Project Title: Identifying Overwintering Habitat of Silver and Bighead Carp in the Lower Mississippi River: Implications for Harvesting and Population Reduction

Geographic Location: Lower Mississippi River - Vicksburg Reach.

Lead Agency: US Army Corps of Engineers, Engineer Research and Development Center (KJ Killgore, A. Oliver, T. Slack, and D. Ruppel)

Participating Agencies: Mississippi Dept. of Wildlife and Fisheries; USGS – Columbia; MS State USGS Cooperative Unit.

Statement of Need: Previous observations in the Lower Mississippi River (LMR) have suggested that Invasive Carp associate with deep (>50-75 feet) holes behind dikes or point bar scour holes during winter. ERDC preliminary data indicates that Carp form tight schools, or aggregations, during overwintering periods making them particularly susceptible to harvesting. The LMR is replete with deep holes where Invasive Carp may aggregate but detailed analysis of these overwintering habitats has not been conducted. A pilot study was conducted to survey the river in order to locate deep holes and identify the presence of Carp aggregations around Vicksburg, MS. Based on these observations, overwintering habitat in the LMR will be mapped and targeted for mass removal of Carp to reduce recruitment to other watersheds.

Project Objectives:

1. Locate large schools of Silver and Bighead Carp overwintering in the LMR
2. Measure and characterize the hydrogeomorphic and water quality environment of each overwintering habitat
3. Evaluate different collecting gears to harvest Carp in large numbers at overwintering locations

Project Highlights: A total of 41 sites along a 58-mile reach of the Lower Mississippi River were surveyed during winter conditions for Invasive Carp aggregation. Optimum overwintering habitat were scallops closest to the dike-vegetated bank interface with deeper, slow-moving water and consistent access back to the main channel. Carp avoided strong currents, and there was no trend in depth selection other than avoiding shallow (<20 ft) water. Re-surveying sites with high Carp abundance over a range of river stages is reccomended to verify optimum habitat conditions, evaluate influence of river stage on occupancy duration, and continue to evaluate species composition and mass removal techniques as part of a management option in the Lower Mississippi River.

Methods: Using Arc-GIS, bathymetric maps showing deep holes primarily associated with dikes, including notched dikes, were developed for the Lower Mississippi River (Appendix 1). Bathymetric data included single and multi-beam survey data from USACE Districts from rivermile 360 - 495 using 2012 aerial imagery to identify the notches. The imagery from 2012 was taken during low water, which is helpful to see if there is a “deep” hole below the dike and determine if access to the deep area is blocked by an island or sand bar. We assumed that the presence of Carp in a deep hole is controlled by fall accessibility and winter low velocity.

A Hummingbird Solix was used to locate Carp in the study reach by observing concentrations of fish marks on the display. We assumed that these fish were Carp partly verified by occasional sightings of jumping individuals. Maximum water depth was recorded at each survey location. Water temperature was measured during each sampling occasion with YSI ProDSS water quality meter. We classified Carp abundance based on the signature pattern on the Hummingbird screen denoted as none, low, medium, high. Data collected to date are summarized below.

Results and Discussion: Carp surveys occurred on two occasions in January - February 2022 covering the Mississippi River between river miles 395-453. A total of 41 locations along the 58-mile reach near Vicksburg, MS were surveyed for Invasive Carp on January 26 and February 10, 2022 (Figure 1). Maps displaying relative abundance of Carp, dike locations, and river miles were prepared (Figure 1). River stage at Vicksburg during the survey period ranged from 19.1 - 31.2 ft; flood stage is 43 feet. Water temperature during the survey period remained at 41 °F.

Bathymetric maps of the study area were prepared prior to the survey denoting deep water habitats associated with dike fields that aided in the selection of survey sites (Figure 2). We also utilized multi-beam survey data when available providing more detailed bathymetric coverage (Figure 2, right panel). Overall, the mean (± standard devision) depth surveyed was 50.8 ± 25.3 ft ranging from 10.0 to 121 ft.

The Hummingbird was operating as we entered a dike pool, or in some cases, a deep scour hole not associated with dikes. However, we learned early that Carp were usually located downstream and close to a dike. The image on the Hummingbird screen was diagnostic of Carp orientation patterns. Spatial arrangement of high Carp abundance was classified as clumped dispersion in which individuals were tightly clustered together (Figure 3). Differences between low to medium abundance were more subjective and were combined in subsequent analysis.

