

Project Title: Contract Fishing for Invasive Carp Detection and Removal 2023

Lead Agency: Illinois Natural History Survey, Jim Lamer

Participating Agencies: Illinois Natural History Survey (INHS), Missouri Department of Conservation (MDC), Illinois Department of Natural Resources (IL DNR), United States Geological Survey-Upper Midwest Environmental Sciences Center (USGS), and United States Fish and Wildlife Service (USFWS)

Geographic Location: Pools 14–19 of the Mississippi River

Statement of Need: Adult silver carp (*Hypophthalmichthys molitrix*), bighead carp (*H. nobilis*), grass carp (*Ctenopharyngodon idella*), and black carp (*Mylopharyngodon piceus*), hereafter referred to as invasive carp, are present in varying abundances in Pools 14 through 19; however black carp have not been collected above Lock and Dam (LD) 19. Bighead and silver carp, collectively referred to as bigheaded carp, have increased in range and abundance throughout the Mississippi River basin, thus increasing their potential for causing ecological and economic damage. Lock and Dam 19 has limited movements of invasive carp upstream as all upstream passage is restricted to the lock chamber, effectively slowing progression and establishment of invasive carp in the UMR. A combination of containment and control measures are thought to be the most effective tools for managing invasive carp in the UMR. The Upper Mississippi River Invasive Carp Team (UMRICT) is an interagency group across five states that is concerned with minimizing the impacts of bigheaded carp in the UMR. Commercial harvest effort programs, funded through the UMRICT, are aimed at capturing and removing bigheaded carp in the UMR to prevent establishment of incipient populations. We propose that targeted commercial harvest at the established and invasion front (Pool 16) will be effective in reducing populations and help alleviate the pressure invasive species elicit at dams.

Illinois Natural History Survey (INHS)

Project Objectives:

1. Targeted removal of 200,000-300,000 lbs of invasive carp species in UMR Pools 14-19 using commercial fishers and intensive netting protocols.
2. Acoustically tag and monitor, collectively, 200 bigmouth buffalo, paddlefish, lake sturgeon, flathead catfish, blue sucker, white bass, freshwater drum, walleye with acoustic tags in Pool 20 in the fall of 2023 to assess frequency and timing of fish passage at Lock and Dam 19.

Project Highlights:

- Commercial removal efforts resulted in 104,233 lbs of invasive carp removed from 01/01/2023–12/31/2023.
- Since the project started in 2015 a total of 1,147,878 lbs of invasive carp have been removed, with 980,019 lbs coming from 2018 – 2023.
- 218 bighead carp (BHCP), 1,866 silver carp (SVCP), 38 hybrid silver carp x bighead carp (SCBC), and 2,142 grass carp (GSCP) were harvested and removed in 2023.

Methods:*Study site*

Data were collected from September 2015 through December 2023 on Pools 14–20 of the UMR. The UMR is classified as the portion of the river above Cairo, Illinois to St. Anthony Falls near Minneapolis, Minnesota. The UMR consists of 29 locks and dams that vary in size and passage capability. The UMR has a drainage basin of 490,000 km² and at the mouth has a discharge of 5,796 m³/s. Pools 14–19 of the Mississippi River are the border waters between Illinois and Iowa, while Pool 20 is the border water between Illinois and Missouri. Pool 14 is 47.0 km long and has an area of 41.6 km². It extends from Lock and Dam 13 near Clinton, IA to Lock and Dam 14 in Le Claire, IA. Pool 15 is 16.7 km long and covers an area of 14.7 km², extending from Lock and Dam 14 in Le Claire, IA to Lock and Dam 15 in Rock Island, IL. Pool 16 is 41.4 km long and occupies an area of 52.6 km². It extends from Lock and Dam 15 in Rock Island, IL to Lock and Dam 16 in Muscatine, IA. Pool 17 is 32.3 km long and covers 30.7 km² between Lock and Dam 16 in Muscatine, IA and Lock and Dam 17 near New Boston, IL. Pool 18 is 42.8 km long and covers 53.8 km². It is located between Lock and Dam 17 near New Boston, IL and Lock and Dam 18 in Gladstone, IL. Pool 19 extends 74.5 km and covers 123.3 km² from Lock and Dam 18 in Gladstone, IL to Lock and Dam 19 in Keokuk, IA. Pool 20 is approximately 34 km long and has an area of approximately 28.3 km² (Jahn and Anderson 1986). It extends from Lock and Dam 19 in Keokuk, IA to Lock and Dam 20 near Canton, MO. Pools 14–18 and 20 have similar aquatic habitats, while Pool 19 shows more similarities to pools further upriver (Pools 4–13), characterized by a higher average size of contiguous impounded and shallow aquatic areas than downstream pools (Koel 2001). Pools can be split into three distinct groups based on dominant aquatic habitat types: Pools 14, 18, and 20, Pools 15 and 17, and Pool 16. Pools 14, 18, and 20 have no contiguous impounded area, contiguous floodplain shallow aquatic area, or tertiary channel. Pools 15 and 17 have a small portion of the tertiary channel and contain a larger floodplain area than other pools. Pool 16 has more secondary channels than other pools (Koel 2001). Tributaries that contribute to Pools 14–19 of the Mississippi River include Wapsipinicon River (converges at Pool 14), Rock River (converges at Pool 16), Iowa River (converges at Pool 18), and Skunk River (converges at Pool 19).

Sample Collection

Fish were collected using nylon filament gillnets provided by Illinois Natural History Survey (INHS) biologists and contracted removal effort personnel. Net mesh sizes used were 3, 3.5, 4, 4.25, 4.5, 4.75, 5, 5.25, and 6-inch bar gillnets. Gillnets were set in a range of habitat areas (backwater, side channel, main channel border, and tributaries) to target bigheaded carp. Bigheaded carp were located using side-scan sonar, acoustic receivers (manual, stationary, and real-time), visual cues, and fishing areas that have had historically high catch rates. The time nets were set and removed was recorded, along with mesh size, net height, length, color, and twine size. Dissolved oxygen, specific conductivity, and water temperature were measured at net locations using a YSI Pro 2030 meter (Yellow Springs, Ohio, USA), and GPS coordinates were taken using a Vemco VR-100 receiver (Bedford, Nova Scotia, Canada). Once set, the nets were either left overnight to fish (“dead set”) or a method called “pounding” was employed which included driving fish towards the nets to scare them into the nets (Butler et al. 2019). Nets were then removed from the water, and fish were removed from the net. Fish collected from nets were identified to species, the number of fish per species was recorded, and the bulk weight of invasive carp

by species was measured and recorded. To collect additional bycatch data, on certain days all collected fish were weighed to the nearest 10 g and measured to the nearest mm. Invasive carp were removed from the system and bycatch were released back into the water at the capture location.

Statistical analyses

Relative weight (Wr) was calculated based on the available standard weight equation for each species. Grass carp could not be included in these analyses because standard weight equations do not exist for this species. Relative weight for a species was compared between years. Box plots were constructed to display the Wr for each species between years. Analysis of Variance (ANOVA) tests were performed to determine if Wr of species were statistically, significantly different ($\alpha=0.05$) between years in all pools combined. A Tukey's Post Hoc test ($\alpha=0.05$) determined between what years any difference in Wr existed.

Results and Discussion:

Contracted Commercial Removal

Low river conditions and flooding greatly impacted our fishing efforts in 2023. Our intensive harvest event occurred from April 4-April 28. During intensive harvest, we contracted 3-4 fishermen crews during the peak period when bigheaded carp occupy backwater areas, which past data indicate can account for 1/3 of our yearly catch. Fishing efforts for 2023 occurred between January 9-January 20 because of mild weather and lack of ice, and began consistently for the year on February 27 with ice-off and continued until December 20.

