

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

Lead Agency: Tennessee Wildlife Resources Agency (TWRA)

Participating Agencies: TWRA; Kentucky Department of Fish and Wildlife Resources (KDFWR); Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP); Alabama Department of Conservation & Natural Resources, Wildlife & Freshwater Fisheries Division (ALWFF); U.S. Fish and Wildlife Service (USFWS); U.S. Army Corps of Engineers; Tennessee Valley Authority; Tennessee Cooperative Fisheries Research Unit, Tennessee Technological University (TTU); and Mississippi State University.

Introduction:

As of 2019, all four species of Asian carp have been collected in the Tennessee and Cumberland rivers (TNCR). The states of Kentucky, Tennessee, Mississippi and Alabama have significant recreational and ecological resources at risk due to Asian carp. This project is needed to help implement portions of the national management and control plan for Asian carp (Conover et al. 2007) and portions of the Ohio River Basin Asian carp control strategy framework (Ohio River Fisheries Management Team 2014).

This project will further develop standardized protocols to assess abundance and population dynamics of Asian carp, and determine effectiveness of control measures. TWRA and KDFWR have invested in commercial carp removal programs, and the USFWS is funding a sound barrier experiment at Barkley Lock. To measure the success of these control measures, agencies need standardized sampling methods that will allow comparisons among water bodies over time. Foundational research on carp sampling has been conducted by USFWS, KDFWR, TWRA, and TTU using the USFWS Asian Carp Base Funds and local funding sources. These projects have tested many sampling methods, identifying the best available methods for sampling carp. This project will increase capacity for standardized sampling in TN and KY, and for the first time include projects in MS and AL. The inclusion of all four states is critical for the evaluation of carp populations in the TNCR.

As mentioned previously, this is a new project in the TNCR for which initial funding associated with federal FY 2019 was received by state partners in Fall of calendar year 2019. The primary work conducted by TWRA, MDWFP, and ALWFF in 2019 involved coordination with field offices, procurement of sampling supplies, and limited initial pilot work. More extensive work will be completed and reported on by these partners in 2020. Below, KDFWR reports on a significant amount of work on this project which was initially funded by their state and will continue forward using federal funds.

Project Objectives:

1. Estimate Asian carp relative abundance, and population demographics in the Tennessee and Cumberland River basins to evaluate management actions.
2. Examine Asian carp impacts on native fish communities.
3. Target and remove Asian carp to suppress populations and reduce propagule pressure in the Tennessee and Cumberland River basins.

Project Highlights:

TWRA

- Procured sampling materials.
- Piloted an initial year of standard gill net sampling in Kentucky and Barkley reservoirs.
- Piloted an initial year of boat-mounted electrofishing to sample Asian carp in Kentucky and Barkley reservoirs.

MDWFP

- Procured sampling materials.
- Coordinated deployment of VEMCO receivers with cooperators.
- Piloted initial gill net sampling in Pickwick and Bay Springs lakes. One Silver Carp was captured in Bay Springs Lake and is believed to be the first collection there.

ALWFF

- Procured sampling materials.
- Assisted partners with collection and tagging of Silver Carp (4 individuals) using electrofishing in Pickwick Lake.

KDFWR

- Conducted standard sampling for Asian carp species with gill nets in Kentucky and Barkley lakes.
- Analyzed data from fish collected to inform population demographics of silver carp.
- Collected information from select native species found in Kentucky and Barkley lakes to assess potential impacts of Asian carp on those species.
- KDFWR continues to receive tag returns from commercial fishing efforts silver carp marked for the Mark-Recapture effort. Data analysis is ongoing.
- Creel surveys were conducted in the Kentucky and Barkley Tailwaters estimating that recreational fishers made 42,457 trips and caught 231,282 fish. The total catch for bighead and silver carp decreased in 2019. Majority of anglers indicated that they were satisfied with the tailwater fishery. Those that were dissatisfied cited 'number of fish' as reason for dissatisfaction.
- Conducted fall community sampling with electrofishing in the Kentucky and Barkley Tailwaters to monitor for impacts of Asian carp on the native fish assemblages in those areas..
- YOY silver carp were reported in the Kentucky Tailwater by an angler. KDFWR conducted sampling in response and collected 58 YOY silver carp in the lower Tennessee River. Sampling for YOY silver carp was conducted in the lower Cumberland River but none were collected.
- Commercial fishers removed over 5.8 million pounds of bigheaded carps through the Asian Carp Harvest Program.
- KDFWR staff conducted 48 ride-alongs with commercial fishers to monitor catch and bycatch data.
- Bycatch of sport fish reported by commercial fishers using the ACHP continued to be minimal (4% of total bycatch), and survival rates increased from 2018 (93.6%).
- Commercial fishers registered with the Tennessee and Cumberland rivers contract fishing program received \$210,163.21 for over 4 million pounds of Asian carp harvested from Kentucky Lake, Lake Barkley, and their respective tailwaters.

- KDFWR coordinated with two private entities to test experimental harvest methods in Kentucky Lake, Lake Barkley, and the Barkley Tailwater. However, catch rates were extremely low and testing with those gears was discontinued.
- KDFWR targeted electrofishing for silver carp removed 24,485 lbs of Asian carp from the Barkley Tailwaters and lower Cumberland River.. Targeted gill netting efforts in Kentucky Lake and Lake Barkley removed approximately 29,211 lbs of Asian carp.
- KDFWR continued to retrieve and process black carp captured by commercial fishers. Two black carp were reported caught in Kentucky Lake. No captures were reported from the Cumberland River in 2019.

Methods:

Agency: Tennessee Wildlife Resources Agency

Objective 1. Estimate Asian Carp Relative Abundance and Population Demographics

TWRA conducted gill net sampling to monitor relative abundance of Asian carp in Kentucky and Barkley reservoirs. On Kentucky Reservoir, six sites were sampled using four nets per site. Sites were sampled during spring (May), summer (July), and fall (Nov). On Barkley Reservoir, three sites were sampled using four nets per site during the spring (May). Because of gear loss during spring sampling on Barkley Reservoir, the number of sampling sites was reduced to two during the summer and fall seasons, and each site was still sampled utilizing four nets. All gill nets were deployed in the afternoon, left overnight, and retrieved the following morning. Nets were distributed in embayments from the mouth to the back of the embayment (approximately 10-foot depth). Individual nets were 300-ft in length with 100-ft panels of 3-, 4-, and 5-in mesh. Nets were 12-ft deep, hobbled to 10-ft every eight feet; nets had 0.5-in foamcore for the floatline and 65-lb leadcore for the lead line. The webbing used in each panel was constructed of 8 ply, 0.2-mm twist mesh.

Agency: Kentucky Department of Fish and Wildlife Resources

Objective 1. Estimate Asian Carp Relative Abundance and Population Demographics

KDFWR used a combination of standardized sampling, mark-recapture efforts, and monitoring of commercial harvest to evaluate relative changes in Asian carp abundance. Standard sampling with gill nets was conducted at sixteen sites in Barkley and Kentucky reservoirs. These standard sites were selected to provide adequate sampling parameters, decrease conflict with anglers, and provide static locations to monitor changes in catch per unit effort (CPUE). Four embayment and four main channel sites were selected on each reservoir. These sites were sampled once during spring (April), summer (July), and fall (October) (Figure 1). During each sampling period a total of four nets were fished at each location and in orientations specific to each location. Sampling occurred when lake levels were greater than 354' msl, and nets were set where water depths were a minimum of 13'. Nets were deployed one hour before sunset and retrieved one hour after sunrise the following morning (USA Sunrise Sunset Calendars, 2019). Specific Global Positioning System (GPS) coordinates were determined for all sets, and nets were set at the same locations each season and year of gill netting effort. Sinking gill nets (12' deep) were tied down to 10' every 8 linear feet. Each 100' panel of webbing was hung with 30" stretch in 16" ties. The mesh sizes

included: 3” square with 5 meshes per 16 linear inches of net; 4” square with 4 meshes per 16 linear inches of net; and 5” square with 3 meshes per 16 linear inches of net. All webbing was constructed of 8 ply with 0.2-mm twist mesh. Cross ties for the nets were constructed with #15 white bonded twine through the webbing. Catch rates were analyzed by species and gillnet mesh size.

Additionally, targets were set to record total length (mm), weight (g), gender, and gonad weight (g) measurements from subsamples consisting of 10 silver carp and 10 bighead carp at each discrete sample site. During fall sampling, a subsample of silver carp were aged from each reservoir using pectoral fin rays (Appendix 2). When scheduling allowed, data was also collected bi-weekly from markets where silver carp were purchased from commercial fishers. Twenty randomly selected fish were measured for total length (mm), total weight (g) and total gonad weight (g). If less than ten female silver carp were randomly sampled, then additional females were selected until their sample size reached ten. Gonadosomatic indices were developed to estimate silver carp spawning periodicity. Observations of spawning patches on bigheaded carps were also recorded to provide additional information on probable spawning periodicities. Demographics were also recorded for Asian carp collected during other KDFWR sampling efforts and included in analyses. Silver carp telemetry data was analyzed to identify silver carp movements reported in the literature as spawning-related behavior, and periodicities of those movements were matched to environmental factors reported to influence spawning (USFWS, 2019).

In September 2018, KDFWR organized a mark – recapture effort for silver carp in Barkley and Kentucky lakes. Partners in the effort included: Tennessee Wildlife Resources Agency (TWRA), Tennessee Tech University (TTU), U.S. Fish and Wildlife Service (USFWS), United States Geological Service (USGS), Murray State University (MSU), and volunteers from United States Forest Service at Land Between the Lakes (LBL). Fish were tagged with a Floy Tag Company, FT-4 Lock-on tag, with a unique identification number. Initially the targeted sample size was 500 fish per reservoir, with a subset of 20% of tagged fish receiving a secondary tag. The primary tag was placed posterior of the dorsal fin and the secondary tag was placed anterior of the dorsal fin. Fish were collected using short set gill nets (<4 hours) and D.C. electrofishing. Tagging effort occurred over eight days (four on each reservoir)

Commercial fishers participating in the Asian Carp Harvest Program (ACHP) are required to provide KDFWR with daily reports including fishing effort, type of gear, pounds harvested, and bycatch information. KDFWR staff occasionally accompanied commercial fishers (ride-along) to verify their harvest reports and collect information additional to that required on a standard commercial fishing report. After each ride-along was completed, data was taken from a random subsample of approximately 20 harvested silver carp, including weights, total lengths, and gender (using the pectoral fin ray).

Black Carp

Although black carp are not specifically addressed in the objectives for this project, KDFWR does collect individuals on occasion and includes the information here as it pertains to Asian carp management in the basin. In 2019, two black carp were harvested from Kentucky Lake by a commercial fisher using trotlines baited with silver carp, often used as cut bait to attract catfish. Both black carp were caught by hooks in the mouth, indicating that they were actively feeding on the cut bait. Additionally, in 2019, KDFWR verified 23 black carp harvested by commercial fishers using gill nets in the Ohio River, and 3 in the Mississippi River (Figure 17). All black carp collected by KDFWR staff were dissected, and sections

were shipped on ice to the respective laboratories for analysis (USGS and USFWS, 2017). In response to a young of year black carp being collected from Gar Creek in 2018, KDFWR staff intended to sample the area for additional young of year black carp in 2019. However, water levels in the adjacent Ohio River prevented sampling for the majority of the year. KDFWR staff did make an attempt to sample Gar Creek in August of 2019, but no black carp were collected during this effort.

Objective 2. Examine Asian carp impacts on native fish communities.

Standard Sampling

During standard sampling described above (Objective 1), total length and weight data were collected from bigmouth buffalo (*Ictiobus cyprinellus*) and paddlefish (*Polyodon spathula*) to assess relative weights. Low relative weight is generally characteristic of fish in poor health, whereas high values indicate fish in excellent health (Blackwell et al. 2000). The values will be compared over time as a potential indicator of competition with Asian carp. These species are of interest because they are often caught in gill nets and have been documented to compete for resources with Asian carp species (Irons et al. 2007, Schrank et al. 2003).

Standard Sport Fish Sampling

KDFWR Western Fisheries District staff collect length-weight data to monitor condition of popular sport fish species in Kentucky Lake and Lake Barkley through standard sampling (KDFWR 2019). Relative weights (W_r) were calculated for black crappie (*Pomoxis nigromaculatus*), white crappie (*Pomoxis annularis*), largemouth bass (*Micropterus salmoides*), and blue catfish. Condition of these sport fish species were compared to pounds of Asian carps harvested to identify trends that may be associated with the increasing Asian carp harvest.

Asian Carp Harvest Program Monitoring

Commercial fishing reports and data collected during ride-alongs with commercial fishers were compiled to provide a summary for 2019 data and to determine if yearly trends are apparent related to bycatch numbers, species caught, and survival rates.

Tailwater Electrofishing

Sampling was conducted in the Kentucky Dam tailwater of the Tennessee River (hereafter referred to as the Kentucky Tailwater) and Barkley Dam tailwater of the Cumberland River (hereafter referred to as the Barkley Tailwater) with pulsed DC electrofishing. Sampling in the Kentucky Tailwater consisted of three 15-minute runs on each bank of the river, and sampling in the Barkley Tailwater consisted of two 15-minute runs on each bank. Electrofishing was conducted in a downstream direction along the banks (Figure 2). Spring sampling in each tailwater was scheduled for one day each month (April, May, and June). However, due to high water events in 2019 (elevation >315ft), sampling did not occur. Fall sampling was conducted as scheduled in each tailwater on one day of each month (September, October, and November). Two dippers were utilized to collect stunned fish, which were identified to the lowest taxonomic level possible, and total lengths (inches) and weights (pounds) were recorded. When large numbers (> 100) of any species were collected, random subsamples were utilized. Relative weights (W_r) were calculated for selected species collected during fall sampling to monitor fish condition. Trends in fish condition are important in the current study, as any observed declines in condition of individual species may be an indicator of competition for resources and reflective of high Asian carp densities in the tailwaters. However, ideal target ranges of W_r values have not been identified for all species and in every

habitat type. Therefore, the W_r values compiled through this study will be used to assess changes in the tailwater fish community over time. With the exception of Asian carp species, all fish were released immediately after processing. Data collected in 2019 was compared to historical data to assess changes in the fish community over time.

Creel Survey

Random, non-uniform probability creel surveys were conducted from February 16, 2019 through November 15, 2019 in the Kentucky Tailwater and the Barkley Tailwater. The Kentucky Tailwater survey extended from the Kentucky Lake Dam downstream to the Interstate 24 bridge. The Barkley Tailwater survey extended from the Lake Barkley Dam downstream to the US Hwy 62 bridge (Figure 2). Dates and periods for surveys each week were randomly selected, and creels were conducted in each tailwater at least 10 days per month in each tailwater, including a minimum of 3 weekend days. Each day was divided into three periods: morning, afternoon, and late evening. The late evening period was only utilized for a portion of the survey to collect snagging and bow fishing data. Daily access point surveys consisted of instantaneous angler counts conducted from the bank with binoculars and angler interviews; no boat was used. Timing of recreational fishers' counts were randomly chosen daily, and data was extrapolated accordingly to calculate daily average and total effort. KDFWR attempted to interview all recreational fishers each day. Data collected during the creel surveys was compared to historical surveys to determine changes in fish community, catch rates, angler use, and success. Recreational fishers were also administered an angler attitude survey to gauge their opinions regarding their levels of satisfaction with the fishery and on current or proposed regulations. Increasing Asian carp numbers in the tailwaters over the past decade has perpetuated an increase in bow fishing. During 2019, regulations were enacted in Kentucky to allow the sale of Asian carp harvested by recreational fishers. The 2019 creel survey will provide data to assess the effects of the new regulation.

Objective 3: Target and Remove Asian Carp

Asian Carp Harvest Program Monitoring

Commercial fishers participating in the Asian Carp Harvest Program are required to provide daily reports including fishing effort, type of gear, pounds harvested, and bycatch information. Ride-alongs were also conducted with commercial fishers occasionally to verify reports. Observers collected all data required on commercial harvest logs with the addition of GPS fishing locations and net soak time (Figure 3). Staff observed 19 different commercial fishers on 48 ride-alongs throughout the year. Ride-alongs were conducted when the fishermen were pulling their nets and harvesting fish, unless commercial fishers were using short net soak times or were drifting net sets. On those occasions, KDFWR staff observed the commercial fishers from start to finish. Ride-alongs were conducted while onboard with commercial fishers or from a department boat closely following the commercial fishers to record catch. After each ride-along was completed, data was recorded from a random subsample of approximately 20 silver carp harvested including weights, total length, and gender (using the pectoral fin ray). Observations were analyzed both in aggregate with fishers' daily reports and separately (i.e. ride-along data). Data was analyzed to determine number of fishing trips, amount and disposition of bycatch by species, and total pounds of Asian carp harvested.

Experimental Gears

KDFWR coordinated with other agencies and private entities to test the efficacy of new gear types for capturing Asian carp in Kentucky and Barkley reservoirs and their tailwaters. Testing was conducted as

collaborative effort with Two River Fisheries, a private individual, and the US Fish and Wildlife Service. Two Rivers Fisheries deployed two experimental net designs that were fished in Kentucky and Barkley Lakes in 2019. The first was similar to a large hoop net in design constructed of 3" mesh netting (Figure 4). The main lead line was 300' long. Wings (100') were attached to either side of the main lead to help guide fish into the throat. Once fish entered the first throat of the trap (100'x6'x6'), they then had to maneuver through a second throat to enter the hoop section, followed by its cod ends (150' long with 6' hoops). This net was set in Sugar Bay of Kentucky Lake (36.858346, -88.134637) on January 31, 2019 and retrieved on February 15, 2019. The net was checked four times during deployment, and soak time was recorded for each interval. All fish were removed from the trap during each interval. The fish were identified to species, and only Asian carp were harvested. Disposition of native fish and total weights of Asian carp harvested were recorded. Two Rivers Fisheries second net design was a large-frame fyke net (Figure 5). This net consisted of four metal ribs in the heart of the fyke, constructed of EMT conduit measuring approximately 8'x8' and funneling down to two fiberglass hoops in the pot approximately 5 feet in diameter. Netting was constructed with approximately 3.5-inch bar mesh. The net had a 300' long by 8' deep lead and a wing on either side of the frame connecting to shore. It was deployed in Lake Barkley in the back of an unnamed embayment (36.991940, -88.141825) on April 26, 2019. Block nets and sound, from boat outboards were used to drive fish from the mouth of the embayment towards the fyke net. Asian carp in the net were harvested on April 29 and April 30, 2019. Data was taken from all fish as previously described for the hoop net test.

KDFWR also tested an experimental boat and gear combination assembled by a private individual for capturing silver carp. The gear targeted jumping silver carp startled by disturbances created by stiff plastic flappers positioned in a row and affixed to the bow of the boat. The flappers were lowered until they impacted the water, which created wakes and noises while the boat was driven. Basket style nets were attached to either side of the boat, just above the water's surface to capture leaping silver carp. This machine was tested for 22 minutes in the Cumberland River below Barkley Dam on August 5, 2019. The boat was driven upstream along the channel margin, and side-scan sonar was used to locate fish. However, the flappers plowed into the water and limited boat maneuverability, thereby rendering the machine inadequate for silver carp harvest. No other attempts were made to test this method.

In October 2019, KDFWR provided assistance to the USFWS staff of the Columbia, MO Fish and Wildlife Conservation Office during sampling efforts with Paupier net and dozer trawl on Kentucky Lake. A detailed report was produced by the USFWS and findings are being used to inform development of standardized and targeted sampling in the Tennessee and Cumberland River basins (Towne et al. 2020).

In 2019, KDFWR used targeted electrofishing to remove Asian carp in the Cumberland River below Lake Barkley Dam. On one occasion, KDFWR staff were joined by staff from the Tennessee Wildlife Resources Agency (TWRA), which provided an additional electrofishing boat and crew. Particular locations for the effort were determined from angler reports of high silver carp densities and high catch rates during previous removal efforts. Additionally, certain areas below Lake Barkley Dam routinely attracts fish at certain water levels, which lends it to very successful sampling for the carps. Electrofishing runs were not standardized, and typically lasted until the boat was laden with fish. Fish were then transferred to a chase boat. Settings varied between 15-120 pps and voltage was adjusted as needed to achieve approximately 8 amps. Depending on the density of fish in an area and presence of recreational

fishers, electrofishing runs in the tailwaters extended the length of the dam and down either bank. Electrofishing runs in the tributaries were conducted in either a back-and-forth pattern from bank to bank or straight down the channel depending on the width of the tributaries. Tributaries sampled were never wider than 50 feet at the mouth and generally much narrower.

KDFWR conducted experimental gill-net sampling targeting Asian carp in Kentucky and Barkley reservoirs. These efforts were often in conjunction with training new commercial fishers on various methods for setting nets. Gill nets were 3", 4", and 5" bar mesh. Net lengths and depths ranged from 100' to 300' and 10' to 12', respectively. The technique used during these removal efforts did not require webbing to be tied down to create bags. All removal efforts were conducted during the day and utilized active methods of circling large schools of fish or blocking them in a cove at a depth where gill nets covered the entire water column. Subsequent to net deployment, boat motor noise was used to herd fish toward the nets. On one occasion, electrofishing was also used to herd fish. Crews typically proceeded to pull nets within an hour of setting them.

Results and Discussion:

Agency: Tennessee Wildlife Resources Agency

Objective 1: Estimate Asian carp relative abundance and population demographics

Catch rates of silver carp from gill netting efforts were highest during summer in both Kentucky and Barkley reservoirs, with catch rates of 5.17 (SE=0.89) and 2.50 (SE=0.89) silver carp per net, respectively. Lowest catch rates were observed during fall in Kentucky Reservoir (0.71 silver carp per net, SE=0.24) and spring in Barkley Reservoir (1.00 silver carp per net, SE=0.46). The range of total length of silver carp was wider in Kentucky Reservoir during each season, and the mean TL was consistently greater in Barkley Reservoir during each season. Low sample size and high variability appear to be constraints associated with our sampling efforts that will require further investigation. Only 9 bighead carp were collected from Kentucky (7 individuals) and Barkley (2 individuals) reservoirs during all seasons combined.

Agency: Kentucky Department of Fish and Wildlife Resources

Objective 1: Estimate Asian carp relative abundance and population demographics

Standard sampling data indicated that overall catch rates for Asian carp (silver, bighead, and grass), were highest in April and decreased through October on both reservoirs (Table 1). Data for silver carp suggested that mean catch per unit effort (CPUE), reported as number of fish per linear yard of gill net, was highest on both reservoirs during April and decreased in July and again in October (Table 2). In 2019, Barkley reservoir had a mean CPUE of 0.019 (SE=0.004) fish/yard whereas Kentucky reservoir had a mean CPUE of 0.026 (SE=0.008) fish/yard, no significant difference was detected when comparing CPUE between reservoirs (N=24, $T_{17}=-0.77$, $P=0.45$).

Catch rates were compared between habitat types (main channel & embayment) within reservoirs. No significant difference in CPUE was detected for Barkley reservoir (N=24, $T_{11}=0.12$, $P=0.91$). However, a significant difference in CPUE was detected for Kentucky reservoir (N=24, $T_{13}=2.86$, $P=0.01$) where the embayment habitat was observed to have higher catch rates. Catch rates were also compared between

2018 and 2019 for each reservoir separately; only data from July and October was included in the analysis, as no data was available for April in 2018. A significant difference was detected for both reservoirs, Barkley (N=16, $T_7=6.22$, $P=0.0004$) and Kentucky (N=16, $T_7=3.62$, $P=0.008$) (Table 2). Data suggested that catch rates decreased significantly between 2018 and 2019.

A length-frequency histogram was created for silver carp from Barkley and Kentucky reservoirs from all capture methods in 2019. Data suggested the 600mm size class of silver carp dominated harvest from both reservoirs. Data from Barkley reservoir also indicated there was a higher frequency of fish above the 600mm size class and few fish below that size class (Figure 6). Whereas, Kentucky reservoir's data indicated there was a lower frequency of fish above the 600mm size class but a higher frequency of fish below that size class (Figure 7).

Age & Growth

Fin rays were collected from silver carp in Barkley and Kentucky reservoirs in October 2019 for aging (Appendix 1). Ages ranged from 3 to 8 years old within Barkley reservoir (N=71) and from 2 to 9 years old within Kentucky reservoir (N=79), with age 4 silver carp being the most abundant in both reservoirs (Figures 8 & 9).

Since the 2015 cohort of silver carp has dominated harvest and was obviously a very strong year class, von Bertalanffy growth models were constructed for the cohort collected in Barkley and Kentucky reservoirs. Models were obtained using back-calculations from otoliths due to concern that fin ray sections partially excluded growth from the first year. No significant difference was found between males and females on either reservoir (Barkley: N=20, $T_{15}=0.93$, $P=0.37$; Kentucky: N=28, $T_{26}=0.74$, $P=0.47$). Consequently, sexes were aggregated within each reservoir for this report. All fish were collected during October 2019. The von Bertalanffy models predicted a higher theoretical maximum length (L_∞) of silver carp in Barkley reservoir (770mm) than in Kentucky reservoir (680mm) (Figure 10). It should be noted that a small percentage of the samples collected in each reservoir had already surpassed these values. Due to a wide range of lengths of age-four fish collected in each reservoir (Barkley: 563-926mm, Kentucky: 456-884mm) L_∞ was left at the calculated number rather than set arbitrarily. A significant difference was observed between the total lengths at capture of silver carp in the two reservoirs (N=48, $T_{46}=-3.15$, $P=0.003$). Growth was also compared by year between the two reservoirs. Growth during year one was significantly higher in Barkley than Kentucky (N=48, $T_{46}=3.74$, $P=0.0005$) while there was no significant difference in growth for year two (N=48, $T_{42}=1.56$, $P=0.13$), year three (N=48, $T_{46}=1.06$, $P=0.30$), and year four (N=48, $T_{28}=1.70$, $P=0.10$).

Mortality

Catch-curve regressions were developed for silver carp by reservoir. Data for age frequencies were $\log_{10}(x+1)$ transformed to compensate for heteroscedasticity. A Chapman-Robson analysis was performed to estimate annual mortality (\hat{A}) and instantaneous mortality (Z). Annual mortality for silver carp from Barkley reservoir was estimated at 41% and instantaneous mortality was estimated at 0.53 (N= 71, $F_{1,4}=5.06$, $P=0.0876$, $R^2=0.56$; Figure 11). Annual mortality for silver carp from Kentucky reservoir was estimated at 47% and instantaneous mortality was estimated at 0.63 (N=75, $F_{1,5}=6.59$, $P=0.052$, $R^2=0.56$; Figure 12).

The estimates for annual mortality are conservative because age-3 fish were included in this model. Typically, data points on the ascending limb are not used for this type of analysis because they are not

considered fully recruited, however with the 2015 cohort being dominant in the population, estimates that include only age 4 and older fish increase mortality estimates. Those estimates produce unrealistic values, especially for Kentucky reservoir. A mortality estimate, specific for the 2015 cohort, will be developed when 4 to 5 years of data is available.

Condition

Linear regressions were constructed to describe the \log_{10} length- \log_{10} weight relationship for silver carp in Barkley and Kentucky reservoirs. The length-weight equation for Barkley reservoir was estimated at $\text{Log}_{10}(\text{weight(g)}) = 2.6776 * \text{Log}_{10}(\text{length(mm)}) - 4.0723$ (Figure 13). The length-weight equation for Kentucky reservoir was estimated at $\text{Log}_{10}(\text{weight(g)}) = 2.9198 * \text{Log}_{10}(\text{length(mm)}) - 4.7786$ (Figure 14). Weights were predicted for Barkley reservoir: 450mm (1076g), 650mm (2881g) and 800mm (5024g) and Kentucky reservoir: 450mm (930g), 650mm (2720g) and 800mm (4987g) (Table 3).

Data collected from sampling in October 2019 was used to analyze relative weights (W_r). Relative weight was calculated using the equation $\text{Log}_{10}(W_s) = -5.15756 + 3.06842(\text{Log}_{10}\text{TL})$ for silver carp and $\text{Log}_{10}(W_s) = -4.65006 + 2.88934(\text{Log}_{10}\text{TL})$ for bighead carp (Lamer, 2015). The mean W_r for silver carp in Barkley reservoir was 94 (N=205, S.E.=±0.53) and the mean W_r for silver carp in Kentucky reservoir was 93 (N=650, S.E.=±0.29). The mean W_r for bighead carp in Barkley reservoir was 107 (N=2) and the mean W_r for bighead carp in Kentucky reservoir was 108 (N=3).

