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

Geographic Location: Lower Mississippi River Basin in Louisiana.

Lead Agency: Louisiana Department of Wildlife and Fisheries (LDWF), Rob Bourgeois (rbourgeois@wlf.la.gov)

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.

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.

Previous studies were funded by the state Aquatic Nuisance Species (ANS) grants, which must support all ANS activities in Louisiana. In order to conduct additional research on temporal and spatial variation in invasive carp breeding, other funding sources must be utilized. 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.

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 Mississippi River.
- The carp were not a high percentage of the ichthyoplankton in the 2021 samples.
- The peak of invasive carp plankton appears to be in May for 2021.

Methods:

Ichthyoplankton samples were collected at 40 sites throughout Louisiana by LDWF personnel in April, May, June, and July 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:

Sample site location data is listed in Appendix 1. Table 1 shows the results of the 344 samples collected. Out the 344 samples that have been sorted, 258 have had 100% of their contents identified (Table 1). The majority of fish that have been sorted but not identified include cyprinids that have either not been confirmed as an invasive carp or not an invasive carp, or are a species waiting on a second opinion to confirm identification.

The identified larval fish consisted of 12,393 individuals from 19 families (Table 2). Clupeidae was the most abundant occurring in the most samples, and Gobiidae was the least abundant occurring in the fewest samples (Table 2). Invasive carp were the 7th most abundant species represented. However, we expect their abundance to increase once we complete all identifications. There are also several yolk-sac larvae (N=392) that have yet to be identified. There were also some larvae (N=75) that were too degraded to confirm identification and were labeled as unidentified degraded. The total number of fish to date (including unidentified yolk-sac and degraded) was 12,860 (Table 2).

Although we have not confirmed the identification of larvae from all samples, invasive carp were only identified in samples from May and June (Table 3). More invasive carp were identified in May (N=216) compared to June (N=52; Table 3). In May, invasive carp were identified in all three tow samples for 4 out of 5 stations compared to only 1 station out of 5 in May (Table 3), which indicates that they are more abundant in May compared to June.

Invasive carp larvae were identified in the Mississippi River (Figure 1). There are several samples from the Atchafalaya River that still need to have their contents confirmed (Figure 1).

Table 1. Status of the samples we have received (N=344) as of January 2022. Sorted samples have had the larvae separated from the sample debris and all fish have been identified to family in the 100% Identified samples.

Sample Status	Total Number	Percent Total
Received	344	100
Sorted	86	25
100% Identified	258	75

Table 2. Total number of larvae identified within each family and larvae that could not be identified because they were too degraded or at the yolk-sac stage as of January 2022. Invasive carp were the seventh most abundant larvae and occurred in 19 samples. There were 37 samples that had no larvae

Family	Frequency	Number
Clupeidae	167	6,411
Catostomidae	107	1,946
Cyprinidae	60	942
Poeciliidae	67	930
Atherinidae	69	888
Centrarchidae	109	735
Invasive Carp	**19**	**268**
Engraulidae	10	110
Syngnathidae	21	54
Percichthyidae	15	25

Lepisosteidae	16	19
Belonidae	10	14
Sciaenidae	10	13
Percidae	9	12
Ictaluridae	3	10
Ophichthidae	6	10
Elopidae	3	4
Aphredoderidae	1	1
Gobiidae	1	1
Subtotal		**12,393**
Unidentified Yolk-sac Larvae	20	392
Unidentified Degraded	27	75
Subtotal		**467**
Total Fish		**12,860**

Table 3. Total number of invasive carp larvae collected each month at each station as of January, 2022. The frequency indicates the number of net tows that collected an invasive carp from that station. For example, if the frequency is three, then all three tows at that station contained invasive carp. No invasive carp have been identified in processed samples from April or July. However, a number of samples from 2021 have not been completely processed.

Month	River	Station	Frequency	Number
April	None	None	0	0
May	Davis Pond	South of HWY 90	1	1
May	Mississippi	33BR	3	11
May	Mississippi	Bonnet Carre	3	14
May	Mississippi	Fort Jackson	3	7
May	Old	None	3	183
			Subtotal	**216**
June	Mississippi	33BR	1	5
June	Mississippi	Bonnet Carre	2	21
June	Mississippi	Fort Jackson	3	26

