Project Title: Early detection and monitoring of Invasive Carp in the Missouri River Basin

This is a merged Technical Report for three previous FY24 Missouri River Basin Workgroup proposals and work plans:

- Control and Containment of Invasive Carp in the Missouri River Basin
- Define the spatial distribution and population demographics of invasive carp populations and the associated fish community in the Missouri River Basin
- Invasive Carp movement and habitat use in the Missouri River Basin to inform containment and control management actions

Lead Author, Agency, and Contact Information:

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Participating Agencies:

- **Iowa:**
  - Iowa Department of Natural Resources (IA DNR)
  - Iowa State University (ISU)
- **Missouri**
  - Missouri Department of Conservation (MDC)
- **Nebraska**
  - Nebraska Game and Parks Commission (NGPC)
  - University of Nebraska-Lincoln (UNL)
- **South Dakota**
  - South Dakota Department of Game, Fish and Parks (SDGFP)
  - South Dakota State University (SDSU)
- **U.S. Fish and Wildlife Service**
  - Columbia Fish and Wildlife Conservation Office (USFWS-CFWCO)
  - Great Plains Fish & Wildlife Conservation Office (USFWS-GPFWCO)

Location of Activities:

The study area includes the mainstem Missouri River from Gavins Point Dam (rkm 1,305.2) to the confluence with the Mississippi River (rkm 0.0) as well as several mainstem Missouri River tributaries, periphery streams, and floodplain lakes within the states of the Missouri River Basin. The study area includes the lowermost mainstem dam (i.e., Gavins Point Dam) and approximately 1,305.2 rkm of open river. Silver, Bighead, and Grass Carp are abundant in the mainstem Missouri River downstream of Gavins Point, also known as the lower Missouri River.

- Gavins Point Dam is the lowermost dam on the mainstem Missouri River and is approximately 23 feet high with no lock structures, which is a physical barrier to fish movement. Gavins Point Dam impounds Lewis and Clark Lake with a rolled earth embankment, hydroelectric powerhouse, and concrete spillway.

- The Lower Missouri River includes the mainstem Missouri River downstream of Gavins Point Dam to the confluence with the Mississippi River.

- Mainstem Missouri River tributaries and periphery streams with direct connection to the Missouri River and floodplain lakes

Statement of Need:
Effective management and containment of invasive carp in the Missouri River Basin require an integrated, science-based strategy that combines movement ecology, population assessment, early detection, and coordinated removal efforts. In alignment with the National Invasive Carp Management and Control Plan (Conover et al. 2007) and Missouri River Basin management frameworks, this effort supports goals related to containment, control, population demographics, and movement invasive carp populations.

Invasive carp—including Silver Carp (*Hypophthalmichthys molitrix*), Bighead Carp (*Hypophthalmichthys nobilis*), Black Carp (*Mylopharyngodon piceus*), and Grass Carp—are well established throughout the Missouri River and its tributaries downstream of Gavins Point Dam and have demonstrated the capacity for large-scale migratory movements among connected river systems. These movements facilitate expansion into tributaries and inland waters of high ecological, recreational, and economic value. Documented spread into upstream systems, including incursions into the Iowa Great Lakes watershed and captures near the Minnesota border via the Little Sioux and James rivers, highlights the urgency of understanding dispersal pathways, barrier effectiveness, and environmental conditions that facilitate range expansion. Tributaries such as the Platte River—Nebraska's largest river system—pose particular concern because they provide connectivity to inland waters without major mainstem impoundments to block fish movement.

Preventing further expansion depends on identifying when and under what environmental conditions adult carp move into tributaries, how they congregate near deterrent barriers, and how they use habitats throughout their life cycle. Understanding movement patterns among the Missouri River and its tributaries will clarify source-sink dynamics, recruitment pathways, and reinvasion risks following control actions. This knowledge is essential for strategically locating deterrent technologies, physical barriers, and concentrated removal efforts to limit dispersal, reproduction, and recruitment. Information on movements before, during, and after management actions will improve both implementation precision and interpretation of outcomes.

At the same time, effective control requires robust estimates of abundance, spatial distribution, and demographic characteristics—including age structure, maturity schedules, and fecundity—across the basin. Early detection sampling is critical for identifying new introductions and documenting spread, allowing rapid response to emerging populations. Monitoring over multiple years provides empirical data to track population trends, compare systems, evaluate management effectiveness, and detect impacts on native fish communities. Particular gaps remain in understanding juvenile life stages, nursery habitats, and recruitment dynamics, which are central to long-term suppression and potential extirpation strategies.

To address these needs, basin partners must employ and refine advanced technologies that improve the accuracy and efficiency of detection and assessment. Tools such as environmental DNA (eDNA), hydroacoustics, and otolith microchemistry offer opportunities to define distribution, estimate abundance, determine natal origin, and reconstruct life-history movements across large spatial scales. Establishing water chemistry baselines and applying trace-element and isotope analyses (e.g., Ba, Sr, Ca, and oxygen isotopes) in otoliths can identify spawning and recruitment sources, informing targeted management actions. Coordinated implementation of these tools across jurisdictions will require sustained collaboration among the U.S. Fish and Wildlife Service, state agencies, universities, and other partners.

In addition to research and monitoring, biomass removal remains a critical component of control. Agency-led removals in tributaries such as the Grand and Kansas rivers have provided valuable operational insights, but commercial harvest capacity within much of the Missouri River Basin remains limited. Expanding and incentivizing commercial harvest, particularly in areas not traditionally open to commercial fishing, may increase economic viability, broaden participation, reduce pressure on agency resources, and enhance large-scale removal effectiveness. Concurrently collecting biological and community data during removal efforts will strengthen adaptive management and guide future strategies.

Collectively, these actions represent the continued development of a comprehensive invasive carp monitoring and management framework for the Missouri River Basin. By integrating movement ecology, demographic assessment, early detection, emerging technologies, and coordinated removal, managers will be better equipped to contain existing populations, prevent further spread into high-value tributaries and inland waters, evaluate management effectiveness, and protect native ecosystems and regional economies over the long term.

Project Objectives:

Control and Containment Workgroup:

Objective #4: Determine the size distribution, relative abundance, and other population characteristics of invasive carp populations in the lower Missouri River and associated tributaries between river kilometers 322 and 885 to help identify areas where population control measures can be implemented and evaluate previous removal efforts.

Define Populations Workgroup:

Objective #1: Characterize spatial (tributaries longitudinally distributed in the Lower Missouri River) and temporal (seasonal and annual) patterns in the Silver and Bighead Carp population demographics (e.g., size structure, relative abundance, recruitment) while developing standard operating procedures that are specific for the lower Missouri River Basin to prescribe and assess population control measures (Agencies involved: NGPC, SDGFP, USFWS).

- Sub-Objective 1: Evaluate a suite of gears and sampling logistics to determine an effective and efficient method to sample all sizes of Silver and Bighead Carp in a variety of aquatic systems.
- Sub-Objective 2: Determine the size distribution, relative abundance, and other population characteristics of the Silver and Bighead Carp populations in various aquatic systems to help identify areas where population control measures can be implemented.
- Sub-Objective 3: Increase understanding of invasive carp reproductive ecology in the Platte River basin to inform knowledge gaps from prior studies.

Movement and Habitat Use Workgroup:

Objective #1: Determine Silver Carp and Bighead Carp residence time and movement in the Missouri River and its tributaries in association with season, environmental conditions, and barriers to inform containment and control management actions.

- Sub-Objective 1: Determine if Silver Carp and Bighead Carp have extended presence in tributaries and directional movement into and out of Missouri River tributaries.
- Sub-Objective 2: Evaluate environmental factors (e.g., season, temperature, discharge) for Silver Carp and Bighead Carp movements in select Missouri River tributaries.
- Sub-Objective 3: Assess fish behaviors in association with an electric barrier at the outflow of the Iowa Great Lakes, a concrete spillway at Creve Coeur Lake, and dams on the Kansas River (WaterOne Dam and Bowersock Dam), particularly how fish approach, challenge, and pass the barriers.
- Sub-Objective 4: Evaluate seasonal congregations of Silver Carp and Bighead Carp in Missouri River tributaries, particularly as they relate to fish barriers.

Project Highlights:

Missouri Department of Conservation (Control and Containment Project):

- Boat electrofishing was conducted at 70 random runs in three tributaries including 20 runs each in the Lamine and Platte Rivers and 30 runs in the Grand River. An additional 30 random electrofishing runs were conducted on the mainstem Missouri River with 10 runs conducted at Delaware Bend, Grand River Bend and Booneville Bends.
- Mini-fyke nets (N = 50) were set in three tributaries and the mainstem Missouri River to help identify and quantify annual spawning success of invasive carp.
- Silver Carp was the most abundant invasive carp with 1,109 sampled. Four Grass Carp were also collected for a total weight of 2,450 kg (5,402 lbs.) of fish removed. No Bighead or Black Carp were sampled electrofishing.
- Silver Carp catch rates were highest at both Platte River sites (218.5 and 169.1 fish per hour).
- Size classes of Silver Carp were similar between all three tributaries with few fish below 500mm. However, Silver Carp median length at the Grand River (556mm) were significantly different ($P<0.001$) than Lamine River (594mm), Platte River (596mm) and Missouri River (595mm).
- Silver Carp sex ratios of males to females indicated fewer males in tributaries and a higher ratio of males at Missouri River sites. However, the Missouri River Bend at the Platte River (MO) captured few individuals.
- Silver Carp young of year were detected with mini-fykes in the Grand and Platte Rivers and Missouri River bend sites at the Grand and Lamine in 2025, although in low numbers.
- The previous sample year (2024) yielded higher numbers of Silver Carp and even Bighead Carp, however, size distributions and length at age data indicates limited recruitment over the last five years.

US Fish and Wildlife Service (Define Populations Project):

- In 2025, USFWS completed 203 standardized electrified dozer trawl transects across five high priority meaningful management units, which collected 878 Silver Carp.
- No young of year Silver Carp were collected in any MMU. The 2019 cohort was the prominent year class in the Missouri River RKM 0-209 MMU.

Nebraska Game and Parks Commission & University of Nebraska-Lincoln (Define Populations Project):

- Approximately 900 bigheaded carp were caught in 2025 across the lower Platte River and its tributaries.
- Peak gonadosomatic index (GSI) occurred in June for females followed by a steady decline through the end of summer into fall. Peak GSI in males occurred in April and May followed by a progressive decline through October.
- Male and female GSI values followed similar trends by locality, with higher GSI occurring in populations further from the Platte-Missouri confluence. Potentially indicative of density-dependent constraints on body condition and reproductive readiness.

- Preliminary histological analysis shows females in this population to be batch spawners and spawning capable throughout the summer.

South Dakota Game, Fish, and Parks & South Dakota State University (Define Populations Project):

- Partners have contributed 636 otoliths from across the Missouri River Basin for isotope analysis to identify invasive carp source populations that could be targeted for management.
- Water chemistry results indicate high potential to be able to differentiate where invasive carp reproduced within the Missouri River Basin.

Iowa Department of Natural Resources & Iowa State University (Movement and Habitat Project):

- Sub-Objective 1: Preliminary results indicate a large proportion of Silver Carp exhibit highly sedentary behavior (47.9% <25 rkm) while a smaller number of individuals exhibit large total displacement ranges (33.3% >100 rkm). Using movement tendencies, we were able to identify 10 management units for Silver Carp in the Missouri River.
- Sub-Objective 2: Preliminary results suggest only a small percentage of Silver Carp used backwater habitat (16.2%) but those that did had prolonged residency periods (mean = 45.8 days). Tributary use was moderate (36.7%) but was mainly confined to confluence areas. Only 9.6% of Silver Carp were detected beyond 10 rkm upstream in a tributary.
- Sub-Objective 3: No acoustically tagged Silver or Bighead Carp have passed the electric barrier at the Iowa Great Lakes outflow from May 2022 through October 2025.
- Sub-Objective 4: Preliminary results show Sill 4 is likely a velocity barrier to the upstream movements of invasive carp and native fishes during high flow with only 2 Silver Carp, 1 Grass Carp, and 1 Bigmouth Buffalo. Barrier presence at Sill 4 appears to be driven by seasonal cues for Silver Carp and Native fishes that differ across species. Silver tend to congregate near Sill 4 later in the summer whereas native fishes are generally present in spring and early summer.

South Dakota Game, Fish, and Parks & South Dakota State University (Movement and Habitat Project):

- Mean weekly temperature and mean discharge were significant factors on weekly displacement of Silver Carp.
- Continued tagging of invasive carp reveals spatial connections among populations/subpopulations even as movements may change with management actions.

US Fish and Wildlife Service (Movement and Habitat Project):

- Tagging efforts were successful in 2025. Thirty-eight fish were captured and tagged in both the Vermillion and Big Sioux Rivers (76 total tags).
- Forty-two of the seventy-six fish tagged in 2025 were detected at least once in the April-June time period.
- Receivers were deployed early in the season (March/April) and secure locations were identified.
- Data is extremely limited for the 2025 sampling season due to limited staff availability during the lapse in Federal funding that occurred in October and November 2025.

Nebraska Game and Parks Commission & University of Nebraska-Lincoln (Movement and Habitat Project):

- 72 Silver Carp, 16 Blue Sucker, 11 Smallmouth Buffalo, and 1 Bigmouth Buffalo were implanted with transmitters in mid-late May 2025.
- 4,240 daily unique detections were captured from 88 different transmitters in 2025.
- Silver Carp exhibited comparable average cumulative movement and linear home ranges to catostomid species despite a few individuals moving much greater distances.

State Report: Missouri

Agency: Missouri Department of Conservation

Project Title: Determine the size distribution, relative abundance, and other population characteristics of invasive carp populations in the lower Missouri River and associated tributaries between river kilometers 322 and 885 to help identify areas where population control measures can be implemented and evaluate previous removal efforts.

Note: Originally submitted under the Control and Containment Work Group

Methods:
Sampling for invasive carp took place from August to September. The lower 40 rkm of the three tributaries were separated into 10 rkm sampling units, although only the lower 20 rkm or less has been accessible during sampling the last five years. For sampling in the Missouri River, the Missouri River bend at the mouth of each tributary was used as the sampling unit. Additional electrofishing runs were conducted in October to evaluate carp removals on the Platte and Lamine River.

One electrofishing setting, 60Hz and 40% duty cycle with volts based on a standard power goal table from conductivity readings at each site for invasive carp electrofishing runs in sample year 2025. This setting was selected based on former years comparing different settings. A target of 10 runs per site was used for sampling. Each run was 5 minutes in length and involved a serpentine pattern going upstream in tributaries and downstream in the mainstem Missouri River. Boat drivers would swing out to the deeper side of the channel and then push any fish into the shallow side similar to methods described in Bouska et al. 2017. This pattern would be repeated until the time limit was reached. Each boat consisted of an MLES Infinity box with 7000w generator, double hoops, and two dip netters.

All species were measured in millimeters and weighed to the nearest gram. For invasive carp, sex was recorded if determination was possible. Habitat descriptors (i.e., pool, run, thalweg) were recorded for each run along with water temperature, and depth. Lapilli otoliths were collected from the first 100 individuals per tributary with no more than 20 structures collected from one run and retained for aging. Following the first 100 individuals, structures were collected on individuals unrepresented or underrepresented for each tributary and associated Missouri River bend. Whole lapilli otoliths were cut in half at the nucleus using an Isomet saw, sanded and polished until the focus and all annuli were visible. Otoliths were read by two independent readers with aging experience and then ages compared, and agreement reached.

Mini-fyke nets were set in tributary and Missouri River bend sites to collect invasive carp young of year to estimate the amount of spawning or reproduction on an annual basis. This was conducted from July through September with number of nets per site based on tributary wetted width and watershed drainage similar to Dunn and Paukert 2020. Three to four mini-fyke nets (3 mm mesh, 4.5 m lead, 1.2 m wide x 0.6 m tall frame) were set per tributary site. Eight mini-fyke nets were set in each Missouri River bend.

Catch per unit effort was calculated as number of fish per minute and extrapolated to fish per hour for electrofishing runs. Silver Carp catch rates and length groups were tested for normality ($P<0.05$). If treatment groups passed the normality test, a one-way analysis of variance (ANOVA) was conducted and multiple pairwise comparisons were made using the Holm-Sidak method. When treatment groups failed normality test, analysis used a Kruskal-Wallis one way analysis of variance on ranks and when a significant difference in treatment groups was detected further analysis and multiple pairwise comparisons were made using Dunn's method. Analysis was conducted using SigmaPlot 14.5 by SYSTAT.

Results & Discussion:

Lamine River – Invasive Carp Sampling

Invasive carp sampling for Lamine River sites was conducted the second and third week of August in 2025. A total of 30 electrofishing runs (10 - Missouri river bend, 10 - Lamine site 1, and 10 - Lamine site 2) and 2.54 gear hours of electrofishing resulted in 186 Silver Carp collected. All electrofishing runs including non-random runs, resulted in 331 Silver Carp and 761 kg (1,678 lbs.) of fish removed from the Lamine River. One Grass Carp was also sampled in the Missouri River Bend at the Lamine during standard sampling. Silver Carp catch rates were not significantly different between sites ($P=0.776$) (Figure 1). Silver Carp catch rates in the Lamine decreased in 2025 and median values were significantly ($P<0.001$) lower than 2021 (Figure 2). Catch rates at the Missouri River Bend (Booneville Bends) were similar the last three years.

Silver Carp lengths ranged from 525mm – 704mm at Lamine River sites with a mean length of 592mm (Figure 3). Silver Carp lengths at the Missouri River Bend at the Lamine (Booneville Bends) ranged from 496mm to 765mm with a mean length of 596mm. Median length of Silver Carp in the Lamine (594mm) were significantly higher ($P<0.001$) than the Grand River (556mm) (Figure 4).

Otoliths were collected from 61 Silver Carp sampled in Lamine River sites and 52 from the Missouri river bend outside of the Lamine River. Length at age data indicated the majority of Silver Carp sampled in the Lamine were from age-5 to age-7 with no fish collected under age-5 (Figure 5). Silver Carp mean lengths at age ranged from 557mm at age-5 to 798mm at age-11. Additional otoliths were taken from one Grass Carp in the Missouri River bend at age-6 and measured 748mm in length. Sex ratios (Male: Female) for Silver Carp sampled in the Missouri river bend was 1.4 : 1 while Lamine River sites were 0.7 : 1.

Lamine River – Mini-fyke Nets

Sixteen mini-fyke sets were conducted for all Lamine River sites in 2025. Sampling resulted in a total of 459 fish (Missouri River = 398, Lamine site 1 = 35, Lamine site 2 = 26). Twelve species were sampled at the Lamine River sites (Lamine site 1 = 8, Lamine site 2 = 9) while 25 species were sampled at the associated Missouri river bend. Silver Carp young of year (N = 28) were collected in the Missouri River bend at the Lamine (Table 2) with a mean length of 22mm during the third week in July.

Grand River – Invasive Carp Sampling

Invasive carp sampling for Grand River sites was conducted the last two weeks of August and the first week of September in 2025. Forty electrofishing runs (10 in the Missouri River bend, 10 Grand River site 1, 10 in Grand River site 2 and 10 in Grand River site 3) and 3.44 electrofishing gear hours resulted in 272 Silver carp and 546 kg (1,203 lbs.) of fish removed from the Grand River. Silver Carp catch per unit effort was significantly higher ($P<0.05$) at Grand River Site 02 (86.0 fish per hour) and the Missouri River Bend at Grand River (89.5 fish per hour) than Grand River Site 03 (31.0 fish per hour) at Bosworth (Figure 1). Silver Carp catch rates decreased in 2025 and median values were significantly lower ($P<0.05$) than 2021 and 2024 (Figure 2).

Silver Carp lengths ranged from 469mm to 801mm for Grand River sites with a mean length of 567mm (Figure 3). Silver Carp lengths at the Missouri River Bend at the Grand ranged from 502mm to 934mm with a mean length of 595mm. Median length of Silver Carp in the Grand River (556mm) were significantly lower ($P<0.001$) than the Lamine River (594mm), Platte River (596mm) and Missouri River (595mm) (Figure4).

Otoliths were collected from sixty-six Silver Carp at the Missouri river bend at the mouth of the Grand River. Sampling at the Grand River sites collected otoliths from eighty-seven Silver Carp. Length at age data indicated that the majority of Silver Carp sampled in the Grand were from age-5 to age-8 with no fish collected under age-5 (Figure 5). Silver Carp mean lengths at age ranged from 537mm at age-5 to 640mm at age-9. Sex ratios (Male: Female) for Silver Carp sampled in the Missouri river bend was 1.3 : 1 while in the Grand River sites it was 0.9 : 1.

Grand River – Mini-fyke Nets

Twenty mini-fyke nets were completed in the Grand River sites including the associated Missouri River bend. This resulted in a total of 928 fish (Missouri River bend= 614, Grand River site 1 = 87, and Grand River site 2 = 76, Grand River site 3 = 151). Thirty species were sampled in the Grand River (Site 1 = 21 and Site 2 = 11, Site 3 = 14). The Missouri River bend sampling resulted in 25 species. Eleven Silver Carp young of year were collected in the lower two Grand River sites. Mean lengths of young year Silver Carp ranged from 24 mm at Grand Site 2 to 27 mm at Site 1. The Missouri River bend at the Grand River only collected one individual Silver Carp measuring 40mm.

Platte River – Invasive Carp Sampling

Invasive carp sampling for Platte River sites was conducted the last week of August in 2025. Thirty electrofishing runs (10 in the Missouri river bend, 10 at site 1, and 10 at site 2) and 2.39 electrofishing gear hours resulted in 364 Silver Carp collected. Additional electrofishing runs resulted in 142 Silver Carp and 2 Grass Carp with a total for all sampling amounting to 1,144kg (2,521 lbs.) of fish removed from the Platte River. Silver Carp mean catch per unit effort at Platte River Site 01 (218.5 fish/hour) and Platte River Site 02 (169.1 fish/hour) was significantly higher ($P<0.001$) than the Missouri River bend site (31.5

fish/hour) (Figure 1). Silver Carp relative abundance in 2025 at Platte River increased from the previous two years but below catch rates from 2020 and 2022 (Figure 2). Silver Carp catch rates at the Missouri River bend site at the Platte River (MO) were low the last three sample years.