Gonadosomatic Index (GSI):

Mean GSI for female silver carp harvested from May to October (the months when silver carp are most likely to attempt to spawn) from Barkley were 2.8% in 2018 compared to 4.2% in 2019 while they were the same in Kentucky during both years at 1.4%. The majority of fish used for this analysis from Barkley reservoir were obtained from commercial harvest, whereas the fish used for the Kentucky reservoir analysis were collected during KDFWR standard sampling. The increase in the GSI value for Barkley is attributed to faster growth rates of silver carp observed in Lake Barkley. Therefore, a higher proportion of the silver carp population in Lake Barkley would be sexually mature and producing larger quantities of eggs. The GSI values have held steady within Kentucky reservoir.

In 2019 no peak in mean discharge (CFS) through Lake Barkley Lock and Dam was observed with a corresponding peak in female silver carp mean GSI values from Barkley reservoir (Figure 15). The highest average GSI scores in females were observed in May and June. The rise in GSI during this time period was likely stimulated by increasing water temperatures as average discharge decreased during this period. No successful spawning events were detected in Barkley or Kentucky reservoirs during 2019.

Sex ratios were calculated for silver carp in both reservoirs from aggregated data in 2019. Barkley reservoir was calculated to be comprised of 48% males (N=627) and 52% females (N=675), a 0.93:1 ratio. Kentucky reservoir was calculated to be comprised of 49% males (N=131) and 51% females (N=135), a 0.97:1 ratio.

Mark-Recapture Effort:

During the marking effort conducted in September 2018, 1,292 silver carp were tagged. A total of 619 silver carp were tagged from Barkley reservoir with a mean length of 684mm and a mean weight of 3,830 grams. In Kentucky reservoir, 673 silver carp were tagged and had a mean length of 627mm and a mean weight of 2,570 grams.

From October 2018 through January 2020, KDFWR received 20 tag returns from commercial fishing efforts. Fifteen came from Barkley reservoir and five from Kentucky reservoir (Figure 16). Three fish were double tagged. The higher frequency of returned fish from Barkley reservoir compared to Kentucky reservoir is not surprising given the majority of commercial fishing pressure occurs on Barkley (Reported under Objective 3).

Data collected from harvested fish indicated that all fish grew from the time of initial tagging to the point when they were harvested. Inspection of tag insertion locations indicated good healing of the marked fish. All recovered fish exhibited localized redness around the tag insertion, however none showed signs of infection. The majority of fish were collected in approximately the same embayment where they were tagged. This is an interesting observation because telemetry data has shown that a portion of the silver carp population in the reservoirs exhibit large scale movement patterns at certain times (USFWS 2019). The tag return data suggests that these fish have developed site fidelity, however, we have not distinguished specific behavioral or environmental characteristic that draws them to a constricted geographic area, relative to the area that is available for use.

Asian Carp Harvest Program Monitoring

Length and weight data were collected on 802 silver carp harvested by commercial fishers. Silver carp ranged from 2.8 – 19.5 lbs with an average of 8.4 lbs. If this metric is used in correlation with the total pounds of silver carp harvested by commercial fishers through the ACHP in 2019, that would produce a rough estimate of 690,789 individual silver carp being removed from Kentucky waters through the ACHP in 2019 (5,802,624 lbs; Table 4). During ride-alongs, commercial fishers were observed using gill nets with a range of bar mesh sizes to target Asian carp (3” – 5” bar mesh; Table 5). Catch per unit effort of gill nets used to harvest Silver carp were highest in gill nets with a bar mesh size of 3.25” (0.52 fish/yard), followed by 3” and 3.5” bar mesh which both had a CPUE of 0.37 fish/yard. This is similar to the previous two years when the highest CPUE was in 3.5” bar mesh nets. However, no ride alongs were conducted with commercial fishers utilizing gill nets with smaller sizes of bar mesh in previous years (Table 5). Information collected from fish harvested through the ACHP was also used in the above demographics analysis.

Black Carp

Black carp recovered by KDFWR staff in 2019 included, 22 males and 5 females, and one was unknown due to the fish being gutted prior to pick-up (Figure 17). Total length ranged from 33.9 - 40.9 inches, and weight ranged from 16.2 – 57.6 lbs. The gut contents are being analyzed by personnel at the USGS lab in Columbia, Missouri, for an ongoing study. The USGS published results from previous diet analysis of wild caught black carp in the United States in 2019 (Poulton et al. 2019). USGS and partners published another document in 2019 containing data collected by KDFWR on black carp captured by commercial fishers (Kroboth et al. 2019).

Objective 2: Examine Asian carp impacts on native fish communities

Standard Sampling

Capture rates of species with potential direct competition from bigheaded carp (silver and bighead) were observed to be low in 2019 standard sampling (Tables 6 & 7). This observation remains consistent with

data collected from standard sampling in 2018. Bigmouth buffalo (N=4) and paddlefish (N=12) catch through standard sampling was low, so catch rates are not reported at this time. These species will continue to be monitored and data will be collected opportunistically. Increased data collection through a gear such as the Paupier net, on both reservoirs, may be valuable in future assessments of native species.

Interestingly, number of bycatch during standard sampling in July and October 2019 were about 50% less than observed bycatch numbers in 2018 (Tables 6 & 7). Common Carp (*Cyprinus carpio*), freshwater drum (*Aplodinotus grunniens*) and smallmouth buffalo (*Ictiobus bubalus*) were the predominant bycatch in Barkley reservoir (61.9%) whereas freshwater drum and smallmouth buffalo were the predominant bycatch in Kentucky reservoir (60%). Catfish spp. (*Ictaluridae*) comprised 25.4% of the bycatch from Barkley reservoir and 20% of the bycatch from Kentucky reservoir. These observed rates increased from data collected in 2018, however these increases were driven by the April sampling period that was absent in 2018. Blue catfish (*Ictalurus furcatus*) remained the dominant catfish species observed as bycatch through standard sampling.

Gizzard shad (*Dorosoma cepedianum*) collected by sampling with a Paupier net and traditional boat electrofishing in October 2019, were measured and used to estimate relative weight values (Wr), using the formula presented in Blackwell et al. 2000. Gizzard shad from Barkley reservoir were estimated to have a mean Wr of 94 (N=69, S.E.=1.0) and gizzard shad from Kentucky reservoir were estimated to have a mean Wr of 92 (N=405, S.E.=0.6). The fish collected from Barkley reservoir were restricted to only traditional boat electrofishing because Paupier net effort was limited to Kentucky reservoir in 2019. Data suggests that relative weights have been increasing in Barkley reservoir since 2017. Gizzard shad from Kentucky reservoir have also exhibited an increase in relative weight since 2017, however 2019's mean Wr values were lower than those observed in 2018. In 2018 several very large shad were collected, thus skewing the mean relative weights higher (Table 8).

Standard Sport Fish Sampling

In Kentucky Lake, 529 black crappie, 268 white crappie, 80 largemouth bass, and 17 blue catfish were measured and used for relative weight analysis in 2019. Black and white crappie both exhibited the lowest mean relative weights since the late 1990's with Wr of 84.6 and 82.8 respectively. Largemouth bass average Wr remained similar to previous years ($Wr = 91.1$). Sampling for blue catfish began in 2004 and has been inconsistent. However, in 2019 blue catfish average Wr was lower than most previous years ($Wr = 99.0$). Historical mean relative weight values were charted along with pounds of Asian carp removed from Kentucky Lake through the commercial fishery (Figure 18). Harvest of Asian carp from Kentucky Lake through the ACHP was the highest in 2014 and 2019 with 194,778 and 235,784 pounds of Asian carp harvested respectively. These years correspond with decreases in condition for both largemouth bass and crappie. If harvest of Asian carp is used as a metric to gauge the population density of adult Asian carp in the lake, one could make the argument that high abundances of Asian carp in Kentucky Lake is negatively impacting sport fish. Inversely, 2015 was the first and only year that young of year silver carp were documented in Kentucky Lake. Condition of largemouth bass and crappie both peaked in 2015 and 2016, which could be an indication that YOY and juvenile silver carp presence in Kentucky Lake provided a food source for these sportfish and contributed to their higher Wr values. However, many factors are known to impact sport fish condition and values recorded since Asian carp have become established in Kentucky Lake have not fluctuated outside of historical variations.

In Lake Barkley, 105 black crappie, 458 white crappie, 67 largemouth bass, and 198 blue catfish were measured and used for relative weight analysis in 2019. Mean relative weights for both black and white crappie were the lowest recorded since 2011 (W_r of 90.5 and 85.1, respectively). Largemouth bass average W_r values were similar to previous ($W_r = 98.0$). Sampling for blue catfish in Lake Barkley began in 2004, but has been inconsistent. Mean W_r for blue catfish collected in 2019 was similar to previous years ($W_r = 97.2$). Historical relative weight values were charted along with pounds of Asian carp removed from Lake Barkley through the commercial fishery (Figure 19). Harvest of Asian carp from Lake Barkley has increased almost every year since the ACHP began in 2013 spiking in 2019 to over 5.3 million pounds (Table 9). Similar to Kentucky Lake, the high harvest of Asian carp in 2019 corresponds with lower condition factors of sportfish species, which may be an indicator of high densities of adult Asian carp competing with these sport fish for resources. However, sport fish condition in the reservoirs is highly variable due to a variety of factors and will continue to be monitored in following years.

Asian Carp Harvest Program Bycatch

According to the ACHP regulation (301: KAR 1:152), commercial fishers are allowed to harvest a ratio of 65% Asian carp to 35% scaled rough fish per month. All other fish caught in commercial gear must be released. Commercial fishers are required to submit daily reports that include bycatch species, number caught, number harvested, number released, and disposition upon release (moribund or alive). Increased effort by commercial fishers fishing under the ACHP has translated into a growing amount of bycatch (34,841 fish in 2019: Table 10). Scaled rough fish, primarily buffalo (*Ictiobus*) species, make up majority of reported bycatch in commercial gill nets fished under the ACHP (Table 10). Harvest of scaled rough fish decreased in 2018 and again in 2019 (80.7%), which is largely reflective of market demand for those species. The number of catfish caught in commercial nets under the ACHP rose slightly in 2019, however the survival rate of this species group remained high at 98.7%. Bycatch of sport fish species increased in 2019 to the highest reported number since 2013 with 171 individuals. However, the survival rate for sport fish species also increased greatly to 93.6%. This high survival rate is likely due to the change in commercial fishing methods in 2019. Previously, the majority of fishermen would fish overnight, dead sets for Asian carp, leaving nets out for 6-8 hrs between harvests. In 2019, most fishermen began utilizing more active methods of fishing for Asian carp, targeting large schools, encircling them with nets, and chasing the fish into the gill nets by making loud noises. This active method of fishing resulted in decreased bycatch per fishing trip for most native species (Table 11). The number of paddlefish reported captured as bycatch increased in 2019 ($n=296$) from 2018 ($n=200$), but remained lower than most previous years. However, the mean survival rate of paddlefish decreased slightly to 80.7% in 2019 (Table 10). Survival rates of all bycatch caught during ride-alongs in 2019 was documented as well (Table 12). During ride-alongs, the survival rate of sport fish in bycatches increased from 2018, but remained lower than what was reported by commercial fishers (82.3%). However, in relation to total bycatch, the number of sport fish captured was low (4% during ride-alongs in 2019). Survival rates of catfish species observed as bycatch during ride-alongs was the highest recorded since 2015 and was very close to what was reported by commercial fishers in 2019 as well (98.3%: Tables 10 & 12). Paddlefish survival rates observed during ride-alongs in 2019 was higher than observed in 2018, but remained significantly lower than what commercial fishers reported on their daily reports (47.6%: Tables 10 & 12).

A comparison for bycatch of paddlefish, catfish species, and sport fish species reported by commercial fishers through daily reports and information collected during ride-alongs shows a decrease since 2015 in number of sport fish captured per trip for most species (Table 11). However, bycatch reported captured per trip for recreationally and commercially important species such as paddlefish and catfish spp. is higher during ride-alongs than from commercial fishing reports (Figure 20). This troubling trend suggests anywhere from 50-75% of bycatch is likely not reported in daily logs submitted to KDFWR by commercial fishers. However, ride-alongs account for a small percentage of the total number of trips made by commercial fishers (2%). To better identify and monitor under reporting of bycatch, KDFWR will continue to increase the number of ride-alongs conducted with commercial fishers targeting Asian carp. To date, there is no indication of negative impacts on the sport fishery resulting from the ACHP.

Bycatch of Paddlefish

As KDFWR monitors sport fish bycatch through the ACHP it also provides the opportunity to monitor other species that compete directly with Asian carp such as paddlefish. Paddlefish are considered a species of conservation need as their life history traits and value of their roe has potential to result in recruitment overfishing of the population. Consequently, there is a need to closely monitor impacts of the ACHP on paddlefish. Generally, experienced commercial fishers can avoid capturing large numbers of paddlefish when they are targeting Asian carp by carefully selecting fishing locations. The number of paddlefish captured is variable over time, but did show an increasing trend that is now declining even though effort is increasing (Tables 9 & 10).

Paddlefish exhibited a relatively low survival rate in 2019 (47.6% during ride-alongs, 80.7% total ACHP) in relation to other species in the bycatch (Tables 10 & 12). Since much of the ACHP effort is during the summer months (i.e. warmer water temperatures), paddlefish are vulnerable bycatch in this fishery. Therefore, water temperatures have been recorded during ride-alongs conducted since 2016 (Table 13). Another factor identified as possibly affecting paddlefish survival in gillnets was length of time the nets are left in the water (i.e. soak time), and has been recorded since 2017 (Table 13). From conducting ride-alongs, it has been observed that the soak time of nets varies among fishermen and depends on the location being fished, weather, and water temperature. Overall, fishermen tend to leave nets in the water longer when water temperatures are cooler as it increases catch rates and like most fish, Asian carp will survive longer in the cooler temperatures. Although sample sizes are small, observations from ride-alongs in 2018 and 2019 indicate that paddlefish survival rates decreased as water temperatures increased. It has also been suggested that since paddlefish have an elongated operculum, it may be more likely for a gillnet to restrict the water flow over their gills than other fish species. There did not appear to be a marked difference in the survival rate of paddlefish based on soak time of nets in 2019. To increase the sample size, water temperature and soak times will continue to be recorded during ride-alongs in 2020.

Kentucky and Barkley Tailwaters Electrofishing

Fall sampling with electrofishing in the Kentucky Tailwater resulted in the capture of 4,489 total fish comprised of 41 species during 3.75 hrs of effort in 2019. Similar to previous years, Clupeid species were the most abundant group collected, comprising 64.9% of the total catch during sampling in 2019 (Figure 21). However, skipjack herring (*Alosa chrysochloris*) and gizzard shad made up the majority of Clupeids caught, in contrast to previous years when threadfin shad (*Dorsoma petenense*) were more numerous (Table 14). In 2019, sampling produced the highest percent of total catch and CPUE (510 fish/hr) of skipjack herring since the survey began in 2015 (Table 15). CPUE of sunfish species including bluegill

and longear sunfish, was high compared to previous years as well, and made up 18% of the total sample (Figure 21 & Table 15). Largemouth and smallmouth bass (*Micropterus dolomieu*) were the most prominent sport fish species collected in the Kentucky Tailwater during fall sampling in 2019 with a CPUE of 29 fish/hr (Table 14). Smallmouth bass CPUE in 2019 was the highest since the survey began in 2015 (Table 15). CPUE for crappie and redear sunfish (*Lepomis microlophus*) increased as well from previous years. Silver carp retained a similar CPUE and portion of the percent total catch as was documented in previous years (Figure 21 & Table 15).

Fall sampling in the Barkley Tailwater resulted in the capture of 3,359 total fish comprised of 29 species in 3.0 hrs of effort in 2019. Complementary to previous years, Clupeid species, were still the most abundant species collected in Barkley Tailwater during fall sampling in 2018, comprising 63.9% of the total catch (Figure 22). Similar to the Kentucky Tailwater, skipjack herring and gizzard shad made up the majority of Clupeids caught, with skipjack herring producing the highest CPUE since the survey began (324 fish/hr; Table 16). In contrast, threadfin shad CPUE was the lowest since the survey began in 2016 (30 fish/hr; Table 16). Sunfish species such as bluegill (*Lepomis macrochirus*) and longear sunfish (*Lepomis megalotis*) produced high catch rates in comparison to previous years and made up 18.9% of the total catch (Table 17 & Figure 22). Black bass (largemouth, smallmouth, and spotted) catch rates increased from 2018 and made up the highest percentage of the total catch since the survey began in 2016 (5.9%; Figure 22). Smallmouth bass CPUE rose to 29 fish/hr, which is higher than all previous survey years. Flathead catfish produced a CPUE of 22 fish/hr which is highest for this species as well. Silver carp CPUE during fall sampling in Barkley Tailwaters increased again in 2019 from previous years (42 fish/hr; Table 16).

Length frequency distribution for silver carp collected in Kentucky Tailwater during fall sampling in 2019 ranged from 16-24 inches (N=15; Table 14). Silver carp lengths from Barkley Tailwater during fall sampling ranged from 16-37 inches, and was dominated by the 18-27 inch classes (N=126; Table 17). These ranges are similar to silver carp collected during fall sampling in 2018.

Silver carp and grass carp were collected in both tailwaters during fall sampling efforts, however no bighead carp were collected in either season. Electrofishing for this project resulted in removal of 15 silver carp from Kentucky Tailwater and 126 silver carp from Barkley Tailwater in 2019.

Although environmental conditions in the spring of 2019 were not conducive for the standard sampling reported here, KDFWR did conduct targeted electrofishing sampling to capture young of year (YOY) Asian carp in the tailwaters in response to angler reports of small silver carp being collected in the Kentucky Tailwater. This sampling was conducted in both tailwaters and downstream the Tennessee and Cumberland rivers to their junction with the Ohio River. Silver carp YOY were only collected in the lower Tennessee River near the mouth of the Clarks River (58 fish). Due to the low number of YOY silver carp in the immediate tailwaters of Kentucky and Barkley Dams, it is likely that these fish were spawned in the Ohio River and swam upstream into the tributaries. A subsample of the YOY fish collected were sent to Dr. Gregory Whitlege at Southern Illinois University for microchemistry analysis. This analysis may produce a more accurate determination of spawning location.

In the Kentucky Tailwater, the mean Wr of gizzard shad increased to a value of 85, the highest observed since the survey began in 2015 (Table 18). The mean relative weight for smallmouth buffalo in 2019 was also the highest recorded since 2015 ($Wr = 100$). Silver carp mean relative weight rebounded from the low observed in 2018 ($Wr = 73$ in 2018, $Wr = 81$ in 2019). This increase is positive as a low mean relative weight for silver carp could also be an indication of increased competition for resources in the tailwaters as the silver carp population grows. Mean relative weight values for other species in the Kentucky Tailwater remained similar to previous years. In the Barkley Tailwaters the mean Wr for silver carp remained similar to previous years ($Wr = 83$; Table 19). During sampling in the Barkley Tailwater in 2019, mean relative weight values observed for gizzard shad ($Wr = 91$) and freshwater drum ($Wr = 103$) were the highest recorded since the survey began in 2016. Mean relative weight values for other species remained similar to those observed in previous years (Table 19).

The Western Fisheries District branch of the KDFWR fisheries division collected data on sportfish in the Kentucky and Barkley tailwaters previous to this study. Data was collected from fish in both tailwaters in the fall of 2002 and 2011 (KDFWR, 2003 and 2012). Fish were collected through standardized electrofishing runs, measured, and weighed. Using this historical data, comparisons of sport fish catch rates and condition were made to the information presented in this report. These comparisons did not reveal any appreciable declines in sport fish numbers or condition since Asian carp have become abundant in the tailwaters (Tables 20, 21, 22, and 23). Recreationally important fish species in the Kentucky and Barkley tailwaters including: catfish, *Morone* spp. (white bass, yellow bass, striped bass, and hybrid striped bass), black bass, sunfish, and crappie, still exhibit good condition despite the high densities of Asian carp in these areas.

Kentucky and Barkley Tailwater Creel Survey

Kentucky Tailwater

During the 2019 survey it was estimated that recreational fishers made 20,347 trips and spent 48,719 hours fishing to catch 131,015 fish (2.6 fish/hr: Table 24) in the Kentucky Tailwater. In comparison, during the 2016 creel survey, recreational fishers made 29,212 trips and exerted 95,643 hours of fishing pressure (Figure 23). The total catch in 2016 was 171,171 fish (1.81 fish/hour). Total hours fished decreased in 2019, but the total catch rate improved. The drop in fishing pressure may be attributable to abnormally high discharge and water elevation throughout most of 2019. Average daily discharge for 2016 and 2019 from February 16 - July 30 was 51,000 cfs and 113,000 cfs, respectively (TVA unpublished data). However, fishing guides have indicated that fishing effort has declined in the tailwaters due to Asian carp abundances and the perception that fish commonly targeted by recreational fishers are not using the areas as they did prior to the carp invasion.

In 2019, 61.8% of recreational fishers fished from the bank while only 21.0% fished from a boat (Table 24). These results are similar to 2016 when 68.3% of recreational fishers fished from the bank and 25.5% fished from boats. The fishing method most commonly used in the tailwater during 2019 was casting (45.0%), followed by still fishing (37.5%). Bow fishing represented 10.3% of recreational fishers, which is a slight increase from 2016 (9.2%). Female recreational fishers using the tailwater decreased from 14% in 2016 to 11% in 2019.

Catfish were targeted on 27.3% of all fishing trips in the tailwater in 2019 (Table 25). This value increased from 2016 when catfish anglers accounted for 19.4% of all trips. The harvest rate of catfish per hour was 0.73, 0.86, and 0.75 for 2007, 2016, and 2019, respectively. Those harvest rates suggest little change in angler success over time. Once again, blue catfish were the most common catfish species caught in the tailwater accounting for 76% of catfish harvested. Length distribution for catfish caught ranged from 3 – 51 inches (Table 26).

Anglers fishing for *Morone* spp. accounted for 10% of all recreational fishers in the tailwater (Table 25), an increase from 2016 when 7% of recreational fishers fished for *Morone* spp. Catch rates were 0.96, 1.51, and 1.88 for 2007, 2016, and 2019, respectively, indicating increasing success over time. Striped bass accounted for 25% of the *Morone* spp. caught, which is higher than the 10% reported in 2016. (Table 25).

Black bass and crappie comprised 9% and 1% of the angling pressure in the tailwater, respectively (Table 25). The catch rates of black bass per hour were 0.78, 0.49, and 0.39 for 2007, 2016, and 2019, respectively. These results indicate a trend of declining catch rates. Largemouth bass comprised 78% of the black bass caught, while smallmouth bass accounted for 22%. The catch rates per hour of crappie were 0.93, 0.58, and 0.23 in 2007, 2016, and 2019, respectively. Effort expended towards crappie by anglers in the tailwater has also decreased over time from 2,170 hours in 2007 to 1,851 hours in 2016 to 411 hours fished in 2019.

Recreational fishers targeting baitfish in the Kentucky Tailwater accounted for 20% of all trips in 2019. Total catches of skipjack herring and shad, increased in 2019 with 84,598 and 1,847 fish of each species harvested, respectively (Table 25). Baitfish were captured by dipping, casting, and rod and reel (Sabiki rigs). Baitfish are economically important for many anglers and KDFWR will continue to collect information on them as this study progresses.

In 2019, no anglers reported that they were targeting sauger, and no sauger were reported caught. Effort was directed towards panfish accounted for 2% of fishing effort in 2019. The harvest rates per hour were 1.90, 1.64, 2.09, and 1.22 for 1992, 2007, 2016, and 2019, respectively.

Bow fishing is permitted year round from the bank or from a boat in the Kentucky Tailwater (301 KAR 1:410). Bow fishers can take an unlimited number of rough fish, except they may only take 5 catfish and 2 paddlefish. Most bow fishers' primary target is Asian carp but some also harvest other species. Snagging contributed 7% of all trips to the tailwater, while bow fishing accounted for 10% of trips (Table 24). Snagging and bow fishing harvested 239 paddlefish in 2019 from the Kentucky Tailwater (Table 25). The average length of paddlefish harvested in 2019 was 32 inches (Table 26). Harvest rates per hour were 0.50, 0.39, 0.10, and 0.07 for 1992, 2007, 2016, and 2019, respectively. The lower success rate is likely due in part to the increased density of Asian carp species congregating in the tailwater. Since Asian carp outnumber paddlefish, snagging is much more likely to hook Asian carp than paddlefish.

Asian carp, specifically silver carp and bighead carp, have increased in density in the Lower Tennessee River and Kentucky Lake over the years. This fact is obvious to anglers in the tailwater as Asian carp are often snagged on baits and lures meant for other fish species and can often be seen swimming in large schools just under the water's surface. Some anglers reported that they can feel their bait bouncing off

the carps as it travels down through the water column. The 2007 creel survey estimated 116 bighead carp and 58 silver carp were caught by recreational fishers in the tailwater. The number of each species caught increased dramatically in 2016, when catch was 2,718 bighead carp and 22,678 silver carp. The total catch dropped in 2019 for bighead and silver carp to 294 and 10,358, respectively (Table 25). Silver carp length distribution ranged from 12 – 38 inches and bighead carp ranged from 24 - 51 inches in 2019 (Table 26). Despite the change in regulations allowing their sale, no recreational fishers indicated that they were going to sell Asian carp they had captured.

An Angler Attitude Survey (AAS) was also conducted during the 2019 tailwater creel survey. Recreational fishers interviewed for the AAS were chosen at random and asked a series of questions related to the species they targeted or fished for the most (Appendix 2). Five groups were asked specific questions about species they targeted; *Morone* spp., crappie, black bass, catfish, and paddlefish. When asked about their level of satisfaction with their respective fisheries, the majority of recreational fishers responded that they were either very satisfied or somewhat satisfied (50-96%), except for crappie anglers who tended to be “neutral” (60%). In 2016 the majority of paddlefish fishers responded that they were either somewhat dissatisfied (31%) or very dissatisfied (25%) with the fishery. Ironically, in 2019 the majority of paddlefish fishers responded that they were somewhat satisfied (45%) with only 20% reporting that they were somewhat or very dissatisfied. When asked about the reason for their dissatisfaction, most paddlefish fishers (60%) cited Asian carp for their dissatisfaction. Similarly, in 2016, most dissatisfied respondents cited Asian carp as the reason for their dissatisfaction. However, in 2019, the most common reason was simply “number of fish”. Although purely speculative, this change may be reflective of recreational fishers increasing acceptance of Asian carp as an ever present nuisance rather than a novel invader. Recreational fishers were also asked if they had eaten Asian carp, with 85% responding “No”. Additionally, 87% answered that they did not know how to clean an Asian carp to produce a boneless fillet.

Barkley Tailwater

During 2019, the creel survey results estimated that recreational fishers made 22,110 trips and spent 42,911 hours to catch 100,267 fish (2.1 fish/hr) in the Barkley Tailwater (Table 27). In comparison, the 2016 creel survey estimated recreational fishers made 23,346 trips, exerted 75,048 hours of fishing pressure and had a total catch of 127,537 fish (0.9 fish/hour) (Figure 24). Similar to Kentucky Tailwater, total hours fished decreased in 2019, but the total catch rate improved, which may be attributable to abnormally high discharge and water elevation throughout most of 2019. In 2019, 84% of recreational fishers fished from the bank while 15% of fished from a boat. This was an apparent increase in bank usage compared to 2016 when 66% of effort was from the bank and 34% of recreational fishers used boats. Most recreational fishers use casting (35%) as a fishing method during 2019, and still fishing was used by 28%. Bow fishing comprised 29% of the total creel data. Female recreational fishers in the tailwater decreased from 14% in 2016 to 9% in 2019.

Catfish were the target species for 23% of all fishing trips in the Barkley Tailwater in 2019 (Table 28), a decrease from 2016 when they accounted for 34% of all trips. Fishing pressure also decreased from 25,773 hrs in 2016 to 9,855 hrs in 2019. Harvest rates were 0.60, 1.27, 1.07, and 1.38 for 1992, 2000, 2016, and 2019, respectively. Therefore, although total pressure and harvest decreased, the harvest rate

was the highest ever recorded. Blue catfish accounted for roughly 95% of catfish harvested. Catfish caught ranged in length from 5 – 38 inches (Table 29).

Anglers fishing for *Morone* spp. accounted for 12% of all recreational fishers fishing the Barkley Tailwater (Table 28), an increase from 9% in 2016. Fishing pressure for *Morone* spp. declined between 2016 (6,707 hours) and 2019 (5,320 hours). Harvest rates were 0.31, 0.25, 0.56, and 0.72 for 1992, 2000, 2016, and 2019, respectively. Similar to what was observed with catfish, harvest rates increased compared to prior surveys. Striped bass accounted for 8% of the *Morone* spp. caught, identical to the percentage observed in 2016. In comparison, during 2001, striped bass accounted for 60% of the *Morone* spp. caught and 50% of the harvest. White bass accounted for 79% of the catch of *Morone* spp. in 2019 (Table 28).