			Subtotal	**52**
July	None	None	0	0

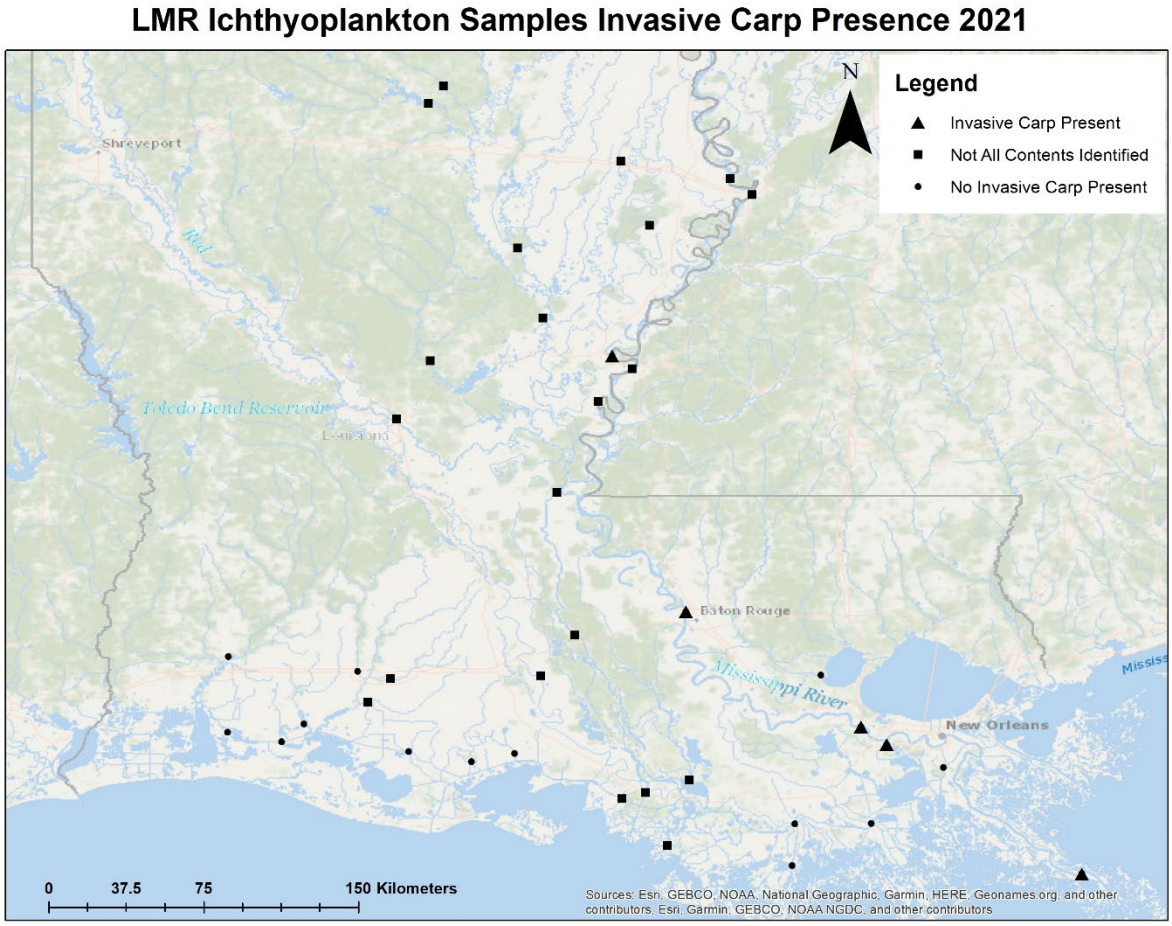

Figure 1. Sample locations where invasive carp have been identified (triangle), not all contents have been identified (squares), and where no invasive carp were identified (circles) as of January 2022.

Recommendations:

Invasive carp were found in relatively low numbers in the MS River South of Baton Rouge. The lack of evidence of reproduction and the relative reduced amount of nursery habitat in that stretch of river indicates that we can reduce sampling sites in that area for the next year. Some

addition sites between the Old River site and Baton Rouge may help define where the decrease in carp larval numbers occurs.

The low number of larval invasive carp in the Davis Pond samples suggest a relative low larval input from the river diversion into the Barataria system.

More sites need to be placed upstream and downstream of sites where invasive carp were located in order to better define the breeding areas.

Studies need to be conducted on salinity tolerance of larval invasive carp. Invasive carp larva detected at the Fort Jackson site were most likely pushed into coastal estuaries and could find their way into a river where invasive carp are not present.

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.

Chapman, D.C., ed. 2006. Early development of four cyprinids native to the Yangtze River, China: U.S. Geological Survey Data Series 239, 51p.

Chapman, D.C., and George, A.E., 2011. Developmental rate and behavior of early life stages of bighead and silver carp. U.S. Geological Survey Scientific Investigations Report 2011–5076. 11 pp.

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 that were sampled during the summer of 2021. Each month consisted of three tows per site.

River	Station	Latitude	Longitude
Atchafalaya	Butte LaRose	30.394158	-91.677597
Atchafalaya	Delta	29.475739	-91.273906
Atchafalaya	Doiron	29.762606	-91.177508
Atchafalaya	Simmesport	31.015028	-91.754644
Bayou D'Arbonne	D'Arbonne	32.71117	-92.315248
Bayou DeLoutre	Buffalo Hole Road	32.787827	-92.249766
Bayou Lafourche	Hwy 4	32.08091	-91.926335
Bayou Macon	North I-20 @ Hwy 80	32.457725	-91.476192
Bayou Petite Anse	1	29.87686	-91.939361
Bayou Plaquemine Brule	1	30.205191	-92.481157
Bayou Queue de Tortue	1	30.101205	-92.579193
Bayou Teche	1	30.216665	-91.82695
Blind	36	30.2179	-90.60379
Calcasieu	Theriot	30.3	-93.19
Davis Pond	South of HWY 90	29.91605629	-90.31758894
Deer Park	.	31.412611	-91.574841
GIWW	Cabot	29.680669	-91.471331
HNC	35 Falgout	29.39074	-90.73
ICWW	1	29.884935	-92.401237
ICWW	32 HNC	29.5713	-90.71751
ICWW	34 B. Lafourche	29.57233	-90.38414
ICWW	Bell City Ditch	29.928	-92.956
ICWW	Crown Point	29.81666329	-90.06930807
ICWW	Willow Lake	29.971	-93.193
Lacassine	LNWR	30.006	-92.859
Little	.	31.5895866	-92.3077163
Mississippi	.	31.555014	-91.42692
Mississippi	33 BR	30.79671	-91.19347
Mississippi	5 Miles North of Vicksburg	32.383985	-91.000322
Mississippi	Bonnet Carre	29.994875	-90.429717
Mississippi	Fort Jackson	29.353469	-89.466275
Mississippi	I-20 Bridge	32.31295	-90.90509
Nezpique	I-10	30.236	-92.624
Old	.	31.610041	-91.515222

Ouachita	.	31.77524	-91.816273
Tensas	Tensas NWR Ramp	32.180169	-91.350698
Vermilion	1	29.841311	-92.12843
Wax Outlet (Atch.)	Calumet	29.707417	-91.370017