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:

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. In this project, the KDFWR will evaluate the response of native fishes, such as gizzard shad, buffalo, and paddlefish, which compete directly with bigheaded carp for zooplankton.

Project Objectives:
1. Assess impacts on native species that compete for food resources with invasive carp.
    1.1. Monitor bycatch of native species collected through invasive carp harvest program.
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.

Project Highlights:

Methods:

Kentucky Department of Fish and Wildlife Resources

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

During field work when bigmouth buffalo and paddlefish are collected, total length and weight data were collected. 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).

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.

Objective 1.1: Monitor bycatch of native fish species collected through invasive carp harvest programs

KDFWR continues to administer the Invasive Carp Harvest Program (ICHP) and content to develop and expand the Experimental Gears and Methods 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. KDWFR staff also collect this information during ride alongs with commercial fishers. These two data sets will be analyzed independently to determine if commercial fishing efforts are negatively impacting native fish species.

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. Additionally, KDFWR staff continues to collaborate with partners to investigate better analysis approach to understand community interactions in these areas.

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 (*W*r) with harvest rates of invasive carps to evaluate trends.

In 2024, KDFWR conducted the creel survey on Barkley 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.

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 2024. 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 369 gizzard shad, 2,617 threadfin shad, and 99 skipjack herring were collected. On Barkley Reservoir 1,698 gizzard shad, 1,351 threadfin shad, and 14 skipjack herring were collected. CPUE for gizzard shad both over 180 mm and under 180 mm was greater in Barkley Reservoir compared to Kentucky Reservoir (Table 2). In 2024 we had reduced catch of gizzard shad on both reservoirs, but similar catches of threadfin shad compared to previous years (Table 3).

Paupier

Sampling with USFWS collected a total of 20,289 fish with the electrified Paupier net boat over four nights spent on Kentucky Reservoir. This sampling was targeting 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 (13.9 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 2024 was like 2023 in both reservoirs (Table 14). Paupier sampling produced higher CPUEs for gizzard shad and silver carp, but lower CPUEs for threadfin shad and skipjack herring (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 (Figure 2) resulted in the capture of 10,107 total fish comprised of 41 species during 4.5 hours of effort in 2024. Gizzard shad catch rates increased in 2023 compared to 2022 and 2021 (113 fish/hr compared to 47 and 44, Table 5). Threadfin shad catch rates decreased in 2023 but increased in 2024. Largemouth bass CPUE was the highest observed since 2020 and smallmouth bass CPUE returned to historical levels after 2023 which had the highest observed since 2015 at 43 per hour. Silver carp and grass carp CPUE remained similar in 2024 compared to 2022 and 2023 (Table 5).

Fall sampling in the Barkley Tailwater (Figure 2) resulted in the capture of 9,505 total fish comprised of 32 species over 3.0 hours of effort in 2024. Threadfin shad catch rates was the second highest seen since 2016 with a CPUE of 2690 fish/hr (Table 6). 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 2 fish/hr and 5 fish/hr, respectively (Table 6). Largemouth bass CPUE increased in 2024 while smallmouth bass CPUE decreased. Grass carp catch rates remained like historical values while silver carp catch rate increased from the previous year's low from 6 fish per hour to 16 (Table 6).

Relative weights (Wr) were calculated for selected species collected during fall sampling to monitor fish condition (Tables 7 & 8). 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 85, the same observed in 2020 (Table 7). Largemouth bass decreased slightly from 2022 and 2023 but remained within historical ranges. Smallmouth bass Wr increased slightly from 2023 but isn't as high as the three years before that (Table 7). 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 = 82) from 2023. Gizzard shad Wr decreased to the second

lowest we have observed since 2020. Smallmouth and largemouth bass relative weights remain steady and within historical ranges (Table 8). 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 2023). White crappie exhibited a mean relative weight (103) that was higher than previous years while black crappie mean relative weight (91) dropped down slightly from previous years. Largemouth bass average *W*r dropped slightly from previous years at 93 and was lower than the preferred range of 95-105. 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 2023). Mean relative weights for both black and white crappie increased slightly from previous years having *W*r of 100 and 102, respectively. Mean *W*r value for largemouth bass in 2022 was 101 which is within the preferred values. 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.

Barkley Reservoir Creel

In 2024, survey results indicated that the number of trips and fishing pressure increased from 2021 back to historical values close to 2018 and 2016 creel data (Table 9). The catch rate for 2024 was the highest we have recorded in the last four Lake Barkley Creels at 581,131 total number of fish caught (Table 9). The methods of fishers remained similar previous surveys at 85% of anglers fishing from a boat and 10% fishing from the bank while only 4 % are fishing from a dock. Angling methods remain like historical values with about 95% of anglers still fishing or casting (Figure 1).

Part of Barkley 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 76.9

% of people answered “Yes” which has increased every year since asking the question. 92.7 % of people surveyed were aware that commercial harvest of invasive carp occurs on Lake Barkley which has also increased slightly every year since asking. Out of the 426 anglers surveyed, 296 or 69.5% of them felt that the abundance of invasive carp has decreased in the past two years (Appendix B).

