

**Project Title:** Early Detection of Invasive Carp Reproduction and Population Expansion in the Tennessee and Cumberland Rivers

**Geographic Location:** Tennessee and Cumberland rivers and northern section of the Tennessee-Tombigbee Waterway (Divide Cut and Bay Springs Lake).

**Lead Agency:** Tennessee Wildlife Resources Agency (TWRA; Cole Harty, cole.r.harty@tn.gov)

**Participating Agencies:** TWRA, Tennessee Technological University (TTU), Kentucky Department of Fish and Wildlife Resources (KDFWR), Alabama Department of Conservation and Natural Resources (ADCNR), and Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP)

**Statement of Need:**

Invasive carp have been present in the Tennessee and Cumberland rivers for over two decades. They negatively impact fisheries where they are present and pose a significant threat to waters upstream of their leading edge. In response to the ongoing invasion, state and federal wildlife agencies have undertaken efforts to reduce the current populations and are working to prevent further invasion. An increased understanding of invasive carp reproduction where the species occur and increased surveillance for population expansion beyond the current presence and invasion fronts have significant implications for informing management actions such as targeted removal efforts and deterrent strategies.

Invasive carp reproductive success has not been definitively confirmed above Kentucky and Barkley dams in the Tennessee and Cumberland rivers (TNCR) despite the observation of large numbers of young of year carp during the fall of 2015. Limited evidence of successful invasive carp reproduction, including collection of eggs by Tennessee Valley Authority and one genetically identified larval silver carp from TWRA (2017), has been detected during larval sampling efforts and the 2015-year class remains a dominant cohort of fish captured during sampling efforts since 2016. The larval and juvenile sampling in this plan is critical for understanding the source of carp in the TNCR and making relative management decisions (location and amount of harvest and deterrence projects).

In addition to monitoring for invasive carp recruitment in reservoirs with existing populations, surveillance and monitoring efforts are needed in waters upstream of the existing invasion front, including in adjacent, connected basins such as the Tennessee-Tombigbee Waterway (TTW). Reports/encounters with individual invasive carp in upstream reservoirs and connected basins are infrequent, but important to informing our understanding of the invasion front and documenting range expansion.

**Project Objectives:**

- 1) Conduct systematic sampling to monitor for and document invasive carp and recruitment.
- 2) Develop and implement monitoring programs for early detection of invasive carp in waters upstream of the current leading edge.

- 3) Determine invasive carp relative densities and assess sampling needs in the Tennessee-Tombigbee Waterway.

### **Project Highlights:**

#### *TWRA*

- Preliminary analysis resulted in positive genetic detections for invasive carp eggs and larva from larval tow and light trap sampling – additional visual ID will be conducted, and more information will be provided in future reports.
- No juvenile invasive carp were detected via any TWRA sampling efforts, and no credible reports were received.
- No silver carp were reported from waters in eastern Tennessee or detected during targeted surveillance efforts.

#### *ADCNR*

- ADCNR staff accessed a new motor for an Oqauwka electrofisher boat and paired with a second boat, a smaller Duracraft with a Smith-Root (model: 5.0) electrofisher control box, were able to commence with spring-fall field sampling described below. To date, ADCNR completed the 2023 calendar year with fully implemented sampling efforts at two target tailwater areas. Work included standardized sampling approaches. Despite efforts, no invasive carp were captured nor witnessed within any of the defined sample areas.

#### *KDFWR*

- No young of year invasive carp were found in Barkley or Kentucky reservoirs in 2023.
- Catch rates of adult silver carp during, paupier sampling in 2023 on Kentucky Lake were the lowest recorded since surveys began.
- No young of year invasive carp were found in the lower Tennessee and Cumberland Rivers in 2023.

#### *MDWFP*

- Due to internal agency factors, project funding was delayed, and purchases for equipment were made in 2023, although not in time to aid in the proposed sampling. Sampling continued as planned, with funding obtained from other sources. Project funding will be used to maintain this monitoring effort into the future following the methods initially proposed.
- Joint sampling efforts by biologists in MDWFP's Northeast Region and the USFWS Lower Mississippi River Fish and Wildlife Conservation Office occurred in Pools E and D of the Tennessee-Tombigbee Waterway in March and September of 2023. In 2023 80 sites were sampled with two gear types. Additionally, Pool A through Bay Springs Lake were sampled in June using three electrofishing boats simultaneously, in cooperation with USFWS and ADCNR. No invasive carp were observed or captured during these events, suggesting carp densities likely remain low in the upper pools of the Waterway. Monitoring will continue in these pools and additional sampling methods will be utilized, as resources allow, to increase confidence that lack of observation represents true absence.

## **Methods:**

### ***TWRA***

*Objective 1. Conduct systematic sampling to monitor for and document invasive carp and recruitment.*

TWRA conducted sampling to monitor for invasive carp reproduction and recruitment on Kentucky and Barkley reservoirs during summer (May-August) and fall (October-November) of 2023. Summer sampling consisted of larval tow nets, larval light traps, electrified dozer trawls, and mini fyke nets, and fall sampling included electrified dozer trawls.

Larval tows were conducted on the edges of the channel of the Tennessee and Cumberland rivers. Ten transects were chosen per sampling section (TWRA Table 1). Each larval tow was standardized to sample 10,000 – 12,500 cubic feet of water, which typically took five to ten minutes per sample. Tows were conducted between 3.22 – 8.05 km/h.