Silver Carp lengths ranged from 464mm to 719mm at Platte River sites with a mean length of 592mm. Silver Carp lengths at the Missouri River Bend at the Platte (Delaware Bend) ranged from 481mm to 688mm with a mean length of 591mm. Median length of Silver Carp in the Platte (596mm) were significantly higher ($P<0.001$) than the Grand River (556mm) (Figure 4).

Otoliths were collected from one hundred four Silver Carp in the Platte River sites. Forty-five otoliths were collected from Silver Carp in the Missouri River bend at the Platte River. Length at age data indicated the majority of Silver Carp sampled in the Platte were from age-5 to age-8 with no fish collected under age-5 (Figure 5). Silver Carp mean lengths at age ranged from 560mm at age-5 to 680mm at age-8. Sex ratios (Male: Female) in the Missouri river site was 2.7 : 1 and 0.9 : 1 in the Platte River sites combined.

Platte River – Mini-fyke Nets

Fourteen mini-fyke nets were completed in the Platte River sites including the associated Missouri river bend. This resulted in 437 fish sampled (Missouri river = 234, Platte River sites = 203). Twenty-one species were sampled in the Missouri river outside the Platte River. Fifteen species were sampled at the Platte River sites. Silver Carp young of year (N = 22) were collected in Platte River Sites. Mean lengths of young year Silver Carp ranged from 23 mm at Platte Site 1 to 25 mm at Site 2.

Discussion:

Silver Carp was the overwhelmingly dominant invasive carp species in all tributaries and their associated Missouri River bends. Catches of Silver Carp were variable between sites with the Platte River (MO) having the highest catch rates. The lower Platte River (MO) produces the highest Silver Carp catch rates annually from 2020 to 2025, possibly due to the lower wetted width compared to the Grand and Lamine rivers and the abundance of snags and woody debris for Silver Carp to congregate. Also, carp removals were conducted on the Grand River in 2022 and 2023, Lamine River in 2024 and not previously on the Platte until September 2025.

The Silver Carp cumulative length frequency distributions in Figure 4 display an interesting trend. Silver Carp from the Missouri River, Lamine River and Platte River indicate similar distributions but the Grand River data suggests it is composed of smaller fish compared to the others. This could imply slower growth from overabundance since it has been two years since carp removal efforts on the Grand. However, this data was collected prior to the Platte carp removal in 2025, and its distribution was similar to the Lamine and Missouri River.

Four Grass Carp were also collected in sample year 2025. Bighead Carp and Grass Carp relative abundance may be underestimated with standard boat electrofishing. This could be due to the amount of Silver Carp jumping while electrofishing, decreasing netter’s ability to catch Bighead or Grass Carp. In the case of Bighead Carp, they also might be occupying deeper areas not affected by standard electrofishing techniques.

Size distributions and length at age data of Silver Carp in 2025 provide evidence to limited recruitment over the last five years in the three tributaries and associated Missouri River bends. There were a high number of young of year Silver and Bighead carp collected in mini-fyke nets in 2024 indicating a high level of reproduction in the lower Missouri River basin. However, there was no evidence of recruitment to age-1 in 2025 sampling. This could potentially be due to the short duration of increased river levels in 2024 resulting in low survival. Silver Carp reproduction was detected in 2025 but at lower numbers compared to 2024.

Studies such as this to collect and examine invasive carp population demographic information in known areas of occurrence are paramount to better plan for control, removal, and management efforts.

Recommendation:
Continue to collect invasive carp population demographic data in the Lamine, Grand and Platte Rivers in addition to sampling the associated Missouri River bend at the confluence of each tributary. The Grand River had two short term rapid invasive carp removals conducted in 2022 and 2023. Invasive carp removals were also conducted on the Lamine in 2024 and both the Lamine and Platte River (MO) in September of 2025. Silver Carp population demographic data is imperative to evaluate and understand potential impacts from removals.

Also, consideration for future sampling may include one or more random or fixed mainstem Missouri River bend(s) in proximity to each tributary but geographically distanced upstream or downstream to gather abundance data outside the potential influence of a tributary.

Tables and Figures

Table 1. Invasive Carp sampling effort and catch results for each site.

Site[1]	# of Samples	60 Hz 40% Mean CPUE	Total # Silver Carp	Total Weight kilograms(lbs.)	Male : Female
MOLR	10	86.6			1.4 : 1
LR1	10	53.9	331	761 (1,678)	0.7 : 1
LR2	10	67.6			
MOGR	10	89.5			1.3 : 1
GR1	10	64.9	272	546 (1,203)	0.9 : 1
GR2	10	86.0			
GR3	10	31.0			
MOPR	10	16.4			2.7 : 1
PR1	10	218.5	506	1,144 (2,521)	0.9 : 1
PR2	10	169.1			

[1]MOLR = Missouri River at mouth of Lamine River, LR1 = Lamine River site 1, LR2 = Lamine River site 2, MOGR = Missouri River at mouth of Grand River, GR1 = Grand River site 1, GR2 = Grand River site 2, GR3 = Grand River site 3, MOPR = Missouri River at mouth of Platte River, PR1 = Platte River site 1, PR2 = Platte River site 2,

[2]Catch per unit effort = # Silver carp/hr.

Table 2. Mini-fyke sampling effort and number of species and fish at each tributary and associated Missouri River bend.

Site[1]	Mini Fyke #nets	Number of Fish	Number of Species	# YOY Silver Carp
MOLR	8	398	25	28
LR	8	61	12	0
MOGR	8	614	25	1
GR	12	314	30	11
MOPR	8	234	21	0
PR	6	203	15	22

[1]MOLR = Missouri River at mouth of Lamine River, LR = Lamine River, MOGR = Missouri River at mouth of Grand River, GR = Grand River, MOPR = Missouri River at mouth of Platte River, PR = Platte River.

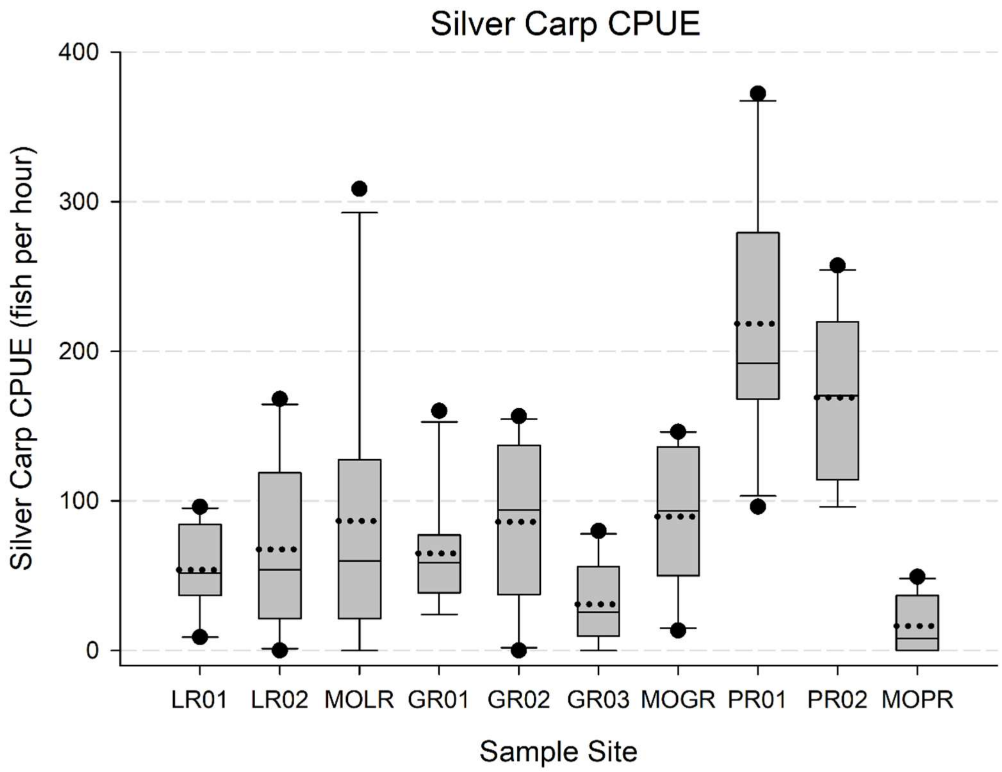

Figure 1. Box plots of Silver Carp catch per unit effort with standard boat electrofishing at each site in Lamine (LR), Grand (GR), Platte (PR), and associated Missouri River bends (MO) at each tributary in sample year 2025. Boxes represent the upper and lower quartiles, solid line represents the median, dotted line represents the mean, whiskers represent the 10th and 90th percentiles and black circles indicate outliers.

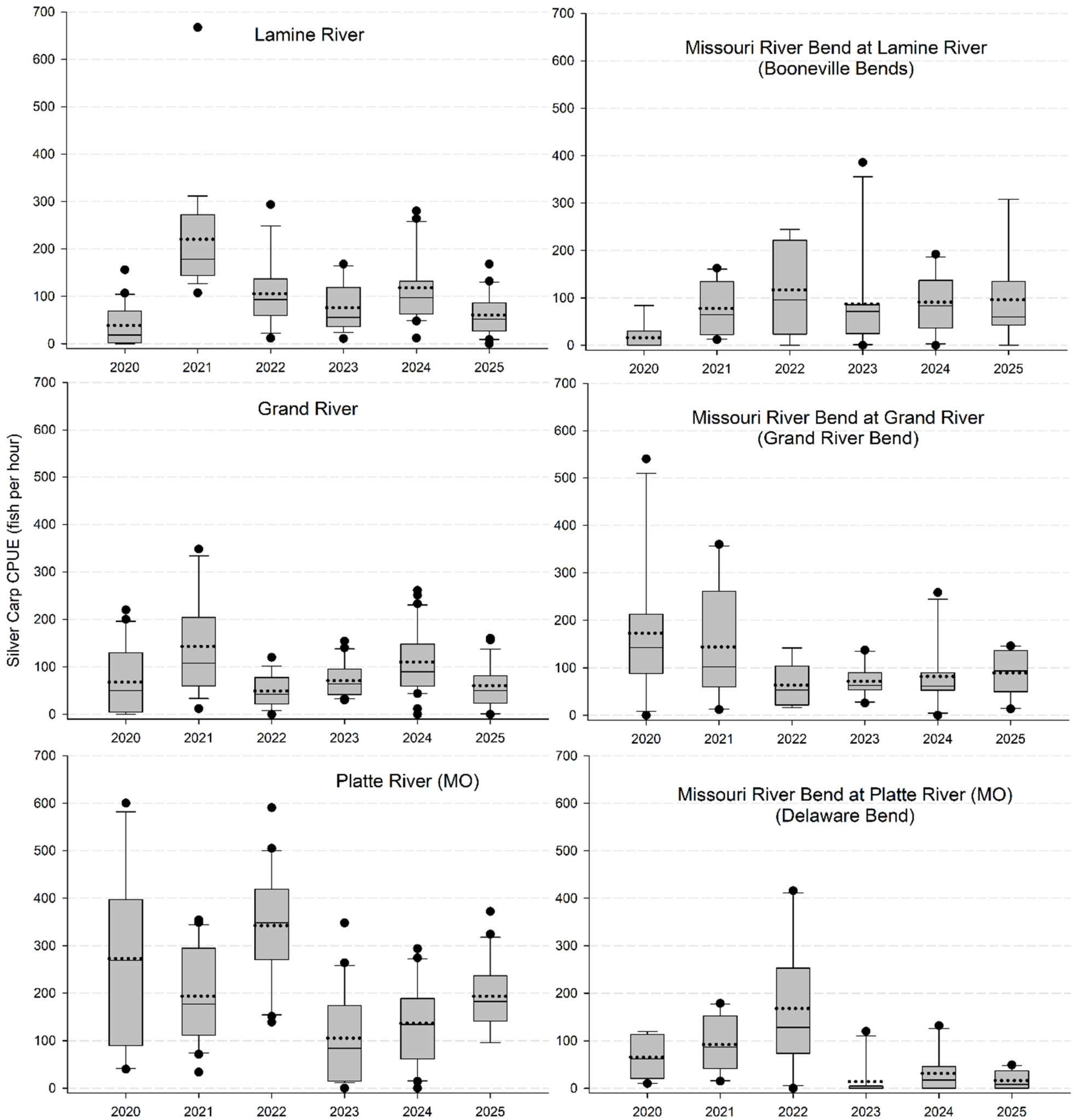

Figure 2. Box plots of Silver Carp catch per unit effort combined annually for Lamine, Grand, Platte, and associated Missouri River bends (MO) at each tributary from 2020 to 2025 using 60Hz and 40% Duty Cycle. Boxes represent the upper and lower quartiles, solid line represents the median, dotted line represents the mean, whiskers represent the 10th and 90th percentiles and black circles indicate outliers.

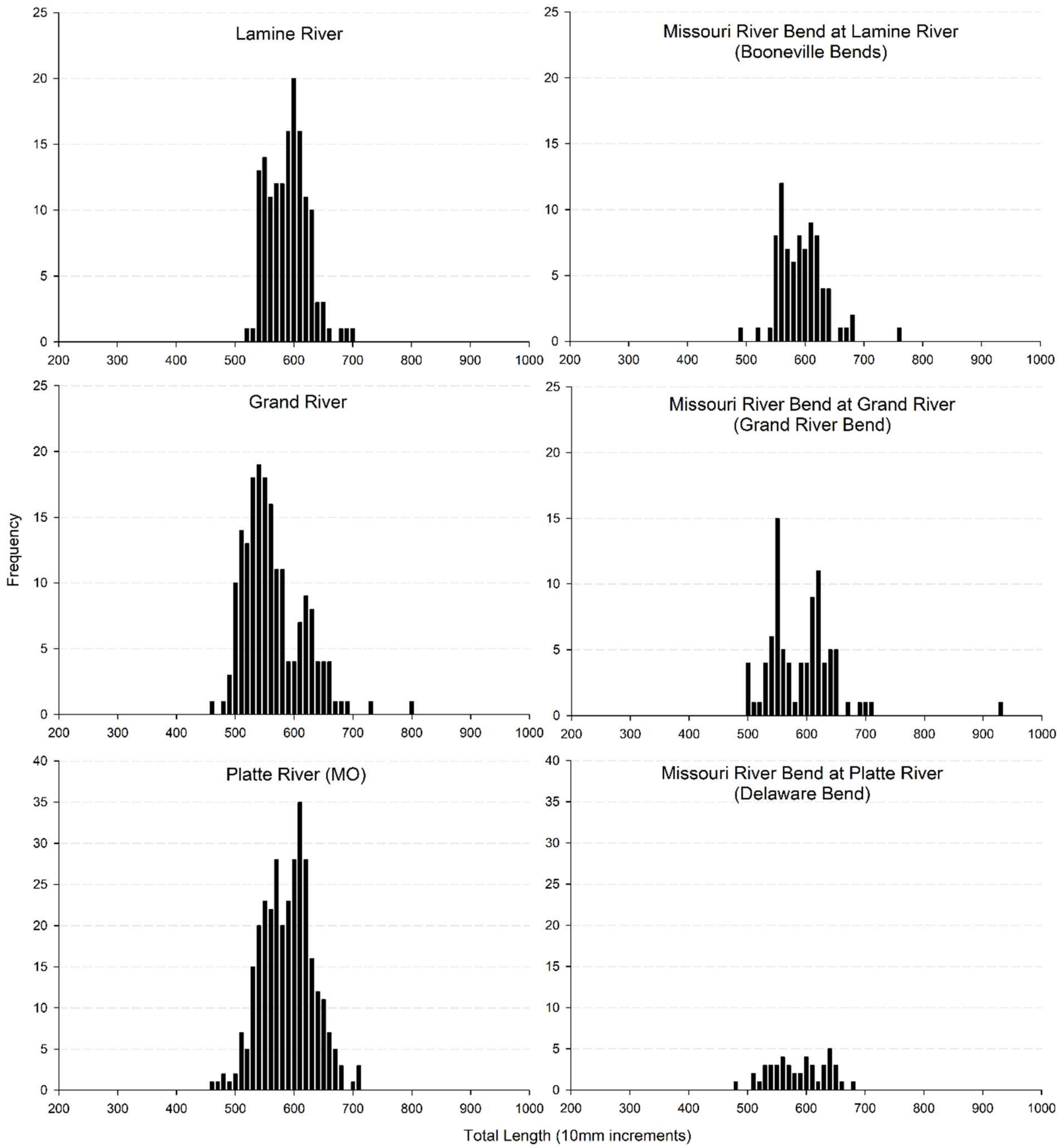

Figure 3. Length frequencies of Silver Carp from electrofishing in 10mm increments for tributary sites combined (left panel) and Missouri River bend sites at each tributary (right panel) in 2025.

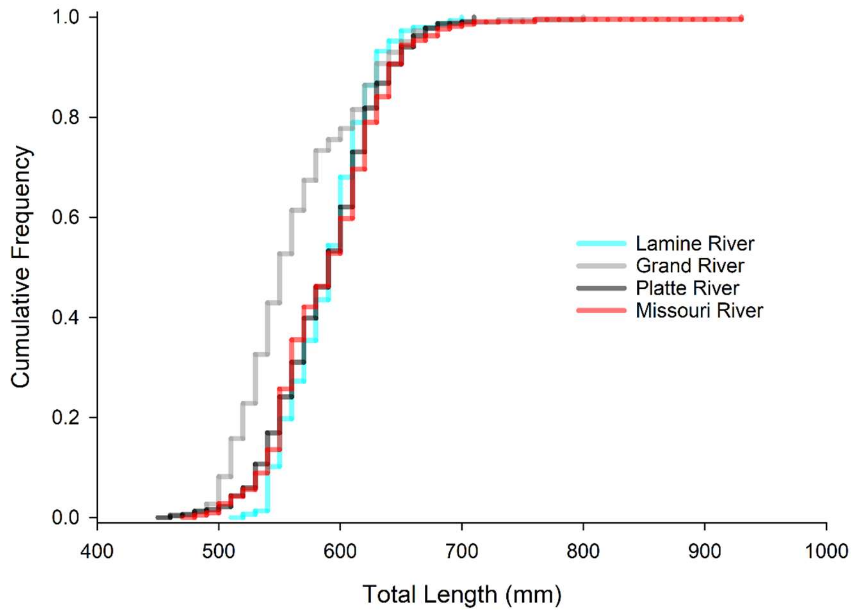

Figure 4. Silver Carp cumulative length frequency distributions at each tributary and Missouri River in 2025.

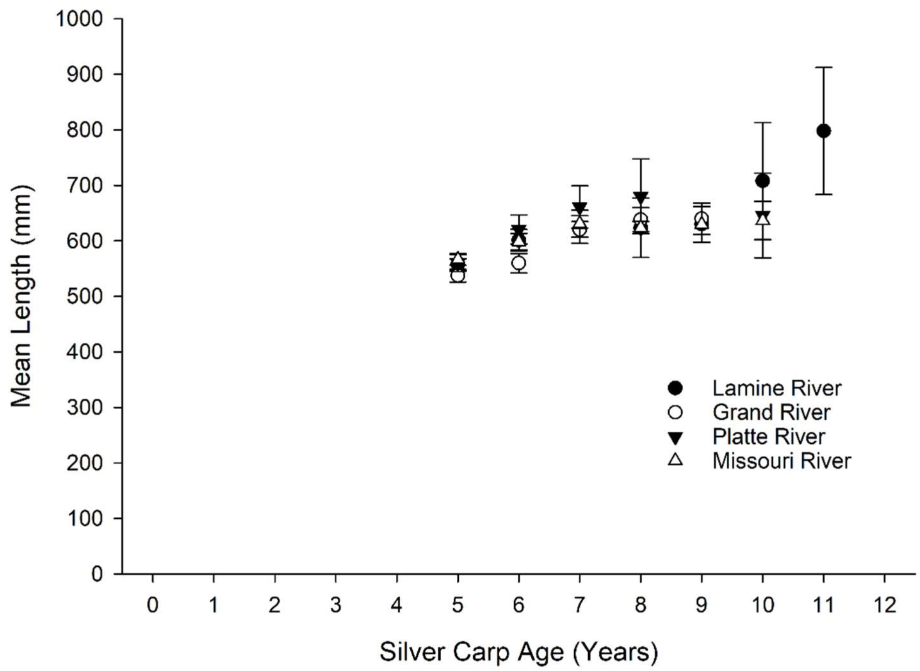

Figure 5. Silver Carp mean length at age +/- 2 standard error for tributaries and Missouri River sites from electrofishing in 2025.

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State Report: South Dakota

Agency: South Dakota Game, Fish, and Parks & South Dakota State University

Project Title: Identifying metrics to assess the impact of management actions and monitoring plan development

Note: Originally submitted under the Define Population Work Group

Methods:
As management actions (e.g., removal, movement deterrents) increase in the Missouri River Basin, we will need quantitative metrics to determine whether and how these efforts affect invasive carp populations. This information will let us set and evaluate management goals through time and adapt our actions based on population responses, such as reductions in relative abundance or size distributions. However, we currently lack sufficient invasive carp population data at the edge of their invaded range in the Dakotas to allow us to quantitatively determine the effectiveness of future management actions. These data should represent multiple population metrics, reflect multiple years to encompass temporal variability, and occur before enhanced management actions commence.

This project has collected baseline invasive carp demographic data from populations along the invasion front in the lower James River using multiple gear types such as electrofishing, hoop nets, and seines at multiple locations. In future years, other South Dakota tributaries will be sampled. Total length, weight, and sex were collected from captured invasive carps. Additionally, lapilli otoliths have been or will be collected and aged from 10 individuals per 10 cm size bin per tributary to create an age-length key and growth curves. Native species were identified to species, measured for total length and weight, and aging structures were collected for select species (Shortnose Gar, Gizzard Shad, Bigmouth Buffalo, Goldeye, and Channel Catfish). This project will provide spatial and temporal patterns in invasive carp CPUE, body condition (relative weight), and age and size distributions. Similar metrics (relative abundance, body condition, size distributions, diversity) will be examined for native fish species that can be used for evaluating native species' responses to future enhanced management efforts and invasive carp removal.