In 2023, we removed 4,284 invasive carp, weighing 47,271 kg (104,233 lbs), from Pools 14–19 of the Mississippi River (Table 1, Table 2, Table 3). An additional 422 invasive carp weighing 5,032 kg (11,096 lbs) were tagged by partners and released back into the UMR (Table 8). Grass carp were the most abundant invasive carp species removed from the UMR (2,142 fish; 23,208 kg; 51,173 lbs), followed by silver carp (1,866 fish; 20,252 kg; 44,655 lbs), bighead carp (218 fish; 3,459 kg; 7,628 lbs), and hybrid carp (38 fish; 372 kg; 820 lbs). A total of 13,616 bycatch fish were captured in gill nets and released (Table 4).

Contracted commercial efforts have been successful in removing large quantities of biomass annually from the UMR. Catch per unit effort (CPUE) has steadily risen from 2018 to 2020, but dropped in 2021, 2022, and 2023, potentially due to low water, which leads to a decrease in accessibility to backwaters where high abundances of fish are historically caught (Fig. 1). As contracted fishing moved upstream, the total CPUE generally decreased. The exception for this was Pools 16 and 17 in 2019, Pool 17 and 18 in 2021, and Pools 17 and 16 in 2022 and 2023. Pools 18 and 19 had the highest overall CPUE, and Pool 14 had the lowest CPUE, with only four invasive carp removed from Pool 14 from 2018 through 2023 (Fig. 2). These results suggest that Pools 18 and 19 are the key focal points for removing pressure from upstream movement and contain the highest densities.

The effectiveness of using one versus 2+ fishing crews was analyzed using data from 2018 through 2023, which showed that CPUE generally increased with additional fishing crews (Fig. 3). Results from 2020 and 2023 may be slightly biased because crews of 3 fishermen were generally used when the harvest

was the lowest for the year. Comparison of CPUE between crews of 1-4 fishermen across years showed that in 2018, 2019, 2020, 2021, 2022, and 2023 a positive trend generally exists between the number of fishing crews and CPUE (Fig. 3).

Total removed weight was the lowest it has been since 2017 at 104,233 lbs. We also had the lowest number of invasive carp removed (4,264) in 2023 since 2017 (Table 3). This year was likely affected by both flooding and low water events. Flooding in the spring limited our access to the river, and the low water on the Mississippi River later in the year made it difficult to target areas where invasive carp tend to congregate. It was also difficult to pinpoint areas to target due to waning acoustic tags in the system. More fish will be tagged in 2024, which should help guide us to places to target more effectively. Additionally, the plan to use additional net designs in 2024 may increase the efficiency of catching targeted invasive carp.

Acoustic Monitoring

We monitored acoustically tagged fish through two methods in Pools 14–19: Vemco VR100 detections during harvest (Table 10), and recaptures of acoustically tagged individuals in nets during harvest (Table 9). These data were used to monitor movements of invasive carp to assist in contracted commercial harvest efforts.

Acoustic tag recaptures

We recaptured 8 unique telemetered individuals during our commercial removal efforts in 2023, with one individual being recaptured twice. These recaptured individuals included one bigmouth buffalo and one silver carp from Pool 16, one bighead carp and one silver carp from Pool 17, and one bighead carp and three silver carp from Pool 18 (Table 9).

Commercial fishing VR 100 detections

Our Vemco VR100 receiver was equipped with a portable omni-directional hydrophone (Vemco Model VH165) to detect the presence of acoustically tagged fish in areas where commercial removal efforts occurred. In 2023, we had 14 detections among four different species: bighead carp, silver carp, bighead x silver hybrid carp, and bigmouth buffalo. There were 2 bighead carp individuals, 9 silver carp individuals, 1 bighead x silver hybrid carp individual, and 2 bigmouth buffalo individuals detected by the VR100 receiver (Table 10). Most of our bigheaded carp detections were captured in Pool 17. Detections in 2023 were low due to VR100 equipment issues.

SEIcarP

From 10/11/2023 to 01/10/2024 we captured fish in support of the SEIcarP model. A total of 198 SVCP, BHCP, and SCBC were captured in Pools 16-19 for the SEIcarP model with the use of gillnets. In Pool 16, 22 SVCP were captured. In Pool 17, 6 SVCP were captured. In Pool 18, 9 SVCP and 1 BHCP were captured. In Pool 19, 148 SVCP, 11 BHCP, and 1 SCBC were captured. Fish were brought to Lee County Conservation Area or the Illinois River Biological Station to be processed. Processing involved taking lengths and weights of fish, checking sex, weighing gonads, and removing otoliths. Otoliths are currently being processed.

Relative Weight of 4 Common Species Caught During Commercial Efforts

Bighead Carp

Bighead carp relative weight (Wr) slightly increased from 2016 to 2018, held steady from 2018 to 2019, and slightly increased from 2019 through 2023 (Fig. 4). There was a statistical difference among years shown using an ANOVA ($p \leq 0.001$, $\alpha = 0.05$). A Tukey's test showed a difference between several years (Table 11). There were low amounts of data associated with bighead carp due to low capture success using gill nets or abundance in these pools. More data are needed to analyze the effects of bighead carp in the UMR.

Silver Carp

Silver carp relative Wr (Fig. 5) remained stable from 2016 to 2019. From 2019 to 2023 there has been a steady upward trend in relative weight. An ANOVA ($p \leq 0.001$, $\alpha = 0.05$) revealed there were significant differences in the data and a t-test showed where those differences were (Table 12). The years that were compared that did not have a significant difference from each other were 2016 and 2019, 2017 and 2019, 2018 and 2020, and 2021 and 2022.

Data are lacking in several areas of this data set. Raised Wr in 2020, 2021, 2022, and 2023 may be a symptom of low sample numbers focused mostly in the spring of the year when fish are plump and preparing to spawn. To continue to monitor Wr , data must be taken diligently and at appropriate times. Continued collections are needed to continue to monitor silver carp Wr and the effects they have on other species.

Bigmouth Buffalo

Bigmouth buffalo show relatively stable Wr throughout all years of sampling (Fig. 6). There was a significant difference found in the data with an ANOVA ($p = 0.008$, $\alpha = 0.05$), a Tukey's test showed a significant difference between 2021 and 2016, 2021 and 2017, 2021 and 2018, and 2022 and 2017 (Table 13). Additional data from various times throughout future years would aid in monitoring this species' health in the UMR.

Paddlefish

Paddlefish have had a relatively stable and increasing trend in Wr throughout the years. Paddlefish showed a slightly decreasing trend in Wr from 2016 to 2017 and an increasing trend from 2017 to 2019, stable from 2019 to 2021, then a slight increase in 2022 and 2023 when all the Pools were combined (Fig. 7). The ANOVA showed significant differences ($p < 0.001$, $\alpha = 0.05$) between the years and a Tukey's test revealed where those differences were (Table 14). Additional data from various times throughout future years would aid in monitoring this species' health in the UMR.

Recommendation:

It is recommended that commercial removal efforts continue to reduce the number of bigheaded carp in Pools 16–19 of the Upper Mississippi River (low-density management zone). It is also recommended that efforts continue to determine the relationship between bigheaded carp and commonly encountered bycatch. This information is important to collect to target bigheaded carp more effectively and efficiently while trying to avoid harming other ecologically and commercially important species.

It is recommended to continue contracting commercial fishermen and increase the number of fishermen per sampling event to increase the total likelihood of bigheaded carp captured. Having additional acoustically tagged bigheaded carp and real-time receivers can offer greater capture success by identifying where schools of bigheaded carp are daily and providing better population estimates.

References:

- Butler, S. E., A. P. Porreca, S. F. Collins, J. A. Freedman, J. J. Parkos, M. J. Diana, and D. H. Wahl. 2019. Does fish herding enhance catch rates and detection of invasive bigheaded carp? *Biological Invasions* 21(3):775–785.
- Jahn, L. A., and R. V. Anderson. 1986. The Ecology of Pools 19 and 20, Upper Mississippi River: A Community Profile. *Biological Report* 85(7.6):142.
- Koel, T. M. 2001. Classification of Upper Mississippi River Pools Based on Contiguous Aquatic/Geomorphic Habitats. *Journal of Freshwater Ecology* 16(2):159–170.

