

Control and Containment of Invasive carp in the Ohio River

Geographic Location: Ohio River basin, extending from the Cannelton Lock and Dam (RM 720.7) to the Racine Lock and Dam (RM 237.5).

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

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.

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.

Objectives:

1. Target and remove Asian 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 22.3 hours of electrofishing effort was used to remove approximately 1,663 kg (~3,666 lbs) of invasive carp from three different pools of the Ohio River in 2022.
2. A total of ~1.5 million pounds (670K kg) of invasive carp have been harvested by contract fishing efforts conducted between July 2019 and March 2023.
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.

KDFWR strongly believes that 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 2022, the loss of key personnel and a shortage of field staff reduced KDFWR's ability to complete all the invasive carp removal sites that it initially planned to sample upstream of the Cannelton Pool. When these targeted removal efforts did occur, it involved pulsed DC electrofishing via a MLES control box (40% duty-cycle) that was initially set to a rate of 80 pulses per second (pps). In previous years, KDFWR often set gill nets near the downstream end of the sampling area to target any invasive carp that tried to evade the electrofishing boat. In previous years, targeted removal efforts involved three (3) field crews; however, in 2022, the agency lacked the necessary amount of field staff to fill more than one crew at a time. This was an unfamiliar situation that required KDFWR to commit to an electrofishing-only approach in order to complete its removal efforts.

KDFWR removal efforts in 2022 were conducted entirely within tributaries and embayments of the Markland, McAlpine and Cannelton pools. Upon capture, all bycatch was immediately identified and then released. Prior to being euthanized, total length, sex, presence of spawning patches, and capture location were recorded for each invasive carp. Other supplemental data collected less frequently included everything from ovary condition/weight.

Like the previous year, KDFWR continued to use the 2022 removal efforts to collect aging structures from invasive carp that were captured from the Cannelton, McAlpine and Markland pools. In this case, agency field staff identified Silver Carp belonging and then harvested the otoliths that would later be processed and examined as part of an ongoing length-at-age analyses.

Invasive Carp Contract Fishing Program

The Contract Fishing Program in the Ohio River officially began in July 2019. In both 2021 and 2022, KDFWR held contracts with eight fishermen that allowed them to target invasive carp in the mainstem river, tributaries and embayments of the Cannelton Pool. The agency provided observers to accompany each program participant in order to record details about their fishing efforts (i.e., location, gear, etc.), their subsequent harvest of invasive carp and comply with the Indiana Emergency Rule allowing contract fishers access to Indiana waters only with an observer. During these efforts, observers were required to obtain size and sex data from daily subsamples of 20 or more randomly selected Silver and Bighead carp. They were also responsible for identifying any bycatch that contract fishers happen to pick up in their nets and then ultimately document any morbidity of the non-target species.

From late 2019 to early 2021, all 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 were producing the better harvest numbers. With another round of 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 the peak harvest months that were identified during the first couple years of the program.

KDFWR's recent 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 one (1) program participants actively fishing for five full days. This 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.

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 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. However, after two days of fishing the tributaries in McAlpine, the catch rates and numbers of harvested invasive carp were much lower than expected. Contract fishers appeared to have difficulty finding areas where their current methods produced results that were comparable to those in Cannelton. At present, any possible expansion is on an indefinite hold due to the increasing numbers of invasive carp being harvested from Cannelton in late 2022 and early 2023.

Results:

Targeted Removal of Invasive Carp

Approximately 22.3 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 2022, KDFWR used the combined efforts from all three pools to capture and removed a total 369 invasive carp, weighing 1,663 kg (3,667 lbs.). Like 2021, most of the 2022 electrofishing efforts (50.2%) were conducted at sites in the McAlpine Pool, and it resulted in the removal of 195 invasive carp that weighed ~856.5 kg (1,888 lbs.). Bycatch of non-target species was rarely encountered due to the selective nature of these electrofishing efforts. However, some shad and alewife species were still captured on occasion to verify they were not juvenile (age-0 to age-1) invasive carp.

INDNR spent three days conducting targeted invasive carp removals in 2022. Understaffing during the beginning of the year prevented accomplishing the anticipated amount of agency removal events (fifteen in the Wabash River basin, five on the Ohio River). 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 4.3 hours were spent electrofishing for invasive carp, producing 1,274 Silver Carp, 1 Bighead Carp, and 5 Grass Carp. Approximately 4,438 kg (9,784 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 2022, INDNR crew removed 2,319 adult invasive carp for approximately 7,889 kg (17,393 lbs). INDNR has assisted ILDNR with contract fishing efforts on the Wabash 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's removal efforts yielded large adults of both carp species. Alongside the USFWS, a total of three removal events were conducted with a total of 548 meters (1,800 ft) of gill netting in Raccoon Creek (R.C. Byrd Pool). Eight adult Bighead Carp and two Silver Carp were removed in September 2022. Additionally, snagging efforts at the old lock chambers at the R.C. Byrd Lock and Dam complex removed a 54" xanthic Bighead carp.

Contract Fishing Program

KDFWR had enough observers on staff during early 2022 to regularly schedule up to five fishermen a week. This increase in effort occurred during an ideal time of the year when invasive carp are known to be more vulnerable to the techniques utilized by the contract fishermen. In early 2022, program participants conducted an average of 52 fishing days per month during a 3-month period (Jan – Mar) that ended with a total of 156 fishing days (Table 2). This was a 58-day increase over the previous 3-month period of Oct-Dec 2021 that had a combined total of 98 fishing days. During efforts made in Jan – Mar 2022, contract fishers deployed 744 gill nets (~ 370,000 net ft) and harvested carp with a combined weight that was estimated to be more than 111,000 kg (or ~245,000 lbs). The contract fishing efforts in Jan-Mar 2022 were greater than any other quarterly period, and the nearly 22,000 carp harvested during these 3 months easily surpassed the yearly totals obtained from all previous efforts, which included 2021 (n = 19,933), 2020 (n = 15,816) and 2019 (n = 6,849). After a strong start, contract fishers continued to exceed expectations throughout 2022 and they ended the year with an overall annual harvest of 39,757 invasive carp weighing an estimated total of nearly 200,000 kg (~ 400,000 lbs).