Results & Discussion:
A fish community assessment began in the James River during the summer of 2025. Multiple sampling gears were used to assess the fish community and collect demographic data at six sites distributed along the James River with boat access (Figure 1) and across a gradient of invasive carp abundances. Sampling gears were selected to be comparable to previous fish community assessments in the James River and included boat electrofishing, seines, and hoop nets. Sampling occurred in summer and fall of 2025 to assess the potential differences in fish community through time and will occur once more in spring 2026.

Species selection for demographic sampling was based on three criteria: representation of different feeding guilds, susceptibility to invasive carp impacts, and predicted moderate to high abundances informed by previous sampling. These species included: Silver Carp, Bigmouth Buffalo, Gizzard Shad, Shortnose Gar, Goldeye, and Channel Catfish. Aging structures were collected from a subset of individuals (distributed among size bins) from these species to determine growth rates and population age structure. Otoliths from fish collected in 2025 are currently being processed for determining ages.

Tables and Figures:

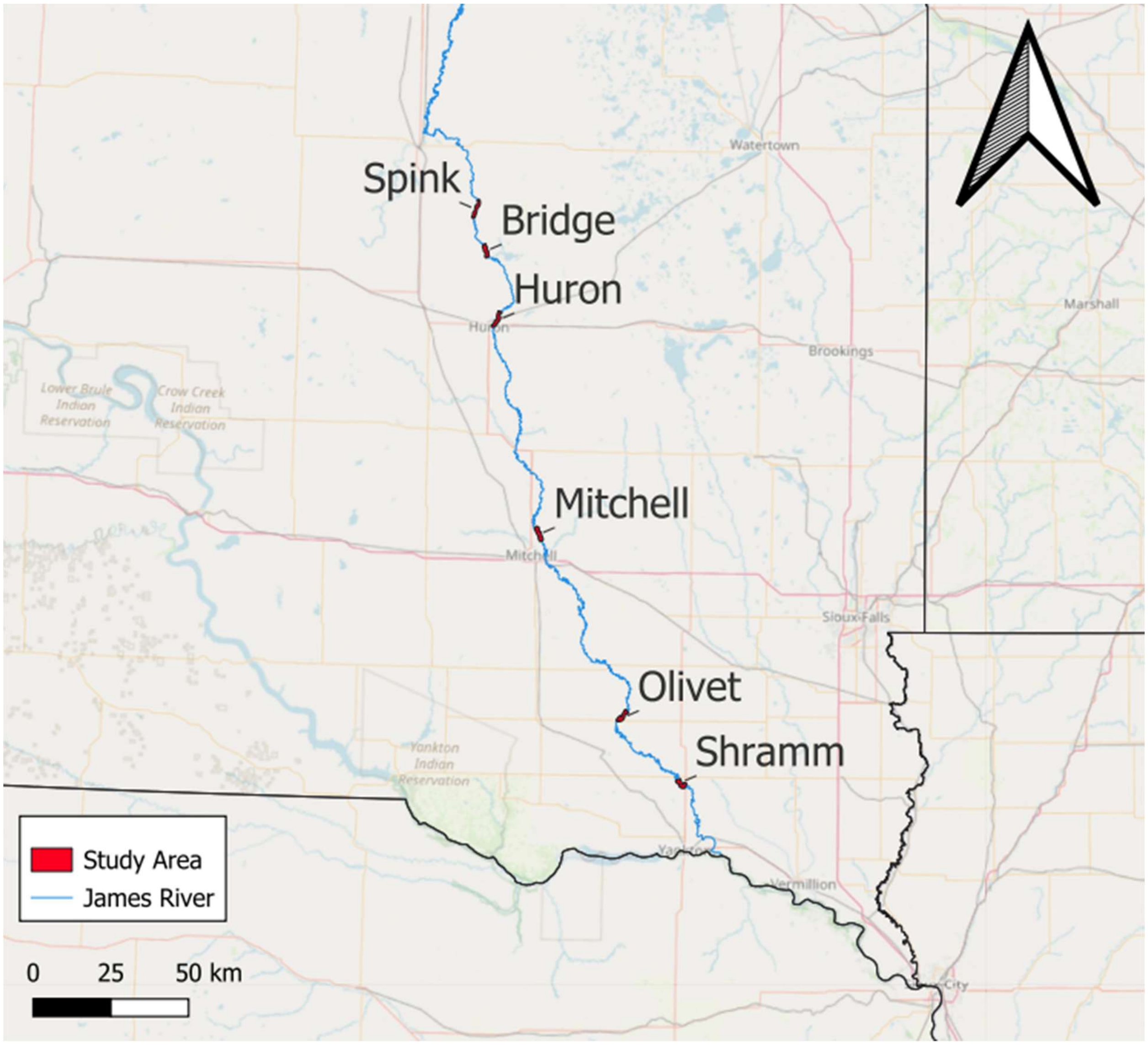

Figure 1. Map of six sampling locations for fish community and demographic data along the James River.

Recommendation:
In order to fully assess the consequences of invasive carp management actions, evaluations should include comparisons of how both invasive carp and native fish population characteristics change through time.

State Report:

Agency: U.S. Fish and Wildlife Service

Project Title: Missouri River Basin Invasive Carp Population Assessment

Note: Originally submitted under the Define Population Work Group

Methods:

Study Area & Site Selection

In 2025, five high-priority meaningful management units (MMUs), as recently defined by the Missouri River Basin Partnership, were selected for sampling: the Missouri River (RKM 0–209; hereafter referred to as Missouri River RKM 0–209), Gasconade River (RKM 167), Osage River below Bagnell Dam (RKM 209), Lamine River (RKM 325), and Grand River (RKM 402). The units were selected due to basin needs, and where active management was occurring. Although the Gasconade River and Osage River are located within the Missouri River RKM 0-209 MMU, they are classified as individual MMUs by the Missouri River Basin Invasive Carp Partnership and were therefore independent from Missouri River RKM 0-209 MMU analyses. Sampling in the Missouri River RKM 0-209 targeted three habitat types including main channel borders, secondary channels, and tributary confluences not defined as an independent MMU. Potential sampling sites were created by dividing all available habitat into 400-meter segments and from all the potential sampling sites, 200 primary and 200 alternate sites were randomly selected and stratified by habitat type. If the primary site could not be effectively sampled, the nearest alternate site within the same habitat type was selected. If certain habitat types were inaccessible (e.g. due to blockages or low water in secondary channels), the corresponding primary sites were allocated to other available habitats in proportion to their availability to reach the target of 200 sample sites completed. For the Gasconade, Osage, Lamine and Grand Rivers MMUs, a similar randomized sampling approach was used but only a single habitat type was available (i.e. tributary channel border). Therefore, 10 samples with a 400-600 m buffer were randomly selected in the lower 10 river kilometers of each tributary confluence. Only the lower 10 RKM were sampled due to minimum depth required to effectively operate the gear.

Data Collection

Daytime sampling with the electrified dozer trawl (EDT; Hammen et al. 2019; Drews 2020) was conducted during August and September 2025. Silver Carp demographic sampling was targeted during August-October due to relatively consistent catch rates (Sullivan et al. 2017) and stable water levels. Additionally, fall sampling reduces the impact of fecund females on length-weight relationships and coincides with annulus formation in otoliths (Thompson and Beckman 1995). A standard EDT transect was defined as a five-minute of electrified effort operated at a speed of 4.8 km/h with a target depth of one meter, following the contour of the shoreline or navigation structures in an upstream direction.

Target power output for each sample site was set by goal tables in Miranda (2009) with amperes adjusted based on water conductivity and Silver Carp behavioral response (Reynolds and Kolz 2012).

All invasive carp captured were identified to species, counted, sexed, and measured for total length (TL; mm) and weight (g). Sex was determined by visual observation of the gonads. For all native fish, individuals were identified to species and counted. However, total length (mm) and weight (g) were only measured for the first 50 individuals of a species per transect for efficiency. For all fish collected, only individuals above 200 mm TL were weighed due to scale sensitivity. Silver Carp that jumped into the boat during standardized sampling (hereafter, “volunteers”) were not used in calculating relative abundances but were used in length- frequency plots and growth models.

Lapilli otoliths were extracted from the first 100 Silver Carp captured in the Missouri River RKM 0-209 MMU, with no more than five Silver Carp otoliths extracted from a single transect spread across the entirety of the unit. After the first 100 otoliths were collected, additional otoliths were extracted from Silver Carp in 50 mm length bins containing fewer than 10 individuals. Otoliths were collected only within the Missouri River RKM 0-209 MMU due to effort, quantity of Silver Carp sampled, and prior extensive age data collected in other MMUs. Otoliths were stored in coin envelopes during collection then transferred to the Columbia FWCO laboratory. Otoliths dried for at least two weeks before being sanded on a transverse plane until the nuclei were visible. Prepared otoliths were mounted in putty, submerged in glycerol, and analyzed using a Nikon SMZ25 dissecting scope by three readers to record a final age through 2/3 or consensus mutual agreement (Maceina and Sammons 2006; Seibert and Phelps 2013). If no agreement was reached, the otolith was not used for age and growth analyses.

Data Analysis

Relative abundance was assessed by calculating catch per unit effort (CPUE) of stock sized (>250 mm: Phelps and Willis 2013) Silver Carp in each respective MMU. To estimate precision of catches, relative standard error (RSE) of CPUE was calculated, with a target RSE of ≤ 25 % (Dumont and Schlechte 2004). Length structure was visualized by calculating the relative length frequency of Silver Carp in 50 mm length classes, and differences between MMU specific length structures were evaluated using a k-sample Anderson-Darling test, with pairwise comparisons conducted when significant differences were detected ($P < 0.05$; Scholz and Stephens 1987). To assess condition, relative weight was calculated for all stock-sized Silver Carp using the observed weight and a standard weight equation specific to Silver Carp (Lamer et al. 2019). The relative weight equation was developed using a 50th percentile approach (Wege and Anderson 1978; Lamer 2015), which defines a Silver Carp in average condition as having a relative weight of 100. Differences in relative weight among MMUs were evaluated using a Kruskal-Wallis test, and, when significant differences were detected ($P < 0.5$), post hoc pairwise Wilcoxon rank-sum tests were conducted to identify which groups differed from one another (Kruskal and Wallis 1952; Wilcoxon 1945).

To assess age structure and recruitment, an age-frequency distribution was visualized for all aged Silver Carp to identify new and/or strong cohorts. Any Silver Carp less than stock length were assumed to be age-0 and displayed on the age-frequency figure. Age data was also used to estimate growth parameters using a von Bertalanffy growth model (von Bertalanffy 1938) to evaluate Silver Carp growth and estimate annual mortality. The growth models provide: L_{inf} - the theoretical average maximum total length, K - Brody's growth coefficient, and t_0 - the theoretical time at which a fish's length is zero. The von Bertalanffy parameters, L_{inf} (cm) and K, are used to calculate mortality. Instantaneous annual mortality (M_{est}) was calculated using the updated Pauly (1980) empirical mortality estimator described in Then et al. (2015) as:

$$M_{est} = 4.1189K^{0.73}L_{inf}^{-0.333}$$

All statistical analyses were conducted in RStudio using R version 4.4.2 (R Core Team 2024). To assess differences in relative length frequency, we applied the k-sample Anderson-Darling tests implemented in the kSamples package (Scholz and Zhu 2025), followed by post hoc pairwise comparisons using PMCMRplus (Pohlert 2024). Differences in condition were evaluated using the Kruskal-Wallis rank-sum test (kruskal.test) and, when appropriate, post hoc pairwise Wilcoxon rank-sum tests (pairwise.wilcox.test).

Results & Discussion:

In 2025, USFWS staff completed 203 standardized EDT transects across five MMUs (Table 1). In the tributary MMUs, sample size targets were achieved with exception of the Gasconade River MMU where insufficient water depths limited sampling. In the Missouri River RKM 0-209 MMU, 165 of the 200 targeted sample sites were completed due to a federal government funding lapse that halted fieldwork. Although the target number of sample sites could not be completed, the quantity and spatial coverage of completed sample sites provide confidence in the population estimates for that MMU.

Across all MMUs, a total of 3,238 fish representing 38 unique species were collected by the EDT (Table 1; Appendix A). Similar to previous years, the most prevalent species collected in 2025 were Silver Carp (N = 878), and Gizzard Shad (N = 865; Appendix A). In the Gasconade and Osage River MMUs, few or no Silver Carp were sampled (Table 1); therefore, these MMUs were excluded from subsequent summaries or analyses. Although Silver Carp are present in these tributaries, they are in low density which necessitates a higher frequency of deployments to effectively detect. Both rivers originate in the Ozarks which can be characterized by clear water, gravel substrate, and low primary productivity. Thus, Silver Carp, a planktivorous species, may prefer more productive habitats, contributing to the low abundance observed in those rivers.

Relative abundance of Silver Carp ranged from 0 to 110 fish per hour among MMUs, with low (i.e., < 25 %) RSE values providing confidence in the Missouri River RKM 0-209 and Lamine River MMUs. In contrast, higher RSE values observed in other MMUs are likely due to small sample size and environmental variation. Catch trends in the Grand River MMU continue to suggest a gradual decline in Silver Carp relative abundance, consistent with trends observed over the past several years (MICRA 2024). The gradual decline of relative abundance may be attributed to a cohort (i.e., 2019 cohort) experiencing natural annual mortality and emigration from the system paired with limited large-scale recruitment to the population. However, the Silver Carp relative abundance in the Lamine River MMU has remained relatively stable during the same time period (MICRA 2024), even with applied harvest actions occurring the previous two years, so further exploration into these relationships is needed. Notably, for the Missouri River RKM 0-209 MMU, this was the first Silver Carp relative abundance estimate derived from a stratified random design on that portion of the mainstem Missouri River. Although the Missouri River RKM 0-209 MMU CPUE estimate is slightly lower than what has been estimated for some of the tributaries historically, the relative abundance would be categorized as a medium density as classified by ongoing workgroups. Sampling in the Missouri River RKM 0-209 MMU encompassed a substantially larger area than the tributary MMUs, which increases the potential for fish avoidance and spatial variability.

Mean Silver Carp length was similar across MMUs; however, the Missouri River RKM 0-209 MMU caught a higher frequency of larger individuals when compared to Grand River and Lamine River MMUs (Figure 2). Conversely, the Grand River MMU caught a high frequency of smaller individuals than the other MMUs (Figure 2). Relative length-frequency among MMUs differed significantly from each other ($P < 0.001$). The k-sample Anderson-Darling test was utilized to put more emphasis on the tails of each distribution as visually observed by the relative length-frequencies. The differences observed between length structures among MMUs may be indicative of Silver Carp selecting different habitat types corresponding with life stage. In 2025, no age-0 or age-1 Silver Carp were sampled, indicating no evidence of successful recruitment to the population from the previous year. In 2024, age-0 Silver Carp were collected in most tributaries (MICRA 2024); therefore, the absence of these fish indicates failure to significantly recruit to the population, or they were undetected due to the limited sampling. Most age-0 individuals collected in fall 2024 measured less than 50 mm in total length, suggesting late-summer or early-fall spawning and insufficient body size to survive the first winter. Overall, the relative length-frequencies indicate continued growth of the Silver Carp population established in tributary MMUs, primarily the 2019 cohort, with similar mean lengths in the Missouri River RKM 0-209 MMU.

Relative weight of Silver Carp ranged from 94 to 100, which differed significantly among MMUs ($P < 0.05$; Figure 3). The Missouri River RKM 0-209 MMU exhibited near average condition, whereas tributary MMUs were slightly below average. This pattern may reflect a higher frequency of larger individuals with greater relative weights being sampled in the Missouri River or greater resource availability associated with lower Silver Carp densities in the mainstem river relative to the tributaries. Larger fish generally display higher relative weights because of a modeling artifact associated with fitting a curved length-weight relationship to a linear standard weight equation. Therefore, the standard weight equation may not perfectly capture the curvature across all size classes, often over- or underestimating weight of small or large fish, resulting in varying estimates in populations with varying length structures (Gerow et al. 2005).

To estimate age, growth, and mortality, staff collected and aged 108 Silver Carp from the Missouri River RKM 0-209 MMU. Assigned ages ranged from 5 to 16 years, with the largest cohort being aged 6 (i.e., 2019 cohort; Figure 4). The age-frequency indicates variable annual recruitment, with both strong and weak cohorts represented. The dominant cohort within the basin was from 2019, as evidenced by the large proportion of age-6 individuals. Previous reports have similarly documented the 2019 cohort as a dominant proportion of the age structure across the basin's tributaries, a pattern now confirmed within the Missouri River itself (MICRA 2022 - 2024). Additionally, a smaller proportion of older individuals (ages 9-10; 2015-2016 cohorts) was observed, consistent with previous findings of those cohorts present in the Kansas River and the upper tributaries (MICRA 2024). As expected from relative length-frequency, no age-0 Silver Carp were collected; furthermore, no age-1 individuals were detected potentially indicating that age-0 Silver Carp spawned and collected in 2024 did not recruit to the population in large numbers. Moreover, using the aged individuals, a von Bertalanffy growth model was generated but due the absence or low quantity of both younger and older Silver Carp, the generated model parameters ($L\infty$ = 678, K = 0.37, and t_0 = 0.59) should be interpreted with caution along with the estimate of mortality, M = 0.49 (Figure 5). Nevertheless, these results represent some of the first age data for Silver Carp in the Missouri River RKM 0-209 MMU. This information provides an important baseline and further collection of age information will continue to refine estimates and improve the understanding of Silver Carp population dynamics in this system.

In summary, the 2025 sampling efforts provided valuable data to further investigate and understand Silver Carp relative abundance and demographics across five distinct MMUs. First, the 2019 cohort is still largely prevalent within the basin as shown by increasing average lengths within the tributary MMUs as well as the age estimates from the Missouri River. Past reports document a large portion of Silver Carp collected within the Lamine River and Grand River MMU being from the 2019 cohort (MICRA 2022-2024). Second, despite the presence of recently spawned Silver Carp captured in tributaries in 2024, no young (i.e., < age-5) fish were detected in the MMUs during this fall's sampling effort. Although not always detected by the gear when sampling, Silver Carp spawning likely occurs annually as the species is an opportunistic, broadcast spawner and as evidenced by a wide age range. However, the Missouri River Basin has not experienced another recruitment event comparable to 2019. Therefore, better understanding of how to prevent or control such an event would be critical for management of the sub-basins Silver Carp population. Furthermore, sampling the Missouri River RKM 0-209 MMU during 2025 further evidences the broadscale proliferation of the 2019 cohort but also demonstrates that sampling in all available habitats could provide a more robust assessment of the population evidenced by the observed difference in length distribution and relative abundance from the tributary MMUs. Sampling the Missouri River RKM 0-209 MMU provided challenges due to high water velocities and shallow sandbar habitats, but the use of the EDT still proved effective for capturing Silver Carp. However, the hydrological complexity of the Missouri River along the ~800-mile gradient needs further exploration to determine if the EDT would be effective in all locations. Finally, further collection of baseline Silver Carp relative abundance and demographics in all MMUs of the Missouri River would continue to provide necessary biological information to the partnership for making management and control decisions. Such decisions can further guide MMU delineation, assist in identifying priority areas for harvest and control activities, and contribute to the assessment of the effects of these actions.

Recommendation:

- Continue collecting Silver Carp population data in MMUs with minimal established information to better refine population status within the Missouri River Basin Invasive Carp Partnership.

- Continue collecting Silver Carp population data in the Missouri River to better understand population trends and inform ongoing management and control actions as they increase.
- Continue evaluating the effectiveness of the EDT on the mainstem river

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Tables and Figures

Table 1. Overview of 2025 standardized electrified dozer trawl (EDT) sampling completed in 2025 across multiple meaningful monitoring units (MMUs). Table details the MMU location, the number of transects completed, total fish caught, total number of Silver Carp (SVCP) caught, SVCP average length in millimeters ± standard error (SE), and SVCP length range in millimeters.

MMU	River Kilometer	Transects (N)	Total Fish (N)	SVCP (N)	Mean TL (mm ± SE)	Min-Max TL (mm)
Missouri River	0-209	165	2,792	748	612 (1.8)	457-884
Gasconade River	167	8	54	0	-	-
Osage River	209	10	61	2	544 (47.8)	496-591
Lamine River	325	10	255	92	598 (3.3)	529-692
Grand River	402	10	76	36	567 (7.5)	482-652

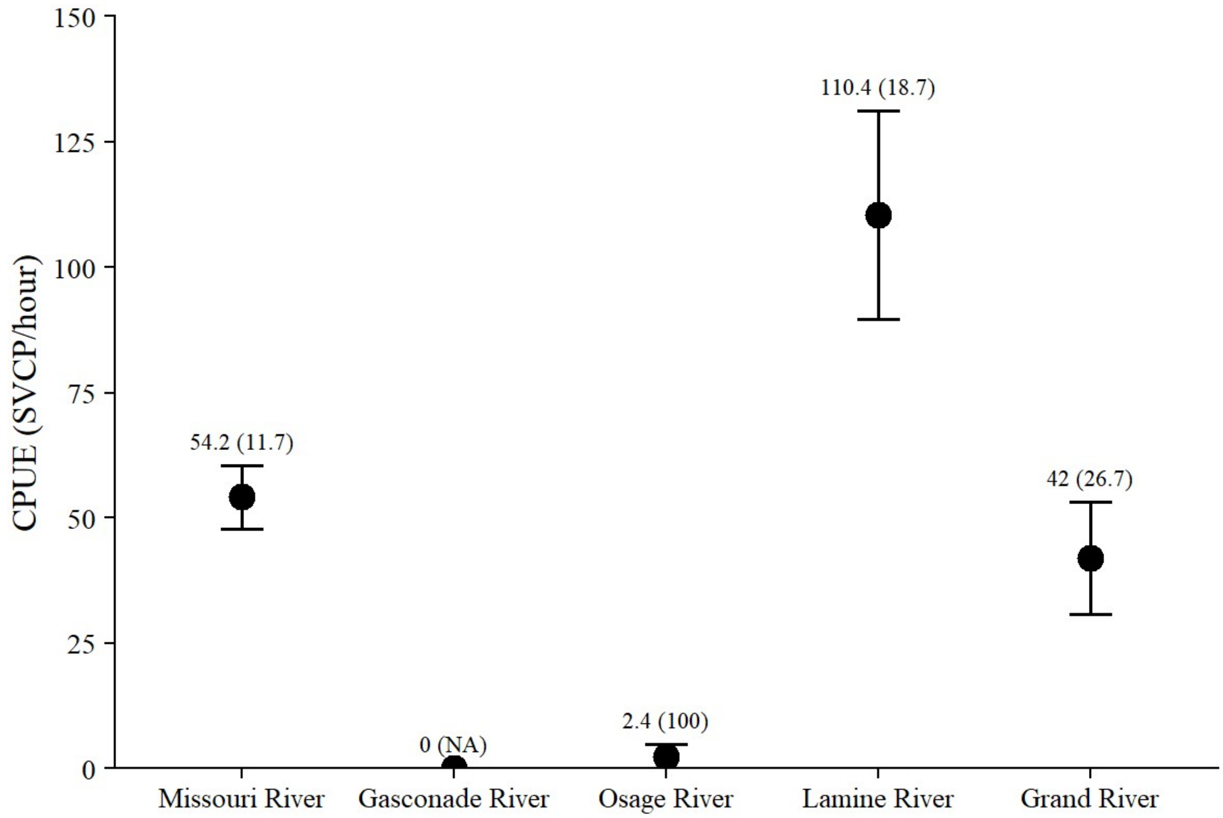

Figure 2. Average relative abundance of Silver Carp (SVCP) measured as catch per unit effort (CPUE) per hour with an EDT across meaningful management units in 2025. The relative standard error (RSE; %) is shown in parentheses for each mean estimate. Error bars represent standard error. The Missouri River RKM 0–209 MMU is abbreviated as "Missouri River" in the figure.