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 2024, the total number of bycatches reported decreased and was the lowest recorded since 2020 (Table 10). 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 10). 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 2024 from 2023 reporting levels, however rates were within historic levels. Survival rates of sportfish (75.0%) and paddlefish (62.8%) decreased in comparison to previous years, and the survival rate of catfish (99.6%) and rough fish (98.1%) remained like previous years (Table 10).

Survival rates of all bycatches caught during ride-alongs in 2024 were documented by KDFWR observers and were analyzed independent of commercial fisher reporting (Table 11). During ride-alongs, the survival rate of sport fish as bycatch decreased from all previous years when data was collected (71.0%). Survival rates of catfish species observed as bycatch during ride-alongs was like previous years at 94.0%. Paddlefish survival rates observed during ride-alongs in 2024 were the lowest observed in the program history at 19.0% and the number of paddlefish captured during ride-alongs was the second highest observed in the program history. (Table 11).

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 12). We observed an increase in bycatch of catfish species in 2024. However, bycatch reported captured per trip for recreationally and commercially important species such as paddlefish and catfish spp. were higher during ride-alongs than from fisheries dependent reports (Table 12). 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 (5.14% in 2024). 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 10).

Paddlefish survival was observed to be low in 2024 (19.0% during ride-alongs, 62.8% total ICHP) in relation to other species in the bycatch (Tables 10 & 11). 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 2024 was 3.27 hours and the two months with the coolest water temperatures 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 as seen from data from April through August of 2024 where survival rate decreases as soak time increases in conjunction with rising average water temperatures due to seasonality (Table 13). However, commercial fishers are more frequently using active methods for targeting invasive carp with gill nets and soak times of nets decreased overall in 2024. To increase the sample size, water temperature and soak times will continue to be recorded during ride-alongs in 2025.

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:

Blackwell, Brian & Brown, Michael & Willis, David. 2000. Relative Weight (Wr) Status and Current Use in Fisheries Assessment and Management. Reviews in Fisheries Science - REV FISH SCI. 8. 1-44. 10.1080/10641260091129161.

Collins, S.F., and D.H.Wahl. 2017.Invasiveplanktivoresas mediators of organic matter exchanges within and across ecosystems. Oecologia 184: 521–530.

Irons, K. S., G. G. Sass, M. A. McClelland, and J. D. Stafford. 2007. Reduced condition factor of two native fish species coincident with invasion of non-native Asian carps in the Illinois River, U.S.A. Is this evidence for competition and reduced fitness? Journal of Fish Biology 71:258-273.

Kentucky Department of Fish and Wildlife Resources (KDFWR). 2023. 2023 Lake and Tailwater Survey: Annual Performance Report. Fw.ky.gov

Schrank, S. J., C. S. Guy, and J. F. Fairchild. 2003. Competitive Interactions between Age-0 Bighead Carp and Paddlefish. Transactions of the American Fisheries Society 132:6, 1222-1228.

Tables and Figures:

Table 1. Paupier net effort and catch rates from sampling conducted in Big Bear embayment of Kentucky Reservoir in 2024. (S.E. = Standard error)

Date (Month-Year)	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		
Nov-24	1.58	22	13.9	4.4		1

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 2024.

Location	Effort (hr)	CPUE GZSD >180 mm	CPUE GZSD <180 mm	CPUE TFSD	CPUE SKJH	CPUE Adult SVCP
Blood River	1.5	58	38	177	33	0
Jonathan	1.5	46	15	1152	4	0
Big Bear	1.5	17	11	211	10	1
Sledd Creek	1.5	52	9	205	19	1
*Kentucky Reservoir**	*6*	*43*	*18*	*436*	*17*	*1*

Location	Effort (hr)	CPUE GZSD >180 mm	CPUE GZSD <180 mm	CPUE TFSD	CPUE SKJH	CPUE Adult SVCP
Demumbers/Willow	1.5	42	79	316	1	5
Eddy Creek	1.5	101	118	91	1	2
Little river	1.5	83	245	213	2	5
Honker Bay	1.5	37	427	281	5	1
*Barkley Reservoir**	*6*	*66*	*217*	*225*	*2*	*3*

* Mean CPUE for each reservoir

Table 3. Comparison of average Catch Per Unit Efforts (CPUE, fish/hour) for Bakley & Kentucky reservoirs baitfish, with night-time electrofishing across years.

Year	Location	Water Temp.* (C)	Effort (hr)	CPUE GZSD >180 mm	CPUE GZSD <180 mm	CPUE TFSD	CPUE SKJH	CPUE Adult SVCP
2024	Barkley Reservoir	20.0	6	66	217	225	2	3
2023	Barkley Reservoir	18.4	6	107	619	125	5	8
2022	Barkley Reservoir	19.3	6	101	726	506	80	1
2024	Kentucky Reservoir	18.7	6	43	18	436	17	1
2023	Kentucky Reservoir	17.2	6	64	759	505	12	1
2022	Kentucky Reservoir	20.6	6	116	984	345	30	0

*Average water temperature recorded during week long sampling event

Table 4. Paupier Net and Night-time Electrofishing (EF) sampling CPUEs for Kentucky Reservoir in fall of 2024.