In 2022, program participants set all 1,238 gill nets within the boundaries of the Cannelton Pool, which has been the case for 99.3% of the nets deployed since July 2019. Through the end of this reporting period, the McAlpine Pool has been the only other pool where nets have been deployed for the contract

fishing program. Program participants fished the McAlpine Pool in 2020 and 2021 and, in both cases, nets were only deployed for 1-2 days before contract fishers returned to the Cannelton Pool.

During each year from 2019 to 2022, contract fishers harvested three different species of invasive carp, which included Silver Carp, Bighead Carp and Grass Carp. The most common, in terms of both numbers and weight, have been Silver Carp. In 2022, Silver Carp ($n = 39,064$) represented more than 98% of the harvested fish, while both Bighead ($n = 420$) and Grass ($n = 273$) carps combined to make up the other ~2% (Table 3). The species composition of all invasive carp caught in 2022 simply echoed an overall trend in the program's results where Silver Carp make up 98.1% of all carp ($n = 140,277$) caught by contract fishers in the last four years (2019-2022).

When comparing the mean daily catch of invasive carp during the peak months (Oct-Feb) of the past four contract fishing seasons (2019-2022), there was an initial decline in daily harvest rates from one year to the next (Figure 1). However, this was not indicative of the program's performance as the overall harvest increased during this same time period. The disparity is related to the shift from year-round efforts in 2019-2020 to the fishing that only occurred in peak months during 2021-2022. 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 also completed ~220 fishing days in Oct 2022 through February 2023, but mean daily harvest actually increased during this period because of the record numbers of invasive carp that program participants caught in 2022.

In 2022, the monthly comparisons of mean daily harvest indicated that contract fishers had their highest catch rates (237 carp/day) during the month of April (Figure 2). In contrast to previous years, the 2022 catch rates appear to be less correlated with river levels, but harvest success did continue to be higher during months with cooler water temperatures. However, high variability in daily harvest during these months can lead to lower mean rates even when contract fishers happen to be catching higher numbers of invasive carp. Additional comparisons between daily catch rates, fishing days and harvest totals during 2022 are needed to provide a better illustration of the contract fishing program's monthly results (Figure 3). Although mean daily catch rates were highest in April, the number of fishing days ($n = 19$) and the harvest totals ($n = 4519$) during this month were not nearly as high. When considering each statistic, the most productive month of contract fishing in 2022 was March, which was at or near the top for fishing days ($n = 56$), daily catch rate (170 fish/day) and total number of harvested carp ($n = 9528$).

Gill nets were the only gear used during the eight-month period that program participants were actively fishing in 2022. Netting effort often varies and can depend a lot on catch, but in 2022, contract fishers typically set out 750-1000 meters (2500-3200 ft) of webbing per day. Silver Carp catch ranged in total length from 100 mm to 1100 mm with most of the fish (>95%) measuring between 650 – 900 mm (Figure 4). Bighead and Grass carp were caught less frequently, but when harvested, Bighead Carp were often 800-1100 mm in total length while most Grass Carp measured between 750 and 950 mm.

The bycatch from contract fishing efforts in 2022 was highest in January (32%) and February (41%) with other months showing that non-target species contributed between 9% and 21% of the total catch (Figure 5). 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 83% of all non-target fish ($n = \sim 13,000$). Freshwater Drum (*Aplodinotus*), Gar (*Lepisosteus*), and Catfish (*Ictaluridae*) were the next three most common types of by-catch identified in the gill nets (Figure 6). Ictiobids exhibited the highest morbidity among the more common bycatch species in 2022 with 1.5% of the buffalo being DOA upon being removed from the gill nets. Paddlefish (*Polyodon*) are considered to be highly vulnerable to nets, but they were only the ninth most commonly caught fish in 2022 as they

contributed 1.1% of all by-catch recorded by observers. It was also determined that only 2, or 1.4%, of all Paddlefish (n = 141) captured in 2022 were identified as being DOA or close to death when they were pulled from the gill nets.

In September and November of 2022, IDNR contracted commercial fishers set 34 miles (55 km) of gill/trammel nets in the Wabash River in Mt. Carmel, IL and New Harmony, IN. In total, 9,431 Silver Carp and 2 Black Carp were harvested with a total estimated weight of invasive carp removed is 33 tons (66,000 lbs.). The by-catch included 37 Shovel-nose Sturgeon, 27 Blue Suckers, 450 Black Buffalo, 310 Smallmouth Buffalo, 75 Bigmouth Buffalo, 85 Freshwater Drum, 9 Blue Catfish, 45 Channel Catfish, 3 Bowfin, and 2 Largemouth Bass. All native species captured were released unharmed.

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 considered to be a high-priority location for any future efforts to control the invasive carp population.

In 2022, KDFWR contracted with eight program participants to provide the necessary fishing effort and as many as five 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 2022 fishing efforts were postponed from June through September. This pause in fishing during the summer months is also expected to help reduce the impacts on any bycatch species. Any impacts that this has on the mortality rates of bycatch will be examined more closely after collecting data from additional years of postponed efforts during the warmer months. The restart of the program's 2022 fishing efforts was scheduled for October 3rd, but unexpected delays in hiring agency observers and contract renewals suspended the official start until the very end of that month. As soon as it resumed, KDFWR instructed program participants to immediately continue using a group fishing technique that was developed during the previous season. This was considered an optimization of the program's fishing efforts and it required all participants to concentrate their nets within the same tributary. Ultimately, this decision not only allowed the program to make up for the late start, but it also led to substantial increases in both the catch rates and total harvest of invasive carp during November and December 2022.