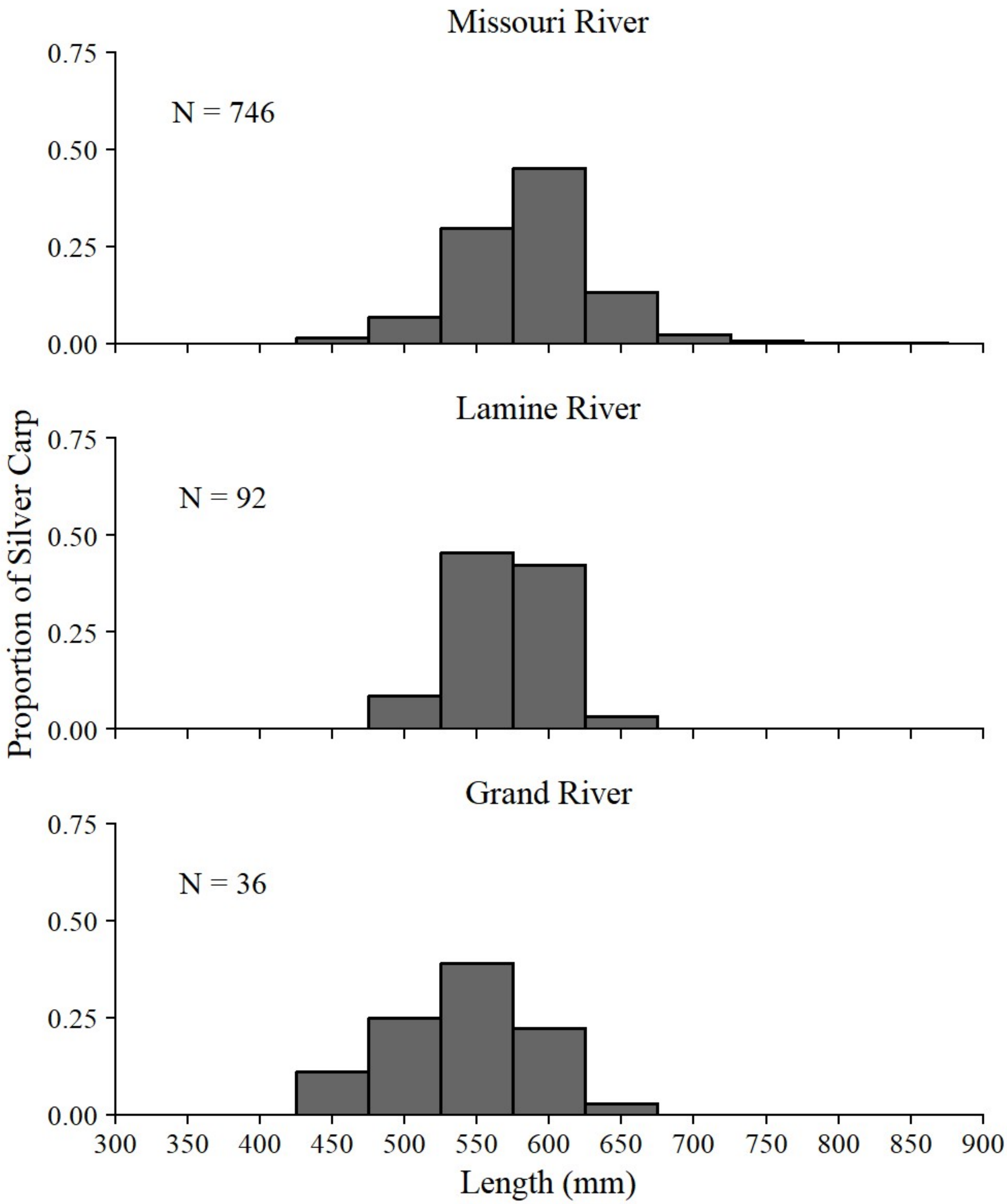

Figure 3. Silver Carp relative length-frequency distributions by 50 mm lengths bins captured by an EDT in 2025 for each meaningful management unit. The Missouri River RKM 0–209 MMU is abbreviated as "Missouri River" in the figure.

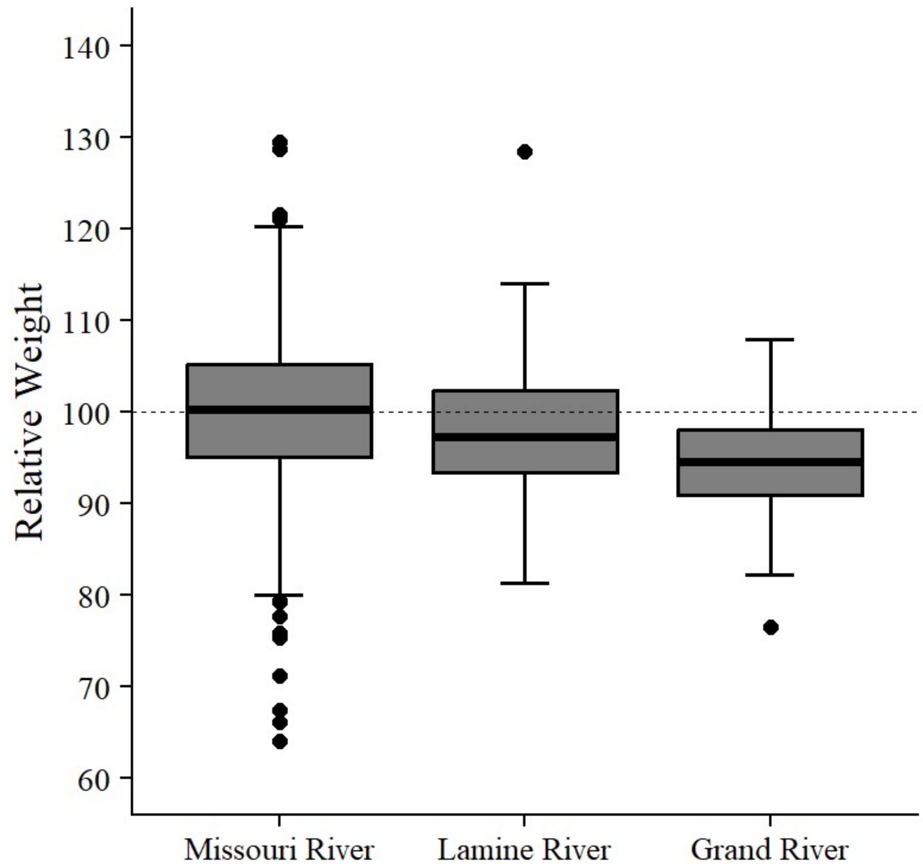

Figure 4. Silver Carp relative weight (W_r) for each meaningful management unit in 2025. The dashed horizontal line indicates an "average" body condition based on a standard weight equation (Lamer 2019). In each box plot, the horizontal line shows the median W_r, the box represents the interquartile range (25th-75th percentile), the whiskers extend to 1.5 times the interquartile range, and points beyond the whiskers indicate outliers. The Missouri River RKM 0–209 MMU is abbreviated as "Missouri River" in the figure.

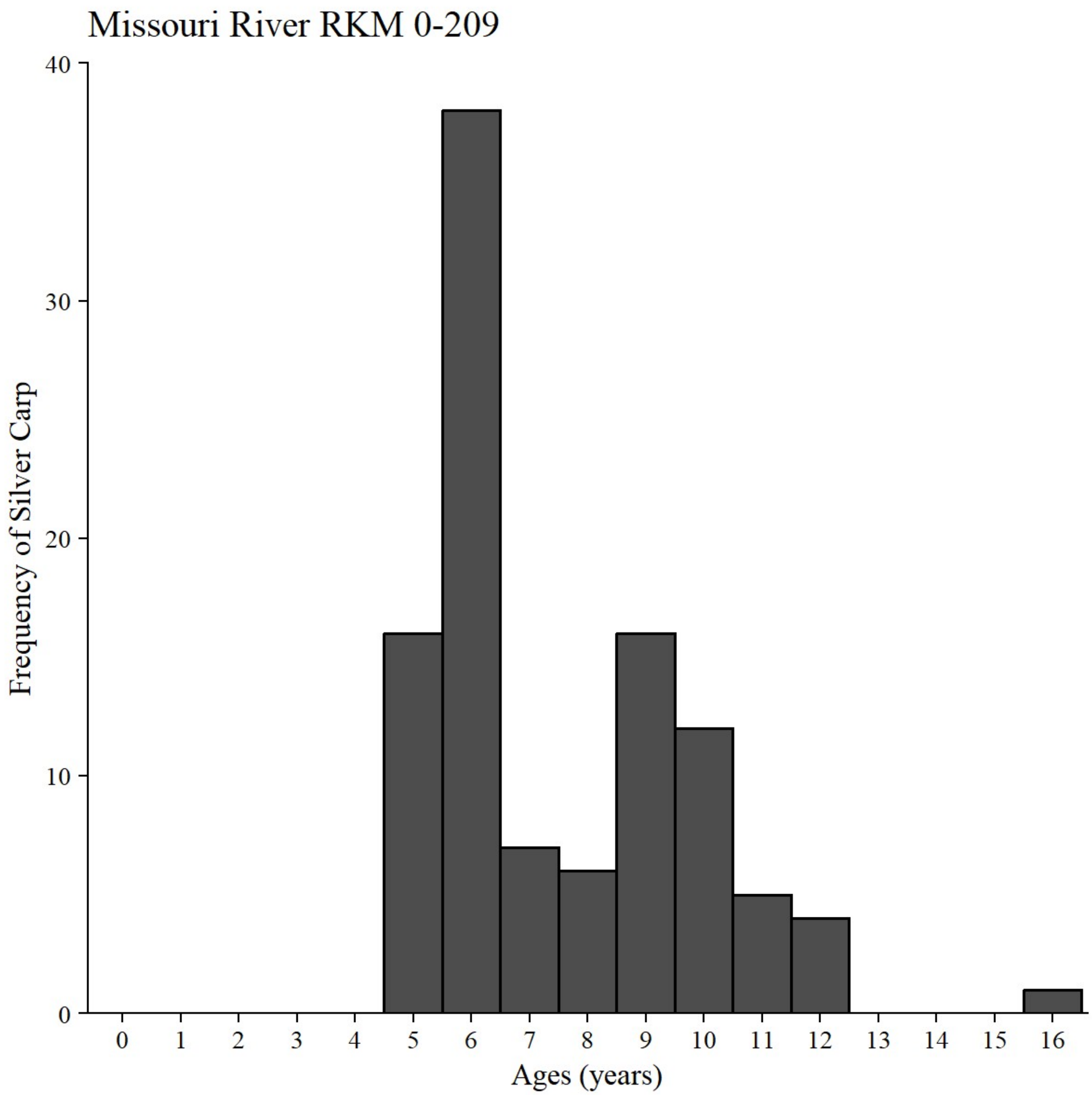

Figure 5. Silver Carp relative age-frequency distribution for the Missouri River RKM 0-209 MMU by the EDT in 2025.

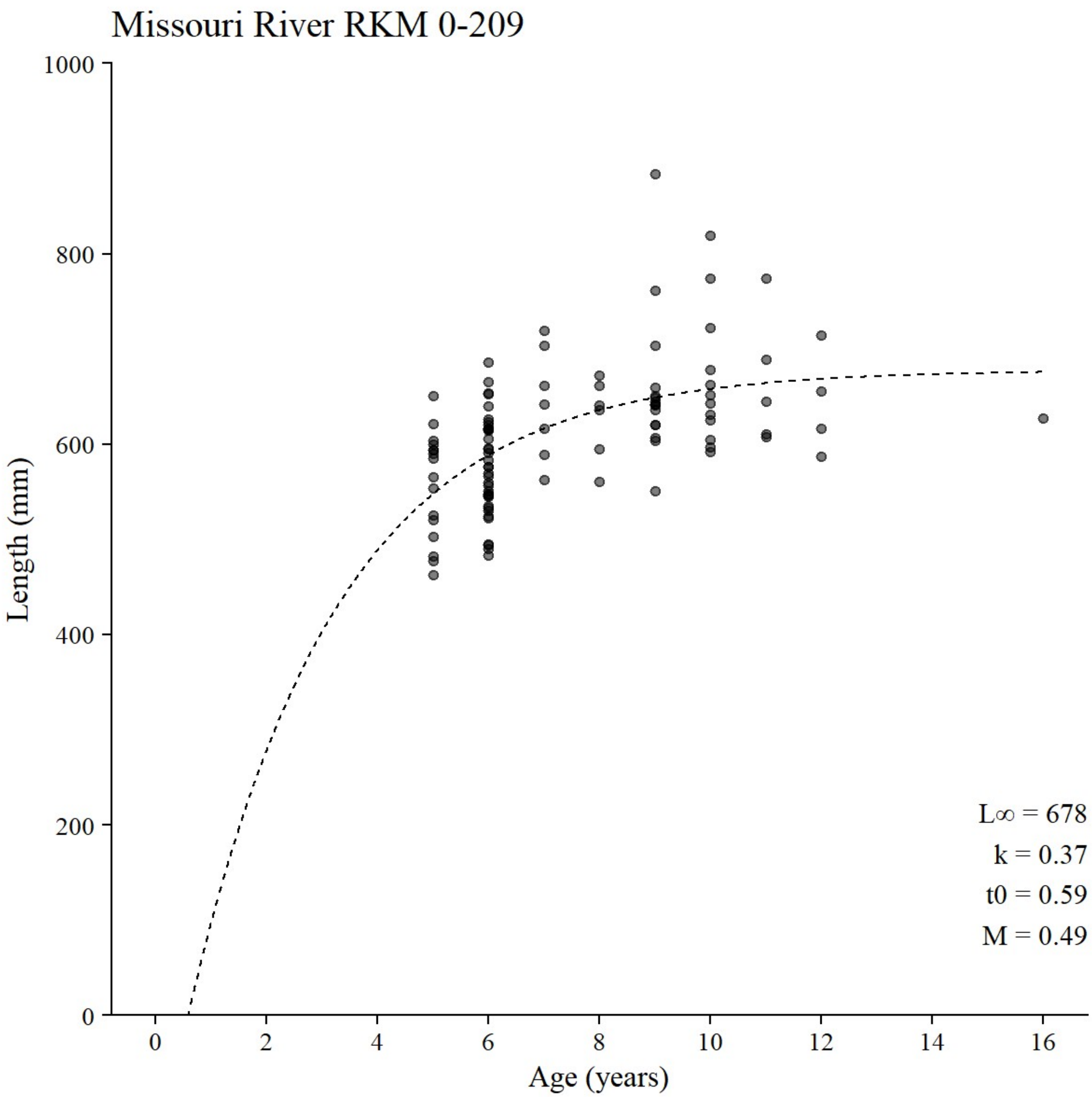

Figure 6. Silver Carp von Bertalanffy growth model for the Missouri River RKM 0-209 MMU, based on samples collected with an EDT in 2025. The growth model estimates: L∞ - the theoretical average maximum total length, K - Brody's growth coefficient, and t_0 - the theoretical time at which a fish's length is zero as well as the calculated mortality rate (M) are displayed in the lower right-hand corner of the figure.

Appendix A. All fish collected by standardized sampling with the electrified dozer trawl in fall 2025 for each meaningful management unit. Totals include all volunteers collected.

Species	Missouri River RKM 0-209	Gasconade River	Osage River	Lamine River	Grand River
Bighead Carp	1	0	0	0	0
Black Buffalo	5	2	0	1	0
Blue Catfish	13	0	0	0	0
Bluegill	1	0	2	1	1
Bigmouth Buffalo	13	0	0	2	0
Blue Sucker	159	0	0	0	0
Common Carp	53	2	6	5	0
Channel Catfish	17	1	1	0	2
Chestnut Lamprey	3	0	0	0	0
Emerald Shiner	87	0	0	46	17
Flathead Catfish	8	1	1	0	0
Freshwater Drum	73	7	1	0	0
Goldeye	187	9	13	1	0
Gold Redhorse	0	0	1	0	0
Grass Carp	21	0	1	0	0
Gizzard Shad	773	6	16	65	5
Longear Sunfish	0	0	1	0	0
Longnose Gar	173	6	3	19	5
Mimic Shiner	2	0	0	0	0
Mooneye	32	1	0	0	0
Mosquito Fish	1	0	0	1	1
Orangespotted Sunfish	1	0	0	0	0
Paddlefish	1	0	0	1	0
Redfin Shiner	0	0	0	4	0
River Carpsucker	24	2	3	4	2
River Redhorse	0	0	1	0	0
River Shiner	1	0	0	0	0
Sicklefin Chub	1	0	0	0	0
Sauger	1	1	1	0	0
Shorthead Redhorse	3	0	0	0	0
Skipjack Herring	16	0	1	2	0
Smallmouth Buffalo	167	9	2	7	2
Shortnose Gar	147	4	0	4	5
Shovelnose Sturgeon	18	0	0	0	0
Silver Carp	748	0	2	92	36
Spotted Bass	0	3	3	0	0
White Bass	41	0	2	0	0
Yellow Bass	1	0	0	0	0
Total	**2,792**	**54**	**61**	**255**	**76**

State Report: Nebraska

Agency: Nebraska Game and Parks Commission & University of Nebraska-Lincoln

Project Title: Increase understanding of invasive carp reproductive ecology in the Platte River basin to inform knowledge gaps from prior studies

Note: Originally submitted under the Define Population Work Group

Methods:
Our study area consists of four localities in eastern Nebraska: two reaches of the Platte River between Columbus and its confluence with the Missouri River near Plattsmouth, the Elkhorn River near Valley, and Salt Creek near Ashland (Figure 1). For clarity, the Platte River localities at Columbus and Plattsmouth are hereafter referred to as “Columbus” and “Plattsmouth”, respectively. These localities were situated near boat access points and chosen in order to sample bigheaded carp along their invasion gradient in the Platte River. Additionally, the Missouri River in Nebraska is considered the core range of bigheaded carp as occupancy decreases the greater the distance (rkm) upstream from the Platte-Missouri Confluence (Logan 2024).

Each of the four localities were sampled biweekly (weather permitting). Bigheaded carp spawning is triggered when water temperatures rise above 18°C and cease when water temperatures fall below that threshold. With this in mind, our sampling season began in mid-April and continued through October in an effort to collect specimens before, during, and after the spawning season in Nebraska. A 4.9 m painted aluminum Jon boat with an ETS Electrofishing Systems (Madison, Wisconsin) MBS-2D control box paired with a 4000-watt Powerhorse generator was used to electrofish bigheaded carp (60 hz, 25% duty cycle). Two netters were utilized to increase catch rate. Electrofishing runs consisted of four 15-minute subsamples to make up a total of one hour of shocking time per locality. When environmental conditions were unfavorable (e.g., low flows), tote barge electrofishing or gill netting via airboat was utilized.

All fish that were caught either by net or had jumped into the boat were processed. Total length (mm), weight (g), and sex were recorded from all collected fish. Sex was verified following the rapid sex assessment described by Wolf et al. (2018) and Lederman et al. (2022) and confirmed by gonad identification. During every sampling event, gonads were extracted from up to five collected fish from every 25 mm length bin (e.g., 501-525 mm, 526-550 mm) to collect data from a range of body sizes. Gonads were weighed (g) and preserved in 10% buffered formalin for future histological analysis. Processed fish were humanely euthanized and returned back into the waterbody they were collected from. All fish were captured and handled under Nebraska Game and Parks Master collection permit 1482 and in accordance with IACUC protocols under UNL IACUC project ID 2690.

We performed generalized linear models, ANOVAs, and Tukey's HSD tests in Program R (R Core Team 2025) to assess total length (TL), weight, gonad size, month, and locality relationships on our current dataset. The GSI value was calculated for female fish collected in each month during the 2025 sampling season (GSI = [gonad weight (g)/body weight (g)] $\times$ 100).