Larval light traps consisted of four clear cylinders with slits in the sides to allow larval fish to enter. There was a hollow tube in the middle for a light source to attract young of year fish, as well as reflective tape to allow the light source to be more visible. Larval light traps were set between 0.30 – 2.44 m deep depending on water conditions. Light traps were set at sunset and picked up after approximately 1.5 hours.

Mini-fyke nets had one wing and were 7.62 meters long with a 0.61 x 1.22-meter-wide mouth with a weight at the cod end. Mini fyke nets were staked onto the shoreline and were deployed for 4 – 6 hours every sampling event. Soak time was variable due to factors such as weather and angler presence within each sampling site. Nets were set before or during larval tows and retrieved after light traps were set. Both Kentucky and Barkley reservoir were sampled with larval light traps and mini-fyke nets (TWRA Table 2).

All larval samples collected by specific gear types were combined for a day of sampling, but kept separate by gear (e.g., all samples collected in a given day from light traps were combined into one). Larval samples were then split between two solutions, 99% ethanol and formaldehyde. Organic matter was discarded along with by-catch such as sport fish. Ethanol treated samples were drained 24 hours after the collection for better preservation. Ethanol treated samples were sent to TTU for DNA batch analysis and formaldehyde samples were kept by TWRA for visual identification if invasive carp DNA were detected.

Dozer trawls were conducted in summer and fall periods in Kentucky (n=200) and Barkley (n=40) reservoirs. Kentucky Reservoir was divided into five sections to encompass the large reservoir (n=20/section). In every embayment sampled, dozer trawls were conducted on both left and right descending banks where water levels allowed. Dozer trawl transects were conducted at sites within embayments with depths greater than 1.8 meters for 5 minutes at approximately 6.4 km/h. Voltage and amperage were adjusted to achieve power outputs greater than 4,000 watts.

*Objective 2. Develop and implement monitoring programs for early detection of invasive carp in waters upstream of the current leading edge.*

Silver Carp surveillance was conducted bi-weekly from early April through late August below Nickajack, Chickamauga, Watts Bar, and Fort Loudoun dams, and monthly during the same time frame below Melton Hill Dam. Each descending bank, beginning between 1.0 – 3.1 km directly below the dams, was tandem electrofished from downstream to upstream with two boats using standard electrofishing settings; the face of the dams and lock chambers (where present) were also surveyed. Variables including temperature, tailwater elevation, discharge, and electrofishing effort were recorded.

#### **ADCNR**

*Objective 2. Develop and implement monitoring programs for early detection of invasive carp in waters upstream of the current leading edge.*

*Boat Electrofishing* – Crews plan to conduct tailwater surveillance targeting invasive carp below dams using boat electrofishing. All locations, except for Wilson Dam, will be sampled once every month (April to September; Table 1). Two dams below Wheeler and Guntersville Reservoir pools were located within the tailwaters, respectively, at Wilson and Wheeler Reservoirs in Alabama waters of the Tennessee River. Sample protocol copied that from verbal communications and a TWRA staff report written by K. Chestnut-Faull (2021). Protocol suggests two electrofisher boats (4 staff members) move in tandem from downstream-to-upstream in offset pairs. The paired boats completed two contiguous transects near the bank moving (3 to 4 mph) towards the reservoir dam at each location and both sides of the river. Pre-sample ETS (model: Trident) electrofisher system settings were based on conductivity (Miranda 2009). However, the Smith-Root model was only able to maintain a range of 6 to 8 Amps regardless of conditions, though, this boat fished effectively. Both main bank transects ended near the same locations at the dam wall face to form one large transect. Effort (nearest s) and temperature (nearest 0.1 C) was recorded. Both the driver and dipper made continuous visual sweeps over the sampled areas to observe either stunned or jumping carp. Invasive carp, encountered during this sampling effort will be documented and, if collected, processed for demographic data (i.e., length, weight, sex, otoliths and pectoral spines).

#### **KDFWR**

*Objective 1. Conduct systematic sampling to monitor for and document invasive carp recruitment.*

KDFWR sampled for young of year (YOY) invasive carp and native baitfish in Barkley and Kentucky reservoirs. This work was conducted for one week on each reservoir in the fall. From each reservoir, 4 embayment's were chosen based on size and boat ramp availability. If YOY invasive carp were collected, then length and weights were recorded, and specimens were kept for further analysis. Environmental parameters such as water surface temperature, reservoir elevation, discharge, and depth were recorded at the sample locations. Boat electrofishing was conducted during the nighttime. Transects did not exceed 15 minutes of peddle time. Sampling was conducted with an MLES box at ~250 volts, ~20 amps, and ~3,000 watts.

KDFWR partnered with the U.S. Fish and Wildlife Service (USFWS) to conduct paupier net sampling in Kentucky reservoir to further inform population demographics and to search for YOY invasive carp. KDFWR provided staff and tender boats to collect length, weights, and aging structures. Sampling design was be informed by previous efforts with this gear type by the USFWS and agreed upon by basin partners. Sampling in Kentucky reservoir was conducted in seven embayments over the course of four nights during the months of October and November. Transects were no more than five minutes long and number of transects per bay was calculated by shoreline distance (one transect/km).

