Project Title: Abundance and distribution of early life stages of invasive carp in the Lower Mississippi River Basin

Geographic Location: Lower Mississippi River Basin in Louisiana.

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Participating Agencies: Louisiana Department of Wildlife and Fisheries (LDWF) Nicholls State University (Quenton Fontenot, NSU)

Statement of Need:
Successful management of invasive carp is dependent on a thorough understanding of life histories and interactions with local environments. Reproduction, a key component of life history, can be used to guide control efforts by identifying where large spawning aggregations occur, and by identifying source and sink populations.

The purpose of this project is to determine where successful reproduction of invasive carp is occurring through the identification and cataloging of larval fish samples in Louisiana waters. The documentation of the presence/absence of invasive carp larvae will assist in determining the leading edge of expansion throughout the Lower Mississippi River Basin and will help document where self-sustaining populations have established. This project will inform the direct management activities to contain the spread of invasive carp such as placement of deterrents and possible locations for other control activities. The long-term goal for the research conducted through this early life stage study, in conjunction with telemetry-based movement studies, is to determine if it would be possible to direct harvest or place barriers or deterrents to further restrict invasive carp movement and reproduction.

In Louisiana, the Red, Atchafalaya, and Mississippi Rivers are connected at the Old River complex which has allowed invasive carp to spread to all three rivers, and further spread to smaller rivers in LA through natural and man-made connections such as flood relief or freshwater diversions used for wetland restoration. Commercial navigation channels have allowed migration between river basins, thereby allowing invasive carp and other fish to move

freely between basins. The LDWF began monitoring ichthyoplankton in 2013 to better understand the extent of invasive carp reproduction and to quantify larval invasive carp in Louisiana. In 2013, the samples were taken in April, May, and June. This project was modified to have the samples taken in May, June, and July in 2014 to try to define a temporal pattern of the presence of invasive carp early life stages. Sample sites were revisited in 2019 to see if invasive carp reproduction has remained constant over time or has spread to other areas where carp reproduction was not detected in 2013-14. The 2019 samples were taken during a historic flood on the Mississippi and Red Rivers and the data does not reflect what we would expect of a "typical" year's reproduction. Future studies will either confirm changes in reproductive patterns as reflected by the 2019 results or that the 2013 and 2014 years are more typical. Ichthyoplankkton sampling took place in 2021 showed a peak in May and it had a large sample of over 97,000 larval invasive carp in one sample taken.

This study supports the objectives of the Lower Mississippi River Basin invasive carp control plan by helping to determine what aquatic habitats in Louisiana are suitable for invasive carp spawning. When combined with other studies, this research may help determine what populations are source populations while assisting in directing efforts for harvest or exclusion.

Project Objectives:

1. Determine the extent of invasive carp spawning activity Mississippi River, Atchafalaya River, and Ouachita River Basins within Louisiana.

Project Highlights:

- Invasive carp are reproducing in the majority of the Lower Mississippi River (LMR) Basin sites sampled in LA. Reproduction is taking place on the Red, Mississippi, Atchafalaya, and the Ouachita Rivers.
- Invasive carp comprised 14.8% of the ichthyoplankton samples collected in the LMR in 2022.
- Invasive carp spawned in all three of the months sampled with a peak occurring in May.
- No larvae were collected west of the Atchafalaya River in 2022 despite large numbers of adults present in some of the areas sampled.

Methods:

Louisiana:

The samples collected in 2021 informed the locations of this year of the study. Ichthyoplankton samples were collected at 38 sites throughout Louisiana by LDWF personnel in April, May, June of 2021. At each sample station, Ichthyoplankton samples were collected by towing a 0.5m diameter 500µm mesh ichthyoplankton net just below the water surface for a duration of 10 minutes per tow. A separate tow was made on the left, middle, and right portions of the channel. Samples were preserved in 70% ethanol or isopropyl alcohol and delivered to NSU.

Upon arrival at NSU, larval and juvenile fish were separated from debris for each sample and stored in plastic containers or scintillating vials containing 70% ethanol or isopropyl alcohol. Each fish was identified to at least the family taxonomic level. Cyprinids were further identified as either an invasive carp species or not an invasive carp species. All fish were identified fishes to family based on Auer (1982). Identification of cyprinids such as invasive carp larvae were based on Chapman (2006), Chapman and George (2011) and George and Chapman (2013). Taxonomic classification beyond family for non-cyprinids was based on Auer (1982).

