim off any excess tissue.
5. Follow appropriate Eyeball Sample Preparation and Shipping Procedures below.

Eyeball Sample Preparation for Overnight Shipment or Storage 1 to 8 Days:

This option will provide the highest quality of samples for analysis.

1. Place extracted eyeball in labeled container (see removal procedures above). Fill to top with contact lens solution or saline.
2. Place container(s) in a sealable plastic bag to contain leaks and place on ice or in a cooler with ice packs.
3. Ship immediately following shipping procedures for Whitney Genetics Lab (shipping procedures below) or keep refrigerated (4 to 8°C) up to 8 days.
4. Proceed to Step 3.

Eyeball Sample Preparation for Storage Longer than 8 Days:

If samples cannot be shipped within 8 days, or if many samples will be collected over a known period of time, you can store and ship all together.

1. Place extracted eyeball in labeled container (see removal procedures above). Fill to top with 20% methanol in contact lens solution or saline.
2. Place container(s) in a sealable plastic bag to contain leaks and place on ice or in a cooler with ice packs. Refrigerate (4 to 8°C) overnight to allow methanol to diffuse into fish eyes.
3. Move samples to a freezer (-20°C). Store frozen until overnight shipment can be arranged. Sample quality will not degrade as long as sample remain frozen (-20°C) until shipment.
4. Ship to Whitney Genetics Lab following procedures below.
5. Proceed to Step 3.

Eyeball Shipping Procedures:

1. Contact Whitney Genetics Lab personnel to make Overnight Priority (for morning delivery) shipping arrangements. If possible, ship samples on same day of catch.
2. Do ***NOT*** ship samples until arrangements have been made for receipt of package.
3. Pack samples in a Ziploc bag to prevent leakage and then enclose in a sealed, insulated container with ice packs to maintain 4 to 8°C. Do ***NOT*** use dry ice for shipping. Include collection data (and sample number if necessary) with package. If using a cooler for shipping, make sure lid is taped securely.
4. Ship priority overnight to the attention of Whitney Genetics Lab Contact.
5. Email confirmation of shipment and tracking numbers to recipient.

Contact Information:

Jennifer Bailey – fish biologist
608-783-8451
608-397-4416 (mobile)
jennifer_bailey@fws.gov

Maren Tuttle-Lau – fish biologist
608-783-8403
maren_tuttle-lau@fws.gov

Shipping Address:

Whitney Genetics Lab – La Crosse Fish Health Center
U.S. Fish and Wildlife Service Resource Center
555 Lester Ave, Onalaska, WI, 54650
608-783-8444

Step 3: Carcass Preparation and Shipping Procedures

Carcass Sample Preparation for Overnight Shipment:

If possible, *ship samples immediately on ice on same day of catch*. Otherwise, freeze the carcass before shipping.

1. Pack entire specimen (with eyes extracted) in an insulated container with plenty of ice packs, frozen water bottles, or ice to keep cool. Do ***NOT*** use dry ice for shipping.
2. Include collection data (and sample number if necessary) in double ziplock bag in container.
3. Seal container to contain leaks. If using a styrofoam cooler within a box, make sure the lid is taped and sealed securely.
4. Ship immediately or keep frozen until Overnight Priority shipping arrangements are made.

Carcass Shipping Procedures:

1. Contact Columbia Environmental Research Center personnel to make Overnight Priority (for morning delivery) shipping arrangements.
2. Do ***NOT*** ship samples until arrangements have been made for receipt of package.
3. Ship specimen in sealed, insulated container (see sample preparation instructions above) priority overnight to the attention of Duane Chapman or Joe Deters.
4. Email confirmation of shipment and tracking numbers to (dchapman@usgs.gov).

