Project Title: Control of Invasive Carp in the Lower Mississippi River Basin

Geographic Location: Lower Mississippi River (LMR) and tributaries

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Statement of Need: Invasive species cause billions of dollars in ecologic and economic damage every year in the United States (Pimentel et al. 2005). While complete elimination of invasive species is nearly impossible, the management or control of these non-native species is necessary to reduce the impact on native species, the ecosystem, and the economy. The rapid expansion of invasive carp (Silver, Bighead, Black, and Grass Carp) throughout the Mississippi River and its tributaries has caused concern throughout the basin. The ability of this group of fishes (especially Silver and Bighead Carp) to rapidly expand and colonize river reaches in high densities, has led to changes in the food webs of the invaded aquatic ecosystems (Irons et al. 2007, Freedman et al. 2012; Sass et al., 2014; Solomon et al., 2016; Pendleton et al., 2017; DeBoer et al. 2018). Not only do invasive carp have ecological impacts, they also pose economic threats through reduction in recreational and commercial opportunities (e.g., reduced recreation, tourism). In response to these threats, many states throughout the Mississippi and Great Lakes basins have been working to find effective strategies to control the expansion of invasive carp into adjacent aquatic systems.

Currently, multiple technologies (i.e., Electrical Dispersal Barrier System, Bio-Acoustic Fish Fence, Acoustic Deterrent System, CO_2, etc.) are being used or field tested to both prevent more invasive carp from entering specific locations and prevent invasion of new areas, but these types of technology are not financially or physically possible in all locations. Because of the need for multiple options to prevent the expansion of and control invasive carp populations, many states are employing contracted commercial harvest. The Asian Carp Regional Coordinating Committee Contract stated that contracted commercial harvest remains one of the most successful tools to reduce the threat of invasive carp moving toward the Great Lakes in the 2019 Asian Carp Action Plan. In the 2019 plan, the coordinating committee also emphasized the importance of harvest in the lower pools to reduce the overall relative abundance of invasive carp in the Illinois River, which could subsequently reduce propagule pressure in areas of lower density. This technique has been shown to be successful in the Illinois and Ohio rivers, and Kentucky and Barkley lakes.

All four invasive carp species are found in the Lower Mississippi River Basin; Grass Carp have been stocked in the past, so they are not the focus of control and management efforts. Silver and Bighead Carp are found throughout the Lower Mississippi River (LMR) and Black Carp are being collected more regularly (Rodgers 2019). The states within the Lower Mississippi River Basin understand the magnitude of the invasive carp threat and the need for coordinated efforts to prevent their continued spread, explore strategies to reduce the abundance of established populations, and better understand the impacts of established populations (Rodgers 2019). Removal efforts address the need for control and management and provide the opportunity to collect data on invasive carp populations and the native fish community to inform future efforts.

Project Objectives:

1) Reduce overall invasive carp population numbers and alleviate propagule pressure in areas with low population density by implementing invasive carp removal programs utilizing commercial fishing in the Lower Mississippi River and tributaries.
2) Reduce the overall density and determine population characteristics of invasive carp in a large natural lake.

Project Highlights:

- *Missouri Department of Conservation*: A total of 22,925 pounds of invasive carp were removed from the lower Mississippi River by Silver Fin Solutions during October - November 2021.
- *Arkansas Game and Fish Commission:* A total of 13,971 pounds of invasive carp were removed from the Arkansas and White rivers by AGFC staff during October - December 2021.
- *Mississippi Department of Wildlife, Fisheries and Parks:* A total of 80,584 pounds of invasive carp were harvested from the Mississippi River and the Yazoo River Basin by 3 commercial fishermen who fished for 52 days from March – August 2021. Silver carp comprised 91% of the harvest. One processor was reimbursed a total of $14, 505.12 (fifhteen cents per pound).
- *Tennessee Wildlife Resources Agency*:
    - Silver Carp collected in Reelfoot Lake were relatively large compared to other populations in Tennessee.
    - Electrofishing didn't result in capture of any Silver Carp, though they were observed on majority of transects.
    - Additional analysis is needed to obtain information on age/growth.
    - Agency staff are working to incorporate removal and bowfishing aspects of the project.

