

## **FY19 Annual Progress Report**

**Project Title:** Evaluation of fish passage for assessment of bigheaded carp deterrents at locks in the Upper Mississippi River

*Agency: U.S. Geological Survey*

### **Project Highlights:**

- We observed 23 bigheaded carps that were originally tagged upstream of LD 19 and then detected downstream in Pool 20 during 2019. Six of these bigheaded carp were then again detected above LD 19 during 2019. From 2017-2019, 19 bigheaded carp originally tagged in the Intensive Management Zone (IMZ; LD 15 to LD 19) were later detected downstream in Pool 20 and then later detected upstream of LD 19.
- In May 2019, 72 bigheaded carps were collected from Pools 18 and 19, then were implanted with transmitters and released downstream of LD 19. Twenty-six of the translocated carps were detected in the lock approach, and 13 were detected upstream of LD 19 in Pool 19 (i.e., 18% of the translocated carps).
- Depth sensitive transmitters (N = 25) were deployed in bigheaded carp during 2019. Half of the depth tags were deployed in bigheaded carps collected in Pool 20, and half were implanted in bigheaded carps that were collected upstream of LD 19 and translocated to Pool 20. Three translocated fish that were tagged with depth sensors were detected in the downstream lock approach, then detected in the lock chamber, then detected upstream of LD 19. The depth sensor transmitters are providing information on the position of bigheaded carps in the water column when inside the lock approach and lock chamber.

### **Methods:**

USGS maintained two telemetry receiver arrays at LD 19 and LD 15. Six receivers were deployed in the downstream lock approach at LD 19 (Figure 1). Three additional receivers were deployed in the lock chamber and one additional receiver was deployed above the upper lock gates at LD 19 to enhance vertical positioning in the lock chamber and to supplement the existing receivers maintained by Missouri Department of Conservation. The telemetry array at LD 15 consisted of 15 receivers dispersed in the area encompassing the approaches to both lock chambers as well as the area upstream of the lock chambers (Figure 2). These receivers were used to monitor the movement of fishes tagged within the IMZ as well as fishes tagged in Pool 20.

The USGS portion of the research was funded by the U.S. Geological Survey Ecosystems Mission Area Invasive Species Program. This annual progress report is distributed solely for purposes of reporting project progress. Because the annual progress report does not represent an official publication by the U.S. Geological Survey (USGS), it does not represent any official USGS finding or policy. Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

A translocation effort occurred in spring 2019, during which 72 silver and bighead carps were captured in Pools 18 and 19 and translocated, tagged, and released downstream into Pool 20.

Lock Queue Reports were obtained from the U.S. Army Corps of Engineers Lock Performance Management System to evaluate the relation between fish passage and operation of the lock for river vessels. Fish residency and presence within the lock approach at LD 19 was evaluated against environmental variables and lock operation using generalized linear mixed-effects models and generalized linear models implemented in R.

