

FY23 Annual Report

Control and Containment of Invasive carp in the Ohio River

Geographic Location: Ohio River basin, extending from the Racine Lock and Dam (RM 237.5) to the Mississippi River (RM 0), including the Wabash River.

Participating Entities: Kentucky Department of Fish and Wildlife Resources (KDFWR), Illinois Department of Natural Resources (ILDNR), Indiana Department of Natural Resources (INDNR), and West Virginia Department of Natural Resources (WVDNR)

Introduction:

The complete eradication of an established invasive species is an extremely difficult task on its own, but it becomes virtually impossible to accomplish without causing collateral damage to native populations. Therefore, the best option for reducing the spread of an invasive species may include the combination of a strong prevention effort and a swift response to possible introductions. When as many as four different species of invasive carp (Silver, Bighead, Grass, and Black Carp) were introduced into a major US waterway, resource managers made numerous attempts to prevent them from expanding into other areas. Despite these efforts, the ranges of all four invasive carp species have steadily increased since their introduction (Kolar et al. 2005). Many of these populations have achieved densities that are high enough to negatively impact the native food web (Irons et al. 2007, Freedman et al. 2012) and disrupt human connections to these natural resources (i.e., fishing, boating, and navigation). With prevention and early response no longer an option for most of the lower Ohio River Basin, it has been determined that large-scale removal projects may be one of the few tools that managers can still utilize in their ongoing efforts to slow down the population's upstream expansion.

Agencies have implemented a suite of removal projects, supporting both incentivized commercial fishing, incentivized waterside pick up, and contract fishing in various areas of the lower Ohio River basin and tributaries. When consistent removal efforts are conducted in areas where the established population meets the invasion front, it has a high potential to decrease upstream immigration, lower pressure on existing barriers, and reduce carp densities at locations where there are species of conservation concern or valued sport fisheries. Cannelton Pool currently marks the establishment front for Silver Carp populations within the mainstem Ohio River. In addition, there are several locations above Cannelton Locks and Dam where Grass and bigheaded carps can be consistently targeted with sampling gear that is essential to large-scale removal efforts. The purpose of this project is to utilize basin-wide knowledge in the ongoing efforts to control and contain invasive carp populations that have become established within the Ohio River basin (ORB). Additionally, the data collected during the targeted removal are used to augment the other evaluation efforts that KDFWR conducts to determine the status of the invasive carp populations in different pools of the Ohio River. Further down river, incentivized commercial harvest and processor pick-up provide tools to utilize existing infrastructure to suppress populations and reduce numbers where these fish are at peak abundance.

Objectives:

1. Target and remove invasive carp to suppress populations and reduce propagule pressure in the Ohio River basin.
2. Implement a removal program using contracted fishers at intensive management zones to reduce invasive carp numbers across the Ohio River basin.

Project Highlights:

1. A total of 56.7 hours of electrofishing effort was used to remove approximately 3,678 kg (~8,108 lbs) of invasive carp from three different pools of the Ohio River in 2023.
2. A total of ~2.1 million pounds (928K kg) of invasive carp have been harvested by contract fishing efforts conducted between July 2019 and February 2024.
3. Contract fishing efforts continued to remove high numbers of invasive carps from the Cannelton Pool of the Ohio River without causing substantial impacts on native fish populations.
4. Incentivized commercial harvest resulted in the removal of 3,534,342 pounds of invasive carp in 2023.
5. Contract facilitation reimbursements to processors for waterside pickup supported the removal of 12,167,337 pounds of invasive carp in 2023.

Agencies strongly agree that commercial removal, including contract fishing in the Cannelton Pool and the agency's additional upstream removal efforts should remain in place to continue reducing the densities of mature invasive carp that are capable of successful reproduction.

Methods:

Clarification of Terminology Referenced in This Document

With the current rate of invasive carp expansion and the massive effort to study and adaptively manage carp impacts across a broad range of Mississippi River sub-basins, it is important to clarify terminology used in technical documentation and annual reports. Therefore, a list of terms and their respective definitions used in this report are provided.

Bigheaded Carps – Silver (*Hypophthalmichthys molitrix*), Bighead (*Hypophthalmichthys nobilis*), and their hybrids.

Establishment Front – The furthest upriver range of invasive carp populations that demonstrates natural recruitment.

Invasion Front – The furthest upriver extent where reproduction has been observed (eggs, embryos, or larvae), but recruitment to young-of-year (YOY) fish has not been observed.

invasive carp – One of four species (i.e. Silver Carp, Bighead Carp, diploid Grass Carp, and Black Carp) that originated from the continent of Asia.

Presence Front – The furthest upstream extent where invasive carp occur, but reproduction is not evident.

Targeted Removal of Invasive Carp

In 2023, a small increase in the number of field staff and the assistance of other agencies have improved KDFWR's ability to conduct further invasive carp removal efforts in areas located upstream of the Cannelton Pool. During these targeted removal efforts, agency crews utilized pulsed DC electrofishing via a MLES control box (40% duty-cycle) that was typically set at a rate of 80 pulses per second (pps). In previous years, KDFWR would set gill nets near the downstream end of the sampling area to target any invasive carp that tried to evade the electrofishing boat. However, a reduction in available field crews during most of 2023 required KDFWR to continue using an electrofishing-only approach to complete its targeted removal efforts.

The 2023 removal efforts continued to be conducted entirely within tributaries and embayments of the Markland, McAlpine and Cannelton pools. Upon capture, all bycatch species were immediately identified

and released. All invasive carp were inspected for tags, and if present, the id numbers were used to determine the status of the transmitter. A healthy tagged fish with an active transmitter presented the only conditions when an invasive carp would have been intentionally released back into the river. Any tagged fish with expired transmitters were ultimately removed for population control. Prior to being euthanized, the length, weight, sex, and presence/absence of a spawning patch were recorded for each invasive carp.

Similar to previous years, KDFWR utilized the 2023 removal efforts to collect aging structures from invasive carp that were captured from the Cannelton, McAlpine and Markland pools. During these situations, agency field staff would identify Silver Carp from specific size classes and then harvest otoliths that would later be processed and examined for the ongoing length-at-age analyses being conducted for the Early Detection and Evaluation Project.

Invasive Carp Contract Fishing Program

During the implementation of the invasive carp contract fishing program, there were changes to the timing of the year when fishing occurred, the number of fishers fishing/ week, access to Indiana waters, and program's administration. The Contract Fishing Program in the Ohio River officially began in July 2019. In 2023, KDFWR held contracts with ten contract fishers that allowed them to target invasive carp in the mainstem river, tributaries and embayments of the Cannelton and Newburgh pools. KDFWR also provided observers to accompany each program participant in order to record details about their fishing efforts (i.e., location, gear, etc) and their subsequent harvest of invasive carp. During these efforts, observers were required to obtain size and sex data from daily subsamples of 20 or more randomly selected Silver, Bighead and/or Grass carp. They were also responsible for identifying any bycatch that contract fishers picked up in their nets and then ultimately document any morbidity of these non-target species.

From late 2019 to early 2021, contract fishing efforts were spread throughout the entire year and any scheduling restrictions occurred only when required by program funding. In late 2021, KDFWR started altering the program's fishing schedule to shift more efforts to the cooler months that consistently produced higher harvest totals. After even more changes in 2022, the agency essentially created a contract fishing season by scheduling most of the program's efforts to occur within a 6-month period that began in October and then continued through March of the following year. This season primarily consists of peak harvest months that were identified during the first few years of the program.

These changes to the contract fishing program were implemented to increase harvest without creating a need for additional funding. The initial adjustments in 2021 involved a 2-month suspension of contract fishing efforts in August and September when high temperatures tend to reduce invasive carp harvest while increasing the mortality rates of any bycatch. For 2022, the agency initially planned to include an additional summer month to the program's suspension period (Jul – Sep). However, soon after the start of 2022, KDFWR had to deviate from this plan to accommodate the larger number of observers ($n = 5$) on their staff, which required the agency to schedule up to 2 additional fishermen each week. As a result, most dates on the schedule in Jan – Mar 2022 produced an average effort of ~5 “fishing days”, which is equivalent to 1 program participants actively fishing for five full days. This unexpected surge in effort also increased program costs to the point that all FY2021 funds were spent by early May 2022, which ultimately caused all contract fishing to be suspended nearly two months sooner than expected.

Like 2021, the 2022 fishing efforts were to resume by early October when river conditions improve (i.e. lower water temperatures) and the next funding cycle is underway. However, delays in contract renewals and the hiring of new observers postponed the restart of the program until the last day of October 2022.

Once fishing efforts resumed, the invasive carp harvest numbers quickly returned to normal. Since then, key scheduling changes and further usage of group fishing techniques greatly increased harvest success.

In late November 2021, some program participants had the opportunity to fish for invasive carp within the McAlpine Pool, which is located directly upstream of Cannelton. These efforts were used to determine if McAlpine could benefit from contract fishing if there is ever a decision to expand the program beyond the Cannelton Pool. After just two days of fishing tributaries in McAlpine, the catch rates and numbers of harvested invasive carp were much lower than expected and contract fishers appeared to have difficulty finding areas that produced results comparable to those in Cannelton. Further expansion of the program's efforts also occurred in late 2023 when contract fishers began to target invasive carp in specific areas of the upper Newburgh Pool. Unlike the McAlpine Pool, the contract fishers' methods were successful at capturing invasive carp in these new areas, and the sites within the Newburgh Pool are likely to be targeted again during future years of the program.