Agency crews have been able to provide regular recommendations based off previous years' experience and monitoring efforts. Suggestions on where to target fish and gear specifications that would maximize success seemed to be the most helpful; however, fishers were allowed to use gears they felt were best during each fishing event. Gill nets with webbing constructed of 3.5in to 4.25in bar-mesh were preferred and appeared to provide the best results when Silver Carp is the primary target of the fishing efforts. Earlier in the program, some fishers began setting nets in specific locations to essentially close off any escape routes that invasive carp may use to leave the area if they happen to avoid the initial capture efforts. In theory, this practice would allow fishers to repeatedly target a tributary or embayment until all invasive carp had been cleared from that area. However, this strategy could only produce the expected results if/when enough fishing pressure directly upstream of the "block nets". Hence, changes were

recently implemented that instructed multiple program participants to target the same tributary and/or embayment. This strategy was developed with the primary goal of focusing the fishing efforts and increasing the number of invasive carp being harvested from each location. The contract fishers initially adopted the practice of group, or “team”, fishing during the second half of 2021 and it resulted in immediate increases in harvest success. The higher catch rates and harvest totals that continued throughout 2022 and early 2023 strongly support the adoption of group fishing as the current standard practice of the contract fishing program.

Throughout 2022, agency observers continued to report that most bycatch was healthy at the time of release. Following a small increase observed during 2021, the morbidity rates of captured Paddlefish declined slightly in 2022. Ictiobids were once again the most common bycatch in 2022, which was followed by Freshwater Drum, Gars, Ictalurids and Common Carp. In most cases, the vast majority of fish appeared to be unharmed or minimally injured following their release. Aside from cooler water temperatures, the instances of low mortality were likely helped by the rapid setting and pulling of gill nets. This fishing style has proven to be quite effective at targeting invasive carp due to their tendency to accumulate in large groups and their uncanny ability to evade capture.

Currently, pairing electrofishing with gill nets has produced the most success for agency crews when targeting invasive carp for removal efforts. Schools of carp can be located with side-scan technology, while groups can be herded using electricity to move fish into entrapment gears. However, capture success is highly dependent on the experience of the driver and dipper and nets often must be fished in sets with several different mesh sizes. Targeting tributary waters gives removal crews an advantage because gears are typically more effective in shallower systems and the tributary banks keep fish from scattering when being pushed into netting gear.

Recommendations:

It is imperative that fishing pressure is sustained or increased throughout the course of our control efforts in the Cannelton Pool to help protect and reduce migration of invasive carps further up the Ohio River. 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 pursue removal in lower density pools and internal waters to reduce invasive carp numbers. Outreach and efforts to spur public and commercial interest within the ORB should continue and will be important in contributing necessary population control efforts as well as providing a useful means for disposal for contract harvests. Further work in aiding facilitation of harvests to markets should also be considered as weekly yields approach levels capable of contributing significant numbers to processors.

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Table 1. Results of electrofishing efforts that KDFWR and INDNR conducted in 2022 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	1.9	1	381	4	386	5.7	1,127.8	16.2	1,149.7
Newburgh	6.3	0	893	2	895	0.0	3,276.9	11.4	3,288.3
Cannelton	4.0	0	154	0	154	0.0	704.3	0.0	704.3
McAlpine	11.2	0	195	0	195	0.0	856.5	0.0	856.5
Markland	7.1	1	19	0	20	2.5	99.9	0.0	102.5
All Pools	30.5	2	1,642	6	1650	8.2	6,065.4	27.6	6,101.3

Table 2. Quarterly summaries of the efforts and results obtained by program participants that fished the Cannelton Pool from July 2019 through April 2023. A “fishing day” is equivalent to a single boat and crew targeting invasive carp for up to 8 hours at a time.

Year	Months	Fishing Effort			Total Carp	Carp per Day	Total Wt. (kg)	Total Wt. (lb)	Mean TL (mm)	Mean Wt. (kg)	Mean TL (in)	Mean Wt. (lb)
		Days	Nets	Net Feet								
2019	Jan-Mar	-	-	-	-	-	-	-	-	-	-	-
	Apr-Jun	-	-	-	-	-	-	-	-	-	-	-
	Jul-Sep	26	191	87,615	2,640	101.5	15,197.5	33,505.3	816	5.99	32.1	13.20
	Oct-Dec	65	640	289,790	4,209	64.8	23,721.2	52,300.3	822	6.11	32.4	13.46
	Total	91	831	377,405	6,849	75.3	38,918.7	85,805.6	821	6.08	32.3	13.40
2020	Jan-Mar	52	352	198,366	7,433	142.9	41,897.2	92,367.0	814	5.83	32.0	12.85
	Apr-Jun	37	345	161,120	3,247	87.8	15,568.8	34,328.5	777	5.17	30.6	11.41
	Jul-Sep	28	318	118,775	1,371	49.0	6,037.4	13,303.1	753	4.65	29.6	10.26
	Oct-Dec	67	528	307,850	3,765	56.2	22,289.1	49,141.5	817	5.89	32.2	12.99
	Total	184	1,543	786,111	15,816	86.0	85,792.5	189,140.1	798	5.53	31.4	12.20
2021	Jan-Mar	67	474	251,400	8,692	129.7	48,685.0	107,332.9	829	6.18	32.6	13.62
	Apr-Jun	40	243	189,520	3,115	77.9	16,189.8	35,682.5	807	5.86	31.8	12.91
	Jul-Sep	2	14	6,000	66	33.0	310.5	684.1	757	4.61	29.8	10.17
	Oct-Dec	98	531	277,775	8,060	82.2	38,044.4	83,879.3	778	5.07	30.6	11.17
	Total	207	1,262	724,695	19,933	96.3	103,229.7	227,578.8	801	5.59	31.5	12.32
2022	Jan-Mar	156	744	369,150	21,993	141.0	111,115.5	244,988.5	802	5.65	31.6	12.47
	Apr-Jun	22	101	53,350	4,976	226.2	24,405.9	53,813.8	794	5.48	31.3	12.07
	Jul-Sep	0	0	0	-	-	-	-	-	-	-	-
	Oct-Dec	76	393	225,620	12,788	168.3	61,875.2	136,437.3	777	5.02	30.6	11.07
	Total	254	1,238	648,210	39,757	156.5	197,369.5	435,239.5	795	5.48	31.3	12.08
2023	Jan-Mar	156	667	307,550	50,089	321.1	245,530.7	541,215.0	780	5.09	30.7	11.23
	Apr-Jun	29	123	51,050	7,714	266.0	37,869.7	83,497.0	783	5.15	30.8	11.36
	Jul-Sep	-	-	-	-	-	-	-	-	-	-	-
	Oct-Dec	-	-	-	-	-	-	-	-	-	-	-
	Total	185	790	358,600	57,803	312.4	283,400.5	624,712.0	781	5.10	30.7	11.25
All	Jan-Mar	431	2,242	1,127,666	88,207	204.7	447,228.4	985,903.3	800	5.56	31.5	12.25
	Apr-Jun	128	811	454,740	19,052	148.8	94,034.3	207,321.8	790	5.42	31.1	11.95
	Jul-Sep	56	523	212,390	4,077	72.8	21,545.5	47,492.5	780	5.21	30.7	11.49
	Oct-Dec	306	2,125	1,107,885	28,822	94.2	145,929.9	321,758.4	795	5.45	31.3	12.01
	Total	921	5,701	2,902,681	140,158	152.2	708,738.0	1,562,476.0	796	5.49	31.3	12.10