Up to five collected fish from every sampling event were randomly selected for gonad extraction from each 25 mm length bin (e.g., 501-525 mm, 526-550 mm) resulting in 602 gonads of the 898 bigheaded carp collected. This resulted in an ample number of tissues from a wide range of individuals throughout the season. In order to assess spawning across the season for each locality, three to five gonads from each sex from every sampling event will undergo histological sectioning (have currently begun and have already processed 15 individuals). Each gonad, previously stored in 10% buffered formalin, was rinsed thoroughly and soaked in water for approximately 24 hours. An approximately 1 cm3 tissue section from each gonad was cut and placed into a labeled tissue bag then put into a plastic embedding mold. Tissues were then dehydrated in ascending concentrations of ethanol (e.g., 85% ethanol up to 100% ethanol). To clear the tissues, specimens were placed in a 100% ethanol/xylene (1:1) mixture and then into 100% xylene. Dehydrated and cleared tissues were infiltrated with melted paraffin at 60°C for a minimum of three hours, but sometimes kept in the oven overnight. Once the tissues are embedded into paraffin, they were sectioned into 10 µm sections using a Leica HistoCore Autocut microtome. Sections were placed onto water on charged glass slides on a slide warmer set at 40°C. Once dried, the slides will be stained.

A hematoxylin and eosin (H&E) staining procedure was used, as it is a common stain used in histological studies of fish gonads (Wolf et al. 2004; Alonso-Fernández et al. 2011; Brown-Peterson et al. 2011; Fatima et al. 2017; Press et al. 2025; Table 4). Delafield's Hematoxylin stains the cell nuclei a deep purple color; eosin stains cytoplasmic structures a pink or red color (Feldman and Wolfe 2014). A coverslip was mounted onto each slide using Permount. Histological slides of bigheaded carp gonads were then examined under a Leica DM2000 LED compound microscope and photographed using a Leica K3C microscope camera.

Male and female fish are being categorized into reproductive phases as outlined in Brown-Peterson et al. (2011) and spawning subphases (Lowerre-Barbieri et al. 2023). Additionally, environmental data will be downloaded from USGS monitoring locations nearest to boat drop-in points. Water temperature and river discharge over time will be analyzed in conjunction with reproductive status as this has the potential for explaining seasonal trends in spawning.

Results & Discussion:

<u>Current Results:</u>

Thus far, 890 Silver Carp and three Bighead Carp were collected in the 2025 season. Of the Silver Carp, 637 were male and 253 were female, for an overall sex ratio of 2.51:1 males to females (Table 1). Bigheaded carp length and weight are positively correlated ($P < 0.01$). There are no differences in size between males and females ($P = 0.22$; Figure 2a). Gonad weight and total weight were positively correlated and females have significantly larger gonads than males ($P < 0.01$; Figure 2b). There are also significant differences in gonad weight by locality and month (Figure 3). On average, fish caught in Columbus have larger gonads than those caught in Plattsmouth ($P < 0.01$) and Salt Creek ($P < 0.01$), and fish from the Elkhorn River have larger gonads than those from Plattsmouth ($P < 0.01$; Figure 3).

Female bigheaded carp GSI was calculated for each month during the 2025 sampling season. The mean GSI of the 195 female gonads collected is 10.73 ± 6.17 SD. Mean GSI of females was generally higher in summer months (June = 14.15 ± 5.62, n = 41; July = 11.00 ± 7.19, n = 27) than in fall months (September = 5.95 ± 3.94, n= 8; October = 3.88 ± 2.50, n = 9). There are significant difference between mean female GSI values from fish caught across the season. June bigheaded GSI values were significantly higher compared to multiple months and October values were lower compared to multiple months. The mean GSI of the 407 male gonads collected is 0.70 ± 0.42 SD. June was the only month that is significantly different from all other months (June = 0.75 ± 0.32; n = 73. All monthly GSI values can be found in Table 2 and Figure 4a,b.

We also calculated GSI by locality and found that GSI of female bigheaded carp from the Platte River in Plattsmouth were significantly different from those caught in the Platte River in Columbus, the Elkhorn River, and Salt Creek ($P < 0.05$). Mean female GSI was lowest from fish out of Plattsmouth (8.35 ± 5.41; n = 45), followed by Salt Creek (10.87 ± 6.18; n = 125), then the Elkhorn River (14.16 ± 5.05; n = 20), with the highest being from Columbus (15.99 ± 7.78; n = 5). The GSI of male bigheaded carp were significantly different ($P < 0.05$) among all localities, except between fish caught in Salt Creek and the Elkhorn River. The lowest mean male GSI was reported from fish captured out of Plattsmouth (0.58 ± 0.36; n =137). Male fish caught out of Salt Creek had a slightly higher mean GSI (0.74 ± 0.44; n = 154) than those from the Elkhorn River (0.72 ± 0.43; n = 86). The highest mean GSI came from male fish capture from Columbus (1.00 ± 0.33; n = 30). Male and female mean GSI by locality follow similar trends. These analyses will be rerun with additional sampling in 2026. All GSI values by locality can be found in Table 2 and Figure 4c,d.

Preliminary histological analyses show that female silver carp are reproductively capable in April-July (Figure 5). Additionally, spawning capable females show evidence of spawning capable oocytes alongside maturing oocytes and vitellogenic oocytes (Figure 5A).

Discussion:

Targeting and removing aquatic invasive species from ecosystems is an ongoing, challenging process. Not only should resource managers consider how much money to allocate towards these efforts, but also the effectiveness of efforts, public perception, and labor involved (e.g., number of employees, time dedicated to sampling and research). Such management planning relies heavily on comprehensive knowledge of reproductive life history traits, which is vital in predicting, preventing, and controlling the spread and establishment of invasive species in novel environments.

The high establishment rate of aquatic invasive species can be attributed to anthropogenic causes, whether through human-mediated taxonomic selection (García-Berthou 2007) or by river industrialization (Haidvogl 2018), as we see in the Missouri and Platte rivers (Eschner et al. 1981; Pegg et al. 2003; Murphy et al. 2004). In Wyoming, half of the 62 unauthorized fish introductions documented in 1973-2002 were a result of the illegal release of species by the public (Rahel 2004). In an effort to increase public awareness of the impact of invasive species, government agencies utilize education programs such as the Stop Aquatic Hitchhikers!™ campaign (Oh et al. 2018). In addition to these programs, agency intervention (e.g., restricting public access to undesirable species, consequences for unauthorized releases) may be necessary to further prevent the unauthorized release of nuisance species. Another study in Wyoming analyzed nonnative fish introductions from 1961 to 2017 and reported that 79% of the cases resulted in no action done to reverse the introduction (Rahel and Smith 2018). While it has proven difficult to completely eradicate a population of invasive species once established, their presence should not be a lost cause. Long-term management efforts are still beneficial in suppressing invasive populations and protecting resources (Jung et al. 2024).

Based on gonadosomatic indices (GSI) calculated from this study thus far, it was found that male and female bigheaded carp in low density areas (i.e., Columbus) had significantly higher GSI values than those at downstream, more densely populated areas, suggesting that fish in low density areas exhibit a greater reproductive investment (Ogunola et al. 2018). Identifying time periods where the majority of fish are in the spawning capable phase provides insight into the spawning season and patterns in the lower Platte River, whereas the presence of fish in this phase over prolonged periods indicates an extended spawning season (e.g., protracted spawning; Tucker et al. 2020). Focusing extirpation efforts during months where GSI values are high can target highly fecund individuals. Specifically, removing Silver Carp from the Platte River in Columbus, Nebraska can slow populations from expanding as fish from this locality have significantly higher GSI values than at other localities. Focusing removal efforts and labor hours on female fish during June and July and male fish in June may also be beneficial as their GSI values were significantly higher during these months than any other months.

Continued research and long-term monitoring are essential for predicting future invasions and developing management plans that are biologically sound. The reproductive indicators identified in bigheaded carp in the lower Platte River could potentially translate to populations in similar shallow river systems across North America, providing a comparative framework for understanding patterns of establishment and reproductive success. Findings from this study provide a valuable baseline for predicting future invasion success and evaluating the effectiveness of removal efforts. Moreover, assessing the long-term effectiveness of the described management efforts and refining protocols as new data is collected will be critical to preventing the further spread of bigheaded carp throughout the United States

Histological classification serves as the most accurate method for determining reproductive phases in fish as it provides the greatest amount of information on intracellular and extracellular components, and is the most efficient method in processing large quantities of specimens (Hunter and Macewicz 1985; Press et al. 2025). Assessing these phases in female and male fish provides insight into the spawning phenology of established invasive populations (Alonso-Fernández et al. 2011; Brown-Peterson et al. 2011). Our preliminary findings show that female silver carp are reproductively capable in April-July and show evidence of spawning capable oocytes alongside maturing oocytes and vitellogenic oocytes (Figure

5A). This suggests bigheaded carp in the Platte River are batch spawners, releasing eggs throughout the summer. Additional investigation is forthcoming to better determine the timing and any differences in spawning phases across time and among different localities. Coupling this information with environmental data (e.g., water temperature and river discharge) could allow resource managers to prepare for extirpation events based on environmental trends.

Figures:

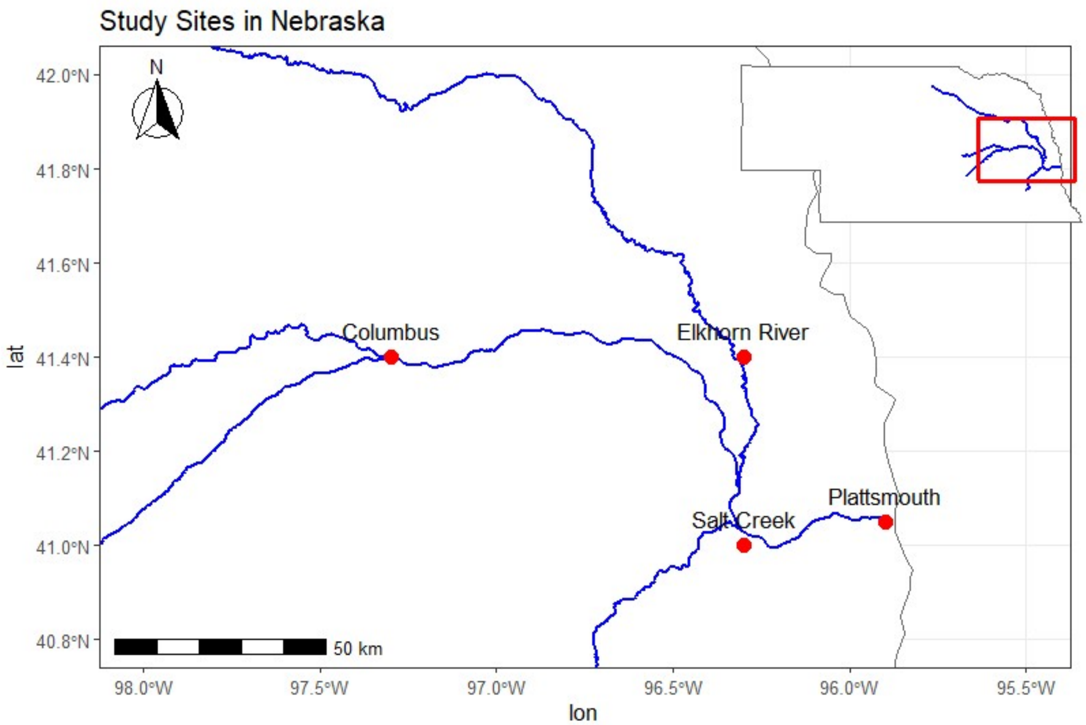

Figure 1. Localities where Silver Carp and Bighead Carp were collected in the Platte River in Plattsmouth and Columbus, the Elkhorn River, and Salt Creek, Nebraska.

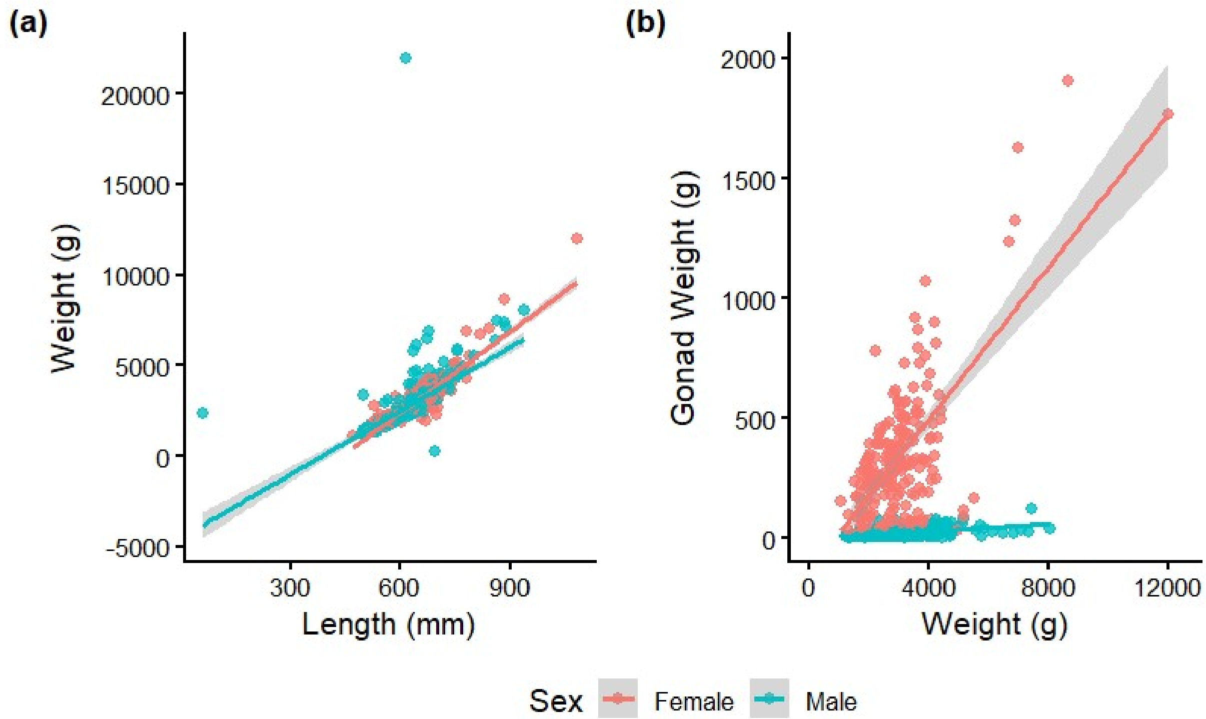

Figure 2. (a) Total length by weight and (b) weight by gonad weight of bigheaded carp.

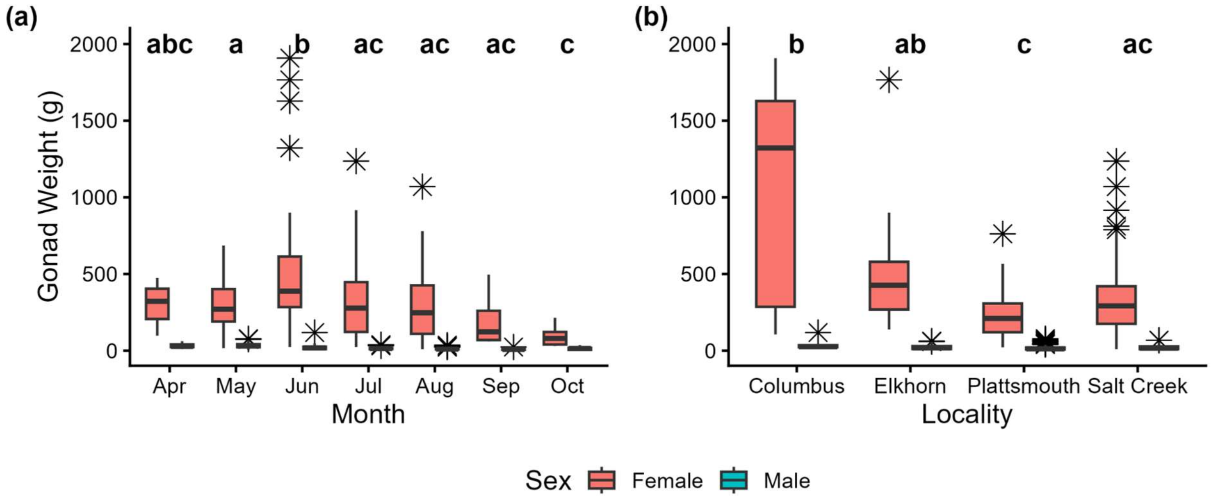

Figure 3. Gonad weight by (a) month and (b) locality for bigheaded carp. Stars denote outliers and letters denote groups based on significance.

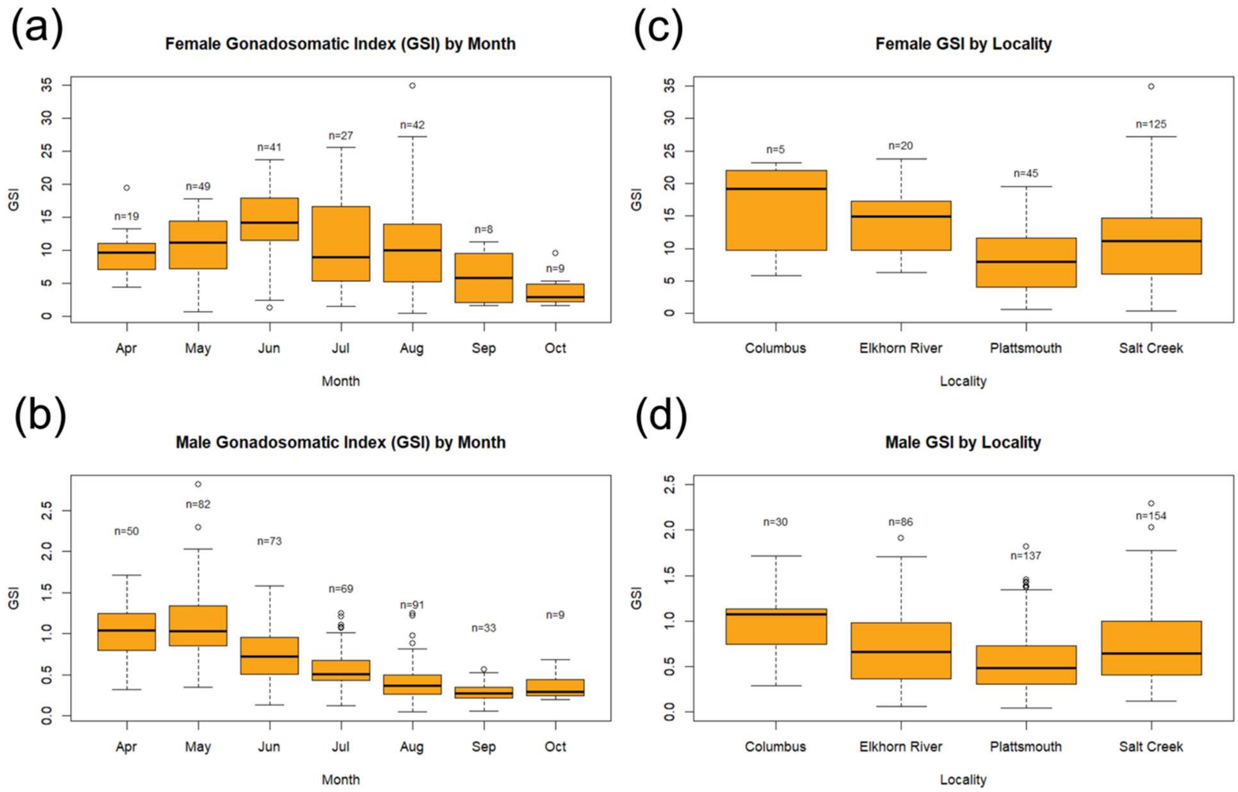

Figure 4. Female (a and c) and male (b and d) Gonadosomatic Index (GSI) by month and locality (Platte River in Columbus and Platte River in Plattsmouth shortened to Columbus and Plattsmouth, respectively). Whiskers denote minimum and maximum GSI in the month, while solid black line denotes median GSI values. Open circles indicate outliers.

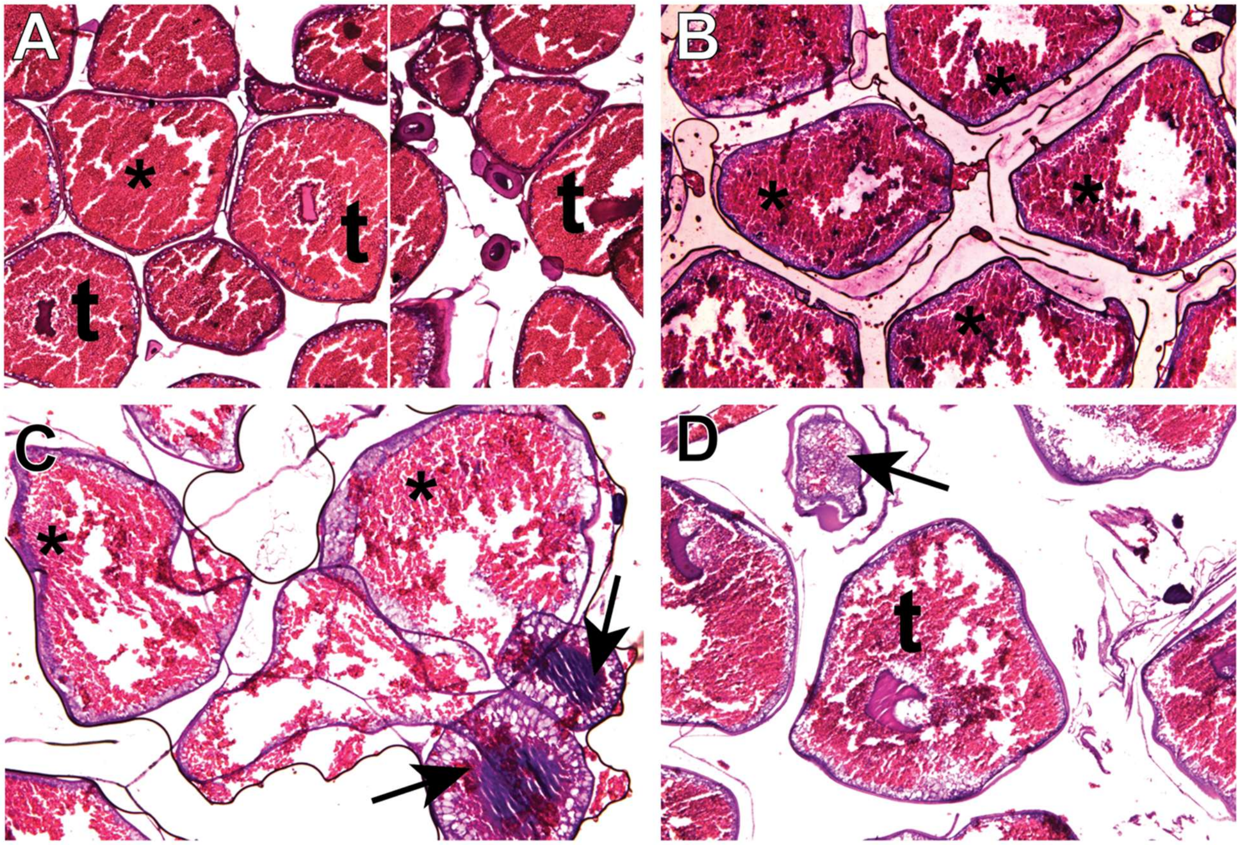

Figure 5. Histological preparations using H&E of female Silver carp. A) female caught in April, B) female caught in May, C) female caught in June, D) female caught in July. * denotes spawning capable oocytes, t denotes tertiary vitellogenic oocytes, black arrows denote primary vitellogenic oocytes.

