

Abundance and Distribution of Juvenile Asian Carp in the Ohio River: Service Award Number F16AP00938

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Abstract: To successfully prioritize Asian carp management strategies in the Ohio River, the spatial extent of their invasion must be understood. In an effort to define where recruitment occurs, targeted electrofishing was conducted in tributaries and embayments of J.T. Myers, Newburgh, Cannelton, and McAlpine Pools of the Ohio River. A suite of habitat variables were collected at each site to more accurately describe the preferred habitat of juvenile Asian carp. Young-of-year Asian carp (<200 mm) were captured at two locations; Hovey Lake (RM 840) in J.T. Myers Pool and a borrow pit (RM 750) in Newburgh Pool. Immature Asian carp (200 to 400 mm) were only captured in J.T. Myers Pool, most from Hovey Lake and Inland Marina (86%). Adult CPUE was highest in Cannelton Pool (4.18 fish/hour). Juvenile Asian carp were more likely to be found in shallow, warm embayments. Multiple years of data will be necessary to increase detection probabilities of juvenile carp after large spawning events and will allow managers to track changes in the invasion front through time to adjust priorities as needed.

Introduction:

Invasive species are continually responsible for undesirable economic and environmental impacts across the nation (Lovell and Stone 2005, Pimentel et al. 2005, Jelks et al. 2008). There has been a considerable effort placed in the management and monitoring of Asian carp (i.e. Bighead Carp and Silver Carp) since their introduction in the early 1980's (Kolar et al. 2005). However, because of their tolerance for a wide range of environmental conditions, carp have successfully expanded their range into the Ohio River basin. Until recently, the effects of Asian carp on native biota has received minimal attention in the Ohio River basin (ORB). Planktivorous species like the bigheaded carps may compete with native biota (e.g. fishes, mollusks, invertebrates) or disrupt trophic interactions (Irons et al. 2007, Sampson et al. 2009). In order to limit the negative impacts of Asian carp populations and their further spread, efforts in the ORB have increased to understand the distribution and abundance of Asian carp in the waters they currently inhabit.

Knowledge of the geospatial ranges for Asian carp in the Ohio River is necessary for evaluating the invasion status of each pool (i.e. the "extent of invasion"). The extent of invasion has three predominant levels (presence front, invasion front, and established front) and is used to guide specific management and control actions in other Mississippi River sub-basins. The "presence front" is the upmost extent of Asian carp capture where densities are low and reproduction has not been documented. The "invasion front" is the location(s) where reproduction (i.e., eggs, embryos, or larvae) has been observed, but recruitment has yet to be documented. Lastly, the "established front" is the location(s) where reproduction and recruitment to the adult life stage is actively occurring. Identifying the specific spatial extents that differentiate the presence, invasion, and established fronts are crucial information that remains unknown for the ORB.

Confirmed Asian carp spawning events have been reported in tributaries (i.e. Wabash River) as far upstream as JT Myers Locks and Dam and signs of spawning (i.e. spawning patches) have been observed as far up river as the Markland pool. Suspected reproduction of nonindigenous *Hypophthalmichthys spp.*

has also been suggested as far up river as the Meldahl pool using ichthyoplankton data provided by a private consulting company (EA Engineering) in 2015 and 2016. To support Basin Framework objectives (ORFMT 2014) this project was initiated in 2016 in an effort to improve capabilities to detect early stages of invasion and spawning populations of Asian carp (Strategy 2.7) and also monitor upstream range expansion and changes in distribution and abundance (Strategy 2.3). In addition to the Basin Framework, this project directly supports the National Plan (Conover et al. 2007) by assisting in the forecast and detection of Asian carp range expansions (Strategy 3.2.4), determining life history characteristics (Strategy 3.3.1), and assembling information about the distribution, biology, life history, and population dynamics of Bighead and Silver Carps (Strategy 3.6.2).

The project objectives were:

- Define the “established population” range of Asian carp in the Ohio River via targeted sampling for juvenile Asian carp.
- Identify characteristics of potential Asian carp nursery areas when juvenile Asian carp are encountered.
- Identify other sources of fish sampling data in the Ohio River that may inform previous objectives (ORSANCO).

Methods:

Sampling was conducted in J.T. Myers, Newburgh, Cannelton, and McAlpine Pools of the Ohio River from 25 July 2016 to 30 August 2016. Flooded creek mouths, tributaries, side channels, and other backwater areas large enough for entrance with an electrofishing boat were selected in each pool to be sampled. To account for possible fluctuations in abundance due to temporal variation all sites were sampled at least twice, unless they were discovered to be inaccessible.

