

## Control and Removal of Asian carp in the Ohio River

**Geographic Location:** Ohio River basin, extending from the Cannelton Lock and Dam (RM 720.7) to the Markland Lock and Dam (RM 531.5) 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), US Army Corps of Engineers (USACE)

### 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 (Kolar et al. 2005) and may densely colonize river reaches, affecting the native food webs in large river ecosystems (Irons et al. 2007, Freedman et al. 2012). Prevention and rapid response are the best tools for limiting establishment of costly invasive species and physical removal of Asian carp in the Ohio River basin may be one tool that can slow their upriver expansion.

Recent studies on Asian carp harvest programs in the Illinois River show that the collapse of silver and bighead carp populations are possible if all fish sizes are targeted (Tsehaye et al. 2013). Diverse and consistent removal efforts in portions of the Ohio River where Asian carp are established may disrupt upriver movement of Asian carp, decrease pressure on existing barriers, and reduce numbers of Asian carp in sensitive areas to protect species of conservation need or important sport fisheries. Removal efforts also provide an opportunity to collect data on the populations of Asian carp in higher density pools of the Ohio River Basin (ORB). This data will provide assessment tools with information that may guide monitoring, barrier defense, and population control efforts in future years.

### Objectives:

1. Target and remove all size classes of Asian carp below Markland Locks and Dam.
2. Explore novel sampling techniques, and gear types that increase carp capture.
3. Identify a use for removed fish and support the creation of Asian carp markets.

### Methods:

Removal efforts in 2017 were confined to Ohio River pools below Markland Lock and Dam (Figure 1). This region was defined in 2016 in order to focus removal efforts in higher density pools where the largest removal impact could be made. Removal efforts conducted in pools above Markland Lock and Dam are reported in the Control and Suppression project for the 2017 sampling season.

### *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 populations 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 when talking about basin-specific invasions. With this in mind, below are a list of terms used in this report that are solely for internal reference.

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, 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).

#### *Targeting and Removal of Asian Carps*

Electrofishing and gill netting for removal in 2017 were conducted over approximately 15 weeks from May through September. Because removal is the primary objective, electrofishing was not rigorously 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 with fish being driven toward the nets with boat noise at 30-minute intervals. Nets were occasionally set overnight in areas where they did not create hazards to navigation.

Sampling efforts focused on tributaries and embayments where densities of Asian carp are highest and fish are easiest to capture. The majority of these locations were derived from monitoring sampling sites in 2016. Additional sites that were either remotely identified using map study, recommended by agency biologists, or areas that contained characteristics of typical carp habitat were also targeted. However, the majority of effort was spent in known, high-density locations where carp were consistently captured.

All Asian carps and by-catch were identified to species. Asian 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 immediately returned to the water upon recovery. 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 including sex, fin spines, and otoliths were collected for each silver or bighead carp captured (Williamson and Garvey 2005, Seibert and Phelps 2013).

#### *Exploration of Novel Sampling Techniques and Gears*

A limited number of novel removal techniques were explored in 2017. These efforts were intended to identify new methods to more effectively target carp. However, because the primary goal of this project was to remove carp and reduce propagule pressure to move upriver, limited effort was expended testing the effectiveness of new techniques.

In 2016 and 2017, winged hoop nets were used to target Asian carp at known high-density locations. This gear was appealing due to their reported success in other systems and because they can be left, unmonitored for days at a time. Hoop nets were typically fished over a 36-hour period and were often placed where falling water levels and wings might corral fish into the gear. Some nets were set below the surface in flow, near woody debris, with throats facing downstream. On other occasions, throats were placed into flow, where pooled water was actively dropping after a rise in river conditions.

Over-night gill net sets were used with more frequency in 2017 due to electrofishing difficulties in dim lighting during night sampling. Gill nets were set three feet underwater in main-stem river locations and deeper tributaries or tributary mouths. Nets were large mesh (4.0” to 5.0” square) and often set perpendicular to the shoreline.

The use of boat electrofishing as a herding tool, in combination with gill nets, was also employed as a removal technique. Large mesh, gill nets were set in areas where fish could be pushed into the gear. Because of the large amount of variation between net locations, there was no effort to maintain consistency in the design or implementation of this technique. Catch between either gears was recorded together.

Collaborative work between KDFWR and USFWS was conducted using hydroacoustic equipment in an effort to identify schools of carp that could be targeted and herded into entanglement gears. Gill nets were strategically placed in sections of a tributary (Clover Creek, KY) and on the main-stem Ohio River where large schools of riverine fishes were located using a hydroacoustic, split-beam sonar array. Electrofishing boats were used in an attempt to move fish into nets after they were dropped around schools of fish.