Mean depth of Carp locations, ranging from 49 – 56 feet, was not signficantly different among relative abudances (ANOVA, n=41, F=0.44, p=0.65; Figure 4). Maximum depth where Carp abundance was highest (81 ft)was less than sites that were either absent of Carp or had low to moderate abundances (110 – 121 ft). Carp avoided shallow (<20 ft) water, but had no apparent trend in occupying deeper water.

Several observations on preferred overwintering sites were recorded. Carp avoided strong currents (approximately >0.5 m/sec) regardless of depth. Large schools were usually located downstream and next to a dike to avoid strong currents. Carp density was especially high below dikes with scallops, where flanking occurs downstream of the dike (Figure 5). Not all areas downstream of dikes with scallops had Carp aggregations. Dikes in the Lower Mississippi River increase flow velocities and eddies along the downstream toe causing scalloped sediment erosion.

Comparing aerial photography of scalloped locations at different river stages where Carp abundance was highest indicated that access to the channel at lower stages may also be an important habitat feature (Figure 5). Carp may avoid scallops that can be accessed at higher stages but may become isolated at lower stages due to obstructions from sandbars or other stone structures. Therefore, based on our initial survey optimum overwintering habitat appears to be

scallops closest to the dike-vegetated bank interface with deeper, slow-moving water and consistent access back to the main channel.

Recommendation: Our initial survey concluded that Carp schools can be easily located in the Lower Mississippi River with electronic fish finders. Some of these locations may be ideal for mass removal if techniques can be developed to capture large numbers of fish during cold water conditions. After our second survey in February, the river rose to flood stage and we were unable to sample for fish using nets and electrofishers to verify species, size, and relative abundance based on CPUE. Antidotal information from a catfish guide who accompanied us during our surveys indicated that Carp moved out of some locations classified as high abundance as river stage increased. FY22-23 studies are recommended to complete the evaluation as a management tool:

- Re-survey all sites once the water temperature drops below 45 °F. Repeat surveys at different river stages as possible.
- Complete fish sampling at multiple locations where Carp are abundant.
- Work with partners (USGS Columbia) to develop a more quantitative assessment of Carp abundance based on the signature pattern on the electronic fish finder.
- Develop maps of the LMR that contain optimum habitat features for overwintering Carp.
- Work with partners to evaluate mass removal techniques during winter.