KDFWR conducted targeted sampling for YOY Black Carp and other invasive carps in the lower Tennessee and Cumberland Rivers. Sampling locations were chosen based on the hydrologic similarity to the location where YOY Black Carp were collected previously in Kentucky. Sampling effort did not exceed 30 days. Areas were sampled with beach seine and backpack electrofishing as accessible. If YOY or juveniles were collected; length and weight were recorded, and the specimens were preserved for additional analysis. Most sites were sampled using a backpack electrofisher (Smith-Root LR-24) for variable durations depending on amount of habitat available to sample. Seining with 20' x 5' and 15' x 5' (1/8" mesh) seines was done at six sites, but proved to be difficult because of the deep, soft mud substrate.

### ***MDWFP***

*Objective 3. Determine invasive carp relative densities and assess sampling needs in the Tennessee-Tombigbee Waterway.*

A “two-pool” rule was implemented into the early detection sampling design of this project. The two-pool rule establishes that monitoring for invasive bigheaded carps will be conducted in all pools with previous detections and the first two pools distal to the leading-edge pool. In this instance, because bigheaded carps have been detected in Bay Springs Lake, sampling was conducted in the two pools below Jamie L. Whitten Lock and Dam—Pool E (G. B. “Sonny” Montgomery Lock) and Pool D (John Rankin Lock). The two-pool rule will be applicable within and among sampling events. To illustrate, if a silver carp was detected in Pool E, but not Pool D, during the first sampling event, sampling would be extended into Pool C (Fulton Lock) for that sampling event.

In 2023, sampling for invasive bigheaded carp occurred in Tennessee-Tombigbee Waterway Pools E and D. Sampling consisted solely of modified electrofishing in March and September of 2023.

Modified electrofishing protocols followed the procedures outlined in Bouska et al. (2017). This protocol affords the boat operator the ability to selectively apply power to encircle or trap invasive carp. Electrofishing transects consisted of ten, randomly selected, ten-minute sites. Power output at each site was standardized to a power goal based on water temperature and conductivity of the sampling area.

In 2023, targeted sampling for invasive carp occurred in March and September. Spring and fall sampling consisted of electrofishing and dozer trawling for ten sites each for Pools D and E.

An additional sampling took place in June of 2023 with crews from Alabama Department of Conservation and Natural Resources and the US Fish and Wildlife Service providing additional electrofishing boats. In each pool from A-E, three boats pushed two sites (dam and channel). Eight embayments in Bay Springs Lake were also sampled using three electrofishing boats.

## **Results and Discussion:**

### ***TWRA***

*Objective 1. Conduct systematic sampling to monitor for and document invasive carp and recruitment.*

A total of 914 samples were collected between larval light traps, larval towing, and mini-fyke nets (TWRA Table 2). DNA batch analysis was conducted on larval samples from Kentucky and Barkley reservoirs in 2021 (n=89) and 2022 (n=80) and resulted in a minimal number of positive detections for both larval tows and light traps. Positive detections via genetic analysis are being evaluated further and we anticipate more information will be available in future reports. In addition, sister-samples to those that were positive for genetic detections are being pulled and analyzed for visual detections.

Dozer trawls conducted on Kentucky Reservoir (n=200) resulted in the capture of 28 invasive carp and on Barkley Reservoir (n=40) resulted in the capture of 35 invasive carp. All carp collected via dozer trawls were adult, with no individual <650 mm encountered.

Although invasive carp larval DNA was detected in tows and light traps, young of year invasive carp were not detected in mini fyke nets or sportfish electrofishing surveys and trap net surveys, indicating invasive carp are attempting to spawn but recruitment into the population remains unsuccessful or undetected.

*Objective 2. Develop and implement monitoring programs for early detection of invasive carp in waters upstream of the current leading edge.*

TWRA began conducting bi-weekly tailwater electrofishing surveys in 2020 in response to the documented angler report. Effort was focused on tailwaters due to Silver Carp tendencies to congregate below dams. Timeframes for tailwater surveillance have been adjusted over time based on multi-agency acoustic telemetry efforts to monitor lock-and-dam passage trends by Silver Carp, which are likely influenced by flows and temperatures (>18° C) that promote spawning behaviors. Bi-weekly surveys took place from mid-June through September, May through September, and March through August in 2020, 2021, and 2022, respectively. One electrofishing boat was used for surveillance in 2020, and an additional boat was added in 2021 to double effort and increase the likelihood of detection. The objective of tailwater surveys was to determine the presence of Silver Carp in the eastern Tennessee portions of the Tennessee River. In 2023, surveillance was conducted every two weeks from early April through late August. A combined total of over 43 hours of electrofishing was conducted below Nickajack, Chickamauga, Watts Bar, Ft. Loudoun, and Melton Hill dams (TWRA Table 3). During these efforts, no silver carp were observed or collected.

## **ADCNR**

*Objective 2. Develop and implement monitoring programs for early detection of invasive carp in waters upstream of the current leading edge.*

*Guntersville Dam & Tailwater* – ADCNR staff electrofished the tailwater section below Guntersville Dam on six occasions between April 12 and September 13, 2023 (Table 1, Figure 1). Effort included 24 person days and 7.52 h (2-boats) of pedal time. The two upstream transects ran towards the dam for a distance of 0.9 km from the south bank, beginning at the access launch ramp. The north bank transect ran 1.27 km from the green channel buoy. The dam encompassed an additional 1.29 km of sample distance for a total of 5.89 km. Electrofisher settings were standardized based on conductivity (ETS system only) readings. Surface water temperatures ranged from 17.8 to 27.8 °C and conductivity ranged from 155 to 174 µs. Invasive carp were not captured nor visually identified by staff during sampling events.