Contact Information:

Duane Chapman
573-875-5399
573-289-0625 (mobile)
dchapman@usgs.gov

Joe Deters
573-875-5399
573-239-9646 (mobile)
jdeters@usgs.gov

Shipping Address:

Duane Chapman or Joe Deters
Columbia Environmental Research Center
U.S. Geological Survey
4200 New Haven Road
Columbia, MO 65201
573-875-5399

Species Codes For Fixed Sited Above and Below The Barrier

Alewife	ALE	Highfin Carpsucker	HFC	Spotted Sucker	SDS
				Spring Chinook Salmon	SCS
Banded Darter	BAD	Lake Trout	LAT	Suckermouth Minnow	SUM
Banded Killifish	BAK	Largemouth Bass	LMB		
Bigeye Chub	BGC	Logperch	LOP	Threadfin Shad	THS
Bighead Carp	BHC	Longear Sunfish	LOS	Trout Perch	TRP
Bigmouth Buffalo	BGB	Longnose Gar	LOG		
Black Buffalo	BKB			Walleye	WAE
Black Bullhead	BLB	Mosquitofish	MOF	Warmouth	WAM
Black Carp	BCP			White Bass	WHB
Black Crappie	BLC	Northern Hog Sucker	NHS	White Crappie	WHC
Blackside Darter	BLD	Northern Pike	NOP	White Perch	WHP
Blackstripe Topminnow	BLT			White Sucker	WHS
Bluegill	BLG	Orangespotted Sunfish	ORS		
Bluntnose Minnow	BLS	Oriental Weatherfish	OWF	Yellow Bass	YLB
Bowfin	BOW			Yellow Bullhead	YEB
Brook Silverside	BRS	Paddlefish	PAH	Yellow Perch	YEP
Brown Bullhead	BRB	Pumpkinseed	PUD		
Brown Trout	BRT				
Bullhead Minnow	BUM	Quillback	ULL		
Central Mudminnow	CEM	Rainbow Smelt	RAS		
Channel Catfish	CCF	Rainbow Trout	RBT		
Coho Salmon	CHO	Redear Sunfish	RSF		
Common Carp	CAP	Redfin Shiner	RDS		
Common Shiner	CMS	River Carpsucker	RVC		
Creek Chub	CRC	River Redhorse	RVR		
		River Shiner	RVS		
Emerald Shiner	EMS	Rock Bass	ROB		
		Round Goby	ROG		
Fall Chinook Salmon	FCS				
Fathead Minnow	FHM	Sand Shiner	SAS	**Hybrid Codes**	
Flathead Catfish	FCF	Sauger	SAR	Bluegill x Green Sunfish	BGH
Freshwater Drum	FRD	Shorthead Redhorse	SHR	Bighead x Silver Carp	BSH
		Shortnose Gar	SHG	Common Carp x Goldfish	CGH
Ghost Shiner	GHS	Silver Carp	SCP	Striped Bass x White Bass	SBH
Gizzard Shad	GZS	Silver Chub	SVC	Yellow Perch x White Bass	YWH
Golden Redhorse	GOR	Silver Redhorse	SVR	White Perch x Yellow Perch	WYH
Golden Shiner	GOS	Skipjack Herring	SKH		
Goldeye	GOL	Smallmouth Bass	SMB	**Other Codes**	
Goldfish	GOF	Smallmouth Buffalo	SAB	Unidentified Sunfish	SUN
Grass Carp	GRC	Spotfin Shiner	SFS	Unidentified Minnow	MIN
Grass Pickerel	GRP	Spottail Shiner	SPS	Unidentified Fish	UID
Green Sunfish	GSF	Spotted Gar	SPG	No Fish Code	NFH

Appendix F. Sample data sheets.

Asian Carp Monitoring Project - Electro Date: _____

Area Surveyed: _____ Biologist (Crew): _____

Wisc Unit DC: Rate: _____ Duty:_____ Range: High or Low Volts:_____ Amps:_____

Smith Root DC: Percent of Setting:_____Pulse Per Second Setting:_____Amps:_____

Other (Describe): _____

Rate Gear Efficency (circle one): Good Moderate Poor

Air Temp: _____ Water Temp: _____ Conductivity: _____ Others: _____

	Run No._____ Lat._____ Lon._____ Start Time: _____ Shock Time: _____	Run No._____ Lat._____ Lon._____ Start Time: _____ Shock Time: _____	Run No._____ Lat._____ Lon._____ Start Time: _____ Shock Time: _____	
Fish Species	No. of Fish	No. of Fish	No. of Fish	Total No. Fish
Gizzard shad >6 in.				
Gizzard shad juv.<6 in.				
Alewife				
Common carp				
Goldfish				
Carp x Goldfish hybrid				
Freshwater drum				
Smallmouth buffalo				
Bigmouth buffalo				
Black buffalo				
River carpsucker				
Quillback				
White sucker				
Channel catfish				
Yellow bullhead				
Black bullhead				
Largemouth bass				
Smallmouth bass				
Bluegill				
Green sunfish				
Pumpkinseed				
Hybrid sunfish				
Rock bass				
White crappie				
Black crappie				
Golden shiner				
Bluntnose minnow				
Fathead minnow				
Spotfin shiner				
Emerald shiner				
Spottail shiner				
Round goby				
White perch				
White bass				
Yellow bass				