For analysis purposes and for the remainder of this report, both “young-of-year” and “immature” are collectively referring to “juvenile” Asian carp; “young-of-year” (YOY) will be defined as fish less than 200 mm, and “immature” will define fish between 200 to 400 mm (likely 1 to 2 years old) which have undeveloped gonads and are not capable of spawning. Adult Asian carp are defined as fish greater than 400 mm with mature, identifiable gonads.

Electrofishing effort consisted of 15-minute transects at each sampling location, unless otherwise impeded. At the biologist’s discretion, more sampling time or multiple runs were conducted at sites where either coverage was limited or juvenile Asian carp were suspected. Specific electrofishing settings varied by crew because of equipment differences, but all boats adjusted settings based on water conductivity to maximize Asian carp collection when possible. Dippers specifically targeted all fish resembling Asian carp. All Asian carp were then identified to species, measured to total length, weighed, and sexed if possible. Lappilli otoliths and fin rays were removed from a subsample of fish and sent to Southern Illinois University (SIU) for age and microchemistry analysis. Young-of-year Asian carp were frozen whole and also sent to SIU for analysis.

Experimental surface trawling was conducted at Hovey Lake (J.T. Myers Pool) on August 1 and August 18, 2016. Indiana DNR borrowed the surface trawl from the Missouri Department of Conservation who modified a benthic trawl to float. The surface trawl was 7.32 m wide, 1.52 m tall, and 6.10 m deep with 19.05 mm bar mesh. The last eight feet of the purse had additional layer of 3.18 mm mesh bag attached internally to improve capture of small fishes. Additional foam floats were added to the top line of the trawl to provide extra buoyancy. Otter boards were 38.1 cm tall, 76.2 cm long, and each had three capped and sealed 5.08 cm (inside diameter) by 83.82 cm long PVC pipes attached to the top of the board allowing them to float. The trawl was deployed off of the front of the boat and attached with 24.38 m

ropes. The boat was motored in reverse for 5 minutes before retrieving the net. Fish captured were identified to species and all Asian carp were processed as described above.

A suite of habitat variables were collected at each site including: water temperature, Secchi disk visibility, conductivity, pH, dissolved oxygen, maximum depth, average depth, tributary width, and presence/absence of woody debris and aquatic vegetation. These habitat variables were used to describe the possible habitat preferences of juvenile Asian carp. Using an alpha level of 0.05, two-sample student's t-Tests (assuming unequal variances) were performed individually on each numerical habitat variable to compare mean measurements between locations with juvenile Asian carp present (N = 9) to those locations without (N = 155). Chi-squared test statistic was used to determine whether juvenile Asian carp exhibited a preference for the presence/absence of woody debris and aquatic vegetation.

Results:

Electrofishing Sampling and Catch – Electrofishing took place at 58 sites for a combined effort of 40.65 hours; eight sites were only sampled once due to limited accessibility, 22 sites were sampled twice with at least two weeks between samples, and 28 sites had multiple sampling locations within a site (i.e. upper and lower portions of larger tributaries), with most locations sampled twice at least two weeks apart (Figure 1).

Young-of-year Silver Carp were only captured at two sampling sites; one individual at a borrow pit in Newburgh Pool, and 10 at Hovey Lake in J.T. Myers Pool. Young-of-year catch per unit effort (CPUE) at Hovey Lake was 12.0 fish/hour. Immature Silver Carp (N = 28) were only captured in J.T. Myers Pool at six sampling sites. Inland Marina (near Evansville, IN) and Hovey Lake were most productive for immature Silver Carp with CPUE's of 20.6 and 14.4 fish/hour, respectively, and accounted for 86% of captured immature carp. Adult Asian carp CPUE was highest in Cannelton Pool (4.18 fish/hour), followed by Newburgh (3.17 fish/hour), J.T. Myers (2.4 fish/hour), and McAlpine Pools (1.54 fish/hour). Only two adult Bighead Carp were captured; one each in Newburgh and Cannelton Pools.

Surface Trawl Sampling and Catch – Hovey Lake surface trawling effort consisted of 1.71 hours of trawling time; one adult, nine immature, and 160 YOY Asian carp were collected. Average CPUE was 93.6 and 5.3 fish/hour for YOY and immature Asian carp, respectively. Seven YOY Asian carp were Bighead Carp, while all others were Silver Carp. Among trawls, YOY CPUE varied from 0.0 fish/hour to 1,480 fish/hour indicating clumped distributions despite the uniform habitat conditions that were sampled at Hovey Lake.