Table 3. Total counts and weights of the three invasive carp species caught by contract fishers between 2019 and Feb 2023. All contract fishing efforts and results were recorded by agency staff that worked solely as project observers.

Cannelton Pool (late 2019 – early 2023)					McAlpine Pool (2020 - 2021)				
Year	Carp Species	Total IC Caught	Harvest Weight (kg)	Harvest Weight (lb.)	Year	Carp Species	Total IC Caught	Harvest Weight (kg)	Harvest Weight (lb.)
2019	BHC ^A	265	2,306.6	5,085.0	2020	BHC	0	0.0	0.0
	GRC ^B	129	1,124.3	2,478.8		GRC	2	16.5	36.3
	SVC ^C	6,455	35,487.9	78,241.8		SVC	2	8.9	19.6
	ALL	6,849	38,919.8	85,806.0		ALL	4	25.4	55.9
2020	BHC	279	2,350.6	5,183.2	2021	BHC	0	0.0	0.0
	GRC	237	1,945.2	4,288.3		GRC	6	65.2	143.8
	SVC	15,300	81,496.8	179,668.6		SVC	109	501.4	1,105.1
	ALL	15,816	85,792.6	189,140.1		ALL	115	566.6	1,248.9
2021	BHC	190	2,201.2	4,852.7	All	BHC	0	0.0	0.0
	GRC	214	1,603.2	3,535.0		GRC	8	81.7	180.1
	SVC	19,529	99,425.4	219,191.2		SVC	111	510.3	1,124.7
	ALL	19,933	103,229.7	227,578.8		ALL	119	592.0	1,304.8
2022	BHC	420	4,488.5	9,895.1	Both Pools Combined (late 2019 - early 2023)				
	GRC	273	2,044.3	4,506.7					
	SVC	39,064	190,863.7	420,837.7					
	ALL	39,757	197,396.5	435,239.5					
2023	BHC	287	3,480.2	7,671.8	Year	Carp Species	Total IC Caught	Harvest Weight (kg)	Harvest Weight (lb.)
	GRC	361	2,909.9	6,415.1	All	BHC	1,441	14,827.0	32,688.0
	SVC	57,155	277,010.3	610,625.1	GRC	1,222	9,708.5	21,404.1	
	ALL	57,803	283,400.5	624,712.0	SVC	137,614	684,794.5	1,509,689.0	
All	BHC	1,441	14,827.0	32,688.0	ALL	140,277	709,330.0	1,563,781.1	
	GRC	1,214	9,626.8	21,224.0					
	SVC	137,503	684,284.2	1,508,564.3					
	ALL	140,158	708,738.0	1,562,476.0					

BHC^A = Bighead Carp

GRC^B = Grass Carp

SVC^C = Silver Carp

Mean Daily Catch of Silver Carp | Peak Contract Fishing Months (Oct-Feb)