Asian Carp Monitoring Project - Nets

Date: _____

Area Surveyed: _____ Biologist (Crew): _____

Air Temp: _____ Water Temp: _____ Conductivity: _____ Others: _____

Set No._____ Lat._____ Lon._____ Total Yds._____	Panel No._____ Type (circle): Tra or Gill Length (yds.)_____ Height (ft.)_____ Mesh (in.)_____ Start Time: _____ End Time: _____	Panel No._____ Type (circle): Tra or Gill Length (yds.)_____ Height (ft.)_____ Mesh (in.)_____ Start Time: _____ End Time: _____	Panel No._____ Type (circle): Tra or Gill Length (yds.)_____ Height (ft.)_____ Mesh (in.)_____ Start Time: _____ End Time: _____	
Fish Species	No. of Fish	No. of Fish	No. of Fish	Total
Gizzard shad >6.0 in.				
Common carp				
Goldfish				
Carp x goldfish hybrid				
Freshwater drum				
Bighead carp				
Silver carp				
Grass carp				
Smallmouth buffalo				
Bigmouth buffalo				
Black buffalo				
River carpsucker				
Quillback				
Channel catfish				

Set No._____ Lat._____ Lon._____ Total Yds._____	Panel No._____ Type (circle): Tra or Gill Length (yds.)_____ Height (ft.)_____ Mesh (in.)_____ Start Time: _____ End Time: _____	Panel No._____ Type (circle): Tra or Gill Length (yds.)_____ Height (ft.)_____ Mesh (in.)_____ Start Time: _____ End Time: _____	Panel No._____ Type (circle): Tra or Gill Length (yds.)_____ Height (ft.)_____ Mesh (in.)_____ Start Time: _____ End Time: _____	
Fish Species	No. of Fish	No. of Fish	No. of Fish	Total
Gizzard shad >6.0 in.				
Common carp				
Goldfish				
Carp x goldfish hybrid				
Freshwater drum				
Bighead carp				
Silver carp				
Grass carp				
Smallmouth buffalo				
Bigmouth buffalo				
Black buffalo				
River carpsucker				
Quillback				
Channel catfish				

Asian Carp Monitoring Project

Date: _____

Area Surveyed: _____ Biologist (Crew): _____

Gear Type (circle one): DC, AC, Nets

Nets (Describe Nets): _____

Fish Species	TL mm	TL mm	TL mm	TL mm	TL mm	TL mm	TL mm	TL mm	TL mm	TL mm
Gizzard shad >6 in.										
Gizzard shad juv.<6 in.										
Alewife										
Common carp										
Goldfish										
Carp x Goldfish hybrid										
Freshwater drum										
Smallmouth buffalo										
Bigmouth buffalo										
Black buffalo										
Quillback										
White sucker										
Channel catfish										
Yellow bullhead										
Black bullhead										
Largemouth bass										
Smallmouth bass										
Bluegill										
Green sunfish										
Pumpkinseed										
Hybrid sunfish										
Rock bass										
White crappie										
Black crappie										
Golden shiner										
Bluntnose minnow										
Fathead minnow										
Spotfin shiner										
Emerald shiner										
Round goby										
White perch										
Yellow Bass										

eDNA Field Data Sheet

DATE_____ NAME_____ START TIME_____ SHEET ____of_____

ID	Volume	Latitude	Longitude	Temp	Depth	Habitat	Collect Time	Filter Time

Notes/Comments:

Appendix G. Executive Summary of the ECALS Interim Technical Review Report.

