Asian Carp Containment and Suppression in the Upper Ohio River

Geographic Location: Ohio River basin, extending from the Markland Lock and Dam (RM 531.5) to the Racine Lock and Dam (RM 238) along with some limited removal in the Smithland pool, below Cannelton.

Participating Agencies: Kentucky Department of Fish and Wildlife Resources (KDFWR), Indiana Department of Natural Resources (INDNR), US Fish and Wildlife Service (USFWS), West Virginia Division of Natural Resources (WVDNR)

Introduction:
Eradication of invasive species after establishment is difficult and often limited by available resources. Since their introduction in the Mississippi River basin, Asian carp (silver carp, bighead carp, and grass carp) have steadily increased their range. Asian carp rapidly and densely colonize river reaches affecting the native food web in large river ecosystems (Irons et al. 2007, Freedman et al. 2012). As a result, funding has been allocated in the basin to limit the impacts of Asian carp where they exist as well as halt their spread into uninhabited waters.

Diverse and consistent removal efforts where Asian carp densities are relatively high may disrupt upriver movement of Asian carp (D. Glover, US Fish and Wildlife Service, personal communication). However, there are few tools available to limit the negative impacts of Asian carp and their spread into new waters. Integrated pest management approaches suggest that inclusion of barrier technologies that prevent movement of the Asian carps into critical areas as well as the targeted removal of Asian carp below barriers are useful for decreasing propagule pressure. Planning and implementation of barriers to Asian carp movement are widely believed to be an important aspect of the control of Asian carp in the Mississippi River basin. However, planning barrier projects can be difficult and require substantial data collection. Urgent efforts to gather distribution and movement data in the Ohio River began in 2015. Currently, the best tool for limiting impacts and further dispersal of Asian carps is the physical removal of fish.

Multi-agency sampling and removal projects have successfully targeted Asian carp along this reach, but the effort required is usually expensive. Removal of Asian carp along this stretch of river reduces the number of Asian carp moving upstream, lessens the likelihood of successful reproduction, and buys managers time to plan and implement potential barriers to Asian carp movement.

Objectives:
- Remove Asian carp from the Ohio River, above Markland dam.
- Attempt to suppress and contain carp below the R.C. Byrd pool.
- Surgically implant transmitters in Asian carp between Markland and Greenup Locks and Dams.
- Explore the development of an Ohio River response protocol.

Methods:
Containment and Suppression efforts in 2017 focused primarily on the pools above Markland Lock and Dam (Figure 1). All other removal effort below Markland Lock and Dam is reported in the 2017 Control and Removal of Asian Carp report. With relatively little information on the best locations to target carp in these pools, effort was blanketed evenly throughout the geographic area in the hope that a select number of fishing grounds could be located for more effective suppression efforts. This strategy made it difficult to focus on sections of river while trying to explore new locations that may be suitable to carp species; however, it provided the basin a way to continue surveillance throughout lower abundance waters while removing some fish.

Clarification of Terminology Referenced in This Document

With the current rate of Asian carp expansion and the massive effort to study and adaptively manage carp impacts across several Mississippi River sub-basins, it is important to clarify terminology used in technical documentation and annual reports. Currently, there may not be consistent terminology used across the basins. With this in mind, below are a list of terms used in this report defined for the specific purpose of this report.

Bigheaded Carps – a term used to reference the collection of the bigheaded carps (*Hypophthalmichthys spp.*) and their hybrids, found in the Ohio River basin.
Establishment Front – the farthest upriver range expansion of Asian carp populations that demonstrates the presence of natural recruitment.
Invasion Front – the farthest upriver extent where reproduction has been observed (eggs, embryos, or larvae) but recruitment to young-of-year fish has not been observed.
Macrohabitat – One of five habitat types used to describe the variety of fixed sites within a pool (e.g. Tributary, Tailwater, Embayment, Island Back-Channel, and Main Stem River).
Presence Front – The farthest upstream extent where Asian carp populations occur, but reproduction is not likely taking place.
Targeted Sampling – sampling that uses gear and/or techniques intended to specifically target one species and exclude others (i.e. silver carp and bighead carp).

