Geographic Location:
The US Fish and Wildlife Service (USFWS) telemetry receiver array spans from Pool 5a downstream to Pool 20 on the Upper Mississippi River.

Participating Agencies:
Minnesota Department of Natural Resources (MNDNR)
Missouri Department of Conservation (MDC)
Southern Illinois University (SIU)
U.S. Army Corps of Engineers (USACE)
U.S. Coast Guard (USCG)
U.S. Geological Survey – Upper Midwest Environmental Sciences Center (USGS)
Western Illinois University (WIU)
Illinois Natural History Survey (INHS)

Point of Contact:
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Statement of Need:
Populations of Silver Carp (*Hypophthalmichthys molitrix*) and Bighead Carp (*H. nobilis*) as well as hybrids (*H. molitrix x nobilis*) between these species, are advancing in the Upper Mississippi River (UMR) basin (Conover et al. 2007; Chapman and Hoff 2011; O'Connell et al. 2011). Three zones of relative abundance of Asian carp have been identified in the UMR; a robust core population (established) below L&D 19, a transitional zone of moderately dense populations with potential reproduction from L&D19 to L&D 15, and a zone where individual captures of some adults have been recorded above L&D15 (USFWS 2016).

Project Description

Telemetry operations span all three management zones to help understand movement and habitat use within and among pools across these zones. It is maintained by a multi-agency cooperative with broad interests concerning the management and spatial ecology of Asian carp and native species whose habitats overlap with Asian carp. Telemetry programs serve two projects described in the *2019 Monitoring and Response Plan for Asian Carp in the Mississippi River Basin*: Evaluation of controls, impacts and behaviors of Asian carp in the lower UMR and Evaluation of fish passage for assessment of Asian Carp deterrents at multiple locks in the Upper Mississippi River. Personnel from USFWS manage the extended longitudinal array and real-time receivers in support of the Evaluations of Controls project. Personnel from USGS manage concentrated telemetry arrays near Locks and Dams 15 and 19 in support of the Evaluation of fish passage project. A project summary for FY 19 Evaluation of fish passage is included in a separate USGS report.

Project Objectives:
1) Utilize real-time and passive receivers to understand Asian carp movement patterns and identify environmental variables that influence those patterns.

2) Increase efficiency of removal efforts by locating congregations of Asian carp and sharing information with removal teams in a timely manner.

Project Highlights:

- To date, the partnership has tagged over 500 Bighead, Silver, and Hybrid Carp; 311 transmitters deployed by USFWS and USGS crews were active the entire year in 2019.
- Two new real-time receivers were installed on backwater lakes near Credit Island (Pool 16) and inside Coolegar Slough (Pool 17). These receivers, along with the two existing real-time receivers in Boston Bay (Pool 18) and Cleveland Slough (Pool 17), have helped inform removal efforts by providing daily information on Asian carp occupancy. Over 126,000 pounds of Asian carp were removed from the four locations during 2019.

Methods:

Acoustic Transmitter Tagging: The USFWS did not tag any additional Asian carp during 2019. Personnel from La Crosse FWCO assisted with operations for the USGS-lead effort to tag and translocate Asian carp below Lock and Dam 19 during June 2019.

Acoustic Receiver Array: Staff from the La Crosse FWCO have maintained an array of stationary receivers (Vemco Model VR2W and VR2-Tx) in the UMR since 2013. In 2019, the USFWS deployed 57 stationary receivers, providing coverage from Pool 5a down to Pool 20. The overall number of receivers deployed in the array was reduced from previous years because of efforts to control USFWS expenditures for array maintenance. The array was condensed into a series of gates where 2-3 receivers were bunched to form an area of detection that spanned the width of the river. Two to three receiver gates were installed in Pools 13 to 19 to better determine movements and distribution in this reach at the leading edge of the population where removal efforts for Asian carp are focused (Figure 1). Single gates or single receivers were deployed in narrow reaches in Pools 5a-11. Receivers were also deployed in several tributaries, including the Wisconsin (Pool 10), Maquoketa (Pool 13), Waupsipinicon (Pool 14), Iowa (Pool 18), and Cedar (Pool 18) Rivers to monitor movements in and out of tributaries. The deployment of the full array was delayed by the extended flooding in the UMR during spring/summer 2019. Crews were able to deploy a small number of receivers in tributaries during April, but installation of receivers on the mainstem UMR were delayed until June and July. When deployed, the USFWS telemetry array bridged a gap between the Minnesota Department of Natural Resources array (Pool 1 to Pool 5) and the Missouri Department of Conservation array (Pool 19 to Caruthersville, MO) resulting in combined telemetry coverage of nearly 1,000 river miles. Data from stationary receivers were downloaded monthly or seasonally. These data provide information on gross movements, movement patterns, possible spawning events, and habitat use; and in turn, inform removal and potential deterrent placement.

