

Project Title: Monitoring Invasive Carp Impacts on Native Fish Communities

Geographic Location: Tennessee and Cumberland Rivers Subbasin

Lead Agency: Kentucky Department of Fish and Wildlife Resources (KDFWR; Joshua Tompkins, Joshua.tompkins@ky.gov)

Cooperating Agency: Murray State University (MSU)

Statement of Need:

In this project, KDFWR will evaluate the response by the native fish community and their fisheries in the presence of invasive carp. The establishment of invasive carp in new areas have been shown to alter native fish communities (Irons et al. 2007) and result in shifting food webs (Collins and Wahl 2017). Fisheries managers seek to understand these dynamics to evaluate the effectiveness of control measures, and to keep stakeholders informed. This work will complement ongoing projects in the TNCR.

Project Objectives:

1. Assess impacts on native species that compete for food resources with invasive carp.
2. Examine invasive carp impacts on fish community assemblages in the tailwaters of dams on the Tennessee and Cumberland rivers.
3. Determine impacts of invasive carp on sport fisheries.
4. Monitor bycatch of native fish species collected through invasive carp harvest programs.

Project Highlights:

- Condition of gizzard shad dropped slightly compared to previous years in Barkley and Kentucky Reservoirs.
- Kentucky and Barkley Tailwaters have good fish community assemblages.
- Barkley and Kentucky Reservoirs saw normal ranges of fish condition and abundance during 2022.
- Kentucky Reservoir saw a decrease in sport fishing effort but saw an increase in catch rates.
- KDFWR personnel conducted 61 ride-alongs with commercial fishers. During which observers recorded 2.4% of bycatch with a 20% of mortality with that bycatch.
- 65.5% of sport fish anglers surveyed during Kentucky Reservoir's creel perceived a decrease in silver carp abundance over the past two years.
- Shad growth was observed to slow in both reservoirs around age 3.

Methods:

Kentucky Department of Fish and Wildlife Resources

Objective 1. Assess impacts on native species that compete for food resources with invasive carp.

KDFWR conducted targeted sampling for shad species with pulsed DC boat electrofishing for one week in both Barkley and Kentucky Reservoirs. Electrofishing runs did not exceed 15 minutes of peddle time and ran parallel to shore in 3-8ft of water. Length and weight were taken from individuals collected. The sampling began at sunset and continued throughout the night. During Paupier net sampling, total length and weight data was recorded for shad species as well. Measurements were used for determining condition factors through relative weight analysis. Values will be monitored over time to determine if they will be useful to assess impacts that invasive carp may have on conditions of the native fishes. The species chosen for this assessment are often captured in gill nets and have been recognized as being vulnerable to competition for resources with invasive carp species (Irons et al. 2007, Schrank et al. 2003).

Objective 2. Examine invasive carp impacts on fish community assemblages in the tailwaters of dams on the Tennessee and Cumberland rivers.

Barkley and Kentucky Reservoirs' tailwaters were sampled with pulsed DC electrofishing in the fall to assess species composition, relative abundance, and condition of represented fish species. Sampling below Kentucky Reservoir (Tennessee River) consisted of three 15-minute transects, moving downstream along each bank of the river (Figure 2). Sampling below Barkley Reservoir (Cumberland River) consisted of two 15-minute transects, moving downstream along each bank of the river (Figure 2). Fall sampling was conducted one day each month in September, October, and November. Two staff collected fish with nets from the bow, netting targeted all species. Data included species, total lengths (mm), and weights (g). When large numbers of a species were collected, measurements on a subsample of at least 25 individuals were taken and extrapolated for that species. The data was compared to historical data collected by the KDFWR Western Fisheries District personnel to assess changes in fish community over time.

Objective 3. Determine impacts of invasive carp on sport fisheries.

Invasive carp harvest continues to increase from Kentucky and Barkley Reservoirs, driven by the Invasive Carp Harvest Program (ICHP) and the additional processors purchasing carp from Western Kentucky. KDFWR continues to monitor condition of sport fish species to identify trends that may be associated with the population dynamics of invasive carps. Information on

sport fish has been gathered routinely throughout the past few decades by KDFWR's Western Fisheries District (WFD). Lengthy data sets on black bass, crappie, and catfish in the two reservoirs are collected from annual standardized sampling. The information was used to compare sport fish conditions (Wr) with harvest rates of invasive carps to evaluate trends.

In 2023, KDFWR conducted the creel survey on Kentucky Reservoir. Random, non-uniform probability creel surveys were conducted (Appendix A). Dates and periods for surveys each week were randomly selected, and creels were conducted at least 20 days per month, including a minimum of 6 weekend days. Timing of recreational fishers' counts are randomly chosen daily, and data was extrapolated accordingly to calculate daily average and total effort. An attempt to interview all recreational fishers each day was made. 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 questionnaire to gauge opinions regarding their levels of satisfaction with the fishery and on current or proposed regulations.

Objective 4. Monitor bycatch of native fish species collected through invasive carp harvest programs.

KDFWR continued to manage the Invasive Carp Harvest Program (ICHP) and an Experimental Fishing Methods contract program to encourage largescale removal of invasive carp. As fishing effort and techniques develop and increase, there is potential for these activities to negatively impact native fish through excessive bycatch when fishers are attempting to target invasive carp. Commercial fishers on the ICHP are required to submit daily reports indicating species of bycatch, harvest status, or condition of bycatch upon release. KDFWR staff also collected this information during ride-alongs with commercial fishers. These two data sets were analyzed independently to determine if commercial fishing efforts are negatively impacting native fish species.

Results and Discussion:

Kentucky Department of Fish and Wildlife Resources (KDFWR)

Objective 1. Assess impacts on native species that compete for food resources with invasive carp.

Electrofishing

Sampling occurred for a week on Barkley Reservoir and a week on Kentucky Reservoir in October of 2023. Sampling targeted, gizzard shad (GZSD), threadfin shad (TFSD), skipjack herring (SKJH) and emerald shiners. The Midwest Lake Electrofishing Systems shock box was set to 120 Hertz, 25% duty cycle, 200-265 volts, 7-18 amps and 2000-4200 watts. On Kentucky

Reservoir 4,933 gizzard shad, 3,032 threadfin shad, and 69 skipjack herring were collected. On Barkley Reservoir 4,354 gizzard shad, 751 threadfin shad, and 751 skipjack herring were collected. CPUE for gizzard shad over 180 mm was greater in Barkley Reservoir, while CPUE for gizzard shad under 180 mm was greater in Kentucky Reservoir (Table 2).

Paupier

Sampling with USFWS collected a total of 17,782 fish with the electrified Paupier net boat over four nights spent on Kentucky Reservoir. This sampling was targeting young of year invasive carp, adult invasive carp, gizzard shad, threadfin shad, and skipjack herring. No YOY invasive carp were collected. CPUE of adult silver carp was lowest it has been in Big Bear embayment (36 fish/hr. Table 1), since Paupier sampling began in 2016. The missing years from 2020 – 2021 has been due to personnel constraints and the Covid pandemic.

Using data collected from both electrofishing and Paupier sampling, condition of native baitfish was calculated to better understand the potential impacts invasive carp. Relative weight (Wr) of gizzard shad over 180mm in 2023 was at an historical low in both reservoirs (Table 3). Paupier and EF sampling produced higher CPUEs for gizzard shad, threadfin shad, and adult silver carp but both the Paupier and standard electrofishing had similar CPUEs for skipjack herring (11 and 12(fish/hr), respectfully. Table 4).

Objective 2. Examine invasive carp impacts on fish community assemblages in the tailwaters of dams on the Tennessee and Cumberland rivers.

Kentucky and Barkley Tailwaters Electrofishing

Fall sampling with electrofishing in the Kentucky Tailwater resulted in the capture of 3,504 total fish comprised of 37 species during 4.5 hours of effort in 2023. Gizzard shad catch rates increased in 2023 compared to 2022 and 2021 (113 fish/hr compared to 47 and 44, Table 6). Threadfin shad catch rates decreased in 2023 but were within the historic range. CPUE of sunfish species including bluegill and longear sunfish, increased from 2022 with a CPUE of 38 fish/hr and 8 fish/hr, respectively. Largemouth bass CPUE was the highest observed since 2019 and smallmouth bass CPUE was the highest observed since 2015 at 43 per hour. Silver carp and grass carp CPUE remained the same in 2023 compared to 2022 at 2 fish/hr (Table 6).

Fall sampling in the Barkley Tailwater resulted in the capture of 8,359 total fish comprised of 33 species over 3.0 hours of effort in 2023. Threadfin shad catch rates was the second highest seen since 2016 with a CPUE of 2103 fish/hr (Table 7). Sunfish species such as bluegill and longear sunfish produced some of the lowest catch rates for those species since the survey began in 2016 with a CPUE of 10 fish/hr and 11 fish/hr, respectively (Table 7). Largemouth and smallmouth bass catch rates both increased in 2023 and the smallmouth bass CPUE was the second highest since 2016. Silver carp CPUE during fall sampling in Barkley Tailwaters was the second lowest since 2016 (6 fish/hr; Table 7).

Length frequency distribution for silver carp collected in Kentucky Tailwater during fall sampling in 2023 ranged from 27-34 inches (N=9; Table 8). Silver carp lengths from Barkley Tailwater during fall sampling ranged from 20-34 inches (N=22; Table 9). These ranges are much wider compared to silver carp collected during fall sampling in 2018 and 2019 and may indicate more mixing of the silver carp population in the Tailwaters, or that fish from a variety of locations are arriving at the tailwaters and looking for passage upstream. We observed similar size structure of skipjack herring, gizzard shad, and threadfin shad in both tailwaters (Table 8 and 9).

Relative weights (Wr) were calculated for selected species collected during fall sampling to monitor fish condition (Tables 10 & 11). 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 invasive carp densities in the tailwaters. Low relative weight is generally characteristic of fish in poor health, whereas high values indicate fish in excellent health (Blackwell et al. 2000). However, ideal target ranges of Wr values have not been identified for all species and in every habitat type. Therefore, the Wr values compiled through this study will be used to assess changes in the Tailwater fish community over time. In the Kentucky Tailwater, the mean Wr of gizzard shad decreased to a value of 86, which is like 2019 and 2020 (Table 10). Largemouth bass also recorded the second highest Wr since 2015 at 111 while smallmouth bass saw the lowest Wr at 87 (Table 10). The mean relative weight for white bass increased slightly from 2022, but still isn't up to historical records. Mean relative weight values for other species in the Kentucky Tailwater remained like previous years. In the Barkley Tailwaters, mean relative weight values decreased for gizzard shad (Wr = 88) from 2022. Smallmouth bass mean relative weight decreased to 93 and that is similar as 2019 and 2020 (Table 11). Bluegill relative weight was a record high in 2023 at 100 (Table 11). All other species in the Barkley Tailwaters had similar mean relative weights to previous years.

Objective 3. Determine impacts of invasive carp on sport fisheries.

Standard Sport Fish Sampling

In Kentucky Reservoir, relative weight analysis was conducted for black crappie, white crappie, largemouth bass, and smallmouth bass (KDFWR 2022). Black and white crappie both exhibited mean relative weights that were higher than 2022 but were not outside of historical norms with Wr of 98 and 99, respectively. Largemouth bass average Wr also remained like values calculated for the previous four years (Wr = 96). Many factors are known to impact sport fish condition and values recorded since invasive carp have become established in Kentucky Reservoir have not fluctuated outside of historical variations. The impacts to sport fish condition associated with this increased removal of invasive carp requires more years of data and will continue to be monitored.

In Barkley Reservoir, relative weight analysis was conducted for black crappie, white crappie, largemouth bass, and blue catfish (KDFWR 2022). Mean relative weights for both black and white crappie remained like previous years having Wr of 96 and 89, respectively. Mean Wr value for largemouth bass in 2022 was 103. Harvest of invasive carp from Barkley Reservoir has

increased almost every year since the ICHP began in 2013. Comparable to Kentucky Reservoir, the sharp rise in harvest of invasive carp in 2019 corresponds with lower condition factors of sportfish species, which may be an indicator of high densities of adult invasive carp competing with these sport fish for resources. Therefore, the increase in condition of sport fish in Barkley Reservoir in subsequent years, may be influenced by a reduced competition with invasive carp as they are continually harvested. 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.