Physical Removal of Asian Carps

Containment and suppression efforts typically ended in the euthanization of Asian carps captured through sampling efforts. Electrofishing and gill netting along the invasion and presence fronts in 2017 was conducted for roughly 5 weeks from May – October. Electrofishing was not standardized, but total effort (hours) was recorded. Pulsed DC electricity at 40% duty-cycle and 80 pulses per second was used most often and voltage was adjusted to target a maximum power goal for each run. Large mesh (4.0" – 5.0" square) gill nets were used, with each set consisting of a minimum 180 minutes of soak time, while fish were driven toward nets with boat noise at 30-minute intervals.

Sampling sites focused on tributaries and embayments (mimicking site selection and protocols from lower pools) where densities of Asian carp were likely the highest and fish were easiest to capture. The majority of these locations were selected using monitoring sampling sites from 2015 and 2016. Some effort was expended to investigate additional sites that were either remotely identified through map study, contained features characteristic of typical carp habitat, or where reports were received of carps congregating in the area.

All Asian carps and by-catch were identified to species. All carp were inspected for tags (both jaw and ultrasonic VEMCO tags) before being euthanized for population control or tagged for the Ohio River Telemetry projects. All by-catch was returned to the water. Asian carp species (bighead carp, silver carp, and grass carp) from each sampling location were measured for total length (mm) and weight (g) to provide estimates of the minimum total weight harvested. When possible, supplemental data included a record of sex and a collection of aging structures (spines and otoliths) for each silver or bighead carp captured (Williamson and Garvey 2005, Seibert and Phelps 2013). All fish captured above Greenup Lock and Dam were euthanized in an effort to define a cutoff point for restricting upriver population progression.

Surgical Implantation of Acoustic Transmitters

With Asian Carp populations still purportedly low above Markland Lock and Dam, information on movement, rate of dispersal, and habitat preferences of invasive carps in these pools is vital. This

information is useful for informing more productive removal efforts in these lower abundance pools so that less time is spent seeking out fish. However, with numbers being relatively low in these pools, it has been difficult to capture fish for telemetry efforts. Any fish encountered during containment and suppression activities in the Markland and Meldahl pools was considered for surgical implantation of an acoustic VEMCO tag. Often carp were in too poor of a condition to tag along the invasion front or were captured in periods where water temperatures were too high to effectively tag fish. Manual tracking was conducted in the Racine pool in 2015 and 2016 to locate a bighead carp traveling farther upriver than all other tagged fish; however, manual tracking was not conducted in 2017. All fish captured above the Meldahl pool and below the Racine pool were removed for containment efforts.

Exploration of ORB Response Protocol
In 2017, the WVDNR and KDFWR performed research into the structure and development of an Ohio River contingency plan. The intent was to look at structured contingency plans and gather information and notes considering similar implementation in the ORB. Emails and notes were shared between WVDNR and KDFWR on the topic and the Upper Illinois Waterway Contingency Response Plan from the Mississippi River Basin 2017 Asian Carp Monitoring and Response Plan was picked as a discussion model. The major facets of that plan were identified and are listed here with some notes and input from discussions between West Virginia and Kentucky State agencies.

Results:
Surgical Implantation of Acoustic Transmitters
Due to the time of year, tagging procedures during this project were often suspended dependent on temperature, weather constraints, and fish condition. In 2016, six fish were tagged with an acoustic VEMCO transmitter during removal efforts in pools above McAlpine. In 2017, only three fish were caught in good enough condition to tag above Markland lock and dam. Several fish were captured in the RC Byrd pool in 2017; however, in an effort to define a cutoff for upriver population progression, all fish caught in the Greenup and RC Byrd pools were euthanized upon capture.

Physical Removal of Asian Carps
A total of 26 hours were spent electrofishing in the four Ohio River pools and tributaries from Markland up through RC Byrd pool (Table 1). Six carp totaling ~54 kg (118 lbs) were removed along the upper pools within the invasion and presence fronts. The largest amount of electrofishing effort was expended in the Markland pool where all six silver carp made up the entirety of fish removed via boat electrofishing for this project. Three of those fish were tagged for the Telemetry of Asian Carp in the Ohio River project.