Tables and Figures:

Table 1. Total weight (lbs) of invasive carp removed from Pools 14–19 on the Upper Mississippi River from 2015 through 2023. Invasive carp are broken down by bighead carp (BHCP), silver carp (SVCP), grass carp (GSCP), and bighead x silver carp (Hybrid). Unsorted weight is an accumulated weight of all species weight when there was no ability to sort by species.

Year	BHCP	SVCP	GSCP	Hybrid	Unsorted	Total
2015	205.9	1,168.1	192.4	0	0	1,566.4
2016	18,800.3	38,274.4	12,488.9	1509.5	0	7,1073.1
2017	15,361.5	32,726.2	19,621.1	405.0	28472.1	95,220.7
2018	26,029.1	98,798.9	49,887.6	482.0	13071.1	188,271.7
2019	24,308.0	90,280.1	53,739.3	613.8	1786.1	170,727.2
2020	13,092.6	120,461.3	35,223.8	421.8	0	169,199.4
2021	15,655.5	116,516.0	75,537.2	915.05	0	208,623.7
2022	9,716.7	67,231.3	60,525.2	1,585.5	0	138,963.5
2023	7,627.6	44,654.9	51,173.3	819.9	0	104,232.6
Totals	130,797.2	610,111.2	358,388.8	6,752.5	43,329.3	1,147,878.3

Table 2. Total weight (kgs) of invasive carp removed from Pools 14–19 on the Upper Mississippi River from 2015 through 2023. Invasive carp are broken down by bighead carp (BHCP), silver carp (SVCP), grass carp (GSCP), and bighead x silver carp (Hybrid). Unsorted weight is an accumulated weight of all species weight when there was no ability to sort by species.

Year	BHCP	SVCP	GSCP	Hybrid	Unsorted	Total
2015	93.4	529.8	87.3	0.0	0.0	710.4
2016	8,526.2	17,358.0	5,663.9	684.6	0.0	32,232.7
2017	6,966.7	14,841.8	8,898.5	183.7	12,912.5	43,184.0
2018	11,804.6	44,806.8	22,624.8	218.6	5,927.9	85,384.0
2019	11,024.0	40,943.4	24,371.6	278.4	810.0	77,427.3
2020	5,937.7	54,631.0	15,974.5	191.3	0.0	76,734.4
2021	7,100.0	52,841.7	34,257.2	415.0	0.0	94,613.9
2022	4,406.7	30,490.4	27,449.1	719.0	0.0	63,022.0
2023	3,459.3	20,251.7	23,207.9	371.8	0.0	47,271.0
Total	593,18.6	276,694.6	162,534.8	3,062.4	19,650.4	520,579.7

Table 3. Total number of invasive carp captured and removed using gill nets in Pools 14–20 of the Upper Mississippi River from 2015 through 2023.

Year	Pool	Bighead Carp	Silver Carp	Hybrid Carp	Grass Carp	Total
2015	14	0	0	0	0	0
	15	0	0	0	0	0
	16	0	0	0	0	0
	17	1	3	0	0	4
	18	0	6	0	0	6
	19	6	56	0	9	71
	20	3	4	0	0	7
Total		10	69	0	9	88
2016	14	0	0	0	0	0
	15	0	0	0	0	0
	16	0	0	0	8	8
	17	22	66	1	54	143
	18	95	136	3	119	353
	19	180	1,781	18	450	2,429
	20	57	255	1	44	357
Total		354	2,238	23	675	3,290
2017	14	0	0	0	0	0
	15	0	0	0	0	0
	16	13	33	1	51	98
	17	106	342	3	37	488
	18	19	64	0	14	97
	19	70	395	0	347	812
	20	0	0	0	0	0
Total		208	834	4	449	1,495
2018	14	2	0	0	0	2
	15	0	0	0	0	0
	16	64	330	2	127	523
	17	119	531	4	157	811
	18	266	1,061	2	690	2,019
	19	305	3,078	22	1,275	4,680
	20	0	0	0	0	0
Total		756	5,000	30	2,249	8,035
2019	14	0	0	0	0	0
	15	2	36	0	4	46
	16	116	364	2	115	597
	17	44	240	1	27	306
	18	372	1,556	5	379	2,313
	19	302	3,637	19	2,113	6,056

Year	Pool	Bighead Carp	Silver Carp	Hybrid Carp	Grass Carp	Total
	20	0	0	0	0	0
	Total	836	5,843	27	2,638	9,318
2020	14	0	1	0	0	1
	15	2	8	0	2	12
	16	77	626	2	92	797
	17	83	819	2	75	979
	18	65	1,139	4	161	1,369
	19	246	4,582	19	1,546	6,393
	20	0	0	0	0	0
	Total	473	7,175	27	1,876	9,551
2021	14	0	0	0	0	0
	15	0	4	0	6	10
	16	26	628	3	268	925
	17	91	660	7	97	855
	18	60	356	5	147	568
	19	350	4,342	28	3,037	7,757
	20	0	0	0	0	0
	Total	527	5,990	43	3,555	10,115
2022	14	0	0	0	1	1
	15	5	25	0	2	32
	16	29	306	4	245	584
	17	11	341	0	38	390
	18	49	793	12	99	953
	19	188	1,734	35	2,150	4,107
	20	0	0	0	0	0
	Total	282	3,199	51	2,535	6,067
2023	14	0	0	0	0	0
	15	0	0	0	0	0
	16	9	198	1	86	294
	17	2	76	3	36	117
	18	55	479	6	207	747
	19	152	1,113	28	1,813	3,126
	20	0	0	0	0	0
	Total	218	1,866	38	2,142	4,264
Total		3,664	32,214	243	16,128	52,223

Table 4. Total number of bycatch species captured using gill nets during contracted commercial removal of invasive carp in Pools 14–20 of the Upper Mississippi River from 2015 through 2023.

Family/Species	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Acipenseridae										
Lake Sturgeon			1	1		3	4	3	1	13
Shovelnose Sturgeon				1	2		2			5
Amiidae										
Bowfin		7	3	16	6	15	5	9	10	71
Catostomidae										
Bigmouth Buffalo	79	868	2,151	2,443	1,986	2,473	4,274	4,195	2,892	21,361
Black Buffalo		262	1,023	959	859	1,310	1,380	822	935	7,550
Golden Redhorse				1						1
Quillback		23	2		7	3		1		36
River Carpsucker	16	95	67	144	82	50	125	179	99	857
River Redhorse				1						1
Shorthead Redhorse		2			2				1	5
Smallmouth Buffalo	19	312	3,249	1,186	974	2,512	2,959	3,425	1,844	16,480
White Sucker									1	1
Centrarchidae										
Black Crappie				1	4	2		2		9
Bluegill					2		1		1	4
Largemouth Bass	1	5	1	7	11	7	2	8	2	44
Smallmouth Bass					1	2	1	1		5
White Crappie		1	6	3	2		2	1	1	16
Clupeidae										
Gizzard Shad	4	8	11	12	8	6	9	17		75
Cyprinidae										
Common Carp	83	1,602	2,279	3,822	3,965	3,460	3,012	4,600	3,730	26,553
Goldfish			1		2	2	1	7	1	14
Hiodontidae										
Mooneye			3	13	13	1	9	4	1	44
Goldeye									1	1
Ictaluridae										
Brown Bullhead						1				1
Channel Catfish	1	61	34	102	92	72	149	175	219	905
Flathead Catfish		4	48	145	90	89	58	57	58	549
Lepisosteidae										
Longnose Gar	21	32	29	124	111	138	135	102	108	800
Shortnose Gar	37	35	29	109	179	267	151	305	189	1,301
Moronidae										
Striped x White Bass	1		2	24	52	26	1		18	124
White Bass	1	5	3	7	3	1			1	21
Sciaenidae										
Freshwater Drum	68	328	814	1,847	3,108	2,613	2,396	2,950	2,274	16,398
Esocidae										

Family/Species	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Northern Pike		18	28	65	67	29	67	24	26	324
<i>Polyodontidae</i>										
Paddlefish	5	1,064	2,078	2,993	2,088	1313	2,671	1,769	1,188	15,169
<i>Percidae</i>										
Sauger			1	3	7		6	1	4	22
Walleye	3	1	1	21	14	14	80	7	11	152
Total	339	4,718	11,864	14,050	13,737	14,414	17,505	18,664	13,616	108,907

Table 5. Total gill netting effort for removed invasive carp (IC) in Pools 14–19 of the Upper Mississippi River in 2021. Invasive carp are broken down by bighead carp (BHCP), silver carp (SVCP), grass carp (GSCP), and bighead x silver carp (SCBC). Unsorted weight is an accumulated weight of all species weight when there was not an ability to sort by species.