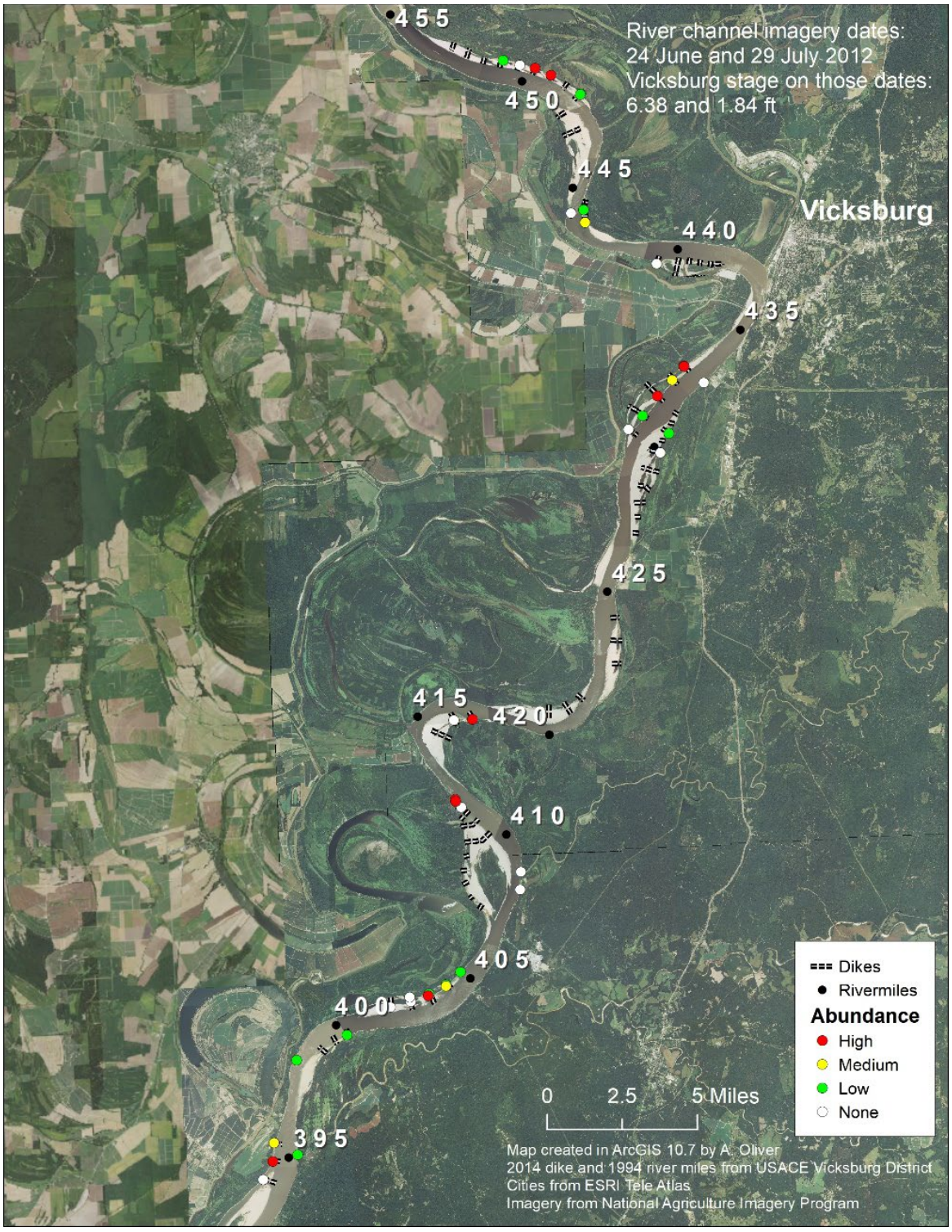

Figure 1. Google Earth map displaying the study reach near Vicksburg displaying the relative abundance of Carp with dike locations by river mile.