*Wheeler Dam & Tailwater* – ADCNR staff electrofished the tailwater section below Wheeler Dam on six occasions between April 12 and September 13, 2023 (Table 1, Figure 2). Effort included 24-person days and 12.26 h (2-boats) of pedal time. The two upstream transects ran for a distance of 0.82 km from the south, beginning at the Wheeler Dam boat access, and 0.73 km from the western-most edge of the rip-rap armoring area on the north banks, respectively. The dam encompassed an additional 2.65 km of sample distance for a total of 4.2 km. Other areas and island edges were occasionally sampled as well. Electrofisher settings were standardized based on conductivity (ETS system only) readings. Surface water temperature was 18.1 to 29.2 °C and conductivity was 160 to 182 µs. No invasive carp were captured nor visually identified by staff during sampling events.

## **KDFWR**

*Objective 1. Conduct systematic sampling to monitor for and document invasive carp recruitment.*

### Electrofishing

KDFWR sampled for YOY invasive carp with nighttime boat electrofishing, in conjunction with sampling for projects under the monitoring of native fish project. This sampling occurred for four nights on Barkley reservoir and four nights on Kentucky reservoir in October of 2023. Sampling targeted young of year invasive carp, gizzard shad (GZSD), threadfin shad (TFSD), skipjack herring (SKJH) and emerald shiners. Sampling on Kentucky reservoir resulted in 8,043 total fish caught and 57% of those were gizzard shad over 180mm. Sampling on Barkley reservoir resulted in 5,179 total fish caught, out of which 72% were gizzard shad over 180mm. No YOY invasive carp were collected from either reservoir. Adult silver carp catch rates were low in both reservoirs, 1 fish/hr in Kentucky reservoir and 8 fish/hr in Barkley reservoir (Appendix B. Table 2)

### Paupier

Sampling with USFWS collected a total of 17,782 fish with the electrified paupier net boat over four nights spent on Kentucky reservoir. This sampling was targeting young of year invasive carp, adult invasive carp, gizzard shad, threadfin shad, and skipjack herring. No YOY invasive

carp were collected. CPUE of adult silver carp was lowest since paupier surveys began in Big Bear embayment (36 fish/hr. Appendix B. Table 1). The missing years from 2020 – 2021 was due to logistic constraints and the Covid pandemic.

Black Carp YOY Sampling:

KDFWR sampled for YOY invasive carp at 24 sites along the lower Ohio River, 9 sites along the Mississippi River, 11 sites along the lower Tennessee River and 11 sites along the lower Cumberland River (Table 3). No sites in the lower Tennessee and Cumberland rivers had YOY invasive carps collected. YOY invasive carp and one YOY black carp were collected in the lower Ohio River in 2023 (Figure 1).

***MDWFP***

*Objective 3. Determine invasive carp relative densities and assess sampling needs in the Tennessee-Tombigbee Waterway.*

Electrofishing and dozer trawling sampling was repeated in 2023 in Pools E and D with an additional effort occurring in the summer with multiple boats working from Pool A through Bay Springs Lake. No invasive carps were observed in 2023.

## Appendix A – TWRA Tables and Figures

TWRA Table 1. Summary of larval Invasive Carp sampling locations, distance, and respective section on Kentucky and Barkley Reservoir.

| Invasive Carp Larval Towing |                                 |                                 |                        |         |
|-----------------------------|---------------------------------|---------------------------------|------------------------|---------|
| Reservoir                   | Start Location (River Mile)     | End Location (River Mile)       | Distance (River Miles) | Section |
| Kentucky                    | State Line (50)                 | Paris Landing Bridge (67)       | 17                     | 1       |
| Kentucky                    | Paris Landing Bridge (66)       | Danville Bridge (78)            | 12                     | 2       |
| Kentucky                    | Danville Bridge (78)            | New Johnsonville Bridge (100.5) | 22.5                   | 3       |
| Kentucky                    | New Johnsonville Bridge (100.5) | I-40 (116)                      | 15.5                   | 4       |
| Kentucky                    | Duck River (1)                  | Buffalo River (16)              | 16                     | 5       |
| Kentucky                    | I-40 (116)                      | Beech River (136)               | 20                     | 6       |
| Barkley                     | KY-TN State line (74)           | Dover (88)                      | 14                     | 1       |
| Barkley                     | Dover (88)                      | Cumberland City (103)           | 15                     | 2       |

TWRA Table 2. Total number of larval samples collected by sampling method.

| 2023 Invasive Carp Larval Sampling |             |                    |                |
|------------------------------------|-------------|--------------------|----------------|
| Location                           | Larval Tows | Larval Light Traps | Mini Fyke Nets |
| Kentucky Reservoir                 | 340         | 190                | 134            |
| Barkley Reservoir                  | 140         | 70                 | 40             |

TWRA Table 3. TWRA Region 3 Silver Carp surveillance effort per tailwater in 2023.