2021	Pool 19	Pool 18	Pool 17	Pool 16	Pool 15	Pool 14	Total
Netting Effort							
Total Yards of Net	242,290	49,610	52,970	68,500	7,240	10,830	431,440
Catch Effort (Removed)							
Total IC (N)	7,757	568	855	925	10	0	10,115
Total IC Weight (kg)	74,490	3,714	8,261	8,057	90	0	94,613
Average IC Weight (kg)	9.6	6.5	9.7	8.7	9	0	9.3
Total Unsorted IC Weight (kg)	0	0	0	0	0	0	0
Total BHCP (N)	350	60	91	26	0	0	527
Total BHCP Weight (kg)	4,510	735	1,512	343	0	0	8,000
Average BHCP Weight (kg)	12.9	12.3	16.6	13.2	0	0	15.2
Total SVCP (N)	4,342	356	660	628	4	0	5,990
Total SVCP Weight (kg)	39,523	2,182	5,804	5,305	28	0	52,842
Average SVCP Weight (kg)	9.1	6.1	8.8	8.4	7	0	8.8
Total SCBC (N)	28	5	7	3	0	0	27
Total SCBC Weight (kg)	322	51	72	17	0	0	415
Average SCBC Weight (kg)	11.5	10.2	10.3	5.6	0	0	10.5
Total GSCP (N)	3,037	147	97	268	6	0	3,555
Total GSCP Weight (kg)	30,135	747	909	2,404	62	0	34,257
Average GSCP Weight (kg)	9.9	5.1	9.4	9.0	10.3	0	9.6
Catch per unit of effort							
CPUE (BHCP/100 yds of net)	0.14	.12	0.17	0.04	0	0	0.12
CPUE (SVCP/100 yds of net)	1.8	.71	1.26	.92	0.05	0	1.4
CPUE (SCBC/100 yds of net)	0.01	0.01	0.01	0.013	.004	0	.01
CPUE (GSCP/100 yds of net)	1.25	.3	.2	.4	.08	0	.82
CPUE (Total/100 yds of net)	3.2	1.1	1.6	1.3	0.14	0	2.34

Table 6. Total gill netting effort for removed invasive carp (IC) in Pools 14–19 of the Upper Mississippi River in 2022. Invasive carp are broken down by bighead carp (BHCP), silver carp (SVCP), grass carp (GSCP), and bighead x silver carp (SCBC). Unsorted weight is an accumulated weight of all species weight when there was not an ability to sort by species.

2022	Pool 19	Pool 18	Pool 17	Pool 16	Pool 15	Pool 14	Pool 13	Total
Netting Effort								
Total Yards of Net	167,250	44,300	43,200	49,400	5,900	10,350	3,650	324,050
Catch Effort (Removed)								
Total IC (N)	4,107	953	390	584	32	1	0	6,067
Total IC Weight (kg)	43,260	9,923	4,150	5,409	313	8.2	0	63,063
Average IC Weight (kg)	10.5	10.4	10.6	9.3	9.8	0	0	10.4
Total Unsorted IC Weight (kg)	0	0	0	0	0	0	0	0
Total BHCP (N)	188	49	11	29	5	0	0	282
Total BHCP Weight (kg)	2,887	847	182	408	82	0	0	4,407
Average BHCP Weight (kg)	16.6	15.4	17.3	16.5	16.4	0	0	15.6
Total SVCP (N)	1,734	793	341	306	25	0	0	3,199
Total SVCP Weight (kg)	15,935	7,989	3,557	2,788	212	0	0	30,482
Average SVCP Weight (kg)	9.2	10.1	10.4	9.1	8.5	0	0	9.5
Total SCBC (N)	35	12	2	4	0	0	0	53
Total SCBC Weight (kg)	506	130	37	47	0	0	0	719
Average SCBC Weight (kg)	35	12	18.5	14.4	0	0	0	14.1
Total GSCP (N)	2,150	99	38	245	1	1	0	2,535
Total GSCP Weight (kg)	23,931	957	374	2,166	18	8.2	0	27,455
Average GSCP Weight (kg)	11.1	9.6	9.8	8.8	9	8.2	0	10.8
Catch per unit of effort								
CPUE (BHCP/100 yds of net)	0.11	0.11	0.03	0.06	0.08	0.00	0.00	0.09
CPUE (SVCP/100 yds of net)	1.04	1.79	0.79	0.62	0.42	0.00	0.00	0.99
CPUE (SCBC/100 yds of net)	0.02	0.03	0.00	0.01	0.00	0.00	0.00	0.02
CPUE (GSCP/100 yds of net)	1.29	0.22	0.09	0.50	0.02	0.01	0.00	0.78
CPUE (Total/100 yds of net)	2.46	2.15	0.90	1.18	0.54	0.01	0.00	1.87

Table 7. Total gill netting effort for removed invasive carp (IC) in Pools 13–19 of the Upper Mississippi River in 2023. Invasive carp are broken down by bighead carp (BHCP), silver carp (SVCP), grass carp (GSCP), and bighead x silver carp (SCBC). Unsorted weight is an accumulated weight of all species weight when there was not an ability to sort by species.

2023	Pool 19	Pool 18	Pool 17	Pool 16	Pool 15	Pool 14	Pool 13	Total
Netting Effort								
Total Yards of Net	165,100	56,250	30,950	46,650	4,450	12,450	2,650	318,500
Catch Effort (Removed)								
Total IC (N)	3,106	747	117	294	0	0	0	4,264
Total IC Weight (kg)	35,104	8,175	1,271	2,740	0	0	0	47,290
Average IC Weight (kg)	11.3	10.9	10.9	9.3	0.0	0.0	0.0	11.1
Total Unsorted IC Weight (kg)	0	0	0	0	0	0	0	0
Total BHCP (N)	152	55	2	9	0	0	0	218
Total BHCP Weight (kg)	2,393	864	10	191	0	0	0	3458
Average BHCP Weight (kg)	15.7	15.7	5.0	21.2	0.0	0.0	0.0	15.9
Total SVCP (N)	1,113	479	76	198	0	0	0	1,866
Total SVCP Weight (kg)	12,343	5,145	933	1,831	0	0	0	20,252
Average SVCP Weight (kg)	11.1	10.7	12.3	9.2	0.0	0.0	0.0	10.9
Total SCBC (N)	28	6	3	1	0	0	0	38
Total SCBC Weight (kg)	247	85	16	24	0	0		372
Average SCBC Weight (kg)	8.8	14.2	5.3	24.0	0.0	0.0	0.0	9.8
Total GSCP (N)	1,813	207	36	86	0	0	0	2,142
Total GSCP Weight (kg)	20,121	2,080	312	694	0	0	0	23,207
Average GSCP Weight (kg)	11.1	10.0	8.7	8.1	0.0	0.0	0.0	10.8
Catch per unit of effort								
CPUE (BHCP/100 yds of net)	0.09	0.10	0.01	0.02	0.00	0.00	0.00	0.07
CPUE (SVCP/100 yds of net)	0.67	0.85	0.25	0.42	0.00	0.00	0.00	0.59
CPUE (SCBC /100 yds of net)	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.01
CPUE (GSCP/100 yds of net)	1.10	0.37	0.12	0.18	0.00	0.00	0.00	0.67
CPUE (Total/100 yds of net)	1.88	1.33	0.38	0.63	0.00	0.00	0.00	1.34