Kentucky Reservoir Creel

In 2023 survey results indicated that the fewest number of trips were made to Kentucky Reservoir, but fishing catches improved. Creel survey results suggests that catch rates improved recently and returned to the top end of the historical range (Table 16). In 2023 the methods of fishers on Kentucky Reservoir remained comparable to the previous surveys in which about 1/3 of anglers still fish while 40-60% of anglers using casting to catch fish (Figure 1).

Part of the Kentucky Reservoir's creel program is an angler attitude survey where anglers are asked their satisfaction with the fishery or about their knowledge of fishery related topics. Given invasive carp's abundance and being considered excellent table fare, a question is asked, "Are you aware that invasive Asian carp are generally considered to be excellent fish to eat?" and 74.5% of people answered "Yes", which has slightly increased since 2016 when only 60% of people said "Yes". 90% of people surveyed knew that commercial harvest of invasive carp occurs on Kentucky Lake, which has increased from 65% in 2020. When asked about their perception of silver carp abundance in Kentucky Reservoir over the past two years, 65.5% of the 330 individuals surveyed indicated a decrease in silver carp abundance, while 7.9% indicated a perceived increase in silver carp abundance. (Appendix A).

Objective 4. Monitor bycatch of native fish species collected through invasive carp harvest programs.

Invasive Carp Harvest Program Bycatch

According to the KDFWR ICHP regulation (301:KAR 1:152), commercial fishers are allowed to harvest a ratio of 65% Invasive 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). In previous years, increased effort by commercial fishers fishing under the ICHP has translated into a growing amount of bycatch. In 2023, the total number of bycatches reported decreased and was the lowest recorded since 2018 (when commercial fishing effort increased dramatically. Table 12). This reduction in bycatch per trip is attributed to changing practices of commercial fishers as most fishers have transitioned from passive setting to active setting of gill nets targeting schools of carp identified via their boat electronics. Scaled rough fish, primarily buffalo (*Ictiobus*) species, make up the majority of reported bycatch in commercial gill nets fished under the ICHP (Table 12). Bycatch of rough fish, and subsequent harvest is variable year to year based on what processors are willing to buy.

Although commercial fishers on the ICHP are limited to how much of their bycatch they can harvest, KDFWR will continue to monitor this trend in future years. The number of sport fish, catfish, and paddlefish collected as bycatch all increased in 2023 from 2022 reporting levels, however rates were within historic levels. Survival rates of sportfish (86.0%) and paddlefish (78.4%) decreased in comparison to previous years, and the survival rate of catfish remained similar (98.6%) (Table 12).

Survival rates of all bycatches caught during ride-alongs in 2023 was documented by KDFWR observers and was analyzed independent of commercial fisher reporting (Table 13). During ride-alongs, the survival rate of sport fish as bycatch decreased slightly in 2023 at 83%. Survival rates of catfish species observed as bycatch during ride-alongs was like previous years at 95%. Paddlefish survival rates observed during ride-alongs in 2023 returned to historical ranges unlike 2022's lowest survival rate. However, it is of note those 2022 values also represent the lowest sample size in recent history (Table 13).

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 14). We see an increase in bycatch of catfish species in 2023. 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 fisheries dependent reports (Table 14). Data suggests 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 (2.8% in 2023). To better identify and monitor under reporting of bycatch, KDFWR will continue to increase the number of ride-alongs conducted with commercial fishers targeting invasive carp. To date, there is no indication of negative impacts on the sport fishery resulting from the ICHP.

Bycatch of Paddlefish

As KDFWR monitors sport fish bycatch through the ICHP it also provides the opportunity to monitor other species that compete directly with invasive 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 ICHP on paddlefish. Generally, experienced commercial fishers can avoid capturing large numbers of paddlefish when they are targeting invasive carp by carefully selecting fishing locations. The number of paddlefish captured is variable over time but is showing a declining trend even though effort is increasing through the ICHP (Table 12).

Paddlefish survival was observed to be low in 2023 (47% during ride-alongs, 78% total ICHP) in relation to other species in the bycatch (Tables 12 & 13). A factor identified as possibly affecting paddlefish survival in gill nets is length of time the nets are left in the water (i.e. soak time). From conducting ride-alongs, it has been observed that the soak time of nets varies among fishers and depends on the location being fished, weather, and water temperature. Overall, fishers tend to leave nets in the water longer when water temperatures are cooler as it

increases catch rates and like most fish, invasive carp will survive longer in the cooler temperatures. Therefore, water temperature and soak time have been recorded during ride alongs since 2017. The lowest mean soak time in 2023 was 3.5 and the two lowest soak times resulted in the highest percentage of paddlefish released alive (Table 15), the combination of soak times greater than 7 hours and rising water temperatures attributes to lower survival rates. However, commercial fishers are more frequently using active methods for targeting invasive carp with gill nets and soak times of nets decreased overall in 2023. To increase the sample size, water temperature and soak times will continue to be recorded during ride-alongs in 2024.

Murray State University

Objective 1. Assess impacts on native species that compete for food resources with invasive carp.

Activities and Methods:

Murray State University conducted sampling and aging of Gizzard Shad and Threadfin shad during 2021 through 2023. Shad were captured with nighttime boat electrofishing and surface trawling. Shad ages were determined by examining the sagittal otolith.

In our samples, shad catch rates tended to be higher in Lake Barkley for nighttime electrofishing (Table 17) and nighttime surface trawling (Table 18). Mean size of shad tended to be greater in Kentucky Lake (Tables 19 and 20) suggesting growth is related to density in these populations. Shad growth tends to slow down around age 3 in both lakes (Figures 3, 4, and 6). Relative weight of Gizzard Shad was below standard for both lakes across all lengths (Figure 5). Shad caught in the surface trawl were larger in Kentucky Lake (Figure 7 & 8). Otoliths were a reliable method for aging Gizzard shad (Tables 21 and 22). Mortality estimates for Gizzard Shad were much higher in fall samples compared to spring samples (Figure 9). Gizzard shad seem to spawn in late April / early May in both lakes (Figure 10). These data will be useful as a baseline to track potential changes in shad communities over time.

Recommendations:

- Continued monitoring of bycatch through the invasive carp harvest program. Increased staff effort will be required as the number of unique commercial trips increase, to properly evaluate potential impacts on native species through the program.
- Continued monitoring of native bait fish species within the reservoirs, to track population responses to the reduction of invasive carp biomass to determine if any remediation projects should be considered within the system.
- Continue education and outreach efforts to inform the public about commercial fishing efforts, to minimize user conflicts. This can be accomplished through continued creel efforts, boat ramp signage and public forums.

References:

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Tables and Figures:

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

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

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

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

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

* Mean CPUE for each reservoir

Table 3. Relative weight (Wr) values of gizzard shad collected from boat electrofishing and Paupier net sampling in Barkley and Kentucky Reservoirs in fall of 2017-2023.

Kentucky Reservoir			
Year	No.	Wr	S.E.
2023	546	84	0.36
2022	1527	91	0.3
2021	85	92	0.5
2020	95	92	0.8
2019	80	92	0.9
2018	268	103	1.70
2017	82	155	1.63

Barkley Reservoir			
Year	No.	Wr	S.E.
2023	392	86	0.32
2022	440	90	0.49
2021	34	90	1
2020	47	93	0.7
2019	69	94	1
2018	35	92	3.08
2017	125	87	1.99

*Gizzard Shad Relative Weights based on formula presented in Balckwell et al. 2000.

Table 4. Paupier Net and Night-time Electrofishing (EF) sampling CPUEs for Kentucky Reservoir in fall of 2023.

Location	Effort (hr)	GZSD CPUE (fish/hr)	TFSD CPUE (fish/hr)	SKJH CPUE (fish/hr)	SVCP CPUE (fish/hr)
KY Reservoir Mean EF *	6	823	505	12	1
<i>KY Reservoir Mean Pauper *</i>	3.9	2309	2117	11	36
Big Bear EF	1.5	356	125	21	1
<i>Big Bear Pauper</i>	0.66	2303	20	9	36
Sledd Creek EF	1.5	142	128	7	2
<i>Sledd Creek Pauper</i>	0.5	2466	16	2	30

* Includes embayment's other than Big Bear and Sledd Creek

Table 6. Comparison of fall electrofishing CPUE for selected species collected in Kentucky Lake tailwaters in 2015 (effort = 1.0 hours), 2016 (effort = 1.75 hours), 2017 (effort = 4.5 hours), 2018 (effort = 1.25 hours), 2019 (effort = 3.75 hours), 2020 (effort = 2.75 hours), 2021 (effort = 3.75 hours), 2022 (effort = 4.5 hours), and 2023 (effort = 4.5 hours). (CPUE=catch per unit effort; S.E.=standard error)

Species	Fall 2015		Fall 2016		Fall 2017		Fall 2018		Fall 2019		Fall 2020		Fall 2021		Fall 2022		Fall 2023	
	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.	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	89	22.3	44	17.6	25	13.9	2	0.7
Gizzard shad	275	58.6	194	78.0	163	61.1	22	10.2	240	92.1	163	69.7	44	21.4	47	11.4	113	30.7
Threadfin shad	251	176.3	1690	1251.0	1263	637.0	2557	1845.1	27	14.9	712	241.1	665	291.6	1860	795.2	330	138.7
Grass carp	13	1.9	6	2.5	2	0.7			6	2.8	8	4.7	1	0.8	2	0.7	2	0.5
Silver carp	6	2.6	44	22.4	4	1.6	9	6.9	4	2.0	9	4.9	9	3.1	2	0.7	2	0.8
Smallmouth buffalo	10	2.6	9	3.7	5	2.1	1	0.8	8	3.0	2	0.8	4	1.3	5	1.2	2	0.7
Bigmouth buffalo					1	0.4	2	1.0					<1	0.3	<1	0.4	<1	0.2
Black buffalo	6	2.0	3	1.9	<1	0.2			1	0.4	<1	0.4			<1	0.4		
Blue catfish					<1	0.2			<1	0.3					<1	0.2		
Channel catfish			1	0.6	1	0.9			<1	0.3					1	0.6	<1	0.4
Flathead catfish			4	1.2	4	1.4			3	1.4	<1	0.4	1	0.4	1	0.5	2	0.7
White bass	8	4.3	7	4.0	<1	0.3	6	5.6	4	1.9	5	2.5	3	1.8	1	0.7	5	1.3
Yellow bass	162	83.5	17	13.3	26	4.1	7	4.3	18	7.8	3	1.6	1	0.4	6	3.1	11	4.3
Striped bass					2	1.0	2	1.0							<1	0.2	<1	0.2
Bluegill	96	29.2	41	11.8	128	30.7	20	4.0	127	48.8	26	5.9	4	2.1	34	8.2	38	6.9
Longear sunfish	14	14.0	48	12.0	80	25.0	7	4.8	67	15.4	10	3.9	2	1.2	5	1.6	8	2.3
Redear sunfish	1	1.0	6	2.3	6	1.6			15	3.9	2	1.1	1	0.4	2	1.0	<1	0.3
Smallmouth bass	9	2.5	21	5.2	11	3.2	2	1.0	29	12.3	10	2.8	6	2.6	15	4.1	43	6.7
Spotted bass	1	1.0	1	0.6	3	1.4	1	0.8	3	1.4					<1	1	2.63	1
Largemouth bass	62	19.8	86	9.4	35	4.3	7	2.9	29	6.2	15	3.6	5	1.7	13	3.2	19	2.7
White crappie	2	2.0	1	0.7	1	0.4			3	1.9					<1	0.2	<1	0.2
Black crappie	2	2.0	1	0.6	3	1.7			2	1.5								
Sauger	1	1.0			1	0.4							1	0.5	<1	0.2	1	0.3
Freshwater drum	13	5.7	6	1.5	4	0.7	4	2.2	8	2.5	11	2.8	5	1.4	15	12.5	12	9.4
White bass/Striped bass hybrid	1	1.0	1	1.1	1	0.5									<1	0.4	1	0.4
Striped mullet											1	1.0	1	0.8	<1	0.6		