Habitat Parameters – Habitat measurements varied substantially among sampling sites. Mean water temperature was significantly greater (M = 85.0 °F, SD = 2.01) at sampling locations with juvenile Asian carp than locations without (M = 79.9 °F, SD = 6.37); $t(20) = -6.02, p < 0.001$. Maximum depth in locations with juvenile carp was significantly lower (M = 7.0 ft, SD = 3.08) than sites with no juveniles (M = 12.3 ft, SD = 5.56); $t(11) = 4.70, p < 0.001$. Similarly, average depth was significantly lower in areas with juveniles (M = 4.2 ft, SD = 1.82) than locations without (M = 6.8 ft, SD = 2.87); $t(10) = 4.01, p = 0.002$. Secchi disk measurement, Conductivity, pH, dissolved oxygen, and tributary width were not statistically different between areas with and without juvenile Asian carp. Juvenile Asian carp did not express a preference for locations with the presence of woody debris, $\chi^2(1, N = 164) = 01.09, p = 0.296$, or the presence of aquatic vegetation, $\chi^2(1, N = 164) = 01.25, p = 0.264$.

Discussion:

The abundance and distribution of juvenile Asian carp in the Ohio River project in 2016 was the first large-scale effort to define the extent of the “established population” range of Asian carp in the river. Eleven sites were sampled in J.T. Myers Pool, 11 in Newburgh Pool, 21 in Cannelton Pool, and 15 in McAlpine Pool for a total of 6.25, 5.37, 16.03, and 13.00 hours of electrofishing, respectively, in each

pool. Collectively, 164 sampling events occurred for a combined effort of 40.65 hours. This effort resulted in the removal of 158 Asian carp (670.8 lbs) from the Ohio River and the outcomes directly addressed Basin Framework Strategy 2.7 by improving capabilities to detect early stages of invasion and spawning populations of Asian carp. The project was the first step in providing baseline data to accurately describe the distribution of Asian carp recruitment for the Water Resources Reform and Development Act (WRRDA) reporting.

The original proposal for this project excluded McAlpine Pool, but shortly after finalized, 2015 EA Engineering data was released which noted Asian carp type eggs collected as far upstream as river mile 405.7 in the Meldahl Pool. The fact that Grass Carp yolk-sac larvae were the only Asian carp larvae identified in Meldahl Pool may indicate that the Asian carp type eggs found there were those of Grass Carp and do not necessarily indicate Silver or Bighead spawning occurred. McAlpine Pool contained the furthest upstream *Hypophthalmichthys sp.* larvae possibly indicating the known extent of the spawning populations of Silver and/or Bighead Carp. Cannelton Pool produced the farthest upstream Silver Carp type yolk-sac larvae (N = 61), which accounted for 0.17% of the total specimens collected. These findings prompted us to allocate additional effort into McAlpine Pool, upstream of the original project study area. Additional assistance from the USFWS was vital and provided the means necessary to expend the extra effort upstream.

Due to the clumped distribution of juvenile Asian carp, particularly YOY, this project was designed to sample as many locations as possible across a temporal scale. There were eight sites that were only sampled once due to inaccessibility or difficult sampling. Fluctuating water levels make it difficult to predict if a particular tributary will be accessible from one week to the next, so crews remained flexible and adjusted sampling when necessary. Over half of the sites contained multiple sampling locations within a site due to the size of the embayment/tributary. A number of these sites were large enough to allow even more sampling locations within a tributary, but the usefulness of additional sampling would have to be weighed on a case-by-case basis; if there were numerous adult Asian carp present but juveniles were not being collected, the biologist would be allowed flexibility to increase sampling effort in that area to determine if juveniles were in fact present.