Black bass and crappie comprised 2% and 0% of the angling pressure in the Barkley Tailwater, respectively (Table 28). The catch rates for black bass were 0.58, 1.04, and 0.63 in 2000, 2016, and 2019, respectively. Smallmouth bass comprised 43% of the black bass caught in 2019, which is a large increase over the 12% reported in 2016. No spotted bass were reported, however this species is often misidentified by anglers. Although, no anglers indicated they were targeting crappie during 2019 (Table 28), 85 were caught by anglers targeting other species. Effort expended towards crappie by anglers in the tailwater has decreased in each survey period (4,808 hours in 2001, 1,790 hours in 2016, 0 hours in 2019).

Recreational fishers targeting baitfish (skipjack herring and shad) accounted for 20% of the total number of trips to the Barkley Tailwater during 2019 (Table 28). Baitfish catch reflects fish caught via dipping, casting, and with rod and reel (Sabiki rigs). Total catches of skipjack increased during 2019 with 49,944 fish caught. Estimated numbers of shad caught decreased from 6,223 fish in 2016 to 3,748 in 2019. The baitfish industry is very important to western Kentucky as people travel from other states to catch or buy dead baitfish caught in the tailwaters.

Sauger fishing in Barkley Tailwater followed a similar trend as Kentucky Tailwater with no sauger reported and no anglers who indicated they were targeting sauger. Panfish anglers made up little more than 2% of the fishing trips to the tailwater (Table 28). Fishing effort targeting panfish also decreased between the 2016 (1,181 hours, 368 trips) and 2019 (970 hours, 500 trips). Harvest rates were 1.90, 1.31, 3.64, and 0.76 for 1992, 2000, 2016, and 2019, respectively. Bluegill catch accounted for the majority of the catch in 2019 (2,135 fish: Table 28).

In the Barkley Tailwater, snagging and bow fishing harvested 407 paddlefish in 2019 (Table 28). The average paddlefish harvested in 2019 from the Barkley Tailwater was 27 inches long (Table 29), a decrease from 2016 when they averaged 29 inches long. Paddlefish caught in 2001 (N = 813) were larger still, with an average length of 39 inches. Bow fishing effort was greater in the Barkley Tailwater (29%) than in the Kentucky Tailwater (10%). Asian carp tend to congregate more heavily on the surface in the Barkley Tailwater which may be contributing to the differences.

The 2001 creel survey conducted in the Barkley Tailwater did not record any Asian carp captured or harvested. Since then, the density of Asian carp, specifically silver carp and bighead carp, has increased dramatically in the Lower Cumberland River and in Lake Barkley. In 2016, it was estimated that 2,853 bighead carp and 21,599 silver carp were caught in Barkley Tailwater. In 2019, recreational fishers

caught an estimated 539 bighead and 17,903 silver carp (Table 28). It should be noted that many recreational fishers are not proficient in identifying between these two species and may be an area where we can better educate through this survey. Length distribution ranged from 10 – 36 inches for silver carp and 25 – 40 inches for bighead carp captured in the Barkley Tailwater (Table 29). As in the Kentucky Tailwater, despite the change in regulations allowing their sale, no recreational fishers indicated that they would sell their harvested Asian carp.

An Angler Attitude Survey (AAS) was also conducted during the 2019 creel survey at the Barkley Tailwater. This AAS was conducted in the same manner as the AAS in the Kentucky Tailwater with a similar format (Appendix 3). Most recreational fishers for all five groups responded that they were either neutral or satisfied with the Barkley Tailwater fisheries (70-90%). In all groups, fishers dissatisfied with the fisheries indicated that ‘number of fish’ was the primary reason for their dissatisfaction. Recreational fishers were also asked if they had eaten Asian carp, with 79% responding “No”. Additionally, 86% answered that they did not know how to clean an Asian carp to produce a boneless fillet.

Asian carp have the potential to negatively affect tailwater fisheries in various ways. Invasive Asian carp have been shown to change trophic dynamics of a large river ecosystem by changing the way native fish feed, and altering food available to them (Freedman et al. 2012). If Asian carp are affecting the food web dynamics of the ecosystem, we may see changes in the fish community over time. In their highest densities, Asian carp may outcompete other fish species for space, which may be apparent through decreasing species diversity. Asian carp may also directly compete with native fish for food, causing declines in native fish condition through time (Irons et al. 2007; Schrank et al. 2003). This study strives to monitor these parameters through routine surveys of the fish community. Growing populations of Asian carp also have social impacts on our sport fisheries. Some recreational fishers may not fish in the tailwater because they fear the Asian carp will jump in their boat, creating a mess, destroying equipment, or even causing injuries. At their highest densities, schools of Asian carp make fishing for other species difficult, as it may be impossible to drop bait to the bottom of the river without snagging a carp. All of these issues could lead to decreases in sport fishing effort and success. To a much lesser degree than traditional fishing methods, higher densities of Asian carp can also positively affect recreational fishers’ usage of the tailwater as we have seen with the rising sport of bow fishing. The number of recreational fishers utilizing the method of snagging has also increased as many recreational fishers now use this method to target Asian carp specifically to either use as bait or for sustenance. KDFWR plans to continue this study to monitor the impacts Asian carp have on the tailwater fisheries over time.

Objective 3: Target and Remove Asian carp

Asian Carp Harvest Program Monitoring

The Asian Carp Harvest Program (ACHP) created by KDFWR allows commercial fishers to target Asian carp in waters where commercial fishing with nets is otherwise restricted. The data in this section is compiled from daily and monthly reports submitted by commercial fishers participating in the ACHP. Implementation of the ACHP has been a key element in the increased harvest of Asian carp from Kentucky waters.

Since 2013, commercial fishers in Kentucky harvested a total of 11,799,156 lbs of Asian carp through the ACHP (11,639,020 lbs silver carp, 160,136 lbs bighead carp). Total harvest would be higher if grass carp

were included, but historically, commercial fishing reports did not delineate grass carp from common carp. In future reports, grass carp will be included. The majority of Asian carp harvested in Kentucky are from Lake Barkley (Table 9). Commercial fishers prefer fishing Lake Barkley over Kentucky Lake as it is shallower, has more embayments to corral fish, less recreational traffic, and the fishers believe the silver carp are larger. Number of commercial fishers in Kentucky and associated trips under the ACHP program has varied annually. A decrease in fishing effort (numbers of trips) and Asian carp harvest in 2015 and 2017 was due to inconsistent market demands. In 2018, the number of fishers targeting Asian carp rose slightly, but fishing effort more than doubled. This trend continued in 2019 when commercial fishers made 2,250 trips and harvested an excess of 5.8 million pounds of Asian carp (Table 9, Figure 25). The increase was largely due to a strong 2015 Asian carp year class that reached harvestable sizes. However, large numbers of Asian carp were too small for food-grade processing, and several regulatory and incentive adjustments were made since late in 2018 to compel fishers to harvest the smaller fish, and to attract more Asian carp fishers in general.

In August, 2018, KDFWR installed an industrial flake ice machine to provide free ice to ACHP fishers. In 2019, the state adjusted the Asian carp cost-share contract program to better compensate fishers for lower prices offered for small fish. Free Asian carp commercial fishing licenses were made available. Perhaps the most significant effort that induced the harvest increase was Kentucky's public-private partnership established to create a fish buyer/distributor. The new business is compelled by substantial incentives to meet aggressive Asian carp purchase and sales goals. The new project created increased demands for Asian carp, and in combination with the other incentives, more fishers from Kentucky and other states were attracted to the ACHP. Several of the new, and some former, fishers also became more efficient at catching and harvesting Asian carp. KDFWR also offered a fishing training program that has helped some commercial fishers to become more efficient.

Concerning the regulatory changes to compel harvest of smaller Asian carp, it is important to note that KDFWR collected data in 2017 that led to the regulatory amendments allowing 3" gill nets for commercial fishing. A very strong year class of silver carp was apparent in 2015 in Kentucky Lake, Lake Barkley, and their associated tailwaters. This cohort was initially observed in commercial nets in 2016 when 8 to 14-inch size fish were incidentally caught. Sampling in Lake Barkley in 2017, KDFWR consistently collected the smaller fish in experimental gill nets with 3" bar mesh. At that time, commercial fishers were restricted to using 3.25" or greater bar mesh. KDFWR sampling revealed there was no increased risk to sport fish with 3" bar mesh, and in 2018, the state passed an emergency regulation allowing commercial fishers in the ACHP to use the smaller mesh size. Similar to KDFWR's data in 2017, decrease in mesh size has not resulted in an appreciable increase of sportfish bycatch by commercial fishers (Table 10). Commercial fishers' adjustments in net sizes during the past several years helped towards the 2019 record harvest, and the highest CPUE of silver carp during ride-alongs (0.52 fish/yard: Table 5, Figure 26Fi).

Asian carp harvest data was summarized by month from January 2013 to December 2019 (Figures 27 & 28). Historically, the number of trips made by commercial fishers under the ACHP decreased during paddlefish season (November-March) and increased again when paddlefish season ended (Figure 27). This shift was expected as many commercial fishers fish Kentucky Lake and Lake Barkley with a special net permit during paddlefish season, which allows gill netting in the lakes without fishing under the ACHP. However, in late 2018 and through 2019, this trend was not apparent as commercial fishers are

now targeting Asian carp year round, and are allowed to receive funds through the contract program administered by KDFWR for Asian carp harvested while fishing on their net permit. The highest number of commercial fishing trips recorded in a single month was 280 in October 2019, followed by November and December in 2019. Total pounds of silver carp harvested per month closely follows the trend of number of trips made with October of 2019 having the highest weight recorded (913,811 lbs). Average pounds of silver carp harvested per trip has varied by year. Except in April, May, and June, the average pounds of silver carp harvested per trip was higher in every month of 2019 than in 2018 (Figure 28). Record high water levels and flows prevailed in these months, which most likely accounted for the lower harvests.

Water conditions routinely affect Asian carp harvest rates, but seasonality is also a factor. KDFWR and MSU telemetry studies indicate that movement rates of silver carp increase in water temperatures between 61.5 °F and 86.0 °F (USFWS 2019). Fish become more active with rising water temperatures in the spring, and they become less susceptible to harvest when moving to the main channels from embayments. Commercial harvest rates also vary among fishers. The most successful fishers understand silver carp tendencies better, and they use higher quality gear with larger boats that have higher weight capacities. In 2019, the average number of pounds harvested per trip was calculated for all fishers who made 10 or more fishing trips (N=42), and average pounds of silver carp harvested varied from 176 lbs/trip to 7,028 lbs/trip. Interestingly, not all fishermen with high catch rates fished frequently (Figure 29).

Ride-Alongs

KDFWR conducted 48 ride-alongs with 19 different commercial fishers utilizing the ACHP January through December 2019 (Figure 3). During ride-alongs 57,433 yards of gillnet were fished and 164,744 lbs of Asian carp were harvested. The majority of fishing effort observed during ride alongs was in Lake Barkley (N=42), which is similar to fishing effort in general. Ride-alongs were also conducted in Kentucky Lake (N=4), the lower Tennessee River (N=1), and the Ohio River (N=1). Commercial fishers set nets primarily along secondary channels, on flats in the main lake, and in embayments. The northern end of Lake Barkley received the most fishing pressure. This may be a result of the ease of access, as it is shorter distance for commercial fishers to drive and transport fish. Another factor may be the sinuosity of Lake Barkley at this location which reduces impacts from high winds. Additionally, in 2019, Lyon County, KY began offering a subsidy for Asian carp harvested from Lake Barkley waters within the county boundaries, which encompasses the northern portion of Lake Barkley. The county's subsidy program was independent of KDFWR contract incentives, and commercial fishers could participate in both programs.

In Lake Barkley, average total weight of silver carp harvested per trip increased during 2019 (3,383 lbs) from all previous years (Table 30). Average total weight of silver and bighead carp harvested per trip during ride-alongs (3,353 lbs) was also higher than those averages for the ACHP as a whole (2,580 lbs) in 2019 (Table 31). After each ride along total length and weight was recorded for 20 randomly selected silver carp. Average weight of individual silver carp harvested during ACHP ride-alongs has decreased since 2016 (Table 4). This trend is a result of the changing dynamics of the silver carp population in Lake Barkley and shifting KDFWR regulations to allow smaller mesh nets to be used. Therefore, an influx of fish from the 2015 year class was harvested.

Asian Carp Contract Fishing Program in the Tennessee and Cumberland Rivers Systems

Interest and participation in the KDFWR contract fishing program for Asian carp has varied greatly since it began in 2016. However, refinements to the system in 2019 increased participation in the program. Contractors received \$210,163.21 for Asian carp harvested from Kentucky Lake, Lake Barkley, and their respective tailwaters. This equates to over 4 million pounds of Asian carp harvested through the program in 2019 (Table 32).

Experimental Gears

The hoop-net gear designed by Two Rivers Fisheries staff was fished for a total of 15 net nights or 360 hours. A total of 441 fish were caught comprising 16 different species. Crappie spp. made up the majority of the catch with 293 fish (86% survival rate). Other native species with high catch rates included freshwater drum (N=45: survival rate = 47%) and redear sunfish (N=31: survival rate = 81%). A total of 35 silver carp were captured through the duration of sampling effort. The catch rate for silver carp with this gear type was very low compared to commercial fishing efforts with gill nets. Additionally, percentage of bycatch and mortality was much higher than commercial gill nets (see ACHP Monitoring section above). Therefore, it was determined that this gear was not efficient for capturing silver carp in Kentucky Lake and sampling was discontinued. This gear may prove to be more efficient in different environments, and communications with Two Rivers Fisheries about future testing locations is ongoing. The large frame fyke net was fished for a total of 4 net nights or 86 hours. This effort resulted in the capture of 46 fish of 6 species. Bycatch consisted primarily of scaled rough fish with the exception of one blue catfish. One grass carp and 34 silver carp were harvested. However, the low catch rate indicated the gear was not as efficient as traditional gill net sets for harvesting Asian carp.

The boat designed to capture jumping silver carp was tested in the Barkley tailwaters and no Asian carp, or other fish were captured. Sampling time was minimal, so very little can be concluded from this effort. Reportedly this gear type has been used in some shallow backwaters in Illinois and was successful at harvesting silver carp. However, in deeper water and open systems where the fish have room to escape, they appeared to be likely to evade the gear rather than leap into the air and get caught in the basket style nets.

Electrofishing

Ten trips were made in the Cumberland River's Barkley Dam tailwater area and associated tributaries. A total of 24,485 lbs of Asian carp were removed in 6.9 hours of electrofishing. Estimated CPUE was calculated at 1,157 fish/hr. On one sampling trip that resulted in the removal of 2,082 lbs of Asian carp, the generator's timer failed, therefore, results for total effort and CPUE do not include that event. CPUE also excludes another event where individual weights could not be recorded, thus preventing the extrapolation of total number of fish harvested. A random sample of 20 silver carp were individually weighed and measured from all other days of effort. Mean total length and weight of these fish was 25.7 inches and 5.7 lbs, respectively.

Gill netting

During 2019, KDFWR crews fished a total of 40,000 linear yards of gill nets during removal efforts, and harvested approximately 29,211 lbs of Asian carp. Gill nets were fished on 9 trips to Kentucky Lake, and 11 species were captured. Asian carp comprised 92.2% of fish numbers collected (2 bighead carp, 106 grass carp, 1,091 silver carp). Gill nets were fished on 20 trips in Lake Barkley, and 16 species were

collected. Asian carp totaled 93.7% of the fish collected (4 bighead carp, 93 grass carp, 2,235 silver carp). Asian carp accounted for a much higher proportion of totals in 2019 in both Kentucky and Barkley reservoirs than in 2018, when they comprised 64% and 61% of the fish collected, respectively. In addition to fish collected in gill nets, on one occasion, 29 silver carp were harvested by electrofishing while being herded towards nets.

Asian carp CPUE differed by mesh size with 3", 4", and 5" bar mesh yielding 0.146 fish/yd, 0.068 fish/yd, and 0.007 fish/yd, respectively for both reservoirs combined. Annual CPUE was reduced from sampling efforts during late spring when large schools were not present in shallow water. Similar to 2018, CPUE's in 2019 using 3" bar mesh produced the highest catch rates, followed by 4" and 5" bar mesh, respectively. However, later in 2019, catch rates in Lake Barkley using 4" bar mesh increased and 3" bar mesh CPUE decreased. The shift in catch rates may be a function of growth within the large 2015 silver carp year class. Commercial fishers in Lake Barkley continue to heavily utilize 3.5" bar mesh, however, some fishers are finding increased success with 4.25" bar mesh. In Kentucky Lake, silver carp exhibit slower growth rates, and commercial fishers primarily relied on 3.25" bar mesh for harvesting silver carp (see ACHP Monitoring section above).

Recommendation:

Additional funding has been requested to significantly increase KDFWR, TWRA, and ALWFF efforts to monitor Asian carp populations. Standardized gill netting methods will be continued in 2020. To increase capture rates and sample sizes in the variable habitats found in the basin, additional gears types are being planned as funding allows. Methods for these gears will be clearly outlined and should be standardized across the basin. Data collected by KDFWR has been useful for identifying trends in demographics of Asian carp populations in the lower reaches of Kentucky and Barkley lakes, and this type of data collection will be expanded throughout the basin. As basin partners begin sampling or continue efforts currently in place, data should be compiled and analyzed congruently to more succinctly identify trends in Asian carp population characteristics throughout the basin. This information will also be utilized to inform removal efforts. It is recommended that targeted removal of Asian carp be continued. KDFWR also suggests that increased observations of commercial fishers through ride alongs be conducted to reduce differences in reporting. Commercial fishing effort throughout the basin is increasing, but relies almost entirely on gill nets as their method of harvest. Gill nets are size selective and the mesh sizes used do not capture all year classes of Asian carp present in the basin. Therefore, effort towards identifying and testing other methods for removing Asian carp should be expanded. Commercial seining shows considerable promise for efficiently removing carp at rates higher than traditional gill netting, and Asian carp harvest areas and associated regulations are planned to facilitate that gear type in Kentucky. KDFWR plans to significantly increase efforts with experimental gear types in Kentucky and Barkley lakes, including research to broaden the scope of the USGS Modified Unified Method, testing promising new pelagic harvest techniques, and initiating a research project with the USGS in the Kentucky tailwater to investigate consistent harvest efforts as a potential deterrent to interpool movement. KDFWR will partner with federal agencies, universities, and other contracted entities on these projects. Impacts of Asian carp and associated removal efforts on native species will continue to be assessed. If it is determined that native fishes are being impacted by Asian carp or removal efforts, then additional actions may need to be taken.

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Tables and Figures:

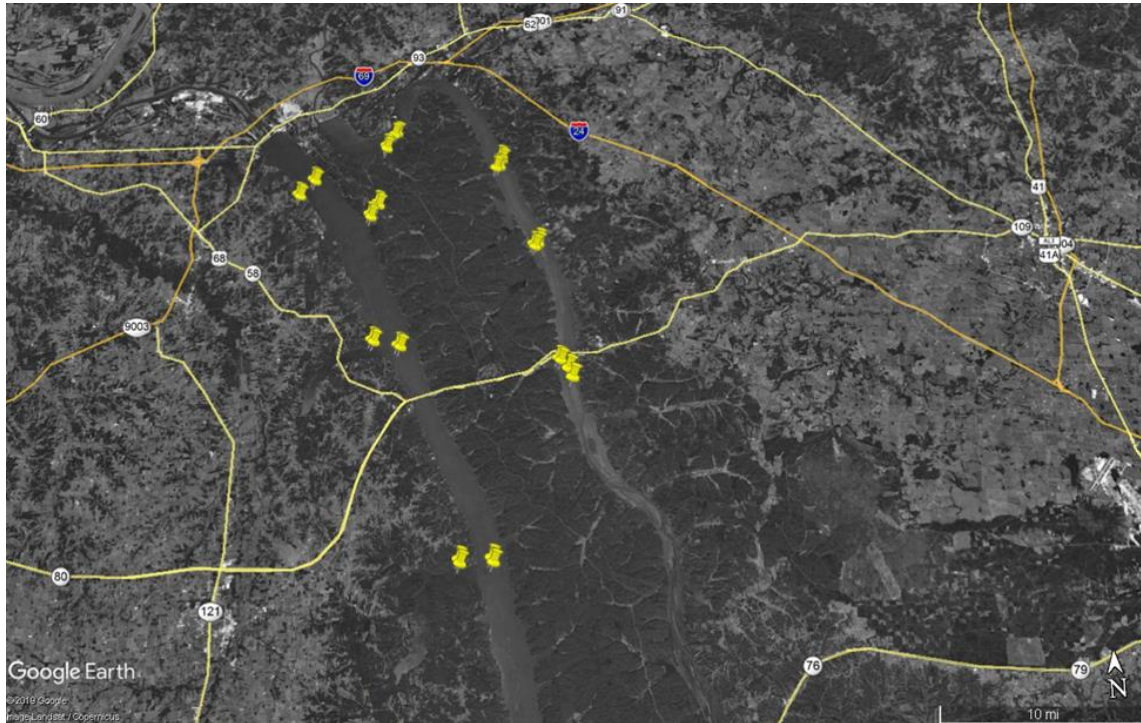


Figure 1. Location of standard sampling sites, where gill nets were fished by Kentucky Department of Fish and Wildlife Resources in 2019.

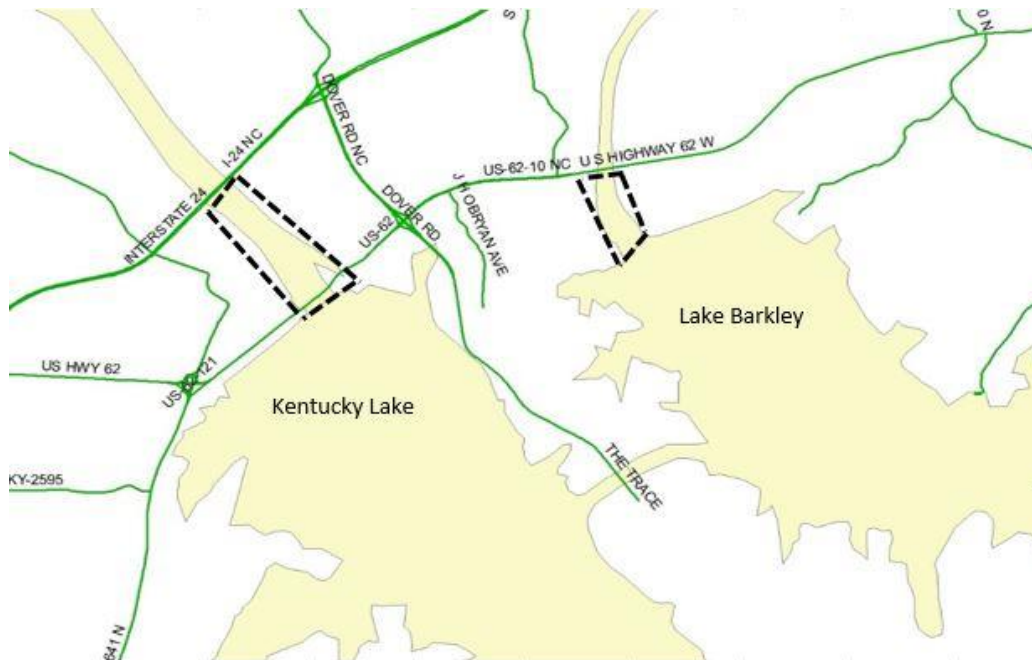


Figure 2. The tailwater electrofishing and creel survey at Kentucky Tailwater extended from the dam downstream to the Interstate 24 bridge. The electrofishing and creel survey at Barkley Tailwater extended from the dam downstream to the US Hwy 62 bridge. Sample areas are outlined by dashed line.

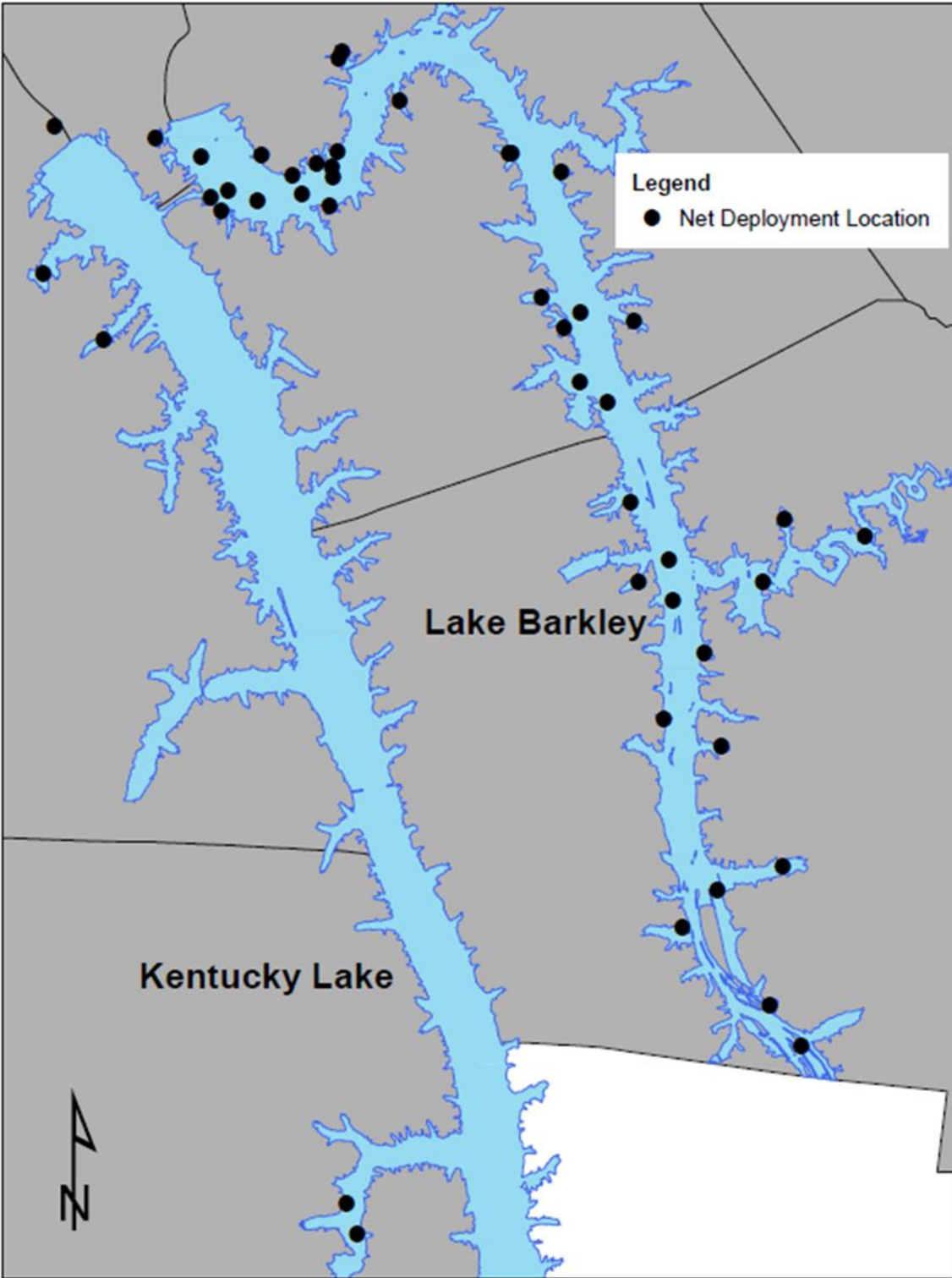


Figure 3. Locations where nets were deployed by commercial fishermen during ride-alongs conducted by KDFWR staff in 2019.

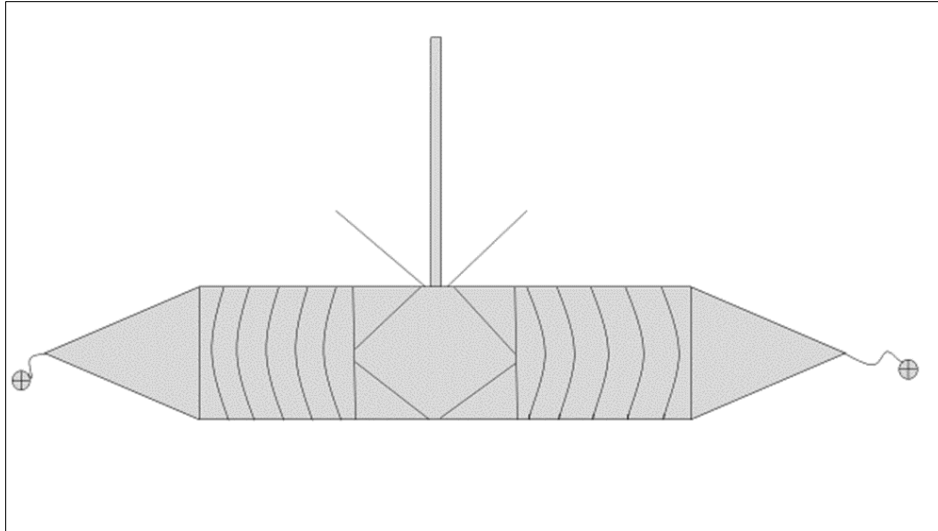


Figure 4. Experimental net designed by Two Rivers Fisheries for capturing Asian carp and fished in Kentucky Lake January 31 - February 15, 2019 with KDFWR supervision.