#### *Support Creation of Asian Carp Markets*

The Kentucky Department of Fish and Wildlife Resources executive leadership is currently working with private business and commercial anglers to aid in furthering the development of an Asian carp fishing industry in Kentucky. Several barriers for a successful industry start-up have been identified and multiple strategies are being developed to address some of the logistical hurdles for market growth. In Kentucky, the Asian carp Harvest Program has been developed to further incentivize commercial anglers to target bigheaded carps specifically.

#### **Results:**

##### *Physical Removal of Asian Carps*

A total of 61 hours were spent electrofishing in three pools of the Ohio River and its tributaries between Smithland and Markland Lock and Dam (Table 1). One thousand four hundred and sixty-six carp were removed using boat electrofishing over these four pools in 2017. The highest level of effort was expended in the Cannelton pool where a total number of 1,077 carps, weighing approximately 6,077 kg (13,400 lbs), were removed. Total effort and capture numbers accounted for in this report include some time and effort placed into the Abundance and Distribution of Early Life Stages project. However, this report does not contain all effort in the pools where juvenile sampling took place. For more detail on effort and removal conducted during juvenile sampling in 2017, please refer to that report.

A total of 8,850 ft of large mesh (4" and 5" square) gill nets were used in capturing 93 invasive carps in the Cannelton and McAlpine pools (Table 2). This amounted to 777 kg (~1,712 lbs) of bighead and silver and grass carp combined. The largest amount of effort was expended in the Cannelton pool with 6,450 ft of gill net fished to remove 90 fish, weighing approximately 634 kg (~1,400 lbs).

##### *Pursuit of Novel Capture Techniques*

No carp within the Cannelton and McAlpine pools have been captured using the hoop nets, and by-catch is typically high. Hoop nets are the only gear that has consistently captured sportfish species as by-catch, with the majority consisting of crappie species. Nets have been deliberately set at sites where electrofishing and gill netting have consistently caught Asian carp in the past. Plans to utilize and target strategic flood zones with hoop nets are planned for 2018. Future target sites include Clover Creek, Flint Island, Oil Creek, and McAlpine Lock and Dam tail-waters in the Cannelton.

The use of boat electrofishing in combination with gill netting appeared to increase carp catches in 2016. In 2017, gill netting while herding carp with boat electrofishing appeared to match or increase yields when compared to gill net catches without electrofishing assistance. Although three bighead carp were captured using these methods in 2016, not a single bighead was captured in 2017. Overnight gill net sets were fished with more frequency in 2017 and have resulted in more captures of bighead carp.

### *Support Creation of Asian Carp Markets*

In 2015, over 1 million pounds of Asian carp were harvested from Kentucky waters and sold to processors within various domestic and exported markets. In 2016, commercial fisherman participating in the Asian Carp Harvest Program in Kentucky waters yielded ~1.4 million pounds of carp which were also sold to various markets. An additional 1.4 million pounds of Asian carp was reported from commercial anglers in 2017 with ~765,000 pounds being harvest through the Asian Carp Harvest Program. In addition, executive leadership in the KDFWR agency has gained an understanding of how commercial fishers and processors operate from inquiries conducted over several years and have identified and worked to lower hurdles for the growing industry. Currently, three Kentucky processors are receiving Asian carp species from commercial anglers and several restaurants in and around Kentucky are serving the fish on their menus.

### *Removal in Other Projects*

While removal was not listed as a primary objective in other ORB projects, Asian carp captured during any sampling on the Ohio River were euthanized unless they were tagged for tracking purposes. Accounts of an additional 1,353 kg (~2,983 lbs) of fish were captured during monitoring efforts and 160 kg (~353 lbs) during containment efforts outside of this project were removed from the river. Details on these additional fish captured during non-targeted sampling are not detailed here, but are included in other ORB reports.

### **Discussion:**

Dams along the Ohio River are likely formidable barriers to dispersal for silver carp migrating up river. Data acquired from sampling efforts in 2017 show that the average sizes of silver carp increase (Figure 2) as you move up river, while catch rates decrease (Figure 3 and Figure 4). This has been a consistent pattern in data gathered since 2015 and is an indication that fish further up river are not only lesser in number, but likely older fish that have had more time to disperse from an established front. With Cannelton being the furthest upriver pool where fish < 400 mm have been observed, it must be prioritized as a major target in terms of population control. Numbers of fish are high enough to suggest that regular fishing pressure is needed, and with the presence of newly recruited fish, it is likely the main source-population contributing to upriver population expansion. Focus on the higher density pools like Cannelton that may be important reservoirs for propagules can alleviate pressure for upriver expansion and decrease efforts expended upriver, where low densities make it difficult to catch and suppress carp populations.