Methods:

Missouri Department of Conservation (MDC)

Invasive carp harvest was implemented using Silver Fin Solutions, a not-for profit who had been completing contracted removal efforts in other states.

Wenom (2021) - Silver Fin Solutions Research Report #2:

To conduct the work outlined in this agreement, SFS used a modified, electrified "dozer trawl" and accompanying tender boat to harvest invasive carp from MDC-designated target areas in upper Mississippi River pools (20, 21, 22) upstream from St. Louis, MO, and in lower Mississippi River areas downstream of St. Louis in the vicinity of New Madrid, MO (i.e., in waters along the state's eastern margin). Given that a few agencies have used smaller versions of the electrified dozer trawl to sample fish in other rivers and tributaries, we had reason to anticipate that our larger dozer trawl/tender boat system would enable us to remove appreciable numbers of invasive carp under big-river conditions.

In anticipation of future projects, and to acquire the equipment necessary to conduct several previously-funded Kentucky Lake projects scheduled for winter, 2021-22, SFS had ordered motors and make-specific machinery parts well in advance of being contacted and eventually contracted by the MDC in June, 2021. Our understanding was that most or all the parts and equipment would be received before or during August 2021. However, lingering COVID-19-related supply chain issues delayed the delivery of many items, including trucks, boat motors, and an assortment of parts. In fact, many of these orders went unfilled for the project's entire duration. Despite persistent communication with vendors and national searches for alternative suppliers, we never obtained the boat motors, trucks, and services we required to make our removal system fully operational and capable of maximizing harvest yields with optimal efficiency.

The modified dozer boat was equipped with electro-fishing equipment capable of delivering a wide range of AC and DC outputs. Electrical discharges were produced using a 7,000i Honda generator that fed power to an ETS electro-fishing box; this directed the AC or DC current to a multi-dropper electrode array, the specifications of which were dependent on water conductivity and depth. The droppers were mounted on fiberglass poles that extended a few meters in front of the net frame of the dozer trawl and consisted of several steel, detachable antennae mounted on a "T" fitting attached to the distal end of each dropper pole. The amount of current tested to assess effectiveness of the electrical field for stunning fish and keeping them from escaping the front opening of the net ranged from 1.3 to 24.0 in conjunction with 35 to 320 volts. Eventually, the electrical dropper arrays were adjusted to provide 40 volts at 7.0 amps, the most effective combination for the Dozer.

Two catch nets were attached side-by-side to a 2-m high x 4-m wide frame affixed to a lift system at the bow of the boat and raised or lowered using an electric hoist system. An elongated, cinchable mesh bag approximately 4 to 8 feet long was attached to each catch net. Stunned fish were collected in the catch nets and pushed into the bags by water flow as the dozer boat was operated at 2.5 – 4.0 mph. Full bags could either be removed from the catch nets and exchanged for empty ones or the bags were lifted with a hoist and emptied into mesh bags or tubs in either the Dozer boat or the tender boat.

All invasive carp were dispatched. Most invasive carp harvested in the lower Mississippi River sites were transferred to trailers and taken to farm fields for unloading. Two local farmers had enthusiastically offered to allow us to deposit our fish in their fields for fertilizer. On two dates, invasive carp collected were taken to the nearest boat ramp area soon after being harvested. The cinched bags of fish were tethered to floats and moored in the river for at least 12 hours. The bags were weighed the following day and transported to Two Rivers Fisheries in Wickliffe, Kentucky. The purpose was to determine if leaving fish in bags in the river would allow most to remain alive, giving time for transport trucks to arrive and for fish to accumulate to yield full loads. In exchange for our donation, Two Rivers Fisheries agreed to give us a report concerning the flesh quality of the fish when they were processed.