| Tailwaters    | Avg Temp (°C) | Avg Discharge (cfs) | Total Effort (hh:mm:ss) | Silver Carp Present (Yes/No) |
|---------------|---------------|---------------------|-------------------------|------------------------------|
| Nickajack     | 24.8          | 18,430              | 15:09:03                | No                           |
| Chickamauga   | 25.0          | 20,366              | 10:23:51                | No                           |
| Watts Bar     | 22.0          | 9,590               | 08:31:06                | No                           |
| Ft. Loudoun   | 21.2          | 9,751               | 06:38:22                | No                           |
| Melton Hill   | 20.9          | 0                   | 02:31:52                | No                           |
| <b>Total:</b> |               |                     | <b>43:14:14</b>         |                              |

## Appendix C – ADCNR Tables and Figures

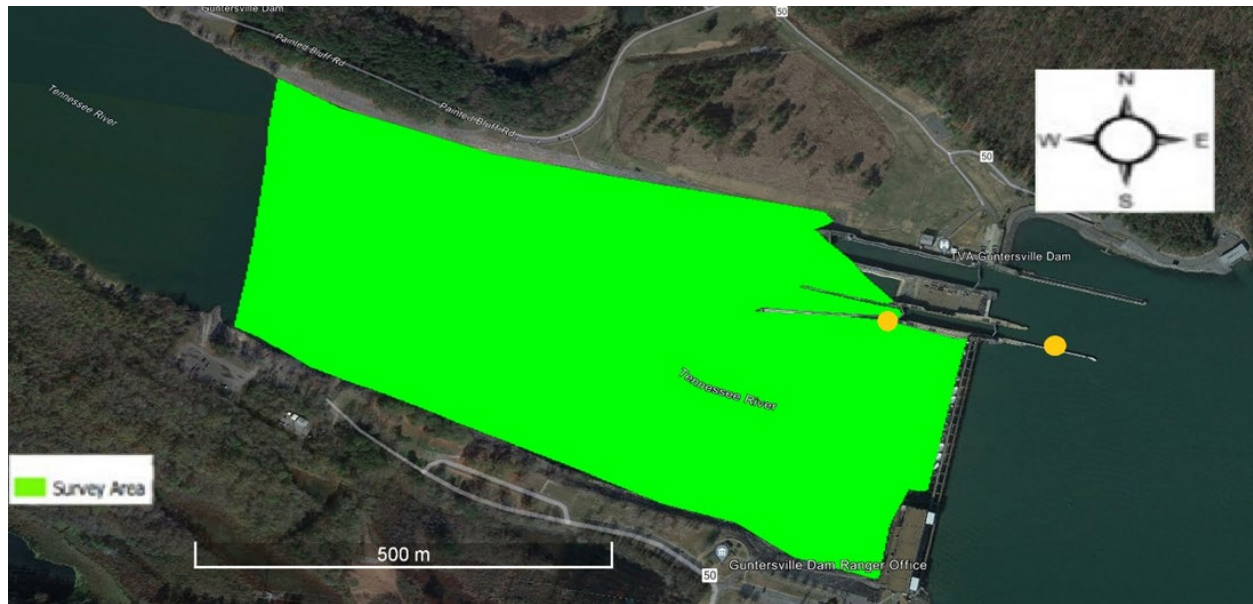


Figure 1. Map of tailwater electrofishing area below Guntersville Dam for targeted carp surveys in Wheeler Reservoir during 2023; green shading indicates survey area upstream of the south access area ramp (34.429829, -86.403347) and green navigation buoy (34.429559, -86.402500) to the north bank. Yellow dots denote telemetry receivers within lower and upper lock chambers.

Figure 2. Map of the tailwater electrofishing area below Wheeler Dam for targeted carp surveys in Wilson Reservoir during 2023. Green shading indicates survey area upstream of the south access area ramp (34.7940983, -87.3892511) and north rip-rap armored bank (34.8114032, -87.3917301).