Location	Effort (hr)	GZSD CPUE (fish/hr)	TFSD CPUE (fish/hr)	SKJH CPUE (fish/hr)	SVCP CPUE (fish/hr)
KY Lake Mean EF *	6	61	436	17	1
*KY Lake Mean Pauiper **	*8.8*	*2129*	*96*	*5*	*19*
Big Bear EF	1.5	28	211	10	1
Big Bear Pauiper	*1.58*	*3174*	*45*	*8*	*13.9*
Sledd Creek EF	1.5	61	205	19	1
Sledd Creek Pauiper	*1*	*3303*	*110*	*6*	*16*

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

Table 5. Comparison of fall electrofishing CPUE for selected species collected in Kentucky Lake tailwaters in 2020 (effort = 2.75 hours), 2021 (effort = 3.75 hours), 2022 (effort = 4.5 hours), 2023 (effort = 4.5 hours), and 2024 (effort = 4.5 hours). (CPUE=catch per unit effort; S.E.=standard error)

Species	Fall 2020		Fall 2021		Fall 2022		Fall 2023		Fall 2024	
	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	89	22.3	44	17.6	25	13.9	2	0.7	8	2.9
Gizzard shad	163	69.7	44	21.4	47	11.4	113	30.7	99	29.8
Threadfin shad	712	241.1	665	291.6	1860	795.2	330	138.7	1841	542.7
Grass carp	8	4.7	1	0.8	2	0.7	2	0.5	1	0.5
Silver carp	9	4.9	9	3.1	2	0.7	2	0.8	2	0.7
Smallmouth buffalo	2	0.8	4	1.3	5	1.2	2	0.7	1	0.5
Channel catfish					1	0.6	<1	0.4	<1	0.2
Flathead catfish	< 1	0.4	1	0.4	1	0.5	2	0.7		
White bass	5	2.5	3	1.8	1	0.7	5	1.3	2	0.6
Yellow bass	3	1.6	1	0.4	6	3.1	11	4.3	23	7.2
Bluegill	26	5.9	4	2.1	34	8.2	38	6.9	49	10.3
Longear sunfish	10	3.9	2	1.2	5	1.6	8	2.3	6	1.9
Redear sunfish	2	1.1	1	0.4	2	1.0	<1	0.3	<1	0.4
Smallmouth bass	10	2.8	6	2.6	15	4.1	43	6.7	19	5.6
Spotted bass					<1	1	2.63	1	2	1
Largemouth bass	15	3.6	5	1.7	13	3.2	19	2.7	20	7.2
Sauger			1	0.5	<1	0.2	1	0.3	1	0.5
Freshwater drum	11	2.8	5	1.4	15	12.5	12	9.4	3	1.0
Striped mullet	1	1.0	1	0.8	<1	0.6				

Table 6. Comparison of fall electrofishing CPUE for all species collected in Lake Barkley tailwaters in 2020 (effort = 2.75 hours), 2021 (effort = 3.0 hours), 2022 (effort = 3.0 hours), 2023 (effort = 3.0 hours), and 2024 (effort = 3.0 hours). (CPUE=catch per unit effort; S.E.=standard error)

Species	Fall 2020		Fall 2021		Fall 2022		Fall 2023		Fall 2024	
	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	41	10.8	28	10.9	17	7.3	11	3.6	7	2.5
Gizzard shad	189	49	8	5.0	38	14.5	113	34.6	276	57.8
Threadfin shad	1298	719	378	182.4	1263	352.9	2103	985.2	2690	944.0
Grass carp	3	1.22	3	0.7			1	0.4	2	1.0
Silver carp	23	6.58	24	6.4	11	2.5	6	2.1	16	4.2
Smallmouth buffalo	10	3.75	3	1.6	13	4.8	5	2.6	3	1.5
Channel catfish	1	0.49			<1	0.33			<1	0.3
Flathead catfish	4	1.57	2	1.2	4	1.3	1	0.4	<1	0.4
White bass	1	0.56	2	1.4	6	2.9	4	2.6	8	3.7
Yellow bass	3	1.24	2	1.0	<1	0.7	1	0.4	1	0.6
Bluegill	37	11.7	21	5.9	21	6.4	10	2.2	2	0.9
Longear sunfish	41	10.1	14	4.7	16	4.1	11	4.5	5	1.7
Redear sunfish	2	0.83	3	1.2	<1	0.3	1	0.4	1	0.8
Smallmouth bass	8	1.53	13	3.0	12	2.1	23	6.1	10	2.4
Spotted bass	1	1.09			<1	0.45	<1	0.28	<1	0.4
Largemouth bass	26	11	15	5.1	6	2.3	15	3.2	25	4.2
Freshwater drum	8	1.87	5	1.7	11	3.0	4	1.3	2	0.9

Table 7. Mean relative weight (Wr) and standard error for a subsample of fish collected during fall electrofishing at Kentucky Tailwaters in 2020 - 2024. (S.E. = standard error)