Arkansas Game and Fish Commission (AGFC)

The AGFC hired seasonal employees and purchased equipment (boats, gill nets, etc.). The gill nets being used are tied down 100 yard nets of 4 or 5 inch square mesh multi-strand monofilament either 6 or 8 feet deep. The crew was trained on net handling, fish identification, and safety protocols. The crew worked 40 hours per week for two months and only 79 hours the third month deploying gill nets and removing all invasive carp captured. This schedule of two months at 40 hours per week and only 79 hours during the third month is our agencies requirements for seasonal employees. The seasonal employees can repeat this 2 month/1 month schedule over and over. Invasive Carp are located using side scan sonar and observation of jumping activity from Silver Carp being disturbed by boat motor noise. Nets are then placed in the locations and more water disturbance is used to drive the fish into the nets. All netting locations, soak time of nets and by-catch (which is released immediately) are recorded for each set. We are developing disposal methods for the removed fish. Arkansas has no commercial processing plants for Invasive Carp currently. We have found two new startup businesses that are taking some of the fish to send to Louisiana for crayfish bait. All the Bighead Carp are being given to the University of Arkansas at Pine Bluff to aid in building a comprehensive data set for that species.

Mississippi Department of Wildlife, Fisheries and Parks (MDWFP)

Originally, we discussed reimbursing either fisherman or invasive carp processors a certain amount per pound of fish harvested. Our purchasing staff said since that would take a long time

to get approval to do so, we needed to try contracting with fishermen by paying them an hourly rate to fish for invasive carp. They would be hired as agency contract workers.

In late October 2020 we printed and mailed 1,111 program description letters and an interest form to all those who had purchased a commercial fishing license in the last 14 months. The letter stated that we would pay them at least $10.00/hr. to fish for invasive carp. They were asked to return the interest form to us by 11/10/2020 to be considered for participation in the contract fishing program. In late October 2020 we also emailed this information to 55 people who had contacted us since December 2017 to inquire about firms purchasing invasive carp.

We had received 52 interest forms; 29 of these people had more than 5 years commercial fishing experience. We contacted 20 people of the 29 people with more than 5 years of commercial fishing experience and asked them to submit information for a background check which is required to be employed as contract workers. We submitted all 20 names to our Law Enforcement Bureau violation database to determine if the individuals had any fish and wildlife citations on their customer record. Eight individuals had fish and wildlife citations in our system. Twenty commercial fishermen were contacted again and instructed to submit the necessary forms for hiring as contract workers. Only one person did this.

Due to this poor response, we decided to pursue a reimbursement program with the two invasive carp processors in Mississippi. In January 2021 MDWFP and USFWS staff had a conference call and MDWFP requested a change in the scope of work to implement a harvest reimbursement program with invasive carp harvesters which was approved by the USFWS.

During January – March 2021, the MDWFP prepared a contractual scope of work, a reimbursement invoice, and an invasive carp fish purchase ticket form for an invasive carp processor fish reimbursement program. We distributed these documents to the invasive carp processing firms in Mississippi and both firms signed contracts to participate. Six month contract documents were signed and executed by Moon River Foods, Inc. and Delta Fisheries and Organics, LLC in March and September 2021. These contracts state that the MDWFP will reimburse these firms 18 cents/pound if they pay licensed Mississippi commercial fisherman at least 25 cents/pound for invasive carp harvested from the Mississippi River where it borders Mississippi and from the Yazoo River Basin as shown in Figure 1.