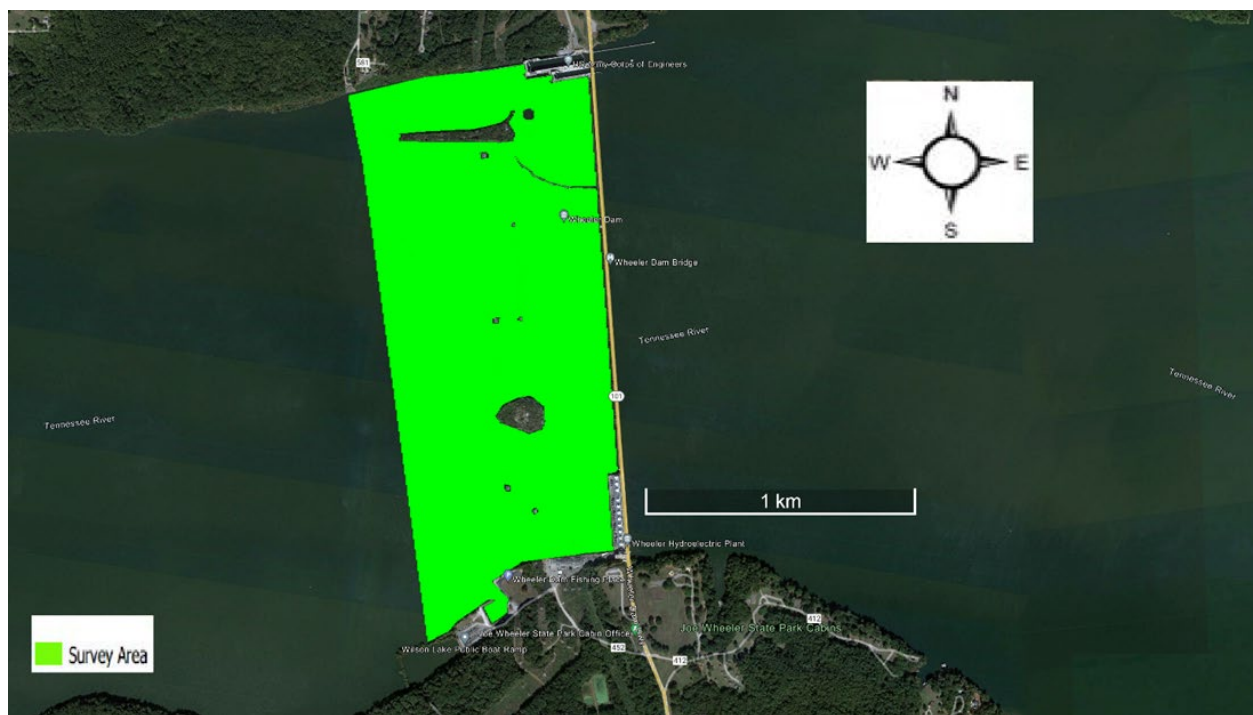


Table 1. Summary of ADCNR standard electrofisher (EF) effort CY2023 at two Alabama tailwater sites below Wheeler and Guntersville Dams on the Tennessee River (upper to lower sites). Pedal-time effort (1 boat, s) is converted to hours (nearest 0.01). Gear or staff days, effort, catch, water quality, EF-settings (ETS System) and output parameters as shown. Total (2-boat) effort was 19.78 h.

| Date      | Tailwater dam | Reservoir         |                   | Carp      |                |                  | Temp. (°C) | Conductivity (µs) | AMPS | Volts | Pulses /s | Duty Cycle |
|-----------|---------------|-------------------|-------------------|-----------|----------------|------------------|------------|-------------------|------|-------|-----------|------------|
|           |               | pool at tailwater | 1-boat Effort (h) | Boats (n) | Staff days (n) | sighted catch or |            |                   |      |       |           |            |
| 4/12/2023 | Guntersville  | Wheeler           | 0.67              | 2         | 4              | 0                | 17.8       | 155               | 12   | 400   | 61        | 26         |
| 5/2/2023  | Guntersville  | Wheeler           | 0.49              | 2         | 4              | 0                | 18.3       | 157               | 11   | 262   | 61        | 26         |
| 6/15/2023 | Guntersville  | Wheeler           | 0.60              | 2         | 4              | 0                | 25.6       | 174               | 13   | 252   | 61        | 26         |
| 7/6/2023  | Guntersville  | Wheeler           | 0.64              | 2         | 4              | 0                | 27.4       | 169               | 12   | 256   | 61        | 26         |
| 8/22/2023 | Guntersville  | Wheeler           | 0.71              | 2         | 4              | 0                | 29.1       | 161               | 12   | 259   | 61        | 26         |
| 9/13/2023 | Guntersville  | Wheeler           | 0.65              | 2         | 4              | 0                | 27.8       | 167               | 13   | 252   | 61        | 26         |
| 4/12/2023 | Wheeler       | Wilson            | 0.97              | 2         | 4              | 0                |            | 182               |      |       | 61        | 26         |
| 5/2/2023  | Wheeler       | Wilson            | 1.07              | 2         | 4              | 0                | 18.1       | 187               | 13   | 246   | 61        | 26         |
| 6/14/2023 | Wheeler       | Wilson            | 1.00              | 2         | 4              | 0                |            | 187               | 13   | 245   | 61        | 26         |
| 7/6/2023  | Wheeler       | Wilson            | 0.98              | 2         | 4              | 0                | 28.1       | 181               | 13   | 249   | 61        | 26         |
| 8/22/2023 | Wheeler       | Wilson            | 1.01              | 2         | 4              | 0                | 29.2       | 160               | 12   | 259   | 61        | 26         |
| 9/13/2023 | Wheeler       | Wilson            | 1.09              | 2         | 4              | 0                | 26.6       | 173               | 12   | 256   | 61        | 26         |
|           |               |                   |                   | 9.89      | 24             | 48               | 0          |                   |      |       |           |            |

## Appendix C – KDFWR Tables and Figures

Table 1. Paupier net effort and catch rates from sampling conducted in Big Bear embayment of Kentucky Lake. (S.E. = Standard error)

| Date   | Net Hours | Number of Silver carp captured | Mean Silver carp CPUE (fish/hr) | S.E. | Number of Grass carp captured | Number of Bighead carp captured |
|--------|-----------|--------------------------------|---------------------------------|------|-------------------------------|---------------------------------|
| Nov-16 | 9.12      | 1,406                          | 168.9                           | 23.0 | 3                             |                                 |
| Oct-17 | 2.12      | 516                            | 229.2                           | 40.3 |                               | 2                               |
| Oct-18 | 4.72      | 1496                           | 308.3                           | 61   | 1                             | 2                               |
| Oct-19 |           | 442                            | ~260                            | ~60  | 1                             |                                 |
| Oct-22 | 1.28      | 105                            | 105.9                           | 33.2 |                               |                                 |
| Nov-23 | 0.66      | 24                             | 36                              | 9.07 |                               |                                 |