Species	2020			2021			2022			2023			2024		
	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	66	85	1.6	79	92	6.0	##	89	1.1	128	86	0.9	184	85	1.1
Yellow bass	4			3	88	8.6							52	88	2.1
White bass	9	95	5.1	8	86	5.9	2	88	4.4	3	91	4.2	5	85	2.8
Bluegill	41	93	8.3	11	97	4.0	28	86	4.6	14	86	6.9	46	92	2.5
Redear sunfish	4	85	5.3	2	104	4.2	6	102	23.6				3	97	17.4
Smallmouth bass	6	100	4.9	9	95	4.9	12	93	3.3	6	87	3.9	31	88	2.4
Spotted bass							1	84					7	109	4.7
Largemouth bass	26	113	8.4	17	87	4.9	33	105	2.7	12	111	10.3	66	101	1.9
Freshwater drum	29	91	3.3	18	90	5.6	25	92	2.4	1	89		12	95	4.6
Smallmouth buffalo	6	81	2.7	14	93	14.3							5	81	2.8
Silver carp	26	76	1.7	32	76	2.0							7	80	4.0

Table 8. Mean relative weight (Wr) and standard error for a subsample of fish collected during fall electrofishing at Barkley Tailwaters in 2020 - 2024. (S.E. = standard error)

Species	2020			2021			2022			2023			2024		
	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	53	96	4.2	20	73	3.1	82	89	1.5	171	88	1.7	206	82	0.7
Yellow bass	7	85	4.5	3	74	8.3							3	90	4.5
White bass	2	115	1.8	3	96	6.4	16	90	3.0	15	109	14.7	23	90	2.3
Bluegill	63	102	2.3	29	118	10.6	27	102	6.2	26	100	3.9	2	80	7.7
Redear sunfish	4	101	13.0	4	101	12.4	1	45		3	77	8.1	4	91	4.4
Smallmouth bass	11	93	2.5	7	81	4.4	15	95	2.8	43	93	2.0	26	94	2.7
Spotted bass	2	103	9.4				2	104.91	2.4	1	75.23		2	93	1.6
Largemouth bass	41	101	4.3	20	101	7.1	10	102	4.0	24	96	5.1	72	99	1.6
Freshwater drum	22	96	2.3	14	92	2.1	33	95	2.5	14	92	3.0	7	110	18.9
Smallmouth buffalo	27	81	1.4	9	78	2.6							6	79	3.3
Silver carp	64	77	1.2	70	78	1.3							49	75	1.1

Table 9. Lake Barkley creel survey fishing pressure and catch rates from 1985 through 2024.

YEAR	**Fishing Trips** # fishing trips	**Fishing Pressure** Total Angler Hours	**Average Trip Length** (hours)	**Catch Rates** Total #	**Catch Rates** Fish / Hour
1985	274,628	875,588	3.19	1,166,532	1.34
1986	226,577	828,487	3.66	1,312,183	1.57
1987	310,544	943,547	3.04	1,644,704	1.85
1991	131,458	413,727	3.15	681,891	1.65
1999	117,580	584,962	4.98	505,213	0.84
2005	192,799	765,331	3.97	1,197,613	1.56
2008	145,774	625,656	4.29	1,032,144	1.55
2012	229,892	958,964	4.17	1,510,876	1.43
2016	89,412	386,341	4.32	457,127	1.14
2018	94,732	408,414	4.31	364,496	0.92
2021	40,898	177,689	4.34	209,277	1.03
2024	61,266	303,721	4.96	581,131	1.91

Table 10. 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 Caught	Survival Rate %	Number Caught	% Survival Rate	Number Caught	Survival Rate %	Number Caught	Survival Rate %	number
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
2024	44	75.0	8,006	98.1	1045	99.6	95	62.8	9,190

*Sport fish are defined in 301 KAR 1:060

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

Table 11. 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 2020 - 2024. Survival rate of fish is defined as fish that swim away after release.

		2020		2021		2022		2023		2024	
	Species	Number captured	Survival rate	Number captured	Survival rate	Number captured	Survival rate	Number captured	Survival rate	Number captured	Survival rate
Sport Fish	White bass			2	100%	1	100%			4	75%
	Yellow bass			1	100%			3	100%	11	64%
	Striped bass	10	80%	1	100%	2	50%			7	43%
	Hybrid striped bass	2	100%	1	100%						
	Sauger	2	50%	3	100%	3	66%	1	100%	8	75%
	Largemouth bass	4	75%	9	100%	2	100%	1	<1%	4	100%
	Smallmouth bass							1	100%		
	Redear sunfish			1	100%	2	100%		100%	3	67%
	Black crappie	1	100%					1	100%		
	White crappie			1	100%			1	<1%	4	100%
	Total	19	81%	19	100%	10	83%	8	75%	41	71%
Catfish species	Blue catfish	32	100%	38	92%	62	97%	43	93%	174	91%
	Channel catfish	5	100%	16	96%	3	100%	11	100%	38	100%
	Flathead catfish	7	100%	26	100%	28	89%	8	100%	41	100%
	Total	44	100%	80	95%	93	95%	62	95%	253	94%
Rough Fish*	Paddlefish	26	50%	16	69%	7	28%	17	47%	68	19%
	Lake sturgeon			1	100%						
	Shovelnose sturgeon	3	100%								
	Skipjack herring	16	<1%	25	36%	29	52%	85	<1%	30	2%
	Smallmouth buffalo	103	100%	173	99%	236	99%	249	99%	236	97%
	Bigmouth buffalo	14	100%	12	75%	6	100%	16	100%	4	100%
	Black buffalo	1	100%					2	100%		
	Common carp	36	97%	17	100%	10	100%	21	100%	86	97%
	Gizzard shad	1	100%					1	100%		
	Freshwater drum	40	82%	54	94%	56	89%	50	76%	211	56%
	River carpsucker	41	100%	5	100%	2	100%			2	100%
	Spotted gar	1	100%	2	100%	1	100%	4	100%		
	Longnose gar	3	100%	3	100%	7	100%	3	33%	1	<1%
	Shortnose gar	5	100%	5	100%	1	100%	6	100%	5	80%
	Total	329	98%	299	92%	348	93%	437	71%	373	91%