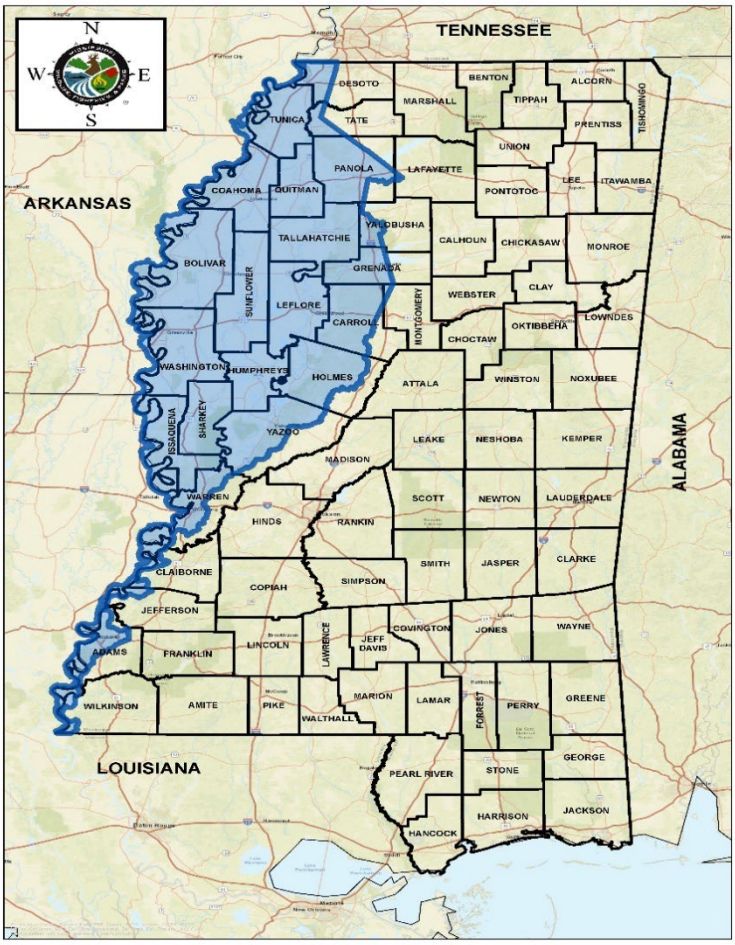

Figure 1. *Mississippi invasive carp harvest areas in the Yazoo River Basin and the Mississippi River as shown in blue.*

Tennessee Wildlife Resources Agency (TWRA)

TWRA sampled four sites on Reelfoot Lake with gillnets. Each site was sampled twice during 2021, once during summer (July-Sept) and again in the winter (Nov-Jan). At each site, four overnight gillnet sets were deployed for a total of sixteen nets per season. Individual nets were 300-ft in length with 100-ft panels of 3-, 4-, and 5-in mesh. Nets were 12-ft deep, hobbled to 10-ft every eight feet; nets had 0.5-in foamcore float line and 65-lb leadcore lead line. The webbing used in each of the panels was constructed of 8 ply, 0.2-mm twist mesh. All species were recorded by mesh size. We did not attempt to herd fish into nets using electrofishing, acoustic boats, or any other method.

TWRA staff sampled 15 electrofishing sites on Reelfoot Lake. Sampling occurred twice during 2021 (spring and fall). Electrofishing surveys were conducted during the daytime using high-frequency pulsed DC boat electrofishing. Voltage and amperage were adjusted to achieve a 3,000-W power output, as possible (Stuck et al. 2015). Electrofishing transects were conducted in accordance with existing sportfish sampling protocols.

Contract/commercial removal efforts are still being pursued; however, no removals have been completed at the time of this report. TWRA staff will continue working with interested vendors to pursue removal actions. Reelfoot Lake is a unique resource that presents many complications for standard removal efforts including copious debris/snags, seasonally important fisheries (i.e., spring crappie fishery), abundant vegetation during warmer months, and high-profile duck hunting use.

Like contract/commercial removal efforts, bowfishing opportunities are still being pursued by TWRA staff, though no bowfishing events have been conducted at the time of this report. We anticipate holding this type of event in the coming year and plan to collect data from harvested carp.