Table 2. Comparison of Catch Per Unit Efforts (CPUE, fish/hour) across embayment's and lakes of baitfish with night-time electrofishing in the fall of 2023.

| Location              | Effort (hr) | CPUE GZSD >180 mm | CPUE GZSD <180 mm | CPUE TFSD  | CPUE SKJH | CPUE Adult SVCP |
|-----------------------|-------------|-------------------|-------------------|------------|-----------|-----------------|
| Blood River           | 1.5         | 35                | 257               | 1144       | 13        | 3               |
| Jonathan              | 1.5         | 41                | 2459              | 624        | 5         | 1               |
| Big Bear              | 1.5         | 55                | 301               | 125        | 21        | 1               |
| Sledd Creek           | 1.5         | 125               | 17                | 128        | 7         | 2               |
| <i>Kentucky Lake*</i> | <i>6</i>    | <i>64</i>         | <i>759</i>        | <i>505</i> | <i>12</i> | <i>1</i>        |

| Location             | Effort (hr) | CPUE GZSD >180 mm | CPUE GZSD <180 mm | CPUE TFSD  | CPUE SKJH | CPUE Adult SVCP |
|----------------------|-------------|-------------------|-------------------|------------|-----------|-----------------|
| Demumbers/Willow     | 1.5         | 42                | 247               | 239        | 14        | 15              |
| Eddy Creek           | 1.5         | 233               | 1135              | 51         | 3         | 2               |
| Little river         | 1.5         | 116               | 382               | 105        | 1         | 13              |
| Honker Bay           | 1.5         | 36                | 712               | 109        | 1         | 0               |
| <i>Barkley Lake*</i> | <i>6</i>    | <i>107</i>        | <i>619</i>        | <i>125</i> | <i>5</i>  | <i>8</i>        |

\* Mean CPUE for each reservoir

Table 3. Summary of YOY invasive carp captures in Western Kentucky during 2022 and 2023.

| <b>2022</b>       | <b># of Sites<br/>Sampled</b> | <b>Sites with YOY<br/>Invasive Carp</b> | <b>Sites with YOY<br/>Black Carp</b> |
|-------------------|-------------------------------|-----------------------------------------|--------------------------------------|
| Ohio River        | 21                            | 2                                       | 1                                    |
| Mississippi River |                               |                                         |                                      |
| Tennessee River   | 2                             |                                         |                                      |
| Cumberland River  |                               |                                         |                                      |
| Total             | 23                            | 2                                       | 1                                    |
| <b>2023</b>       | <b># of Sites<br/>Sampled</b> | <b>Sites with YOY<br/>Invasive Carp</b> | <b>Sites with YOY<br/>Black Carp</b> |
| Ohio River        | 24                            | 3                                       | 1                                    |
| Mississippi River | 9                             | 2                                       |                                      |
| Tennessee River   | 11                            |                                         |                                      |
| Cumberland River  | 11                            |                                         |                                      |
| Total             | 55                            | 5                                       | 1                                    |