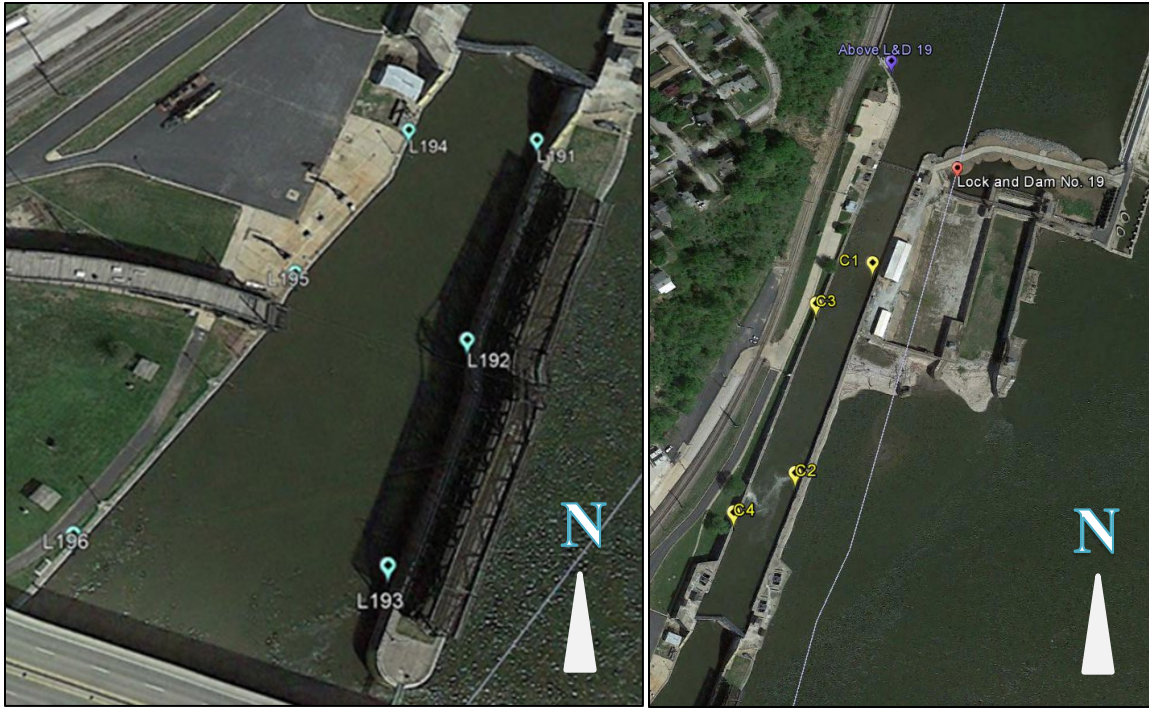
### **Results:**

From 2017-2018, USGS and partners documented a total of 14 instances when bigheaded carps were detected in the downstream lock approach, then detected in the lock chamber, then detected upstream of LD 19 in Pool 19. Thirteen of these events involved bigheaded carps that were originally tagged in the IMZ and one event involved a bigheaded carp originally tagged in Pool 20. During 2019, 6 additional bigheaded carp (that were originally tagged in the IMZ) were detected in the downstream lock approach, then detected in the lock chamber, then detected upstream of LD 19 in Pool 19.

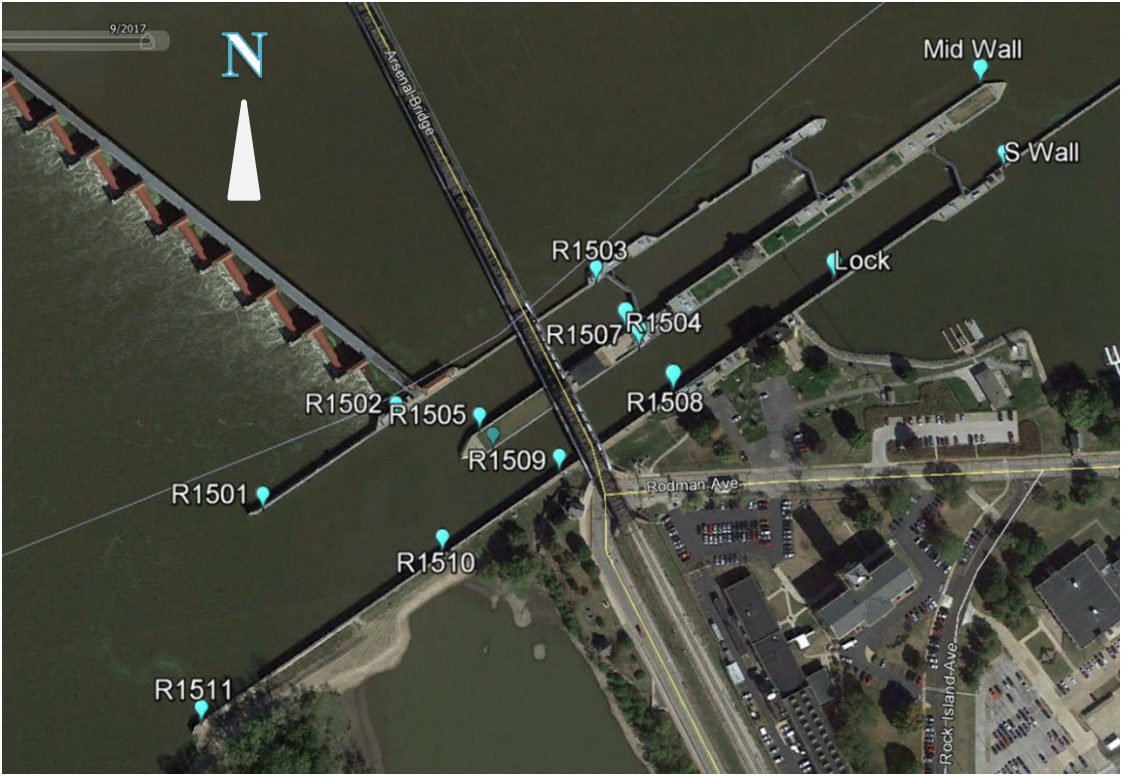
In 2019, USGS and partners documented a total of 13 instances when translocated bigheaded carps were detected in the downstream lock approach, then detected in the lock chamber, then detected upstream of LD 19 in Pool 19.

Depth sensitive transmitters ( $n = 25$  total) were deployed in bigheaded carps during spring 2019. Data from these tags provided information about the fishes' position within the water column and how fishes interact and respond to river vessel presence in the downstream lock approach and the lock chamber. Depth tags were split between bigheaded carps that originated from P19 (translocated fish;  $n = 12$ ) and Pool 20 ( $n = 13$ ). Depth sensor tags are providing information about where bigheaded carps reside within the water column (Figure 3).