Results and Discussion:

Louisiana:

Table 1 lists the results of the 342 samples collected in Louisiana. Samples were broken down by family composition with invasive carp making up 18,972 of the 78,029 larvae collected (14.8%). Clupeidae was most abundant occurringed in 249 samples. Belonidae was the least abundant occurring in only two samples. Invasive carp were the second most abundant species represented. Some larvae (N=940) were too degraded to confirm identification.

Invasive carp were identified in samples from April, May, and June (Table 2) with 22 out of 38 sites having invasive carp larvae present (Figure 1). Eight sites had invasive carp present during all three months. Samples collected in April included 1,241 invasive carp larvae, samples in May had 17,210 while those collected in June included 521 invasive carp larvae. The largest single sample of 7,056 invasive carp larvae was collected from a single site in June. In 2022, evidence of invasive carp reproduction was found in in the Red, Mississippi, Atchafalaya, and the Ouachita Rivers. An Intercoastal Waterway site, located between 2 sites where invasive carp

were present, was the only site outside of those major rivers which had invasive carp larvae. The smaller river basins to the west of the Atchafalaya did not have reproducing populations of invasive carp in 2022. Sample site location information is listed in Appendix 1.

Table 1. The total number of larvae identified within each family is shown. Frequency represents the number of samples that contained at least one individual in that family. Total number and frequency of larvae that could not be identified due to degradation are also listed. Invasive carp were the second most abundant larvae and occurred in 131 samples. Nineteen samples had no larvae.

Family	Frequency	Number
Clupeidae	249	43,031
InvasiveCarp	**131**	**18,972**
Catostomidae	133	8,857
Atherinidae	61	2,378
Centrarchidae	148	1,597
Cyprinidae	61	1,492
Sciaenidae	40	188
Percichthyidae	33	139
Engraulidae	24	122
Poeciliidae	30	120
Percidae	32	66
Lepisosteidae	27	45
Ophichthidae	3	40
Syngnathidae	21	30
Elopidae	5	6
Ictaluridae	4	4
Belonidae	2	2
Subtotal		**77,089**
Unidentified Degraded	103	940
Total Fish		**78,029**

Table 2. The total number of invasive carp larvae collected by month at sample station. The frequency indicates the number of net tows that collected invasive carp from that station. For example, if the frequency is three, then all three tows at that station collected invasive carp.

Month	River	Station	Frequency	Number
April	Atchafalaya	All Flow - Simmesport	1	1
April	Atchafalaya	Grand Bayou	3	18
April	Black Hawk	Scar Lake	1	1
April	Boeuf	Hwy 4	1	2

April	Deer Park	.	2	2
April	ICWW	1	3	38
April	Mississippi	Black Hawk	2	10
April	Mississippi	Vidalia	3	86
April	Ouachita	.	3	1,070
April	Ouachita	Columbia	2	13
			Subtotal	**1,241**
May	Atchafalaya	All Flow - Simmesport	3	5,912
May	Atchafalaya	American Pass	2	81
May	Atchafalaya	Butte LaRose	3	610
May	Atchafalaya	Delta	1	4
May	Atchafalaya	Wax Lake Outlet	3	71
May	Atchafalaya	Grand Bayou	3	7,056
May	Black Hawk	Scar Lake	2	5
May	Boeuf	Hwy4	3	31
May	Deer Park	.	1	1
May	ICWW	1	3	37
May	Mississippi	Black Hawk	1	160
May	Mississippi	BR/I-10	3	511
May	Mississippi	Davis Pond	2	9
May	Mississippi	I-20 Bridge	3	1,247
May	Mississippi	Mardi Gras	3	199
May	Mississippi	Thompson Creek	2	5
May	Mississippi	Vidalia	3	299
May	Mississippi	1-Mile North of Yazoo	3	967
May	Ouachita	.	1	3
May	Ouachita	Columbia	1	1
May	Ouachita	Forsyth Chauvin	1	1
			Subtotal	**17,210**
June	Atchafalaya	All Flow - Simmesport	3	25
June	Atchafalaya	American Pass	1	1
June	Atchafalaya	Butte LaRose	3	122
June	Atchafalaya	Delta	2	6
June	Atchafalaya	Grand Bayou	3	36
June	Atchafalaya	Wax Lake Outlet	3	10
June	Boeuf	Hwy 4	1	2
June	ICWW	1	3	6
June	Mississippi	Black Hawk	1	2
June	Mississippi	BR/I-10	3	81
June	Mississippi	Davis Pond	1	1
June	Mississippi	I-20 Bridge	2	12
June	Mississippi	Mardi Gras	1	1
June	Mississippi	Thompson Creek	3	129
June	Mississippi	Vidalia	3	19