Environmental DNA Calibration Study

Executive Summary

The Environmental DNA Calibration Study (ECALS) is a three-year study to improve the understanding and interpretation of the detection of Asian carp DNA in environmental samples (eDNA). eDNA surveillance programs seek to detect the presence of genetic material (DNA in cells sloughed off in slime, feces, urine, etc.) extracted from water samples; the detection of genetic material is linked to the possible presence of Asian carp. The study involves collaboration between the U.S. Army Corps of Engineers, the U.S. Geological Survey, and the U.S. Fish and Wildlife Service. ECALS addresses three major Action Items from the Asian Carp Regional Coordinating Committee (ACRCC) Asian Carp Control Strategy Framework, of which results to date are presented below. Initial ECALS efforts focused on eDNA vectors whereas marker development and calibration experiments will receive greater attention in 2013. Full report for the ECALS can be found at: http://www.asiancarp.us/documents/ECALS_INTERIM.pdf.

Asian Carp eDNA Vectors

In addition to DNA shed by live Asian carp, vectors of Asian carp eDNA could transfer eDNA into the Chicago Area Waterway System (CAWS). To integrate what has been learned through ECALS and other ACRCC studies, a conceptual model is being developed to provide a structured visualization of the potential eDNA inputs (e.g. presence of a live fish vs. vectors of eDNA) as well as the factors or variables that influence release, transport, persistence, and detection of eDNA in the CAWS. ECALS is investigating several potential eDNA vectors:

Storm Sewers
Asian carp carcasses are transported on ice brought to Chicago-area fish markets. That ice and associated body fluids are dumped into storm gutters and street drains. Because fish may be displayed on ice at these markets during the day, change out of melting ice (potentially multiple times during the day) may supply additional amounts of ice/ice water containing Asian carp fluid/tissue into the storm sewer system. The ECALS Team executed trials in fall 2011, summer 2012, and fall 2012 to demonstrate that ice from ice chests holding Asian carp carcasses could be a source of eDNA in the CAWS.

- Two points of particular interest have been observed – One, Asian carp eDNA was detected in sewers prior to our trials (perhaps originating in fish markets) and two, eDNA that was deposited into storm sewers during experimental trials largely dissipated in receiving waters (CAWS) within a day. Whether the eDNA signal was lost due to degradation, dilution, or downstream flow is unclear.

Fertilizers
Wild-caught Asian carp are used to develop fertilizer for commercial and residential uses. The team tested two brands of fertilizer that contain Asian carp as part of the fertilizer formula for the presence of detectable eDNA (using current markers).

- There were no eDNA detections in assays of small volumes of either brand of fertilizer. Tests of larger volumes or more samples of fertilizer may be needed to completely rule out this potential vector. Currently, the team is searching for more information on the role of Asian carp in producing these fertilizers and for additional brands of fertilizer that may contain Asian carp DNA.

Fisheries gear
Gear (boats, nets) used by natural resources agencies, contract fishermen and/ or recreational anglers may be exposed to Asian carp DNA in waters where Asian carp are present then moved into the CAWS where some Asian carp DNA could be sloughed off into the water. The potential for these sources to harbor eDNA and result in a positive eDNA detection was evaluated in fall 2012.

- Vessel hulls have considerable amounts of adhering DNA, which can persist for days and is not removed by overland transport.
- Adhering DNA also does not appear to be completely or quickly washed off of boats moving through the water. Thus, vessel hulls can be vectors for DNA movement.
- Nets appear to be sources of very large amounts of eDNA but require confirmation and quantitation of DNA associated with nets through an additional sampling trial.

Bird Transport and Deposition of eDNA
Given the assumption that eDNA is deposited by piscivorous (fish-eating) birds, ECALS has focused on the amount of eDNA in a bird fecal sample, degradation, and piscivorous bird feeding and movement patterns in the Chicago region.