Results:

Targeted Removal of Invasive Carp

Approximately 56.7 hours of boat electrofishing was conducted at a variety of tributary and mainstem sites located in three different pools (Cannelton, McAlpine and Markland) of the Ohio River. (Table 1). In 2023, KDFWR (with assistance from INDNR) used the combined efforts from all three pools to capture and removed a total 683 invasive carp, weighing 3,678 kg (8,108 lbs.). Like in previous years, most of the 2023 electrofishing efforts (53.1%) were conducted at sites in the McAlpine Pool, which resulted in the removal of 301 invasive carp weighing a total of ~1707.7 kg (3,764 lbs.). Bycatch of non-target species continue to be rarely encountered due to the selective nature of the electrofishing efforts. However, shad and alewife species were captured on occasion to verify that they were not juvenile (age-0 to age-1) invasive carp.

INDNR spent three days conducting targeted invasive carp removals in 2023. Removals took place in Little Pigeon Creek a tributary of the Ohio River located in Newburgh Pool (near Yankeetown, IN) and on the West Fork White River near Elnora, Indiana (Smithland Pool). A total of 13.8 hours were spent electrofishing for invasive carp, producing 1,885 Silver Carp, 1 Bighead Carp, and 64 Grass Carp. Approximately 6,055 kg (13,349 lbs) of invasive carp were removed through these agency removal efforts (Table 1). Combined with other project sampling efforts (targeted spring sampling, otolith collections, and fish community sampling) throughout 2023, INDNR crew removed 2,807 adult invasive carp for approximately 9,270 kg (20,437 lbs). INDNR helped ILDNR and SIU with community sampling for a removal event on a Grayville oxbow, spending 1 hour actively electrofishing. INDNR also assisted KDFWR with the contract fishing program on the Ohio River, providing ride-along observers when needed. Also, INDNR has been working to create a new permit allowing the use of gill nets and seines for harvesting invasive carp in otherwise closed waters. Draft language has been developed and the permit has been introduced into the first step of the rule-making process, however a timeline for when or if the permit will become effective remains unknown.

WVDNR conducted a total of four removal events yielding nine adult Bighead carp and four adult Silver carp from the R.C. Byrd Pool of the Ohio River. One solo removal event was conducted in Tenmile Creek of the Kanawha River (1 Silver carp) and three removal events were conducted in cooperation with the USFWS Ohio River sub-station staff in Raccoon Creek and the disused lock chambers of R.C. Byrd Dam from July-September 2023. A total effort of 685 meters (2250 ft) of gill nets were deployed for these efforts. Additionally, one adult Bighead and one adult Silver carp were caught and removed via gill nets set to collect Paddlefish in October of 2023.

Contract Fishing Program

At the beginning of 2023, KDFWR had enough observers on staff to regularly schedule up to 4 fishers a week. Program participants conducted an average of 56 fishing days per month during the first few months of 2023 (Jan – Mar) and ended this 3-month period with a total of 168 fishing days, which was comparable to the 156 days fished during this same time period in 2022 (Table 2). During these efforts in Jan – Mar 2023, contract fishers used 711 gill net sets (~ 325,100 net ft) to harvest a total of 54,700 carp that had a combined weight of more than 276,000 kg (~609,000 lb). Contract fishing efforts in Jan-Mar 2023 yielded the highest harvest totals than any 3-month period of the program, including the previous high of nearly 22,000 invasive carp that were captured and removed in Jan-Mar 2022. After the strong start to 2023, contract fishers continued to harvest high numbers of invasive carp in April and May (n = ~19,000 fish). By the time that contract fishing efforts were suspended for the summer months, a total of nearly 74,000 invasive carp weighing over 372,000 kg (~821,600 lb) had been harvested during the first five months of 2023.

Throughout 2023, program participants set an overall total of 1543 gill nets within both the Cannelton and Newburgh pools. In fact, by the end of 2023, sites within the Newburgh Pool were being regularly targeted by contract fishing efforts. This trend continued during the first two months of 2024, when nearly 33% of all gill nets had to be set at sites in the Newburgh Pool when Indiana tributaries were temporarily closed to contract fishing efforts.

During each year from 2019 to 2023, contract fishers have harvested three different species of invasive carp, which include Silver, Bighead and Grass carps. The most common by far, in terms of both numbers and weight, have been Silver Carp. In 2023, Silver Carp (n = 81,163) represented more than 98.7% of the harvested fish, while both Bighead (n = 496) and Grass (n = 531) carps combined to make up the other ~1.3% (Table 3). The species composition of all invasive carp caught in 2023 simply echoed an overall trend in the program's results where Silver Carp have made up 98.3% of all carp (n = 181,178) caught by contract fishers in the last 5+ years (Jul 2019 – Feb 2024).

After comparing the mean daily catch of invasive carp during peak months (Oct-Feb) of the past five contract fishing seasons (2019-2023), there was an initial decline in daily harvest rates during the first few years (Figure 1). However, this was not indicative of the program's performance as the overall harvest totals were increasing during this same time period. The disparity is related to the shift from year-round efforts in 2019-2020 to fishing that only occurred during peak months beginning in late 2021. In Oct 2021 – Feb 2022, program participants completed a total of ~225 fishing days, which was a sizable increase over the 120 fishing days from the same time period in 2019-2020. Contract fishers then completed ~220 fishing days in Oct 2022 through February 2023, but mean daily harvest actually increased substantially during this period, which included record numbers of invasive carp being harvested by contract fishers during Jan and Feb 2023. In contrast, a similar number of fishing days completed between Oct 2023 and February 2024 (n = 224) failed to match the record output of the previous 2022-2023 season, which is indicated by a decline in daily harvest rates during each of the 5 peak fishing months.

In 2023, the monthly comparisons of mean daily harvest indicated that contract fishers had their highest catch rates during the months of February (375 carp/day) and March (363 carp/day) (Figure 2). In contrast to 2022, the 2023 catch rates appear to be much more correlated with river levels, even though cooler water temperatures continue to have a large influence on harvest success. This can be misleading because high variability in daily harvest during these months can lead to lower rates even if contract fishers are still catching high numbers of invasive carp.

Gill nets continued to be the only gear used during the eight-month period that program participants were actively fishing in 2023. Netting effort often varies and can depend a lot on catch, but throughout 2023, contract fishers typically set out 600-750 meters (2000-2500 ft) of webbing per day. The Silver Carp catch ranged in total length from 100 mm to 1100 mm with most of the fish (~99%) measuring between 600 – 900 mm (Figure 3). Bighead and Grass carp were caught less frequently, but when harvested, most Bighead Carp (>85%) had total lengths of 750 to 1150 mm and nearly 88% of all Grass Carp measured between 750 - 1050 mm.

The bycatch from contract fishing efforts in 2023 was highest in January (31%) and June (32%) with other months showing that non-target species contributed between 9% and 27% of the total catch (Figure 4). All bycatch species were released immediately, and agency observers specifically documented any non-target fish that were either dead-on-arrival (DOA) or appeared to be moribund. Smallmouth and Bigmouth Buffalo (*Ictiobus* spp.) were the most common bycatch and contributed more than 81% of all non-target fish ($n = \sim 15,520$). Freshwater Drum (*Aplodinotus*), Catfish (*Ictaluridae*) and Paddlefish (*Polyodon*) were the next three most common types of bycatch found in the gill nets (Figure 5). In contrast to 2022, Ictiobids had only the 3rd highest morbidity rate among the common bycatch species in 2023 with 2.7% of the buffalo being DOA. Paddlefish (*Polyodon*) are considered to be highly vulnerable to nets, but they were only the fourth most commonly caught fish in 2023 contributing as little as 2.2% of all bycatch recorded by observers. However, it was determined that the Paddlefish ($n = 416$) pulled from contract fishing nets in 2023 also exhibited the highest morbidity rate (3.9%) of any other bycatch species.

ILDNR Contract Fishing

In February and March 2023, ILDNR contracted commercial fishers conducted a two-week removal effort in Bonpas Creek, a tributary of the Wabash River in Grayville, IL. During this effort 12,000 yards of gill and trammel net was deployed. In total, approximately 30,000 Silver carp and 2 Black carp were removed, with a total estimated weight of 112.5 tons (225,000 lbs.). Bycatch included 1550 Smallmouth Buffalo, 950 Bigmouth Buffalo, 450 Black Buffalo, 74 Freshwater Drum, 24 Channel Catfish, 22 Shovel-nose Sturgeon, 20 Largemouth Bass, 6 Blue Suckers, 5 Blue Catfish, and 3 Bowfin. All native species captured were released unharmed.

Hydroacoustic sampling results of the Grayville oxbow targeted harvest in March 2023 on the Wabash River.

Block nets separated the oxbow from the Wabash main channel throughout the harvest event. Only the southwest portion of the Grayville oxbow was targeted for removal and assessment. Hydroacoustic sampling by SIU was conducted prior to harvest/sampling but after block nets were in place. INDNR electrofished the adult fish community in the oxbow to inform hydroacoustic analyses. Gillnet harvest occurred for several days, followed by hydroacoustic sampling, and then removal of the block nets. Silver, common, and grass carp were harvested during the removal event and were therefore combined for hydroacoustic analyses and are referred to here as ‘invasive carp’.