Table 7. Comparison of fall electrofishing CPUE for all species collected in Lake Barkley tailwaters in 2016 (effort = 1.99 hours), 2017 (effort = 3.0 hours), 2018 (effort = 1.0 hour), 2019 (effort = 3.0 hours), 2020 (effort = 2.75 hours), 2021 (effort = 3.0 hours), 2022 (effort = 3.0 hours), and 2023 (effort = 3.0 hours). (CPUE=catch per unit effort; S.E.=standard error)

Species	Fall 2016		Fall 2017		Fall 2018		Fall 2019		Fall 2020		Fall 2021		Fall 2022		Fall 2023	
	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.	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	41	10.78	28	10.9	17	7.3	11	3.6
Gizzard shad	209	52.4	104	18.2	23	8.1	362	224.8	189	49.03	8	5.0	38	14.5	113	34.6
Threadfin shad	4598	1818.7	1252	602.1	67	12.8	30	18.8	1298	719.49	378	182.4	1263	352.9	2103	985.2
Grass carp	5	2.6	1	0.5			6	1.7	3	1.22	3	0.7			1	0.4
Silver carp	4	2.0	14	7.7	29	17.2	42	33.4	23	6.58	24	6.4	11	2.5	6	2.1
Smallmouth buffalo	15	7.6	10	2.7	1	1.0	5	3.2	10	3.75	3	1.6	13	4.8	5	2.6
Bigmouth buffalo	1	0.9	<1	0.3	1	1.0										
Black buffalo			1	0.7									<1	0.33	1	0.37
Channel catfish	<1	0.4	1	0.5					1	0.49			<1	0.33		
Flathead catfish	8	3.6	6	3.1			22	5.9	4	1.57	2	1.2	4	1.3	1	0.4
White bass	7	3.9	3	1.1	3	3.0	1	0.7	1	0.56	2	1.4	6	2.9	4	2.6
Yellow bass	2	0.7	28	16.0			4	3.0	3	1.24	2	1.0	<1	0.7	1	0.4
Striped bass	1	0.9	2	1.4	1	1.0	<1	0.3	2	1.25					<1	0.33
Bluegill	46	15.3	56	14.6	70	14.5	50	13.2	37	11.66	21	5.9	21	6.4	10	2.2
Longear sunfish	102	25.0	83	16.8	46	25.4	153	30.5	41	10.06	14	4.7	16	4.1	11	4.5
Redear sunfish	8	2.1	3	1.2	2	1.2	3	1.2	2	0.83	3	1.2	<1	0.3	1	0.4
Smallmouth bass	7	2.3	9	1.2	4	1.6	29	7.2	8	1.53	13	3.0	12	2.1	23	6.1
Spotted bass	2	1.0	<1	0.3	1	1.0	7	2.0	1	1.09			<1	0.45	<1	0.28
Largemouth bass	48	8.0	55	10.3	13	5.0	30	8.1	26	11.01	15	5.1	6	2.3	15	3.2
White crappie	4	1.5	1	0.7			<1	0.3	<1	0.36						
Black crappie			2	1.3			<1	0.3	<1	0.36	<1	0.3			1	0.37
Freshwater drum			5	1.5	7	4.7	9	3.4	8	1.87	5	1.7	11	3.0	4	1.3
White bass/Striped bass																
Striped bass	<1	0.4	3	2.3	4	4.0			1	0.73	1	1.0	<1	0.3		

Table 8. Length frequency and CPUE (fish/hr) for select species of fish collected during 4.5 hours of electrofishing at the Kentucky Tailwater in fall of 2023. (CPUE = catch per unit effort; S. E. = standard error)

effort: S. E. = standard error)																																		TOTAL	CPUE (fish/hr)	S. E.
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	29	30	31	32				
Skipjack herring						1	3	3		2																							9	2	0.7	
Gizzard shad*		1	6	13	4	45	59	57	51	59	25	54	13	8	2						1												541	113	30.7	
Threadfin shad*		33	221	34																													1713	330	138.7	
Grass carp																					3		2	1					1	1			8	2	0.5	
Common Carp																						1	1	2			1	1					6	1	0.5	
Silver carp																											1	4			2	2		9	2	0.8
Emerald Shiner*	13	54	62	1																													242	47	20.9	
Smallmouth buffalo												1	2	2	2	2			1	1													11	2	0.7	
Channel Catfish																					1		1										2	0	0.4	
Flathead catfish							1		1	2	2	2	1										1										10	2	0.7	
White bass				1	2	5	8	8	1							1																	26	5	1.3	
Yellow bass		1	14	7	17	9	6	2																									56	11	4.3	
Bluegill		95	33	47	10	11	3																										199	38	6.9	
Longear sunfish		16	12	9	6																												44	8	2.3	
Redear sunfish					1	1																												2	0	0.3
Smallmouth bass		1	18	43	68	56	26	3	1	1	3	1	2					1	1														225	43	6.7	
Spotted Bass				1	6	3	3	1																									14	2.63	0.96	
Largemouth bass		1	3	6	13	18	17	12	8	2	4	3	4	3	2	1	1			1													99	19	2.7	
White Crappie				1																														1	0.19	0.19
Freshwater drum*			1	7	21	2	1									2		1	1		4												63	11.7	9.35	
White bass/Striped bass hybrid				1	1	1																											3	0.56	0.4	

* species were randomly subsampled

Table 9. Length frequency and CPUE (fish/hr) for select species of fish collected during 3.0 hours of electrofishing at the Barkley Tailwater in fall of 2023. (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	29	30	31	32	33	34				
Skipjack herring			1	1	1	9	16	8	3	1																								40	11	3.6		
Gizzard shad*		1	2	11	15	28	22	23	34	29	24	23	14	2	3																			354	113	34.6		
Threadfin shad*		77	216	12																														7321	2103	985.2		
Grass carp																									1				1	1				3	1	0.4		
Silver carp																				1	1	1	1			1	1	2		2	3	4	3	1	1	22	6	2.1
Smallmouth buffalo																3	4	6	1	4															18	5	2.6	
Flathead catfish									1								1																		2	1	0.4	
White bass							1	2	3	1			4	4																					15	4	2.6	
Yellow bass							1					1																								2	1	0.4
Bluegill		3	3	4	15	7	3																												35	10	2.2	
Longear sunfish		9	11	12	8																														40	11	4.5	
Redear sunfish						1					1	1																								3	1	0.4
Smallmouth bass				6	13	17	9	1	9	5	4	4	3	2	3	2	1																		79	23	6.2	
Largemouth bass					3	5	20	5	1		1	1	5	3	1	3	1	3																	52	15	3.2	
Black crappie											1		1																							2	1	0.4
Sauger																	2																			2	1	0.4
Freshwater drum															1	1	1	3	4	3	1														14	4	1.3	

* species were randomly subsampled

Table 10. Mean relative weight (Wr) and standard error for a subsample of fish collected during fall electrofishing at Kentucky Tailwaters in 2016 - 2023. (S.E. = standard error)

Species	2016				2017				2018				2019				2020				2021				2022				2023			
	N	Mean	W _r	S.E.	N	Mean	W _r	S.E.	N	Mean	W _r	S.E.	N	Mean	W _r	S.E.	N	Mean	W _r	S.E.	N	Mean	W _r	S.E.	N	Mean	W _r	S.E.	N	Mean	W _r	S.E.
Gizzard shad	45	72	1.6		215	83	0.7		21	77	2.0		152	85	0.5		66	85	1.6		79	92	6.0		126	89	1.1		128	86	0.9	
Blue catfish					1	108							1	99											1	84						
Channel catfish	1	102			1	105							1	100											5	101	7.4					
Flathead catfish	7	98	6.2		19	100	6.3						11	99	6.2		1	106			1	123										
Yellow bass	29	84	1.8		104	83	2.2		7	90	12.3		33	80	4.6		4				3	88	8.6									
White bass	13	99	2.6		2	97	20.4		7	108	1.3		8	90	3.3		9	95	5.1		8	86	5.9		2	88	4.4		3	91	4.2	
Striped bass									1	101															1	87						
White bass/Striped bass	2	81	7.5																						2	109	7.3					
Bluegill	49	103	3.7		220	93	2.2		18	89	6.4		148	94	0.8		41	93	8.3		11	97	4.0		28	86	4.6		14	86	6.9	
Redear sunfish	10	85	6.9		28	93	3.3						42	97	2.3		4	85	5.3		2	104	4.2		6	102	23.6					
Smallmouth bass	13	91	2.0		9	92	3.4		1	82			4	92	5.5		6	100	4.9		9	95	4.9		12	93	3.3		6	87	3.9	
Spotted bass	1	123			6	109	3.1						1	117											1	84						
Largemouth bass	89	102	1.7		117	97	1.9		7	93	5.5		41	99	1.7		26	113	8.4		17	87	4.9		33	105	2.7		12	111	10.3	
White crappie	2	90	8.7		3	76	7.3						4	84	3.0																	
Black crappie					12	90	2.7																									
Sauger					3	97	21.8														4	78	4.2		1	71			1	83		
Freshwater drum	11	100	2.7		17	92	3.3		5	89	3.8		21	92	2.9		29	91	3.3		18	90	5.6		25	92	2.4		1	89		
Smallmouth buffalo	15	79	1.5		22	77	1.4		1	78			29	100	3.2		6	81	2.7		14	93	14.3									
Bigmouth buffalo					3	86	1		2	75	7.4																					
Silver carp	75	89	1.6		19	82	2.4		11	73	3.2		15	81	1.2		26	76	1.7		32	76	2.0									

Table 11. Mean relative weight (Wr) and standard error for a subsample of fish collected during fall electrofishing at Barkley Tailwaters in 2016 - 2023. (S.E. = standard error)

Species	2016				2017				2018				2019				2020				2021				2022				2023			
	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.	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	53	96	4.2		20	73	3.1		82	89	1.5		171	88	1.7		
Channel catfish	1	67			2	92	1.0									2	111	5.6					1	110								
Flathead catfish	13	94	1.7		17	106	5.8						66	99	3.8	10	96	3.4		6		6.8										
Yellow bass	2	88	8.7		73	79	1.3						11	87	4.5	7	85	4.5		3	74	8.3										
White bass	11	96	3.7	8	86	2.2	3	98	4.9	3	85	7.7	2	115	1.8	3	96	6.4	16	90	3.0	15	109	14.7								
Striped Bass				2	90	5.9				1	109		5	108	5.6																	
White bass/Striped bass hybrid				9	89	2.7	4	103	4.6				2	102	2.8	3	73	5.0	1	99												
Bluegill	49	111	3.1	107	104	2.5	31	115	8.3	85	103	1.6	63	102	2.3	29	118	10.6	27	102	6.2	26	100	3.9								
Redear sunfish	17	93	2.1	9	97	3.7	2	106	14.6	9	101	3.9	4	101	13.0	4	101	12.4	1	45		3	77	8.1								
Smallmouth bass	4	86	3.6	11	95	3.8	3	87	5.6	22	92	2.5	11	93	2.5	7	81	4.4	15	95	2.8	43	93	2.0								
Spotted bass	3	107	11.0					1	125	3	106	10.1	2	103	9.4				2	104	91	2.4	1	75	23							
Largemouth bass	37	101	1.9	118	95	1.2	10	95	3.4	58	98	1.6	41	101	4.3	20	101	7.1	10	102	4.0	24	96	5.1								
White crappie				3	88	6.6				1	92		1	116																		
Black crappie				5	86	6.3				1	76		1	85			1	93										2	86	0.9		
Freshwater drum	6	84	4.4	14	97	3.0	7	82	3.5	27	103	2.3	22	96	2.3	14	92	2.1	33	95	2.5	14	92	3.0								
Smallmouth buffalo	21	84	1.4	28	84	1.6	1	99		16	92	1.9	27	81	1.4	9	78	2.6														
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	64	77	1.2	70	78	1.3														

Table 12. Number and disposition of bycatch from commercial fishing efforts under the Invasive 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 Invasive 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
2020	148	92.5	17,394	78.8	768	99.2	222	85.7	18,592
2021	126	98.4	19,433	87.7	733	99.0	126	81.0	20,418
2022	47	93.6	11,335	80.2	568	98.8	58	81.0	12,008
2023	93	86.0	10,427	66.6	1008	98.6	236	78.4	11,764

*Sport fish are defined in 301 KAR 1:060

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

Table 13. Species composition, number of individuals captured, and survival rate of species observed in bycatch during KDFWR ride-alongs with commercial fishers fishing under the Invasive Carp Harvest Program in 2016 - 2023. Survival rate of fish is defined as fish that swim away after release.