Currently, electrofishing has produced the most success in capturing silver carp due to their transient nature and explosive reaction to electricity. Silver carp can be sought out quickly with boat electrofishing techniques and schools can easily be targeted when found. More aggressive movements and sinuous patterns are often used to pin fish against the bank when targeting silver carp and can be effective at getting fish to surface. However, because they are difficult to catch when airborne, CPUE is often more variable and highly dependent on both the experience of the driver and dipper. In addition, increased catch rates when electrofishing in 2017 correlated with spawning activity and increased movement into tributaries during the summer months (Figure 5). Targeting of tributary waters and tributary mouths give removal crews an advantage because gears are typically more effective in these shallower waters. Future sampling efforts should be designed to take advantage of this period to maximize catch. Additional exploratory efforts should be pursued to increase removal success outside of spawning periods (approximately May – August).

Despite lessons learned from previous years, electrofishing conducted within the removal framework in 2017 produced a lower overall total catch when compared to removal conducted in 2016. However, there was roughly a 232% increase in catch of targeted carp using improved gill netting techniques when compared to 2016. This increase is likely due to better site selection and increased experience among

removal crews running gill nets. Additionally, longer soak times when targeting bighead carp has also caused an increase in overall carp captures. In the future, nets will range from 3” bar mesh to 6” bar mesh to decrease size selectivity and target a wider range of length-classes.

Due to the biology and habits of Asian carps, recommendations on utilizing herding techniques seemed like an effective way to force fish to move into gears or traps. Previously, efforts in 2016 did appear to show that a combination of boat electrofishing and gill nets produced higher success rates than single gear methods. This strategy was also productive in 2017 and will continue to be refined. In 2017, floating nets were also successful as in previous years when targeting fish at the top of the water column. One fishing technique often reference, drifting gill nets, has yet to be successful when deployed across the removal range, but likely needs to be attempted at night when carp are ram-feeding at the surface to see success.

Commercial or contract angling should be encouraged in the future to place additional pressure on Asian carp populations within these pools. Increased focus on upper pools with established populations and higher densities will likely allow the reduction of density dependent dispersal. Currently, participating agencies have consistently been able to remove around 9,100 kg of Asian carps per year in these relatively lower density pools (Cannelton – RC Byrd). With no indication that relative abundances have decreased, more effort must be placed in the removal fish along the invasion front. Effective target parameters for population control cannot be developed without an indication that population numbers are being lowered, but annual yields exceeding 9,100 kg (~20,000 lbs) should be attempted in the future.

#### **Recommendations:**

Future removal effort should focus primarily on the Cannelton pool during the months of June to August when spawning activity is observed and fish begin to congregate below McAlpine Lock and Dam or in the tributaries. During this time period, special consideration should be given to Clover Creek, Oil Creek, and Yellowbank Creek where juvenile fish have been observed. Sinking Creek, Poison Creek and the Salt River, appear to harbor large groups of fish year around and are important targets within the Cannelton pool. Gill netting activity should increase overall with an emphasis on setting gears near top water during evening hours and overnight. Efforts to spur public and commercial interest within the Cannelton pool should continue and will be an important in contributing to the necessary population control efforts for the Ohio River basin.

#### **Project Highlights:**

- Prevention and control are currently the best tools for limiting establishment of costly invasive species. Physical removal of Asian carps in the Ohio River basin is one of our few tools to slow their upstream expansion.
- Removal in 2016 was altered from removal conducted in 2015 in order to focus removal efforts in higher density pools where larger impacts could be made. This was continued in 2017 and efforts must be increased in order to slow and stop upriver progression of carp in the ORB.
- Electrofishing conducted in JT Myers though McAlpine pools in 2016 produced about a 100% increase in effort and a 340% increase in catch when compared to work completed in all five pools sampled in 2015. Efforts in 2017 produced slightly lower yields than in 2016, but the overall biomass removed between the two years was similar.
- Gill netting efforts in Cannelton and McAlpine alone were approximately equivalent to all the effort placed into the five pools previously targeted for removal in 2015. Total catch increased in 2016 (over 160%) and then increased again in 2017 (over 230%) as removal crews began to refine gill netting techniques.

- Effective target parameters for population control cannot be developed without an indication that population numbers are being lowered, but annual yields exceeding 9,100 kg (~20,000 lbs) have been consistent for the past two years and should be increased using lessons learned in the future.