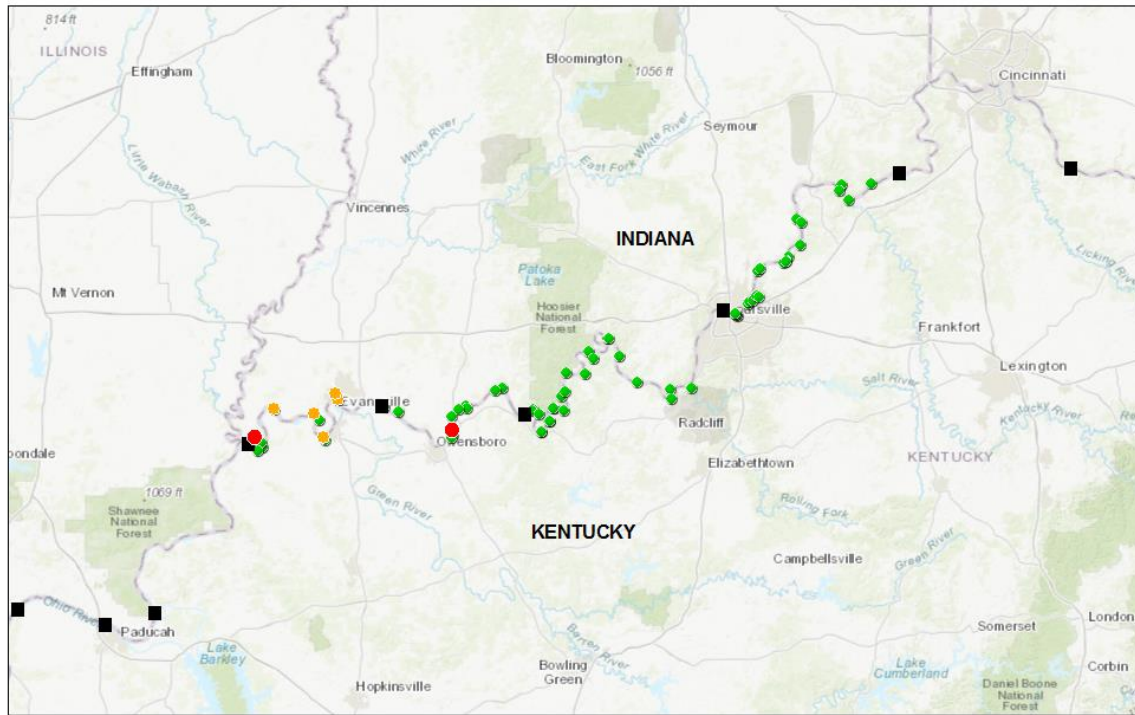
The collection of one YOY Silver Carp from a borrow pit in Newburgh Pool indicates spawning occurs upstream of river mile 750. The borrow pit is located only 28 miles downstream of Cannelton Lock and Dam; it is unknown at this time whether 28 miles of river would provide enough drift time for an egg to hatch and larvae mature enough to seek out the backwaters of the borrow pit. Newburgh is a relatively short pool (55 miles) in the Ohio River navigation system, so there is a possibility that either the egg/larvae drifted downstream from a spawning event in Cannelton Pool, or a spawning event occurred in one of the larger upstream tributaries of the Newburgh Pool, possibly the Anderson River. Spawning of both Bighead and Silver Carp certainly occurs in J.T. Myers Pool as indicated by YOY of each species found at Hovey Lake. These results open the discussion of allocating additional effort towards identifying tributaries that account for the most recruitment, hence population growth.

Our preliminary data suggest the “established front” of Asian carp in the Ohio River is below Cannelton Lock and Dam. To address Strategy 2.3 of the Basin Framework, we recommend this project continue for multiple years to account for varying environmental variables, and fluctuations in recruitment, to gain a better understanding of recruitment sources within the river and track progress of the invasion fronts. Additional years of data will allow us to better define preferred juvenile Asian carp habitat and will assist in determining ideal sample sites within the “invasion front” to monitor for the presence of recruitment. Also, various gears should be experimented with in an effort to increase detection probabilities of juvenile Asian carp in areas of lower densities. If areas are identified as productive sources of recruitment, managers should begin to develop strategies to lower recruitment in those areas, if at all possible.

In addition to the efforts directly associated with the “Abundance and distribution of juvenile Asian carp in the Ohio River” project, Indiana DNR personnel also assisted KDFWR and USFWS with the “Monitoring and response of Asian carp in the Ohio River” and “Distribution, movement, and lock and dam passage of Asian carp in the Ohio River through acoustic telemetry” projects. All data collected during work on these projects were sent to respective project leads within KDFWR and USFWS.

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August 7, 2017

- YOY Asian Carp Present
- Immature Asian Carp Present
- Sampling Sites
- Lock and Dam

1:2,311,162
 0 20 40 80 mi
 0 30 60 120 km
 Sources: Esri, HERE, DeLorme, Intermap, IntraMap, P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GEBCO, IGN, Kaiser NL, Ordnance Survey.

Figure 1. Sampling sites for 2016 juvenile Asian carp targeted electrofishing in J.T. Myers, Newburgh, Cannelton, and McAlpine Pools of the Ohio River. Green dots represent all sites where juvenile Asian carp were not collected, orange dots represent sites where immature (200 to 400 mm) Asian carp were collected, and red dots indicate sites where young-of-year (<200 mm) Asian carp were collected.