	Species	2016		2017		2018		2019		2020		2021		2022		2023	
		Number captured	Survival rate	Number captured	Survival rate	Number captured	Survival rate	Number captured	Survival rate	Number captured	Survival rate	Number captured	Survival rate	Number captured	Survival rate	Number captured	Survival rate
Sport Fish	White bass	1	<1%					1	100%			2	100%	1	100%		
	Yellow bass	20	50%	1	100%	6	33%	4	75%			1	100%			3	100%
	Striped bass	19	79%	1	100%	3	33%	5	80%	10	80%	1	100%	2	50%		
	Hybrid striped bass	2	100%			1	100%	5	80%	2	100%	1	100%				
	Sauger	1	<1%	2	100%	3	33%	4	75%	2	50%	3	100%	3	66%	1	100%
	Largemouth bass	1	100%	5	80%	3	67%	25	80%	4	75%	9	100%	2	100%	1	<1%
	Smallmouth bass							4	100%							1	100%
	Redear sunfish	1	100%			2	50%	6	83%			1	100%	2	100%		100%
	Black crappie					5	50%	1	100%	1	100%					1	100%
	White crappie			1	100%	6	67%	2	50%			1	100%			1	<1%
Total		46	88%	10	96%	29	54%	57	82%	19	81%	19	100%	10	83%	8	75%
Catfish species	Blue catfish	27	74%	47	94%	42	91%	96	95%	32	100%	38	92%	62	97%	43	93%
	Channel catfish	10	80%	17	82%	12	100%	13	100%	5	100%	16	96%	3	100%	11	100%
	Flathead catfish	9	89%	19	100%	8	88%	40	100%	7	100%	26	100%	28	89%	8	100%
	Total	46	81%	83	92%	62	93%	149	98%	44	100%	80	95%	93	95%	62	95%
Rough Fish*	Paddlefish	83	48%	62	48%	38	32%	63	48%	26	50%	16	69%	7	28%	17	47%
	Lake sturgeon					1	100%					1	100%				
	Shovelnose sturgeon									3	100%						
	Skipjack herring	23	17%	47	13%	18	<1%	79	<1%	16	<1%	25	36%	29	52%	85	<1%
	Smallmouth buffalo	145	99%	13	85%	98	100%	186	98%	103	100%	173	99%	236	99%	249	99%
	Bigmouth buffalo	8	100%	4	100%	7	100%	34	97%	14	100%	12	75%	6	100%	16	100%
	Black buffalo	17	94%			2	100%	4	100%	1	100%					2	100%
	Common carp	48	98%	33	94%	27	100%	479	84%	36	97%	17	100%	10	100%	21	100%
	Gizzard shad	5	<1%	3	33%			3	<1%	1	100%					1	100%
	Freshwater drum	76	67%	27	52%	73	71%	71	63%	40	82%	54	94%	56	89%	50	76%
	River carpsucker	3	100%					35	97%	41	100%	5	100%	2	100%		
	Spotted gar					2	50%	3	100%	1	100%	2	100%	1	100%	4	100%
	Longnose gar	8	88%	9	44%			9	67%	3	100%	3	100%	7	100%	3	33%
	Shortnose gar	9	44%	1	100%	2	50%	11	55%	5	100%	5	100%	1	100%	6	100%
	Total		571	77%	365	72%	392	83%	1277	87%	329	98%	299	92%	348	93%	437

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

Table 14. Comparison for number of paddlefish, catfish, and sport fish caught per trip as reported by commercial fishers fishing under the Invasive Carp Harvest Program versus observations made by KDFWR staff during ride-alongs in 2016-2023. (S.E. = standard error).

Species	2016				2017				2018				2019				2020				2021				2022				2023			
	Ride-	S.E.	alongs	S.E.	Ride-	S.E.	alongs	S.E.	Ride-	S.E.	alongs	S.E.	Ride-	S.E.	alongs	S.E.	Ride-	S.E.	alongs	S.E.	Ride-	S.E.	alongs	S.E.	Ride-	S.E.	alongs	S.E.	Ride-	S.E.	alongs	S.E.
Paddlefish	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	0.11	0.01	0.87	0.49	0.05	0.01	0.28	0.13	0.03	0.01	0.15	0.09	0.13	0.03	0.28	0.13
Blue catfish	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	0.19	0.01	1.07	0.34	0.15	0.01	0.66	0.2	0.19	0.02	1.35	0.38	0.41	0.08	0.70	0.2
Channel catfish	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	0.05	0.01	0.17	0.11	0.05	0.01	0.28	0.08	0.06	0.01	0.07	0.05	0.67	0.01	0.18	0.08
Flathead catfish	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	0.06	0.01	0.23	0.09	0.04	0.01	0.45	0.19	0.03	0.01	0.61	0.23	0.74	0.02	0.13	0.05
Catfish*	0.07	0.02			0.17	0.05			0.23	0.04			0.21	0.03			0.08	0.01			0.16	0.01			0.08	0.02			0.33	0.12		
Largemouth bass	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	0.02	<0.01			0.02	<0.01	0.16	0.06	0.01	<0.01	0.04	0.03	<0.01	<0.01	0.02	0.02
Smallmouth bass	<0.01				<0.01				<0.01	<0.01	0.08	0.05	0.02	<0.01	0.13	0.06		<0.01	<0.01		<0.01	<0.01			<0.01	<0.01			<0.01	<0.01	0.02	0.02
Bass**	0.02	0.02			0.02	0.01			0.01	<0.01			0.02	0.01				<0.01	<0.01		<0.01	<0.01			<0.01	<0.01			0.01	<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	<0.01	<0.01	0.07	0.07			0.02	0.02								
Striped bass	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	0.01	<0.01	0.33	0.33	<0.01	<0.01	0.02	0.02	<0.01	<0.01	0.04	0.03	0.01	0.01		
Yellow bass	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	<0.01	<0.01			<0.01	<0.01	0.02	0.02	<0.01	<0.01			0.01	<0.01	0.05	0.04
White bass	<0.01		0.07	0.05					<0.01	<0.01	0.02	0.02	<0.01	<0.01			<0.01	<0.01			<0.01	<0.01	0.03	0.02	<0.01	<0.01	0.02	0.02	0.01	0.01		
Sauger	<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	0.01	<0.01	0.07	0.05	0.01	<0.01	0.05	0.03	<0.01	<0.01	0.07	0.04	<0.01	<0.01	0.02	0.02	
Crappie	0.01	0.01				0.03	0.03	0.01	0.01	0.29	0.21	<0.01	<0.01	0.06	0.05	<0.01	<0.01	0.03	0.03	<0.01	<0.01	0.02	0.02	<0.01	<0.01			0.01	<0.01	0.03	0.02	
Redear sunfish	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	<0.01	<0.01			<0.01	<0.01	0.02	0.02	<0.01	<0.01	0.04	0.03	<0.01	<0.01			
Yellow perch																													<0.01	<0.01		

*Commercial fishers do not always delineate species of catfish on their reports, therefore this row accounts for these catfish that were not identified to 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 15. Number and survival rate of paddlefish captured by commercial fishers during KDFWR ride-alongs under the Invasive Carp Harvest Program for each month paddlefish were observed caught in 2017 - 2023.

Year	Month	No. paddlefish captured	% released alive	Mean water temp (°F)	Mean soak time (hours)
2017	April	6	0%	67.6	13
	May	15	33%	68.5	10
	June	35	60%	79.5	8.3
	September	2	50%	74	10
	December	4	75%	50	21.3
2018	April	4	75%	54.9	11
	May	9	60%	66.1	10.2
	June	12	35%	81.7	10.6
	August	12	0%	82.9	11.6
2019	February	43	61%	46.9	11.4
	March	1	0%	49.8	11
	April	3	33%	60.25	9.7
	May	7	14%	74	6.4
	June	4	0%	76.9	11.3
	August	2	0%	84.1	8.8
	October	3	67%	69.8	8.2
2020	March	9	89%	49.1	7.8
	May	5	20%	66.1	6.5
	September	11	36%	77	7.25
	October	1	100%	68.6	8.8
2021	March	3	100%	57.5	3.25
	May	5	80%	63	13
	July	4	0%	87	9
	October	4	100%	71	11.25
2022	May	4	0%	75	8.5
	August	2	50%	80.5	3.625
	September	1	100%	76	5.5
2023	April	2	50%	60.5	3.5
	June	4	25%	79.5	7.5
	July	1	0%	82	7
	August	3	0%	84	11.75
	October	7	86%	72.4	4.25

Table 16. Kentucky Reservoir creel survey fishing pressure and catch rates from 1964 through 2023.

YEAR	Fishing Trips #	Fishing Pressure Total Angler Hours	Average Trip Length (hours)	Catch Rates Fish/Hour
	fishing trips	Hours	(hours)	Fish/Hour
1964	316,201	1,712,549	5.4	0.98
1978	343,440	1,181,882	3.4	
1979	213,138	917,413	4.3	
1984	440,368	1,175,264	2.7	
1985	304,722	1,253,296	4.1	0.91
1986	261,735	1,167,826	4.5	1.16
1987	334,373	1,316,938	3.9	1.25
1991	298,186	1,278,559	4.3	1.13
1998	84,049	337,169	4.0	0.81
2003	207,357	980,132	4.7	1.31
2004	376,210	1,351,675	3.6	1.24
2007	285,078	1,077,120	3.8	1.48
2011	228,393	982,665	4.3	1.59
2015	188,601	841,143	4.5	1.09
2017	173,145	855,798	4.9	1.60
2020	146,711	617,660	4.2	0.82
2023	98,550	449,112	4.6	1.50

Table 17. Average nighttime electrofishing catch per unit effort (CPUE, fish/hour) for Gizzard Shad and Threadfin Shad from Kentucky Lake and Lake Barkley during 2021 and 2022. Standard error shown in parenthesis.

	Kentucky Lake		Lake Barkley		Mann-Whitney U
	N	CPUE	N	CPUE	
All Gizzard Shad	1,647	66 (14)	4,434	233 (56)	W = 55, p-value = 1.6e-5
Gizzard Shad ≥180mm	1,401	56 (13)	1,120	59 (7)	W = 139.5, p-value = 0.02
Gizzard Shad ≥280mm	334	13 (4)	137	7 (2)	W = 237, p-value = 0.78
All Threadfin Shad	729	29 (15)	1,134	60 (36)	W = 191, p-value = 0.27

Table 18. Average nighttime surface trawling catch per unit effort (CPUE, fish/minute) for Gizzard Shad and Threadfin Shad from Kentucky Lake and Lake Barkley during 2021 and 2022. Standard error shown in parenthesis. Surface trawling was conducted only in Kentucky Lake during 2021.

	Kentucky Lake		Lake Barkley	
	N	CPUE	N	CPUE
Gizzard Shad	3,095	5 (2.9)	6,671	51 (16.4)
Threadfin Shad	29,233	44 (10.8)	25,170	191 (57.1)

Table 19. Sample size (N), mean length (mm) with standard error shown in parentheses and length range of shad collected from Kentucky Lake and Lake Barkley nighttime electrofishing surveys during 2021-2022.

	Kentucky Lake			Lake Barkley		
	N	Mean Length	Range	N	Mean Length	Range
Gizzard Shad	1,647	232.8 (1.4)	66-367	4,434	130.7 (1.0)	34-438
Threadfin Shad	729	89.4 (0.4)	58-167	1,134	82.3 (0.3)	53-158

Table 20. Sample size (N), mean length (mm) with standard error shown in parentheses and length range of shad collected from Kentucky Lake and Lake Barkley nighttime surface trawling surveys during 2021-2022.