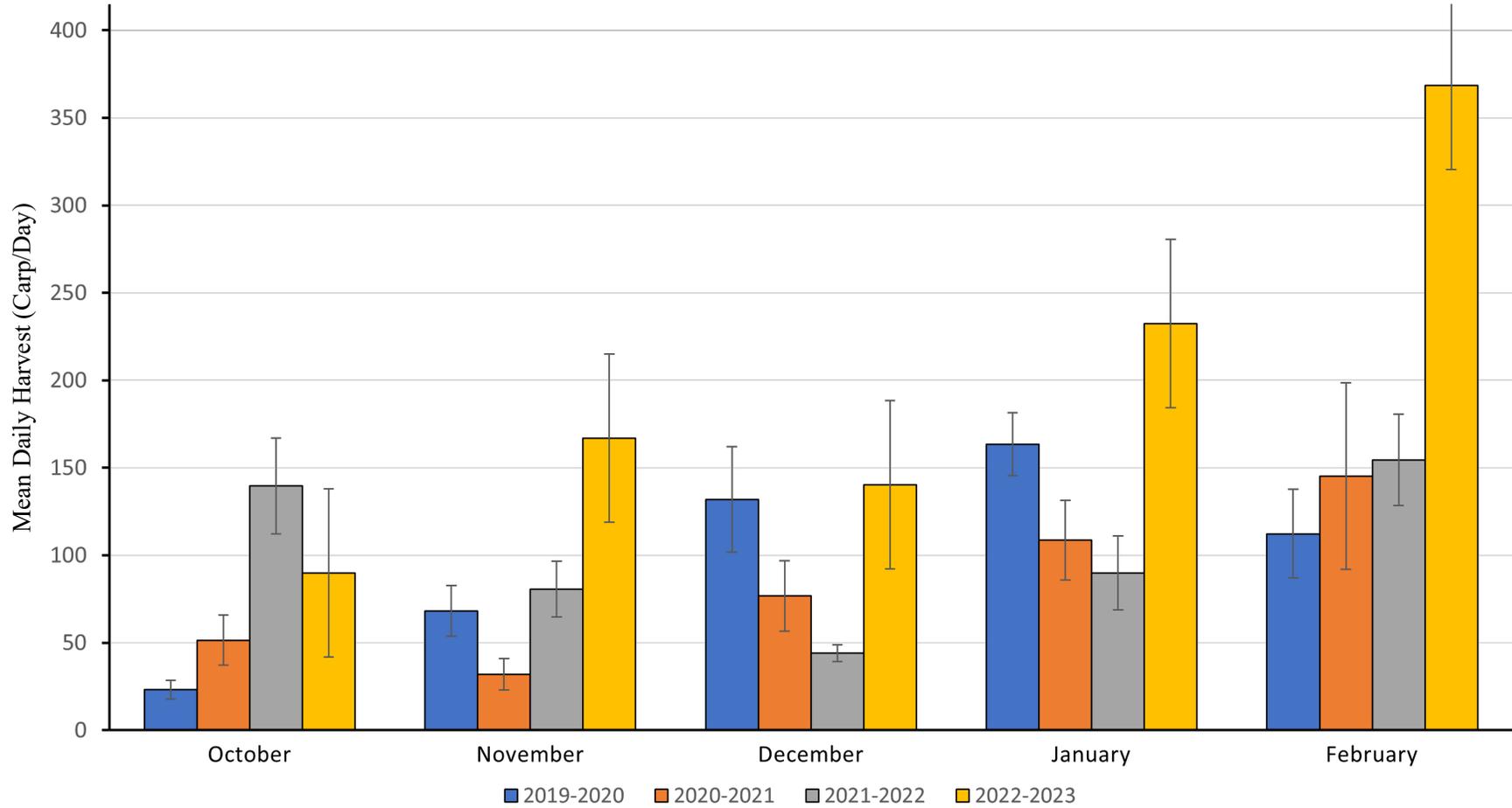


Figure 1. Graph shows the difference in average daily silver carp harvests for peak months from the past two contract fishing seasons. Error bars indicate SE.