Estimated invasive carp densities before harvest were highest near the center of the oxbow, slightly offshore (Figure 1). Spatial distributions of the entire adult fish community were relatively evenly distributed throughout the oxbow prior to harvest for all fish sizes (Figure 2). Harvest reduced invasive carp densities (Figure 3) and shifted their spatial distributions toward the eastern, nearshore area of the oxbow (Figure 1). Spatial distributions of the entire adult fish community were distributed toward the southern portion of the oxbow closest to the main channel following harvest, especially for medium to large size classes (Figure 2).

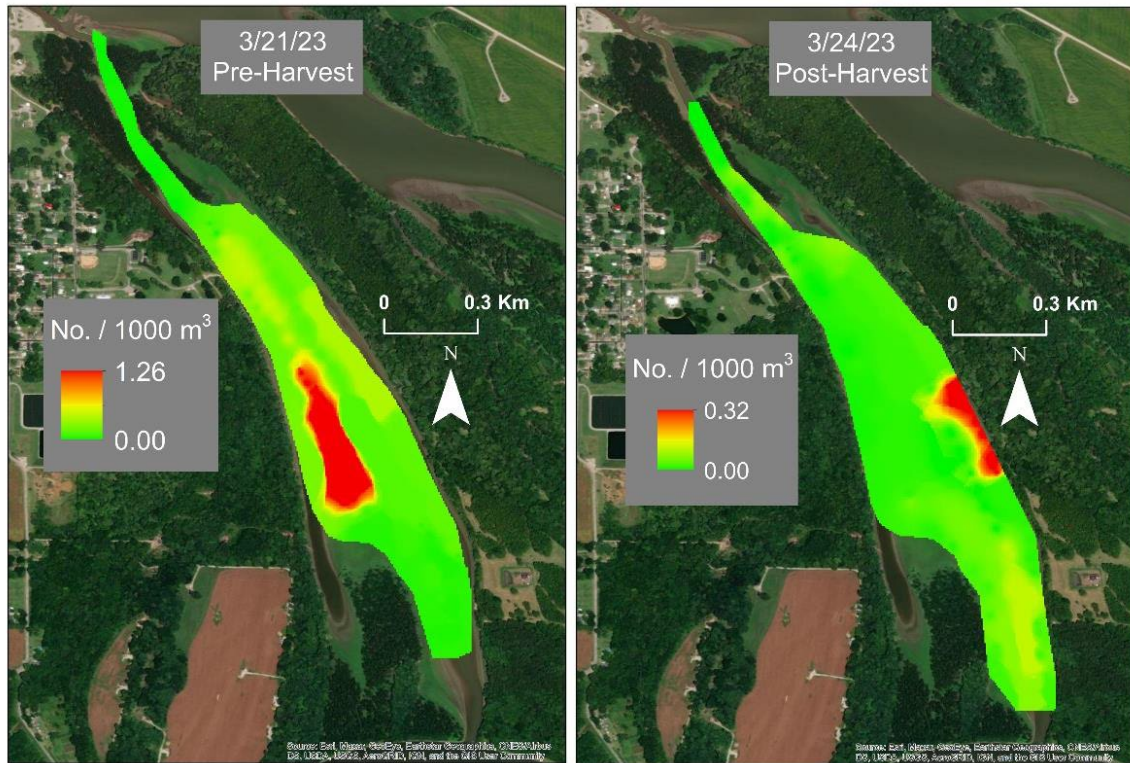


Figure 1. Spatial distributions of invasive carp before and after harvest in the Grayville oxbow of the Wabash River in March 2023. Note the lower density scale in the post-harvest panel.

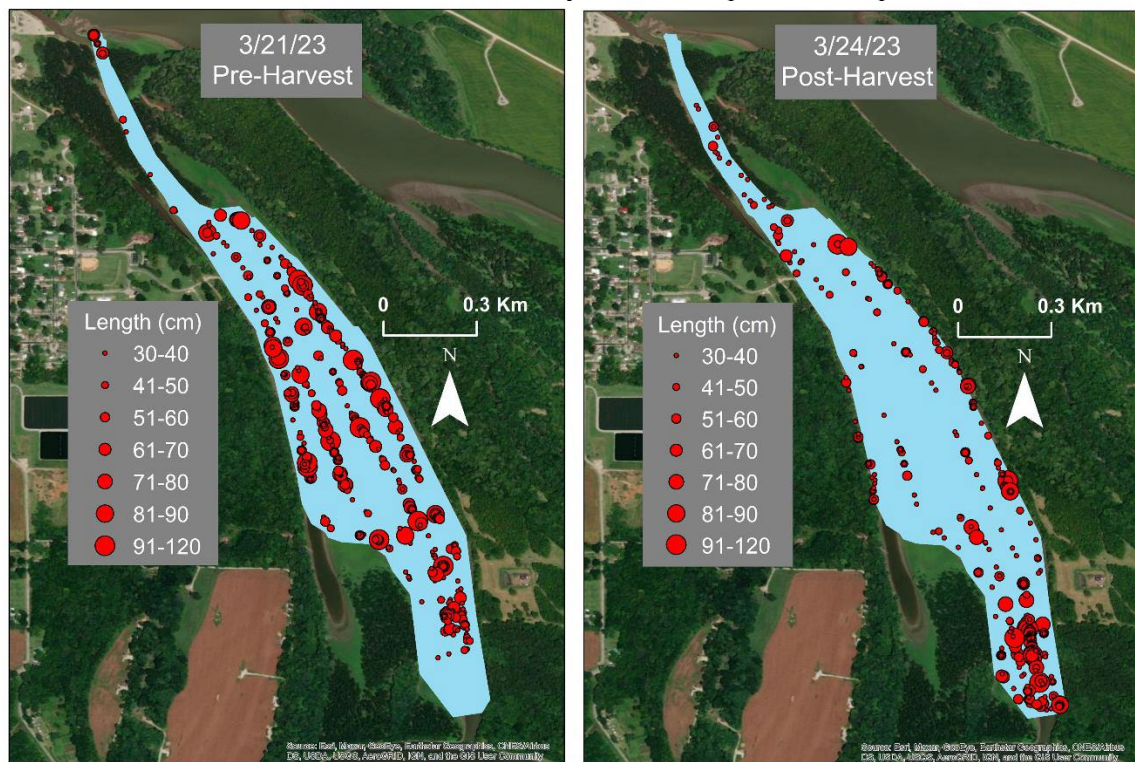


Figure 2. Spatial distributions and estimated sizes of the entire adult fish community sampled during hydroacoustic sampling pre- and post-harvest of invasive carp from the Grayville oxbow of the Wabash River in March 2023.

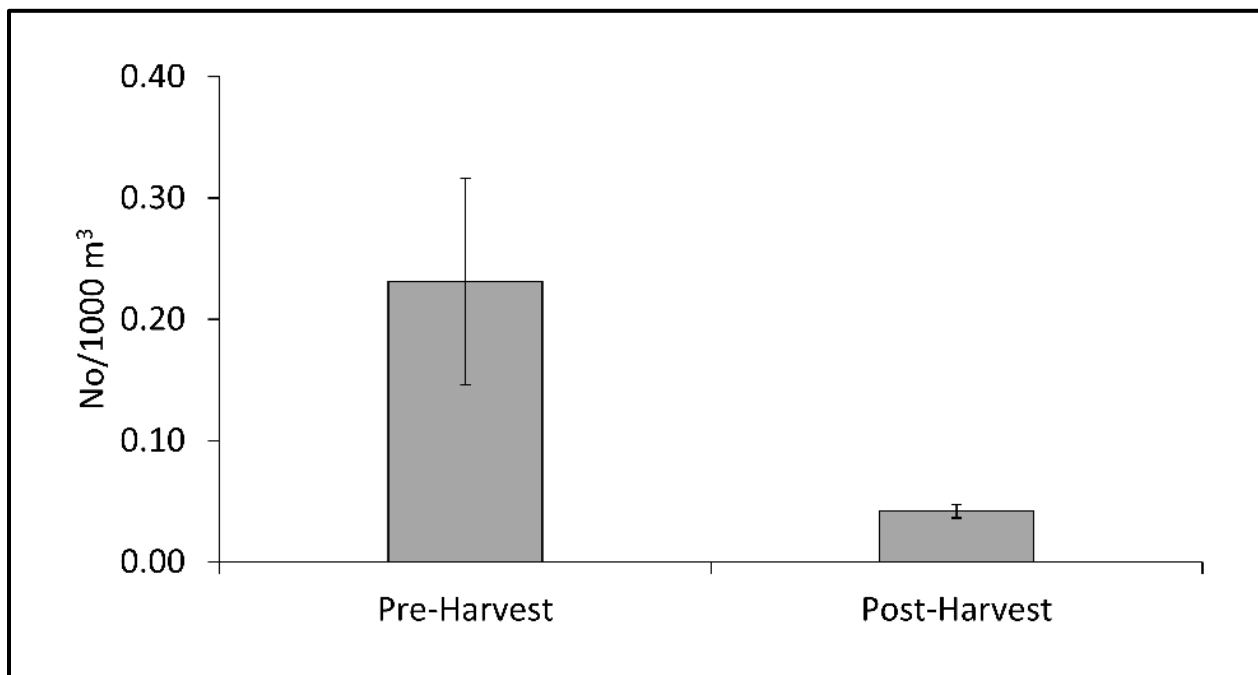


Figure 3. Mean (standard error) estimated invasive carp densities from hydroacoustic sampling conducted pre- and post-harvest of invasive carp from the Grayville oxbow of the Wabash River in March 2023.