- Piscivorous birds have the capacity to be a direct vector of Asian carp DNA or to contaminate fomites (e.g. barges, boats) with Asian carp DNA via fecal deposits.
- Silver Carp DNA was detected in fecal samples collected from piscivorous birds offered one to three meals of Silver Carp.
- Silver carp DNA could be amplified from bird fecal samples collected up to 1 week following consumption of a Silver Carp meal.
- Silver Carp DNA in fecal material deposited on metal sheets persisted for 30 days under ambient environmental conditions despite exposure to temperatures exceeding 60°C (140°F).
- Satellite-tagged double-crested cormorants exhibited large variation in daily and seasonal bird movement, with some birds staying close to tagging locations and others traveling as far as Canada or the Gulf Coast. Additional work will examine available records of the frequencies of observation for other piscivorous birds in the CAWS region.
- Throat and cloacal swabs taken at the time of satellite-tagging resulted in Silver Carp DNA detection in 13 of 15 cormorants (positive Silver Carp DNA from: 3 throat only, 4 cloaca only, and 6 both throat and cloaca) from a rookery near Peoria, IL and 7 of 15 cormorants (positive Silver Carp DNA from 6 throat only and 1 both throat and cloaca) from a rookery near Baker's Lake (within the CAWS), showing evidence of Asian carp consumption.

Fish Carcasses
Since biologists had reported the presence of dead Asian carp on decks of barges above the U.S. Army Corps of Engineers Electric Dispersal Barrier in the Chicago Sanitary and Shipping Canal (CSSC) and slime from those decaying Asian carp trailing down the sides of barges to the water line, concerns have existed regarding the capacity of fomites (objects that carry DNA) like barges to transport Asian carp DNA (in the form of carcasses or slime) from areas where Asian carp are present to areas where they are not present or abundant. The goal of this study was to assess whether Asian carp carcasses or residual slime on fomites such as barges or boats could be responsible for the presence of Asian carp DNA in waters where Asian carp are not present.
Silver Carp eDNA can be detected for at least 18 days when the surfaces of carp carcasses or water that had flowed over those carcasses were sampled. Samples from Asian carp slime coat that had been placed on metal surfaces also showed intact Asian carp DNA, but disappeared by day 18. These trials indicate that carcasses, or rain or other run-off from surfaces where Asian carp carcasses or slime residue reside, can be a source of eDNA entering a system.

Barge Transport of Carcasses
Guidelines for vessel operators were developed in May 2012 by USACE, ILDNR, and USEPA for vessels that enter the CAWS through four lock and dams (Dresden Island, Brandon Road, Lockport, and TJ O'Brien). The guidelines outline the protocol for vessels that may be carrying dead Silver or Bighead Carp carcasses (and potentially depositing them on the upstream side of the barrier) and require that lock staff document these occurrences, verify the species, and ensure removal before the vessel crosses.

- During the 2012 shipping season, there were three reported incidents concerning a total of five Asian carp carcasses on vessels. On 10 April, two Silver Carp were found on the deck of a tow at Lockport; on 12 April one Silver Carp was found on a barge at the mouth of the Calumet River; and on 8 June two separate barges locking upstream at Brandon Road each reported having one Silver Carp on deck.

Sediments
The potential for sediments both within the CAWS and outside of the CAWS to sequester and/or transport eDNA was investigated.

- Five of 13 stream bank samples taken approximately 105 km downstream of Lockport on the Illinois River tested positive for Silver arp DNA; Bighead Carp DNA was not detected.
- Sediment samples (n=28) were collected from Lake Peoria dredged materials being off-loaded at the old US Steel site near Calumet Harbor. Eleven samples tested positive for Silver Carp DNA, and one sample tested positive for Bighead Carp DNA.
- Additional surface sediment samples were collected in November 2012 from Lake Calumet and Lockport Pool for eDNA sorption studies that are presently underway.

Asian Carp eDNA Genetic Marker Development

The current eDNA markers for both Bighead and Silver Carp are comprised of short segments of the mitochondrial DNA control region (or "D-loop") and primarily provide information on

presence/absence of that DNA in a sample. The team's aim is to develop a suite of different markers that provide different capabilities, including 1) improved detection probabilities by increasing the number of markers simultaneously assayed, 2) more efficient processing by reducing background non-target PCR amplification, 3) real-time quantitative PCR estimates of DNA abundance (qPCR has added benefit of increased efficiency by eliminating gel electrophoresis and reducing or eliminating the need for sequencing), 4) data on allelic variability (or "polymorphism") to a degree that will allow at least broad estimation or corroboration of Asian carp abundance, and 5) some indication of the nature or time since deposition of an eDNA sample.