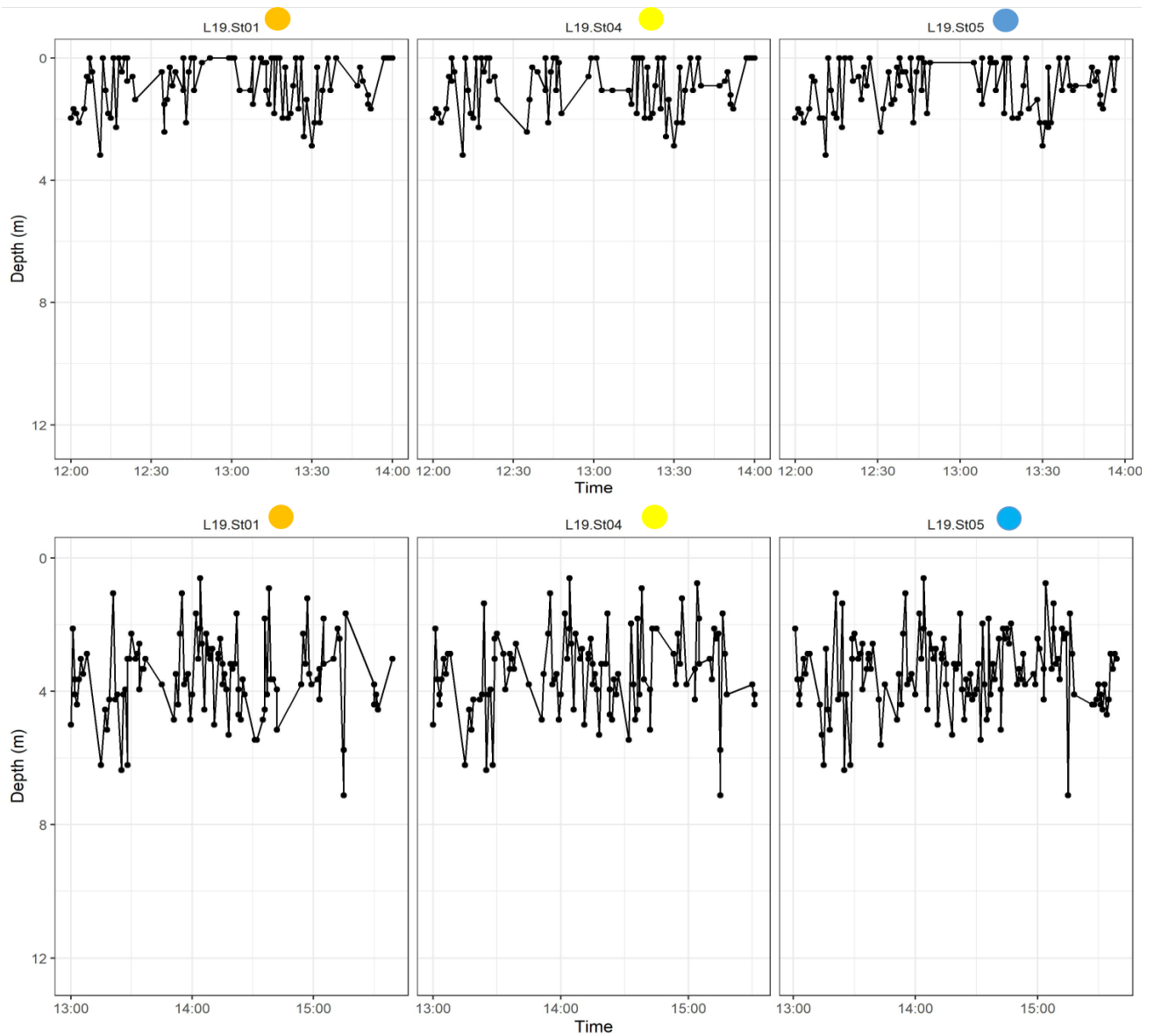
Presentations of LD 19 data were provided at the International Conference on Aquatic Invasive Species, National Conference of the American Fisheries Society, and the Mississippi River Research Consortium. Analysis of data from 2017-2018 to determine how environmental conditions and lock operations affect native species and Asian carp movement and behavior at LD 19 has been completed and a peer-reviewed manuscript with those results is currently in review at the journal *Biological Invasions*. Analysis of depth sensor tags and an evaluation of differences in behavior of Asian carps that originated from the UMR IMZ relative to Asian carps collected from Pool 20 is currently being conducted and an associated manuscript will be submitted to a peer reviewed journal in 2020.



**Figure 1.** Location of receivers completing the array in the lock approach at Lock 19. Receivers noted in blue are located in the downstream lock approach, receivers in yellow are located inside the lock chamber, and the receiver in purple is located in the upstream lock approach.



**Figure 2.** Location of receivers completing the array in the lock approach at Lock 15.



**Figure 3.** Depth profiles for a silver carp (top) and bighead carp (bottom) that were detected in the downstream lock approach, then detected in the lock chamber, then detected upstream of LD 19 in Pool 19. The three panels are the simultaneous depth readings from three receivers in the downstream approach (i.e., Station 1, 4, 5; colored dots correspond to location of receivers on the image to the right). These profiles report fish depth in the downstream approach for 2 hours prior to being detected in the lock chamber and later detected upstream of LD 19. The plots also depict the simultaneous performance of the depth tags among the three different receivers.