Enhanced Contract Removal

Enhanced Contract Fishing was initiated in early 2022, offering contracts to licensed commercial fishers for compensation of \$0.10 per pound for invasive carp removed from designated commercial waters and sold to a fish processor(s) or other buyer(s) for at least \$0.07 per pound. The program used the same terms and maintains the designated waters of the previous program initiated in 2022. Designated waters includes the commercial waters of the following:

- (1) the portion of the Wabash River from the Ohio River to the southernmost city limits of Lafayette, Indiana
- (2) Skillet Fork River
- (3) Little Wabash River
- (4) Embarras River, except from Route 130 in Coles County upstream to the Harrison Street Bridge
- (5) Lake Charleston
- (6) Ohio River from McAlpine Dam to its confluence with the Mississippi River
- (7) the tailwaters of Kentucky and Barkley Lakes
- (8) Green River from the highway 259 bridge at Brownsville, Kentucky, downstream to the confluence with the Ohio River.

During 2023, ILDNR Enhanced Contract Removal Program had a total of 23 fishers under contract. With those 23 fishers, a total of 3,534,342 lbs of invasive carp were removed. Since the program's inception of March 2022, a total of 4,959,933 lbs have been removed from the designated waters of the Ohio River and its tributaries. Of that total amount, 98% of the invasive carp removed were Silver carp. February through May, and October were the months with the highest catch totals for 2023. Summer months of 2023 saw a dramatic decrease in the amount of invasive carp reported harvest (Figure 4).

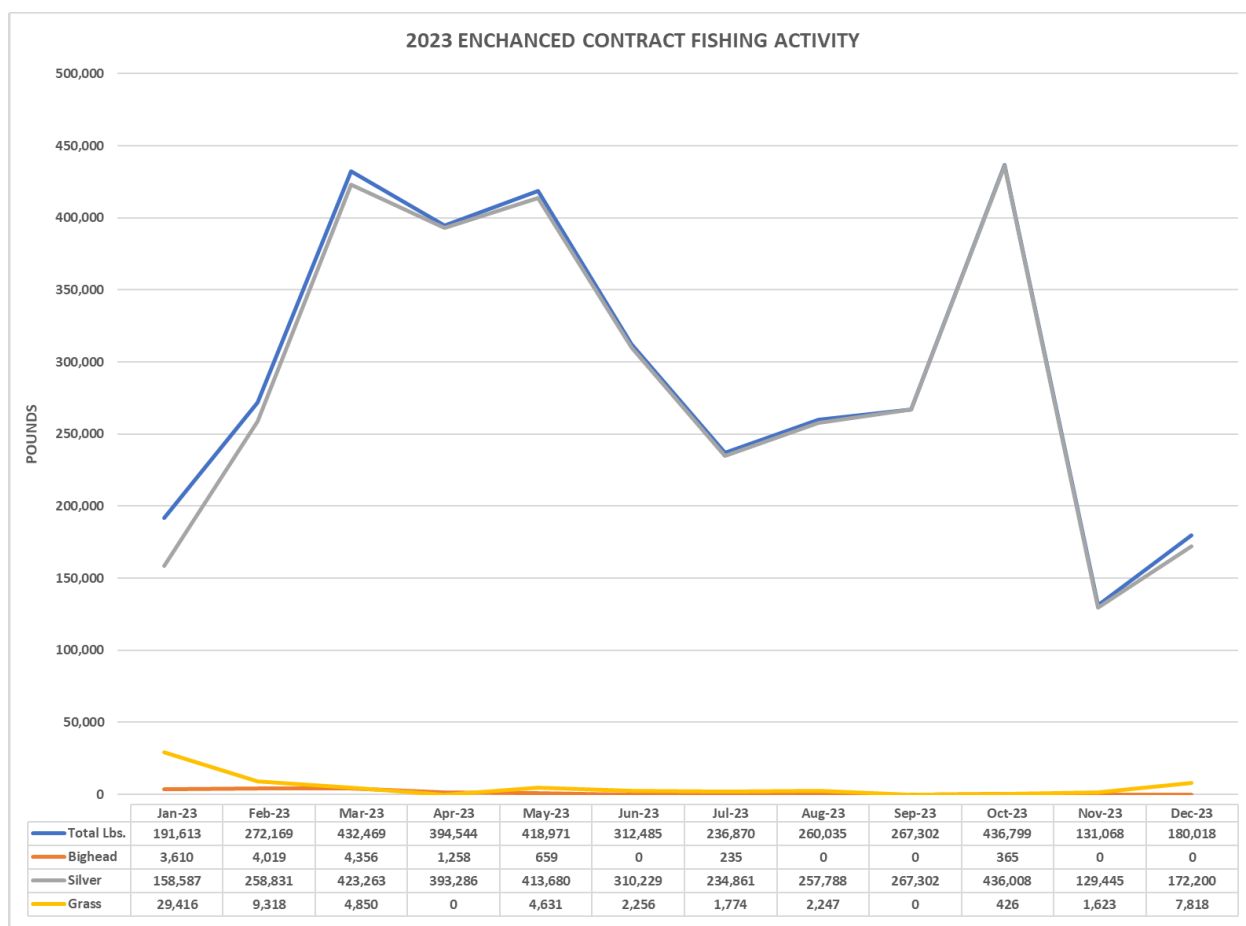


Figure 4. 2023 Enhanced Contract Removal per month

Contracted Facilitation

The Contracted Facilitation program also was initiated in early 2022 and offered contracts to fish processors and other buyers purchasing invasive carp from commercial fishers. Purchases must be made from either a facility or pick locations within 10 miles of designated waters. Compensation is \$0.05 per pound for invasive carp removed from designated commercial waters and purchased for at least \$0.07 per pound. This program facilitates practicable mechanisms for use of the harvested fish by private industry for a variety of purposes, including human consumption. The program in this proposal maintains similar terms and made the following changes to the designated waters. The designated waters from which fishers may remove invasive carp and where processors may pick up were expanded. New water bodies included LaGrange Pool on the Illinois River; Designated Waters – Designated waters include the commercial waters of the following:

- (1) Peoria and LaGrange Pools of the Illinois River
- (2) the portion of the Wabash River from the Ohio River to the southernmost city limits of Lafayette, Indiana
- (3) Ohio River from McAlpine Dam to its confluence with the Mississippi River
- (4) the tailwaters of Kentucky and Barkley Lakes
- (5) Kentucky and Barkley Lakes in Kentucky

(6) Green River from the highway 259 bridge at Brownsville, Kentucky, downstream to the confluence with the Ohio River.

Additional Fishing Areas - Invasive carp caught in the following waters may also be picked up at one of the above designated water pick up locations: (1) Little Wabash River; (2) Skillet Fork River; (3) Embarras River, except from Route 130 in Coles County upstream to the Harrison Street Bridge; and (4) Lake Charleston.

The Contracted Facilitation Program had 7 processors under contract in 2023. Throughout 2023 a total of 12,167,337 lbs. were processed. Since the Program's inception of March 2022, a total of 21,008,353 lbs. have been processed. Silver carp make up 85% of the total number of invasive carp processed, with Bighead, Grass and undisclosed invasive carp combining to make the remaining 15%. Contracted facilitation had its highest month in January then fluctuating down as the year progressed. (Figure 5.)