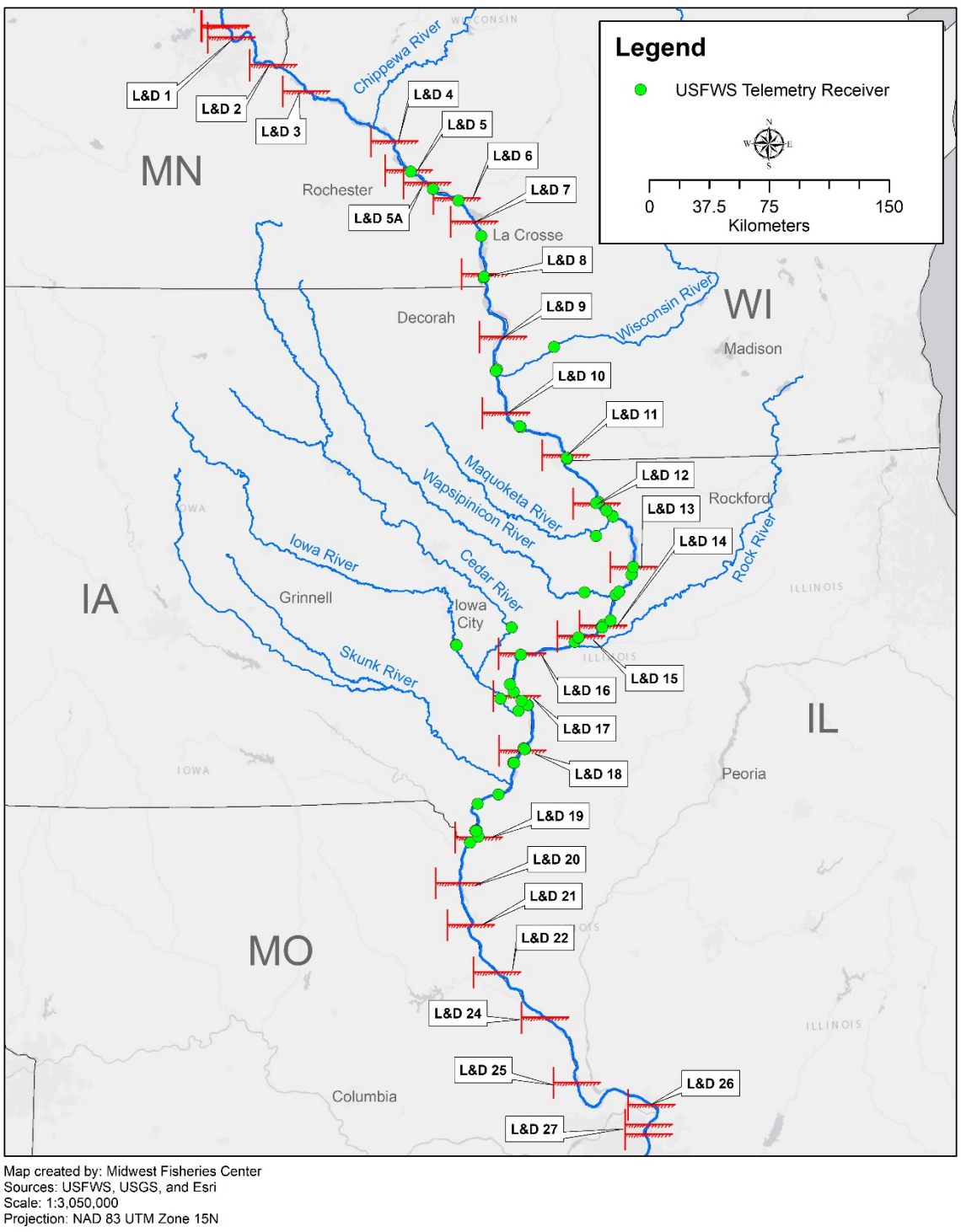

Figure 1. *Locations of stationary receivers deployed by the USFWS/USGS (Green) in the Mississippi river basin during 2019 deployed on navigation buoys or on the bottom of the river.*

Real Time Receivers: Two new real-time receivers were constructed and deployed on Pools 16 (Credit Island) and 17 (Coolegar Slough). These receivers and two others deployed in 2018 at other locations in Pools 17 and 18 were deployed in direct support of contract removal programs being conducted on the UMR. They were built according to specifications matching those of real-time receivers previously deployed on the Illinois Waterway. The real-time receiver is comprised of a Vemco Model VR2C receiver combined with a Campbell Scientific datalogger and cellular router mounted on a floating platform. Power was supplied to the electrical components via solar panels mounted on the float. The two receivers were deployed in these four UMR backwaters because previous data collected from both stationary receivers and manual tracking indicated that Asian carp used these locations frequently throughout the spring and summer and contracted commercial fishers routinely fish in these backwaters during removal efforts.

Results:

Acoustic Receiver Array: During 2019, nearly 800,000 detections were recorded on stationary receivers. Of note, one male Silver Carp originally tagged in Pool 17 during April 2017 made an upstream migration apparently ending in Pool 4 on 12 June 2019. The individual went downstream and was later detected in the Wisconsin River during early August. It was last detected in Pool 11 during late August 2019. The USFWS was also able to share data collected by our telemetry array to advance research by our partners. Five paddlefish tagged by collaborators at Western Illinois University were detected and appear to have made similar lengthy migrations to Pool 4 and the Wisconsin River during the same time period as the Silver Carp.

Real-time Receivers: The two real-time receivers constructed during 2018 were deployed in Boston Bay and Cleveland Slough during April 2019. The new platforms were deployed at Credit Island and in Coolegar Slough during June. All four real-time units performed well until they were removed during early November 2019. Data on Asian carp occupancy in those backwater lakes was transmitted to program mangers via text messages or emails each morning. That information was used to guide contract fishers to more productive fishing sites. A total of 18,543 pounds of Asian carp were removed backwaters with real-time receivers during 2019.