- Asian carp specimens from across North America (10 Silver Carp populations, 12 Bighead Carp populations) and Asia (3 populations each, Silver and Bighead Carp) were acquired, and DNA sequencing was performed using a next-generation DNA sequencer. As a result, complete mitochondrial DNA sequences for 33 Bighead and 25 Silver Carp from 9 North American locations were obtained.
- Genetic material for numerous non-target fish species occurring in the CAWS was procured and, along with existing data on aquatic species DNA residing in GenBank, is being used to test new markers to ensure that they are specific to silver and/or bighead carp.
- For presence/absence markers, the team is testing 12 trial markers that potentially could be used to selectively detect silver carp, testing 11 for bighead carp, and testing 17 that could potentially amplify both Asian carp species to the exclusion of all other species. Expectations are that most will be eliminated, as DNA segments that correspond to eDNA markers that would have both absolute specificity for a target species and high detectability (in large part a function of being relatively more numerous in cells than other DNA segments, like mitochondrial DNA) are rare.

Asian Carp eDNA Increased Efficiency and Calibration Studies

Increasing Efficiency

Presently, the time from field sampling to analytical results for eDNA can take as long as two weeks. Even before laboratory analysis, several hours of very intensive fieldwork followed by laborious sample filtering is required. ECALS is evaluating ways to reduce time and effort for this process. Identification of the most cost and time-efficient extraction approach and most robust cross-platform quantitative PCR (qPCR) approach will benefit future monitoring efforts.

- Tissue grinding using a higher-throughput bead-beater instrument demonstrated no significant difference in apparent DNA yield or quality compared to the Quality Assurance Project Plan (QAPP) method, and could replace the longer vortexer-based step in the existing protocol.
- Comparison of different DNA extraction kits suggests that different extraction kits may yield different quantities of amplifiable DNA, and that different extraction kits may have varying susceptibilities to environmental inhibitors.
- A comparison of different sampling methods (filtration, centrifugation, sieve cloth) has been hampered by difficult field conditions and equipment contamination. Refined protocols and additional fieldwork are planned for 2013.
- A comparison of sampling from different depths in the CAWS water column yielded more positive eDNA hits (7 of 15 samples) for surface samples than for mid-column samples (0 of 15 samples) or bottom-depth samples (1 of 15 samples).

Calibration Studies

Calibration studies seek to examine eDNA release (i.e. shedding) rates and degradation rates under laboratory conditions to inform hydrodynamic modeling of how deposited eDNA may be distributed by water flow in the CAWS. The team has designed experiments to determine how fish size, number, behavior, as well as water temperature and diet influence eDNA loading (or shedding) by Asian carp. We will also investigate sperm as a source of eDNA over time in static water conditions.

Loading Studies

- Preliminary studies show that eDNA shedding rates are consistent over different water-flow rates. Currently, one experiment assessing effects of temperature on shedding rates of silver carp sub-adults has been completed. The team found no effect of temperature on shedding rates.
- Preliminary studies of eDNA from sperm in water showed that eDNA was detectable for at least 17 days.
- Results of these studies will provide information necessary to determine the degree to which qPCR can be used to determine abundance or biomass of bighead and silver carp from eDNA samples. Eight of the 12 designed studies (examining effects of temperature, biomass and diet; and sperm degradation) have been completed.
- However, some trials are incomplete because PCR inhibitors have prevented DNA quantification using qPCR. The team observed that the greatest PCR inhibition is associated with samples from tanks that were fed algae and is currently working to find ways to reduce PCR inhibitors without reducing the sensitivity of the qPCR assay for these lab-based samples. However, it has become apparent that a more accurate measurement of inhibition and a more extensive survey of methods for avoiding or removing inhibitors will be necessary, especially for the processing of field samples that are likely to have many more (and more diverse) PCR inhibitors.

Hydrodynamic Model

- The hydrodynamic grid for the area to be modeled has been completed, and protocols have been established to enable passing of information back and forth between the hydrodynamic and eDNA transport (i.e. water quality) parts of the model. Results from other ECALS investigations (e.g. eDNA degradation studies) will be incorporated into the eDNA transport model when available. 3D simulations of the hydrodynamics of the barrier area are also underway, and the electrical field modeling is in preliminary development at present.