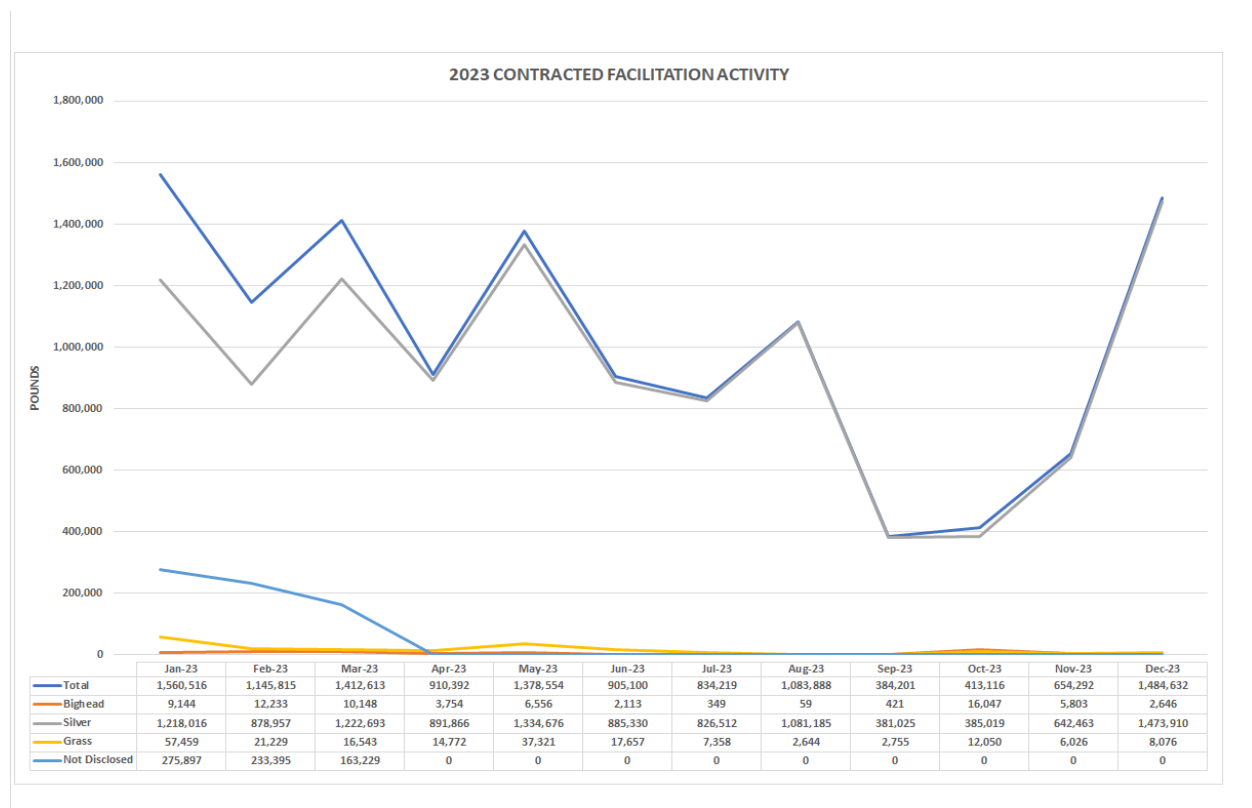


Figure 5. 2023 monthly processed totals for the Contracted Facilitation project

Discussion:

The locks and dam projects throughout the Ohio River are thought to provide some level of containment for the invasive carp species found within the mainstem river. Data acquired from several years of monitoring have demonstrated that average size and condition of Silver Carp increase as you move upstream, which is often accompanied by a transition to populations that consist of fewer, older fish. With it being a location where <400 mm carp are encountered each year, Cannelton continues to be one of the most upstream pools within the establishment zone. Because of this, its size and mounting evidence of successful reproduction as recently as 2021, the Cannelton Pool is still considered to be a high-priority location for any future efforts to control the invasive carp population.

In 2023, KDFWR contracted with ten program participants to provide the necessary fishing effort and as many as four observers were hired to record harvest success and any impacts of non-target species. Overall, fishers continued to be most successful when their efforts are focused within tributaries where decreased water depths allow the gill nets to catch invasive carp at higher rates. Because of past difficulties in capturing carp during warmer months, all fishing efforts were postponed from June through September of 2023, which was also expected to help reduce impacts on bycatch species. Any effect that this may have on morbidity rates will be examined more closely after collecting additional data from upcoming years where efforts are postponed during warmer months. Unlike a nearly 30-day delay experienced in 2022, the program resumed as planned on October 2nd, 2023, with participants immediately employing the same group fishing techniques that produced record harvests back in January, February and March of 2023. These techniques are considered to be an optimization of the program's fishing efforts as they require all participants to concentrate their nets in the same tributary.

Agency crews continue to provide regular recommendations based off previous years' experience and monitoring efforts. This includes information on where to target invasive carp and what gear specifications could be used to maximize fishing success; however, contract fishers have been routinely allowed to utilize gears that they felt would work best during each fishing event. Participants used gill nets with webbing constructed of 3.25 to 4.5 in bar-mesh throughout 2023, and this appeared to provide the best results when Silver Carp was the primary target. Earlier in the program, contract fishers started setting nets in specific locations with the purpose of closing off any routes that invasive carp could use to leave a tributary if/when they were able to avoid the initial capture efforts. This practice was intended to allow the contract fishers to repeatedly target an area until all invasive carp had been captured and removed. However, this would only produce the expected result if/when the appropriate amount of fishing pressure was applied directly upstream of these "block nets". This was a primary factor in KDFWR's decision to instruct multiple contract fishers to focus their efforts in the same tributary and/or embayment. These "group fishing" techniques were initially implemented during the second half of 2021 and appeared to result in immediate improvements. Higher harvest totals in 2022 and 2023 strongly support the continued use of group fishing, especially in areas with higher densities of invasive carp (i.e. Cannelton & Newburgh pools).

Similar to previous years, agency observers in 2023 continued to report that most bycatch was healthy at the time of release. After a temporary decline in 2022, Paddlefish captured by contract fishers once again exhibited the highest morbidity rates of all bycatch species, but it should be noted that fairly low numbers ($n = \sim 400$) of Paddlefish were caught in 2023. Ictiobids (i.e. Smallmouth Buffalo) were once again by far the most common bycatch in 2023, which was followed by Freshwater Drum and Catfish. Like in past years, most of these fish appeared to be unharmed, or only minimally injured, following their release. In addition to the shift to cooler water temperatures, the instances of low bycatch mortality were likely aided by the rapid setting and pulling of gill nets.

For agency removal efforts, electrofishing methods used in 2023 continued to produce the most success for the crews that were targeting lower density populations of invasive carp. When available, these efforts can be even more effective if side-scan technology is used to locate schools of Silver Carp that can be herded into gill nets using the electrofishing gear. However, capture success appears to be highly dependent on the experience of both the driver and the dipper. Targeting tributary waters gives removal crews an advantage because current sampling gears are often more effective in shallower water and the tributary banks help keep the invasive carp from scattering too far away from the electrofishing boats.

Pairing hydroacoustics with commercial fishing in discrete locations has the opportunity to demonstrate the extent of invasive carp population impacts in defined areas. Pre- and post hydroacoustic surveys within the Grayville oxbow demonstrate a profound reduction in large body fish returns. The corresponding pounds of fish removed by contract commercial fishers correlates with this finding.

In areas where invasive carp population densities are high, incentivizing removal by contract fishers is an economical strategy to reduce biomass, lessening impacts on native fisheries and reducing propagule pressure upstream. Incentivized commercial harvest has steadily increased from 1.4 M pounds in 2022 to over 3.5 M pounds in 2023. The bulk of this harvest consists of Silver Carp. Most of the harvest occurred within the Ohio River (2 M pounds) with both the Wabash River and Kentucky and Barkley tailwaters with slightly over a half million pounds removed (.79 M and .69M).

The enhanced facilitation program provides a unique opportunity to facilitate commercial fishing efforts by incentivizing processors to pick up the fish near where the fishing occurs rather than requiring commercial fisher to haul fish hundreds of miles. The program incentivized removal of 12 M pounds of invasive carp in 2023. Most of the incentivized removal occurred in Barkley Lake (3.7M) and the Illinois River (3.8 M). The Ohio River followed with 1.8 M with the remainder occurring in Kentucky Lake, the Wabash River, KY and Barkley tailwaters and undisclosed.

This program facilitates practicable mechanisms for use of the harvested fish by private industry for a variety of purposes, including human consumption. This program also contributes to providing critical information on population densities of invasive carp over time in the Ohio River system to guide agency management efforts.

Recommendations:

It is imperative that fishing pressure is sustained and/or increased throughout the lower Ohio River to help protect and reduce migration of invasive carps further up the Ohio River. Incentivizing commercial harvest and pairing that with incentivized processor pickup has increased efficiency and harvest in the lower portion of the Ohio River and other targeted waters. These programs provide a large amount of biomass removal for minimal investment and should remain in place. Contract fishing should continue to support population control efforts and should be closely monitored so that recommendations can be made to increase efficiency and successful harvest. Agency crews should continue to conduct removal efforts in lower density pools and internal waters to help reduce the numbers of all invasive carp species. Outreach and efforts to spur public and commercial interest within the ORB should continue as it is likely to become even more important to the long-term control of the current invasive carp populations. Further work in aiding facilitation of harvests to markets should continue in the future as it is expected to become even more difficult to convince commercial anglers to become long-term participants of the ongoing contract fishing program.

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Table 1. Results of electrofishing efforts that KDFWR and INDNR conducted in 2023 with the sole purpose of collecting and removing invasive carp from the middle Ohio River.

Ohio River Pool	EF Effort (hr)	Total Count (N)				Total Weight (kg)			
		Bighead Carp	Silver Carp	Grass Carp	Total Carp	Bighead Carp	Silver Carp	Grass Carp	All Carp
Smithland	9.8	1	1,732	63	1,796	2.5	5,234.9	237.2	5,474.6
Newburgh	4.0	0	153	1	154	0.0	576.8	3.7	580.5
Cannelton	3.9	0	90	1	91	0.0	366.1	6.7	372.8
McAlpine	30.1	0	301	0	301	0.0	1,707.7	0.0	1,707.7
Markland	14.5	7	27	0	34	17.7	274	0.0	292.5
All Pools	62.3	8	2,303	65	2,376	20.02	8,159.5	247.6	8,428.1

Table 2. A summary of the results obtained by program participants fishing from July 2019 to February 2024. A “fishing day” equals 1 crew fishing ~8 hr.