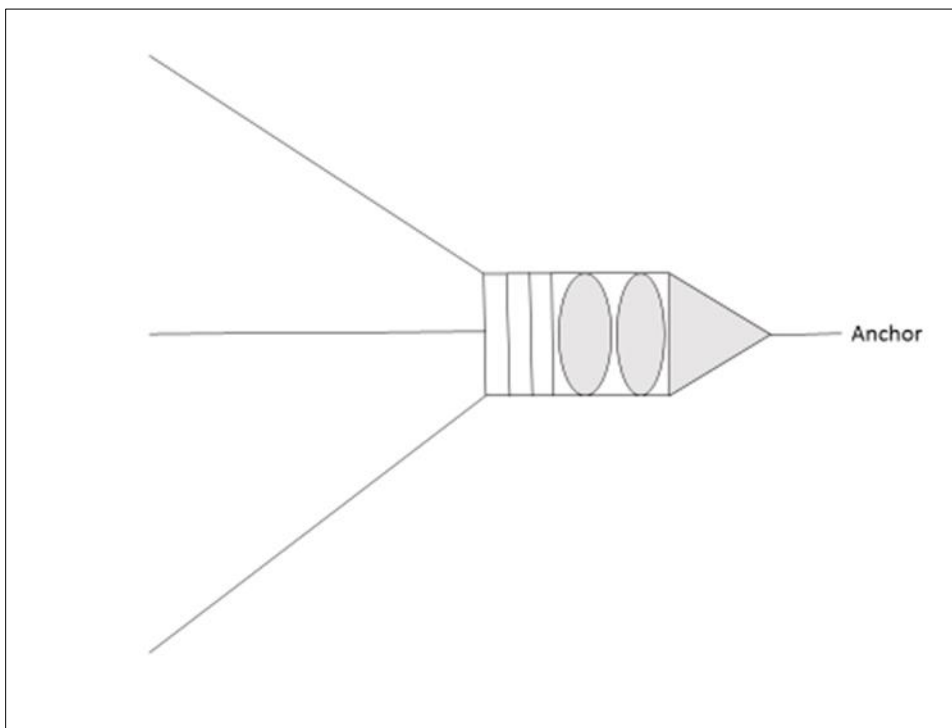


Figure 5. Experimental net designed by Two Rivers Fisheries for capturing Asian carp and fished in Lake Barkley April 26th - 30th, 2019 with KDFWR supervision.

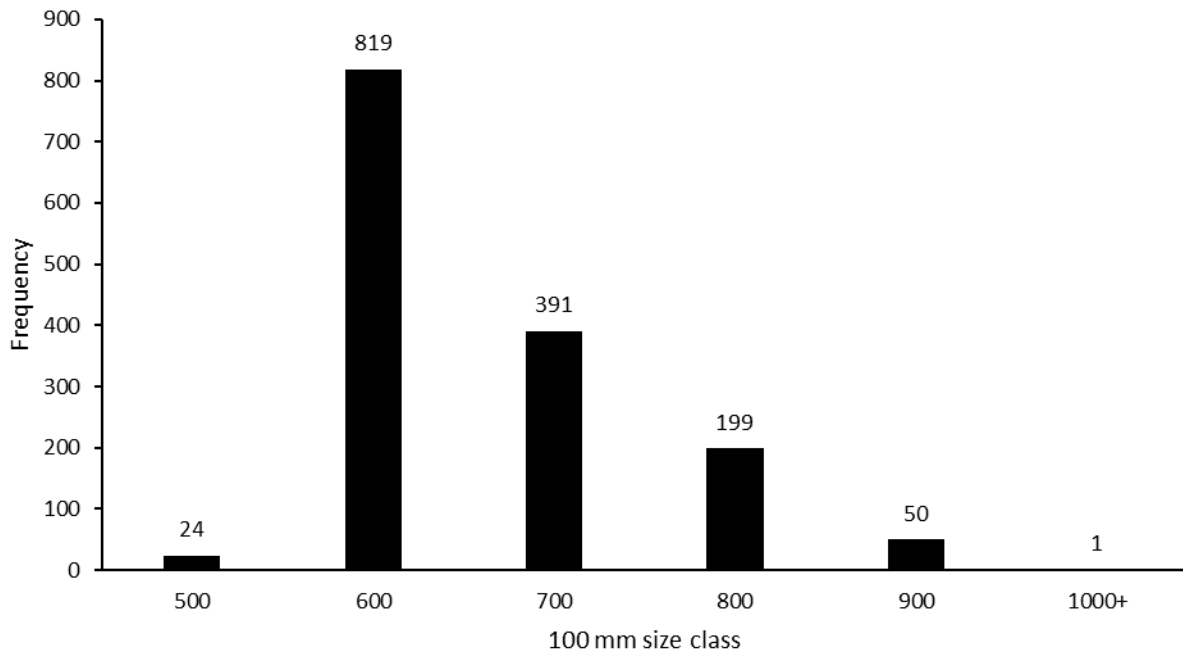


Figure 6. Length-frequency distribution of silver carp collected from Barkley reservoir, from all methods in 2019 (N=1484).

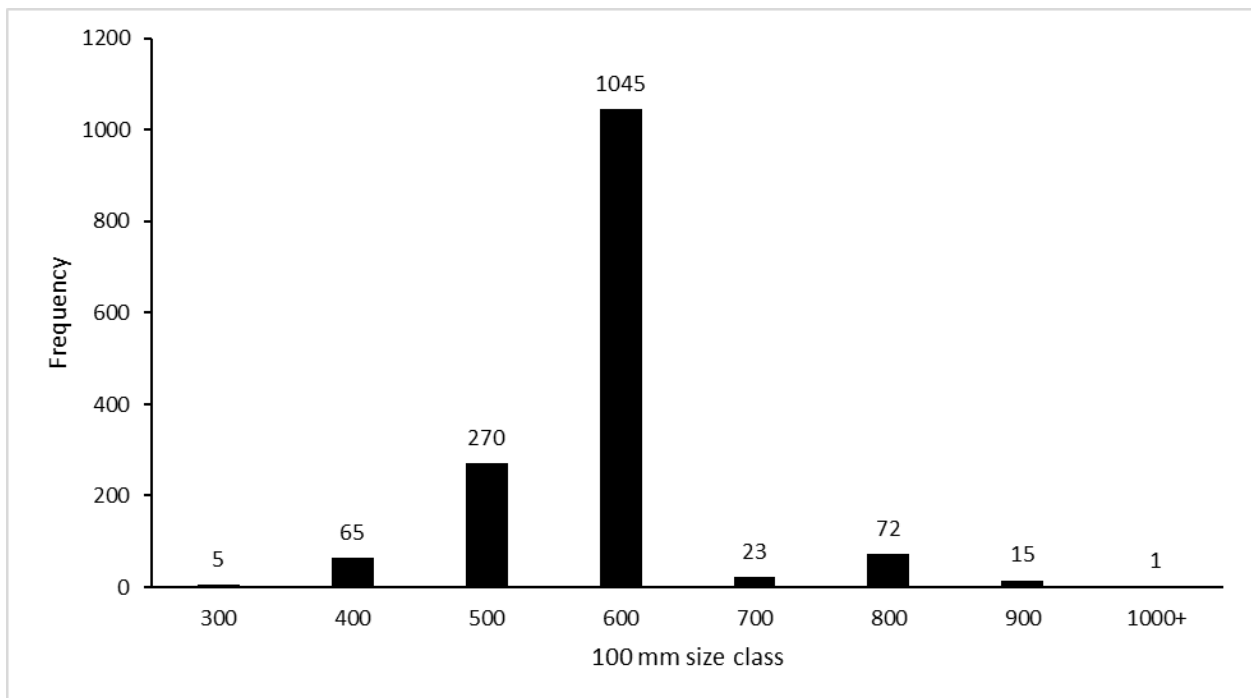


Figure 7. Length-frequency distribution of silver carp collected from Kentucky reservoir, from all methods in 2019 (N=1496).

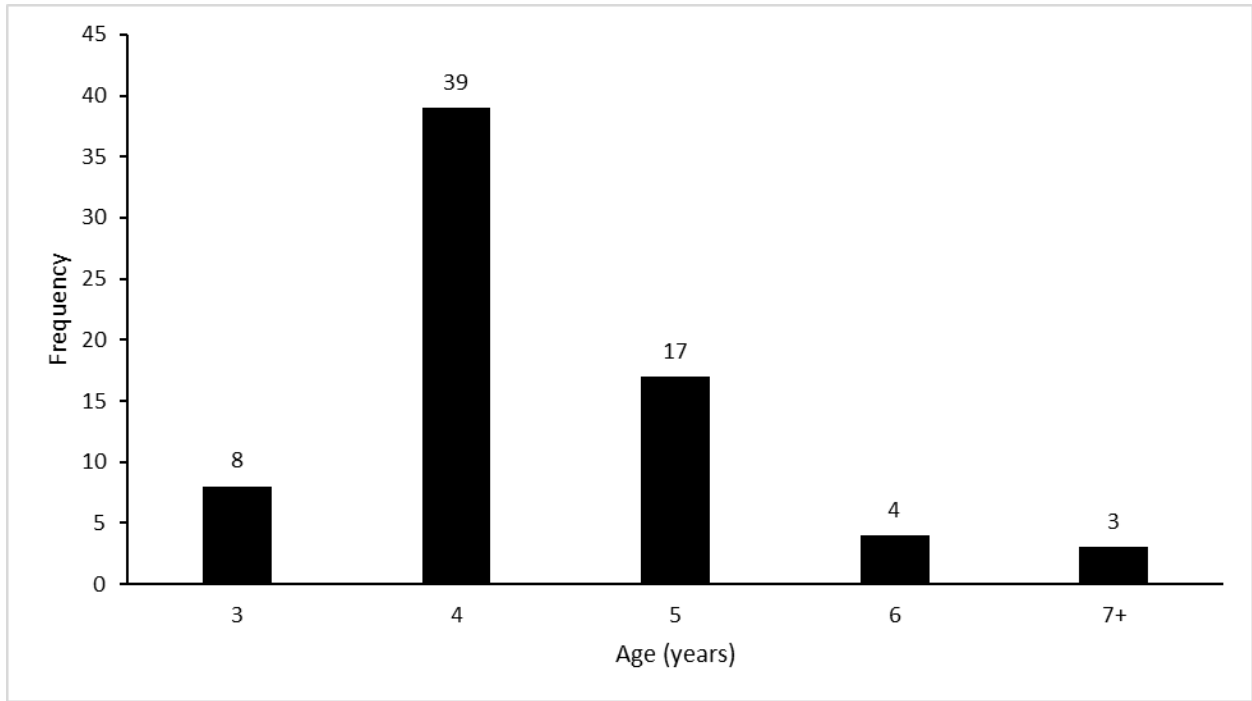


Figure 8. Age-frequency distribution for silver carp collected from Barkley reservoir in 2019 (N=71).

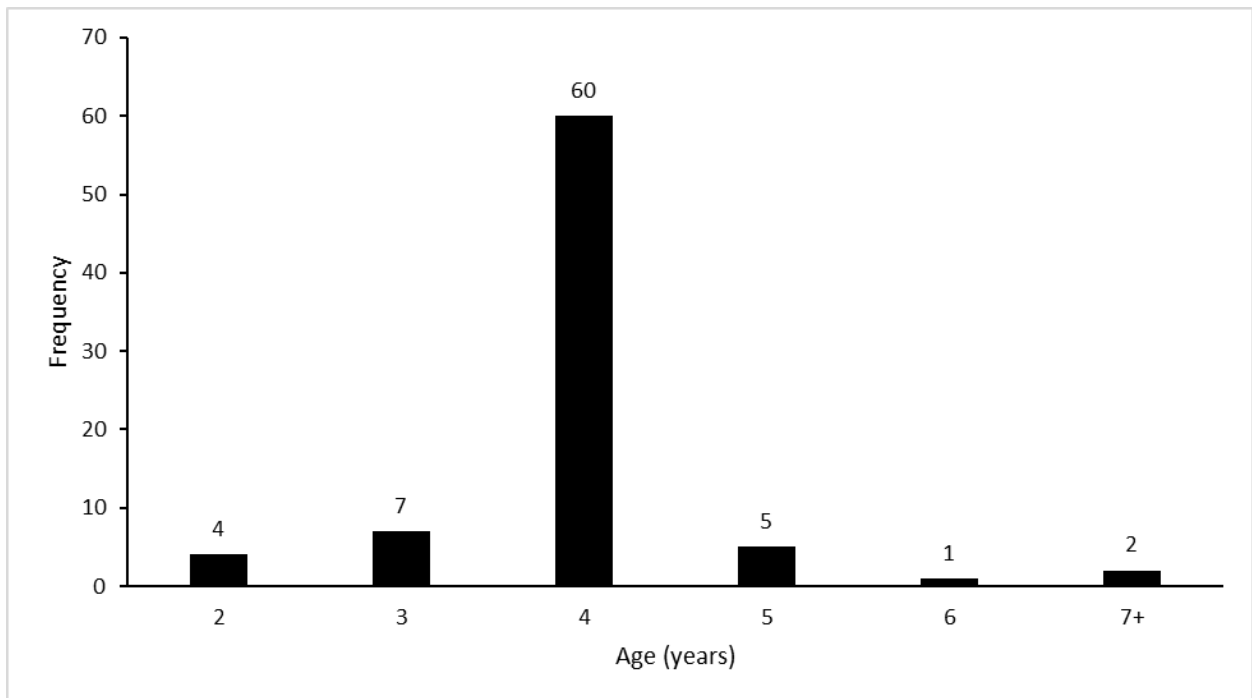


Figure 9. Age-frequency distribution for silver carp collected from Kentucky reservoir in 2019 (N=79).

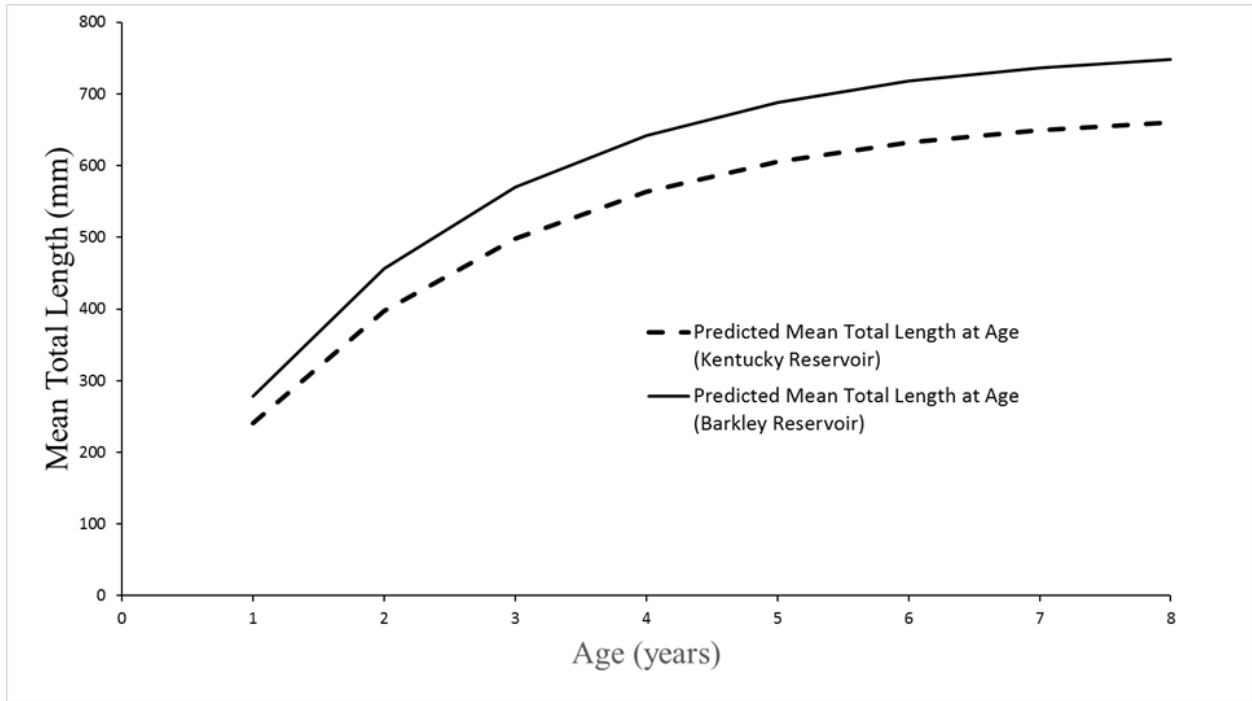


Figure 10. Von Bertalanffy growth models for predicted mean total length at age for silver carp from Kentucky and Barkley Reservoirs in 2019.

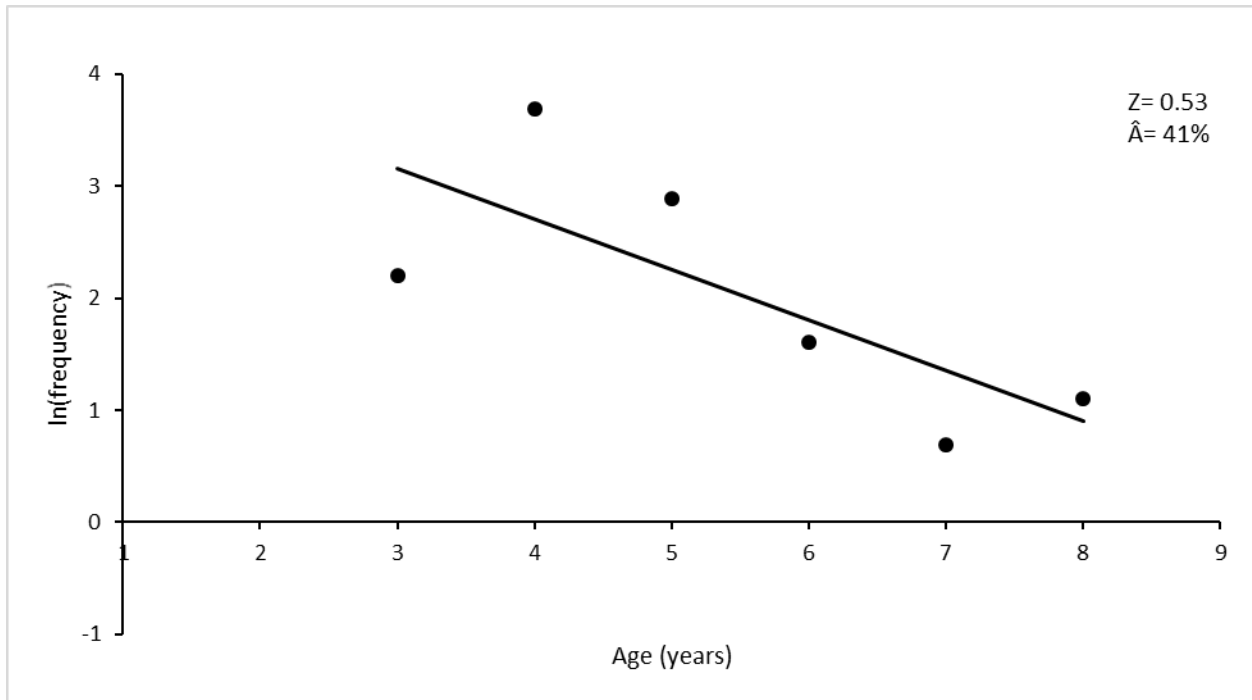


Figure 11. Catch-curve regression estimating mortality of silver carp in Barkley reservoir in 2019 (N=71, $F_{1,4}=5.06$, $P=0.0876$, $R^2=0.56$).

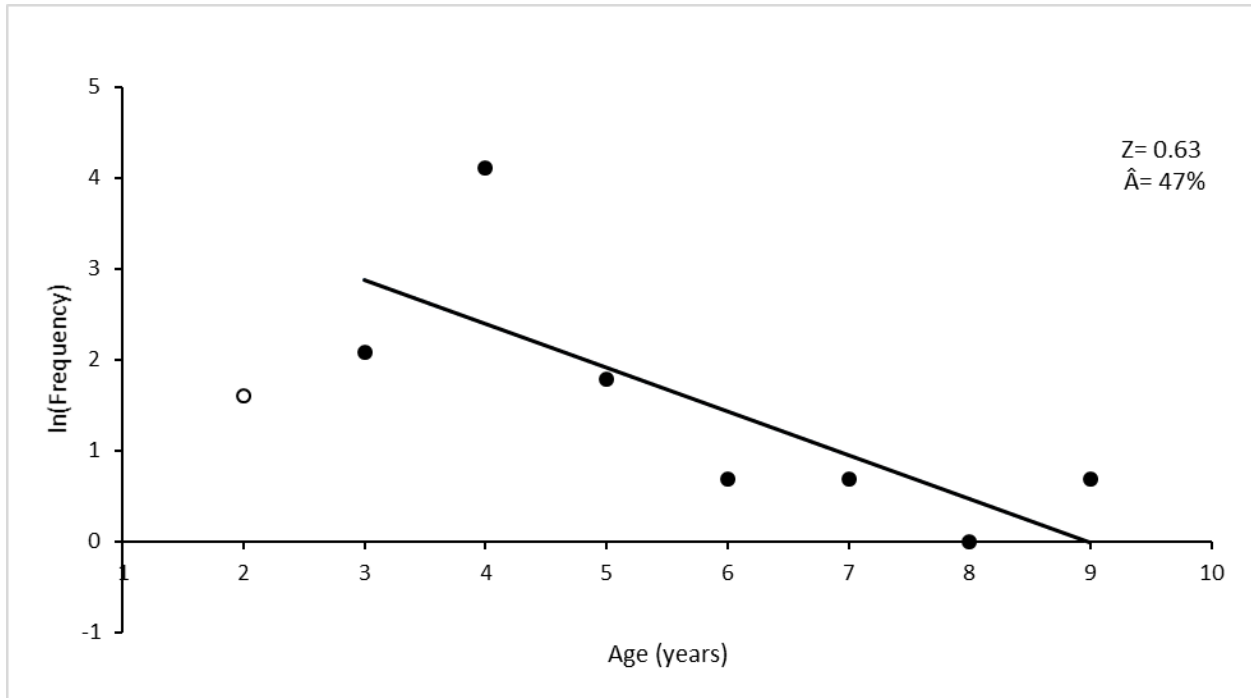


Figure 12. Catch- curve regression estimating mortality of silver carp in Kentucky reservoir in 2019 (N=75, $F_{1,5}=6.59$, $P=0.052$, $R^2=0.56$). The open circle represents the cohort of fish not considered fully recruited to the gears used for data collection and thus not used to estimate A and Z.

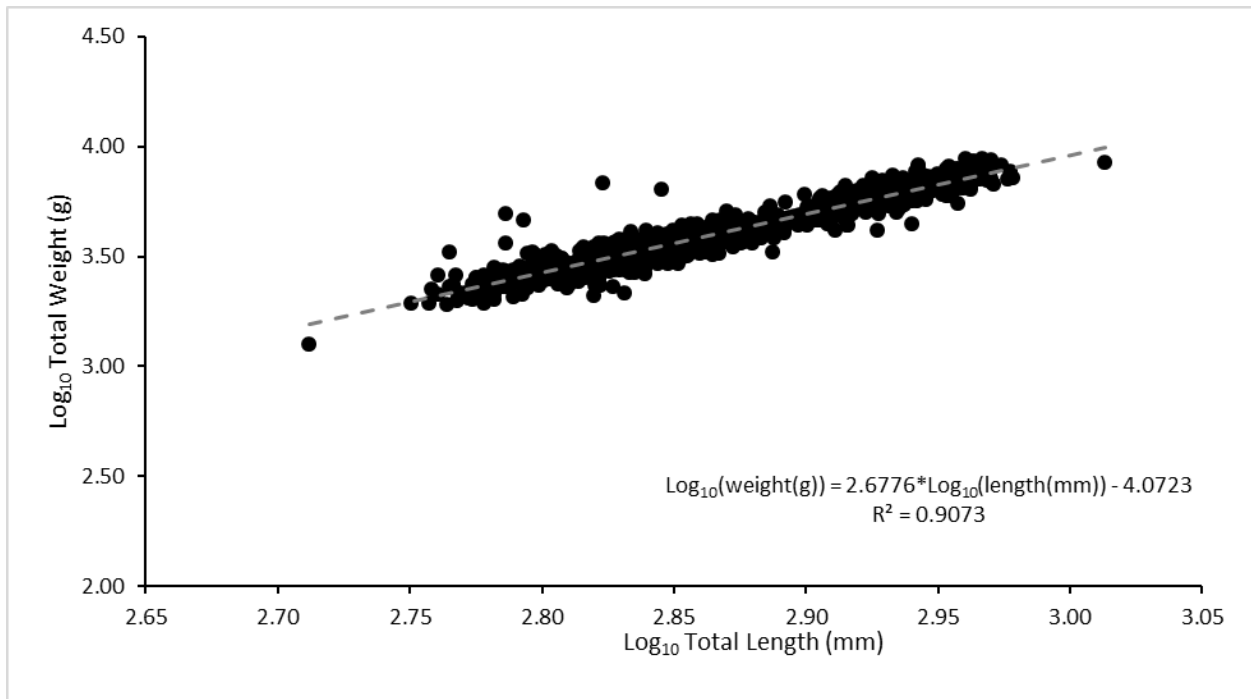


Figure 13. A scatterplot of Log_{10} transformed lengths and weights for silver carp collected from Barkley reservoir in 2019 with a regression line describing the relationship between lengths and weights (N=1484).

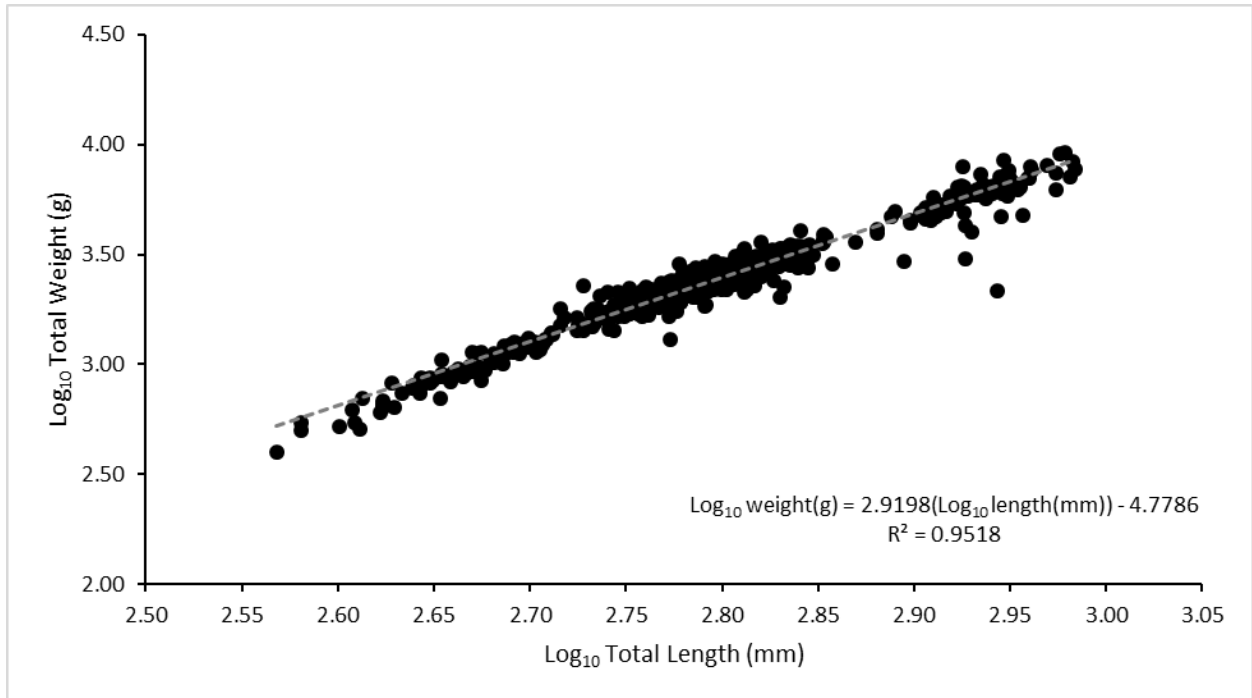


Figure 14. A scatterplot of Log₁₀ transformed lengths and weights for silver carp collected from Kentucky reservoir in 2019 with a regression line describing the relationship between lengths and weights (N=952).