Table 8. *Invasive carp tagged, translocated, and released from Pools 16-19 of the Mississippi River in 2021 -2023. Invasive carp are broken down by bighead carp (BHCP), silver carp (SVCP), grass carp (GSCP), and bighead x silver carp (SCBC).*

Year	Species	Number Tagged	Number Translocated	Weight (kg)
2021	SVCP	274	274	2,629
	BHCP	63	63	882
	GSCP	55	55	533
	Total	392	392	4,044
2022	SVCP	304	84	3,160
	BHCP	41	5	682
	GSCP	96	96	1,102
	SCBC	11	0	110
	Total	452	185	5,054
2023	SVCP	264	264	3,031
	BHCP	39	19	632
	GSCP	119	99	1,369
	Total	422	382	5,032
Total		1,266	959	14,130

Table 9. *Number of tagged fish captured from commercial removal efforts in Pools 16–19 in the Upper Mississippi River from 2021 through 2023.*

USFWS/USGS Acoustically Tagged Fish Recaptures								
Year	2021			2022		2023		
Pool	16	17	19	16	17	16	17	18
BHCP	2	1	2	1	0	0	1	1
BMBF	3	0	0	0	0	1	0	0
SCBC	1	0	0	0	0	0	0	0
SVCP	1	0	0	1	7	1	1	4
Unknown	0	0	0	0	0	0	0	0
Total Captures	7	1	2	2	7	2	2	5

Table 10. Number of fish detections from the VR100 receiver during commercial removal efforts in Pools 15–19 in the Upper Mississippi River from 2021 through 2023.

VR100 Detections														
Year	2021					2022					2023			
Pool	15	16	17	18	19	15	16	17	18	19	16	17	18	19
BHCP	0	1	1	2	5	0	1	2	2	1	0	1	1	0
BMBF	3	36	2	0	3	3	19	1	0	3	1	0	0	1
PDFH	0	7	0	0	0	0	4	1	0	1	0	0	0	0
SCBC	0	2	0	1	0	0	0	0	1	0	0	0	1	0
SVCP	1	13	4	8	9	4	14	4	19	5	0	6	2	1
Total Detections	4	59	7	11	17	7	38	8	22	10	1	7	4	2

Table 11. *Bighead Carp Wr comparison by year in pools 16-19 of the Mississippi River from 2016-2023*

Year	diff	lwr	upr	p.adj
2017-2016	1.3773292	-3.1199724	5.874631	0.9830657
2018-2016	2.3829902	-2.4247638	7.190744	0.8043059
2019-2016	2.650641	-2.6645168	7.965799	0.7992764
2020-2016	4.605029	-13.4562193	22.666277	0.994348
2021-2016	7.6946924	2.6598375	12.729547	0.0001072
2022-2016	10.6064473	5.1782933	16.034601	0.0000001
2023-2016	20.5216462	11.7378072	29.305485	0
2018-2017	1.005661	-3.9818811	5.993203	0.9987172
2019-2017	1.2733119	-4.2050074	6.751631	0.9968232
2020-2017	3.2276998	-14.8822358	21.337635	0.9994263
2021-2017	6.3173632	1.1105559	11.524171	0.0058887
2022-2017	9.2291181	3.6411011	14.817135	0.0000174
2023-2017	19.1443171	10.2607982	28.027836	0
2019-2018	0.2676509	-5.4682674	6.003569	0.9999999
2020-2018	2.2220388	-15.9674786	20.411556	0.9999544
2021-2018	5.3117022	-0.1654886	10.788893	0.0649227
2022-2018	8.2234571	2.3826771	14.064237	0.0005535
2023-2018	18.138656	9.0940066	27.183305	0
2020-2019	1.9543879	-16.3757771	20.284553	0.999982
2021-2019	5.0440513	-0.8835135	10.971616	0.1625421
2022-2019	7.9558062	1.6907351	14.220877	0.0030779
2023-2019	17.8710052	8.546731	27.195279	0.0000002
2021-2020	3.0896634	-15.1611944	21.340521	0.9995915
2022-2020	6.0014183	-12.3618304	24.364667	0.9754344
2023-2020	15.9166172	-3.702248	35.535483	0.2119986
2022-2021	2.9117549	-3.1173392	8.940849	0.8246452
2023-2021	12.8269539	3.6595688	21.994339	0.0006204
2023-2022	9.9151989	0.5260541	19.304344	0.0299419

Table 12. Silver Carp Wr comparison by year in pools 16-19 of the Mississippi River from 2016-2023

Year	diff	lwr	upr	p.adj
2017-2016	1.1312033	-0.5845123	2.846919	0.4824924
2018-2016	4.1406111	2.3480122	5.93321	0
2019-2016	0.8166585	-1.3029299	2.936247	0.9409052
2020-2016	5.6122669	1.6495685	9.574965	0.0004727
2021-2016	13.7203125	11.8068642	15.633761	0
2022-2016	13.1964894	10.3438392	16.04914	0
2023-2016	18.9580006	14.4314976	23.484504	0
2018-2017	3.0094078	1.1469784	4.871837	0.0000271
2019-2017	-0.3145448	-2.4935096	1.86442	0.999862
2020-2017	4.4810636	0.4862907	8.475837	0.0155562
2021-2017	12.5891092	10.61009	14.568128	0
2022-2017	12.0652861	9.1682453	14.962327	0
2023-2017	17.8267973	13.2721884	22.381406	0
2019-2018	-3.3239526	-5.5639566	-1.083949	0.0001873
2020-2018	1.4716558	-2.5567361	5.500048	0.9553585
2021-2018	9.5797014	7.5336693	11.625734	0
2022-2018	9.0558784	6.1126529	11.999104	0
2023-2018	14.8173895	10.2332655	19.401514	0
2020-2019	4.7956084	0.6114495	8.979767	0.0120613
2021-2019	12.903654	10.5658149	15.241493	0
2022-2019	12.3798309	9.2267657	15.532896	0
2023-2019	18.1413421	13.4197494	22.862935	0
2021-2020	8.1080456	4.0244424	12.191649	0.0000001
2022-2020	7.5842225	2.9850765	12.183368	0.0000163
2023-2020	13.3457337	7.5574904	19.133977	0
2022-2021	-0.5238231	-3.5421753	2.494529	0.9995287
2023-2021	5.2376881	0.6049711	9.870405	0.0141951
2023-2022	5.7615112	0.6685361	10.854486	0.0140951

Table 13. *Bigmouth buffalo Wr comparison by year in pools 16-19 of the Mississippi River from 2016-2023*

Year	diff	lwr	upr	p.adj
2017-2016	-0.59250558	-3.60542431	2.420413	0.9989224
2018-2016	0.16201938	-2.66563357	2.989672	0.9999998
2019-2016	0.42155002	-2.43357435	3.276674	0.999838
2020-2016	-0.68109799	-7.74997376	6.387778	0.9999911
2021-2016	2.89932128	0.30055861	5.498084	0.0166064
2022-2016	2.99235516	-0.09659133	6.081302	0.0655605
2023-2016	0.50621551	-4.33377548	5.346206	0.9999844
2018-2017	0.75452495	-2.21717329	3.726223	0.9945541
2019-2017	1.0140556	-1.98379437	4.011906	0.970495
2020-2017	-0.08859242	-7.21631111	7.039126	1
2021-2017	3.49182686	0.73702438	6.246629	0.0031183
2022-2017	3.58486074	0.36353187	6.80619	0.0170869
2023-2017	1.09872108	-3.82681259	6.024255	0.9975791
2019-2018	0.25953065	-2.55206078	3.071122	0.9999934
2020-2018	-0.84311737	-7.8945226	6.208288	0.9999611
2021-2018	2.7373019	0.18644351	5.28816	0.0253646
2022-2018	2.83033578	-0.21841832	5.87909	0.0913797
2023-2018	0.34419613	-4.47024297	5.158635	0.9999989
2020-2019	-1.10264802	-8.16511428	5.959818	0.9997645
2021-2019	2.47777126	-0.10350606	5.059049	0.0706201
2022-2019	2.57080514	-0.50344527	5.645056	0.1803447
2023-2019	0.08466548	-4.74595952	4.91529	1
2021-2020	3.58041927	-3.38235761	10.543196	0.7738955
2022-2020	3.67345315	-3.48673434	10.833641	0.7759743
2023-2020	1.1873135	-6.88437822	9.259005	0.999842
2022-2021	0.09303388	-2.74472013	2.930788	1
2023-2021	-2.39310577	-7.07677635	2.290565	0.7796257
2023-2022	-2.48613965	-7.45854281	2.486263	0.798301