Year	Months	Fishing Effort			Total Carp Harvested	# Carp per Day	Total Harvest (kg)	Total Harvest (lb)	Mean Length & Weight			
		Days	Nets	Net Feet					TL (mm)	TW (kg)	TL (in)	TW (lb)
2019	JUL-SEP	26	191	87,615	2,640	101.5	15,261.6	33,646.0	843	5.78	33.2	12.74
	OCT-DEC	65	640	289,790	4,209	64.8	24,982.6	55,077.1	847	5.93	33.4	13.07
	TOTAL	91	831	377,405	6,849	75.3	40,244.1	88,723.1	846	5.87	33.3	12.94
2020	JAN-MAR	52	352	198,366	7,433	142.9	44,042.5	97,097.1	834	5.93	32.8	13.07
	APR-JUN	37	345	161,120	3,247	87.8	15,991.4	35,254.9	795	4.92	31.3	10.85
	JUL-SEP	28	318	118,775	1,371	49.0	6,375.2	14,055.0	772	4.65	30.4	10.25
	OCT-DEC	67	528	307,850	3,765	56.2	23,247.6	51,252.2	830	6.17	32.7	13.60
	TOTAL	184	1543	786,111	15,816	86.0	89,656.7	197,659.3	813	5.67	32.0	12.50
2021	JAN-MAR	67	474	251,400	8,429	125.8	51,142.9	112,750.7	842	6.07	33.1	13.38
	APR-JUN	40	243	189,520	3,115	77.9	15,855.3	34,955.0	814	5.09	32.1	11.22
	JUL-SEP	2	14	6,000	66	33.0	321.7	709.1	742	4.87	29.2	10.74
	OCT-DEC	97	562	289,875	8,060	83.1	39,882.4	87,925.7	786	4.95	31.0	10.91
	TOTAL	206	1293	736,795	19,670	95.5	107,202.2	236,340.4	813	5.45	32.0	12.02
2022	JAN-MAR	156	744	369,150	21,993	141.0	116,790.4	257,478.9	822	5.31	32.4	11.71
	APR-JUN	22	101	53,350	4,976	226.2	25,066.1	55,261.2	837	5.04	32.9	11.11
	JUL-SEP	0	0	0	--	--						
	OCT-DEC	84	433	235,360	13,431	159.9	68,093.3	150,119.9	805	5.07	31.7	11.18
	TOTAL	262	1278	657,860	40,400	154.2	209,949.8	462,860.0	818	5.20	32.2	11.46
2023	JAN-MAR	168	711	325,100	54,700	325.6	276,210.1	608,939.1	832	5.05	32.8	11.13
	APR-JUN	112	403	183,200	19,294	172.3	96,465.0	212,668.9	809	5.00	31.8	11.02
	JUL-SEP	0	0	0	--	--						
	OCT-DEC	114	429	287,213	8,196	71.9	35,957.6	79,273.0	774	4.39	30.5	9.68
	TOTAL	394	1543	795,513	82,190	208.6	408,632.7	900,881.0	813	4.97	32.0	10.96
2024	JAN-MAR	110	350	163,750	16,253	147.8	72,086.3	158,923.1	787	4.44	31.0	9.79
	TOTAL	110	350	163,750	16,253	147.8	72,086.3	158,923.1	787	4.44	31.0	9.79
ALL YEARS	JAN-MAR	553	2,631	1,307,766	108,808	196.8	560,272.2	1,235,188.8	826	5.15	32.5	11.35
	APR-JUN	211	1,092	587,190	30,632	145.2	153,377.7	338,140.0	809	5.01	31.9	11.05
	JUL-SEP	56	523	212,390	4,077	72.8	21,958.5	48,410.2	803	5.39	31.6	11.88
	OCT-DEC	427	2,592	1,410,088	37,661	88.2	192,163.5	423,647.9	808	5.10	31.8	11.24
	TOTAL	1247	6838	3,517,434	181,178	145.3	927,771.9	2,045,386.9	816	5.12	32.1	11.29

Table 3. Total counts and weights of the three Invasive carp species caught by contract fishers between 2019 and Feb 2024. All contract fishing efforts and results were recorded by agency observers.

Cannelton Pool (late 2019 – early 2024)					McAlpine Pool (2020 - 2021)				
Year	Species	Total IC Caught	Harvest Weight (kg)	Harvest Weight (lb)	Year	Species	Total IC Caught	Harvest Weight (kg)	Harvest Weight (lb)
2019	BHC ^A	265	2,197.9	4,845.6	2020	BHC	0	0.0	0
	GRC ^B	129	1,264.4	2,787.6		GRC	2	16.6	37
	SVC ^C	6,455	36,781.8	81,089.9		SVC	2	9.2	20.3
	ALL	6,849	40,244	88,723.1		ALL	4	25.8	57.0
2020	BHC	279	2,247.5	4,954.9	2021	BHC	0	0.0	0
	GRC	235	1,975.7	4,355.7		GRC	6	65.2	144
	SVC	15,298	85,407.7	188,291.8		SVC	109	525.9	1,159.4
	ALL	15,812	89,630.9	197,602.3		ALL	115	591.1	1,303.0
2021	BHC	189	2,034.0	4,484.2	All	BHC	0	0.0	0
	GRC	208	1,564.5	3,449.2		GRC	8	81.8	180
	SVC	19,158	103,012.7	227,104.0		SVC	111	535.1	1,179.7
	ALL	19,555	106,611.2	235,037.4		ALL	119	616.9	1,360.0
2022	BHC	428	4,224.5	9,313.5	Newburgh Pool (2023 - early 2024)				
	GRC	298	2,234.7	4,926.7	Year	Species	Total IC Caught	Harvest Weight (kg)	Harvest Weight (lb)
	SVC	39,674	203,490.5	448,619.8	2023	BHC	4	46.4	102
	ALL	40,400	209,949.8	462,860.0		GRC	24	174.7	385
2023	BHC	492	5,168.3	11,394.1		SVC	4,426	16,486.9	36,347.4
	GRC	507	4,020.3	8,863.2		ALL	4,454	16,708.0	36,834.9
	SVC	76,737	382,736.2	843,788.9	2024	BHC	8	89.7	198
	ALL	77,736	391,924.7	864,046.1		GRC	5	52.9	117
2024	BHC	15	240.5	530		SVC	7,145	26,300.1	57,981.8
	GRC	60	591.9	1,305		ALL	7,158	26,442.7	58,296.2
	SVC	9,020	44,811.3	98,791.9	All	BHC	12	136.1	300
	ALL	9,095	45,643.6	100,626.9		GRC	29	227.6	502
All	BHC	1,668	16,112.7	35,522		SVC	11,571	42,787.0	94,329.2
	GRC	1,437	11,651.5	25,687		ALL	11,612	43,150.7	95,131.1
	SVC	166,342	856,240.1	1,887,686.2					
	ALL	169,447	884,004.3	1,948,895.8					

All Pools Combined (late 2019 - early 2024)				
Year	Species	Total IC Caught	Harvest Weight (kg)	Harvest Weight (lb)
All YEARS	BHC	1,680	16,248.8	35,822.4
	GRC	1,474	11,961.0	26,369.4
	SVC	178,024	899,562.2	1,983,195.1
	ALL	181,178	927,771.9	2,045,386.9