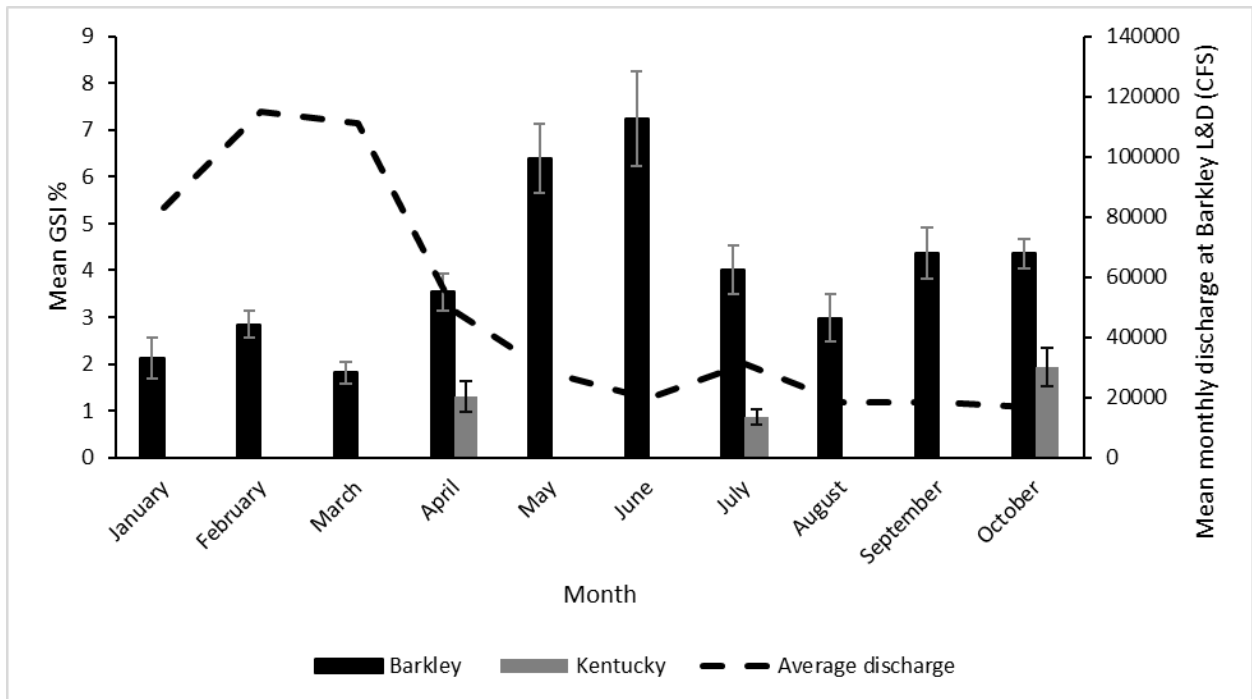


Figure 15. Mean gonadosomatic index (GSI) for female silver carp captured in Barkley (N=376) and Kentucky (N=65) reservoirs from January through October 2019, plotted against mean monthly discharge (cubic feet per second, CFS) through Barkley Lock and Dam. I-represents (\pm) standard error.

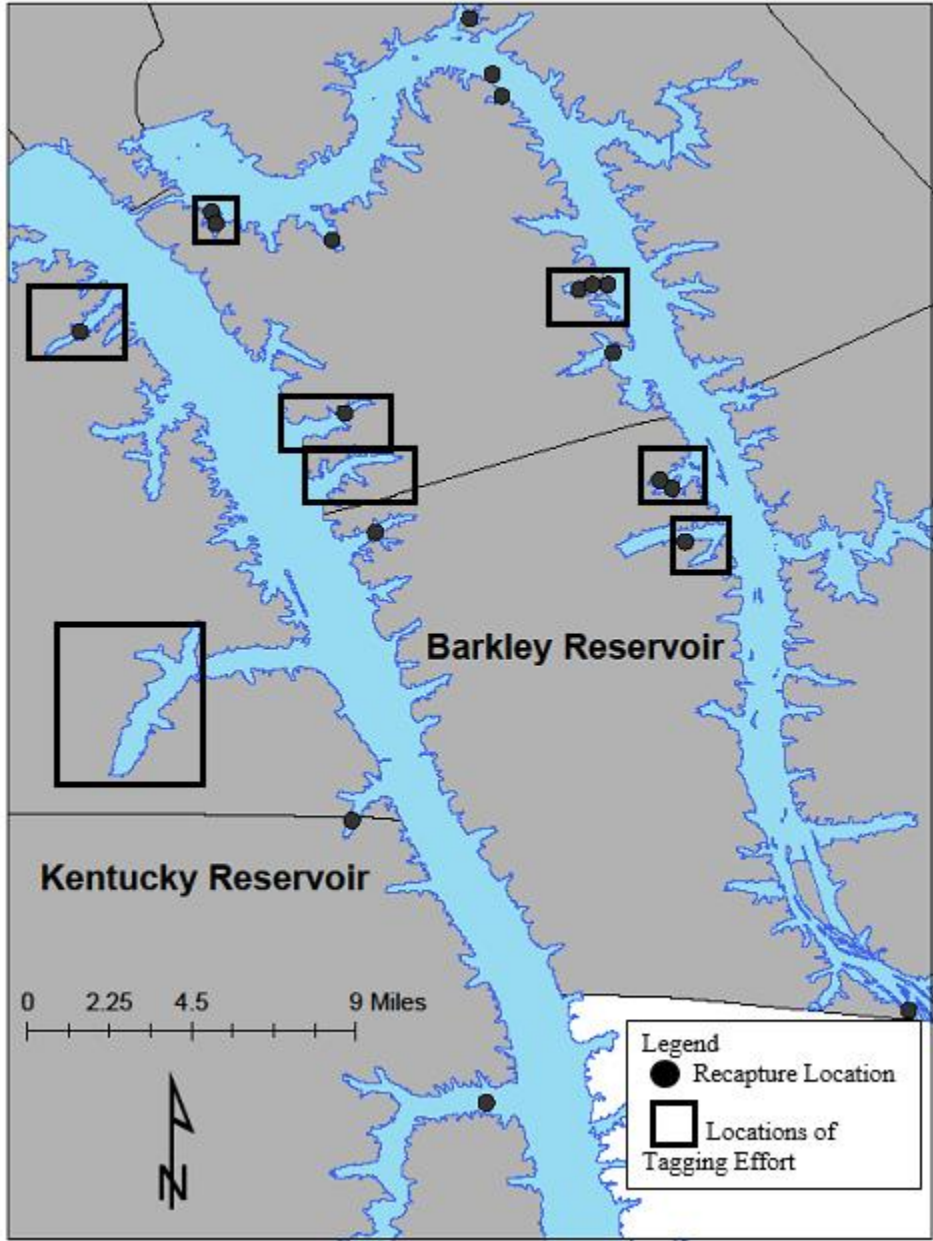


Figure 16. Locations of recaptured silver carp that were tagged as part of the mark-recapture effort to estimate abundance of silver carp in Barkley and Kentucky reservoirs.

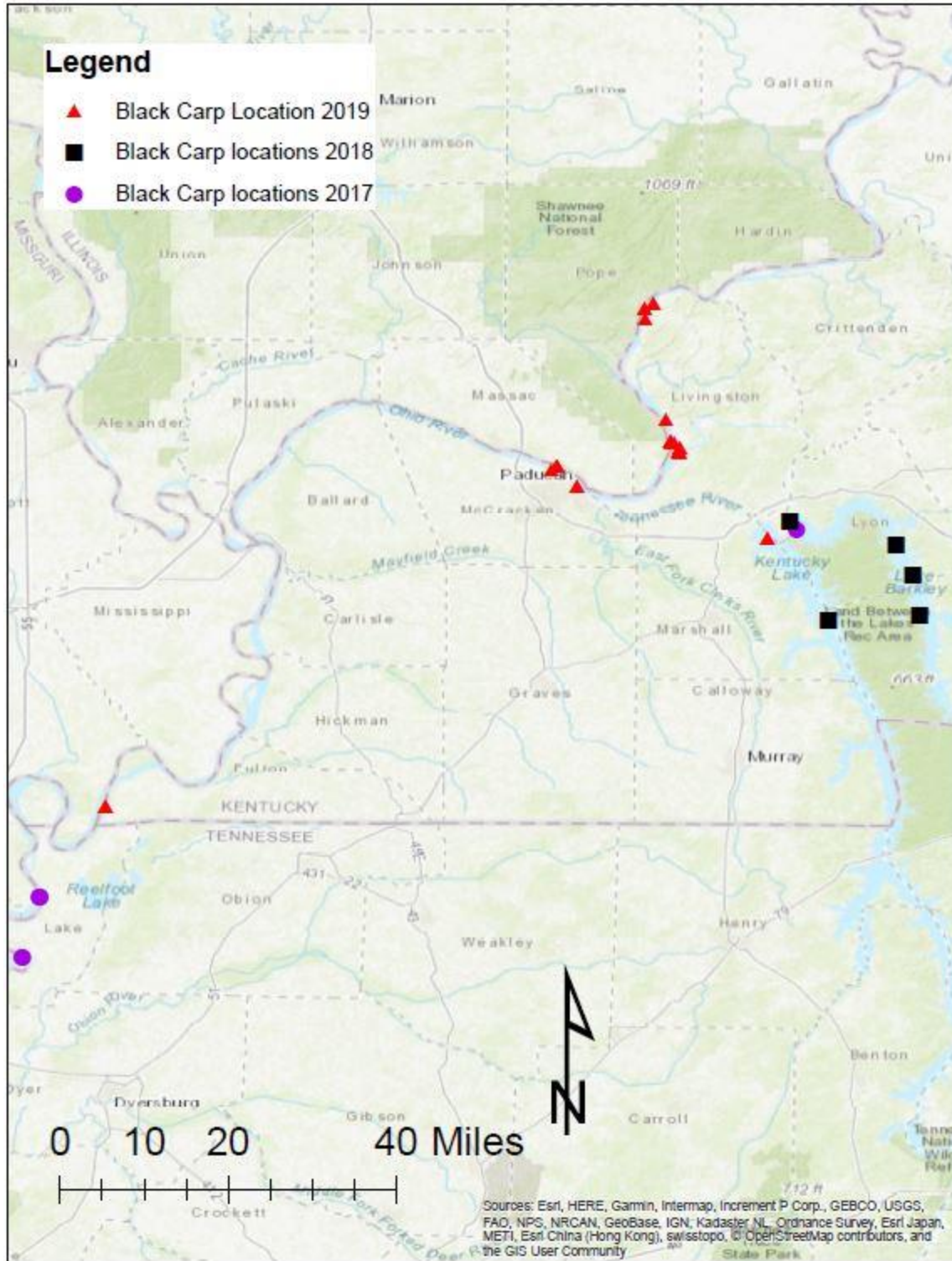


Figure 17. Locations of black carp captures reported by commercial fishers to KDFWR. Additional fish from the Ohio and Mississippi rivers were captured and sent to Illinois by commercial fishers.

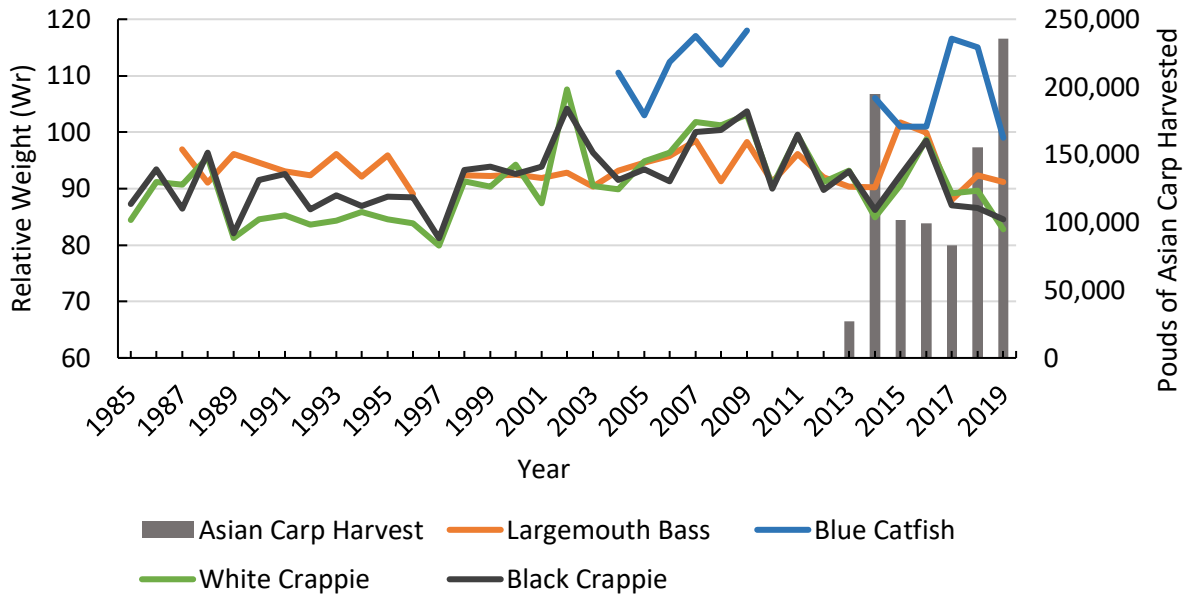


Figure 18. Mean relative weights of popular sport fish species sampled in Kentucky Lake annually, plotted against pounds of Asian carp harvested from Kentucky Lake by commercial fishers under the Asian Carp Harvest Program since the program began in 2013.

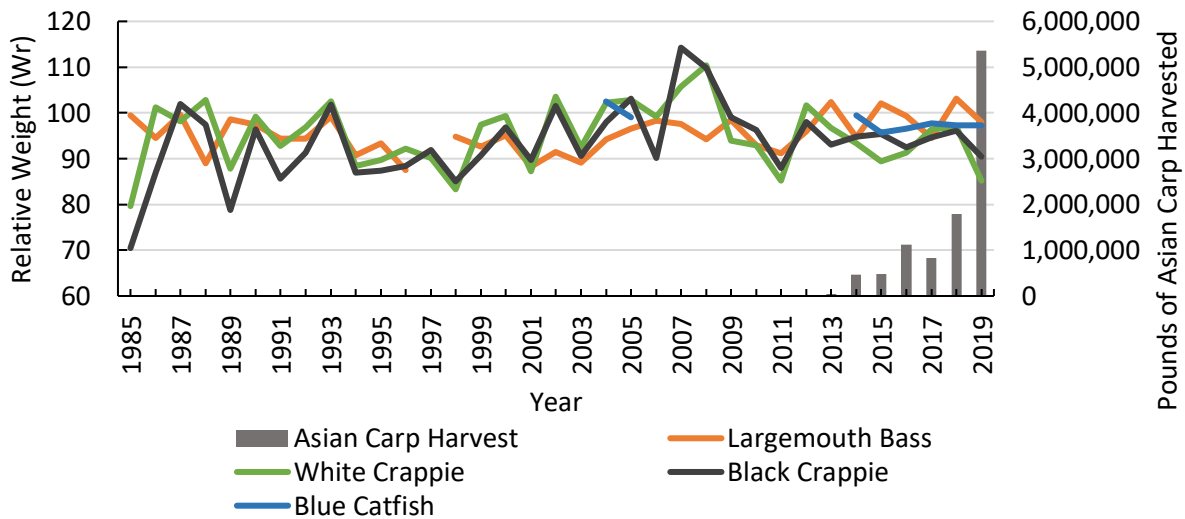


Figure 19. Mean relative weights of popular sport fish species sampled in Lake Barkley annually, plotted against pounds of Asian carp harvested from Lake Barkley by commercial fishers under the Asian Carp Harvest Program since the program began in 2013.

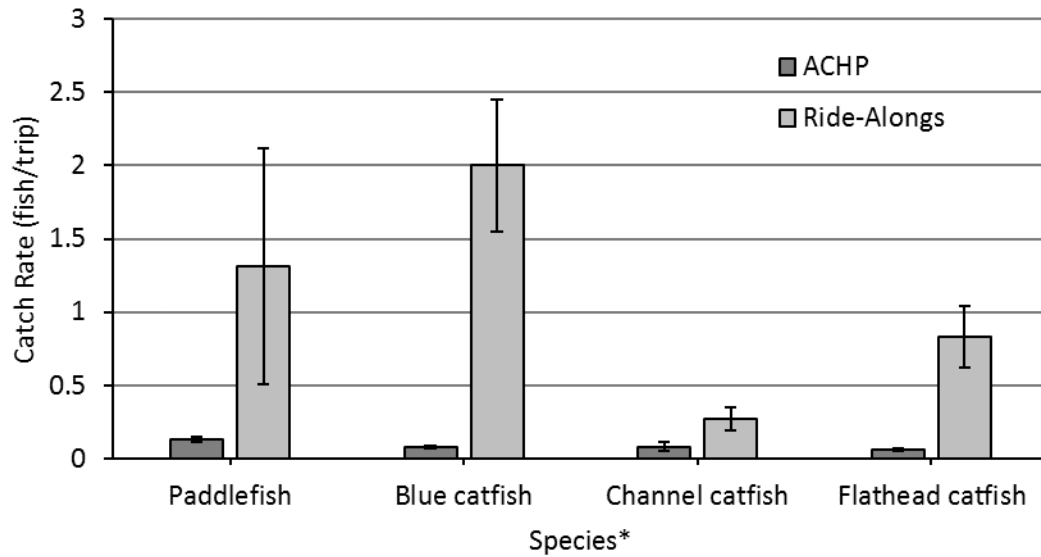


Figure 20. Comparison of catch rates (fish/trip) for some recreationally and commercially important species reported as bycatch by commercial fishers and through KDFWR ride-alongs with commercial fishers using the Asian Carp Harvest Program. Error bars represent standard error values.

*Some commercial fishers do not report catfish to species, therefore, this graph only utilizes catfish that were identified to species.

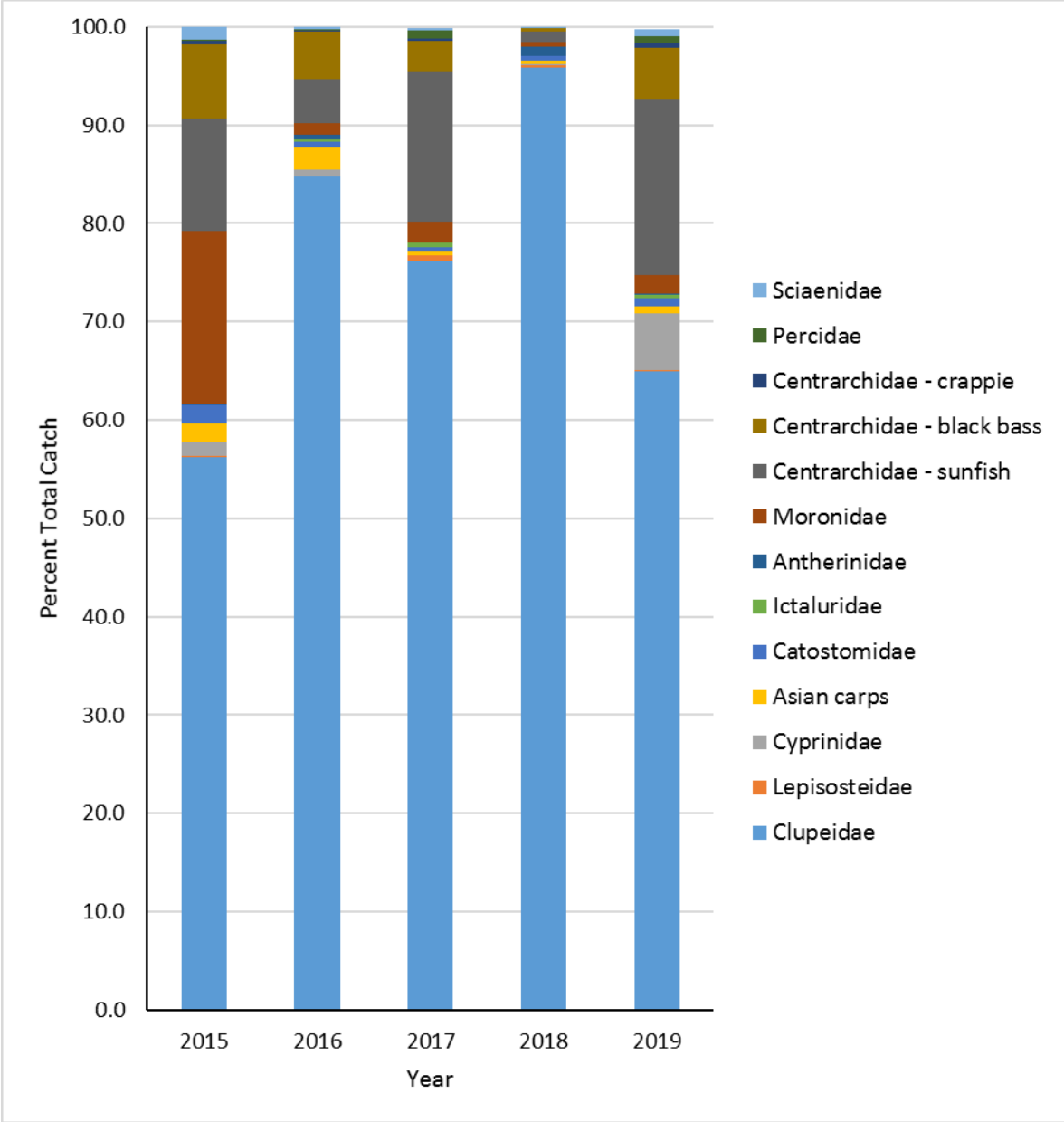


Figure 21. Comparison of percent total catch by number of each family identified from fall community sampling via electrofishing in the Kentucky Tailwater 2015-2019.

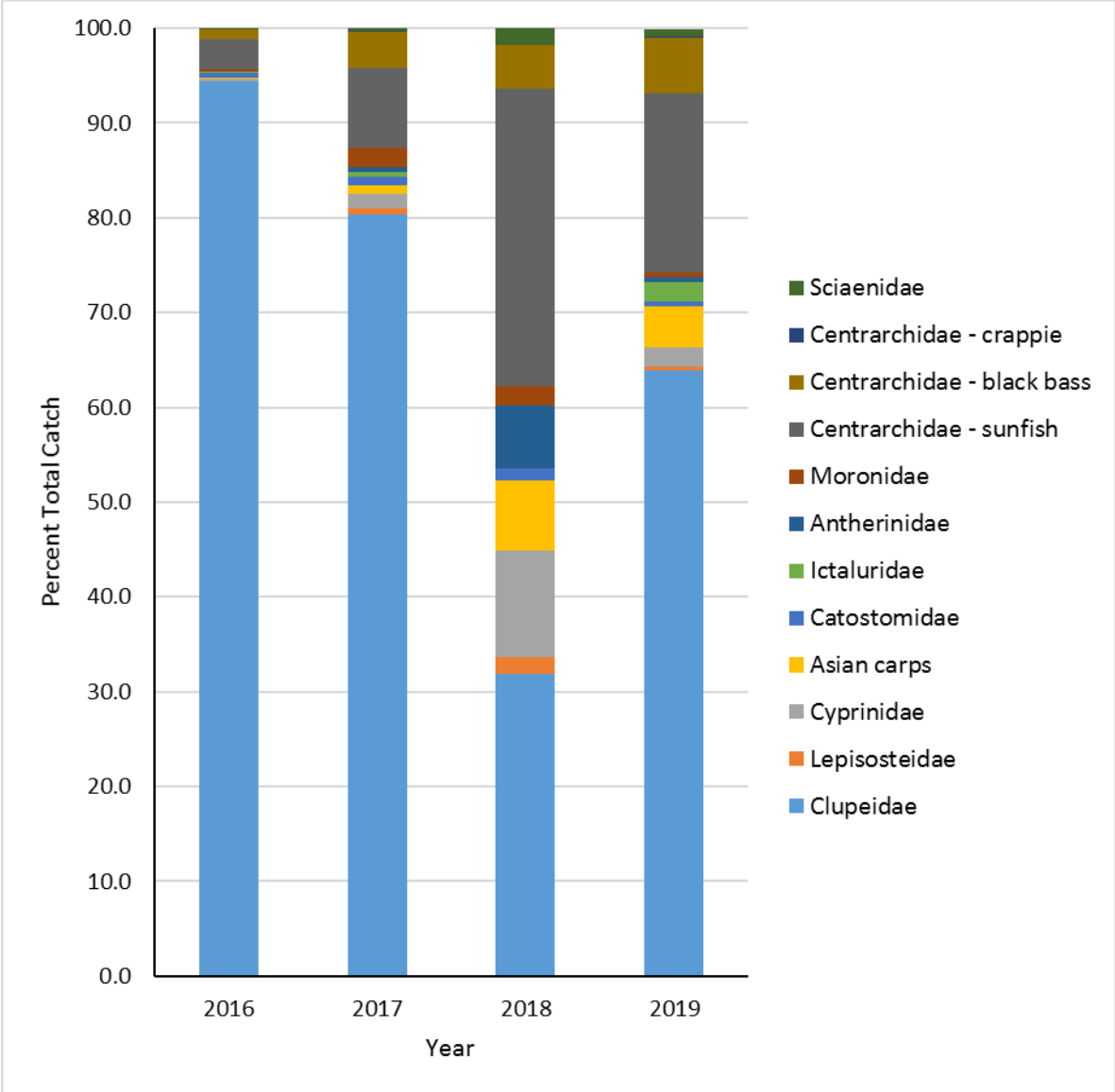


Figure 22. Comparison of percent total catch by number of each family identified from fall community sampling via electrofishing in the Barkley Tailwater 2016-2019.

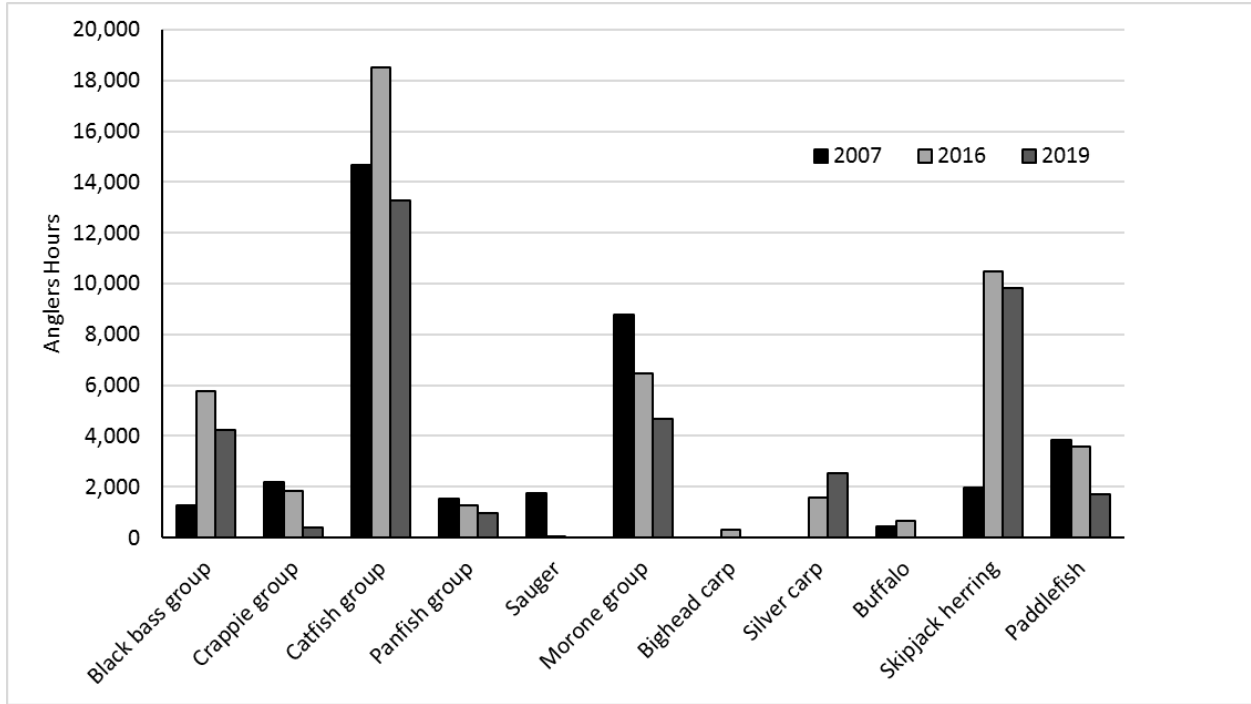


Figure 23. Total hours spent fishing for each species group in Kentucky Lake Tailwaters as estimated during creel surveys in 2007, 2016, and 2019.