A total of 4,500 ft of gill net was set to capture three bighead carp, four silver carp and one grass carp in the four pools along the invasion and presence fronts (Table 2). The majority of effort was placed in Markland pool, where all four silver carp were captured. Outside of project activities, two additional bighead carp were recreationally snagged out of the old lock chambers on the RC Byrd Lock and Dam. This event caused partners to focus suppression efforts within the lower portion of the RC Byrd pool. Three bighead carp were captured near Raccoon Creek using gill nets in the RC Byrd pool after receiving these reports just upriver of the lock and dam. Additionally, two bighead were captured using snagging techniques by the WVDNR hatchery staff after being sighted in the old lock chambers at the RC Byrd lock and dam complex.

Exploration of ORB Response Protocol
A list of notes and information was compiled from reading the Upper Illinois Waterway Contingency Response Plan (Asian Carp Regional Coordinating Committee 2017). Below is a review of that process.

- Responses are specified depending on observed changes in the Asian carp populations within five pools of the Illinois Waterway (IWW) through annual interim reports and monitoring or removal activities.
    - ORB activities currently fulfill this action and should be continued to track changes in Asian carp population status.
- The plan recognizes a chain of command within the federal government, each member state, and participating agencies. An expert panel was created by the Monitoring and Response Work Group (MRWG) to evaluate the population status, waterway conditions, and outline various scenarios in order to provide a process for initiating response actions that utilize available tools and authorities.
    - This is currently not identified in the ORB. A working group is likely necessary to begin to compile a list of authorities, scenarios, and response actions that are realistic for the ORB.
- The plan defines and recognizes 2015 as a benchmark to aid in evaluation of Asian carp statuses from future years and describes the current state of invasion by pool.
    - A benchmark in the ORB would have to be agreed upon using data available; work started in 2015. Since then, project objectives have been altered to better accomplish project goals.
- The plan defines a navigation pool as the "best and most appropriate scale" for contingency planning purposes.
    - Because dams have the ability to partially restrict fish movements, pools are currently being used to reference relative abundances. They are likely the best unit of measurement for response planning in the ORB.
- The plan defines an "Incident Action Plan" "(IAP) that uses "SMART" objectives (Specific, Measureable, Achievable, Realistic, and Task-oriented), which highlight unique responses by agency and location at varying degrees of significance (Significant Change, Moderate Change, and No Change).
    - This is well structured and would likely require substantial time and effort to develop for the Ohio River.
    - Responses are only effective with good coordination and participation in the plan.
    - Life stage, type of capture, and location from the Great Lakes are also taken into consideration when prescribing actions.
    - Some potential actions included increased sampling effort, barrier operations, complex noise, contracted fishing, hydroacoustics, and block netting and temporary flow control.

Discussion:

Total captures of invasive bigheaded carps across all activities in the upper pools of the invasion and lower presence fronts were low. The increased effort required to catch fish in this section of water reflects the difference in abundances of these fish when compared to the Cannelton and McAlpine pools. One issue that frequently makes the capture of these fish difficult is the amount of river that is being covered by relatively few crews; this project covers ~ 480 km of main stem river with the narrowest portions typically exceeding 300 meters in width and many large tributaries throughout. Focusing on preferred habitats where carp seem to consistently reside is the best approach to catching fish in these pools, but any chance of blanketing surveillance efforts throughout the pools or investigating additional areas would have to be limited. A couple of potential sampling sites have been identified for 2018 removal efforts. Those sites are suggested in Table 3.

Overall, electrofishing seems slightly more effective for locating silver carp in the low-density pools. When population densities are low, electrofishing may be a better gear to utilize when seeking out groups of silver carp simply because it allows for greater coverage when surveying for the presence of these fish.

Netting is often limited by the number of nets that can be deployed over a stretch of river and the man-hours required to run and maintain them. However, boat electrofishing rarely yields bighead carp captures and nets remain the better choice when targeting this species. Reports of greater success when targeting *Hypophthalmichthys spp*. at night and in cooler months suggests that some gears may be more successful if deployed during fall and winter months. In 2017, 20 overnight sets were utilized to target bighead carp along the main stem river. In the R.C. Byrd pool, one instance resulted in the capture of three bighead carp over one net-night; however, paddlefish bycatch made up 35% of the total catch. Using overnight sets in 2017 produced 0.20 bighead/set while the shorter, daily sets from 2016 and 2017 produced 0.18 bighead/set. Although this was only a small increase in catch, the total number of man-hours necessary to work overnight sets decreases while soak time is maximized. Nevertheless, gill netting during the warmer months can be stressful on paddlefish and other non-target species entangled in gears for long periods of time. Balancing efforts by targeting areas where bighead carp are frequently found and focusing netting effort in cooler water temperatures will likely result in higher yields during future removal efforts.