Table 14. *Paddlefish Wr comparison by year in pools 16-19 of the Mississippi River from 2016-2023*

Year	diff	lwr	upr	p.adj
2017-2016	-6.38627994	-11.55869869	-1.2138612	0.0045616
2018-2016	7.26965503	3.08448625	11.4548238	0.0000042
2019-2016	9.86147087	6.02427008	13.6986717	0
2020-2016	7.56118245	-14.89548303	30.0178479	0.971296
2021-2016	7.17682866	2.91538073	11.4382766	0.0000097
2022-2016	18.48025803	14.82411024	22.1364058	0
2023-2016	13.751553	9.45050148	18.0526045	0
2018-2017	13.65593497	8.46559839	18.8462716	0
2019-2017	16.24775081	11.33368264	21.161819	0
2020-2017	13.94746239	-8.71805725	36.612982	0.5739695
2021-2017	13.5631086	8.31107141	18.8151458	0
2022-2017	24.86653797	20.09250689	29.6405691	0
2023-2017	20.13783294	14.85361112	25.4220548	0
2019-2018	2.59181584	-1.26950363	6.4531353	0.4573258
2020-2018	0.29152742	-22.16927182	22.7523267	1
2021-2018	-0.09282637	-4.37600471	4.190352	1
2022-2018	11.210603	7.52915019	14.8920558	0
2023-2018	6.48189797	2.15931514	10.8044808	0.0001532
2020-2019	-2.30028842	-24.69885924	20.0982824	0.9999863
2021-2019	-2.68464221	-6.62850946	1.259225	0.438061
2022-2019	8.61878716	5.33830442	11.8992699	0
2023-2019	3.89008213	-0.09654483	7.8767091	0.0617456
2021-2020	-0.38435379	-22.85949124	22.0907837	1
2022-2020	10.91907558	-11.44918947	33.2873406	0.8177817
2023-2020	6.19037055	-16.29230965	28.6730508	0.9910915
2022-2021	11.30342937	7.53548622	15.0713725	0
2023-2021	6.57472434	2.17824585	10.9712028	0.0001623
2023-2022	-4.72870503	-8.54138141	-0.9160286	0.0042778

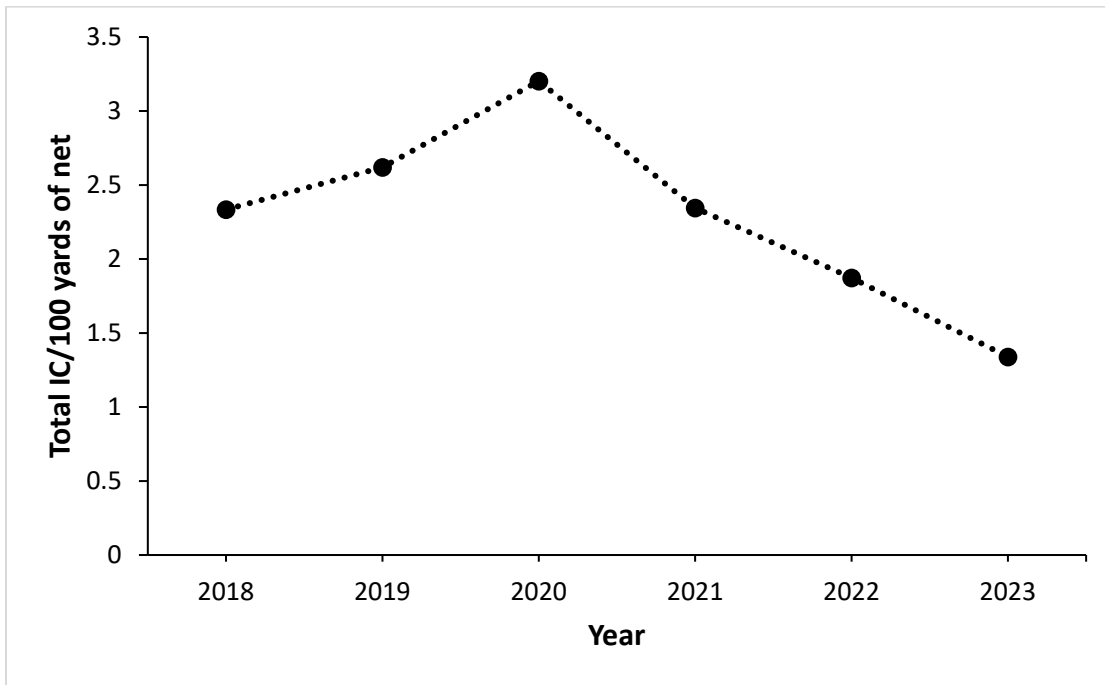


Figure 1. Total catch per unit effort by year for invasive carp removed by contracted removal from the Upper Mississippi River Pools 14–19 using gill nets from 2018 through 2023.

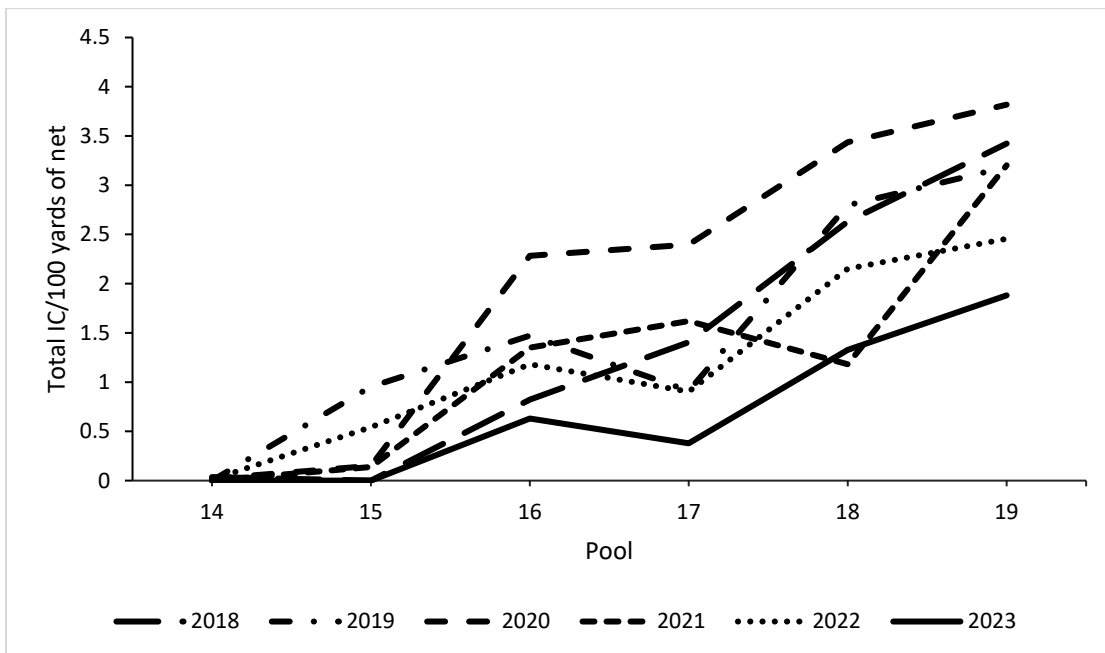


Figure 2. Catch per unit effort by year and pool in the Upper Mississippi River in Pools 14-19 for invasive carp removed during contracted commercial removal using gill nets from 2018 through 2023.