Tables

Table 1. Male to female ratio of bigheaded carp caught in this study in 2025 by month and by locality.

	Males	Females	Sex Ratio
Month			
Apr	87	28	3.11:1
May	122	59	2.07:1
Jun	78	42	1.86:1
Jul	76	34	2.24:1
Aug	200	69	2.90:1
Sep	47	13	3.62:1
Oct	28	9	3.11:1
Locality			
Columbus	30	5	6:1
Elkhorn River	98	20	4.9:1
Plattsmouth	204	59	3.46:1
Salt Creek	306	170	1.8:1

Table 2. Mean gonadosomatic index (GSI) values for female and male bigheaded carp sampled in each month and by locality during the 2025 sampling season. A total of 194 female and 405 male Silver Carp and one female and two male Bighead Carp were included in the evaluation. Platte River in Columbus and Platte River in Plattsmouth were shortened to Columbus and Plattsmouth, respectively

Month	Mean GSI	SD
Females		
Apr	9.587619	3.487685
May	10.638212	4.606602
Jun	14.154737	5.621425
Jul	11.003971	7.194168
Aug	10.344445	7.404019
Sep	5.948594	3.937546
Oct	3.875856	2.500901
Males		
Apr	1.039929	0.3200034
May	1.0819858	0.444044
Jun	0.7474522	0.3216027
Jul	0.5676091	0.2530634
Aug	0.408166	0.2148273
Sep	0.2930187	0.1203169
Oct	0.3747748	0.1651027
Locality	**Mean GSI**	**SD**
Females		
Columbus	15.986456	7.78181
Elkhorn River	14.157053	5.047385
Plattsmouth	8.345582	5.40571
Salt Creek	10.873618	6.176151
Males		
Columbus	0.9971491	0.3267922
Elkhorn River	0.7205228	0.4290684
Plattsmouth	0.5775498	0.3599298
Salt Creek	0.7378588	0.4397371

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State Report: South Dakota

Agency: South Dakota Game, Fish, and Parks & South Dakota State University

Project Title: Using otolith microchemistry to identify the natal origin and movement of invasive carp in the Missouri River Basin.

Note: Originally submitted under the Define Population Work Group

Methods:

SDGFP in conjunction with SDSU will work to determine invasive carp recruitment sources throughout the Missouri River Basin. This work will build upon a prior study by Southern Illinois University that identified differences in water chemistry throughout the Missouri River Basin (stable oxygen isotope ratio and strontium, barium, and calcium concentrations). Since otoliths are chemically inert, the chemical composition of the environment is collected in otoliths as fish grow and move among locations with different water chemistry. We can then analyze the chemical composition from the core of an adult's otolith to identify the location where it was spawned. This allows us to determine whether adults collected from a location were produced in that area or if they were spawned in another location and subsequently moved later in life. This knowledge can identify potential locations from which adult Missouri River Basin invasive carp are recruiting while informing source-sink dynamics and decisions regarding the location of management actions (e.g., placement of movement deterrents or removal effort).

Otolith microchemistry can provide an important tool for determining the natal origin of freshwater fishes from environments with distinct water chemistries (Campana et al 2000; Gibson-Reinemer et al. 2009; Zitek et al. 2010). Water samples were previously collected and analyzed from the Missouri River main channel and tributaries (Listed in Table 1 of Whitledge 2022). This prior study indicated that many tributaries and main channel reaches have distinct chemical signatures that can be used to identify the natal origins of invasive carp (Whitledge 2022). To account for possible changes in water chemical signatures between this study and prior data reported by Whitledge (2022), 46 additional water samples spanning two years were collected and analyzed for trace elements (barium, Ba; strontium, Sr; and calcium, Ca) and oxygen isotope ratios ($\delta^{18}O$). These water samples were collected using 250-mL, acid-washed, polyethylene bottles that are pre-rinsed with river water, filtered through a Whatman Puradisc PP filter (0.45 µm), and stored in sealed, acid-washed polyethylene bottles. Water samples were sent to the University of Southern Mississippi for stable oxygen isotope ratio ($\delta^{18}O$) analysis.

In 2024 and 2025, lapilli otoliths from 18 locations (tributaries and main channel reaches) throughout the Missouri River Basin were obtained from state and federal partners for trace element analysis. Up to 50 otoliths per location were selected for analysis across a range of available sizes and sexes. Otoliths were mounted in epoxy and transversely sectioned to create a thin section exposing the nucleus, and thin sections were mounted to a glass slide. With one otolith, laser-ablation ICP-MS will be used along a transect of the otolith beginning at the nucleus and ending at the margin to measure chemical signatures throughout the lifespan of the fish. Microchemistry will be analyzed for strontium, barium, and calcium concentrations. If needed to differentiate the origin, a core sample will be extracted from the second otolith using micro-milling and sent to the University of Arizona for $\delta^{18}O$ analysis. Chemical composition data will ultimately determine the proportion of adults present at a location that was spawned in that location versus the proportion of adults spawned in other specific tributaries or main channel reaches. These results will also allow us to quantify the amount of movement occurring among tributaries and main channel reaches, a temporal scale that complements ongoing telemetry work and spawning assessments in the basin.

The natal origin of Silver Carp will be evaluated by comparing trace-elemental markers and their ratios (Sr:Ca, Ba:Ca) measured from otoliths to chemical signatures from water samples. To screen for potential markers allowing the separation of chemical signatures from different rivers, we will use correlation analysis to evaluate relationships between element concentrations in water samples and otoliths. Trace elements and δ18O in lapilli otoliths that are correlated to water concentrations will be included in a model-based discriminant function or cluster analysis, such as k-nearest neighbor (KNN; Rosing et al. 1998). To evaluate classification error for assigning natal origin to carp, we will use a cross-validation approach. Age-0 Silver Carp may be targeted from tributaries across the basin to validate results from otolith microchemistry. Microchemical signatures from the otoliths of these age-0 individuals from known locations may be used as a training dataset for discriminant function analysis alongside the available water data (Hegg and Kennedy 2021).

Results and Discussion:

From the 22 target locations in the Missouri River Basin, otoliths from 636 adult Silver Carp and Bighead Carp were obtained from 14 locations. Young-of-year individuals were obtained from seven locations for microchemical signature confirmation. Previously collected data on otolith microchemistry from Silver Carp in the James River and Vermillion River in South Dakota, and several Nebraska rivers will also be used in future analyses, resulting in at least 18 rivers being assessed. Otoliths could not be obtained from 5 locations (Big Nemaha, Hinkson, Loutre, a Missouri River reach in Nebraska, and the Platte River in Nebraska) due to sampling limitations. Otoliths were contributed by: U.S. Fish & Wildlife Service - Columbia Fish and Wildlife Conservation Office, Iowa Department of Natural Resources, Kansas Department of Wildlife and Parks, and Missouri Department of Conservation. When more otoliths were available than needed for analysis of a location, we randomly selected otoliths across the range of fish total lengths. We also ensured we had multiple years represented and equal representation of males and females where feasible.

Water samples for microchemistry comparison to otoliths were obtained from 21 of the 22 target locations in 2024 and 2025. Samples were sent to the University of Southern Mississippi for processing. Water chemistry results indicate differences among tributaries across the chemical signatures examined (Figure 2).

Tables and Figures:

Figure 7. Locations of water and otolith collection (N = 22).

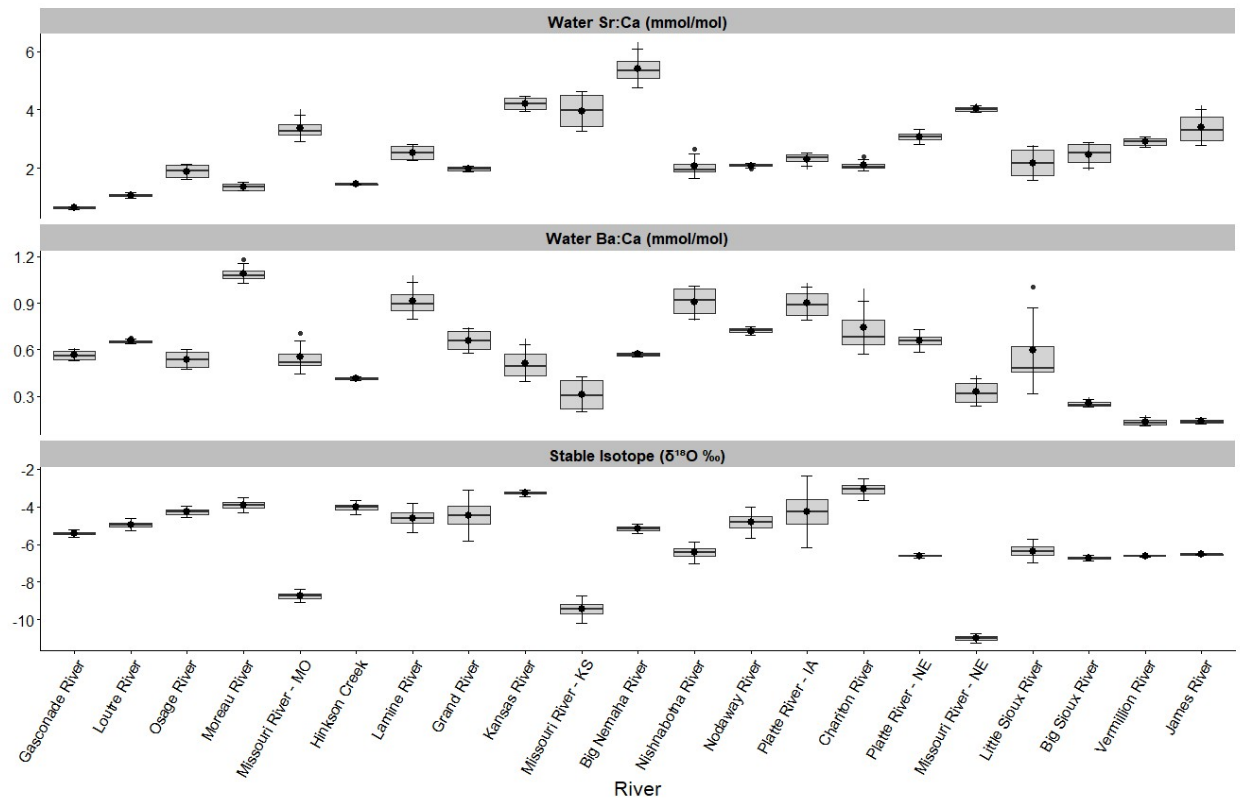

Figure 2. Water chemistry results from 21 locations throughout the Missouri River and its tributaries.

Recommendation: Processing of otoliths and a second year of water chemistry samples (collected in summer 2025) will help identify natal origins for invasive carps.

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State Report:

Agency: U.S. Fish and Wildlife Service

Project Title: Determine Silver Carp and Bighead Carp residence time and movement in the Missouri River and its tributaries in association with season, environmental conditions, and barriers to inform containment and control management actions

Note: Originally submitted under the Movement and Habitat Use Work Group

Methods:
In mid-September 2025 the Great Plains FWCO completed eDNA sampling at multiple locations on the Big Sioux River upstream of an impassible barrier (waterfall) located within Falls Park, Sioux Falls, SD. This portion of the Big Sioux River has not been extensively sampled for the presence of invasive carp eDNA.

Four sites were selected upstream of the waterfall on the Big Sioux River to identify potential range expansion of invasive carp above the barrier. Four additional sites were selected on Split Rock Creek upstream of the confluence with the Big Sioux River to determine the extent of range expansion on the unimpeded portion of the creek. The sampling at the four Split Rock Creek sites was not completed due to staff availability during the lapse in federal funding that occurred in October and November 2025.

US Fish and Wildlife Service Regional backpack eDNA sampling protocols were followed at each site sampled on the Big Sioux River. This included obtaining nine water samples and one field blank with a backpack eDNA system (Smith-Root eDNA Sampler) and adhering to stringent field contamination prevention measures. A new, sealed self-desiccating 5-micron eDNA filter was used for each sample. and was affixed to the backpack inlet. Water was pumped through the filter at a minimum flow rate of 0.1 L/min and a maximum pressure of 10 PSI until 2 L of water were filtered or until the system identified a flow rate of less than 0.1 L/min. The filter was removed from the inlet and placed in a sealed bag for shipment to the laboratory for testing. The process was repeated for the eight remaining samples and the field blank at each sample site.

Filter packs were shipped to the Bozeman Fish Health Center for eDNA analysis. Samples could not be processed in time for reporting due to staff availability during the lapse in federal funding that occurred in October and November 2025.

Results and Discussion:
No results are avaialable for this report, however results will be provided electronically to the Missouri River Invasive Carp Partnership and will be included in the 2026 technical report. Additional sampling will occur in 2026 to continue to identify potential invasive carp range expansion in these tributaries.

State Report: Iowa

Agency: Iowa Department of Natural Resources & Iowa State University

Project Title: Determine Silver Carp and Bighead Carp residence time and movement in the Missouri River and its tributaries in association with season, environmental conditions, and barriers to inform containment and control management actions

Note: Originally submitted under the Movement and Habitat Use Work Group

Methods:
Sub-Objective 1: In fall 2025, we tagged 120 Silver Carp at six locations on the Missouri River (Figure 1), bringing our total Silver Carp tagged over the entirety of the study to 369 Silver Carp (Table 1). To monitor movement of tagged Silver Carp we maintained existing acoustic receiver arrays in the Floyd, Little Sioux, Boyer, and Nishnabotna rivers (further detailed in sub-objective 2). To expand our detection coverage of tagged individuals, we obtained detections from existing partner agency arrays distributed throughout the Missouri River and its tributaries (Figure 1).

Sub-Objective 2: To monitor backwater habitat use of Silver Carp, we deployed nine acoustic receivers in seven backwaters of the Missouri River in summer 2025 (Table 2, Figure 1). We deployed one receiver in small backwaters (< 3 ha) where one receiver was able to obtain complete coverage. In larger backwaters, we deployed one receiver near the mouth and a second receiver further into the backwater, out of the line-of-sight of the first receiver, to better detect fish that occupied the backwater. We removed all backwater receivers in late fall 2025 before water levels dropped. To monitor tributary use of Silver Carp, we deployed an acoustic array of 25 omnidirectional receivers throughout four tributaries of the Missouri River. We deployed 19 receivers in the Little Sioux River spanning 373 river kilometers (average separation of 18.5 kilometers) and two receivers in each of the Floyd, Boyer, and Nishnabotna rivers beginning in fall 2023 (Table 2). In these three tributaries, one receiver was deployed less than 2 km from the confluence with the Missouri River while another receiver was deployed 1-18 km further upstream. We primarily deployed receivers on existing bridge piers; thus, bridge availability and accessibility determined receiver locations. We visit receivers twice per year to download detection data and replace batteries.

Sub-Objective 3: In 2025, we tagged 14 Silver Carp with V16-4x acoustic transmitters in Milford Creek, supplementing tagging efforts conducted in 2022 and 2023 (Table 3). However, we were unable to successfully find and capture a bigheaded carp in Milford Creek. Therefore, we captured Silver Carp using boat electrofishing in the Little Sioux River near Linn Grove, IA and tagged and released the fish upriver of the farthest upstream road crossing on Milford Creek 1.9 rkm downriver of the electric barrier. We also maintained our existing array of the three receivers in Milford Creek (Figure 2) and downloaded receivers in Spring and Fall.

Sub-Objective 4: To assess barrier residency and passage of invasive carp and native fishes at Sill 4 in 2025. We continued to implant V16-4x and V13-1x transmitters and invasive carp in the Little Sioux River downriver of Sill 4 (Table 4). In 2025, lower water conditions prevented the use of a boat downriver of Sill 4. As a result, we made attempts to capture fish by canoe and wading using hoop nets, gill nets, and angling. Despite our efforts, we only successfully captured and tagged one Silver Carp and one Channel Catfish. To further increase our sample size, we captured fish downriver of Sills 1-3 and transported and tagged the fish near the confluence receiver 7.32 rkm downriver of Sill 4. In total, we captured and tagged 53 fish downriver of Sill 4 in 2025 (Table 4). Furthermore, we maintained our array of five acoustic receivers within near proximity of Sill 4 and our additional receivers throughout the Little Sioux River upriver of Sill 4 to monitor passage (Figure 2). Due to concerns of buried receivers and public tampering we monitored the receivers near Sill on a bi-weekly basis and downloaded receivers monthly. We downloaded all other receivers in the Little Sioux River basin in spring and fall.

Results and Discussion:
Sub-Objective 1: We have most recently downloaded receivers in the Floyd, Boyer, and Nishnabotna rivers in fall 2025 (Table 2). We have also received and analyzed detection data from partner agencies as recently as January 2025. Most of our current preliminary analyses are therefore limited to fish tagged in 2023 and 2024 with sufficient detection histories to analyze movement patterns. Of tagged individuals with more than 2 days (n=119) of detection histories, a large proportion of tagged individuals display extremely sedentary behavior (Figure 3). Almost half (47.9%) of Silver Carp were never detected beyond 25 river kilometers. However, carp that did move exhibited extremely mobile tendencies. A third (33.3%) of Silver Carp had a total range of >100 river km, 16.9% had a total range of >200 river km, 4.2% had a total range >500 river km, and 1.2% had a total range >100 river km. To identify meaningful management units for Silver Carp in the Missouri River, we used a network analysis framework to model detection histories of Silver Carp. We applied a community detection algorithm to our generated network to identify communities where individual fish are more likely to remain for an extended period of time. These communities represent areas of the network where movement is concentrated within an area while minimizing between community movements. We identified 10 management units for the Missouri River (Figure 5). These management units varied in their spatial range (average span 69.4 rkm), such as the small unit right below Gavins Point Dam and larger management units lower in the Missouri River. Overall, most units span the mainstem between tributaries in our study area. These units are built on movement tendencies and thus can be used to define subareas of the Missouri River to assess the impact of management actions.

Sub-Objective 2: We retrieved and downloaded all nine backwater receivers in late Fall 2025 (Table 2). Cumulatively, we acquired 957,122 detections of Silver Carp (n = 60) across the nine backwater receivers (Table 2). Overall, only a small percentage of Silver Carp (16.2%) used Missouri River backwaters. Of the individuals that did enter a backwater, backwater use appears to be driven by proximity to their tagging location. In only two instances was a fish detected at a backwater receiver >8 river km from their tagging location. The mean distance from backwater to tagging location across all 60 individuals was 4.21 km (SE = 1.67 km). The only two backwaters that did not detect any Silver Carp were both >30 river km from a tagging location. No fish were detected in more than one backwater. Preliminary results indicate residency durations differ among backwaters potentially due to differences in size; Silver Carp resided in the smallest backwater shorter periods compared to the other four backwaters that detected Silver Carp. However, as this was the pilot year of the project and receivers were only deployed in backwaters from summer until late fall 2025, a more complete detection history for each backwater throughout the year is needed. This will allow us to evaluate how residency may vary in response to backwater characteristics and environmental variables such as temperature, discharge, and seasonality.

Occupancy of Silver Carp appears to differ among tributaries (Figure 4). We have not detected Silver Carp in the Floyd River. The receiver located nearest to the Boyer River has detected 6 Silver Carp for up to 4 days, but none were detected on the receiver 12 km upstream. These detections suggest few fish use the Boyer River, and they only stay short periods of time near the confluence. The receiver located at the confluence of the Nishnabotna River has detected 23 Silver Carp; however, the receiver located 19 km upstream only detected one. Residency near the confluence of the Nishnabotna River appears to be high as 15 of the 23 fish detected on this receiver were never detected on any other receiver in the basin. The receiver nearest to the confluence in the Little Sioux River detected 16 Silver Carp. Residency was high in the Little Sioux River as 11 fish were also detected at the receiver located 8.4 km upstream and 8 fish were detected at the receiver located 8.9 km upstream, just downstream of Sill 4, a significant barrier to passage (see sub-objective 4). From external partner receiver arrays, Silver Carp we tagged visited an additional eight tributaries throughout the Missouri River. Receivers in the James River detected two Silver Carp, one of which made a significant exploration (movement >2 km upstream of the confluence) to a maximum of 355 river kilometers upstream. Receivers in the Vermillion River detected two fish, of which both made considerable exploration into the tributary (30 km and 90 km). Receivers in the Big Sioux River detected 13 fish, two of which made significant explorations to 88 and 240 km upstream, respectively. Receivers in the Platte River detected 12 fish, five of which made significant explorations. Receivers in the Elkhorn River, a tributary of the Platte River, detected one fish up to 46 km upstream for a total of 98 kilometers from the confluence with the Missouri River. Receivers in the Kansas and Osage rivers detected one fish in each of the tributaries, but neither fish explored more than one kilometer from the confluence. Last, receivers in the Grand River detected three fish, but none made exploratory movements of more than 3 km. Silver Carp use of tributaries is thus low overall with few fish making movements past tributary confluences.