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

Table 12. 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 2020-2024. (S.E. = standard error).

	2020				2021				2022				2023				2024			
Species	ICHP	S.E.	Ride-alongs	S.E.	ICHP	S.E.	Ride-alongs	S.E.	ICHP	S.E.	Ride-alongs	S.E.	ICHP	S.E.	Ride-alongs	S.E.	ICHP	S.E.	Ride-alongs	S.E.
Paddlefish	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	<0.01	<0.01	0.64	0.65
Blue catfish	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	<0.01	<0.01	1.63	0.61
Channel catfish	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	<0.01	<0.01	0.36	0.32
Flathead catfish	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	<0.01	<0.01	0.38	0.58
Catfish*	0.08	0.01			0.16	0.01			0.08	0.02			0.33	0.12			0.01	<0.01		
Largemouth bass	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	<0.01	<0.01	0.04	<0.01
Smallmouth bass	0.02	<0.01	0.13	0.06	<0.01	<0.01			<0.01	<0.01			<0.01	<0.01	0.02	0.02				
Bass**					<0.01	<0.01			<0.01	<0.01			0.01	<0.01						
Hybrid striped bass	<0.01	<0.01	0.07	0.07			0.02	0.02												
Striped bass	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					0.06	0.48
Yellow bass	<0.01	<0.01			<0.01	<0.01	0.02	0.02					0.01	<0.01	0.05	0.04			0.1	0.63
White bass	<0.01	<0.01			<0.01	<0.01	0.03	0.02	<0.01	<0.01	0.02	0.02	0.01	0.01					0.04	<0.01
Sauger	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			0.07	0.14
Crappie	<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			0.04	0.33
Redear sunfish	<0.01	<0.01			<0.01	<0.01	0.02	0.02	<0.01	<0.01	0.04	0.03	<0.01	<0.01					0.03	<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 those 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 13. 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 2020 - 2024.

Year	Month	No. paddlefish captured	% released alive	Mean water temp (˚F)	Mean soak time (hours)
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
2024	February	5	100%	49	7.75
	April	6	17%	65.5	12.67
	May	23	17%	73.7	7.72
	June	14	7%	80.5	8.75
	July	4	0%	85.7	8.81
	August	15	7%	83.7	10.68
	September	1	100%	77	3.27

Table 14. Relative weight (*Wr*) values of gizzard shad collected from boat electrofishing and paupier net sampling in Barkley and Kentucky reservoirs in fall of 2020-2024.

Kentucky Lake			
Year	No.	Wr	S.E.
2024	649	86	0.45
2023	546	84	0.36
2022	1527	91	0.3
2021	85	92	0.5
2020	95	92	0.8
Lake Barkley			
Year	No.	Wr	S.E.
2024	330	85	0.59
2023	392	86	0.32
2022	440	90	0.49
2021	34	90	1
2020	47	93	0.7