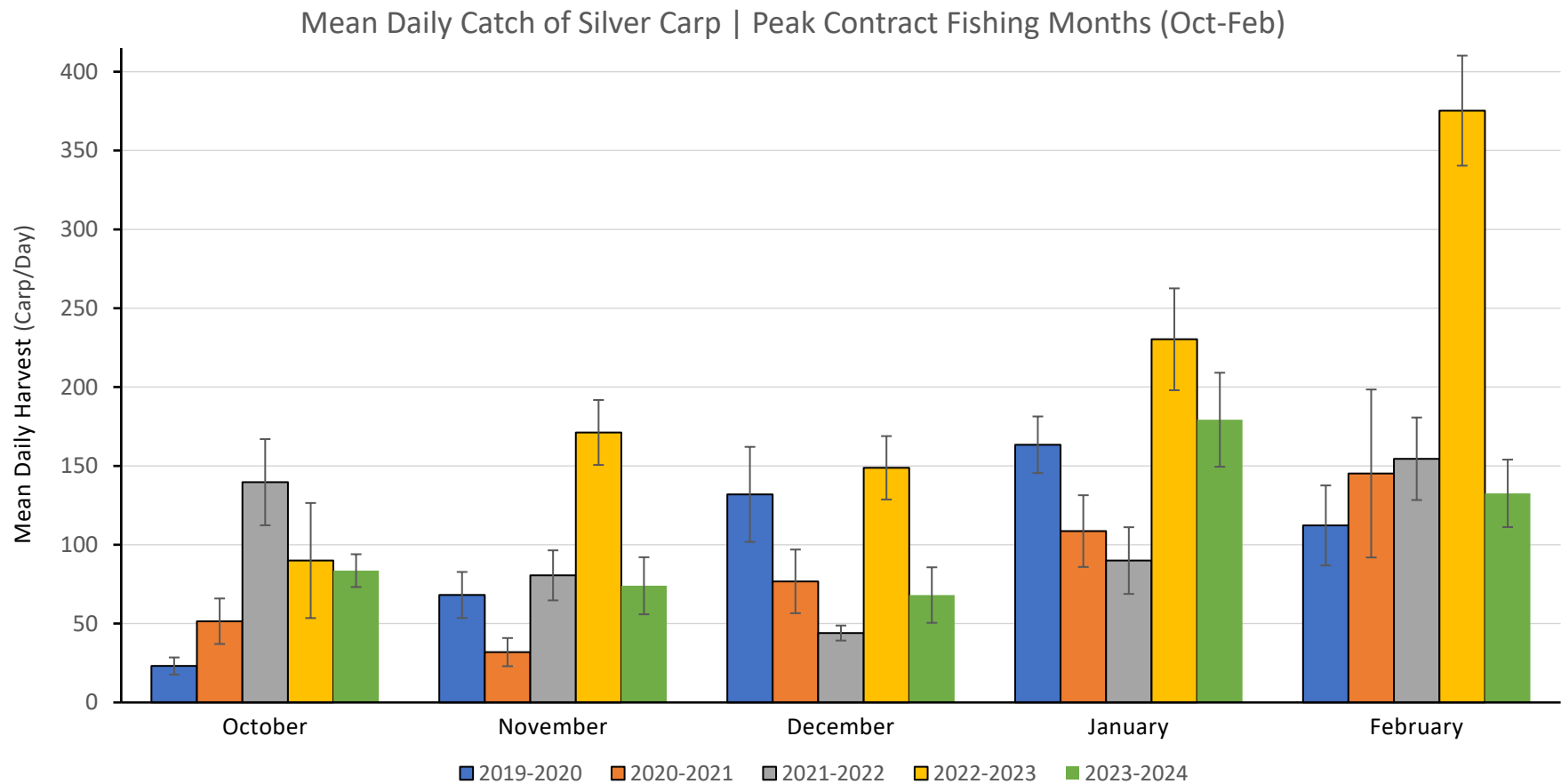


Figure 1. Graph illustrates the differences in average daily silver carp harvest for peak months of the past five contract fishing seasons. Error bars indicate SE.

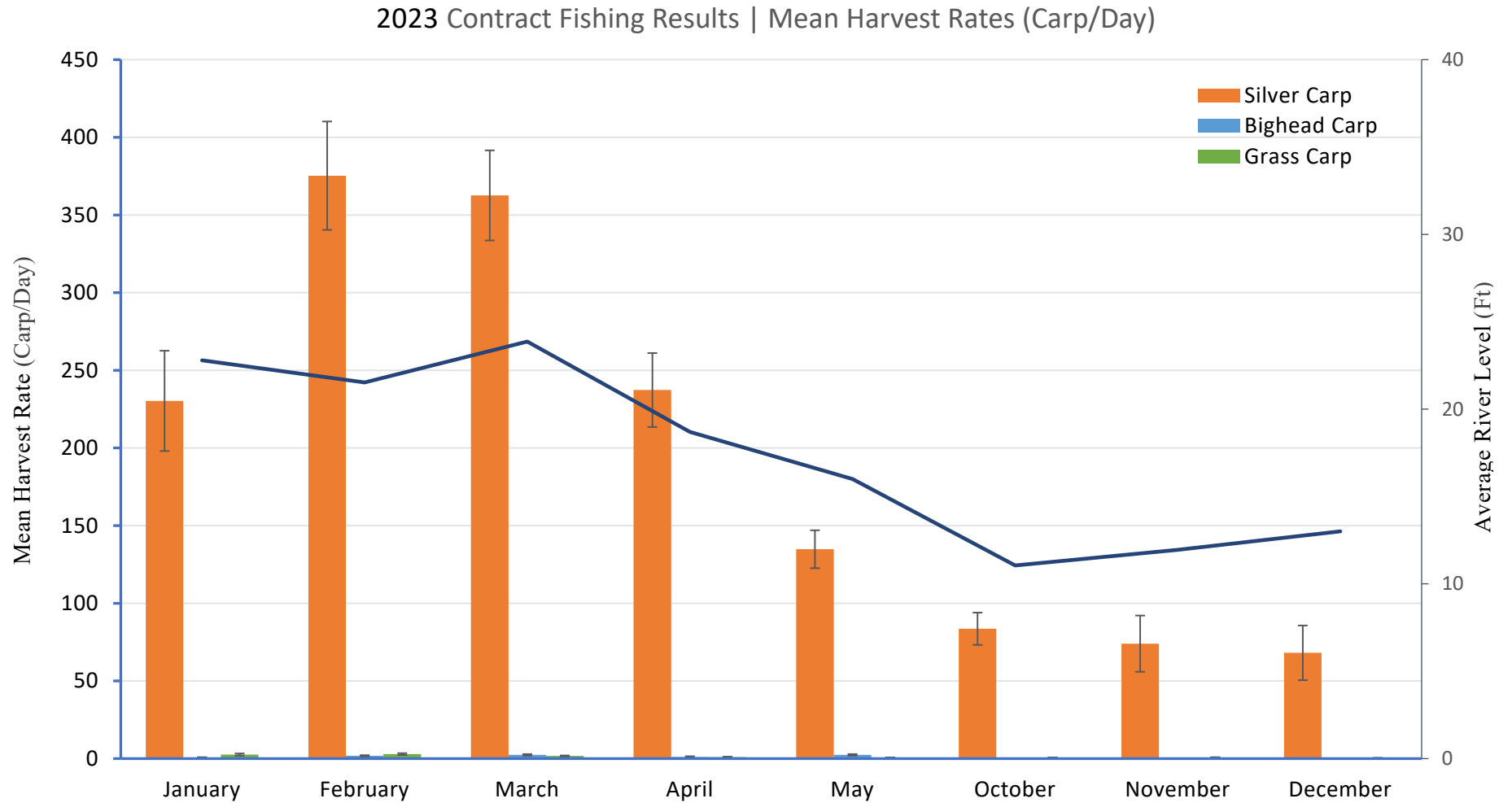


Figure 2. The average harvest rates (Fish/Day) in months between January and December 2023 that KDFWR employed contract fishermen to remove invasive carp. Error bars represented the standard error for daily catches. In addition, mean river level was calculated from data recorded by a USGS gage located at Cannelton Locks & Dam. Average daily landings in 2023 continued to be influenced by both temperature and river levels.

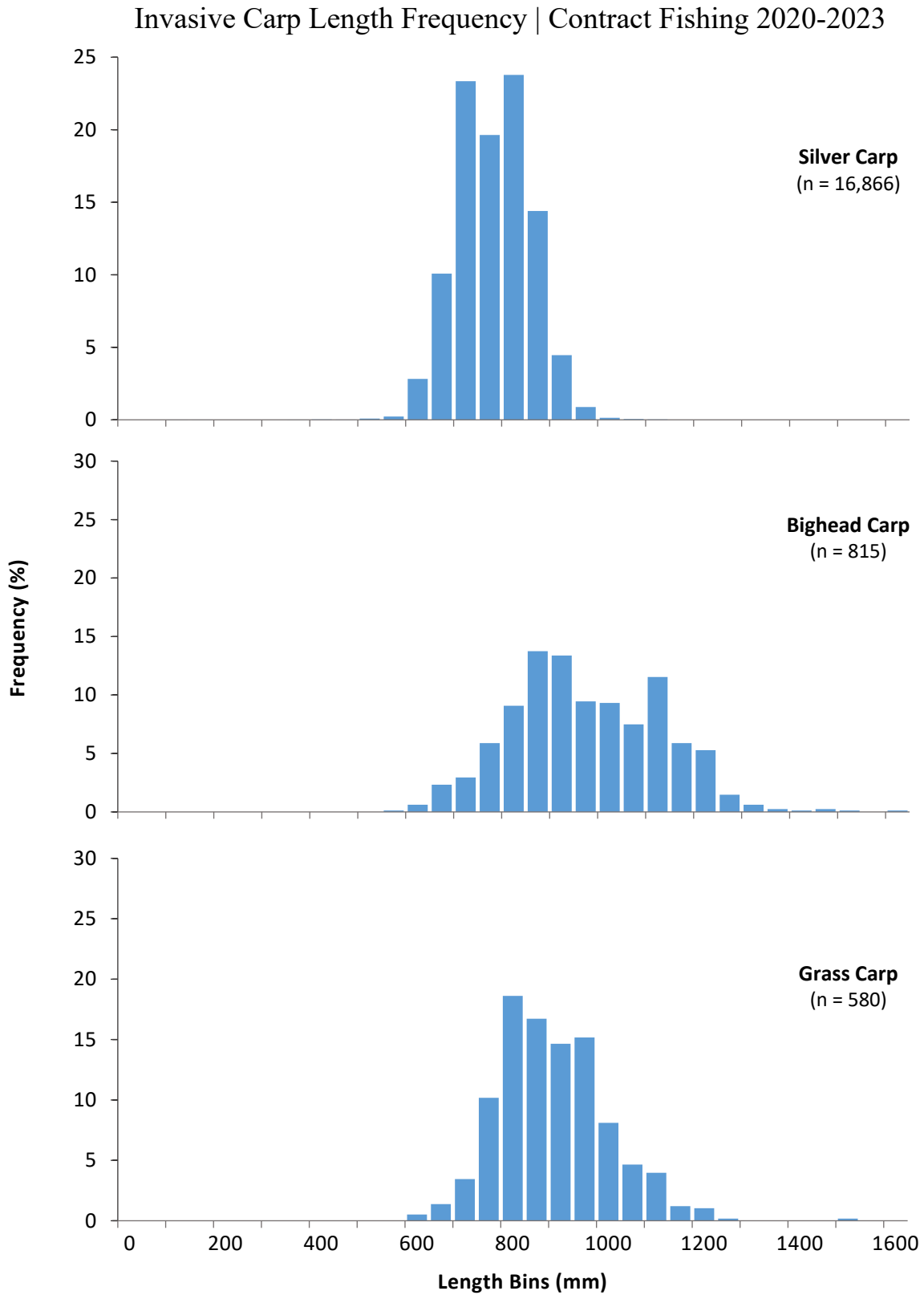


Figure 3. Length frequency distributions generated from subsamples of invasive carp that contract fishers caught and removed from the Cannelton Pool in 2020-2023.