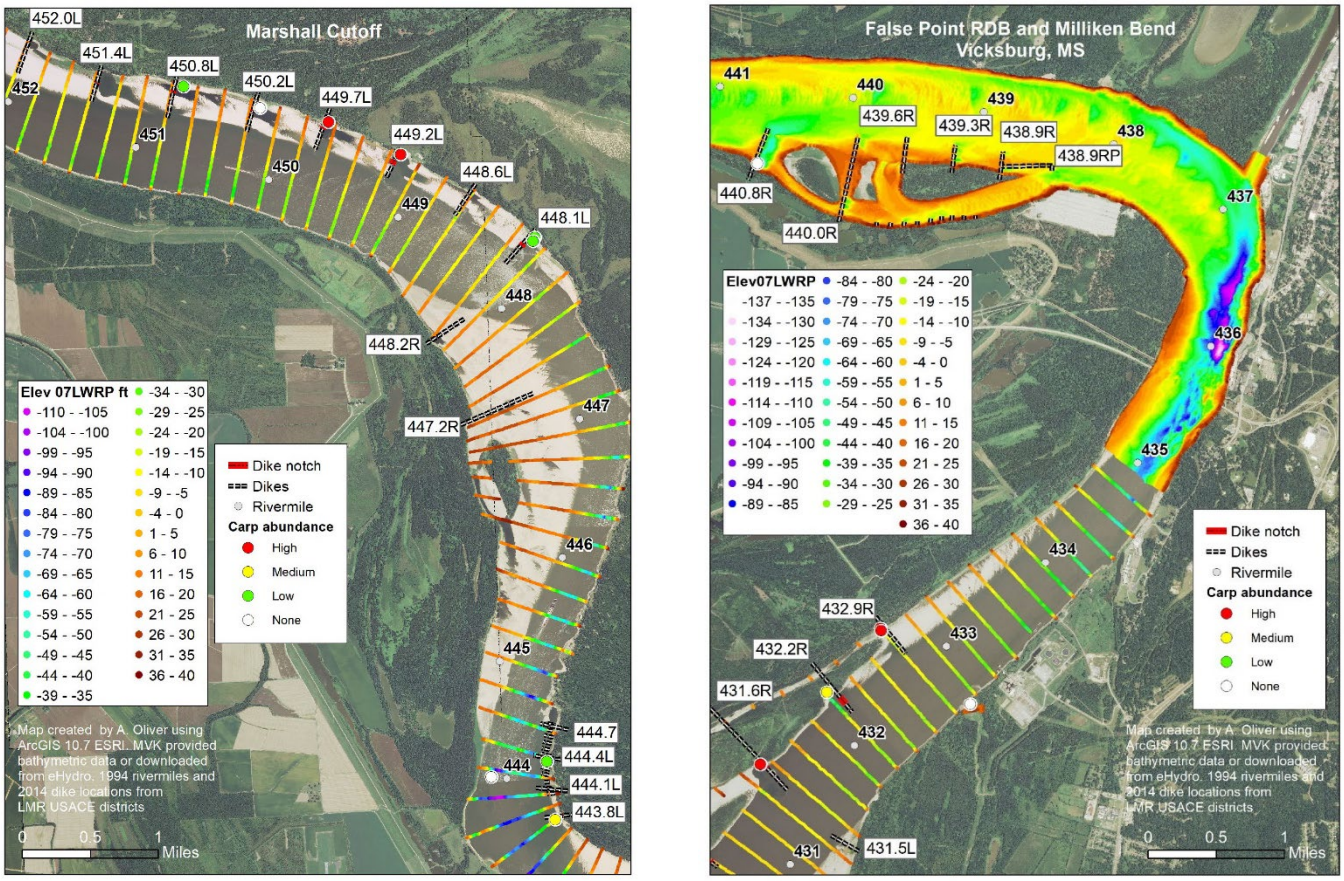

Figure 2. Example maps used to evaluate survey locations based on deep water habitat and presence of dikes (left panel), designation of Carp abundance after survey was completed, and a comparison of mapping bathymetry using single-beam (right panel, bottom half) and multi-beam (right panel, top half) survey data. Bathymetric maps of the entire study reach are available upon request.

Figure 3. Images of Carp displayed on the Hummingbird screen. The relative abundance of Carp would be rated as “high” for these three images.