2022 Contract Fishing Results | Mean Harvest Rates (Carp/Day)

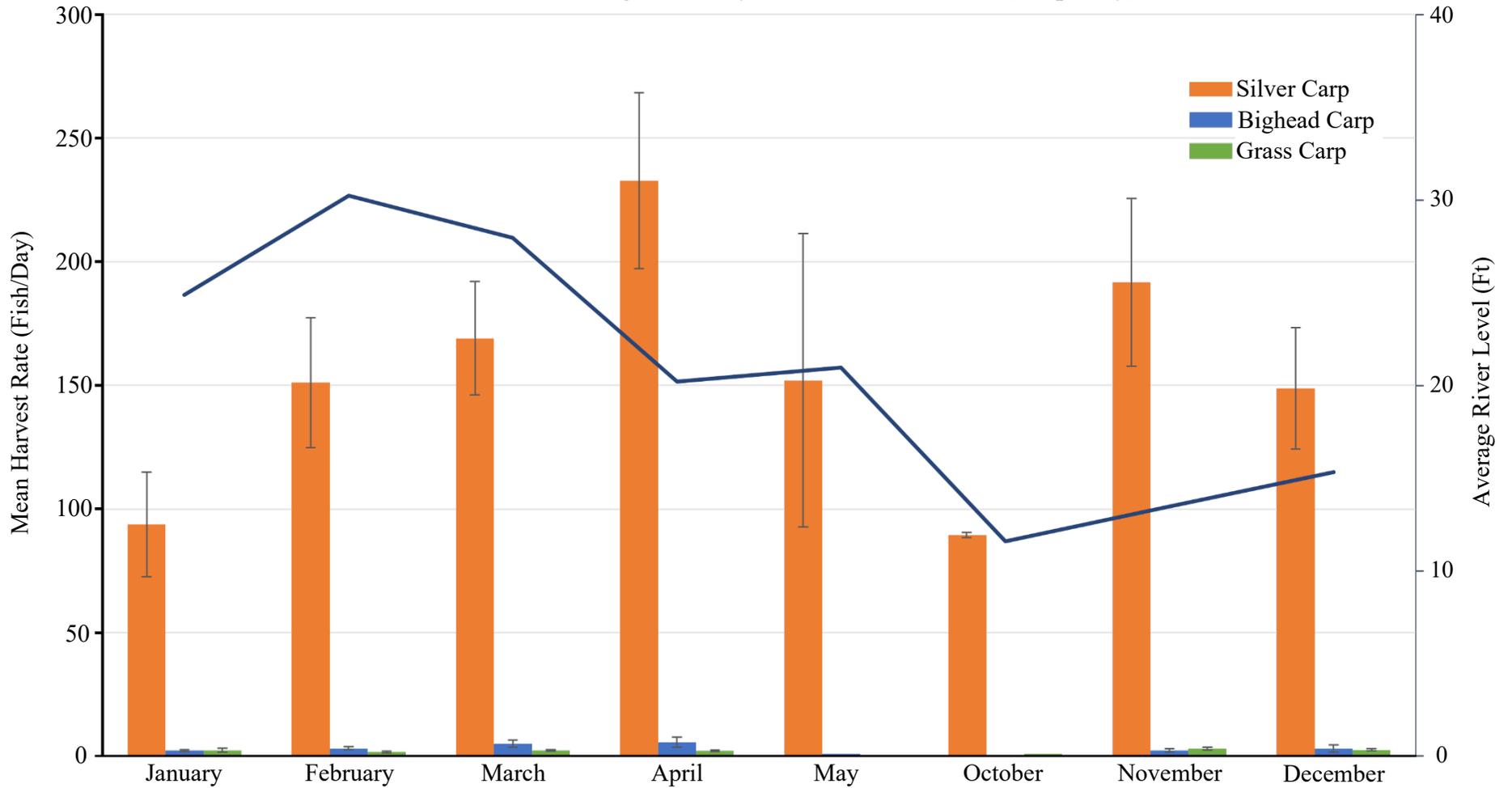


Figure 2. Mean harvest rates (Fish/Day) in months between Jan and Dec 2022 that KDFWR employed contract fishermen to remove invasive carp. Error bars represent the standard error for daily catches. Average level of the Ohio River was also calculated using data obtained from a USGS gage that's located at Cannelton Locks & Dam. Average daily landings in 2022 continued to correlate with water temperatures, but river levels turned out to be less influential.

2022 Contract Fishing Program | Monthly Results

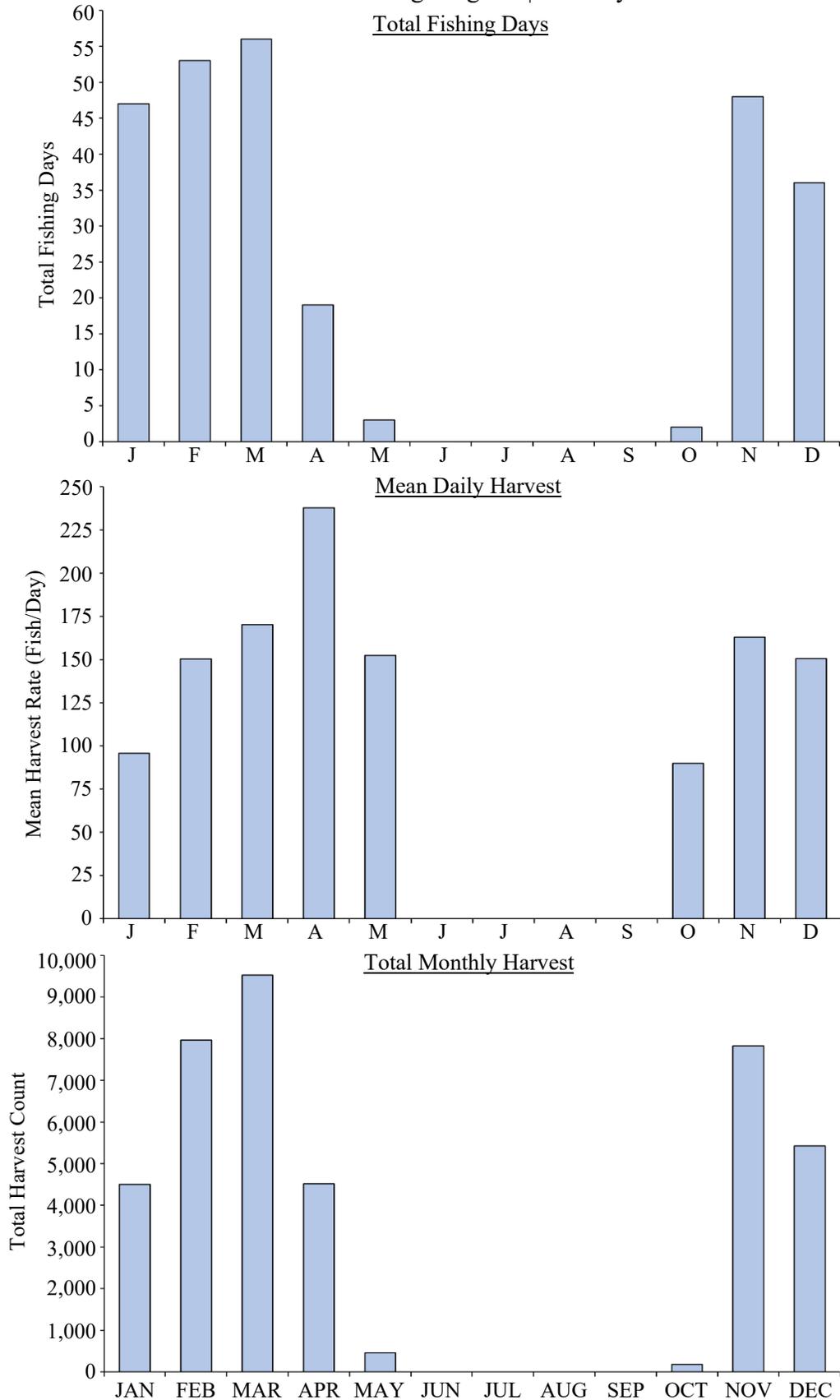


Figure 3. Monthly Results of the 2022 contract fishing efforts that include total fishing days, the average daily catch rate (carp/day) and the total number of invasive carp harvested by all program participants.