Percent Bycatch by Month | 2023 Contract Fishing Efforts

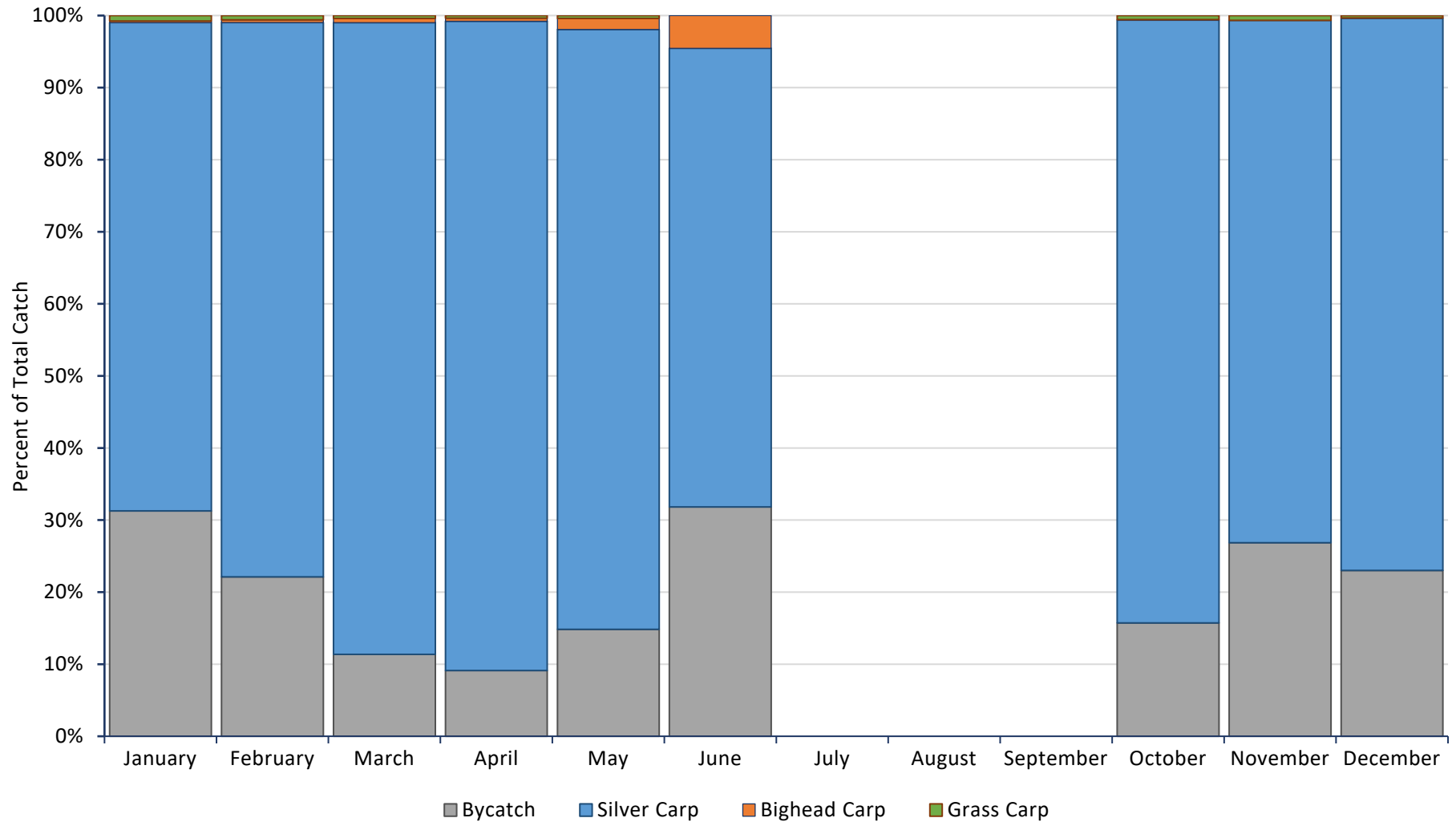


Figure 4. The monthly percent contribution of bycatch and the three invasive Carp species caught during the contract fishing efforts conducted in January through December 2023.

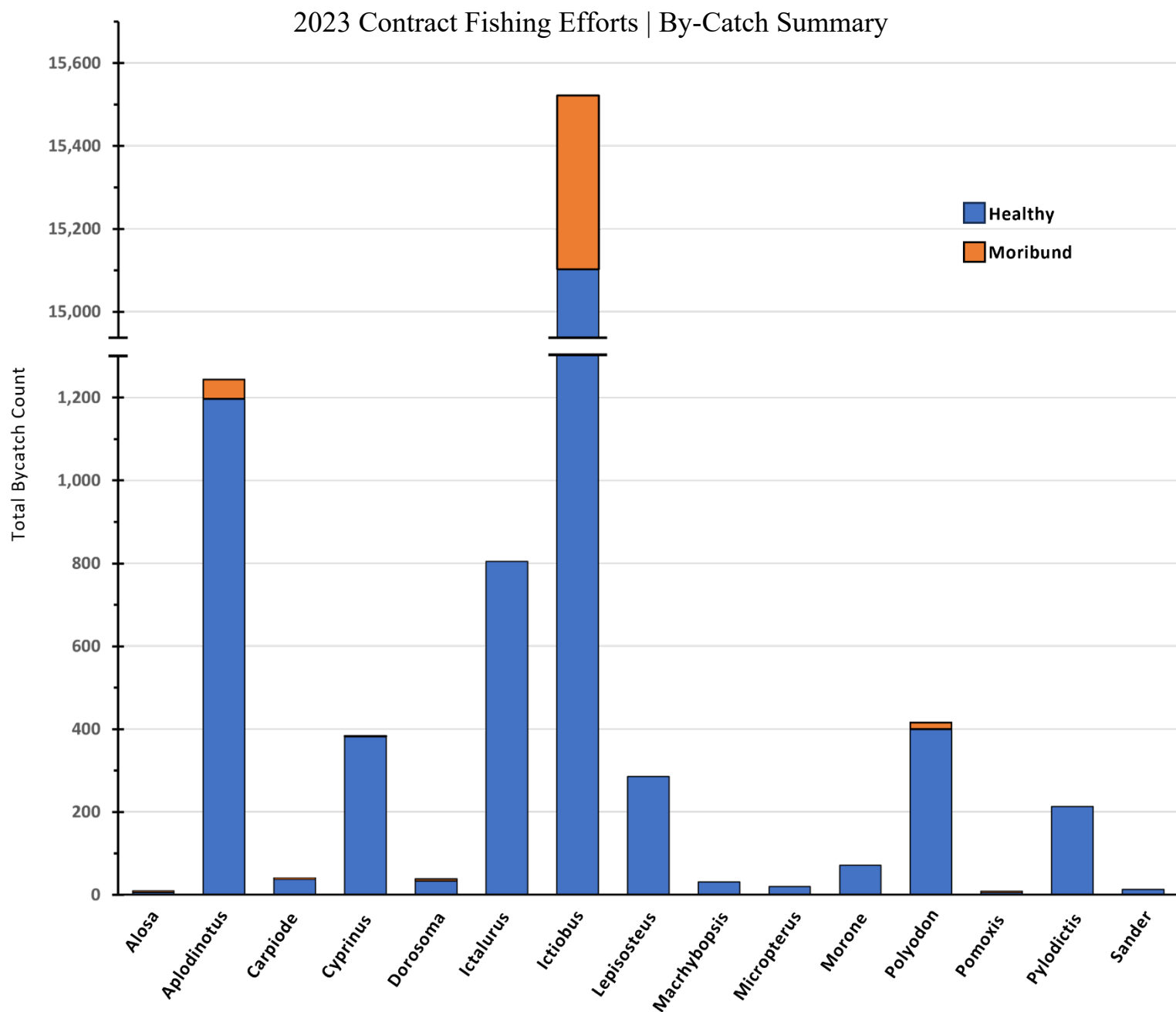


Figure 5. Total counts of all contract fishing bycatch recorded from January through December 2023. Color indicates the status of the fish after being removed from gill nets. Bycatch was considered moribund if it suffered significant damage or could not swim off following release. Healthy, or resilient, fish were those that quickly recovered and could swim away under their own power.