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

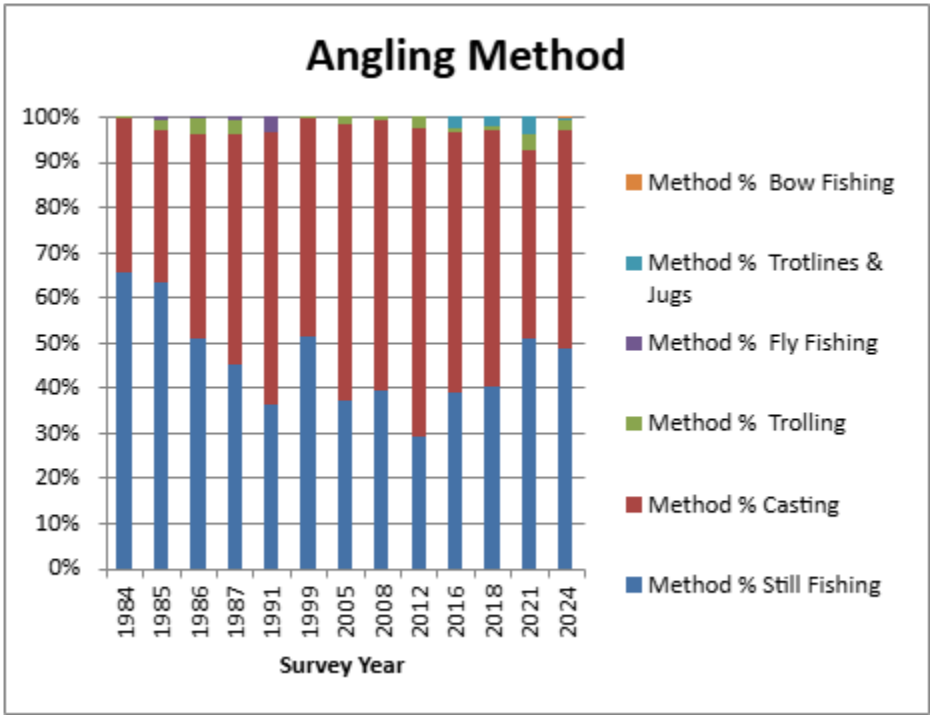


Figure 1. Angling method for fishing on Barkley Reservoir 1984-2024.

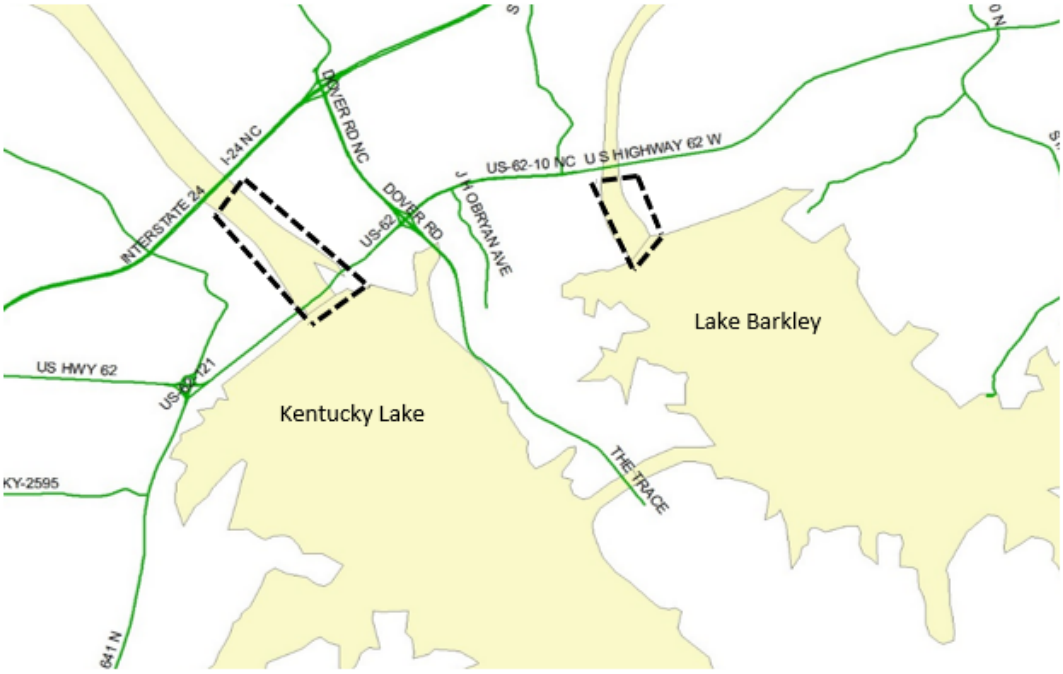
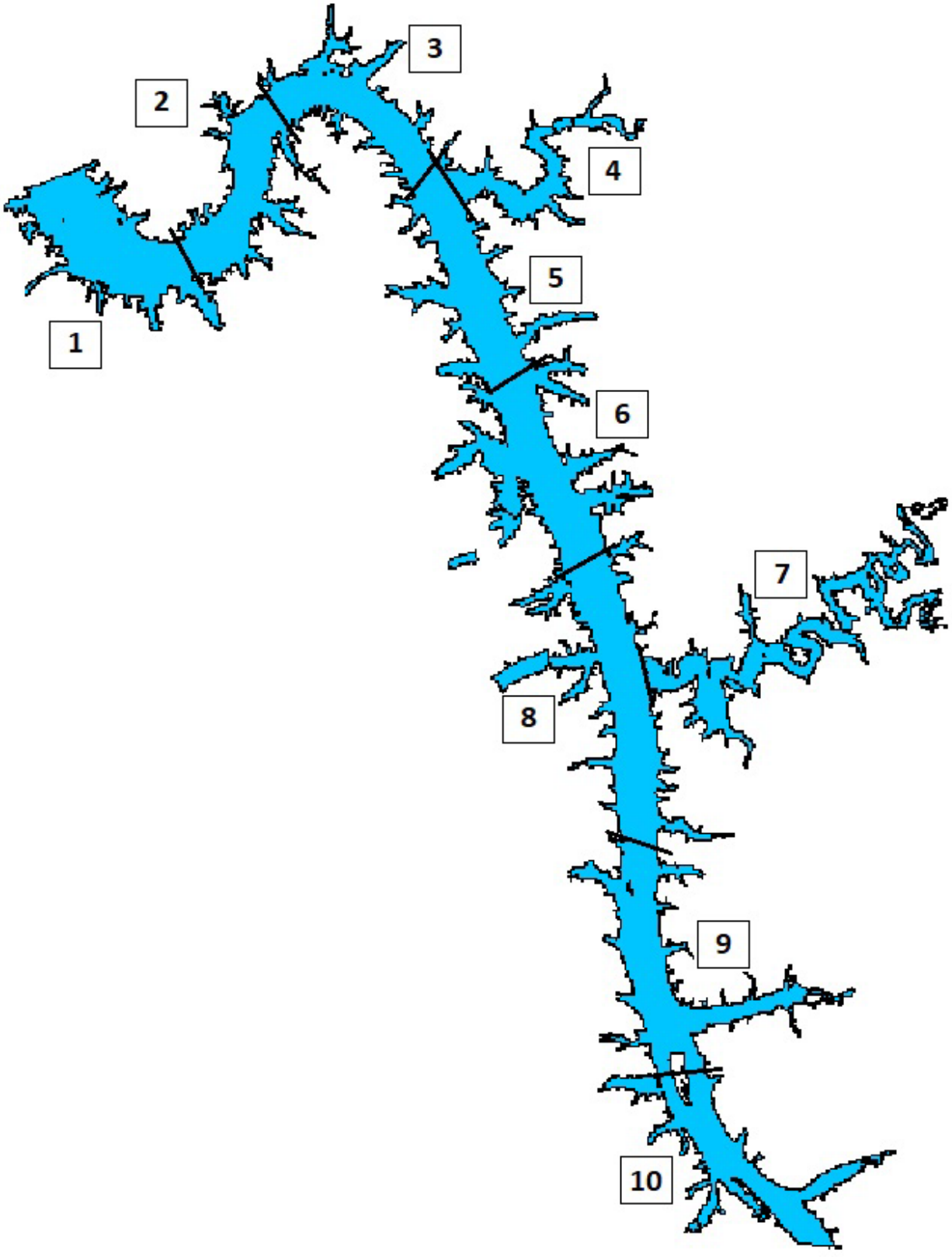