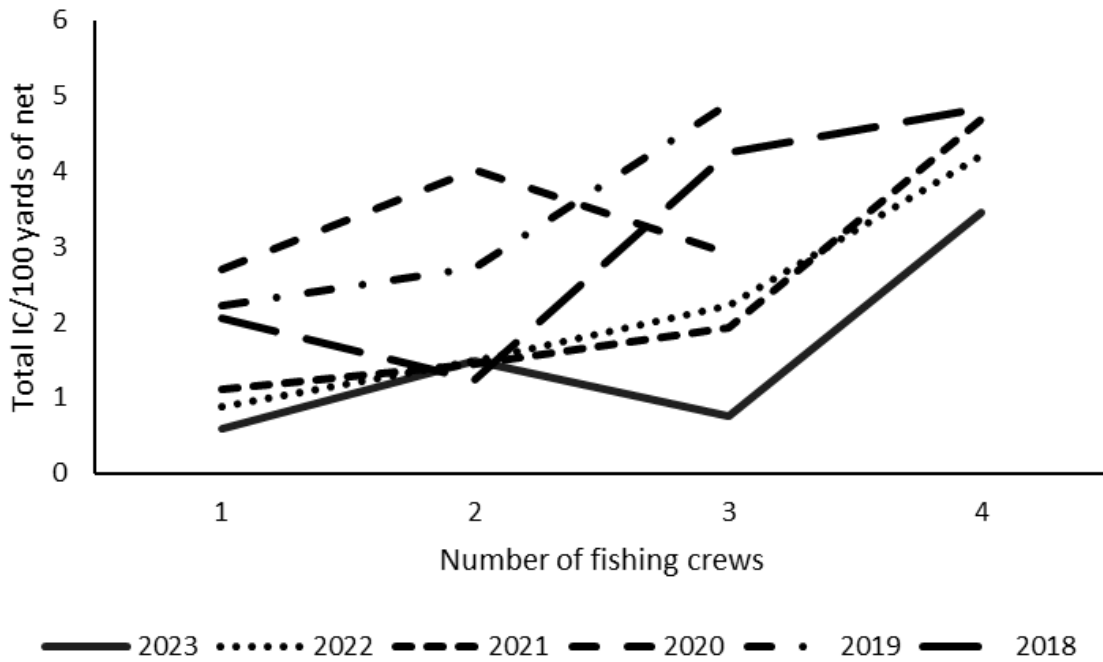


Figure 3. Catch per unit effort by year and pool in the Upper Mississippi River in Pools 14-19 for invasive carp removed during contracted commercial removal using gill nets from 2018 through 2023.

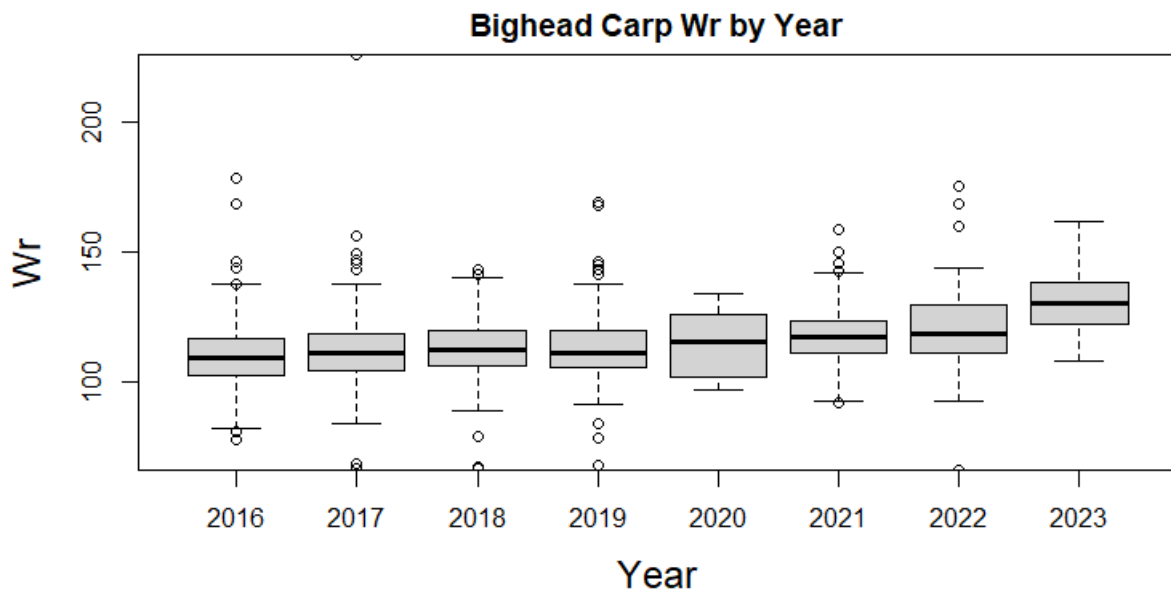


Figure 4. Bighead Carp Wr by year in Pools 16–20 of the Upper Mississippi River from 2016 through 2023

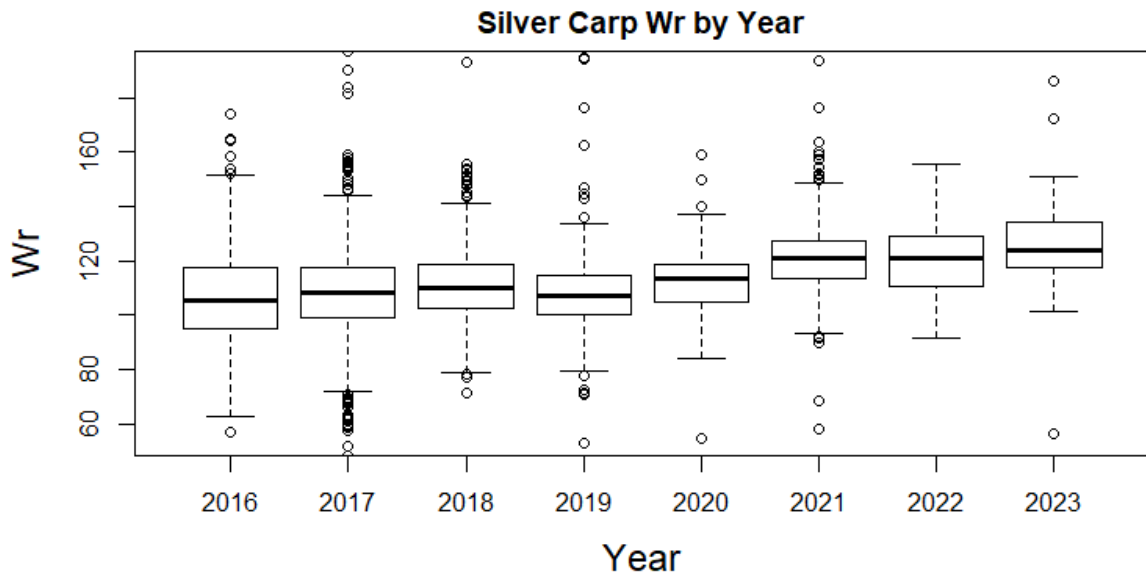


Figure 5. Silver Carp relative weight (*Wr*) by year in Pools 16–19 of the Upper Mississippi River from 2016 through 2023.