	Kentucky Lake			Lake Barkley		
	N	Mean Length	Range	N	Mean Length	Range
Gizzard Shad	3,095	64.3 (0.3)	33-275	6,761	68.4(0.2)	25-208
Threadfin Shad	29,233	75.2 (0.1)	31-172	25,170	64.9 (0.1)	28-141

Table 21. Precision of two readers estimating the age of Gizzard Shad otoliths collected during the fall of 2021 from Kentucky Lake and Lake Barkley. ACV is the average coefficient of variation.

Fall 2021	N	Agreement	±1	±2	±3	ACV	SD
Kentucky Lake	98	92.9%	6.1%	1.0%	0.0%	1.6	6.0
Lake Barkley	108	90.7%	9.3%	0.0%	0.0%	1.5	5.4

Table 22. Precision of two readers estimating the age of Gizzard Shad otoliths collected during the spring of 2022 from Kentucky Lake and Lake Barkley. ACV is the average coefficient of variation.

Spring 2022	N	Agreement	±1	±2	±3	ACV	SD
Kentucky Lake	118	79.7%	19.5%	0.8%	0.0%	3.3	7.2
Lake Barkley	118	86.4%	12.7%	0.0%	0.8%	2.2	6.6

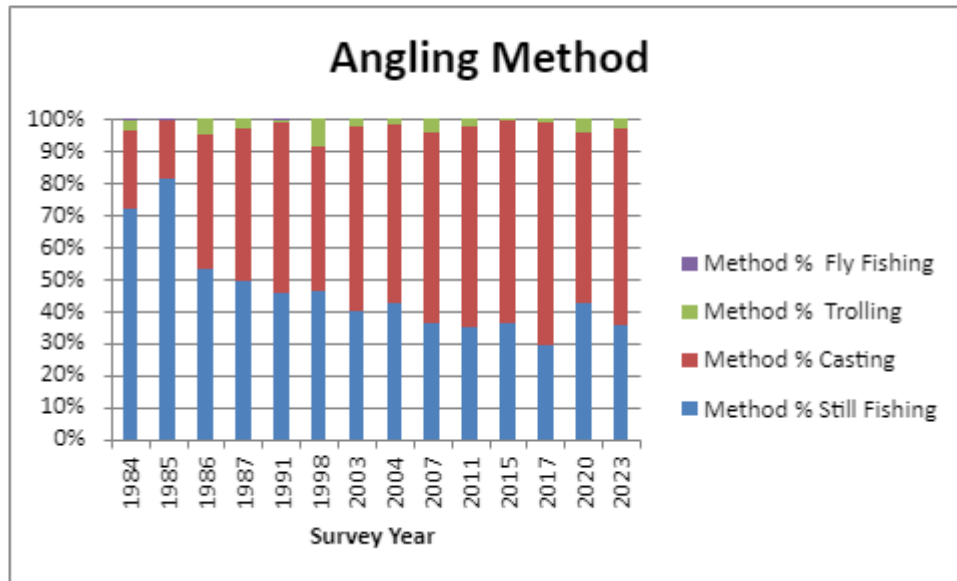


Figure 1. Angling method for fishing on Kentucky Reservoir 1984-2023.

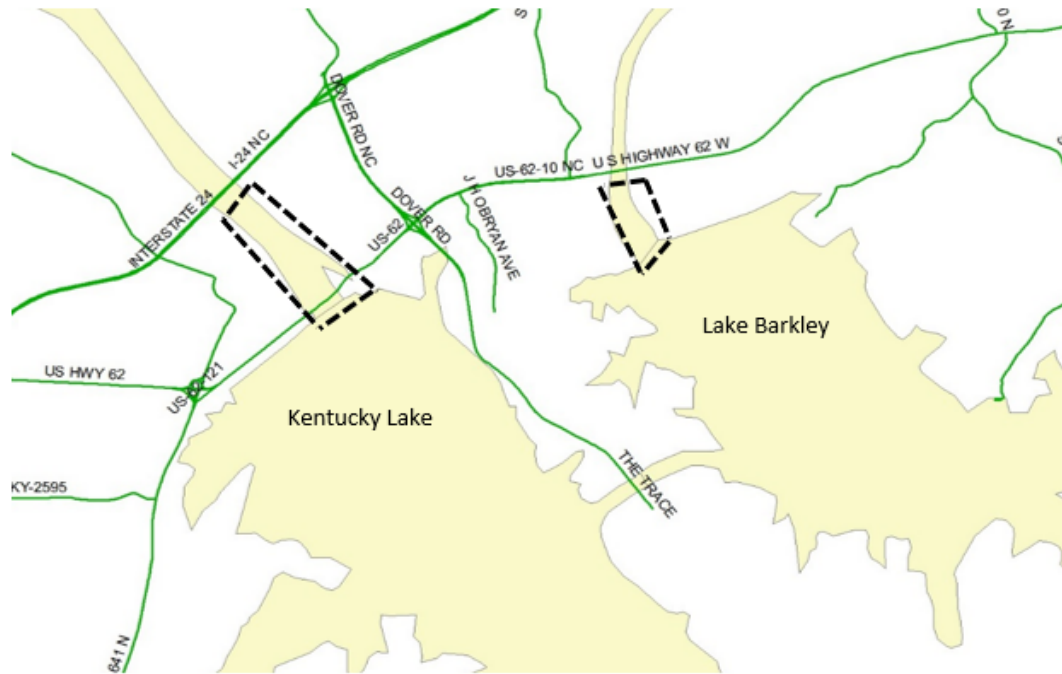


Figure 2. The tailwater electrofishing at Kentucky Tailwater extended from the dam downstream to the Interstate 24 bridge. The electrofishing at Barkley Tailwater extended from the dam downstream to the US Hwy 62 bridge. Sample areas are outlined by dashed line.

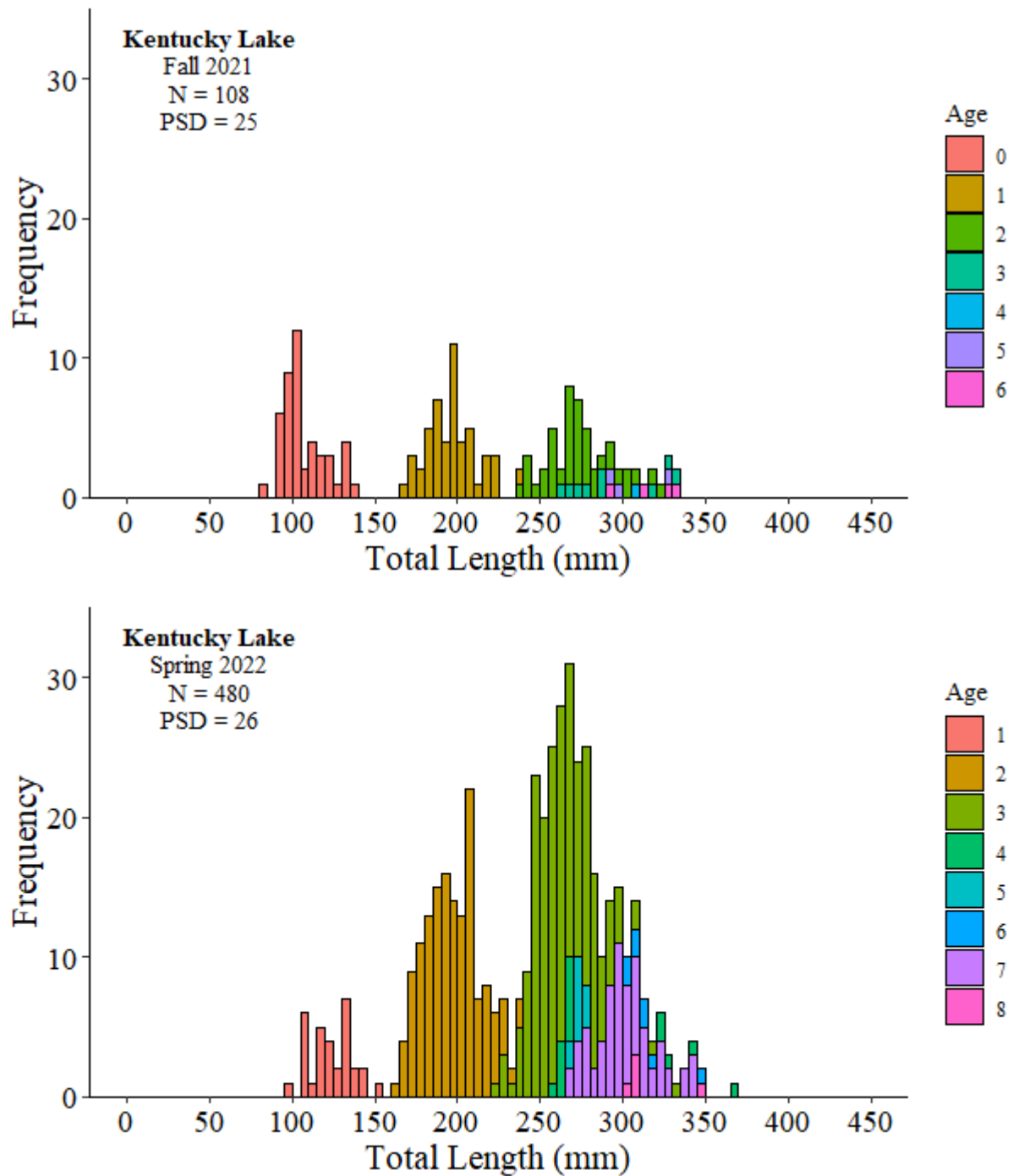


Figure 3. Length-age histograms of Gizzard Shad captured by nighttime electrofishing during fall 2021 (top) and spring 2022 (bottom) from Kentucky Lake. Sample size (N) and Proportional Size Distribution (PSD) values are also shown.