### **Literature Cited**

- Freedman, J. A., S. E. Butler, and D. H. Wahl. 2012. Impacts of invasive Asian carps on native food webs. Page Illinois-Indiana Sea Grant.
- Irons, K. S., G. G. Sass, M. A. McClelland, and J. D. Stafford. 2007. Reduced condition factor of two native fish species coincident with invasion of non-native Asian carps in the Illinois River, U.S.A. Is this evidence for competition and reduced fitness? *Journal of Fish Biology* 71(Supplement D):258–273.
- Kolar, C. S., D. C. Chapman, W. R. Courtenay Jr., C. M. Housel, J. D. Williams, and D. P. Jennings. 2005. Asian carps of the genus *Hypophthalmichthys* (Pisces, Cyprinidae) -- A biological synopsis and environmental risk assessment. Page Report to U.S. Fish and Wildlife Service. Washington, D.C.
- Seibert, J. R., and Q. E. Phelps. 2013. Evaluation of Aging Structures for Silver Carp from Midwestern U.S. Rivers. *North American Journal of Fisheries Management* 33(4):839–844.
- Tsehaye, I., M. Catalano, G. Sass, D. Glover, and B. Roth. 2013. Prospects for Fishery-Induced Collapse of Invasive Asian Carp in the Illinois River. *Fisheries* 38(10):445–454.
- Williamson, C. J., and J. E. Garvey. 2005. Growth, Fecundity, and Diets of Newly Established Silver Carp in the Middle Mississippi River. *Transactions of the American Fisheries Society* 134(6):1423–1430.

Figures:

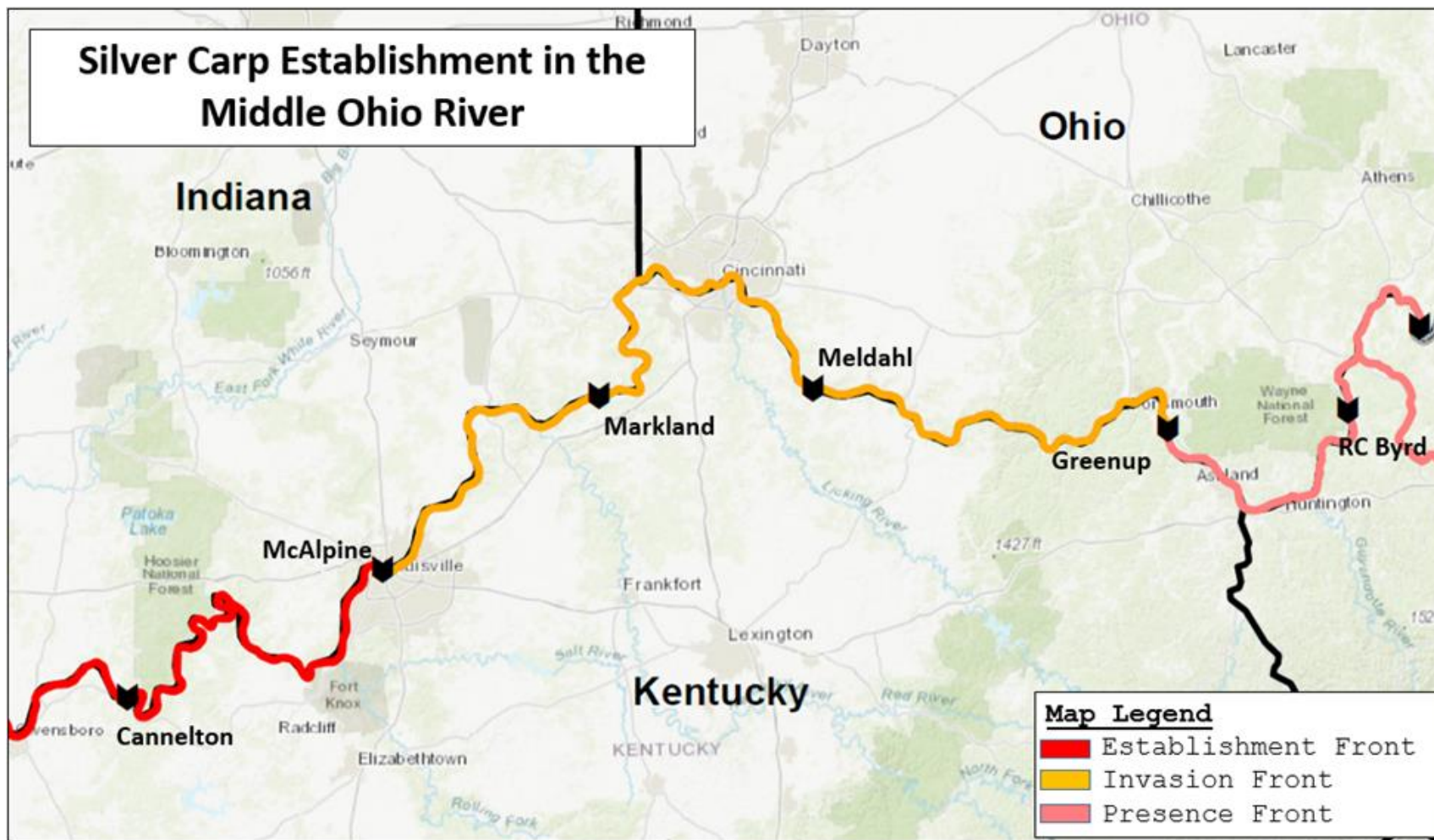


Figure 1. A map depicting the differing levels of Asian carp establishment in the middle Ohio River where targeted sampling and regular suppression is currently being conducted.



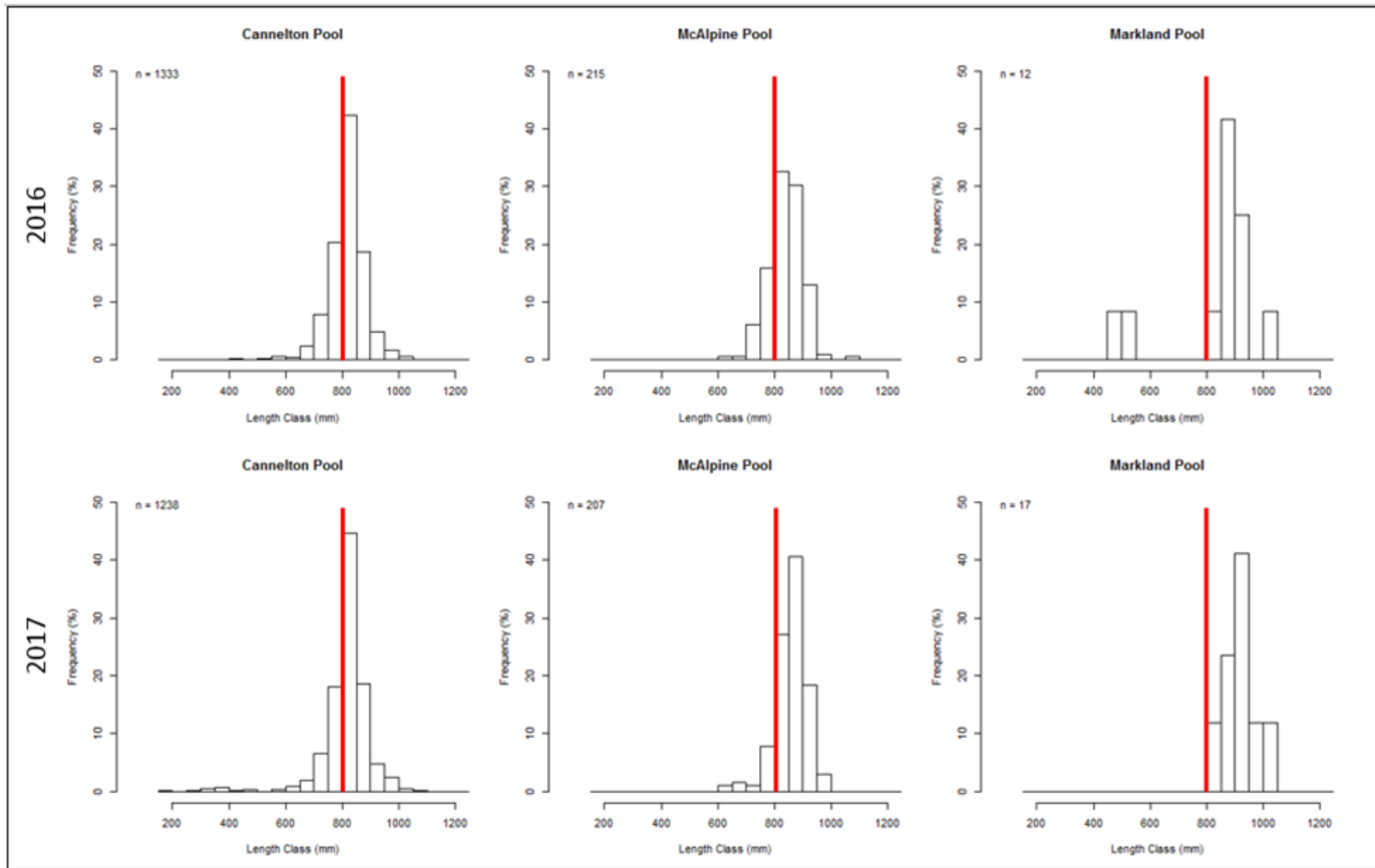


Figure 2. Length frequencies of silver carp captured during sampling efforts in 2016 and 2017. A line at 800mm highlights the change in length-classes from fish captured farther upriver with Cannelton being the farthest pool downstream and Markland the farthest pool upstream.