Figure 2. The tailwater electrofishing at Kentucky Tailwater extended from the dam downstream to the Interstate 24 bridge. The electrofishing at Barkley Tailwater extended from the dam downstream to the US Hwy 62 bridge. Sample areas are outlined by dashed line.

Appendix A. Lake Barkley Creel divided into ten areas.



Appendix B. Lake Barkley Angler Attitude Survey Results for 2024.

1. Have you been surveyed this year? Yes - stop survey No – continue

2. Name _____ (**Optional**) Zip Code _____

3. On average, how many times do you fish Lake Barkley in a year? N=423

   First time here 5.0% 1-4 20.6% 5-10 13.0% More than 10 61.5%

4. Which species of fish do you fish for at Lake Barkley (**check all that applies**)? N= 426
   Redear 9.4% Bluegill 18.8% Black bass 63.4% Crappie 42.5% Catfish 30.3% White Bass 13.4% Yellow Bass 2.1% Carp 0.2% Sauger 0.2%

5. Which one species do you fish for most at Lake Barkley (**check only one**)? N=426
   Redear 1.2% Bluegill 2.8% Black bass 52.6% Crappie 25.8% Catfish 13.8% White Bass 3.8%

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 Lake Barkley? N=40
   Very satisfied 17.5% Somewhat satisfied 40.0% Neutral 25.0% Somewhat dissatisfied 12.5% Very dissatisfied 5.0%

   6a. If you responded with somewhat or very dissatisfied in question (6) – what is the single most important reason for your dissatisfaction? N=7
   Number of fish 85.7% Size of fish 14.3%

Bluegill Anglers

7. In general, what level of satisfaction or dissatisfaction do you have with the Bluegill fishing at Lake Barkley? N=80
   Very satisfied 35.0% Somewhat satisfied 30.0% Neutral 12.5% Somewhat dissatisfied 18.8% Very dissatisfied 3.8%

   7a. If you responded with somewhat or very dissatisfied in question (7) – what is the single most important reason for your dissatisfaction? N=18
   Number of fish 88.9% Size of fish 11.1%

Black Bass Anglers

8. In general, what level of satisfaction or dissatisfaction do you have with the black bass fishing at Lake Barkley? N=270
   Very satisfied 21.1% Somewhat satisfied 45.2% Neutral 15.9% Somewhat dissatisfied 12.6% Very dissatisfied 5.2%

   8a. If you responded with somewhat or very dissatisfied in question (8) – what is the single most important reason for your dissatisfaction? N=48
   Number of fish 75.0% Size of fish 10.4% Lake levels 4.2% Asian carp 6.3%
   Lack of Grass 2.1% Personal 2.1%

Crappie Anglers

9. In general, what level of satisfaction or dissatisfaction do you have with crappie fishing at Lake Barkley? N=181
   Very satisfied 27.6% Somewhat satisfied 35.9% Neutral 14.4% Somewhat dissatisfied 17.1% Very dissatisfied 5.0%