Appendix H. Analysis of Bighead and Silver Carp Spawn Patches.

Spawn Patch Preservation/Analysis:

Bighead and Silver Carp males use their pectoral fins to irritate the ventral margin of females during the spawning season (Figure 1). Recent spawning or prespawning interactions between males and females will leave an irritated patch on the breast of the female fish, and scales are often lost. Presence of regenerated scales is evidence that a female fish may have been courted by a male fish (although it is impossible to tell from this feature if spawning actually occurred). The number of annuli in regenerated scales may also be useful in determining the number of years since spawning activity occurred. It is as yet unclear how many scales are lost on average or if scales are lost each time the fish spawns. However, in order to preserve potential information on spawning activity or presence of male fish where a female fish is captured, it is prudent to preserve the breast of Bighead and Silver Carp caught from areas where the presence of Asian carps caught is being investigated if allowable by the state and regulatory bodies. For the 2013 Monitoring and Response Plan participants, fish collected in the CAWS or the Great Lakes should follow the chain of command and custody protocols is of primary importance with biological data being collected after securing the fish. Fish collected in Brandon Road Pool require a voucher per the 2013 MRP. Additional biological data will be processed after those protocols have been followed and likely in a lab setting. For fish collected below Brandon Road Lock and Dam, it is permissible to follow the procedures as long as it would not interfere with ongoing tracking/telemetry.

Figure 1. Spawn patch of a female Bighead Carp, located on the breast of the fish between the pelvic and pectoral fins.

If a Bighead or Silver Carp is caught from the Great Lakes or the CAWS, FIRST FOLLOW ALL PROTOCOLS IN THIS MANUAL; See: **Appendix C. Handling Captured Asian Carp and Maintaining Chain-of-Custody Records**. If there is no conflict with existing protocol, the portion of the fish illustrated in Figure 2 should be photographed as soon as possible after capture, to document abrasions from recent sexual activity. In areas outside of the CAWS and the Great Lakes sections should be preserved from damage to ensure scale regeneration can be analyzed if required by state and regulatory agencies.

Protocols for analysis of scale regeneration in this area are not yet prepared, but care should be taken to preserve the scales and skin in this area. This technique is only useful when employed on female Bighead and Silver Carp. Although external features are useful in identifying the sex of a captured Bighead or Silver Carp, none of these features are 100% reliable in identification of sex. Therefore

this portion of the fish should be preserved at least until the sex is determined by the examination of the gonads. When the gonads are examined, care should be taken to avoid cutting through the area of the spawn patch. Note that histological examination of gonads may also be useful in evaluating recent spawning activity.

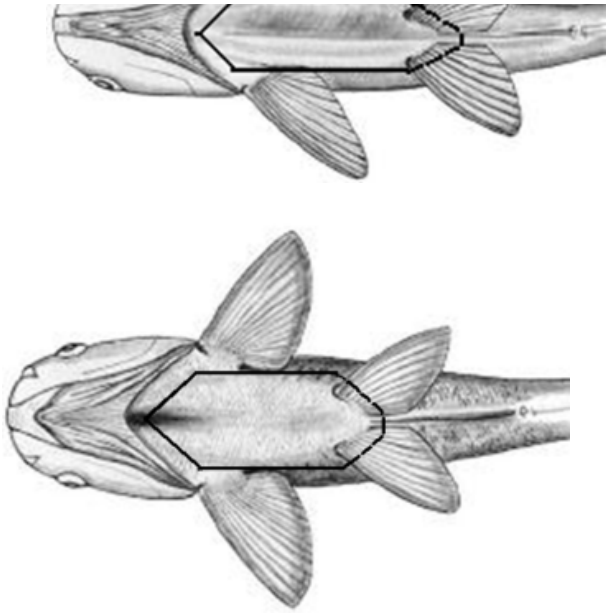


Figure 2. Areas to be preserved for analysis. Silver Carp on left, Bighead Carp on right. (FIRST FOLLOW ALL PROTOCOLS IN THIS MANUAL See: **Appendix C. Handling Captured Asian Carp and Maintaining Chain-of-Custody Records** for fish collected in the CAWS or the Great Lakes; **managers may not allow dissection of fish collected in these areas and need to be consulted about any physical samples being taken**).