Invasive Carp Length Frequency | Contract Fishing 2021-2022

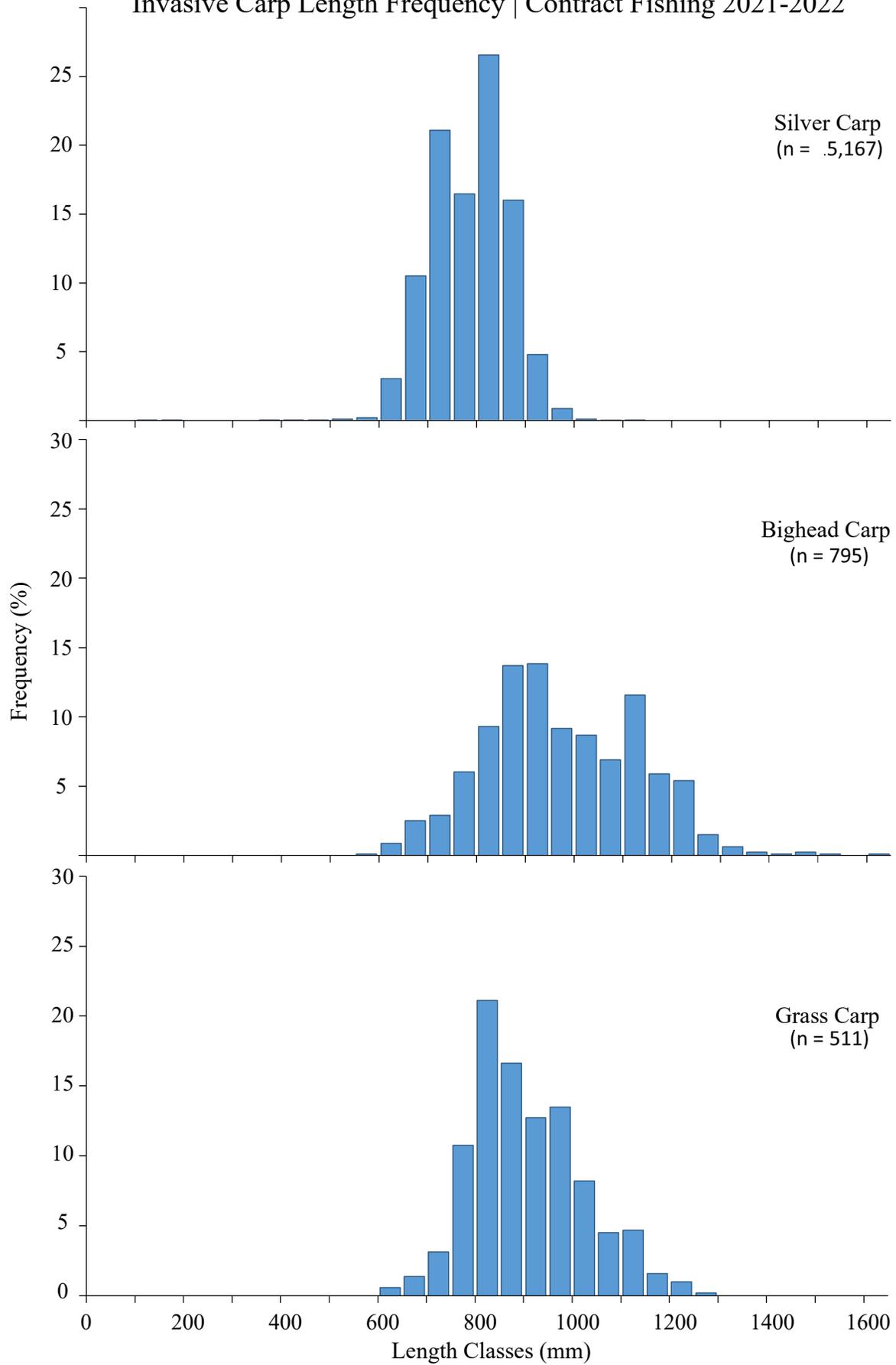


Figure 4. Length frequency distributions generated from subsamples of invasive carp that contract fishers caught and removed from the Cannelton Pool in 2021-2022.