June	Ouachita	.	3	8
June	Ouachita	Columbia	1	2
June	Red	End of Red	3	58
			Subtotal	**521**

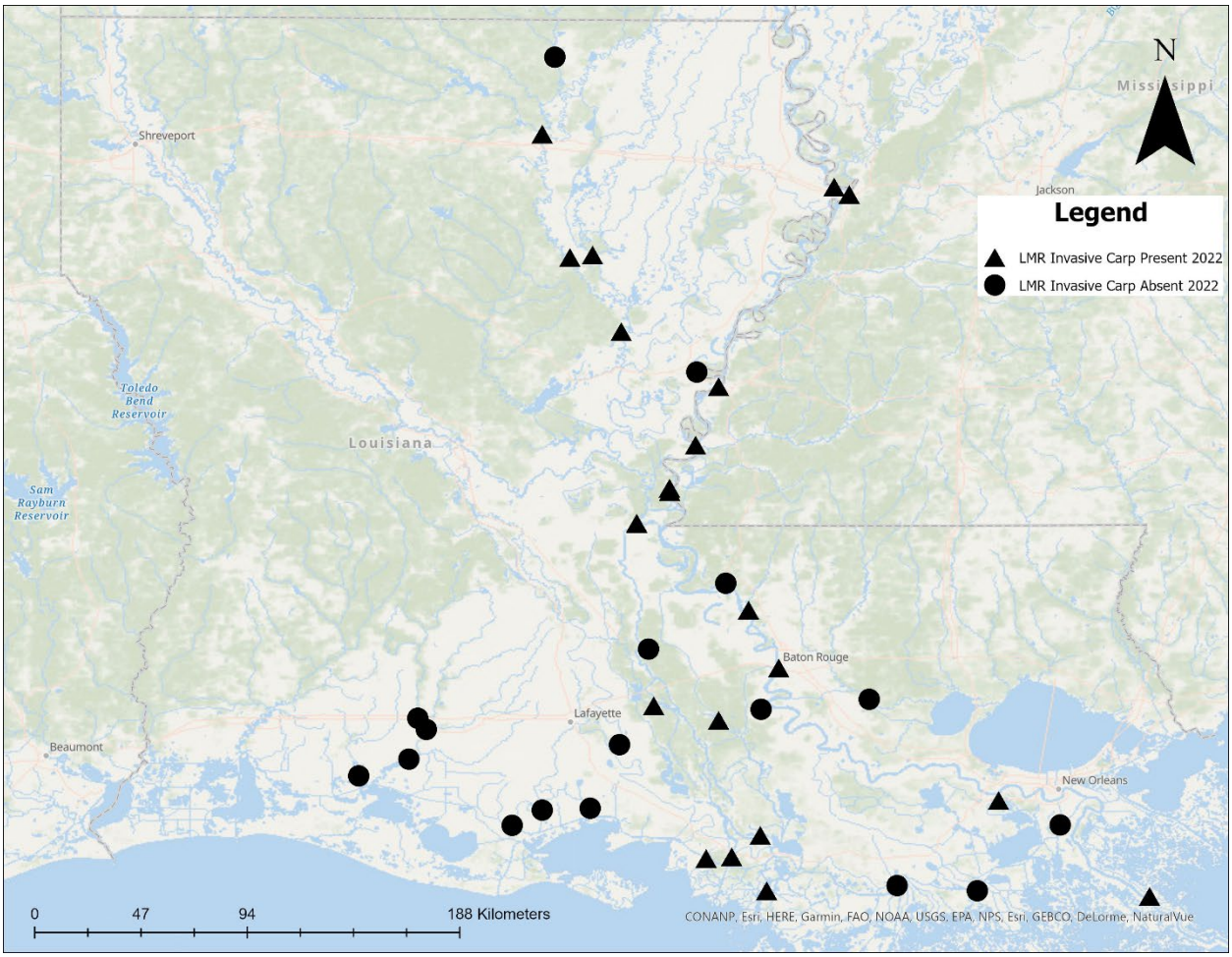

Figure 1. Sample site map indicating sites where invasive carp were present (▲) and those where invasive carp were not detected (•) during 2022 sampling.

Recommendation:

Future ichthyoplankton studies could be carried out at fewer sites with more frequent sampling to ascertain what environmental factors may be triggering reproduction. A study will be taking place in 2023 sampling ichthyoplankton from February to November to ascertain the pattern of reproduction in invasive carp in the Atchafalaya River.

Rivers to the west of the Atchafalaya River did not have any invasive carp larvae collected during the study. However, adult invasive carp have been seen and tagged in these basins. Tagged carp from areas with no larvae present have returned to the Atchafalaya River in the Spring prior to the breeding period. The rivers to the west likely do not have a strong enough flow regime to support reproduction.

References:

Auer, N.A. (ed.). 1982. Identification of larval fishes of the Great Lakes basin with emphasis on the Lake Michigan drainage. Great Lakes Fishery Commission, Ann Arbor, MI 48105. Special Pub. 82-3:744 pp.

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George A.E., and Chapman D.C. 2013. Aspects of Embryonic and Larval Development in Bighead Carp *Hypophthalmichthys nobilis* and Silver Carp *Hypophthalmichthys molitrix*. PLoS ONE 8(8): e73829