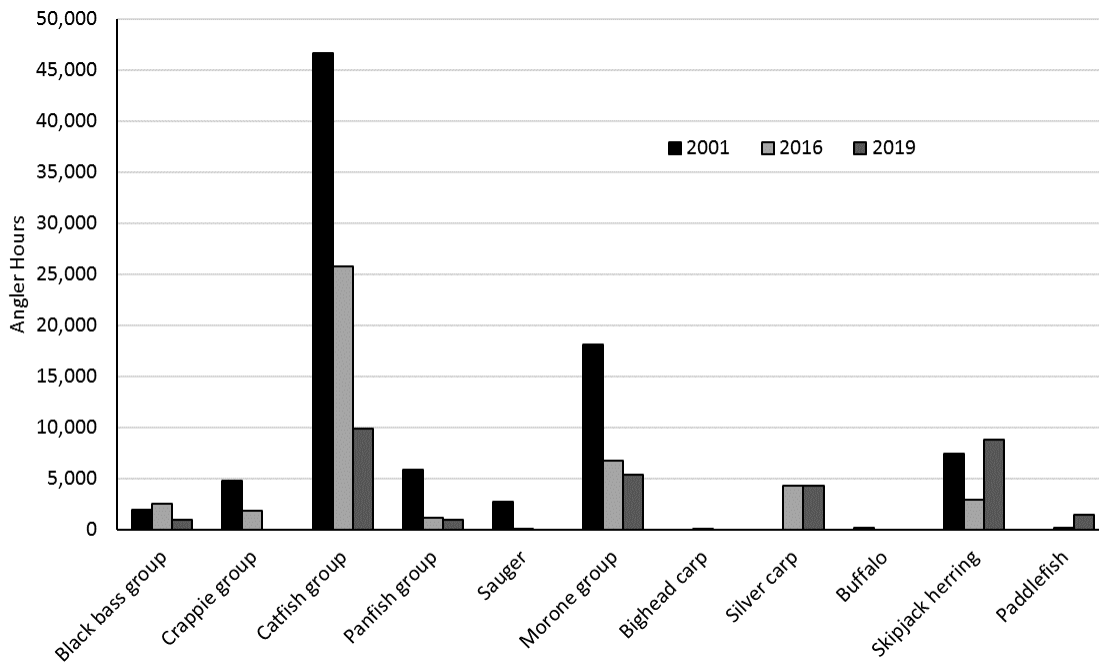


Figure 24. Total hours spent fishing for each species group in Lake Barkley Tailwaters as estimated during creel surveys in 2001, 2016, and 2019.

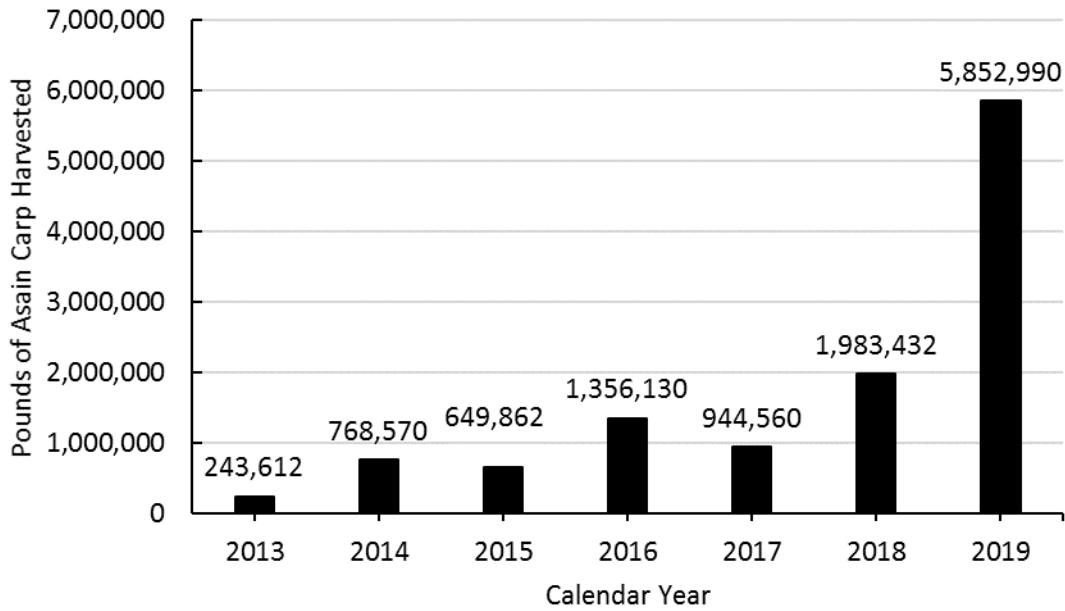


Figure 25. Pounds of bigheaded carp harvested through the KDFWR Asian Carp Harvest Program by calendar year 2013 - 2019.

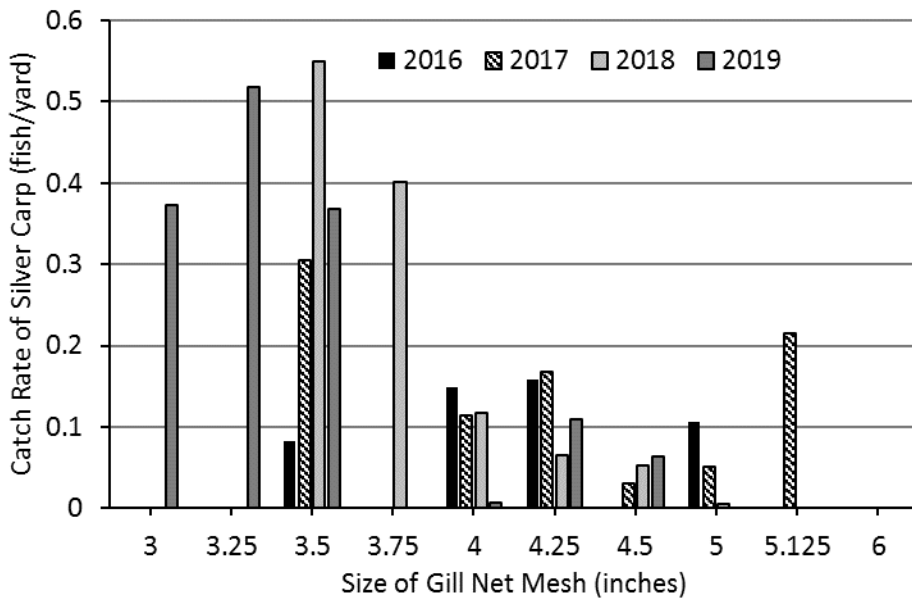


Figure 26. Catch rates (number of fish / yard of net) of silver carp by gill net mesh size during ride-alongs with commercial fishers fishing under the Asian Carp Harvest Program.

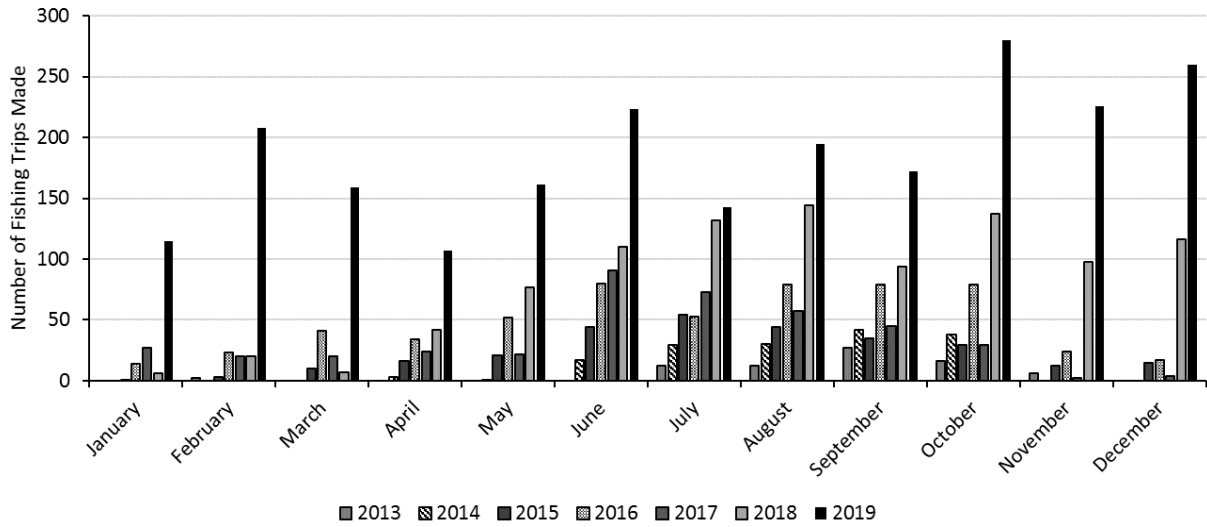


Figure 27. Number of fishing trips made monthly by commercial fishers fishing under the Asian Carp Harvest Program from January 2013 - December 2019.

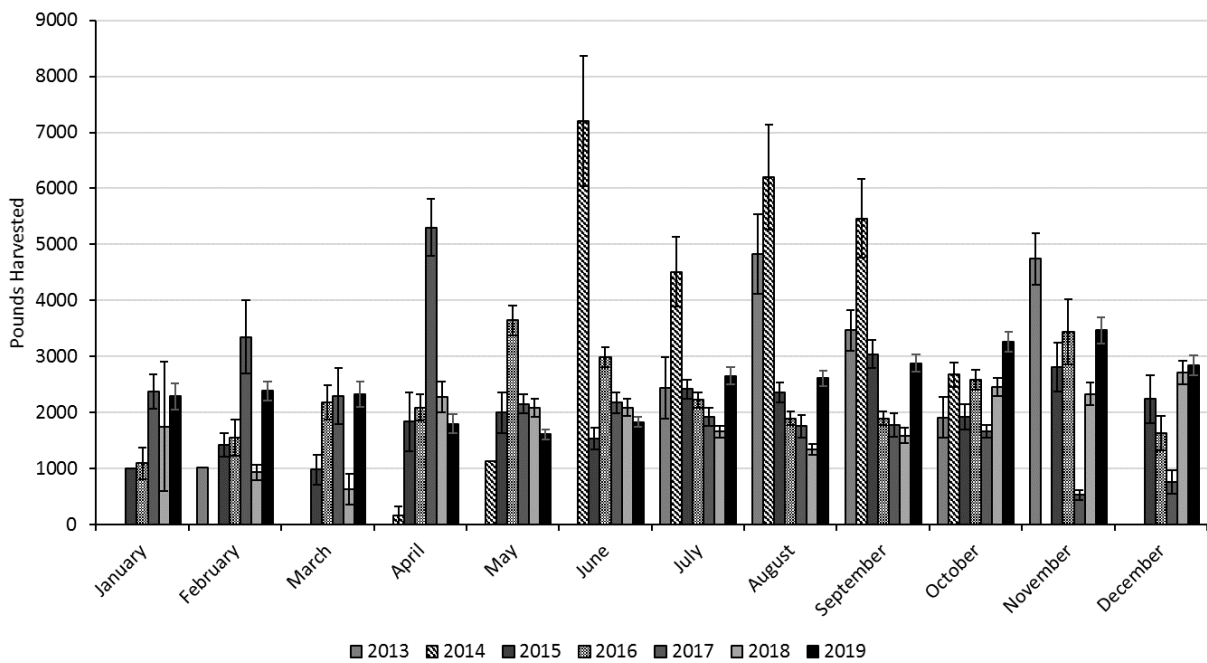


Figure 28. Monthly average total weight (lbs) of silver carp harvested per trip by commercial fishers fishing under the Asian Carp Harvest Program January 2013 - December 2019. Error bars represent standard error values.

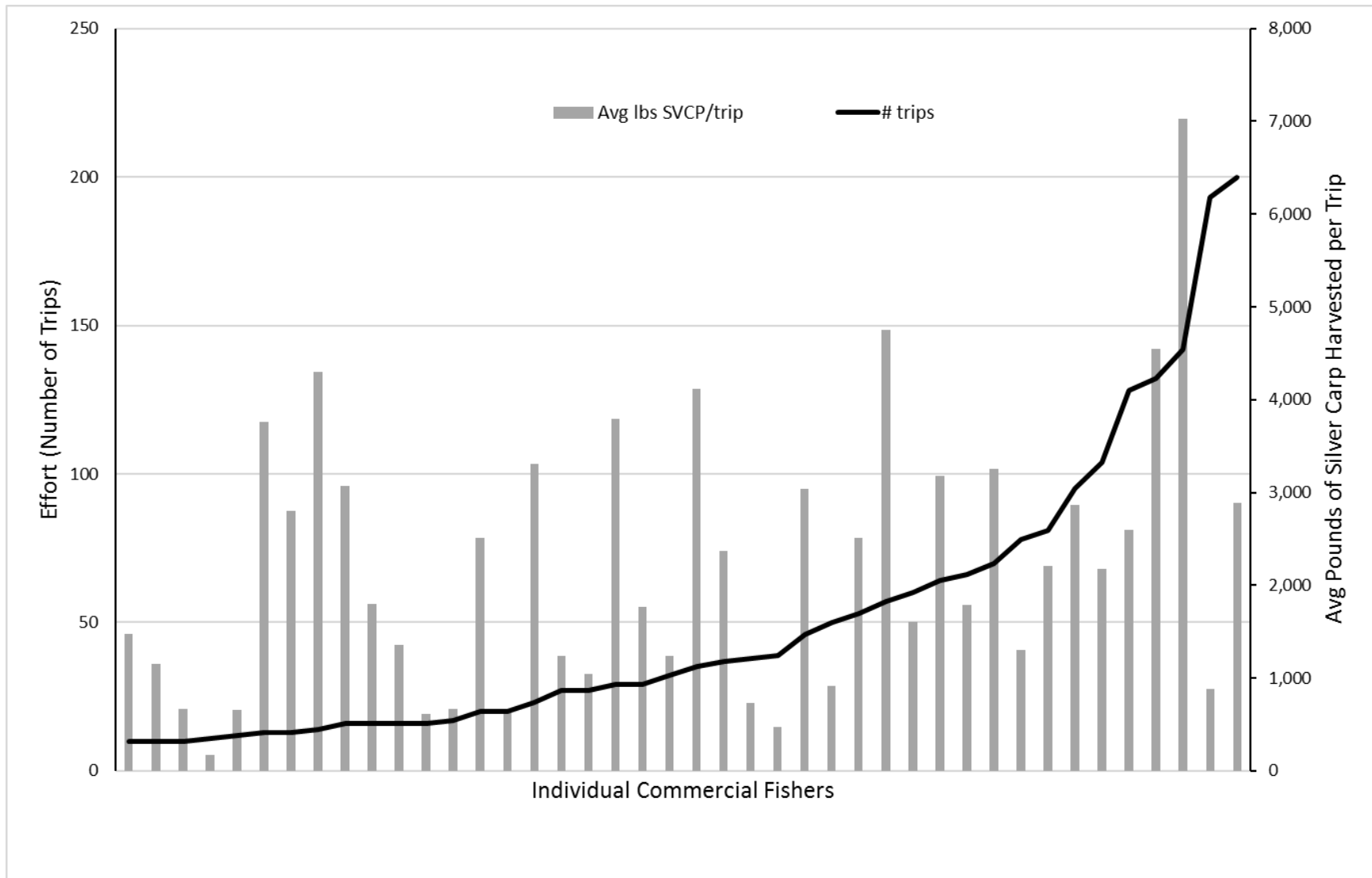


Figure 29. Average weight harvested per trip by individual commercial fishers compared to the number of trips taken by those fishers under the Asian Carp Harvest Program in 2019.

Table 1. The number of carp captured during each standard sampling period by reservoir in 2019.

Species Captured	Barkley Reservoir				Kentucky Reservoir			
	April	July	October	Totals	April	July	October	Totals
Bighead carp	3	4	2	9	4	12	1	17
Grass carp	0	0	1	1	1	0	4	5
Silver carp	74	64	48	186	109	81	61	251
Totals	77	68	51	196	114	93	66	273

Table 2. A summation of catch per unit effort (CPUE) for silver carp in Barkley and Kentucky reservoirs, by month and habitat type in 2019. 2018 values are included in parenthesis for comparison. CPUE reported in fish/linear yard of gill net.

	Site	Month	Bar mesh size			Mean Total CPUE
			3"	4"	5"	
Barkley Reservoir	Main Channel	April	0.062	0.013	0.002	0.026
		July	0.03 (.088)	0.024 (.024)	0.004 (0)	0.019 (.038)
		October	0.023 (.079)	0.011 (.008)	0 (0)	0.011 (.029)
	Embayment	April	0.032	0.028	0.002	0.021
		July	0.017 (.388)	0.041 (.069)	0.004 (.002)	0.021 (.153)
		October	0.023 (.208)	0.03 (.064)	0.004 (.004)	0.019 (.092)
Kentucky Reservoir	Main Channel	April	0.03	0	0.004	0.011
		July	0.004 (.313)	0.009 (.034)	0.002 (.004)	0.005 (.117)
		October	0.015 (.109)	0.006 (.019)	0 (0)	0.007 (.043)
	Embayment	April	0.167	0.002	0.002	0.057
		July	0.114 (.448)	0.021 (.088)	0.002 (.008)	0.046 (.181)
		October	0.081 (.72)	0.011 (.079)	0.002 (0)	0.031 (.266)

Table 3. A summation of estimated weights for silver carp at three lengths from Barkley and Kentucky reservoirs in 2019, compared to previous estimate reported in 2018.

Reservoir	Year	Predicted weight (g) at 450mm	Predicted weight (g) at 650mm	Predicted weight (g) at 800mm
Barkley	2018	933	2789	5176
	2019	1076	2881	5024
Kentucky	2018	950	2733	4963
	2019	930	2720	4987

Table 4. Average length and weight of silver carp harvested during ride-alongs with commercial fishers under the Asian Carp Harvest Program 2015-2019.

Year	Number Sampled	Average total length of silver carp (inches)	Average weight of individual silver carp harvested	S. E.
2015	206	33.2	15.2	0.12
2016	448	34.5	17.7	0.10
2017	416	34.0	16.1	0.10
2018	387	31.0	11.6	0.10
2019	802	28.1	8.4	0.04

Table 5. Number of bighead carp and silver carp captured by gill net mesh size as observed during KDFWR ride-alongs with commercial fishers fishing under the Asian Carp Harvest Program 2016 - 2019. (CPUE = catch per unit effort)

Year	Net Bar Mesh Size (inches)	Effort (yards)	Number of Silver carp	Silver carp CPUE (fish/yard)	Number of Bighead carp	Number of Grass carp
2016	3.5	1883	155	0.08		17
	4	2067	308	0.15		1
	4.25	9300	1469	0.16	8	12
	5	16983	1811	0.11	44	13
	6	1067	3	0.00		
2017	3.5	200	61	0.31	4	1
	4	1983	225	0.11	1	1
	4.25	23400	3918	0.17	19	31
	4.5	2283	68	0.03		
	5	4125	212	0.05	3	1
	5.125	400	86	0.22	4	2
2018	3.5	6883	3778	0.55	8	24
	3.75	167	67	0.40		
	4	3250	381	0.12	4	3
	4.25	14100	920	0.07	54	8
	4.5	2767	145	0.05	4	
	5	867	5	0.01	1	
2019	3	2967	1106	0.37	2	5
	3.25	9600	4979	0.52	10	83
	3.5	39300	14483	0.37	30	177
	4	300	2	0.01	0	0
	4.25	3700	406	0.11	18	3
	4.5	2567	162	0.06	5	1
	5	67	0	0.00	0	0

Table 6. The number of fish captured by species and percent of total by-catch during standard sampling with gill nets from Barkley reservoir in 2018 and 2019.

Species Captured	April(19)	July(19)	October(19)	Totals	Percent %
Bigmouth buffalo	0	1	0	1	0.5
Blue catfish	15	12	16	43	21.0
Channel catfish	0	1	1	2	1.0
Common carp	23	8	18	49	23.9
Flathead catfish	2	3	2	7	3.4
Freshwater drum	5	22	20	47	22.9
Lake sturgeon	2	0	0	2	1.0
Largemouth bass	0	0	1	1	0.5
Longnose gar	0	0	1	1	0.5
Paddlefish	3	6	0	9	4.4
Redear sunfish	0	0	1	1	0.5
River carpsucker	1	2	2	5	2.4
Shortnose gar	0	2	0	2	1.0
Skipjack herring	0	1	1	2	1.0
Smallmouth buffalo	4	14	13	31	15.1
Striped bass	1	0	0	1	0.5
Yellow bass	0	1	0	1	0.5
Totals	56	73	76	205	

Species Captured	April(18)	July(18)	October(18)	Totals	Percent %
Bigmouth buffalo		4	2	6	2.5
Black buffalo		6	3	9	3.8
Blue catfish		10	14	24	10.0
Channel catfish		1	1	2	0.8
Common carp		9	13	22	9.2
Flathead catfish		3	4	7	2.9
Freshwater drum		41	21	62	25.9
Gizzard shad		1	0	1	0.4
Largemouth bass		1	1	2	0.8
Paddlefish		4	1	5	2.1
Redear sunfish		0	1	1	0.4
River carpsucker		3	3	6	2.5
Skipjack herring		2	4	6	2.5
Smallmouth buffalo		64	19	83	34.7
White crappie		1	0	1	0.4
Yellow bass		0	2	2	0.8

Totals	150	89	239
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Table 7. The number of fish captured by species and percent of total by-catch during standard sampling with gill nets from Kentucky reservoir in 2018 and 2019.

Species Captured	April(19)	July(19)	October(19)	Totals	Percent %
Bigmouth buffalo	0	2	1	3	1.2
Black Buffalo	0	2	0	2	0.8
Blue catfish	20	11	4	35	13.7
Channel catfish	2	1	2	5	2.0
Common carp	7	3	4	14	5.5
Flathead catfish	5	1	5	11	4.3
Freshwater drum	6	46	16	68	26.7
Largemouth bass	3	0	2	5	2.0
Longnose gar	2	1	0	3	1.2
Paddlefish	0	1	0	1	0.4
River carpsucker	2	9	7	18	7.1
Shortnose gar	0	1	0	1	0.4
Skipjack herring	0	1	0	1	0.4
Smallmouth buffalo	2	33	50	85	33.3
Striped bass	2	0	0	2	0.8
White crappie	1	0	0	1	0.4
Totals	52	112	91	255	

Species Captured	April(18)	July(18)	October(18)	Totals	Percent %
Bigmouth buffalo		2	3	5	1.3
Black buffalo		5	3	8	2.1
Blue catfish		12	9	21	5.4
Channel catfish		3	4	7	1.8
Common carp		13	13	26	6.7
Flathead catfish		5	4	9	2.3
Freshwater drum		93	39	132	34.2
Largemouth bass		1	1	2	0.5
Paddlefish		4	1	5	1.3
River carpsucker		6	14	20	5.2
Skipjack herring		0	3	3	0.8
Smallmouth buffalo		75	73	148	38.3
Totals		219	167	386	

Table 8. Gizzard shad relative weight (W_r) values collected with boat electrofishing and Paupier net sampling during October in Barkley and Kentucky reservoirs.

Reservoir	Species	Year	W_r	Sample Size	Standard Error
Barkley	Gizzard Shad	2017	87	125	1.9
		2018	92	35	3.1
		2019	94	69	1
Kentucky	Gizzard Shad	2017	82	155	1.6
		2018	103	268	1.7
		2019	92	405	0.6

Table 9. Measures of effort and catch reported by commercial fishers fishing under the Asian Carp Harvest Program by calendar year, January -December 2013 - 2019.

Water Body	Year	Number of Days/Trips	Number of fishermen	Weight silver carp harvested (lbs)	Weight bighead carp harvested (lbs)	Number of grass carp harvested
Lake Barkley	2013	45	5	187,022		
	2014	61	6	464,003	1,360	
	2015	189	12	472,487	10,278	55
	2016	447	22	1,112,585	5,693	285
	2017	345	15	826,016	9,669	196
	2018*	835	23	1,762,830	25,932	2,037
	2019*	1,846	60	5,318,535	45,665	6,900
Kentucky Lake	2013	21	4	26,400	491	7
	2014	82	3	193,786	992	3
	2015	59	6	84,190	17,791	81
	2016	52	8	96,652	2,884	114
	2017	54	8	71,487	11,754	7
	2018*	116	8	143,996	11,537	56
	2019*	140	28	233,806	1,978	996
Ohio River	2013					
	2014	11	1	74,879		
	2015	16	3	26,864	1,206	14
	2016	30	5	90,012	3,216	179
	2017	8	4	11,217	713	16
	2018	21	4	37,553	70	14
	2019	129	9	142,520	521	
Statewide**	2013	76	7	243,121	491	9
	2014	160	9	765,768	2,802	3
	2015	283	16	617,062	32,800	178
	2016	565	24	1,343,464	12,666	639
	2017	414	21	921,288	23,272	232
	2018*	982	29	1,945,693	37,739	2,110
	2019*	2,250	66	5,802,624	50,366	8,879

*In 2018 KDFWR began allowing commercial fishermen to receive subsidy funds from the Asian Carp Harvest Program while fishing on their net permit, which allows them to harvest catfish and paddlefish. Commercial fishing effort from net permit holders that received subsidy funds is included in this table for 2018 and 2019.

**Effort and harvest occurs under the ACHP in other water bodies to a lesser degree and is included in the statewide totals.

Table 10. Number and disposition of bycatch from commercial fishing efforts under the Asian Carp Harvest Program by calendar year, January - December. Survival rate is defined as fish that swam away upon being released from the net. Harvest of scaled rough fish is permitted under the Asian Carp Harvest Program.

Year	Sport Fish*		Scaled Rough Fish**		Catfish Species		Paddlefish		Total number of bycatch
	Number Caught	Survival Rate %	Number Caught	% Harvested	Number Caught	Survival Rate %***	Number Caught	Survival Rate %***	
2013	29	100.0	7,132	93.7	100	97.0	305	90.5	7,566
2014	78	92.3	4,505	75.1	128	99.2	120	65.0	4,831
2015	97	89.7	7,462	80.5	719	95.0	980	65.0	9,258
2016	115	75.7	10,811	76.1	719	95.5	573	68.2	12,218
2017	25	92.0	9,565	91.8	541	95.7	314	75.5	10,445
2018	46	71.7	25,703	86.1	1201	98.3	200	85.5	27,150
2019	171	93.6	32,861	80.7	1512	98.7	296	80.7	34,841

*Sport fish are defined in 301KAR 1:060

**Scaled Rough fish are defined in 301 KAR 1:152

***In 2018 KDFWR began allowing commercial fishermen to receive subsidy funds from the Asian Carp Harvest Program while fishing on their net permit, which allows them to harvest catfish and paddlefish. Therefore, the survival rates for 2018 and 2019 only account for fish that were dead or alive upon release and not those that were harvested.

Table 11. Comparison for number of paddlefish, catfish, and sport fish caught per trip as reported by commercial fishers fishing under the Asian Carp Harvest Program versus observations made by KDFWR staff during ride-alongs in 2015-2019. (S.E. = standard error).