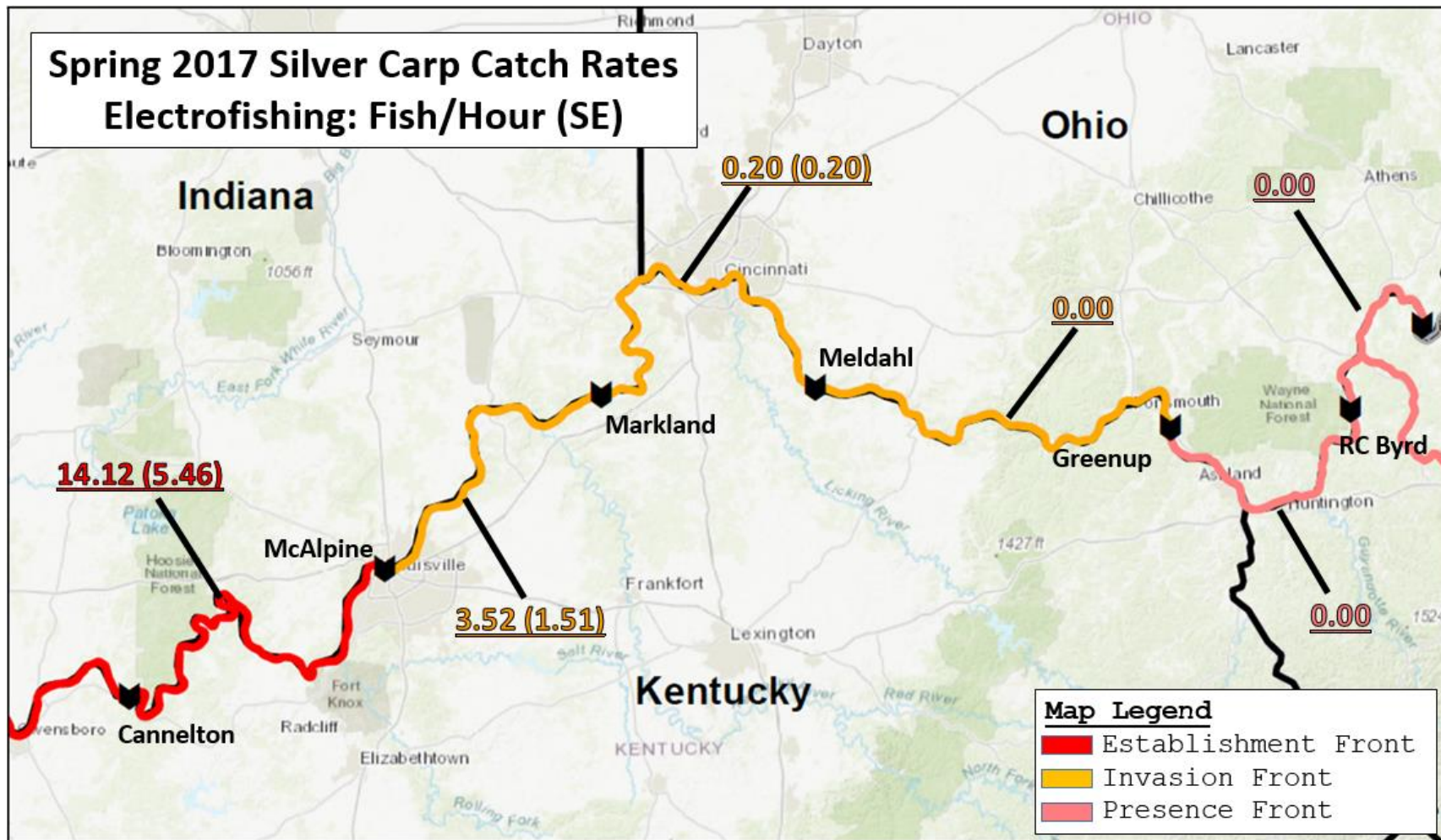


Figure 3. Mean silver carp catch rates by navigation pool using boat electrofishing during targeted sampling in 2017. Standard errors are in parenthesis.