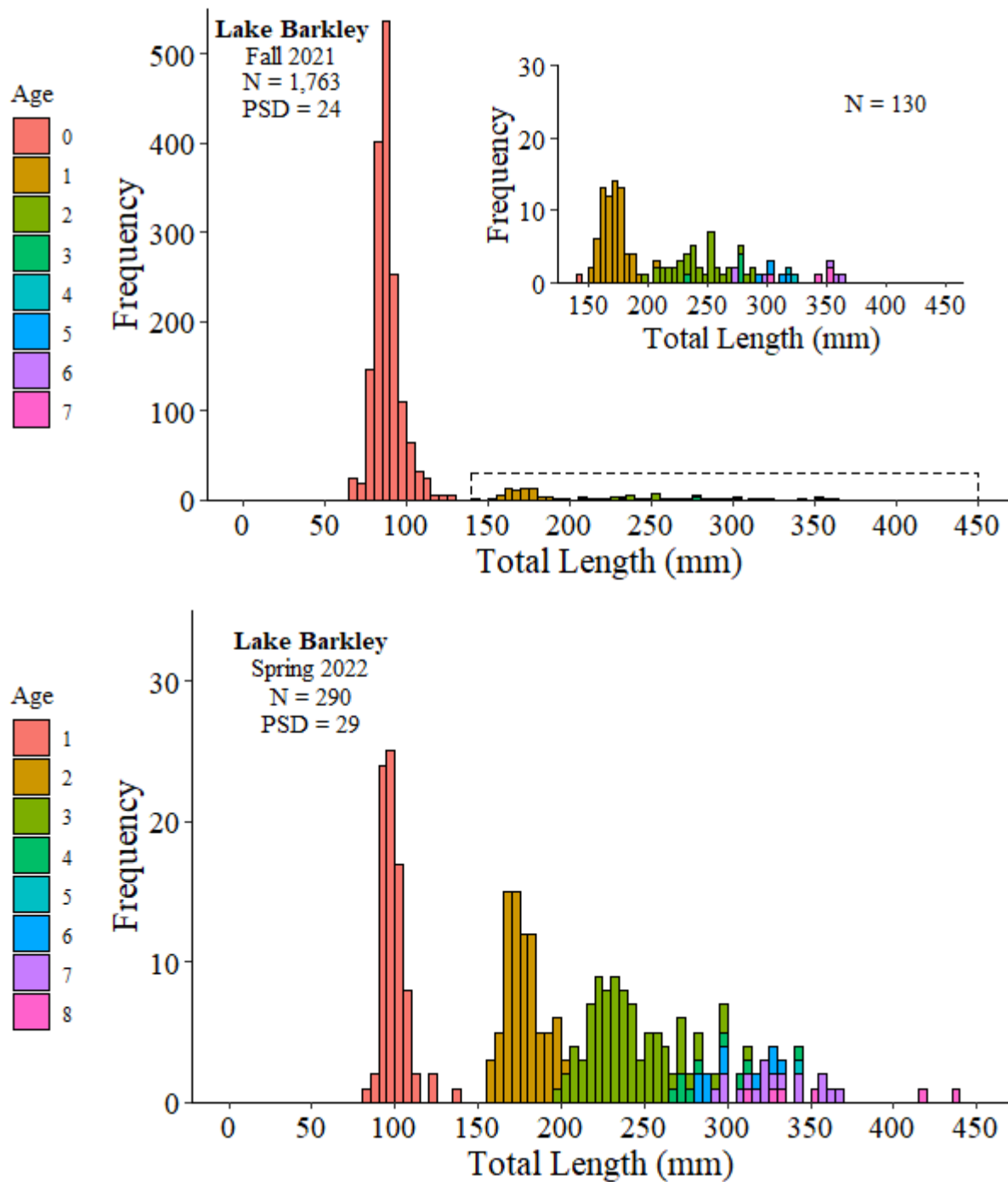


Figure 4. Length-age histograms of Gizzard Shad captured by nighttime electrofishing during fall 2021 (top) and spring 2022 (bottom) from Lake Barkley. Note the differences in y-axis between the plots, the top plot is also zoomed in on fish ≥ 150 mm for comparison. Sample size (N) and Proportional Size Distribution (PSD) values are also shown.

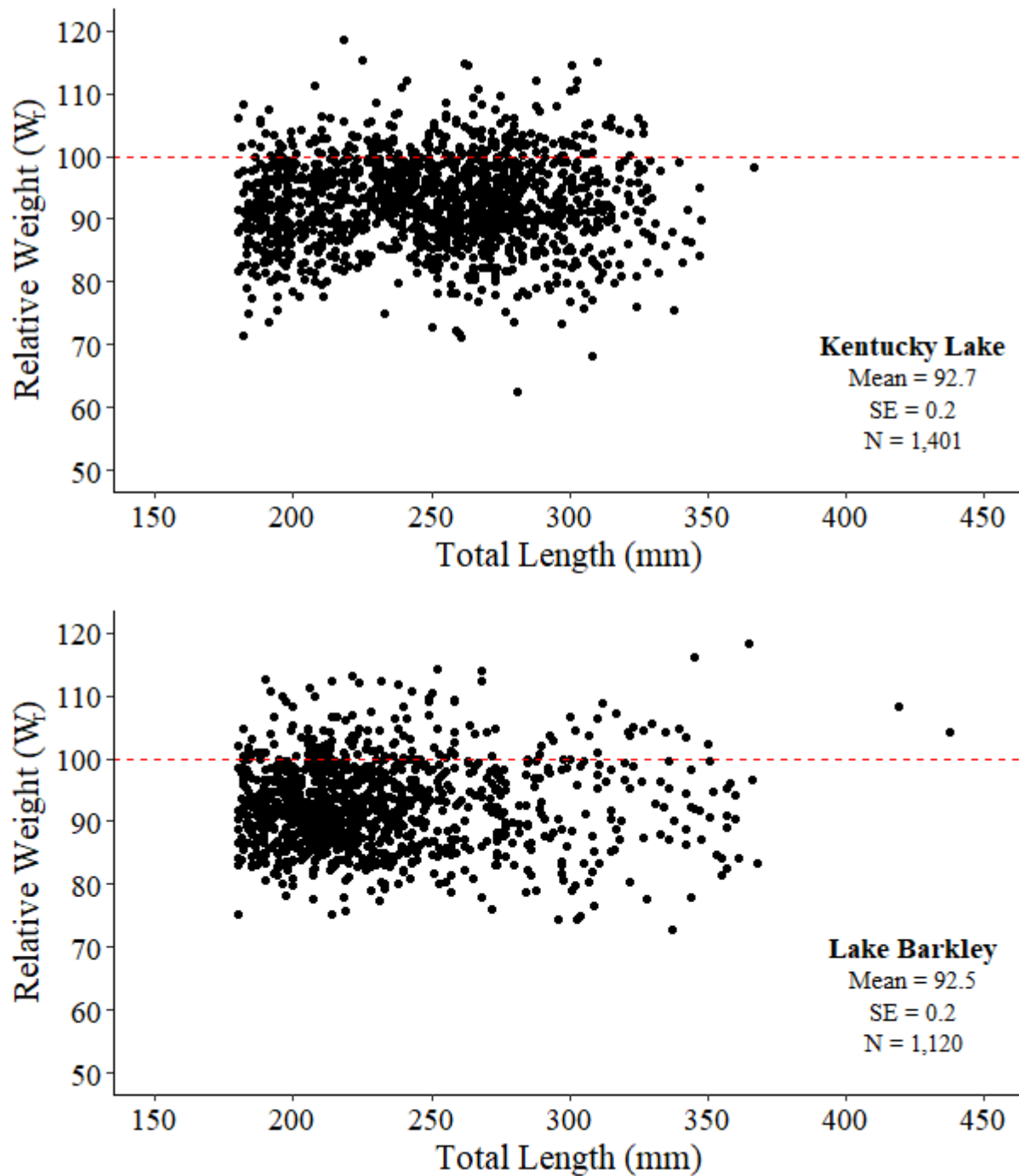


Figure 5. Scatterplot of total length (mm) and relative weight (W_r) of Gizzard Shad captured from Kentucky Lake (top) and Lake Barkley (bottom) during 2021 and 2022. Dashed red line represents a relative weight of 100 or equal to the 75th percentile for Gizzard Shad.

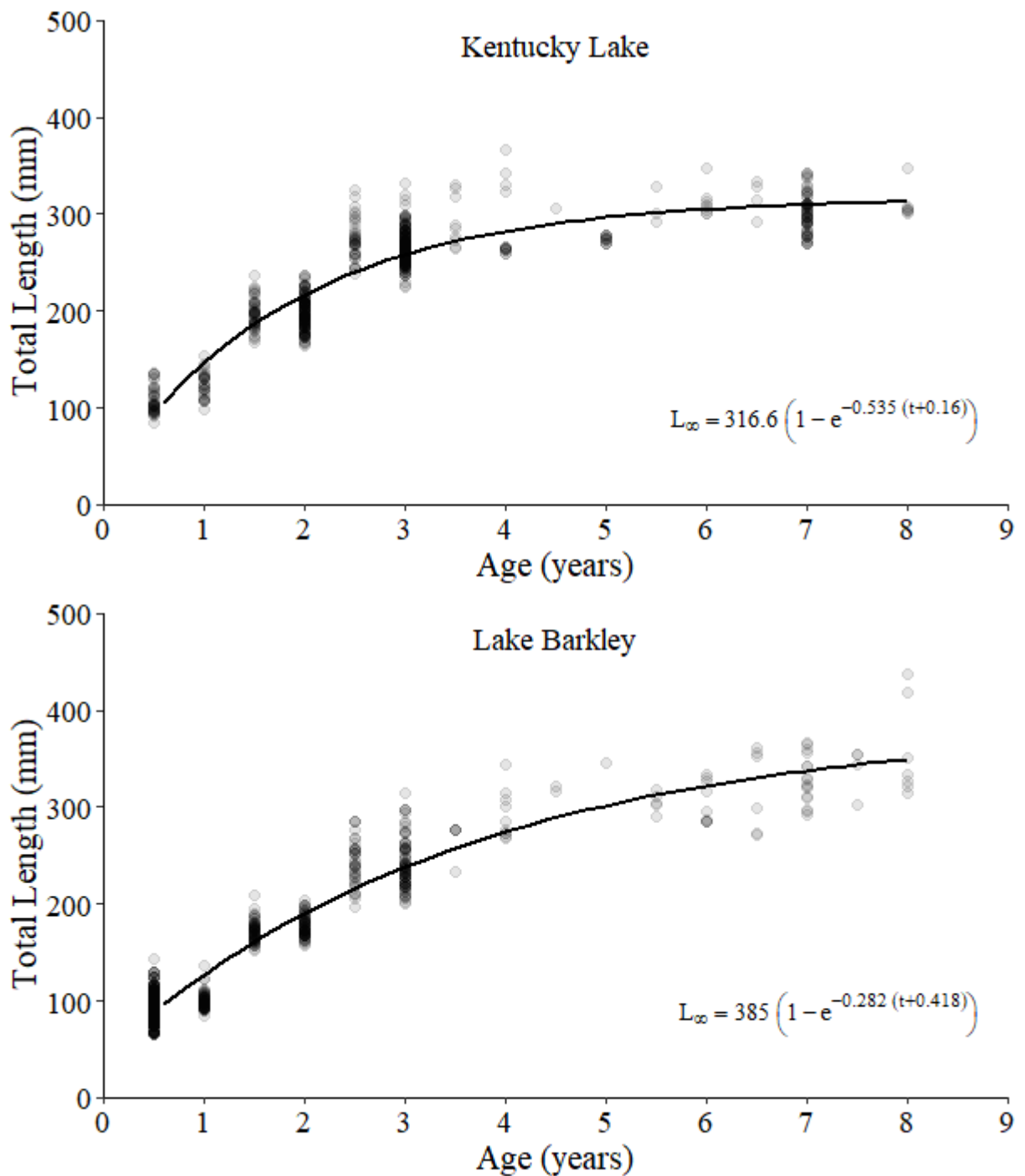


Figure 6. Kentucky Lake (top) and Lake Barkley (bottom) Gizzard Shad von Bertalanffy growth curve calculated from otoliths collected during October 2021 and April/May 2022. Gizzard Shad collected in October 2021 were given ages of half years to account for that year's growth.

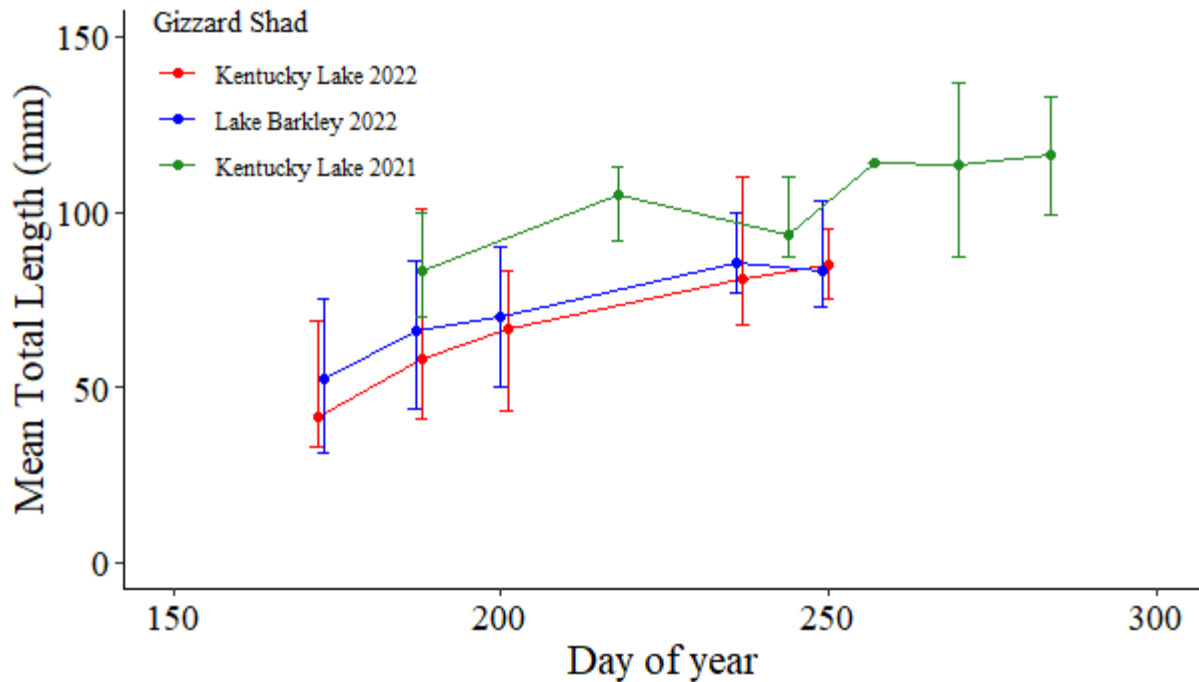


Figure 7. Mean length of young of year (YOY) Gizzard Shad by day of year captured during surface trawling surveys. Surface trawling only occurred on Lake Barkley during 2022. Error bars represent minimum and maximum lengths.