Results and Discussion:

Missouri Department of Conservation (MDC)

Wenom (2021) - Silver Fin Solutions Research Report #2:

SFS harvest efforts in the Mississippi River were conducted from September 19 through November 2, 2021 (Table 1). Transects were run on 28 days and 4 nights. Three of the 4 nights were conducted as double shifts. A total of 174 transects were completed; Pool 20 (n=30), Pool 21 (n=29), Pool 22 (n=64), and Lower River (n=51). A total of 35,939 pounds (22,925 pounds from the LMR) *of invasive carp were harvested in 2,230 minutes* (1,348 minutes on the LMR) *of pedal time.*

A considerable amount of each day's effort was spent searching for aggregations of fish. Although most of the carp were often deeper than the Dozer's effective electrical field, we experienced a few transect runs that yielded fairly high amounts of carp. It is unclear whether the fish were compelled to rise to the field or if there were enough fish located in the effective field range to provide the decent yields. The Dozer typically pushed carp from aggregation areas while running transects and harvesting fish. Therefore, areas were rarely successfully worked twice in a particular day, a significant factor in daily harvests. This meant we had to locate several carp aggregation areas each day to be able to stay in fish. This was true regardless of where we worked.

During the final four days in the lower river, water levels rose at a pace of over a foot per day and slow water that was present along the island side channel eventually all but disappeared. As water levels rose considerably and water flows changed, many of the invasive carp moved away from the previously preferred areas and were much more difficult to sample as slack and slow water conditions disappeared. For that reason, on the last afternoon of sampling, SFS moved its operation from the Seven Island Access area sampled in the morning to an irrigation canal (St. John's Bayou) located near New Madrid, Missouri. As expected, the canal had large amounts of

invasive carp and gar. In 50.6 minutes of electro-fishing, 2,109 pounds of invasive carp were harvested for an average of 2,503 pounds per hour. Although that afternoon's electro-fishing yield only rated fifth in terms of pounds per hour for runs of 10 minutes or more, it was apparent that invasive carp daily harvest yields would be consistent in the canal since there was no need to spend time locating schools as is often necessary in the main river. These conditions mimic those in tributaries of carp dominated rivers, with the caveat being the canal had lower presence of species considered important to the public and to conservation agencies. Also, with the use of block nets, harvest rates would increase significantly. The SFS Dozer would be very effective in reducing invasive carp or other nuisance species in irrigation canals.

The experiment with Two Rivers Fisheries for which carp were held in mesh bags for at least 12 hours prior to deliver to the processor had very positive results. Most of the fish remained alive during holding, and Two Rivers Fisheries indicated the quality of the fish at delivery as excellent. This was even though the fish were transferred from bags to totes with ice at Two Rivers and not examined until the following day. Therefore, there is great utility in using detachable mesh bags on the Dozer in conjunction with a tender boat operation to pick up bags, quickly transport the fish to holding areas near the truck pickup points and place the bags in the water until being transported. Fish quality is important for most processors, whether the fish are to be processed into fish meal or used for it or food.

The simple fact is that maximizing pedal time in areas that hold fish is key to maximizing daily harvest potential. Therefore, familiarity of the areas to be worked and understanding habitat types of which invasive carp associate under various water level and flow conditions are important to maximizing harvests, as is the density of carps within pools or areas to be worked. Additionally, SFS plans to make significant changes and additions to the Dozer that will make it more efficient at ensuring fish collected in the nets will remain there or be pushed into the bags, a major issue during this project. We will also add parts to further increase pedal time such as quick-detach cod nets and a substantial tender boat with a crane capable of easily hoisting 2,000-lb bags of fish. We believe our reported harvest rates during this project can be increased at least four-fold and would be glad to have the opportunity to test the adjusted Dozer system of harvesting invasive carp in the presence of MDC staff when the gears are fully functional as planned.

There are several advantages of using the Dozer trawl system over commercial gill nets. Dozer-captured fish are generally uninjured and can be stockpiled alive in net storage bags to await landing and transport. They can be handled in bulk, and do not require extensive net picking and the relatively few non-target fish collected can easily be released unharmed in most situations. The dozer trawl can sample shallow or deeper water with a large variety of water flow conditions, allowing for harvest when common commercial gear is less effective or not fishable. For safety reasons, trained operators are required to operate the Dozer, and harvest potential

depends on the operator's ability to "read" the river. Knowing the nuances of a boat's operation and repair comes, in part, from personally constructing it, as was the case with SFS crew and the dozer trawl boat we used.