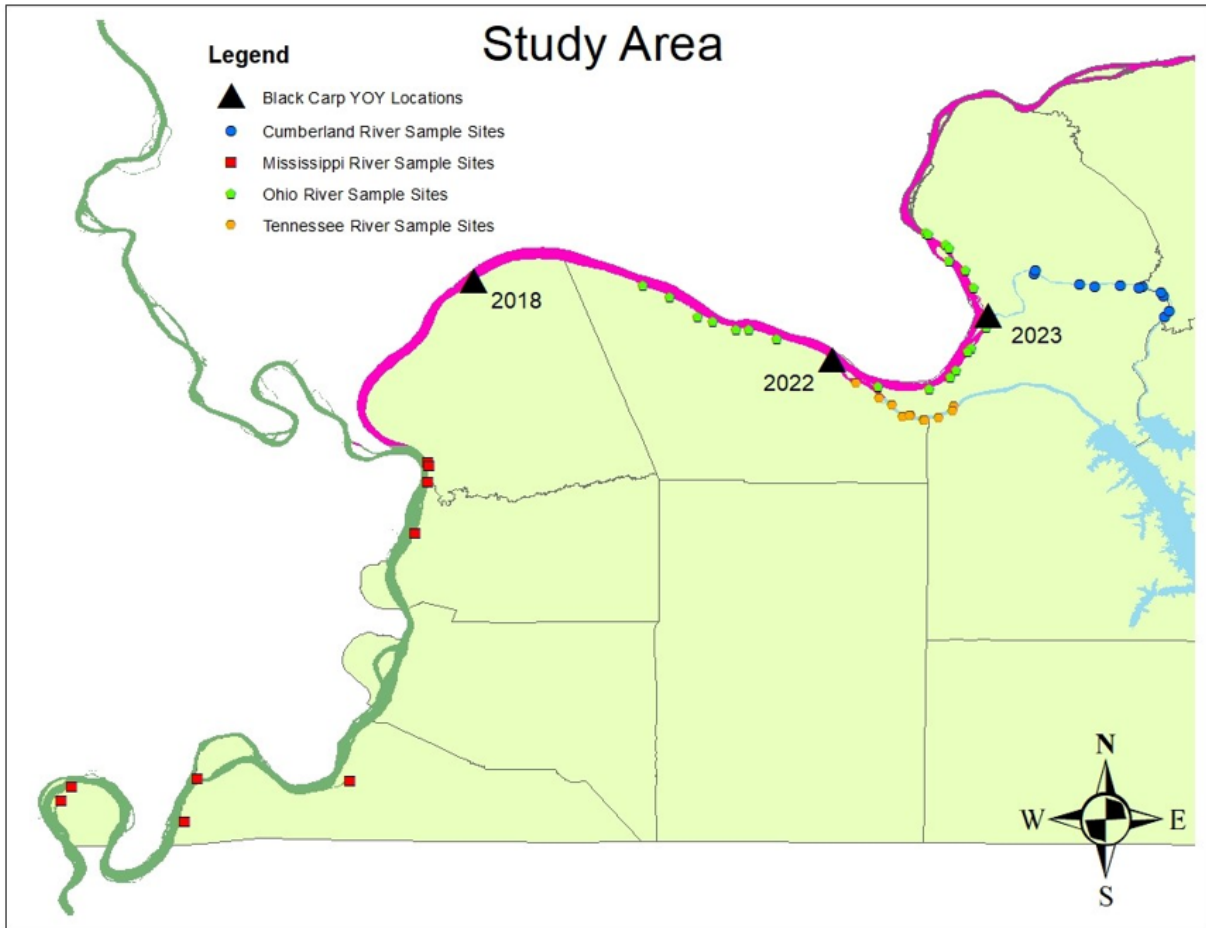


Figure 1. Site localities sampled for YOY invasive carps during 2023, as well as locations of YOY Black Carp captures in 2018, 2022, and 2023.

**Recommendation:**

- TWRA – Recommends continued evaluation/monitoring of reproduction and recruitment by invasive carp in the Tennessee and Cumberland rivers.
- TWRA – Recommends continued incorporation of invasive carp surveillance efforts into annual workplans in East TN reservoirs of the Tennessee River.
- ADCNR - Currently, there is no immediate need for expansion of new studies or actions outside of current management plans and actions during 2023 to 2024. Wilson Dam and the adjacent Florence Canal (i.e., navigation lock approach channel) will be added to 2024 collections. This may change with needs or adjustments per discussions among other TNCR partner agency staff.
- KDFWR – Recommends the continued effort to survey for young of year invasive carp in the Tennessee and Cumberland River sub-basin.
- KDFWR – This project serves as an early detection program and will inform management response and decision making, if YOY invasive carp are detected within the sub-basin.
- MDWFP – Continue monitoring the Tennessee-Tombigbee Waterway for invasive carp.
- MDWFP – Use alternative sampling methodology including electrofishing using multiple boats and using sidescan sonar to locate fish where possible.

## References

- ADCNR. 2023. Invasive Carp Monitoring Plan in Alabama Waters of Tennessee River Reservoirs. Draft report (January 3, 2023), 10 pp.
- Bouska, W. W., D. C. Glover, K. L. Bouska, and J. E. Garvey. 2017. A refined electrofishing technique for collecting Silver Carp: implication for management. *North American Journal of Fisheries Management* 37:101–107.
- Chestnut-Faull, K. 2021. Silver Carp Surveillance, TWRA Region III Reservoirs, Tennessee Wildlife Resources Agency. Report dated 10 August, 2021. 13 pp.
- Conover, G., R. Simmonds, and M. Whalen, editors. 2007. Management and control plan for bighead, black, grass, and silver carps in the United States. Asian Carp Working Group, Aquatic Nuisance Species Task Force, Washington, D.C. 223 pp.  
<http://www.micrarivers.org.php7-35.lan3-1.websitetestlink.com/wp-content/uploads/2018/08/Final-ANSTF-Approved-Asian-Carp-Plan.November-2007.pdf>
- Green, S. R. 1985. An overview of the Tennessee-Tombigbee Waterway. *Environmental Geology and Water Sciences* 7: 9–13
- Miranda, L. E. S. 2009. Standardizing electrofishing power for boat electrofishing. In S. Bonar, W. Hubert, A. Hubert, & D. Willis (Eds.), *Standard methods for sampling North American freshwater fishes*. Bethesda, MD: American Fisheries Society.
- Ohio River Basin Asian Carp Control Strategy Framework. Ohio River Fisheries Management Team, October 24, 2014. [http://www.micrarivers.org.php7-35.lan3-1.websitetestlink.com/wp-content/uploads/2018/08/ORFMT\\_Asian\\_Carp\\_Strategy.pdf](http://www.micrarivers.org.php7-35.lan3-1.websitetestlink.com/wp-content/uploads/2018/08/ORFMT_Asian_Carp_Strategy.pdf)
- R Core Team. 2021. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.
- Wolf, M. C., Q. E. Phelps, J. R. Seibert, and S. J. Tripp. A rapid assessment approach for evaluating Silver Carp gender. *Acta Hydrobiologica Sinica* 42:1208–1210.
- Post van der Burg, M., D.R., Smith, A.R., Cupp, M.W., Rogers, and D.C., Chapman. 2021. Decision analysis of barrier placement and targeted removal to control invasive carp in the Tennessee River Basin: U.S. Geological Survey Open-File Report 2021–1068.