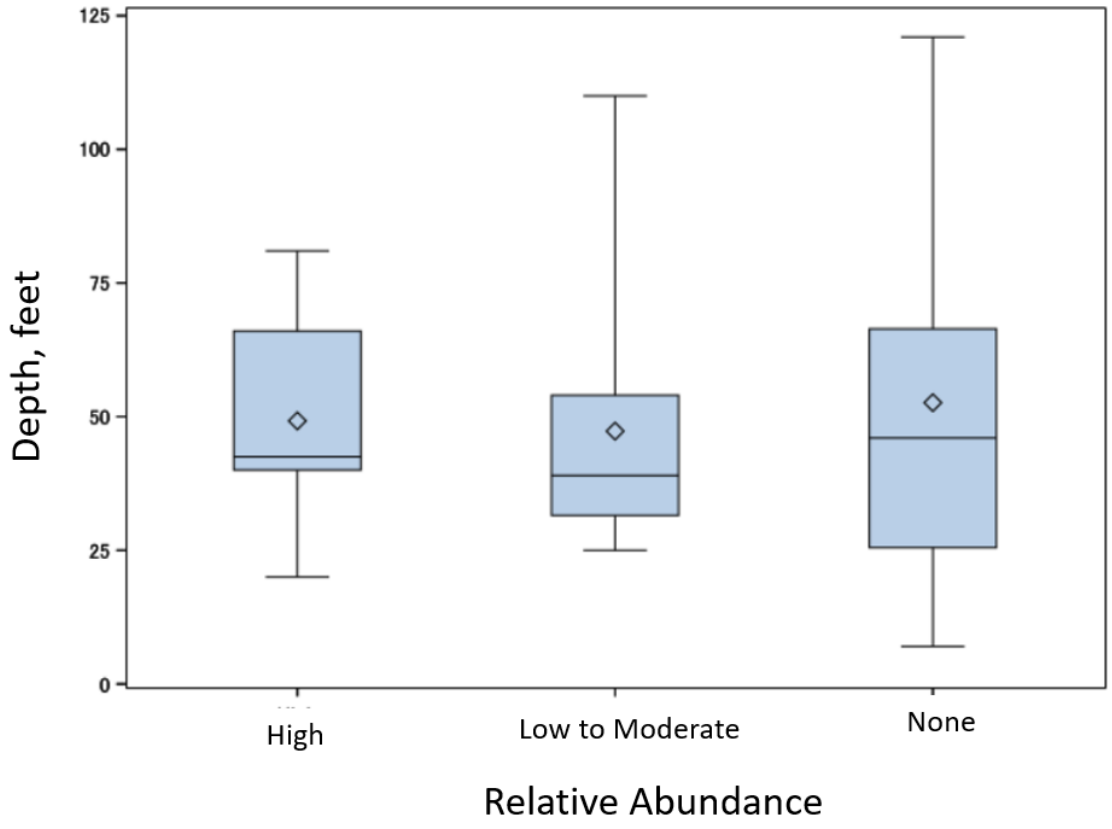

Figure 4. Box and Whisker plot of mean (symbol), mode (line) interquartile range between the 25th and 75th percentiles (shaded box) and the minimum-maximum value (whiskers). Mean depths were not statistically different among Carp abundance classes.

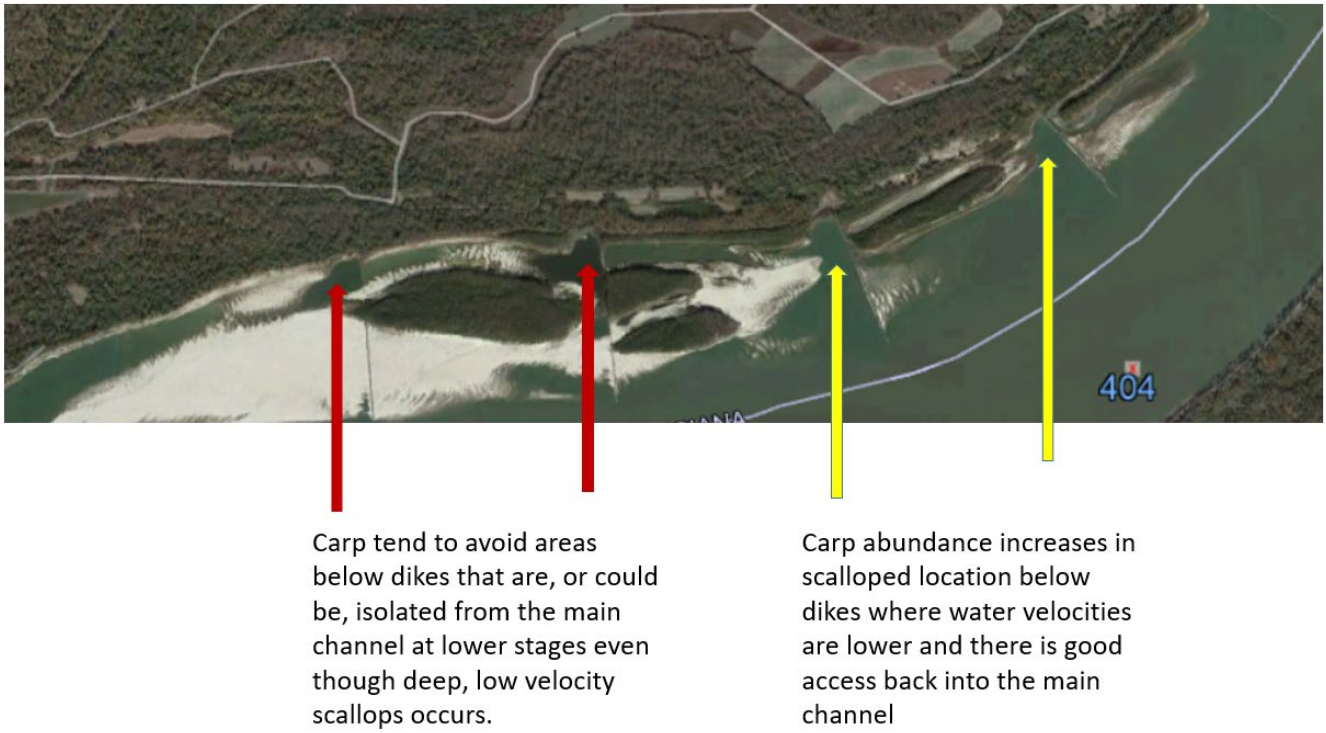

Figure 5. Google Earth image comparing differences in scallops with and without access to the main channel during lower river stages. Carp may avoid areas that become isolated as river stages decline.