From this abbreviated effort, the combination of the ability to find aggregations, an experimental gear that can be fished at times and locations that can not be typically fished by commercial fishermen, and the experimental quick detachable nets to hold harvest has been shown to be effective. We believe with this season of experience, future efforts will be more successful and provide a means for mass removals in a wide variety of areas often not accessible by commercial fishermen or with typical commercial fishing gear.

Table 1. *Invasive carp harvest effort and weight totals by pool and date. Harvests were conducted in three pools of the Upper Mississippi River and in the Lower Mississippi River from RM 889 to RM 925. An electrified Dozer trawl was used to collect fish.*

Pool	Date	Time (min)	Distance (meters)	Weight (pounds)	Harvest/min	Harvest/hr
20	8-Oct	30	2,414	253	8.4	506.2
	9-Oct	62	4,656	1,126	18.2	1,089.5
	12-Oct***	141	10,622	2,520	17.9	1,075.0
	Total	233	17,692	3,899	16.8	1,005.6
21	3-Oct	28	1,971	249	8.9	532.7
	4-Oct	81	6,399	880	10.9	654.5
	5-Oct	27	2,092	120	4.4	266.7
	6-Oct	35	2,836	139	4.0	237.3
	Total	171	13,299	1,388	8.1	487.3
22	19-Sep	35	2,179	199	5.7	341.1
	20-Sep	39	2,830	533	13.7	819.6
	21-Sep	25	2,347	469	18.8	1,125.2
	27-Sep	90	6,974	1,104	12.3	737.1
	28-Sep	61	4,970	597	9.8	587.2
	29-Sep	91	7,622	1,235	13.6	815.6
	30-Sep	66	4,632	1,043	15.8	948.3
	1-Oct	172	11,869	2,548	14.9	891.4
	Total	578	43,424	7,727	13.4	801.9
Lower	17-Oct	61	5,018	1,183	19.5	1,168.4
	18-Oct	92	7,437	2,454	26.6	1,593.2
	19-Oct	48	3,824	386	8.1	487.4
	20-Oct	114	12,903	2,165	19.0	1,138.8
	Oct-21*	2	161	126	63.0	3,780.0
	24-Oct**	0	0	30	0.0	0.0
	25-Oct***	156	13,304	2,706	17.3	1,040.8
	26-Oct	63	5,914	1,020	16.2	971.4
	28-Oct***	128	12,016	1,448	11.3	678.8
	29-Oct	84	7,886	3,364	40.0	2,402.9
	30-Oct***	266	24,972	2,870	10.8	647.4
	31-Oct	81	7,603	725	9.0	537.1
	1-Nov	147	13,800	1,125	7.7	459.2
	2-Nov	107	10,003	3,323	31.2	1,871.2
	Total	1,348	124,840	22,925	17.0	1,020.2
All Pools	Grand Total	2,330	199,255	35,939	15.4	925.5

* Dozer motor quit, ** Attempted gill net sets, *** Included night fishing

Arkansas Game and Fish Commission (AGFC)

The AGFC originally planned to hire commercial fishers to remove invasive carp in the Arkansas River from Pine Bluff to the Mississippi River and from the confluence of the Little Red River downstream to the Mississippi River. Letters were sent to approximately 1,350 current commercial fisher license holders in September 2020 notifying them of the funding opportunity. Nineteen commercial fishers responded and were sent the RFP for the project. The AGFC received no proposals from these commercial fishers by the submission deadline. The AGFC then requested an amendment to the grant to allow hiring seasonal employees and purchase of removal equipment (boats, nets, etc.). The AGFC advertised the positions, completed interviews and hired two staff for this removal program.

This removal program is new to our agency and the best methods for capturing Invasive Carp are being adapted as lessons are learned. We have found that nets need to reach from the surface to the bottom of the water. This aids in preventing the Invasive Carp from going over or under the nets. The multi-stranded monofilament seems to work better than single-strand monofilament. Setting nets parallel to each other with only a few feet between them helps catch the fish that jump the net in their avoidance behavior.