Discussion:

The maintenance of the longitudinal array of passive receivers continues to provide useful information about the dispersal patterns of Silver and Bighead Carp in the UMR. The longitudinal array, combined with limited manual tracking events during previous years, have helped biologists identify a selection of backwaters where Asian carp congregate and can be targeted by removal efforts. Additionally, the extent of the array has allowed managers to understand the timing and distance of semi-annual migration patterns. Collaborators at USGS are currently working to construct highly sophisticated models using USFWS telemetry data to develop estimates of yearly and monthly pool-to-pool transition rates of Silver and Bighead Carp in the UMR. The results of these models will provide a key parameter used in spatially-explicit

population models designed to assess and predict the effects of management strategies, such as contract removals, on Asian carp.

The installation of real-time receivers in four primary Asian carp congregation areas during 2018 and 2019 furthered the capacity of the telemetry program to inform removal efforts by providing daily information on Asian carp occupancy. Patterns of fish occupancy in these backwaters guides daily scheduling to make removal crews more efficient in their work. Knowing the timing of Asian carp usage of these areas on a daily schedule would likely result in increased removal of Asian carp while reducing the probability that crews fish in unproductive locations. These "hot spots" can get "cold" (and vice versa) and this transition from productive to unproductive can be quick and not completely predictable. These hot spots are often a long distance apart in the management zone. Travelling to one unproductive fishing location can cost a day's effort because relocating to an alternative fishing location becomes temporally infeasible. Real-time text communication from the receivers eliminates the loss of time and effort fishing in unproductive locations.

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