Percent Bycatch by Month | 2022 Contract Fishing Efforts

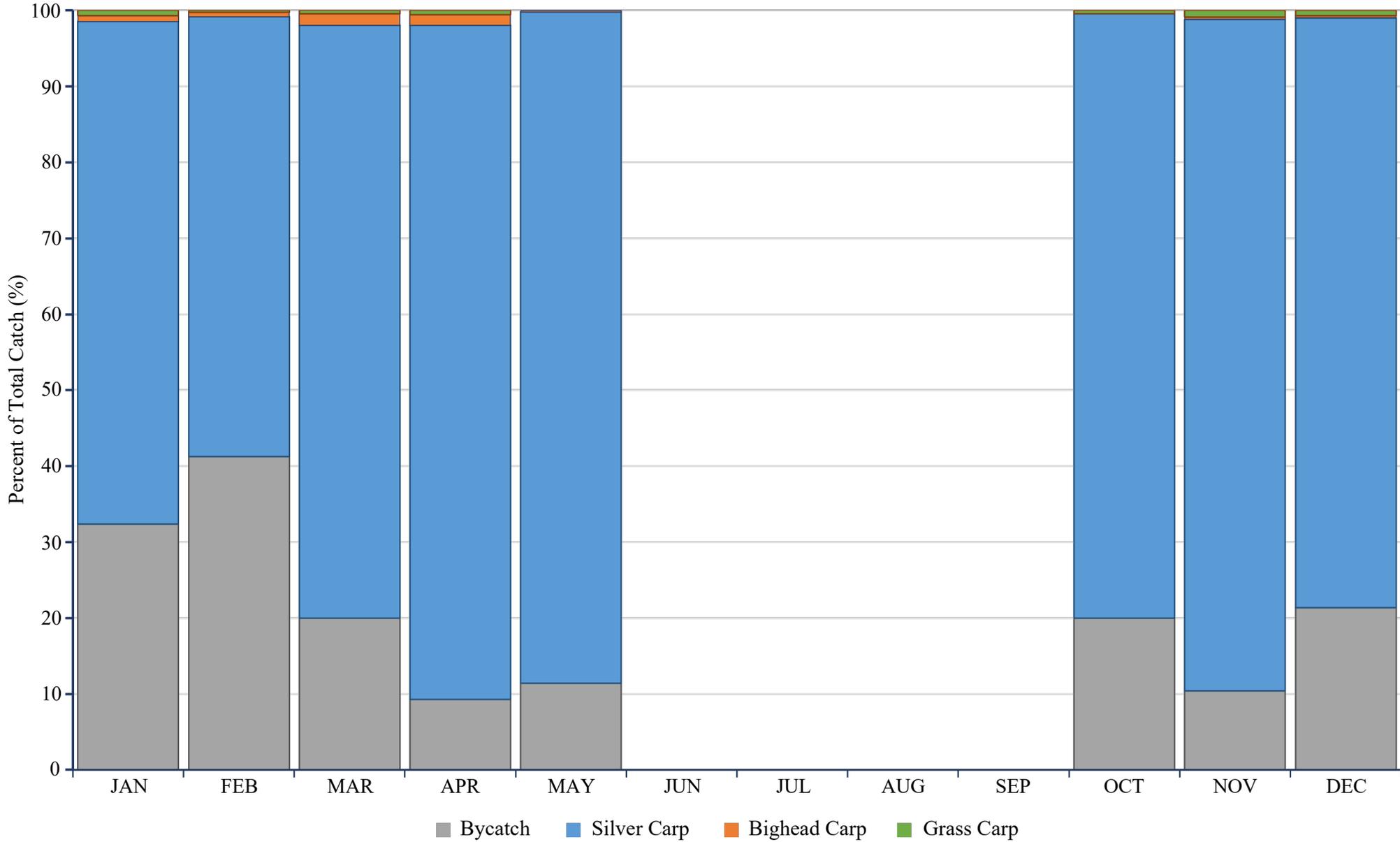


Figure 5. The monthly percent contribution of bycatch and the three invasive Carp species caught during the contract fishing efforts conducted in January through December 2022.

2022 Contract Fishing Efforts | By-Catch Summary

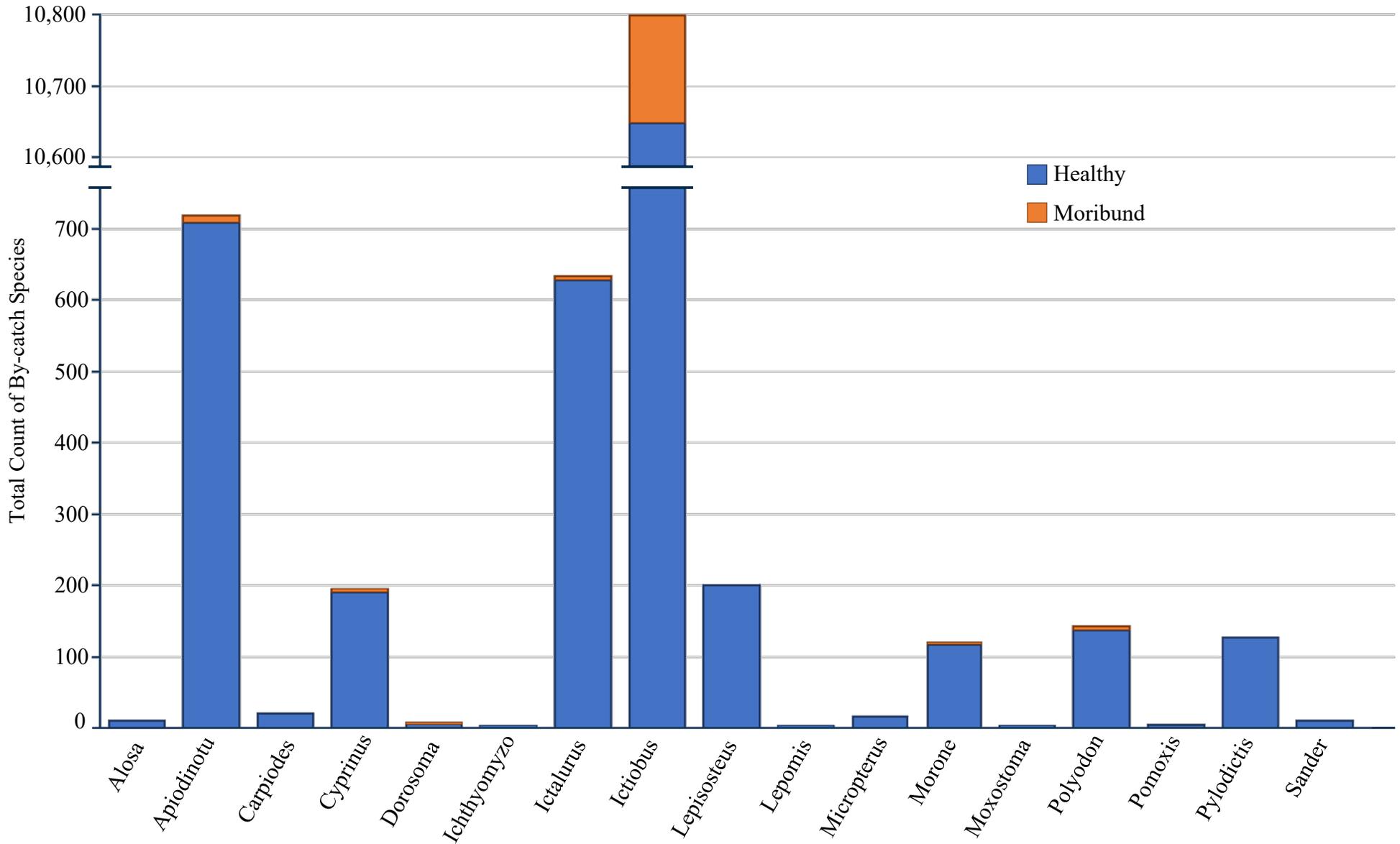


Figure 6. Total counts of all contract fishing bycatch recorded from January through December 2022. The color indicates the status of these fish after being removed from gill nets. Any bycatch was marked moribund if it suffered significant damage or could not swim off after release. Healthy, or resilient, fish were those that quickly recovered and could swim away under their own power