With reports of Asian carp being seen above RC Byrd Locks and Dam, removal effort in the RC Byrd pool is likely to increase. The bighead carp caught in RC Byrd were euthanized because they had exceeded the exclusion point for tolerable upriver expansion. A better understanding of the rate of dam passage continues to be a primary objective of the telemetry project and will likely inform response activities and removal efforts in future removal and containment projects in lower abundance pools. Information gained from telemetry efforts in these pools will be incorporated into the containment and suppression project in the ORB due to its similarities and overlap with that work.

With discussions and focus around long-term planning within the ORB, future effort needs to be placed into developing a contingency plan similar to the one being used in the IWW. The IWW plan provides the framework for a knowledgeable panel to review information on an annual basis and provide recommendations to combat population expansion and dispersal. With an ORB specific plan, information from all basin projects can be used to implement unified responses to Asian carp populations and keep the basin focused on integrated pest management.

Recommendations:
It is recommended that an ORB panel be created in order to develop a contingency plan that defines pool-specific goals for halting upriver expansion of carp populations. Regular removal is suggested to continue as a tool for surveillance and suppression efforts, but it is also recommended that the goals and objectives of this project be combined with the removal project due to a large overlap in project goals. This will also allow crews to focus on only visiting a few sites in lower density pools throughout the season without having to spread resources over a vast geographic length of river. Sites should be limited to tributaries where carp captures are relatively frequent (e.g. Eagle Creek, Ohio Brush Creek, Raccoon Creek) and a couple of locations along the main stem river where contract anglers have captured fish in the past (e.g. River Miles 348 – 350 and 342 – 344). The absorption of this project within removal efforts will also make reporting more efficient and incorporate more partners within one project throughout the basin, focused on population control.

Project Highlights:

- In 2017, an upper boundary defining the exclusion point for tolerable upriver expansion was established by basin partners. Currently, Asian carps above RC Byrd Lock and Dam are considered too far up the system and are targeted for removal.
- A total of 26 hours were spent boat electrofishing along with 4,500 ft of gill net worked to remove 160 kg (~352 lbs) of Asian carps from the pools between Markland and RC Byrd Locks and Dams.

- Efforts to tag three fish during removal efforts contributed to the total number of individuals surgically implanted with transmitters along the lower density pools of the ORB.
- Due to the lower numbers of invasive carps in these pools, electrofishing may be better utilized when seeking out groups of silver carp. Nets in combination with electrofishing may be useful once groups of fish are located.
- Gill netting remains the more effective gear to use when targeting bighead carp, but can involve large amounts of bycatch.
- In the future, this project will be combined with containment efforts due to project overlap and reporting efficiency.

Literature Cited

Asian Carp Regional Coordinating Committee. 2017. 2017 Asian Carp Monitoring and Response Plan.

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Figures:

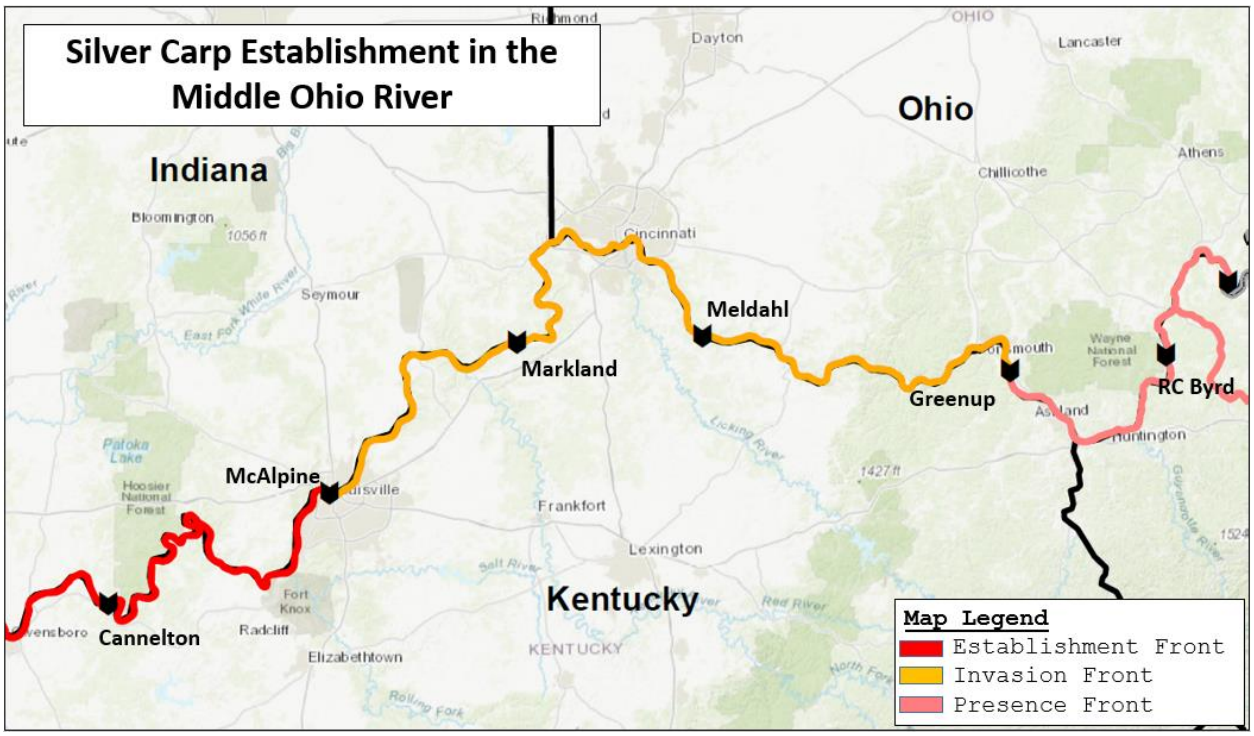

Figure 1. A map depicting the differing levels of Asian carp establishment in the middle Ohio River where targeted sampling and regular suppression is currently being conducted.

Tables:

Table 1. Electrofishing effort (hours) and resulting catch of three species of Asian carp (number and weight) for four pools of the Ohio River during Asian carp containment efforts in 2017.

Pool	Electro Hours (hr)	Bighead Carp (N)	Silver Carp (N)	Grass Carp (N)	Total (N)	Bighead Carp (kg)	Silver Carp (kg)	Grass Carp (kg)	Total (kg)
Markland	11.00	0	6	0	6	0.00	53.79	0.00	53.79
Meldahl	7.50	0	0	0	0	0.00	0.00	0.00	0.00
Greenup	5.00	0	0	0	0	0.00	0.00	0.00	0.00
RC Byrd	2.50	0	0	0	0	0.00	0.00	0.00	0.00
Total	26.00	0	6	0	6	0.00	53.79	0.00	53.79

Table 2. Gill netting effort (feet) and resulting catch of three species of Asian carp (number and weight) for five pools of the Ohio River during Asian carp removal efforts in 2017.

Pool	Total Net Length (ft)	Bighead Carp (N)	Silver Carp (N)	Grass Carp (N)	Total (N)	Bighead Carp (kg)	Silver Carp (kg)	Grass Carp (kg)	Total (kg)
Markland	1800	0	4	0	4	0.00	32.57	0.00	32.57
Meldahl	900	0	0	0	0	0.00	0.00	0.00	0.00
Greenup	1050	0	0	0	0	0.00	0.00	0.00	0.00
RC Byrd	750	3	0	1	4	67.04	0.00	6.41	73.45
Total	4500	3	4	1	8	67.04	32.57	6.41	106.02

Table 3. Suggested locations for focusing removal efforts in upper pools of the sampling range based off of sampling efforts since 2015.

Pool	Site	Type	Presence Documented
Markland	Belterra Embayment	Embayment	Yes
	Craig's Creek	Embayment	Yes
	Great Miami River	Embayment	Yes
	Big Bone South Fork	Tributary	Yes
	Little Miami River	Tributary	Yes
	Big Indian Creek	Tributary	Yes
Meldahl	Eagle Creek	Tributary	Yes
	Ohio Brush Creek	Tributary	Yes
	RM 340 - 350	Main Stem	Yes
	RM 342 - 344	Main Stem Tailwater	Yes
RC Byrd	Old Lock Chambers	Man-made Structure	Yes
	Raccoon Creek	Tributary	Yes