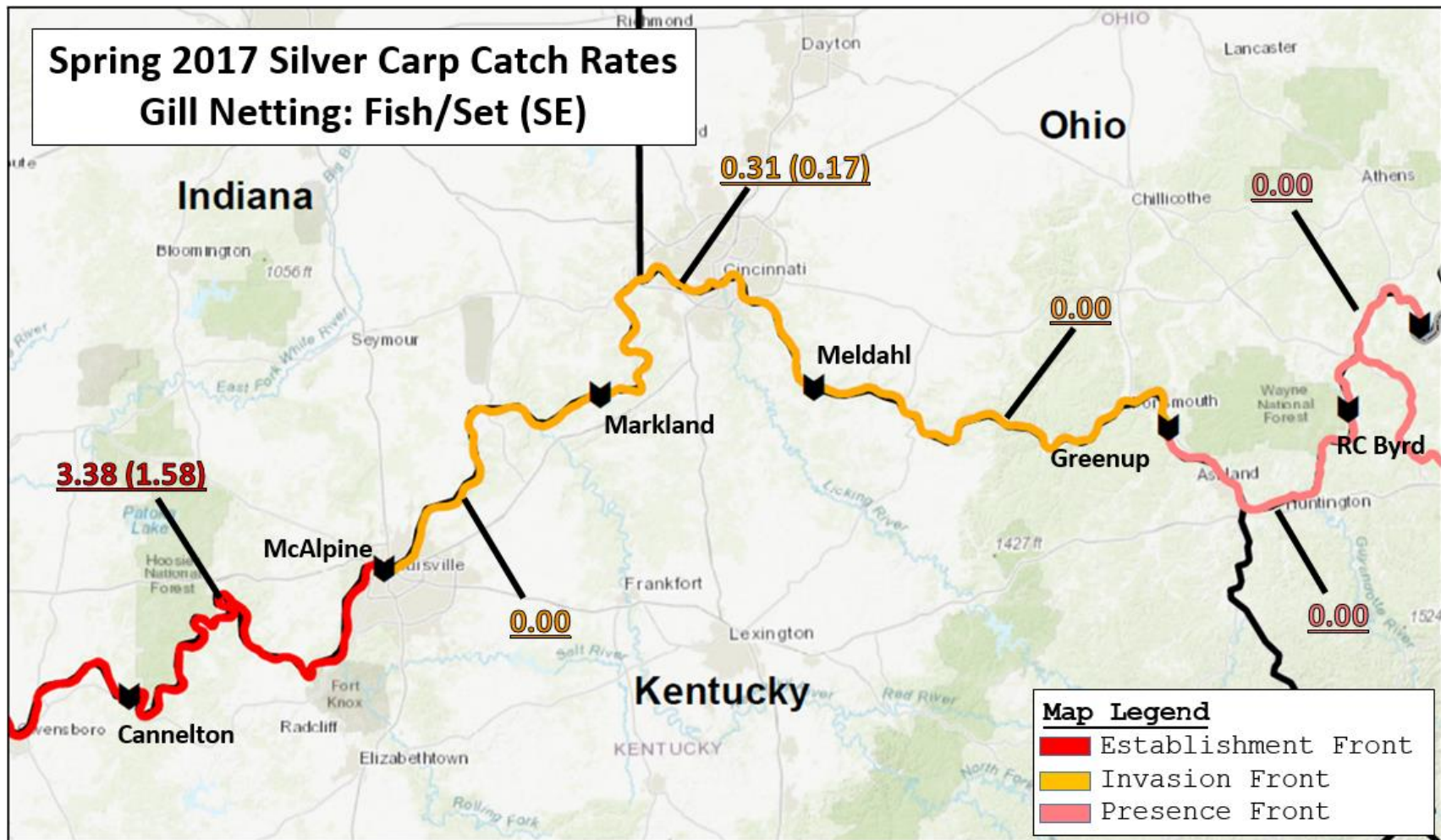


Figure 4. Mean silver carp catch rates by navigation pool using gill netting during targeted sampling efforts in Spring 2017. Standard errors are in parenthesis.