In total the crew removed 926 Silver Carp, 44 Bighead Carp, and 11 Grass Carp for a total of 13,971 lbs. of invasive carp removed during October - December 2021.

Mississippi Department of Wildlife, Fisheries and Parks (MDWFP)

Delta Fisheries and Organics, LLC purchased no invasive carp due to start up difficulties. Flooding conditions in the spring of 2020 hindered fishing activity and Moon River Foods Inc. began purchasing invasive carp along with buffalofishes, Common Carp and catfishes in late March 2021. They continued purchasing fish as needed to fulfill orders from customers but were limiteded by processor staffing who prepare the fish for frozen storage. They stopped purchasing fish on August 9, 2021. Pounds of invasive carp purchased in this program are shown in Table 1.

Table 1. *Pounds, percent by species and funds expended for invasive carp purchased in CY 2021 harvested from the Mississippi River and Yazoo River Basin waters.*

	Sliver Carp	**Bighead Carp**	**Grass Carp**	**Total**
Pounds	73,750	5,171	1,663	80,584
Percent by weight	91.52	6.42	2.06	100
Amount Paid by Processor	$18,437.50	$1,292.75	$415.75	$20,146.00

Grant Funds Expended	$13,275.00	$930.78	$299.34	$14,505.12

Almost all (91.52%) of the harvest by weight consisted of Silver Carp.

Invasive carp were harvested by three commercial fisherman, one each from Mississippi, Louisiana, and Kentucky. They fished nine water bodies (Table 2) eight of which are in the Mississippi River basin and one is in the Yazoo River basin (Lake George). Invasive carp were harvested on 52 days among these water bodies.

Table 2. *Mississippi invasive carp harvest locations and days fish per location.*

Water Body Name	Days of Harvest	Basin Name
Lake Lee	19	MS River
Beulah Lake	13	MS River
Desoto Lake	8	MS River
Mississippi River	4	MS River
Chotard Lake	4	MS River
Horseshoe Lake	1	MS River
Tunica Lake	1	MS River
Lake Whittington	1	MS River
Lake George	1	Yazoo River
Total Days	52	

Harvest ranged from 174 to 6,703 pounds per day and averaged 1,549.7 pounds per day. Total effort in terms of days of fishing and pieces of gear set was not recorded by the fishermen.

The low payment rate per pound offered by the processors compared to the prices fishermen receive for other species, processing ability per day, weather and water levels, along with the logistics of transporting the catch to the processing plant in a fresh condition were all factors believed to account for the low harvest over the project period.

A more detailed data analysis will be presented in the final project report.

Due to the lack of participation, FY21 funds were not requested for this project. FY20 funds will be expended until depleted or returned to the USFWS.

Tennessee Wildlife Resources Agency (TWRA)

Gill net sampling resulted in the capture of 54 Silver Carp, 25 during summer and 29 during winter. Catch per unit effort was 1.56 (SE = 0.29) in summer and 1.81 (SE = 0.29) in winter. Mean length from the summer sample was 863 mm (n = 25; SD ± 78) and from the winter sample was 918 mm (n = 29; SD = ± 64). No Silver Carp captured were less than 700 mm (Figure 1) in length, suggesting that there has been little or no natural reproduction in recent years; we would not expect natural reproduction in this natural lake due to lack of required flow. This also supports our hypothesis that the Silver Carp population in Reelfoot Lake is primarily a result of fish migrating past the spillway at high water. Silver Carp were relatively large compared to what is typically encountered in other Tennessee systems populated by Silver Carp (e.g., Kentucky and Barkley lakes). Mean relative weight (Wr) was 102.7 (n = 25) from the summer sample and 106.1 (n = 29) from the winter sample. The good condition of carp in the existing population suggests that there is no shortage of food resources, and that densities are below any threshold that would cause negative density-dependent impacts on growth or condition. Additionally, the carp in the population are large, sexually mature adults. Sex ratio favored females with 1.45 females to every 1 male captured for summer and winter sample combined (n = 54). We have not yet been able to complete age estimation and are currently waiting on supplies and equipment for staff to fulfill this component.