9a. If you responded with somewhat or very dissatisfied in question (9) – what is the single most important reason for your dissatisfaction? N=40
Number of fish 87.5% Size of fish 5.0% Asian carp 2.5% Can't catch them 2.5%
Personal 2.5%

Catfish Anglers

10. In general, what level of satisfaction or dissatisfaction do you have with the catfish fishing at Lake Barkley? N=128
Very satisfied 71.9% Somewhat satisfied 17.2% Neutral 6.3% Somewhat dissatisfied 3.1%
Very dissatisfied 1.6%

10a. If you responded with somewhat or very dissatisfied in question (10) – what is the single most important reason for your dissatisfaction? N=6
Number of fish 100.0%

White Bass Anglers

11. In general, what level of satisfaction or dissatisfaction do you have with the White Bass fishing at Lake Barkley? N=57
Very satisfied 68.4% Somewhat satisfied 19.3% Neutral 8.8% Somewhat dissatisfied 3.5% 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 100.0%

Crappie Anglers Only

12. When you fish for crappie at Lake Barkley, how often do you release keeper size fish (>10")? N=181
Always 6.1% Often 23.2% Sometimes 26.5% Rarely 22.1% Never 22.1%

12a. If you release them, what is the number one reason you release a keeper size crappie? N=142
Only caught a few 28.2% Release large females 8.5% Release large fish 11.3%
Too close to the size limit 10.6% Only keep larger fish 6.3% Only practice catch and release 18.3%
Only keep a few per trip 3.5% Looks unhealthy 1.4% Catch and release sometimes 0.7%
Catch them while fishing for bass 0.7% Freezer is already full 1.4%
Already have enough in the livewell 4.9% Don't want to deal with them 0.7%
Catch crappie in other states 0.7% Already have a limit 2.8%

Catfish Anglers Only

13. When you fish for catfish at Lake Barkley, which is more important to you: catching trophy fish or catching more keeper size fish to eat? N=128
Trophy fish 9.4% Catching keeper fish to eat 67.2% Both equally important 17.2% No opinion 6.3%

All Anglers

14. When you fish at Lake Barkley, do you use some form of real-time, forward-facing sonar like livescope or a similar system? N=424
Yes 41.0% No 59.0%

14a. If "Yes", how often do you use it while crappie fishing? N=173
Always 63.6% Often 15.6% Sometimes 13.3% Rarely 7.5% Never 0.0%

15. Are you satisfied with the current size and creel limits on all sport fish at Lake Barkley? N=423
Yes 89.8% No 10.2%

15a. If you responded "No" to Question 15, which species are you dissatisfied with and what size and creel limits would you prefer? N=43

LMB minimum size 12" 2.3% LMB minimum size 14" 7.0% LMB minimum size 18" 2.3%
LMB 15-18" slot 2.3% LMB 15-24" slot 2.3% 1 LMB over 18"/day 2.3%
1 LMB under 15"/day 2.3% LMB creel limit 3/day for a few years 2.3%
LMB creel limit 3/day 4.7% SMB minimum size 12" 2.3% SMB minimum size 14" 4.7% SMB minimum size 18" 4.7% SMB 15-18" slot 2.3%
SMB creel limit 3/day 4.7% SMB creel limit 3/day for a few years 2.3%
Crappie minimum size 10.5" 2.3% Crappie minimum size 11" 23.3% Crappie minimum size 12" 14.0%
Crappie slot limit under 10" 2.3% Crappie slot limit 14" 2.3% Crappie creel limit 15/day 23.3%
Crappie creel limit 10/day 9.3% Crappie creel limit 30/boat 2.3%
RES minimum size 8" 2.3% RES minimum size 10" 2.3% SAG minimum size 12" 2.3%
SAG No minimum size 2.3% White Bass creel limit 30/day 2.3%
BLG creel limit 25/day 2.3% No bass tournaments for a few years 2.3%
Crappie creel limit 10/day until post spawn 2.3%
Crappie guides unable to keep fish while guiding 2.3%

16. Have you participated in an organized fishing tournament on any body of water within the last 12 months? N=425 Yes 39.8% No 60.2%

16a. If "Yes", were any of the tournaments an alternative format (catch, photo, release; onboard weighing, etc) N=166 Yes 6.6% No 93.4%

16b. 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=169
Support 78.7% Oppose 6.5% No Opinion 14.8%

16c. Would you support or oppose a regulation requiring tournaments to report their fishing effort and catch to our department? N=169
Support 71.0% Oppose 12.4% No Opinion 16.6%

17. Based on your personal experience on the water, how do you feel the abundance of Asian carp has changed in Lake Barkley in the past two years? N=426
Increasing 8.0% Decreasing 69.5% No change 8.7% No opinion 13.8%

18. Are you aware that Asian carps are generally considered to be excellent fish to eat? N=425
Yes 76.9% No 23.1%

19. Are you aware that commercial harvest of Asian carps occurs on Lake Barkley? N=424
Yes 92.7% No 7.3%