APPENDIX 1. LDWF ichthyoplankton sample site locations during the summer of 2022. Each month consisted of three tows per site.

River	Station	Latitude	Longitude
Amite	.	30.31	-90.83
Atchafalya	Butte LaRose	30.29019	-91.6867
Atchafalya	Wa xLake Outlet	29.69003	-91.3771
Atchafalya	Delta	29.55504	-91.2381
Atchafalya	American Pass	29.7754	-91.2635
Atchafalya	Big Alabama Bayou	30.50927	-91.7069
Atchafalya	Grand Bayou	30.23206	-91.42901
Atchafalya	All Flow-Simmesport	31.01504	-91.75463
Bayou Plaquemine	.	30.27	-91.26
Bayou Sara	Mississippi	30.77	-91.4
Bayou Schooner	1	29.809314	-92.24945
Bayou Teche	1	30.130404	-91.82289
Black Hawk	ScarLake	31.154293	-91.62415
Boeuf	Hwy4	32.08	-91.93
Deer Park	.	31.325056	-91.52057
Delcambre Canal	.	29.877993	-91.93847
ICWW	Crown Point	29.810729	-90.07092
ICWW	1	29.68364	-91.47848
ICWW	HNC	29.57	-90.72
ICWW	LaRose	29.55	-90.4
Lacassine	NWR	30.005359	-92.85863
Mermentau	HWY90	30.190194	-92.58995
Mermentau	LAHWY14	30.071877	-92.65909
Mississippi	Mardi Gras	29.532731	-89.71641
Mississippi	BR/I-10	30.44	-91.19
Mississippi	Thompson Creek	30.67	-91.31
Mississippi	Davis Pond	29.913806	-90.31644
Mississippi	Black Hawk	31.140188	-91.62324
Mississippi	1-Mile North of Yazoo	32.35	-90.97
Mississippi	I-20 Bridge	32.32	-90.91
Mississippi	Vidalia	31.557193	-91.42903
Nezpique	I-10	30.234275	-92.62483
Old	Vidalia	31.609644	-91.51536
Ouachita	.	31.775615	-91.81603
Ouachita	Forsyth Chauvin	32.56	-92.13
Ouachita	Alabama Landing	32.86	-92.08

Ouachita	Columbia	32.07	-92.02
Red	End of Red	31.01247	-91.7538