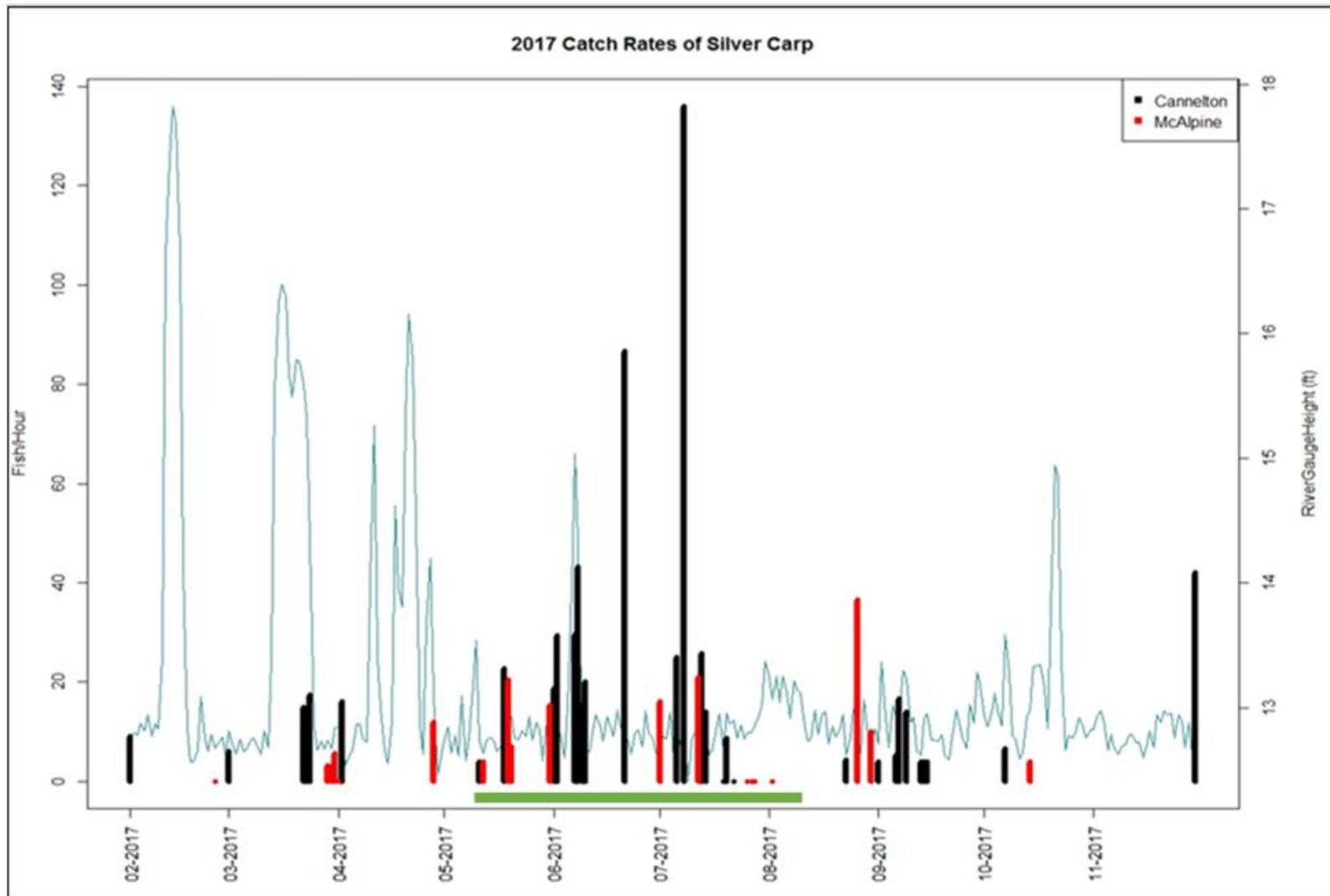


Figure 5. A histogram showing catch rates by month of silver carp captured in Cannelton and McAlpine in 2017 along with the gauge height in feet. The green line between the months of May and August indicate the period where spawning patches appear on females.

**Tables:**

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

<b>Pool</b>	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)
Smithland	1.00	1	195	1	197	1.85	92.67	15.88	110.40
Cannelton	43.00	10	1050	17	1077	79.61	5924.24	73.27	6077.12
McAlpine	17.00	0	192	0	192	0.00	1314.13	0.00	1314.13
Total	61	11	1437	18	1466	81.46	7331.04	89.15	7501.65

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

<b>Pool</b>	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)
Cannelton	6450	11	76	3	90	148.84	456.64	28.44	633.92
McAlpine	2400	1	2	0	3	24.58	118.38	0.00	142.96
<b>Total</b>	<b>8850</b>	<b>12</b>	<b>78</b>	<b>3</b>	<b>93</b>	<b>173.42</b>	<b>575.02</b>	<b>28.44</b>	<b>776.88</b>