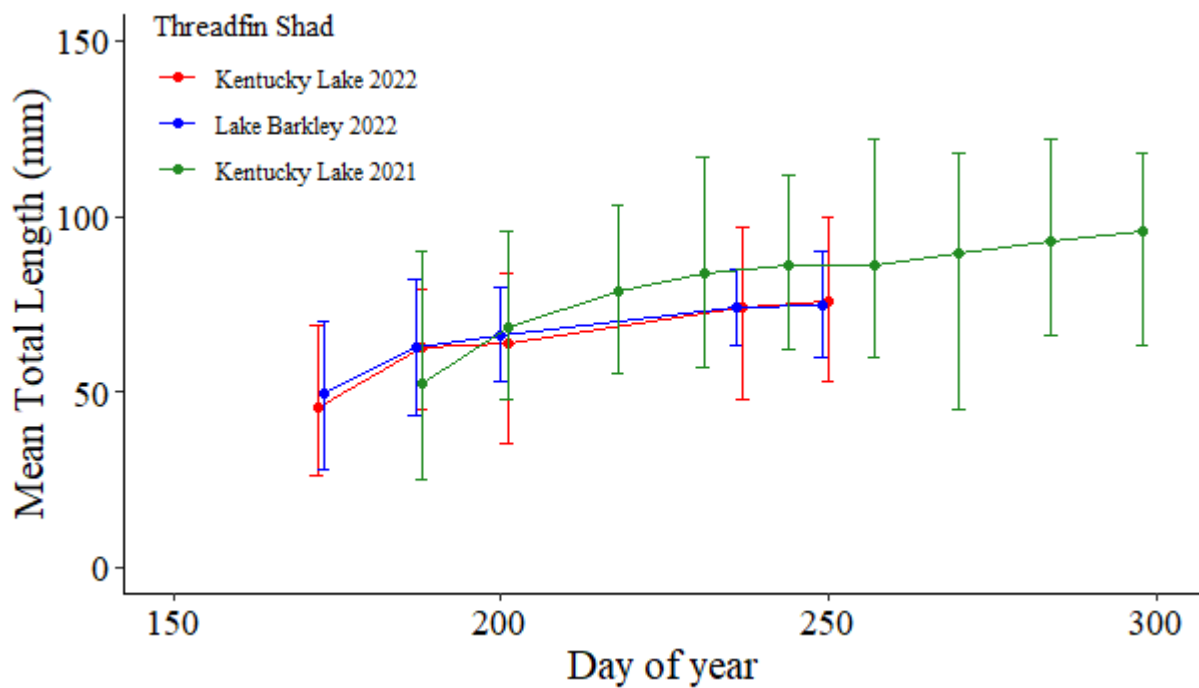


Figure 8. Mean length of young of year (YOY) Threadfin Shad by day of year captured during surface trawling surveys. Surface trawling only occurred on Lake Barkley during 2022. Error bars represent minimum and maximum lengths.

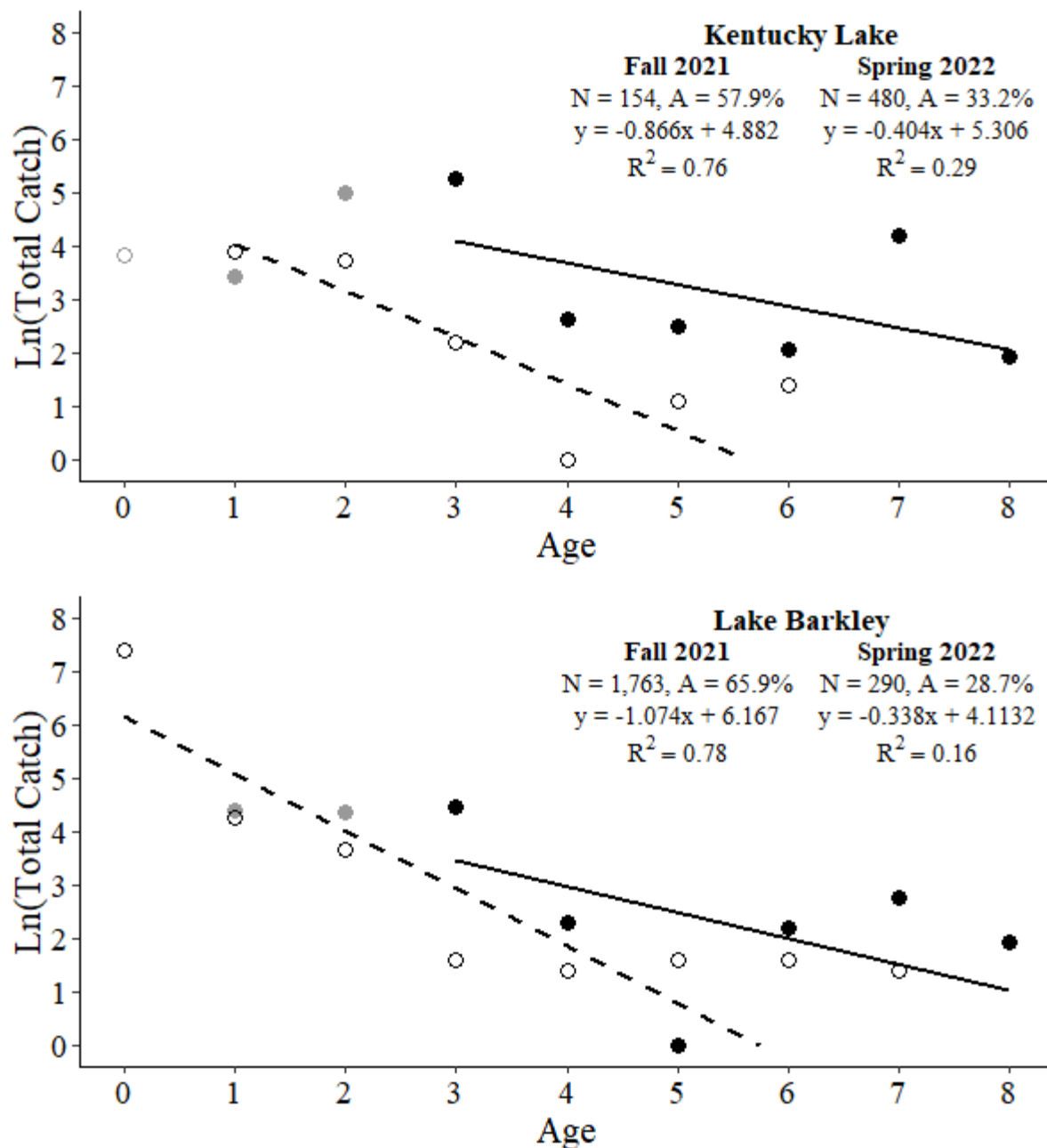


Figure 9. Weighted catch-curve regressions for Gizzard Shad in Kentucky Lake (top) and Lake Barkley (bottom) from fall 2021 (open circles/dashed line) and spring 2022 (filled circles/solid line). Grey dots represent year classes not included in regression analysis.

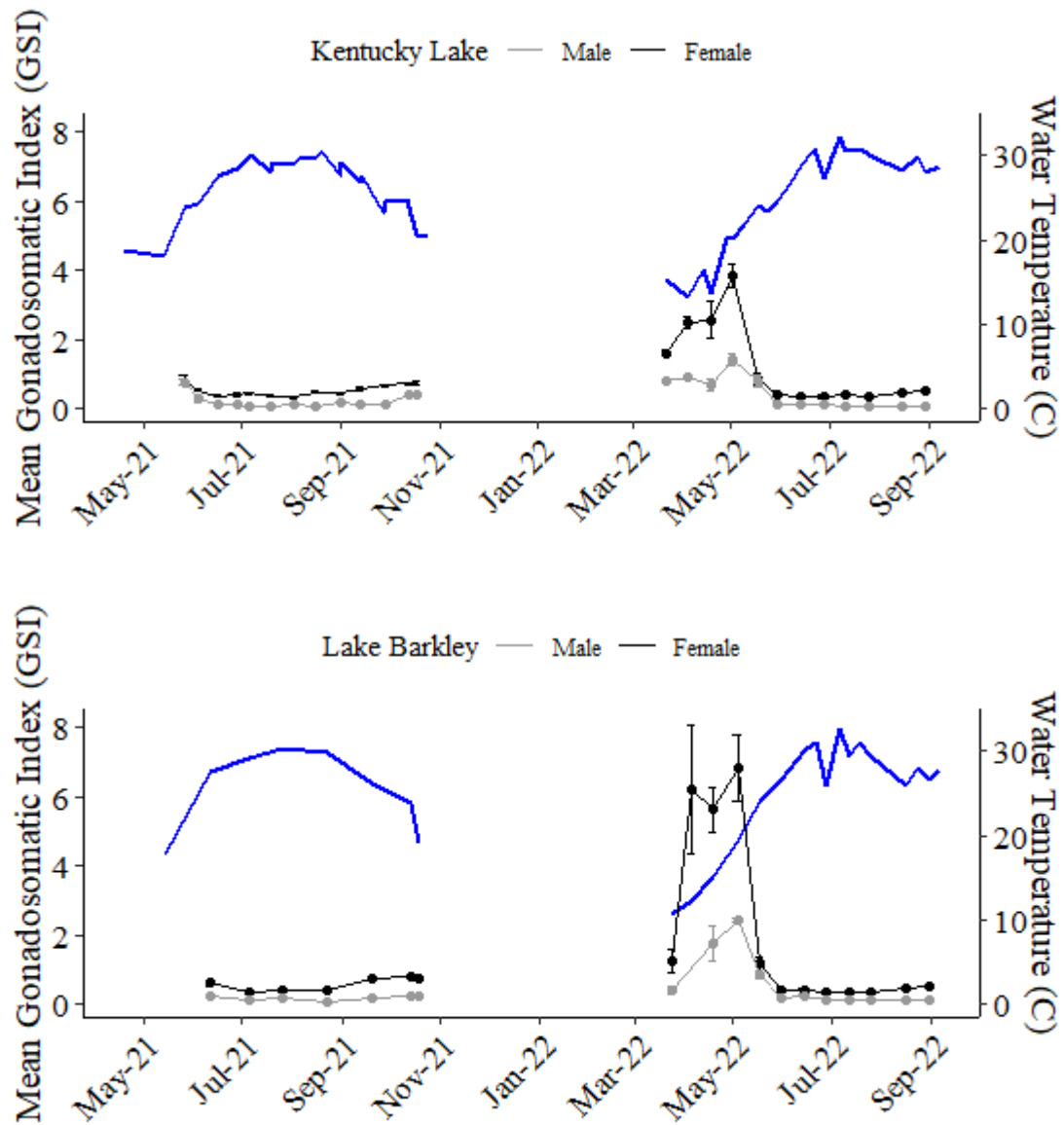
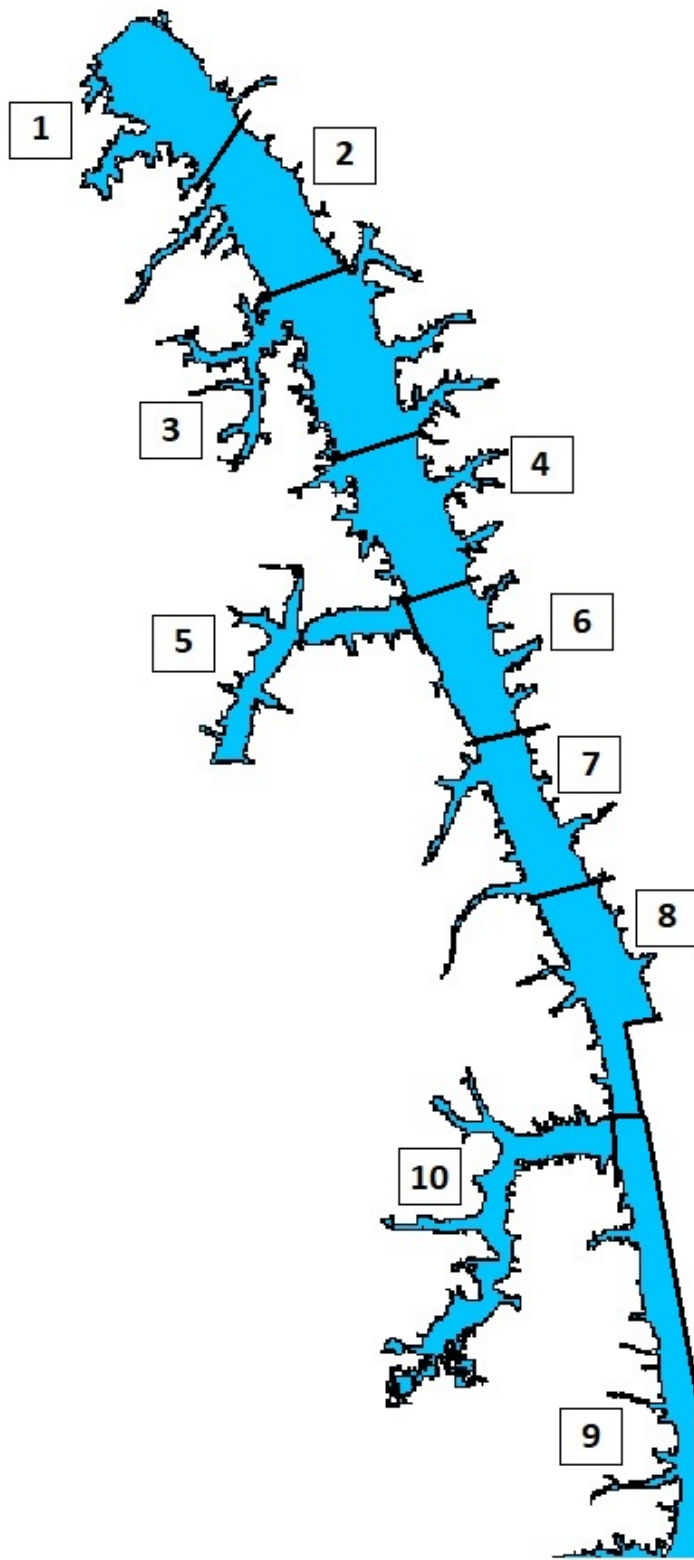