Sub-Objective 3: Cumulatively, we acquired 322,822 invasive carp detections (2022: 139,994 detections; 2023: 136,941 detections; 2024: 45,937 detections; 2025: 171,733) on the three receivers within Milford Creek between May 2022 to May 2024. A majority of these detections (322,605) were recorded by the acoustic receiver 250 m downstream of the electric fish barrier. Of the 33 fish (9 Silver Carp and 24 Bighead Carp) tagged in Milford Creek, all but 1 Silver Carp have been detected near the barrier. The number of fishes detected near the barrier coincides with increased water levels and leads to a high proportion of the bigheaded carp present at the barrier when there is sufficient flow for bigheaded carp to traverse the barrier (Figure 5). However, despite fish being present and available to pass the electric barrier, no acoustically tagged bigheaded carp have been detected in the Iowa Great Lakes suggesting the electric barrier is an effective deterrent.

Sub-Objective 4: We amassed 2,370,605 detections with 958,563 detections in 2024 and 1,412,042 detections in 2025. In total, only four passage events occurred between all species despite high flows throughout a large part of the summer of 2024 and 2025. We detected four fish that passed upstream of Sill 4 during 2024: one Bigmouth Buffalo in June when discharge was 220 m^3/s and three invasive carp from August to October with discharge ranging from 9 to 50 to m^3/s , and no fish passed upriver in 2025 (Figure 6). The lack of upstream passage during the high water periods in June through mid-July 2024 and most of the 2025 summer and some passage during lower flows suggest Sill 4 may be acting as a potential velocity barrier to upstream passage of invasive carp, but a Bigmouth Buffalo successfully passed Sill 4 under flows double the 35 year median discharge.

Presence of invasive carp and native fishes at Sill 4 differs across species with differing seasonal and environmental conditions. Results from proportional hazard Cox models indicate the emigration from the Little Sioux River altogether is largely driven by water temperature across species (Figure 7). Native fishes are more likely exit the Little Sioux River with increasing water temperatures in late spring through summer, especially Blue Suckers that exit the Little Sioux River rapidly when water temperatures exceed about 22°C. However, Blue Suckers and Bigmouth Buffalo demonstrate consistent migratory tendencies and exit the Little Sioux River, but Smallmouth Buffalo have a low likelihood of exiting the Little Sioux River throughout the year. In comparison, Silver Carp and Grass Carp emigration is less strongly related to water temperature with more variability, but the likelihood of emigration is generally negatively related to water. Binary Sill 4 presence-absence Generalized Linear Mixed Models indicates there may be seasonal species presence differences at Sill 4 (Figure 8). Silver Carp presence at Sill 4 peaks in late July and early August but are persistent from June through September. Conversely, Channel Catfish have a high probability of presence near Sill 4 from early April through mid-June, and Bigmouth Buffalo presence peaks in May and June. Blue Suckers generally have a high probability of presence near Sill 4 from May until they exit the Little Sioux River in the summer. However, Smallmouth Buffalo presence at Sill 4 remains low throughout the year but peaks later in July and August. This further supports the claim that Smallmouth Buffalo are likely residents within this small stretch of river. Collectively, the emigration and Sill 4 presence data suggest native fishes are more likely to be present near Sill 4 in spring and early summer whereas Silver Carp presence peaks in mid-summer but are persistent from June through September.

Tables and Figures:

Table 1. Number, size, and sex of Silver Carp tagged in the Missouri River from 2023 to 2025 at each of six sampling locations. See Figure 1 for tagging locations.

		# Tagged			Total Length (mm)		Sex	
Site	River km	2023	2024	2025	Mean	Min-Max	Male	Female
Weedland	1,162	24	24	20	596	438-930	25	18
Winnebago	1,140	23	23	21	599	442-894	20	49
Decatur	1,113	19	19	20	572	400-694	34	24
Blair	1,043	23	30	16	608	413-838	37	27
Bartlett	934	18	0	25	645	435-792	47	21
Peru	872	23	23	18	604	417-810	29	38

Table 2. Deployment and maintenance information for acoustic receivers located throughout the Missouri River basin. See Figure 1 for visual references for acoustic receiver locations.

Deployment Date	Most Recent Download	Removal Date	Waterbody	Site Name	Receiver	Latitude	Longitude	Mount Type	# of detections	# of Silver Carp
3/28/2024	11/1/2025		Floyd River	FLD - Confluence	VR2Tx-482418	42.494269	-96.389882	BR	0	0
3/28/2024	11/1/2025		Floyd River	FLD - 11th St	VR2W-137666	42.50193	-96.38484	BR	0	0
10/25/2023	10/31/2025		Boyer River	BR - Boyer Confluence	VR2Tx-482419	41.467015	-95.910164	BT	350	6
3/28/2024	5/16/2025	6/11/2025	Boyer River	BR - 335th St Missouri Valley	VR2W-134579	41.549011	-95.871703	BR	0	0
6/11/2025	10/31/2025		Boyer River	BR - 335th St Missouri Valley	VR2W-137634	41.549011	-95.871703	BR	0	0
10/25/2023			Nishnabotna River	NR - Nishnabotna Confluence	VR2Tx-486248	40.48664	-95.68802	BT	46,746	23
7/11/2024			Nishnabotna River	NR - US 275 Hamburg IA	VR2W-137629	40.601582	-95.645416	BR	63	1
6/11/2025	10/31/2025	10/31/2025	Missouri River Backwater	MO Backwater - Harbor 671 South	NexTrak-801459	41.8109942	-96.0977823	BT	0	0
7/4/2025	10/31/2025	10/31/2025	Missouri River Backwater	MO Backwater - Harbor 671 North	NexTrak-801466	41.8170544	-96.1090257	BT	0	0
7/4/2025	10/31/2025	10/31/2025	Missouri River Backwater	MO Backwater - Blair	NexTrak-801461	41.5599221	-96.0960723	BT	553,880	33
8/21/2025	11/1/2025	11/1/2025	Missouri River Backwater	MO Backwater - Omaha	NexTrak-801455	42.1739633	-96.3544646	BT	26,557	3
8/20/2025	10/26/2025	10/26/2025	Missouri River Backwater	MO Backwater - Levee Road Entrance	NexTrak-801454	40.5083547	-95.6980567	BT	89,638	15
8/20/2025	10/26/2025	10/26/2025	Missouri River Backwater	MO Backwater - Levee Road Backwater	NexTrak-801453	40.5092514	-95.6968571	BT	57,325	15
8/21/2025	10/31/2025	10/31/2025	Missouri River Backwater	MO Backwater - Pop-N-Docs Marina	NexTrak-801463	42.0107966	-96.2423091	BT	268	3
8/21/2025	10/31/2025	10/31/2025	Missouri River Backwater	MO Backwater - Skinny Italy Entrance	NexTrak-801467	41.9824471	-96.1761638	BT	181,920	5
8/21/2025	10/31/2025	10/31/2025	Missouri River Backwater	MO Backwater - Skinny Italy Backwater	NexTrak-801472	41.9859135	-96.1801837	BT	47,534	5

Table 3. Tagging summary of bigheaded carp in Milford Creek from 2022 through 2025.

	Species	
Year	Silver Carp	Bighead Carp
2022	9	14
2023	0	9
2024	0	0
2025	14	0
Total	23	23

Table 4. Summary of fishes tagged in spring 2024 and 2025, including species, count of individuals tagged, mean total length (mm), minimum total length (mm), maximum total Length (mm), and year.

Year	Species	Number tagged	Mean total length (mm)	Minimum total length (mm)	Maximum total length (mm)
2024	Bigmouth Buffalo	18	607	479	772
	Blue Sucker	5	566	480	630
	Channel Catfish	4	445	419	475
	Flathead Catfish	2	476	452	499
	Grass Carp	11	782	637	852
	Silver Carp	23	636	559	923
	Smallmouth Buffalo	19	450	368	575
2025	Bigmouth Buffalo	8	502	386	655
	Blue Sucker	10	629	552	750
	Channel Catfish	1	NA	610	610
	Grass Carp	8	694	592	790
	Silver Carp	21	610	500	710
	Smallmouth Buffalo	5	540	415	652

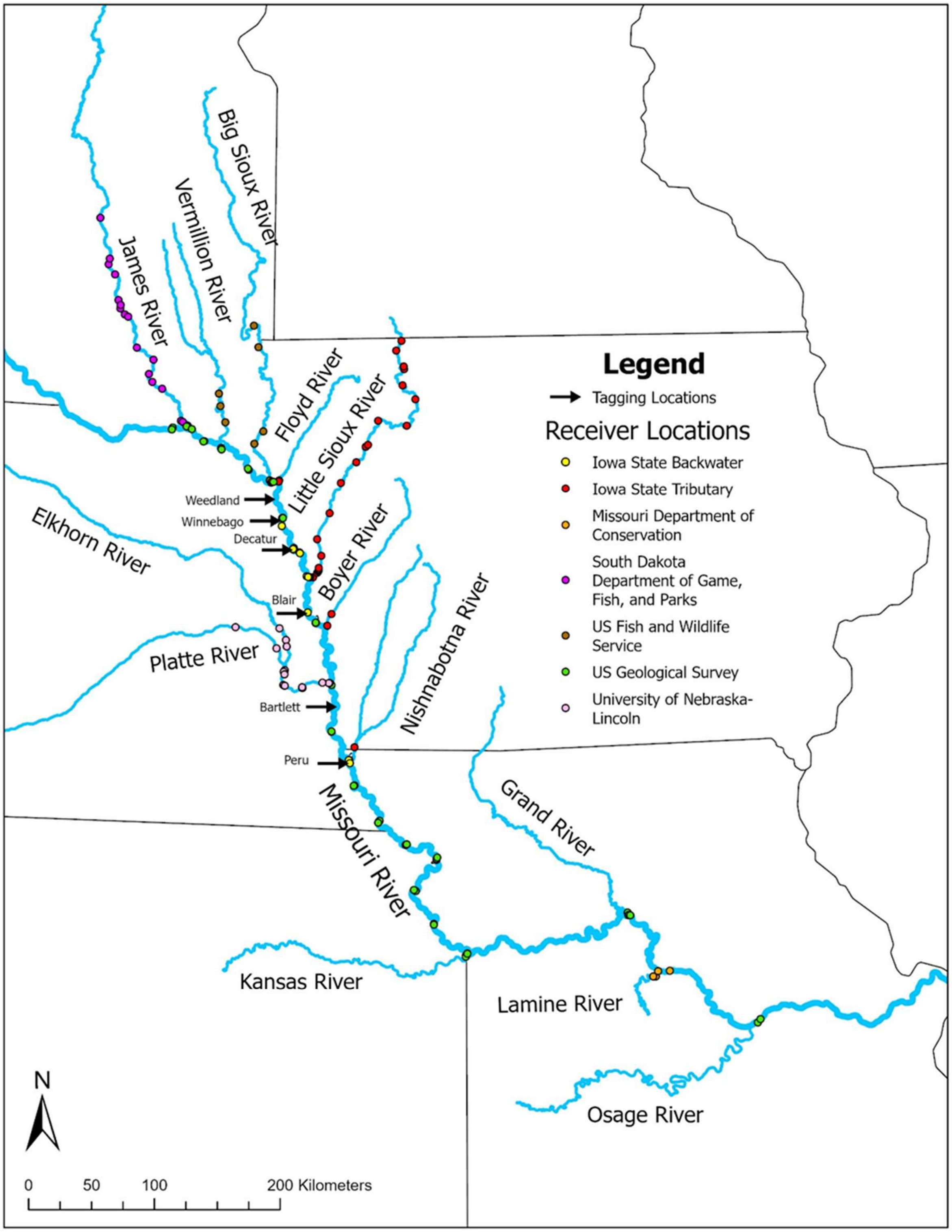

Figure 1. Stationary acoustic receivers deployed throughout the Missouri River basin to observe movements of Silver Carp. Tagging locations are indicated by black arrows. Receivers are colored by ownership.

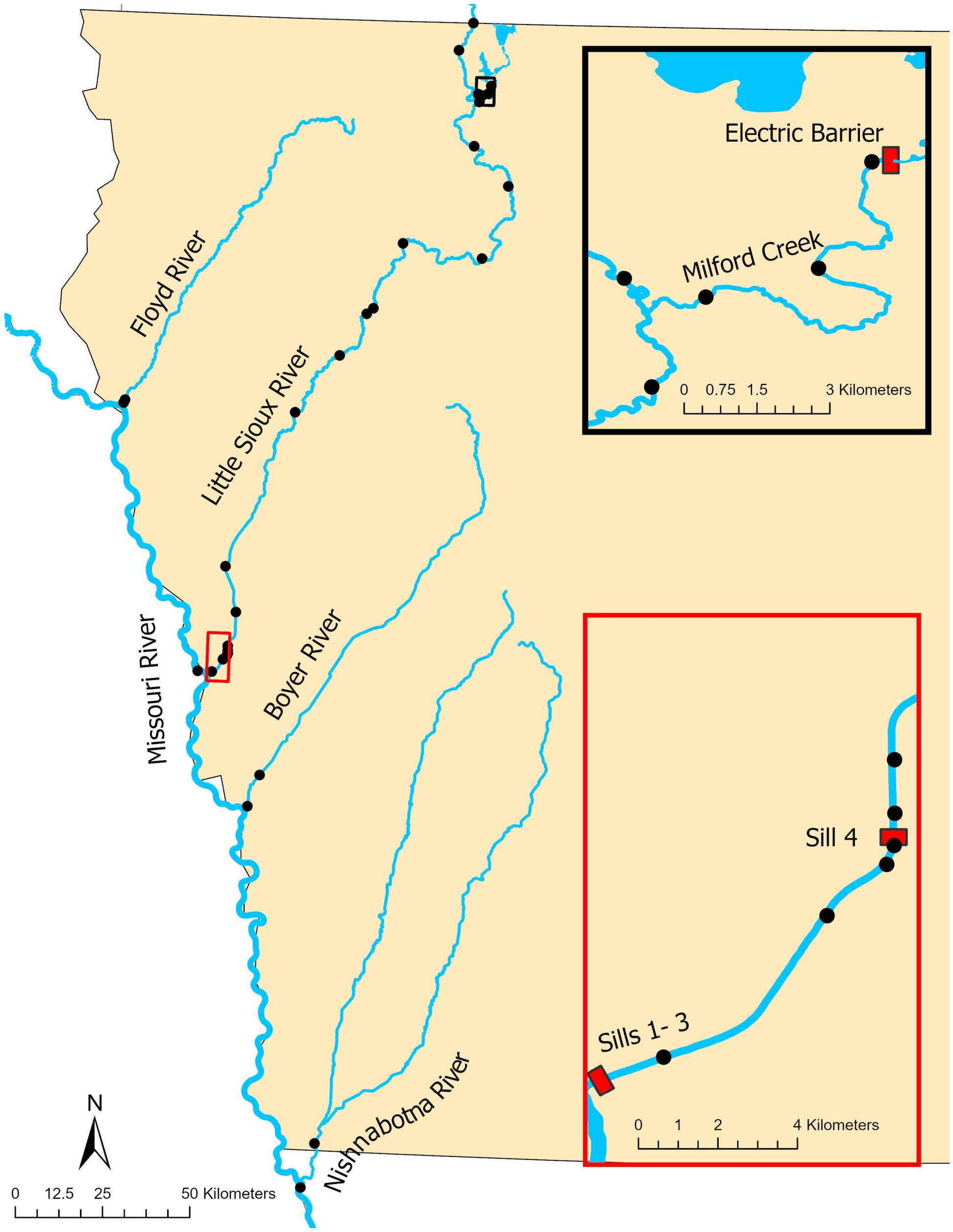

Figure 2. Little Sioux River acoustic telemetry array in 2025 with a focus on the Milford Creek Array (black) and receivers near Sill 4 (red).

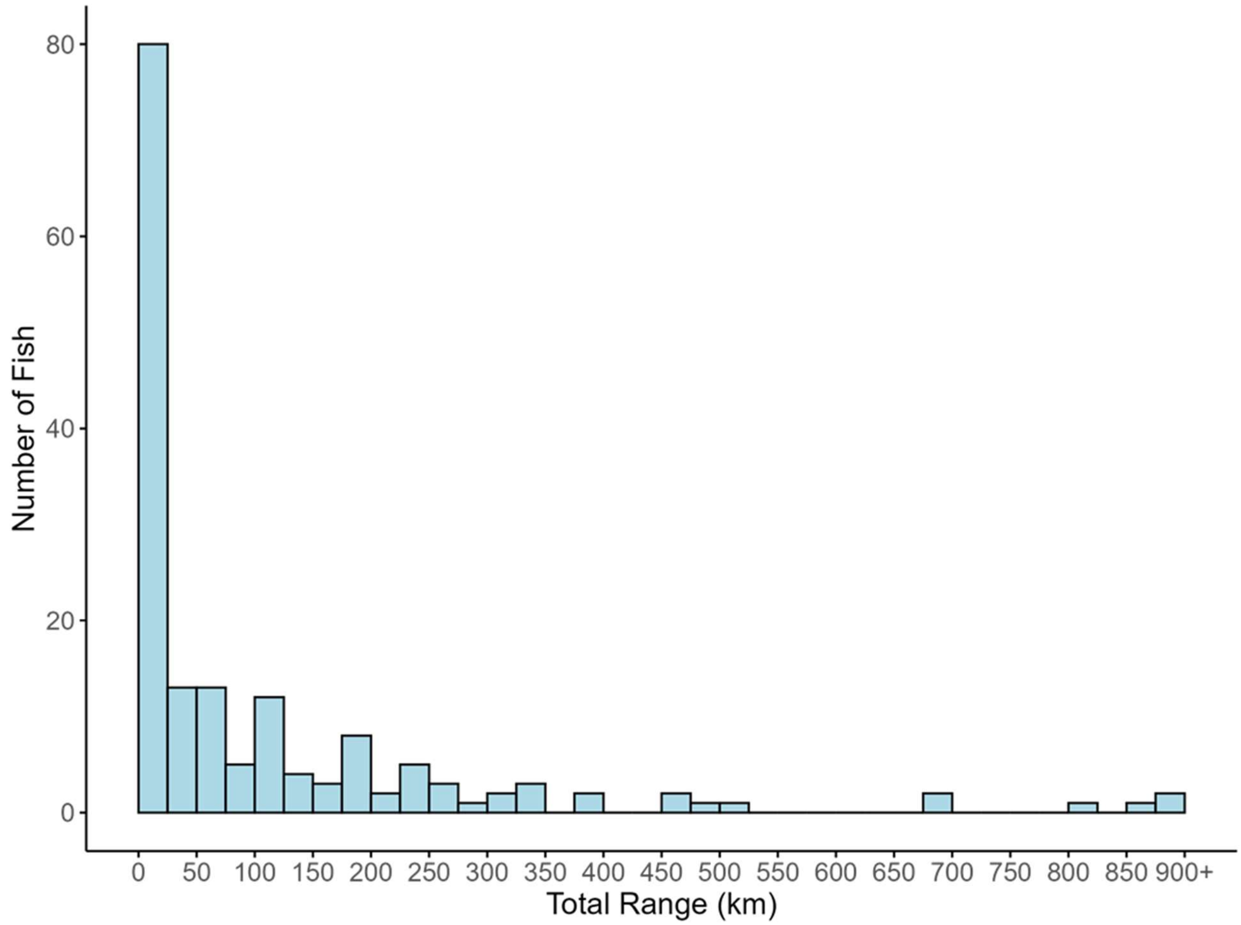

Figure 3. Histogram of total displacement ranges by Silver Carp in the Missouri River basin. Range calculated by subtracting the river kilometer of the downstream-most receiver that a fish was detected from the upstream-most detection. Only fish detected for >2 days over the study period considered.