Species	2015				2016				2017				2018				2019			
	ACHP	S.E.	Ride-alongs	S.E.	ACHP	S.E.	Ride-alongs	S.E.	ACHP	S.E.	Ride-alongs	S.E.	ACHP	S.E.	Ride-alongs	S.E.	ACHP	S.E.	Ride-alongs	S.E.
Paddlefish	3.46	0.52	13.88	5.31	1.02	0.08	2.96	0.60	0.90	0.12	2.00	0.95	0.22	0.03	1.54	0.53	0.13	0.02	1.31	0.80
Blue catfish	1.32	0.25	2.09	0.63	0.74	0.06	1.21	0.28	0.63	0.08	1.52	0.33	0.47	0.04	1.75	0.37	0.08	0.01	2.00	0.45
Channel catfish	0.24	0.05	0.81	0.19	0.08	0.02	0.36	0.16	0.06	0.02	0.55	0.20	0.09	0.01	0.50	0.13	0.08	0.03	0.27	0.08
Flathead catfish	0.69	0.08	0.66	0.18	0.38	0.04	0.39	0.17	0.41	0.06	0.61	0.19	0.14	0.02	0.33	0.13	0.06	0.01	0.83	0.21
Catfish*	0.30	0.05			0.07	0.02			0.17	0.05			0.23	0.04			0.21	0.03		
Largemouth bass	0.05	0.20	0.22	0.12	0.08	0.70	0.04	0.04	0.01	<0.01	0.16	0.06	0.01	<0.01	0.08	0.06	0.02	0.01	0.52	0.24
Smallmouth bass					<0.01												<0.01	<0.01	0.08	0.05
Spotted bass					<0.01		0.04	0.04												
Bass**	0.13	0.05			0.02	0.02			0.02	0.01			0.01	<0.01			0.02	0.01		
Hybrid striped bass					<0.01		0.07	0.05					<0.01	<0.01	0.04	0.04	<0.01	<0.01	0.10	0.05
Striped bass	0.08	0.03	0.13	0.06	0.12	0.03	0.68	0.37	0.02	<0.01	0.03	0.03	0.01	<0.01	0.08	0.06	0.01	0.01	0.10	0.05
Yellow bass	0.01	0.01	0.09	0.70	0.04	0.02	0.71	0.45	<0.01	<0.01	0.03	0.03	0.01	<0.01	0.25	0.15	<0.01	<0.01	0.08	0.07
White bass	0.01	0.01	0.06	0.06	<0.01		0.07	0.05									<0.01	<0.01	0.02	0.02
Sauger	0.03	0.02			<0.01		0.04	0.04	<0.01	<0.01	0.06	0.04	<0.01	<0.01	0.13	0.70	<0.01	<0.01	0.08	0.07
Crappie	0.03	0.01			0.01	0.01					0.03	0.03	0.01	0.01	0.29	0.21	<0.01	<0.01	0.06	0.05
Redear sunfish	<0.01		0.03	0.03	0.01		0.04	0.04	<0.01	<0.01			<0.01	<0.01	0.04	0.04	<0.01	<0.01	0.13	0.07

*Commercial fishers do not always delineate species of catfish on their reports, therefore this row accounts for those catfish that were not identified species

**Commercial fishers do not always delineate what species of black bass they catch, therefore this row accounts for black bass that were not identified to species

Table 12. Species composition, number of individuals captured, and survival rate of species observed in bycatch during KDFWR ride-alongs with commercial fishers fishing under the Asian Carp Harvest Program in 2016 - 2019. Survival rate of fish is defined as fish that swim away after release.

Species	2016		2017		2018		2019	
	Number captured	Survival rate	Number captured	Survival rate	Number captured	Survival rate	Number captured	Survival rate
White bass	1	<1%					1	100%
Yellow bass	20	50%	1	100%	6	33%	4	75%
Striped bass	19	79%	1	100%	3	33%	5	80%
Hybrid striped bass	2	100%			1	100%	5	80%
Sauger	1	<1%	2	100%	3	33%	4	75%
Sport Fish	1	100%						
Spotted bass	1	100%						
Largemouth bass	1	100%	5	80%	3	67%	25	80%
Smallmouth bass							4	100%
Redear sunfish	1	100%			2	50%	6	83%
Black crappie					5	50%	1	100%
White crappie			1	100%	6	67%	2	50%
Total	46	88%	10	96%	29	54%	57	82%
Catfish species								
Blue catfish	27	74%	47	94%	42	91%	96	95%
Channel catfish	10	80%	17	82%	12	100%	13	100%
Flathead catfish	9	89%	19	100%	8	88%	40	100%
Total	46	81%	83	92%	62	93%	149	98%
Paddlefish	83	48%	62	48%	38	32%	63	48%
Lake sturgeon					1	100%		
Skipjack herring	23	17%	47	13%	18	<1%	79	<1%
Smallmouth buffalo	145	99%	13	85%	98	100%	186	98%
Bigmouth buffalo	8	100%	4	100%	7	100%	34	97%
Black buffalo	17	94%			2	100%	4	100%
Common carp	48	98%	33	94%	27	100%	479	84%
Gizzard shad	5	<1%	3	33%			3	<1%
Rough Fish*	76	67%	27	52%	73	71%	71	63%
Freshwater drum								
River carpsucker	3	100%					35	97%
Mooneye	3	<1%						
Chestnut lamprey	1	<1%						
Threadfin shad	1	<1%						
Blue sucker	49	80%					2	100%
Spotted gar					2	50%	3	100%
Longnose gar	8	88%	9	44%			9	67%
Shortnose gar	9	44%	1	100%	2	50%	11	55%
Total	571	77%	365	72%	392	83%	1277	87%

* Rough fish capture numbers only include fish that were released and does not include fish that were harvested.

Table 13. Number and survival rate of paddlefish captured by commercial fishers during KDFWR ride-alongs under the Asian Carp Harvest Program for each month paddlefish were observed caught in 2016 - 2019.

Year	Month	Number paddlefish captured	% released alive	Mean water temp (°F)	Mean soak time (hours)
2016	March	4	50.0%	54.4	
	April	15	66.7%	62.5	
	May	9	55.6%	69.4	
	June	44	45.5%	81.9	
	July	2	0.0%	81.5	
	August	1	100.0%	81.5	
	September	8	62.5%	80.5	
2017	April	6	0.0%	67.6	13.0
	May	15	33.3%	68.5	10.0
	June	35	60.0%	79.5	8.3
	September	2	50.0%	74	10.0
	December	4	75%	50	21.3
2018	April	4	75.0%	54.9	11.0
	May	9	60.0%	66.1	10.2
	June	12	35.0%	81.7	10.6
	August	12	0.0%	82.9	11.6
2019	February	43	60.5%	46.9	11.4
	March	1	0.0%	49.8	11
	April	3	33.3%	60.25	9.7
	May	7	14.3%	74	6.4
	June	4	0.0%	76.9	11.3
	August	2	0.0%	84.1	8.8
	October	3	66.7%	69.8	8.2

Table 14. Length frequency and CPUE (fish/hr) for select species of fish collected during 3.75 hours of electrofishing at Kentucky Tailwater in fall of 2019. (CPUE = catch per unit effort; S. E. = standard error)

Species	Inch Class																				TOTAL	CPUE (fish/hr)	S. E.		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				21	>22
Skipjack herring*			1739	171	1																		1911	510	200.3
Gizzard shad*			81	285	329	50	43	38	27	21	9	8	6	3									900	240	92.1
Threadfin shad			36	66																			102	27	14.9
Grass carp												4	13	4	2								23	6	2.8
Silver carp																2	1	6	1	2	1	2	15	4	2.0
Smallmouth bufflao			1	16	5	4						2	1									29	8	3.0	
Black buffalo																						2	2	1	0.4
Blue catfish																					1	1	0	0.3	
Channel catfish																					1	1	0	0.3	
Flathead catfish				1		1			1		3		1	2		1						1	11	3	1.4
White bass			4	1	2	2	2	2			1	1											15	4	1.9
Yellow bass		16	24	10	4	6	2	7															69	18	7.8
Bluegill*	1	31	106	238	94	6	1															477	127	48.8	
Longear sunfish*	3	34	137	59	17																	250	66.67	15.43	
Redear sunfish		2	14	8	23	7		1			1											56	15	3.9	
Smallmouth bass		7	32	32	23	12			1	2	1											110	29	12.3	
Spotted bass			6	5									1									12	3	1.4	
Largemouth bass			16	26	10	9	7	4	6	1	3	4	1	5	4	6		4	2		1	109	29	6.2	
White crappie		5	4		2	1							1									13	3	1.9	
Black crappie		3	6																			9	2	1.5	
Freshwater drum			4	10	4	2						1		1		2	1	1	1		3	30	8	2.5	

* species were randomly subsampled

Table 15. Comparison of fall electrofishing CPUE for selected species collected at Kentucky Tailwater in 2015 (effort = 1.0 hours), 2016 (effort = 1.75 hours), 2017 (effort = 4.5 hours), 2018 (effort = 1.25 hours), and 2019 (effort = 3.75 hours). (CPUE=catch per unit effort; S.E.=standard error)

Species	2015		2016		2017		2018		2019	
	CPUE (fish/hr)	S.E.	CPUE (fish/hr)	S.E.	CPUE (fish/hr)	S.E.	CPUE (fish/hr)	S.E.	CPUE (fish/hr)	S.E.
Skipjack herring	22	8.4	1	0.6	18	9.5	2	1.6	510	200.3
Gizzard shad	275	58.6	184	78.0	163	61.1	22	10.2	240	92.1
Threadfin shad	251	176.3	1690	1251.0	1263	637.0	2557	1845.1	27	14.9
Grass carp	13	1.9	6	2.5	2	0.7			6	2.8
Silver carp	6	2.6	44	22.4	4	1.6	9	6.9	4	2.0
Smallmouth buffak	10	2.6	9	3.7	5	2.1	1	0.8	8	3.0
Bigmouth buffalo					1	0.4	2	1.0		
Black buffalo	6	2.0	3	1.9	< 1	0.2			1	0.4
Blue catfish					< 1	0.2			< 1	0.3
Channel catfish			1	0.6	1	0.9			< 1	0.3
Flathead catfish			4	1.2	4	1.4			3	1.4
White bass	8	4.3	7	4.0	< 1	0.3	6	5.6	4	1.9
Yellow bass	162	83.5	17	13.3	26	4.1	7	4.3	18	7.8
Striped bass					2	1.0	2	1.0		
Bluegill	96	29.2	41	11.8	128	30.7	20	4.0	127	48.8
Longear sunfish	14	14.0	48	12.0	80	25.0	7	4.8	67	15.4
Redear sunfish	1	1.0	6	2.3	6	1.6			15	3.9
Smallmouth bass	9	2.5	21	5.2	11	3.2	2	1.0	29	12.3
Spotted bass	1	1.0	1	0.6	3	1.4	1	0.8	3	1.4
Largemouth bass	62	19.8	86	9.4	35	4.3	7	2.9	29	6.2
White crappie	2	2.0	1	0.7	1	0.4			3	1.9
Black crappie	2	2.0	1	0.6	3	1.7			2	1.5
Sauger	1	1.0			1	0.4				
Freshwater drum	13	5.7	6	1.5	4	0.7	4	2.2	8	2.5
White bass /										
Striped bass	1	1.0	1	1.1	1	0.5				

Table 16. Comparison of fall electrofishing CPUE for selected species collected at Barkley Tailwater in 2016 (effort = 1.99 hours), 2017 (effort = 3.0 hours), 2018 (effort = 1.0 hour), and 2019 (effort = 3.0 hours). (CPUE=catch per unit effort; S.E.=standard error)

Species	2016		2017		2018		2019	
	CPUE (fish/hr)	S.E.	CPUE (fish/hr)	S.E.	CPUE (fish/hr)	S.E.	CPUE (fish/hr)	S.E.
Skipjack herring	< 1	0.5	8	2.9	35	18.0	324	158.4
Gizzard shad	209	52.4	104	18.2	23	8.1	362	224.8
Threadfin shad	4598	1818.7	1252	602.1	67	12.8	30	18.8
Grass carp	5	2.6	1	0.5			6	1.7
Silver carp	4	2.0	14	7.7	29	17.2	42	33.4
Smallmouth buffalac	15	7.6	10	2.7	1	1.0	5	3.2
Bigmouth buffalo	1	0.9	< 1	0.3	1	1.0		
Black buffalo			1	0.7				
Channel catfish	< 1	0.4	1	0.5				
Flathead catfish	8	3.6	6	3.1			22	5.9
White bass	7	3.9	3	1.1	3	3.0	1	0.7
Yellow bass	2	0.7	28	16.0			4	3.0
Striped bass	1	0.9	2	1.4	1	1.0	< 1	0.3
Bluegill	46	15.3	56	14.6	70	14.5	50	13.2
Longear sunfish	102	25.0	83	16.8	46	25.4	153	30.5
Redear sunfish	8	2.1	3	1.2	2	1.2	3	1.2
Smallmouth bass	7	2.3	9	1.2	4	1.6	29	7.2
Spotted bass	2	1.0	< 1	0.3	1	1.0	7	2.0
Largemouth bass	48	8.0	55	10.3	13	5.0	30	8.1
White crappie	4	1.5	1	0.7			< 1	0.3
Black crappie			2	1.3			< 1	0.3
Freshwater drum			5	1.5	7	4.7	9	3.4
White bass / Striped bass	< 1	0.4	3	2.3	4	4.0		

Table 17. Length frequency and CPUE (fish/hr) for select species of fish collected during 3.0 hours of electrofishing at Barkley Tailwater in fall of 2019. (CPUE = catch per unit effort; S. E. = standard error)

Species	Inch Class																											TOTAL	CPUE (fish/hr)	S. E.	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27				>28
Skipjack herring*			793	165	13																								971	324	158.4
Gizzard shad*			117	788	102	29	26	12	4	2	3	2	1																1086	362	224.8
Threadfin shad		6	68	15																									89	30	18.8
Grass carp												3	6	6	2														17	6	1.7
Silver carp															2	4	10	6	4	2	3	17	24	15	16	15	8	126	42	33.4	
Smallmouth buffalo				2	2	1									2	4	3	1	1									16	5	3.2	
Flathead catfish			1		1	9	11	9	13	8	3	3	4		1	1	1		1						1			67	22	5.9	
White bass						1								1	1													3	1	0.7	
Yellow bass			1				5	6																				12	4	3.0	
Striped bass																												1	0	0.3	
Bluegill	1	10	10	55	51	20	2																					149	50	13.2	
Longear sunfish	1	139	120	145	51	3																						459	153	30.47	
Redear sunfish				4	6																							10	3	1.2	
Smallmouth bass			12	23	22	8	5	1	3	5	4	1		1		1		1										87	29	7.2	
Spotted bass				11	6	1	2			1																		21	7	2.0	
Largemouth bass			2	3	6	7	14	7	7	4	10	5	4	7	1	4		3	5		1							90	30	8.1	
White crappie							1																					1	0	0.3	
Black crappie											1																	1	0	0.3	
Freshwater drum								1					1	2	2	1	7	4	1	6	1	1						27	9	3.4	

* species were randomly subsampled

Table 18. Mean relative weight (Wr) and standard error for a subsample of fish collected during fall electrofishing at Kentucky Tailwater in 2015 - 2019. (S.E. = standard error)

Species	2015			2016			2017			2018			2019		
	N	Mean	Wr S.E.	N	Mean	Wr S.E.	N	Mean	Wr S.E.	N	Mean	Wr S.E.	N	Mean	Wr S.E.
Gizzard shad	19	76	2.5	45	72	1.6	215	83	0.7	21	77	2.0	152	85	0.5
Blue catfish							1	108					1	99	
Channel catfish				1	102		1	105					1	100	
Flathead catfish				7	98	6.2	19	100	6.3				11	99	6.2
Yellow bass	29	74	1.2	29	84	1.8	104	83	2.2	7	90	12.3	33	80	4.6
White bass	7	92	4.1	13	99	2.6	2	97	20.4	7	108	1.3	8	90	3.3
Striped bass										1	101				
White bass / Striped bass hybrid				2	81	7.5									
Bluegill	69	88	1.7	49	103	3.7	220	93	2.2	18	89	6.4	148	94	0.8
Redear sunfish	1	98	0.0	10	85	6.9	28	93	3.3				42	97	2.3
Smallmouth bass	6	93	3.1	13	91	2.0	9	92	3.4	1	82		4	92	5.5
Spotted bass	1	103	0.0	1	123		6	109	3.1				1	117	
Largemouth bass	42	102	3.2	89	102	1.7	117	97	1.9	7	93	5.5	41	99	1.7
White crappie	2	79	0.9	2	90	8.7	3	76	7.3				4	84	3.0
Black crappie	1	91	0.0				12	90	2.7						
Sauger	1	87	0.0				3	97	21.8						
Freshwater drum	12	91	5.4	11	100	2.7	17	92	3.3	5	89	3.8	21	92	2.9
Smallmouth buffalo	10	76	2.9	15	79	1.5	22	77	1.4	1	78		29	100	3.2
Bigmouth buffalo							3	86	1	2	75	7.4			
Silver carp	6	84	2.3	75	89	1.6	19	82	2.4	11	73	3.2	15	81	1.2

Table 19. Mean relative weight (Wr) and standard error for a subsample of fish collected during fall electrofishing at Barkley Tailwater in 2016 - 2018. (S.E. = standard error)

Species	2016			2017			2018			2019		
	N	Mean	Wr S.E.	N	Mean	Wr S.E.	N	Mean	Wr S.E.	N	Mean	Wr S.E.
Gizzard shad	96	70	1.6	176	80	0.9	18	75	2.5	45	91	1.2
Channel catfish	1	67		2	92	1.0						
Flathead catfish	13	94	1.7	17	106	5.8				66	99	3.8
Yellow bass	2	88	8.7	73	79	1.3				11	87	4.5
White bass	11	96	3.7	8	86	2.2	3	98	4.9	3	85	7.7
Striped Bass				2	90	5.9				1	109	
White bass /												
Striped bass hybrid				9	89	2.7	4	103	4.6			
Bluegill	49	111	3.1	107	104	2.5	31	115	8.3	85	103	1.6
Redear sunfish	17	93	2.1	9	97	3.7	2	106	14.6	9	101	3.9
Smallmouth bass	4	86	3.6	11	95	3.8	3	87	5.6	22	92	2.5
Spotted bass	3	107	11.0				1	125		3	106	10.1
Largemouth bass	37	101	1.9	118	95	1.2	10	95	3.4	58	98	1.6
White crappie				3	88	6.6				1	92	
Black crappie				5	86	6.3				1	76	
Freshwater drum	6	84	4.4	14	97	3.0	7	82	3.5	27	103	2.3
Smallmouth buffalo	21	84	1.4	28	84	1.6	1	99		16	92	1.9
Bigmouth buffalo	2	88	4.0	1	79		1	84				
Silver carp	9	81	2.9	41	83	2.1	29	83	2.7	70	83	1.5

Table 20. Comparison of fall electrofishing CPUE for select sport fish species collected at Kentucky Tailwater in 2002, 2011, and 2019. Ammended from KDFWR 2003 and 2012. (CPUE=catch per unit effort; S.E.=standard error)

Species	2002		2011		2019	
	CPUE (fish/hr)	S.E.	CPUE (fish/hr)	S.E.	CPUE (fish/hr)	S.E.
Channel catfish	5	2.0	15	12.4	< 1	0.3
Flathead catfish	2	0.8	3	2.0	3	1.4
White bass	2	1.4	11	3.9	4	1.9
Yellow bass	<1	0.3	26	4.4	18	7.8
Bluegill			20	4.1	127	48.8
Longear sunfish			12	4.1	67	15.4
Redear sunfish			5	2.3	15	3.9
Smallmouth bass	6	1.3	5	1.2	29	12.3
Spotted bass			<1	0.3	3	1.4
Largemouth bass	17	3.7	85	16.1	29	6.2
White crappie	1	0.6	2	1.5	3	1.9
Black crappie	3	2.3	2	0.6	2	1.5
Sauger	3	2.3	1	0.5		
White bass /						
Striped bass hybrid			2	0.7		

Table 21. Comparison of fall electrofishing CPUE for select species collected at Barkley Tailwater in 2002, 2011, and 2019. Ammended from KDFWR 2003 and 2012. (CPUE=catch per unit effort; S.E.=standard error)

Species	2002		2011		2019	
	CPUE (fish/hr)	S.E.	CPUE (fish/hr)	S.E.	CPUE (fish/hr)	S.E.
Grass carp			<1	0.4	6	1.7
Silver carp			16	9.7	42	33.4
Smallmouth buffalo			<1	0.4	5	3.2
Black buffalo			4	2.6		
Blue catfish			1	0.8		
Channel catfish	1	0.4	3	1.5		
Flathead catfish	5	1.4	7	2.2	22	5.9
White bass	3	1.7	16	8.7	1	0.7
Yellow bass			2	1.1	4	3.0
Striped bass	1	0.4	4	2.7	< 1	0.3
Bluegill			53	13.3	50	13.2
Longear sunfish			38	11.4	153	30.5
Redear sunfish	1	0.9	2	1.1	3	1.2
Smallmouth bass	8	1.5	2	1.6	29	7.2
Spotted bass	6	2.3	1	0.5	7	2.0
Largemouth bass	11	2.9	72	22.8	30	8.1
Black crappie	1	0.4	4	3.1	< 1	0.3
Freshwater drum			6	1.9	9	3.4
White bass / Striped bass hybrid	1	0.9	2	1.9		

Table 22. Mean relative weight (W_r) and standard error for a subsample of fish collected during fall electrofishing at Kentucky Tailwater in 2002, 2011, and 2019. Ammended from KDFWR 2003 and 2012. (S.E. = standard error)

Species	2002			2011			2019		
	N	Mean W_r	S.E.	N	Mean W_r	S.E.	N	Mean W_r	S.E.
Channel catfish	16	94	3.8	59	104	1.8	1	100	
Flathead catfish	6	88	2.4				11	99	6.2
Yellow bass	1	78		102	94	4.6	33	80	4.6
White bass	7	91	2.9	36	104	4.3	8	90	3.3
Redear sunfish				15	98	2.9	42	97	2.3
Smallmouth bass	11	92	3.3	4	94	6.9	4	92	5.5
Largemouth bass	22	90	3.5	124	98	1.2	41	99	1.7
White crappie	3	109	2.4	8	92	4.1	4	84	3.0
Black crappie	10	94	3.1	9	111	10.8			
Sauger	11	83	3.8	3	78	6.1			

Table 23. Mean relative weight (*Wr*) and standard error for a subsample of fish collected during fall electrofishing at Barkley Tailwater in 2002, 2011, and 2019. Ammended from KDFWR 2003 and 2012. (S.E. = standard error)

Species	2002			2011			2019		
	N	Mean <i>Wr</i>	S.E.	N	Mean <i>Wr</i>	S.E.	N	Mean <i>Wr</i>	S.E.
Channel catfish	2	93	4.0	6	98	4.0			
Flathead catfish	15	95	2.8	18	96	2.2	66	99	3.8
Yellow bass				4	88	3.4	11	87	4.5
White bass	9	86	2.2	39	93	1.1	3	85	7.7
Striped Bass	2	81	2.7	9	93	1.9	1	109	
White bass/Striped bass hybrid	3	74	4.7	6	95	3.6			
Bluegill				112	104	1.2	85	103	1.6
Redear sunfish	3	100	10.4	5	92	1.2	9	101	3.9
Smallmouth bass	18	87	1.8	4	92	4.3	22	92	2.5
Spotted bass	7	102	3.7	3	106	11.7	3	106	10.1
Largemouth bass	22	94	3.0	145	95	1.4	58	98	1.6
White crappie							1	92	
Black crappie	2	100	7.1	9	98	2.1	1	76	

Table 24. Fishery statistics derived from a creel survey at Kentucky Tailwater (226 acres), February - November 2019.

Fishing Trips		
No. of fishing trips	20,347	
Trips/acre	90.3	
Fishing Pressure		
Total angler-hours (S.E.)	48,719	(972.3)
Angler-hours/acre	215.6	
Catch / Harvest		
No. of fish caught (S.E.)	131,015	(21,876.0)
No. of fish harvested (S.E.)	106,965	(21,391.7)
Lb of fish harvested	69,093	
Harvest Rates		
Fish/hour	2.6	
Fish/acre	519.8	
Pounds/acre	525.2	
Catch Rates		
Fish/hour	2.8	
Fish/acre	576.1	
Miscellaneous Characteristics (%)		
Male	89.3	
Female	10.7	
Resident	73.4	
Non-resident	21.6	
Method (%)		
Still fishing	37.5	
Casting	45.0	
Trolling	<1	
Drifting	0.0	
Snagging	7.0	
Bowfishing	10.3	
Dipping	<1	
Mode (%)		
Boat	21.0	
Bank	61.8	
Pier	17.2	

Table 25. Fish harvest statistics derived from a creel survey at Kentucky Tailwater (226 acres), February - November 2019.

	Black bass group	Largemouth bass	Smallmouth bass	Spotted bass	Illegal black bass	Crappie group	White crappie	Black crappie	Catfish group	Channel catfish	Flathead catfish	Blue catfish	Panfish group	Bluegill	Green Sunfish	Longear sunfish	Sauger	Freshwater drum
No. caught	2,627	1,966	560		0	128	29	99	11,873	2,365	421	9,086	3,284	3,094			0	1,232
(per acre)	(11.62)	(8.70)	(2.48)		(0.00)	(0.57)	(0.13)	(0.44)	(52.54)	(10.46)	(1.86)	(40.20)	(14.53)	(13.69)	(0.00)	(0.00)	(0.00)	(5.45)
No. harvested	799	485	256			10	10	0	10,562	2,185	280	8,098	1,864	1,842			0	147
(per acre)	(3.54)	(2.15)	(1.13)			(0.04)	(0.04)	(0.00)	(46.73)	(9.67)	(1.24)	(35.83)	(8.25)	(8.15)		(0.00)	(0.00)	(0.65)
% of total no. harvested	0.83	0.50	0.26			0.01	0.01	0.00	10.93	2.26	0.29	8.38	1.93	1.91		0.00	0.00	0.15
Lb. harvested	1,946	1,498	448			9	9	0	26,256	3,582	1,046	21,628	286	284			0	205
(per acre)	(8.61)	(6.63)	(1.98)			(0.04)	(0.04)	(0.00)	(116.18)	(15.85)	(4.63)	(95.70)	(1.27)	(1.26)		(0.00)	(0.00)	(0.91)
% of total lb. harvested	183	141	0.42			0.01	0.01	0.00	24.66	3.36	0.98	20.32	0.27	0.27		0.00	0.00	0.19
Mean length (in)		17.7	15.2				12.0			17.8	20.7	18.9		6.7				15.5
Mean weight (lb)		2.91	1.71				0.85			1.82	3.97	2.48		0.22				1.62
No. of fishing trips for that species	1767					171			5,551				409					0
% of all trips	8.7					0.8			27.3				2.0					0.0
Hours fished for that species	4,231					411			13,292				978					0
(per acre)	(18.72)					(1.82)			(58.81)				(4.33)					(0.00)
No. harvested fishing for that species	423					10			9,939				1,197					0
Lb harvested fishing for that species	1,235.0					9.0			25,209.0				217.0					0.0
No./hour harvested fishing for that species	0.10					0.02			0.75				1.22					0.00
% success fishing for that species	18.0					7.7			38.7				65.4					

Table 25 (continued). Fish harvest statistics derived from a creel survey at Kentucky Tailwater (226 acres), February - November 2019.

	Morone Group	White bass	Striped bass	Hybrid striped bass	Yellow bass	Common Carp	Bighead carp	Silver carp	Grass carp	Suckers	Buffalo	Skipjack herring	Shad	Gar	Mooneye	Paddlefish	Bowfin	Anything
No. caught (per acre)	11,707 (51.80)	8,068 (35.70)	2,190 (9.69)	212 (0.94)	1,237 (5.47)	18 (0.08)	294 (1.30)	10,358 (45.83)	101 (0.45)	(0.00)	315 (1.39)	86,090 (380.93)	1,847 (8.17)	184 (0.81)	(0.00)	284 (1.26)	(0.00)	
No. harvested (per acre)	6,990 (30.93)	5,464 (24.18)	1,042 (4.61)	107 (0.47)	378 (1.67)		5,893 (26.08)	9,887 (43.75)	59 (0.26)	(0.00)	146 (0.65)	84,599 (374.33)	1,847 (8.17)	88 (0.39)		239 (1.06)	(0.00)	
% of total no. harvested	7.24	5.66	1.08	0.11	0.39		6.10	10.23	0.06	0.00	0.15	87.57	1.91	0.09		0.25	0.00	
Lb. harvested (per acre)	6493 (28.73)	3313 (14.66)	2930 (12.96)	210 (0.93)	39 (0.17)		294 (1.30)	55547 (245.78)		(0.00)	1010 (4.47)	19551 (86.51)	51 (0.23)	503 (2.23)		946 (4.19)	(0.00)	
% of total lb. harvested	6.10	3.11	2.75	0.20	0.04		0.28	52.18		0.00	0.95	18.37	0.05	0.47		0.89	0.00	
Mean length (in)		11.8	19.5	15.7	6.4		34.6	21.9	26.5		19.5	7.7	4.0	43.6		31.6		
Mean weight (lb)		0.72	3.25	2.10	0.10		20.80	5.06			5.05	0.20	0.02	7.68		4.53		
No. of fishing trips for that species	1913							1059				4,108				703		11,098
% of all trips	9.6							5.2				20.2				3.5		22.8
Hours fished for that species (per acre)	4,653 (20.59)							1,571 (7.0)				9,835 (43.52)				1,684 (7.45)		4,635 (20.51)
No. harvested fishing for that species	6,169							4,339				83,247				118		
Lb harvested fishing for that species	5,417.0							23,258.8				19,422.7				491.7		
No./hour harvested fishing for that species	133							2.10				8.46				0.07		
% success fishing for that species	41.1							43.3				67.1				15.4		16.82

Table 27. Fishery statistics derived from a creel survey at Barkley Tailwater (75.2 acres) February - November 2019.