Results are limited for electrofishing. No invasive carp were captured during the effort; however, Silver Carp were observed on the majority of transects completed. Future efforts will not be conducted in accordance with existing sportfish sampling, but rather will be conducted as separate, targeted effort.

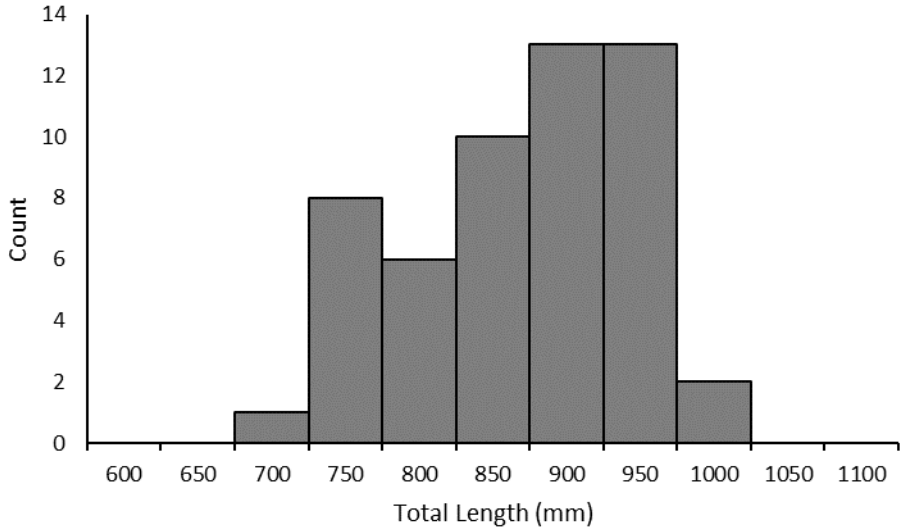

Figure 1. *Length-frequency histogram of gill net captured Silver Carp from Reelfoot Lake during the summer and fall of 2021.*

Recommendations:

- *Missouri Department of Conservation (MDC)*
    - Information to improve contracted harvest measures is needed. Programs to engage commercial fishers or other entities has largely fallen short of harvest goals. Market instability decreases commercial fishing likelihood for participation because of return on investment. Existing contracted removal efforts through Silver Fin Solutions was largely experimental and a learning process. Innovative methods, participation, and monetary incentive will all be important to improving contracted harvest for control and management of invasive carp.
- *Arkansas Game and Fish Commission (AGFC)*
    - Have a second crew trained and ready to increase effort and hopefully catch rates beginning January 2022. Data analysis will be conducted to inform further removal efforts.
    - Various methods to herd/drive the fish into the nets will be explored including the use of electrofishing boats, different sounds, etc..
- *Mississippi Department of Wildlife, Fisheries and Parks (MDWFP)*
    - Harvesting of invasive carp is hampered by two main factors: the low price paid to harvesters and the daily processing capability of the existing firms. Additionally, the firms need to expand their customer markets which would allow them to buy more fish throughout the year. The financial resources of these firms appears limited even with our reimbursement program. State and federal funds to develop and expand processing infrastructure and help develop markets is needed. Development of consumer convenient invasive carp products for human consumption by American consumers is needed to drive in country demand. Renewing business contacts with the Mississippi Development Authority (MDA) to assist processing firms with infrastructure funding as was done in Tennessee and Kentucky is needed. The MDA can also help develop local and foreign market contacts to increase demand for invasive carp products.
    - Discussions with the US Department of Agriculture should be initiated at the federal level to explore opportunities for the purchase of invasive carp products in a commodity food program for distribution to public schools and prisons.
- *Tennessee Wildlife Resources Agency (TWRA)*
    - Continue pursuit of removal options and bowfishing events.
    - Adjust electrofishing settings and efforts to target carp.
    - Continue monitoring to inform management actions and to detect any shift in population characteristics that may increase understanding of migrations and population density.
    - Complete age/growth analysis.

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