Figure 10. Mean gonadosomatic index (GSI) by date for male (gray) and female (black) Gizzard Shad from Kentucky Lake (top) and Lake Barkley (bottom). Error bars are standard error of mean. Blue line represents mean water temperature (C) recorded during sampling.

Appendix A. Kentucky Reservoir Creel Survey Areas 2023.



Appendix B. KENTUCKY RESERVOIR ANGLER ATTITUDE SURVEY 2023

1. Have you been surveyed this year? Yes - stop survey No – continue
2. Name _____ (Optional) and Zip Code _____

3. On average, how many times do you fish Kentucky Lake in a year? N=330

First time here 1.8% 1-4 22.4% 5-10 7.9% More than 10 67.9%

4. Which species of fish do you fish for at Kentucky Lake (**check all that applies**)? N=330
Redear 13.9% Bluegill 28.8% Black bass 62.1% Crappie 50.3% Catfish 26.4% White Bass 7.0% Yellow Bass 4.8%
Striped Bass 2.1% Silver Carp 0.3% Gar 0.3% Sauger 0.6% Hybrid Striped Bass 0.3%
5. Which one species do you fish for most at Kentucky Lake (**check only one**)? N=330
Redear 0.6% Bluegill 5.2% Black bass 53.3% Crappie 30.0% Catfish 9.1% White Bass 1.2% Yellow Bass 0.6%

Answer the following questions for each species you fish for – (see question 4)

Redear Anglers

6. In general, what level of satisfaction or dissatisfaction do you have with Redear fishing at Kentucky Lake? N=46
Very satisfied 6.5% Somewhat satisfied 37.0% Neutral 23.9% Somewhat dissatisfied 23.9%
Very dissatisfied 8.7%
- 6a. If you responded with somewhat or very dissatisfied in question (6) – what is the single most important reason for your dissatisfaction? N=15
Number of fish 86.7% Size of fish 0.0% Not happy with regulations 0.0% Poor weather 13.3%

Bluegill Anglers

7. In general, what level of satisfaction or dissatisfaction do you have with the Bluegill fishing at Kentucky Lake? N=95
Very satisfied 23.2% Somewhat satisfied 42.1% Neutral 17.9% Somewhat dissatisfied 12.6%
Very dissatisfied 4.2%
- 7a. If you responded with somewhat or very dissatisfied in question (7) – what is the single most important reason for your dissatisfaction? N=16
Number of fish 81.3% Size of fish 18.8% Not happy with regulations 0.0%

Black Bass Anglers

8. In general, what level of satisfaction or dissatisfaction do you have with the black bass fishing at Kentucky Lake? N=204
Very satisfied 19.6% Somewhat satisfied 43.6% Neutral 16.2% Somewhat dissatisfied 15.2%
Very dissatisfied 5.4%
- 8a. If you responded with somewhat or very dissatisfied in question (8) – what is the single most important reason for your dissatisfaction? N=42
Number of fish 71.4% Size of fish 7.1% Not happy with regulations 0.0% Lake levels 4.8% Asian carp 4.8%
Poor weather 2.4% No grass anymore 2.4% Poor knowledge 2.4% Doesn't fish enough 2.4% Cormorants 2.4%

Crappie Anglers

9. In general, what level of satisfaction or dissatisfaction do you have with crappie fishing at Kentucky Lake? N=165
Very satisfied 19.4% Somewhat satisfied 31.5% Neutral 15.8% Somewhat dissatisfied 24.2%
Very dissatisfied 9.1%
- 9a. If you responded with somewhat or very dissatisfied in question (9) – what is the single most important reason for your dissatisfaction? N=55
Number of fish 87.3% Size of fish 0.0% Not happy with regulations 0.0% Asian carp 5.5% Poor weather 1.8%
Bad time of year 3.6% Lake levels 1.8%

Catfish Anglers

10. In general, what level of satisfaction or dissatisfaction do you have with the catfish fishing at Kentucky Lake? N=87
Very satisfied 41.4% Somewhat satisfied 37.9% Neutral 12.6% Somewhat dissatisfied 5.7%
Very dissatisfied 2.3%
- 10a. If you responded with somewhat or very dissatisfied in question (10) – what is the single most important reason for your dissatisfaction? N=7
Number of fish 85.7% Size of fish 0.0% Not happy with regulations 0.0% Too much commercial fishing 0.0%
Water levels 14.3%

White Bass Anglers

1. In general, what level of satisfaction or dissatisfaction do you have with the White Bass fishing at Kentucky Lake? N=23
Very satisfied 26.1% Somewhat satisfied 47.8% Neutral 17.4% Somewhat dissatisfied 8.7%
Very dissatisfied 0.0%

- 11a. If you responded with somewhat or very dissatisfied in question (11) – what is the single most important reason for your dissatisfaction? N=2

Number of fish 50.0% Size of fish 0.0% Not happy with regulations 0.0% Asian carp 50.0%

All Anglers

2. When you fish for crappie at Kentucky Lake, do you use some form of real-time, forward-facing sonar like livescope or a similar system? N=166
Yes 50.0% No 50.0%

- 12a. If "Yes", how often do you use it while crappie fishing? N=83

Always 72.3% Frequently 9.6% Occasionally 7.2% Rarely 10.8% Never 0.0%

3. When you fish for crappie at Kentucky Lake, how often do you release keeper size fish (>10")? N=164

Always 3.7% Frequently 22.0% Occasionally 32.9% Rarely 12.8% Never 28.7%

- 13a. If you release them, what is the number one reason you release a keeper size crappie? N=119

Only caught a few 37.0% Release large females 15.1% Release large fish 18.5%
Too close to the size limit 4.2% Only keep larger fish 5.0% Only practice catch and release 10.1%
Release everything under 11" 0.8% Only keeps fish when guiding 0.8% Only keep fish out of cold water 1.7%
Only keeps a few per trip 0.8% Freezer is already full 0.8% Don't eat fish 0.8% Culling 0.8%
Already caught a limit 3.4%

14. If you fish for catfish in Kentucky Lake, which is more important to you: catching trophy fish, or catching more keeper size fish to eat? N=87 Trophy fish 9.2% Catching keeper fish to eat 65.5% Both equally important 16.1% No opinion 9.2%

15. If you fish for catfish, would you support or oppose a statewide 12-inch minimum size limit on catfish? N= 87

Support 78.2% Oppose 19.5% No Opinion 2.3%

16. Are you satisfied with the current size and creel limits on all sport fish at Kentucky Lake? N=330 Yes 87.9% No 12.1%

- 16a. If you responded "No" to Question 16, which species are you dissatisfied with and what size and creel limits would you prefer? N=40

LMB minimum size 14" 5.0%	LMB minimum size 18" 5.0%	LMB minimum size 20" 2.5%
LMB slot limit 2.5%	LMB creel limit 3/day 2.5%	SMB minimum size 14" 5.0%
SMB minimum size 18" 12.5%	SMB minimum size 21" 2.5%	SMB minimum size 24" 2.5%
SMB slot limit 2.5%	SMB creel limit 3/day 2.5%	Crappie minimum size 8" 2.5%
Crappie minimum size 9" 2.5%	Crappie minimum size 11" 17.5%	Crappie minimum size 12" 25.0%
Crappie slot limit 5.0%	Crappie slot limit 10-12" 2.5%	Crappie slot limit 10-14" 2.5%
Crappie slot limit 9-14" 2.5%	Crappie creel limit 15/day 22.5%	Crappie creel limit 10/day 7.5%
RES minimum size 10" 2.5%	RES creel limit 20/day 2.5%	RES creel limit 15/day 2.5%
RES creel limit 10/day 2.5%	Catfish minimum size 16" 2.5%	Yellow Bass creel limit 30/day 2.5%
BLG creel limit 30-40/day 2.5%	BLG creel limit 20/day 2.5%	Bass tournaments limit 3/angler 2.5%

17. Have you participated in an organized fishing tournament on any body of water within the last 12 months? N=330

Yes 38.2% No 61.8%

- 17a. If "Yes", were any of the tournaments an alternative format (catch, photo, release; onboard weighing, etc) N=126

Yes 4.8% No 95.2%

- 17b. To help us learn more about fishing tournaments in Kentucky, would you support or oppose a regulation requiring tournaments to post upcoming tournament dates and locations on our website? N=126

Support 86.5% Oppose 7.9% No Opinion 5.6%

- 17c. Would you support or oppose a regulation requiring tournaments to report their fishing effort and catch to our department? N=126

Support 77.8% Oppose 15.1% No Opinion 7.1%

18. Silver carp are the most abundant of the 4 invasive Asian carp species in Kentucky Lake and often jump when disturbed. Based on your personal experience on the water, how do you feel the abundance of silver carp has changed in Kentucky Lake in the past two years? N=330

Increasing 7.9% Decreasing 65.5% No Change 13.9% No Opinion 12.7%

19. Are you aware that invasive Asian carps are generally considered to be excellent fish to eat? N=329

Yes 74.5% No 25.5%

20. Are you aware that commercial harvest of invasive Asian carps occurs on Kentucky Lake? N=329

Yes 90.0% No 10.0%