Fishing Trips			
No. of fishing trips (per acre)	22,110	(294.0)	
Fishing Pressure			
Total angler-hours (S.E.)	42,911	(1,275)	
Angler-hours/acre	570.6		
Catch / Harvest			
No. of fish caught (S.E.)	100,267	(17,408)	
No. of fish harvested (S.E.)	91,091	(16,983)	
Lb of fish harvested	141,328		
Harvest Rates			
Fish/hour	2.1		
Fish/acre	1211.3		
Pounds/acre	1879.4		
Catch Rates			
Fish/hour	2.3		
Fish/acre	1333.3		
Miscellaneous Characteristics (%)			
Male	91		
Female	9		
Resident	80		
Non-resident	20		
Method (%)			
Still fishing	28		
Casting	43		
Spider rigging	<1		
Bowfishing	29		
Mode (%)			
Boat	15		
Bank	84		

Table 28. Fish harvest statistics derived from a creel survey at Barkley Tailwater (75.2 acres) February - November 2019.

	Black bass group	Largemouth bass	Smallmouth bass	Spotted bass	Crappie group	White crappie	Black crappie	Catfish group	Channel catfish	Flathead catfish	Blue catfish	Panfish group	Bluegill	Redear sunfish	Longear sunfish	Green sunfish	Sauger	Freshwater drum
No. caught	1,911	734	542	0	85	85	0	15,344	3,963	303	13,213	2,242	2,135	64	43	0	0	551
(per acre)	(25.41)	(9.76)	(7.21)	(0.00)	(1.13)	(1.13)	(0.00)	(204.04)	(52.70)	(4.03)	(175.70)	(29.81)	(28.39)	(0.85)	(0.57)	(0.00)	(0.00)	(7.33)
No. harvested	777	210	135	0	43	43	0	13,867	1,535	194	12,138	964	879	43	43	0	0	90
(per acre)	(10.33)	(2.79)	(1.80)	(0.00)	(0.57)	(0.57)	(0.00)	(184.40)	(20.41)	(2.58)	(161.41)	(12.82)	(11.69)	(0.57)	(0.57)	(0.00)	(0.00)	(1.20)
%of total no. harvested	0.85	0.23	0.15	0.00	0.05	0.05	0.00	15.22	1.69	0.21	13.33	1.06	0.96	0.05	0.05	0.00	0.00	0.10
Lb. harvested	640	400	240	0	19	19	0	27,202	2,608	823	23,771	192	167	21	3	0	0	151.7
(per acre)	(8.51)	(5.32)	(3.19)	(0.00)	(0.25)	(0.25)	(0.00)	(361.73)	(34.68)	(10.94)	(316.10)	(2.55)	(2.22)	(0.28)	(0.05)	(0.00)	(0.00)	(2.02)
%of total lb. harvested	0.45	0.28	0.17	0.00	0.01	0.01	0.00	19.25	1.85	0.58	16.82	0.14	0.12	0.02	0.00	0.00	0.00	0.11
Mean length (in)		15.4	18.2			10			16.55	22.3	19.6		6.45	9	5			15.8
Mean weight (lb)		1.95	3.71			0.45			1.49	4.64	3.84		0.18	0.50	0.08			1.92
No. of fishing trips for that species	482				0			5,078				500						0
%of all trips	2.2				0.0			23.0				2.3						0.0
Hours fished for that species (per acre)	935				0			9,855				970						0
(per acre)	(12.4)				(0.0)			(131.1)				(12.9)						(0.0)
No. harvested fishing for that species	105				0			13,580				741						0
Lb harvested fishing for that species	255				0			26,227				174						0
No./hour harvested fishing for that species	0.11				0.00			1.38				0.76						0.00
%success fishing for that species	13.0				0.0			50.4				29.0						0.0

Table 28 (continued.). Fish harvest statistics derived from a creel survey at Barkley Tailwater (75.2 acres) from February - November 2019.

	Morone Group	White bass	Striped bass	Hybrid striped bass	Yellow bass	Common carp	Blue sucker	Buffalo	Mooneye	Skipjack herring	Shad	Gar	Bighead carp	Silver carp	Grass carp	Paddlefish	Bowfin	Anything
No. caught	6,909	5,428	606	198	677	115	39	99	21	49,944	3748	367	539	17903	635	430	0	
(per acre)	(91.88)	(72.18)	(8.06)	(2.64)	(9.00)	(1.53)	(0.52)	(1.32)	(0.28)	(664.15)	(49.84)	(4.88)	(7.17)	(238.07)	(8.44)	(5.72)	(0.00)	
No. harvested	4,224	3,663	433	87	41	59	0	37	21	49,724	3727	161	539	16433	432	407	0	
(per acre)	(56.17)	(48.71)	(5.76)	(1.15)	(0.55)	(0.78)	(0.00)	(0.49)	(0.28)	(661.22)	(49.56)	(2.14)	(7.17)	(218.52)	(5.74)	(5.41)	(0.00)	
%of total no. harvested	4.64	4.02	0.48	0.10	0.05	0.06	0.00	0.04	0.02	54.59	4.09	0.18	0.59	18.04	0.47	0.45	0.00	
Lb. harvested	3,464	1,772	1,443	244	6	114.5	0	372	22	9,169	210	950	6,793	90,686		1,341	0	
(per acre)	(46.06)	(23.56)	(19.19)	(3.24)	(0.08)	(1.52)	(0.00)	(4.95)	(0.29)	(121.93)	(2.80)	(12.64)	(90.33)	(1205.93)	(0.00)	(17.83)	(0.00)	
%of total lb. harvested	2.45	1.25	1.02	0.17	0.00	0.08	0.00	0.26	0.02	6.49	0.15	0.67	4.81	64.17	0.00	0.95	0.00	
Mean length (in)		11.3	19.67	17.38	7	16.0	18.5	26.0	16.0	7.9	5.2	34.5	33.7	22.9	26.0	27.1		
Mean weight (lb)		0.63	3.11	2.68	0.14	2.29	2.66	10	1.02	0.2	0.06	5.12	18.06	5.76		3.29		
No. of fishing trips for that species	2741									4539			0	2185		752		5822
%of all trips	12.4									20.5			0.0	9.9		3.4		26.3
Hours fished for that species	5,320									8,809			0	4,241		1,460		11,300
(per acre)	(70.7)									(117.1)			(0.0)	(56.4)		(19.4)		(150.3)
No. harvested fishing for that species	3,856									49,451			0	4,141		301		
Lb harvested fishing for that species	3,170									9,126			0	24,346		888		
No./hour harvested fishing for that species	0.72									5.61			0.00	0.98		0.21		
%success fishing for that species	32.2									56.0			0.0	41.9		38.5		28.8

Table 30. Fishing effort and total weight (lbs) of Asian carp harvested during KDFWR ride-alongs with commercial fishers fishing under the Asian Carp Harvest Program on Lake Barkley 2015 - 2019. (S.E. = standard error)

Year	Effort *	Mean effort per trip	S. E.	Number of ride alongs	Number of fishers	Total WT of bighead carp harvested (lbs)	Mean total WT of bighead carp harvested/trip (lbs)	S. E.	Total WT of silver carp harvested (lbs)	Mean total WT of silver carp harvested/trip (lbs)	S. E.
2015	17850	1116	50.5	16	5	1608	101	43.1	35130	2196	256.6
2016	25135	1143	70.4	22	4	704	32	13.7	61533	2797	481.8
2017	30491	1089	90.1	28	8	558	20	6.3	69459	2481	421.3
2018	23260	1108	81.7	21	10	362	17	7.8	49248	2345	477.1
2019	52367	1247	251.8	42	19	838	20	6.7	142102	3383	498.0

*effort is calculated in yards of gillnet fished.

Table 31. Comparison of the average weight harvested per trip of silver carp and bighead carp during KDFWR ride-alongs, and through commercial fishers reports for the Asian Carp Harvest Program in 2016 - 2019. (S.E. = standard error)

		Silver carp	S. E.	Bighead carp	S. E.
2016	Ride Alongs	2,280	402.2	40	12.4
	Commercial fishing reports	2,378	70.5	22	3.3
2017	Ride Alongs	2,386	395.0	25	8.2
	Commercial fishing reports	2,225	92.8	56	7.6
2018	Ride Alongs	2,219	422.6	16	6.9
	Commercial fishing reports	1,981	54.2	38	4.0
2019	Ride Alongs	3,353	475.7	23	7.2
	Commercial fishing reports	2,580	53.0	22	1.6

Table 32. Summary of Asian carp harvest and expenditures of funds through Contract fishing in Kentucky Lake, Lake Barkley and their associated tailwaters under the KDFWR Asian Carp Harvest Program.

Year	Total number of trips	Total pounds of Asian Carp caught	Total funds paid out
2016	41	94,121	\$4,706.06
2017	70	191,921	\$9,596.05
2018	565	722,740	\$36,136.98
2019	1,448	4,203,264	\$210,163.21

Appendix 1. Silver carp pectoral fin ray removal, cutting and aging protocol.

- 1) Use a sharp knife to completely remove the first fin ray, from the left side of the fish, below the articulating process.
 - a. Remove as much of the excess tissue as possible.
 - b. If the fin ray is too long to fit inside a scale envelop, use a pair of sheers to remove the top $\frac{1}{2}$ to $\frac{2}{3}$ of the fin ray.
 - c. Place the fin ray, lower portion with the articulating process, into a scale envelope with corresponding data
 - i. Length, weight, sex, date, capture location, etc.
- 2) Once back at the office, hang the envelope with the fin ray in the cage to air dry
 - a. Small oven can also be used to expedite this process
- 3) After several weeks of air drying the fin ray is ready to be processed in the lab. The drying process can be expedited in a drying oven at low temperature.







Fin Ray Cutting Protocol with Low Speed Isometric Saw

- 1) Blade used in this protocol is a 4" x .012" x 1/2" 1A1R precision Diamond metal Bond Blade, Medium Mesh Size Diamond.
- 2) Remove tray below saw and fill with water and 3 or 4 drops of dish soap
- 3) Replace and raise the tray so that the blade is in contact with the solution
- 4) Attach the fin ray to the holder. (Note: You may need to flip bottom piece so that the notch is facing up for larger fin rays.) It should be attached so that the base is cut off right where it begins to sharply curve as seen in picture below.

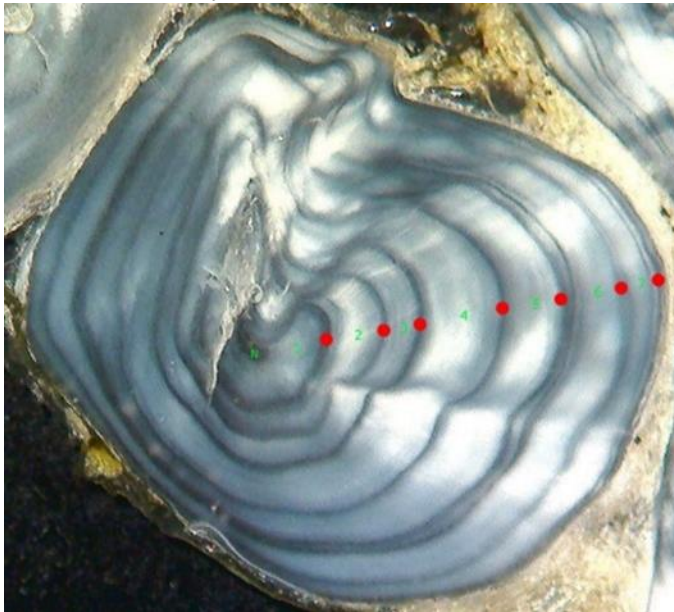


- 5) Make the first cut and then turn the adjustment knob one full turn and five clicks. Then cut off the first section. Repeat to get the second section.

- a. Section thickness may need to be adjusted slightly depending on the girth of the particular fin ray
- 6) Make three sections from each fin ray
 - a. Be vigilant to replace all of the sample back into their proper envelope
- 7) Make sure to empty out the tray at the end of the day. Leaving water in tray can cause it rust.

Fin Ray Aging Protocol

- 1) After cross sections have dried and are opaque in appearance, place them in a receptacle with a dark background and submerge in water
 - a. Age using a dissecting microscope and archive picture of a good fin ray from each fish with a mounted camera
- 2) Using reflected light, count the dark bands (winter growth), starting with the first entire band outside of the center of the spine.
 - a. For fin rays collected in the fall (October) count to the last annulus but not out to the spine margin
 - b. Spines with interior lumen larger than the first growth ring should not be used
- 3) Aging should be conducted blindly by two individuals without prior knowledge of fish demographics
 - a. Any fish differing in age more than 2 years should be excluded
 - b. Fish differing in age ≤ 2 years should be reevaluated until an agreed age can be reached by readers



The above picture would be aged as 7 using the aforementioned protocol.

Appendix 2. Kentucky Tailwater Creel Survey (15 February 2019 - 15 November 2019)

KENTUCKY LAKE TAILWATER ANGLER ATTITUDE SURVEY 2019

1. Have you previously completed this survey? Yes - stop survey No – continue
2. Name _____ and Zip Code _____ (Optional)
3. Have you fished at the Kentucky Lake Tailwaters in the last 12 months? Yes 76%, No 24%
3a. If yes, How many times have you fished at the Kentucky Lake Tailwaters in the past 12 months?
First time = 21%, 1-4 = 28%, 5-10 = 22%, More than 10 = 29%

4. What angling techniques do you use when fishing at Kentucky Lake Tailwater (check all that apply)?
Rod and reel 89%, Snagging 18%, Bow fishing 23%, Other 0%
5. What species of fish do you fish for at the Kentucky Lake Tailwaters (check all that apply)?
34% - Catfish, 24% - Striped bass/White bass/Hybrids, 5% - Crappie, 14% - Black bass, 20% - Paddlefish, 54% - Skipjack/Bait, 24% - Asian carp, 10% - Other species

6. Which one species do you fish for most at Kentucky Lake Tailwaters (check only one)?
19% - Catfish, 12% - Striped bass/White bass/Hybrids, 8% - Black bass, 1% - Crappie, 5% - Paddlefish, 15% - Asian carp, 38% - Baitfish, 2% other species

Striped Bass/White Bass/Hybrid Anglers

7. In general, what level of satisfaction do you have with Striped Bass/White Bass/Hybrid fishing at Kentucky Lake Tailwaters?
42% - Very satisfied, 54% - Somewhat satisfied, 0% - Neutral, 4% - Somewhat dissatisfied 0% - Very dissatisfied
0% - No opinion

- 7a. If you responded with somewhat or very dissatisfied in question (6) - what is the single most important reason for your dissatisfaction?
0% - Number of fish, 0% size of fish, 0% - Not happy with regulations, 0% - Too many anglers, 100% - Dont know how to catch them, 0% - other reason

Crappie Anglers

8. In general, what level of satisfaction do you have with crappie fishing at Kentucky Lake Tailwaters?
20% - Very satisfied, 20% - Somewhat satisfied, 60% - Neutral, 0% - Somewhat dissatisfied 0% - Very dissatisfied
0% - No opinion

- 8a. If you responded with somewhat or very dissatisfied in question (7) - what is the single most important reason for your dissatisfaction?
0% - Asian carp, 0% - Number of fish, 0% - Size of fish

Black Bass Anglers

9. In general, what level of satisfaction do you have with the black bass fishing at the Kentucky Lake Tailwaters?
29% - Very satisfied, 43% - Somewhat satisfied, 7% - Neutral, 7% - Somewhat dissatisfied, 0% - Very dissatisfied, 7% - No opinion

- 9a. If you responded with somewhat or very dissatisfied in question (8) - what is the single most important reason for your dissatisfaction?
0% - Asian carp, 100% - Number of fish, 0% - Size of fish, 0% - Fluctuating water

Catfish Anglers

10. In general, what level of satisfaction do you have with the catfish fishing at the Kentucky Lake Tailwaters?
32% - Very satisfied, 50% - Somewhat satisfied, 9% - Neutral, 3% - Somewhat dissatisfied, 0% - Very dissatisfied, 6% - No opinion

- 10a. If you responded with somewhat or very dissatisfied in question (9) - what is the single most important reason for your dissatisfaction?
0% - Asian carp, 0% - Number of fish, 100% - Too much commercial fishing, 0% - Snaggers, 0% - Water levels, 0% - More bait, 0% Too many anglers, 0% - Not happy with regulations, 0% - Size of fish,
-

Appendix 2 (continued). Kentucky Tailwater Creel Survey (15 February 2019 - 15 November 2019)

Paddlefish Anglers

Paddlefish are a species of concern for fish and wildlife management agencies. They do not reproduce until older ages, and can be more susceptible to overharvest than other species. Because they travel long distances, they are managed collectively by multiple agencies on a regional scale with oversight from the United States Fish and Wildlife Service. As a result, KDFWR is working to understand the fishing pressure and harvest of paddlefish in Kentucky waters, and manage the harvest of paddlefish to a sustainable level.

11. In general what level of satisfaction do you have with Paddlefish fishing at Kentucky Lake Tailwaters?
 5% - Very satisfied, 45% - Somewhat satisfied, 10% - Neutral, 20% - Somewhat dissatisfied, 5% - Very dissatisfied, 15% - No opinion
- 11a. If you responded with somewhat or very dissatisfied in question (10) - what is the single most important reason for your dissatisfaction?
 60% - Asian carp, 20% - Number of fish, 0% - Too much commercial fishing, 0% - Too much harvest, 0% - Less restrictions during summer snagging, 0% - Size of fish
12. Currently, the snagging creel limit for Kentucky Lake Tailwater is 8 fish in aggregate (maximum of 8 paddlefish allowed), while the statewide creel limit is 2 fish per day. Would you support or oppose decreasing the creel limit for paddlefish to 2 fish per day?
 80% - Support 10% - Oppose 10% - No opinion
- 12a. If you answered "oppose" to the previous question, what creel limit would you support for paddle fish in the Kentucky Lake Tailwaters?
 50% - 4 fish per day 0% - 6 fish per day 50% - Other limit
13. How many trips do you make to bow fish during the months of March-August?
 9% - 100 trips, 4% - 80 trips, 4% - 50 trips, 13% - 20 trips, 13% - 10 trips, 4% - 6 trips, 22% - 5 trips, 17% - 2 trips, 4% - 1 trip, 9% - 0 trips
14. On average how many silver carp do you as an individual shoot per trip?
 4% - 100 fish, 9% - 50 fish, 9% - 20 fish, 4% - 12 fish, 26% - 10 fish, 4% - 7 fish, 4% - 6 fish, 22% - 5 fish, 4% - 4 fish, 9% - 3 fish, 4% - 1 fish.
15. On average how many bighead carp do you as an individual shoot per trip?
 4% - 50 fish, 4% - 20 fish, 4% - 12 fish, 4% - 3 fish, 9% - 2 fish, 26% - 1 fish, 48% - 0 fish.
16. On average how many grass carp do you as an individual shoot per trip?
 4% - 5 fish, 4% - 2 fish, 4% - 1 fish, 83% - 0 fish.
17. How many pounds does an average silver carp that you shoot weigh?
 17% - 15, 9% - 12, 35% - 10, 9% - 8, 9% - 7, 9% - 6, 13% - 5.
18. How many pounds does an average bighead carp that you shoot weigh?
 5% - 82, 24% - 30, 29% - 25, 5% - 20, 15% - 15, 5% - 11, 5% - 10.
19. How many pounds does an average grass carp that you shoot weigh?
 26% - 15, 5% - 12, 21% - 10, 5% - 5, 37% - NA
20. On average how many Paddlefish do you shoot per year?
 5% - 30 fish, 5% - 20 fish, 5% - 10 fish, 10% - 5 fish, 10% - 3 fish, 15% - 2 fish, 33% - 1 fish, 19% - 0 fish.
21. The current statewide season for snagging paddlefish is February 1 - May 10. Would you support creating a paddlefish season for bow fishing that aligned with these dates?
 17% - Yes 83% - No
22. What do you do with Asian carp that you catch?
 1% - Eat, 43% - Sink, 16% - Let go, 18% - Use for bait, 22% - other.
23. Have you ever tried eating Asian carp?
 15% - Yes, 85% - No
24. Do you know how to clean an Asian carp to produce a boneless fillet?
 13% - Yes, 87% - No
25. Do you follow the western kentucky fisheries facebook page?
 26% - Yes, 74% - No

All Anglers

26. Are you satisfied with the current size and creel limits on all sportfish at Kentucky Lake Tailwaters?
 97% - Yes 3% - No
- 13a. If not, which species are you dissatisfied with and what size limits would you prefer?

Species	Size Limit	Creel Limit	# of Anglers
Striped bass/White bass/Hybrids	only 5 >15"	15	1
Catfish	1 > 35" flathead and blue, 28" channel		1
Catfish	Wants commercial catfish limits		1

Appendix 3. Barkley Tailwater Creel Survey (15 February 2019 - 15 November 2019)

BARKLEY LAKE TAILWATER ANGLER ATTITUDE SURVEY 2019

1. Have you previously completed this survey? Yes - stop survey No – continue
2. Name _____ and Zip Code _____ (Optional)
3. Have you fished at the Lake Barkley Tailwaters in the last 12 months? Yes 74%, No 26%
 - 3a. If yes, How many times have you fished at the Lake Barkley Tailwaters in the past 12 months?
First time = 21%, 1-4 = 25%, 5-10 = 21%, More than 10 = 34%
4. What angling techniques do you use when fishing at Lake Barkley Tailwater (check all that apply)?
Rod and reel 89%, Snagging 0%, Bow fishing 27%, Other 0%
5. What species of fish do you fish for at the Lake Barkley Tailwaters (check all that apply)?
42% - Catfish, 27% - Striped bass/White bass/Hybrids, 3% - Crappie, 11% - Black bass, 19% - Paddlefish, 60% - Skipjack/Bait, 27% - Asian carp, 11% - Other species
6. Which one species do you fish for most at Lake Barkley Tailwaters (check only one)?
23% - Catfish, 16% - Striped bass/White bass/Hybrids, 1% - Black bass, 0% - Crappie, 4% - Paddlefish, 14% - Asian carp, 41% - Baitfish, 0% other species

Striped Bass/White Bass/Hybrid Anglers

7. In general, what level of satisfaction do you have with Striped Bass/White Bass/Hybrid fishing at Lake Barkley Tailwaters?
15% - Very satisfied, 65% - Somewhat satisfied, 0% - Neutral, 15% - Somewhat dissatisfied 5% - Very dissatisfied 0% - No opinion
 - 7a. If you responded with somewhat or very dissatisfied in question (6) - what is the single most important reason for your dissatisfaction?
50% - Number of fish, 0% size of fish, 0% - Not happy with regulations, 0% - Too many anglers, 100% - Don't know how to catch them, 50% - other reason

Crappie Anglers

8. In general, what level of satisfaction do you have with crappie fishing at Lake Barkley Tailwaters?
50% - Very satisfied, 20% - Somewhat satisfied, 0% - Neutral, 50% - Somewhat dissatisfied 0% - Very dissatisfied 0% - No opinion
 - 8a. If you responded with somewhat or very dissatisfied in question (7) - what is the single most important reason for your dissatisfaction?
0% - Asian carp, 0% - Number of fish, 0% - Size of fish, 100% other reason

Black Bass Anglers

9. In general, what level of satisfaction do you have with the black bass fishing at the Lake Barkley Tailwaters?
25% - Very satisfied, 38% - Somewhat satisfied, 13% - Neutral, 13% - Somewhat dissatisfied, 13% - Very dissatisfied, 0% - No opinion
 - 9a. If you responded with somewhat or very dissatisfied in question (8) - what is the single most important reason for your dissatisfaction?
0% - Asian carp, 100% - Number of fish, 0% - Size of fish, 0% - Fluctuating water

Catfish Anglers

10. In general, what level of satisfaction do you have with the catfish fishing at the Lake Barkley Tailwaters?
48% - Very satisfied, 35% - Somewhat satisfied, 6% - Neutral, 3% - Somewhat dissatisfied, 0% - Very dissatisfied, 6% - No opinion
 - 10a. If you responded with somewhat or very dissatisfied in question (9) - what is the single most important reason for your dissatisfaction?
0% - Asian carp, 0% - Number of fish, 0% - Too much commercial fishing, 0% - Snaggers, 0% - Water levels, 0% - More bait, 100% Too many anglers, 0% - Not happy with regulations, 0% - Size of fish,
-

Appendix 3 (continued). Barkley Tailwater Creel Survey (15 February 2019 - 15 November 2019)

Paddlefish Anglers

Paddlefish are a species of concern for fish and wildlife management agencies. They do not reproduce until older ages, and can be more susceptible to overharvest than other species. Because they travel long distances, they are managed collectively by multiple agencies on a regional scale with oversight from the United States Fish and Wildlife Service. As a result, KDFWR is working to understand the fishing pressure and harvest of paddlefish in Kentucky waters, and manage the harvest of paddlefish to a sustainable level.

11. In general what level of satisfaction do you have with Paddlefish fishing at Lake Barkley Tailwaters?
 23% - Very satisfied, 62% - Somewhat satisfied, 15% - Neutral, 0% - Somewhat dissatisfied, 0% - Very dissatisfied, 0% - No opinion
- 11a. If you responded with somewhat or very dissatisfied in question (10) - what is the single most important reason for your dissatisfaction?
 0% - Asian carp, 0% - Number of fish, 0% - Too much commercial fishing, 0% - Too much harvest, 0% - Less restrictions during summer snagging, 0% - Size of fish
12. Currently, snagging is only allowed downstream of the 62 bridge below Lake Barkley Tailwaters. The creel limit below the 62 bridge is 8 fish in aggregate (maximum of 8 paddlefish allowed). Would you support or oppose decreasing the creel limit for paddlefish to 2 fish per day.
 92% - Support 0% - Oppose 8% - No opinion
- 12a. If you answered "oppose" to the previous question, what creel limit would you support for paddlefish in the Kentucky Lake Tailwaters?
13. How many trips do you make to bow fish during the months of March-August?
 5% - 80 trips, 10% - 60 trips, 15% - 50 trips, 5% - 25 trips, 5% - 20 trips, 10% - 15 trips, 15% - 10 trips, 5% - 7 trips, 5% - 4 trip, 5% - 3 trips, 5% - 2 trips
14. On average how many silver carp do you as an individual shoot per trip?
 10% - 30 fish, 5% - 22 fish, 5% - 20 fish, 5% - 15 fish, 5% - 12 fish, 35% - 10 fish, 5% - 7 fish, 30% - 5 fish.
15. On average how many bighead carp do you as an individual shoot per trip?
 5% - 20 fish, 5% - 12 fish, 10% - 5 fish, 10% - 2 fish, 35% - 1 fish, 35% - 0 fish.
16. On average how many grass carp do you as an individual shoot per trip?
 5% - 3 fish, 5% - 2 fish, 20% - 1 fish, % - 70 fish.
17. How many pounds does an average silver carp that you shoot weigh?
 15% - 15, 10% - 12, 25% - 10, 25% - 8, 5% - 7.5, 5% - 7, 5% - 6, 5% - 5.
18. How many pounds does an average bighead carp that you shoot weigh?
 5% - 60, 5% - 45, 10% - 40, 15% - 30, 15% - 25, 30% - 20, 5% - 17, 5% - 15.
19. How many pounds does an average grass carp that you shoot weigh?
 20% - 20, 20% - 15, 5% - 12, 30% - 10, 10% - 8
20. On average how many Paddlefish do you shoot per year?
 5% - 25 fish, 5% - 20 fish, 5% - 15 fish, 15% - 10 fish, 5% - 7 fish, 5% - 6 fish, 10% - 5 fish, 10% - 4
21. The current statewide season for snagging paddlefish is February 1 - May 10. Would you support creating a paddlefish season for bow fishing that aligned with these dates?
 15% - Yes 85% - No
22. What do you do with Asian carp that you catch?
 3% - Eat, 45% - Sink, 12% - Let go, 12% - Use for bait, 27% - other.
23. Have you ever tried eating Asian carp?
 21% - Yes, 79% - No
24. Do you know how to clean an Asian carp to produce a boneless fillet?
 14% - Yes, 86% - No
25. Do you follow the western kentucky fisheries facebook page?
 29% - Yes, 71% - No

All Anglers

26. Are you satisfied with the current size and creel limits on all sportfish at Lake Barkley Tailwaters?
 99% - Yes 1% - No
- 13a. If not, which species are you dissatisfied with and what size limits would you prefer?

Species	Size Limit	Creel Limit	# of Anglers
Paddlefish	unspecified, but wants a limit	1	1