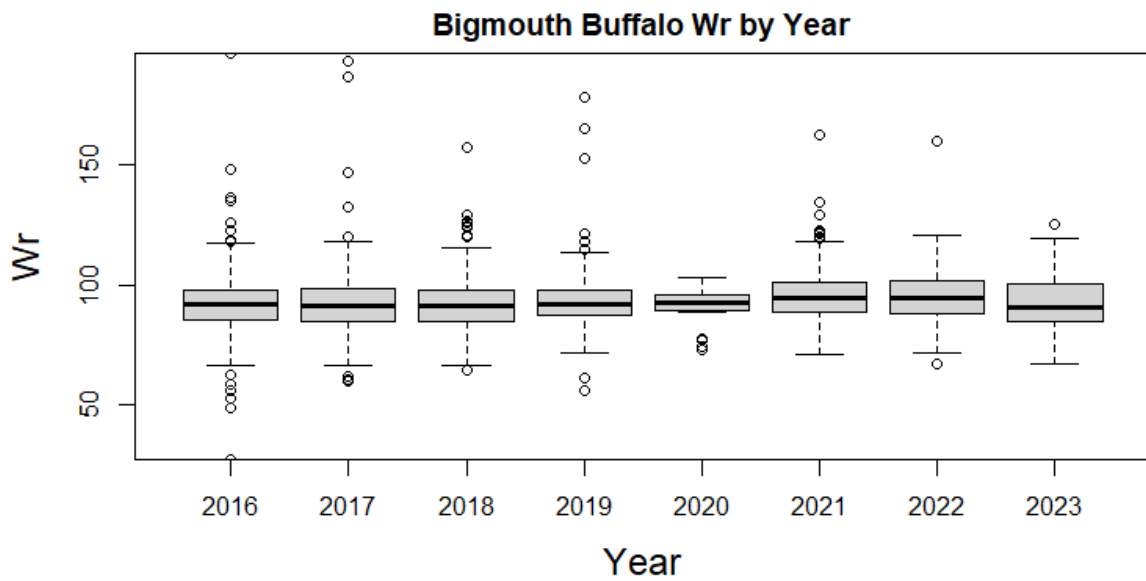


Figure 6. Bigmouth buffalo relative weight (*Wr*) by year in Pools 16–19 of the Upper Mississippi River from 2015 through 2023.

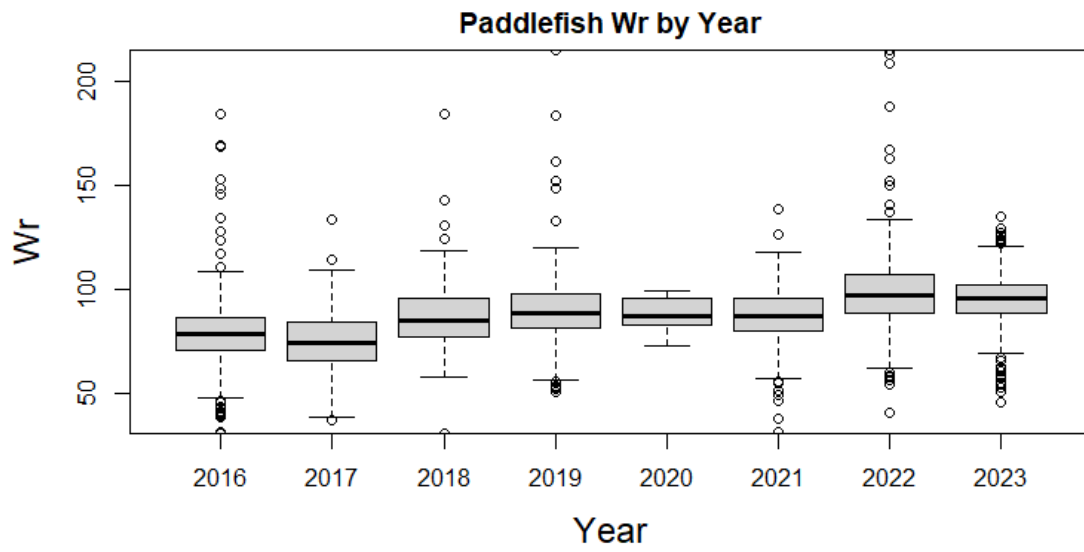


Figure 7. Paddlefish relative weight (*Wr*) by year in Pools 16–19 of the Upper Mississippi River from 2015 through 2023.

Missouri Department of Conservation (MDC)

Statement of Need: Populations of invasive carp (silver carp, bighead carp, black carp, and grass carp) have rapidly expanded throughout the Mississippi River basin. Management and control of invasive carp is necessary to reduce their impact on native species, the ecosystem, and the economy. In response to these threats, many states throughout the Mississippi and Great Lakes basins have been working to find effective strategies to manage existing populations and to control the expansion of invasive carp into adjacent aquatic systems. Appropriations for the Department of Interior indicate that ‘while the Committees (House Subcommittee on Interior, environment, and Related Agencies and the Senate Subcommittee on Interior, Environment, and Related Agencies) recognize the importance of studying and understanding invasive carp patterns, the Service is encouraged to take action on a strategy that increases the focus on biomass removal and restricts carp progression by coordinating with other Federal partners on constructing invasive carp barriers’. This project addresses the need for biomass removal.

Project Objectives:

- Targeted removal of invasive carp in UMR Pools 20, 21, 22, 24, and 25 using agency staff and/or contracted/commercial fishing to reduce invasive carp density below Lock and Dam 19 and potentially decrease the number of invasive carp attempting to pass upstream into the Intensive Management Zone.

Project Highlights:

- The Missouri Incentivized Carp Harvest Program was launched on 12 October 2023, to promote the commercial harvest of invasive carp from the UMR. The commercial harvest of 121,209 lbs. of silver carp were incentivized through the program during 2023.

Methods:

In July 2023, MDC contracted with Tetra Tech, Inc. to implement and manage an invasive carp removal program. On 12 October 2023, the Missouri Incentivized Carp Harvest Program (MO-ICHP) was launched (Figure 1) to promote the commercial harvest of invasive carp from UMR Pools 20, 21, and 22. On 1 December 2023, the program was expanded to include Pools 24 and 25. The program offers \$0.10/lb. for invasive carp (silver carp, bighead carp, grass carp, and black carp) caught in designated waters and sold to any processor for at least \$0.07/lb. Individuals with a valid commercial fishing permit in Missouri or Illinois can participate and must abide by all applicable commercial fishing regulations. Tetra Tech, Inc. manages contracts with and reimbursements to program participants.

Results and Discussion:

During 2023, 22 commercial fishers entered contracts to participate in the MO-ICHP and the commercial harvest of 121,209 lbs. of silver carp were incentivized through the program (Table 1). Harvest steadily

increased month to month and was highest on Pool 20 (54,708 lbs.) and Pool 25 (39,783 lbs.). No harvest of bighead carp, grass carp, or black carp were reported.

Tables and Figures:

Table 1. *Pounds of silver carp harvested through the Missouri Incentivized Carp Harvest Program during 2023.*

2023						
Month	Pool 20	Pool 21	Pool 22	Pool 24	Pool 25	Total
Oct	3,476	0	3,632	NA	NA	7,108
Nov	22,343	0	16,462	NA	NA	38,805
Dec	28,889	0	0	6,624	39,783	75,296
Total	54,708	0	20,094	6,624	39,783	121,209



**WE'RE LAUNCHING A NEW
INCENTIVIZED CARP HARVEST PROGRAM
ON THE MISSISSIPPI RIVER!**

Thursday, October 12, 2023, 7-8 pm (CST)
Call or Text the FISH LINE for meeting details 217-969-2045

Full and Part-Time Fishers

The new Incentivized Carp Harvest Program for the Mississippi River is getting started for fishers holding valid Missouri, Illinois, Kentucky or Tennessee commercial fishing licenses.

Call into our virtual meeting to learn more!

The Program will be offering 10¢ per pound for Invasive Carp (Bighead, Grass, Silver and Black carp) caught in Designated Waters of the Mississippi River and sold to any processor for a minimum of 7¢ per pound. Designated Waters include the Upper Mississippi River (Pools 20, 21, and 22) and the Lower Mississippi River from the Missouri-Arkansas border to the confluence of the Ohio River. Other requirements apply.

To get information on how to join the meeting, call or text the **FISH LINE, 217-969-2045**.
If you have questions or can't join the meeting, but want to hear about the program, please call or email:

Joe McMullen, (314) 301-1506 x4215, Joe.McMullen@mdc.mo.gov.



Figure 1. Postcard invitation sent to commercial fishing permit holders in Missouri and Illinois for an informational, public meeting announcing the launch of the Missouri Incentivized Carp Harvest Program.

Recommendations:

- Continue to promote and fund the Missouri Incentivized Carp Harvest Program.
- Consider implementation of a transportation incentive whereby buyers are paid to pick up invasive carp riverside. Riverside pick up by buyers should save harvesters time and money and may increase the amount of time they are able to fish.