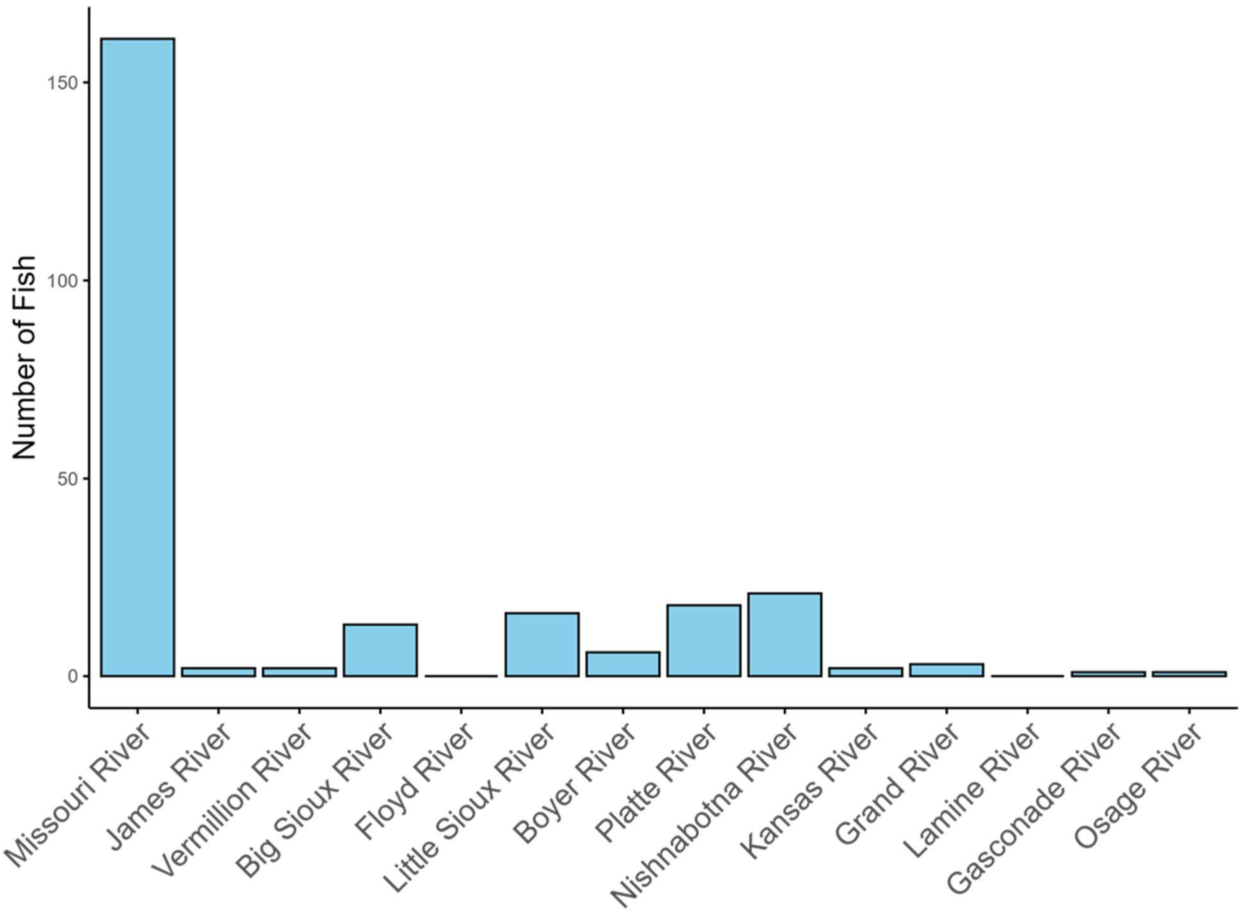

Figure 4. Histogram showing the total number of Silver Carp that were detected in tributaries of the Missouri River, with the number of Silver Carp detected in the Missouri River for scale. Tributaries are listed in a descending order by river kilometer of their confluence with the Missouri River

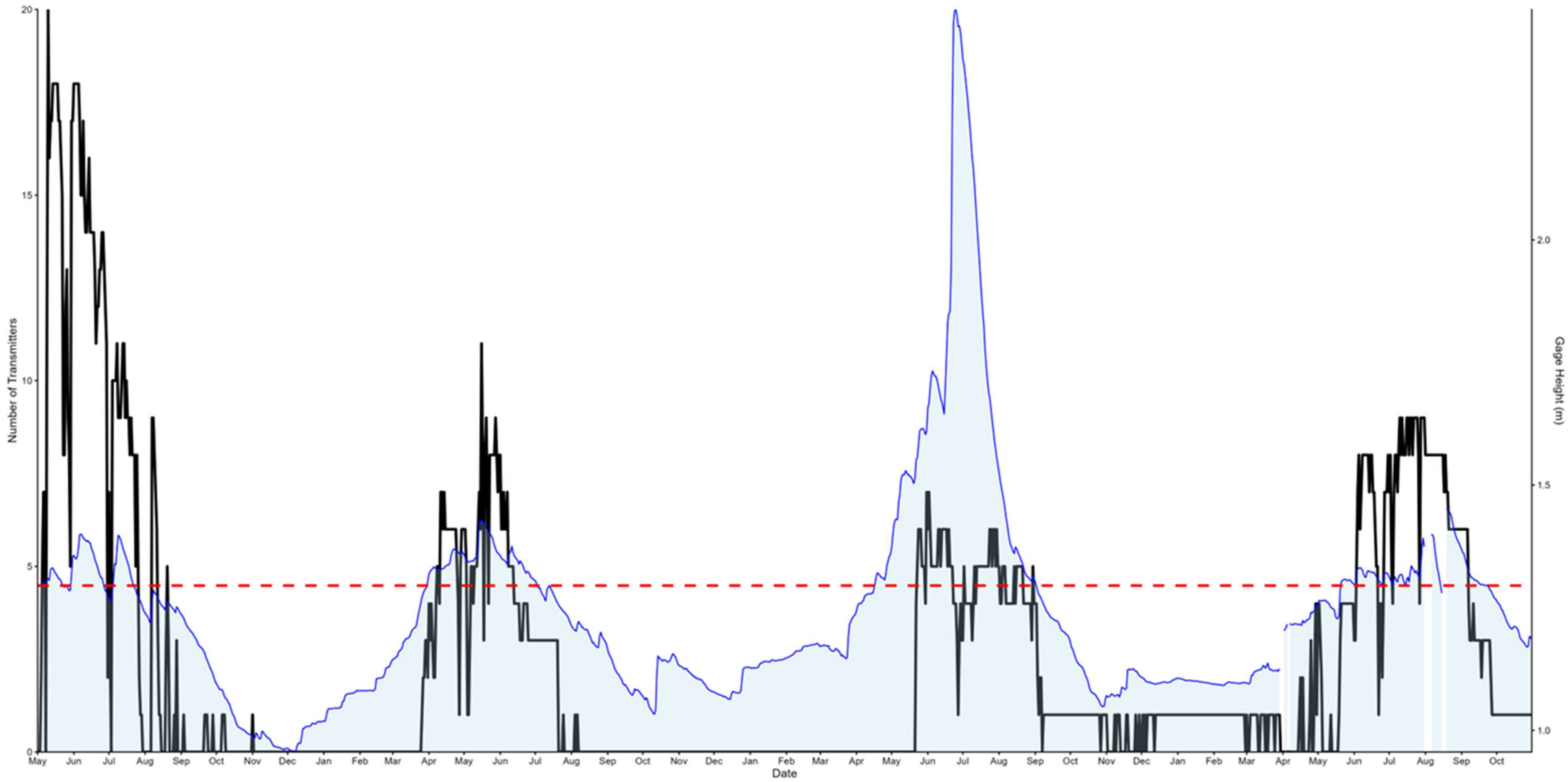

Figure 5. Daily counts of acoustically tagged invasive carp detected near the Milford electric barrier (black) with the gauge height of West Okoboji Lake (blue). The dashed red line represents the mark where an estimated 3 inches of water is flowing over the barrier at which point it is electrified.

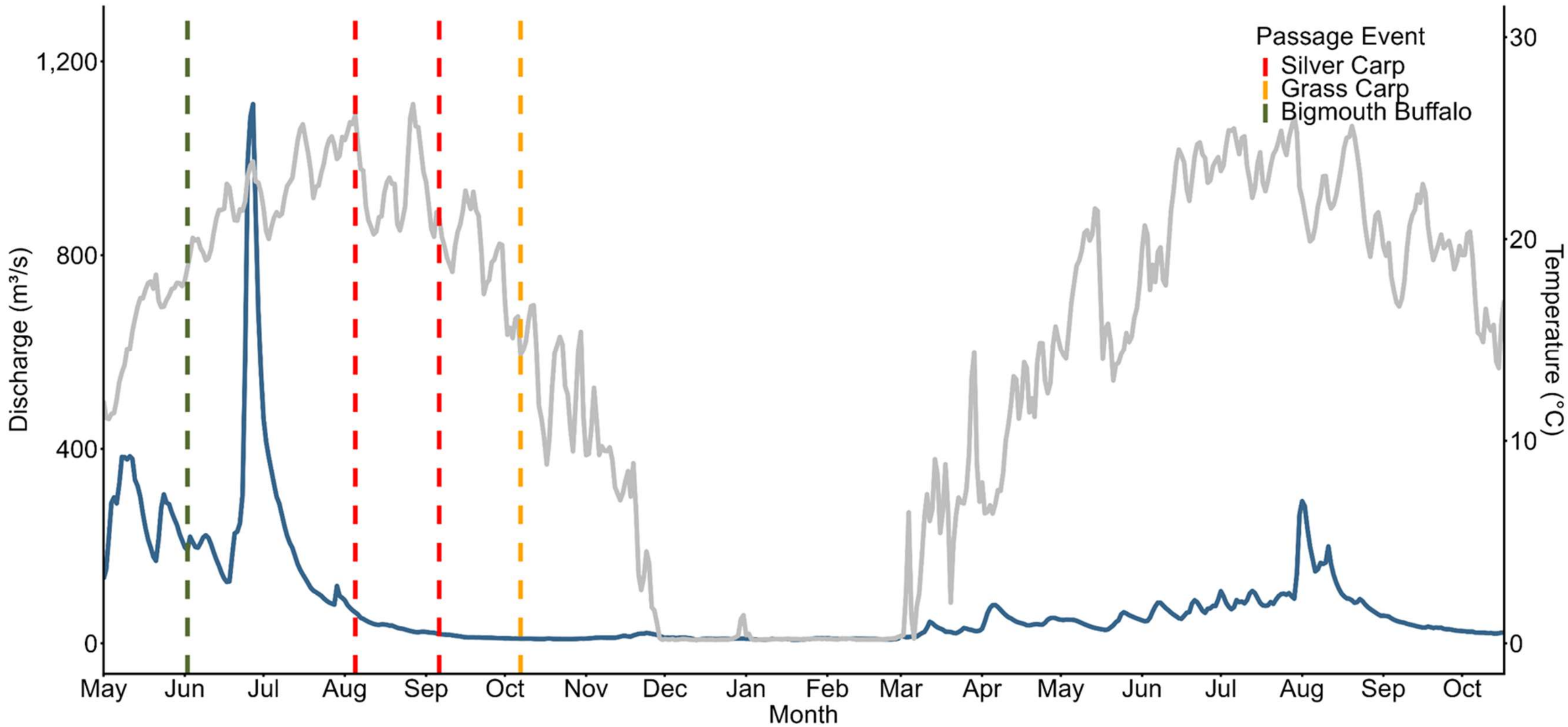

Figure 6. Sill 4 passage events from May 10, 2024 to October 20, 2025, with discharge (m3/s) in blue and water temperature (°C) in gray.

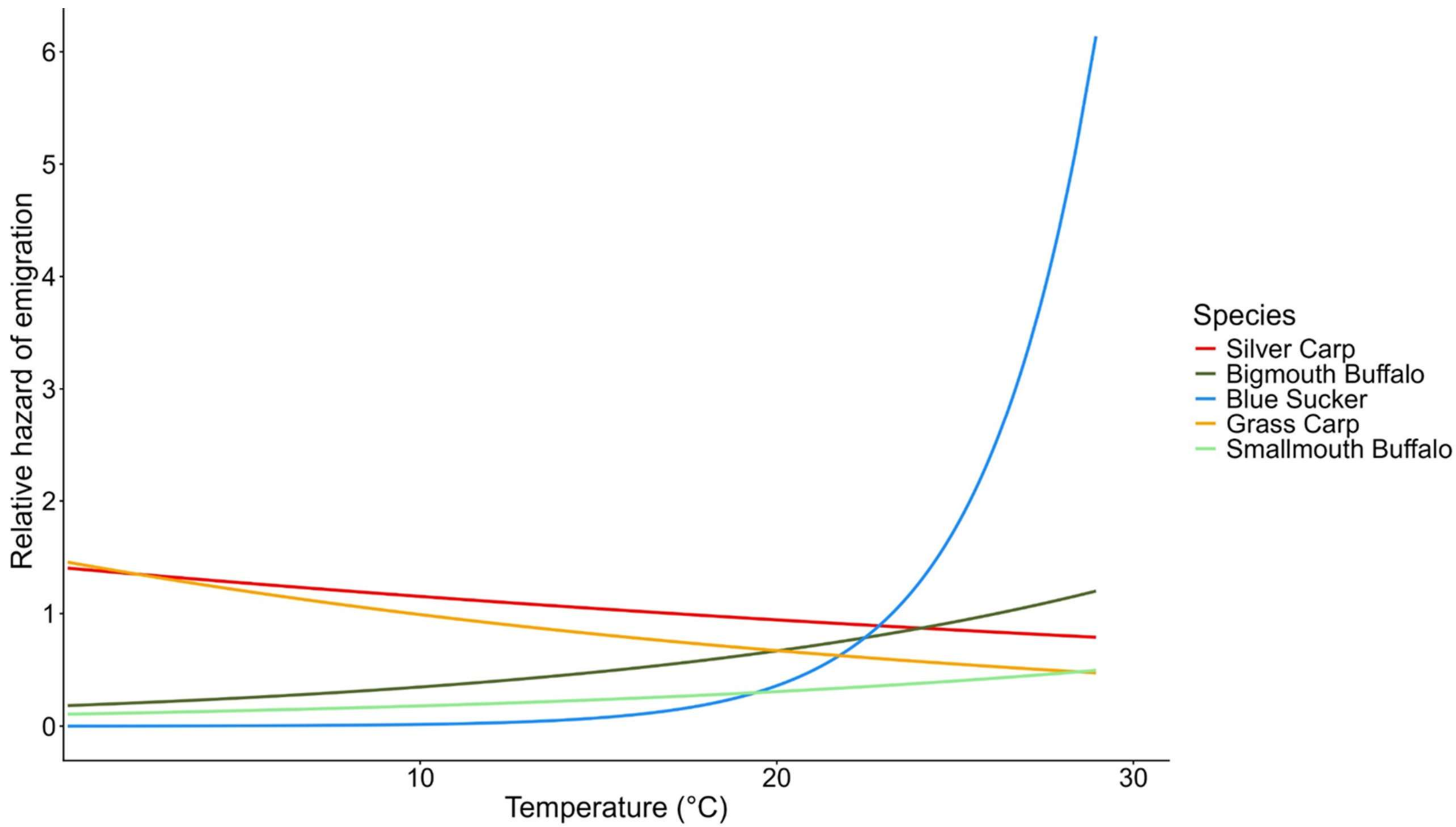

Figure 7. Relative hazard of exiting the Little Sioux River by species relative to Silver Carp at 17 °C as a function of water temperature, with discharge held constant.

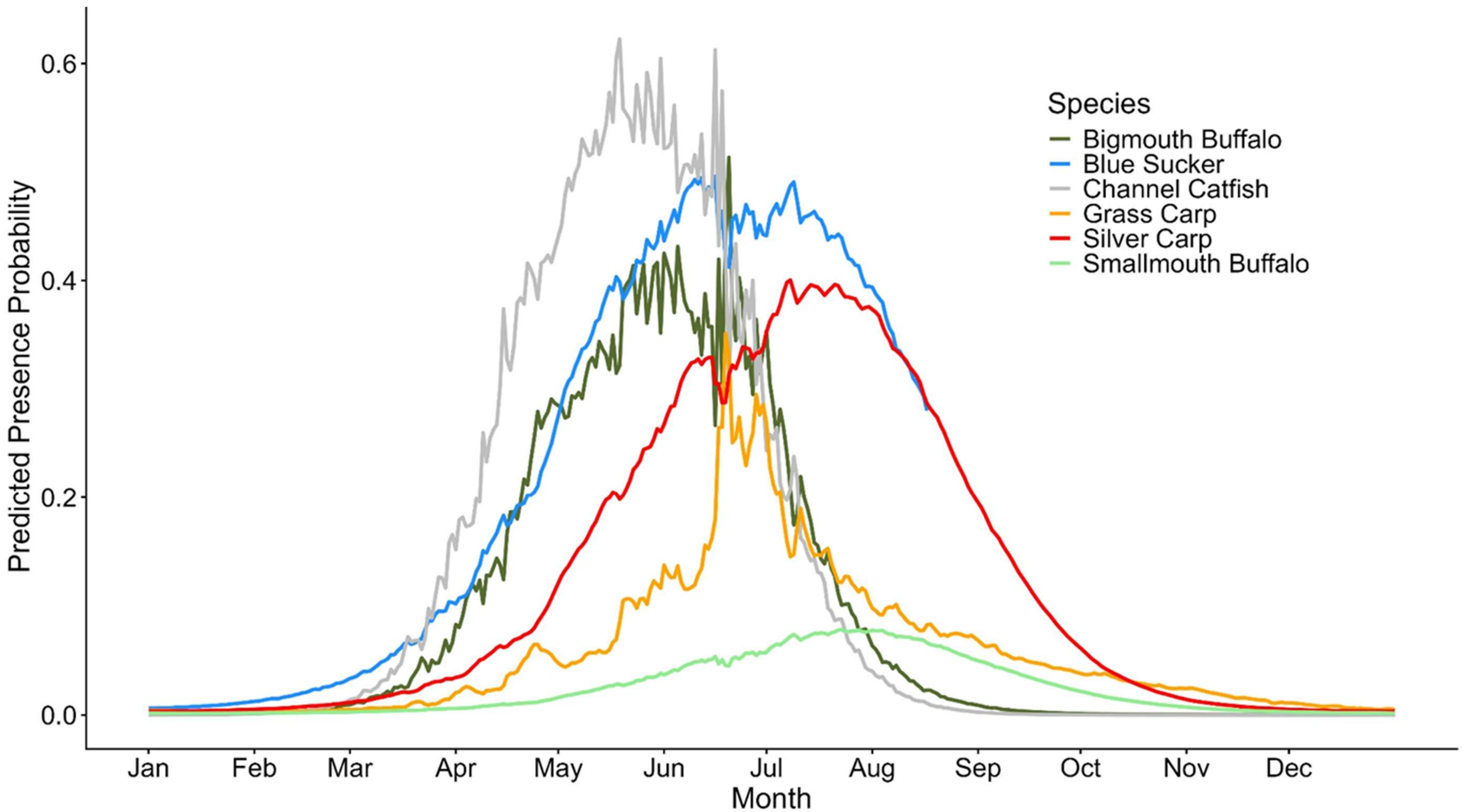

Figure 8. Predicted probability of presence at Sill 4 by species throughout the year using the 35-year median discharge, with no daily water temperature fluctuations

Recommendation:

We would first like to acknowledge that these are preliminary results, and our recommendation will be stronger following the completion of these projects. To control current population levels, we recommend utilizing the management units for Silver Carp we have established for the Missouri River. Our results indicate that connectivity between management units is low, whether that is between areas of the Missouri River or between the mainstem and tributaries. This indicates that management actions in each respective unit are likely to have sustained effects as fish are unlikely to immediate backfill the area following harvest. To contain invasive carp expansion, our results indicate the Iowa Great Lakes Outflow electric barrier is an effective deterrent at restricting the movement of bigheaded carp within the Little Sioux River basin, and operation should continue. However, to better manage the conflicting management goals of restricting invasive carp expansion while accounting for native fishes conservation, it may be potentially advantageous in rivers with an established invasive carp population upstream of a barrier to remove barriers and restore connectivity for native fishes spawning movements, but operate a nonphysical barrier during the summer through fall to still restrict the movements of invasive carp without impinging native fishes movement. Alternatively, given natural reproduction may be limited in the Little Sioux River upriver of Sill 4, native fishes upstream movements remain limited, and passage risk is highest during low flows, a nonphysical barrier could be retrofitted at Sill 4 and operated cost efficiently during low flows when nonphysical barriers are more effective to diminish the upriver Little Sioux River Silver Carp populations through natural mortalities.

State Report: Missouri

Agency: Missouri Department of Conservation

Project Title: Invasive carp movement and habitat use in the Missouri River Basin to inform containment and control management actions.

Note: Originally submitted under the Movement and Habitat Use Work Group

Methods:
No additional invasive carp were implanted with acoustic transmitters and no additional stationary telemetry receivers were deployed during 2025. All active stationary telemetry receivers were downloaded and maintained quarterly throughout the year; data was shared with the appropriate partners annually or upon request, and was uploaded to the Riverine Acoustic Fish Telemetry (RAFT) Network.

Results and Discussion:
Invasive carp movement has been tracked on a broad scale. Of the 320 invasive carp tagged, 169 were detected at least a single day during 2025. 161 of those invasive carp were not detected outside the Missouri River system, while eight invasive carp traveled approximately 32.2 – 447.7 river miles from their original tagging locations outside of the Missouri River system. One invasive carp tagged in Creve Coeur Creek traveled 62.0 river miles and was detected in the Illinois River at river mile 3.2 (Figure 1). Three invasive carp tagged in Creve Coeur Creek, one invasive carp tagged in the Moreau River, and one invasive carp tagged in the Lamine River traveled 32.2 – 212.0 river miles and were detected in the MMR at Mosenthein Island and the Lock and Dam 27 navigation canal (Figure 2). One invasive carp tagged in Creve Coeur Creek traveled 115.4 river miles and was detected in the Meramec River (Figure 3). One invasive carp tagged in the Grand River traveled 447.7 river miles and was detected in the Ohio River at Cairo, IL (Figure 4). 67 of those invasive carp were not detected outside of their respective tributaries, meaning they were only detected within the tributary that they were originally tagged in. Six invasive carp tagged in Creve Coeur Creek traveled approximately 1.9 – 171.8 river miles (total distance from tributary, not accounting for total distance actually traveled) within the Missouri River system (Table 1). 32 invasive carp tagged in the Moreau River traveled approximately 7.0 – 595.5 river miles within the Missouri River system (Table 1). 17 invasive carp tagged in the Lamine River traveled approximatley 7.1 – 606.7 river miles within the Missouri River system (Table 1). Nine invasive carp tagged in the Grand River traveled approximately 33.3 – 391.8 river miles within the Missouri River system (Table 1). 36 invasive carp tagged in the Kansas River traveled approximately 1.2 – 441.5 river miles within the Missouri River system (Table 1).

Tables and Figures:

Table 2. Origin (CCC = Creve Coeur Creek, MR = Moreau River, LR = Lamine River, GR = Grand River, KR1 = Kansas River RM1.0, KR16 = Kansas River RM16.0), previously detected location (End2024), transmitter ID, detected locations, distance from origin (DFO), and total distance traveled during 2025 (TD25) for each invasive carp tagged in the lower Missouri River system.

Origin	End2024	Transmitter ID	Detected Locations	DFO	TD25
CCC	St Charles	A69-1602-48945	MOR RM131.3 - MOR 367 Bridge	100.6	227.5
CCC	Chester	A69-1602-48946	St Charles	3.7	112.6
CCC	Chester	A69-1602-48947	MOR RM146.1 - Boonville - Lamine Mouth - MOR RM146.1	171.8	344.5
CCC	MOR 367 Bridge	A69-1602-48949	Upper LD27	32.2	9.6
CCC	St Charles	A69-1602-48953	MOR RM146.1 - MOR RM131.3 - Mosenthein SC - Meramec RM0.5	115.4	319.4
CCC	STL 255	A69-1602-48955	Upper LD27	32.2	25.4
CCC	MOR RM2	A69-1602-48961	Upper LD27	32.2	3.5
CCC	new	A69-1602-48974	MOR RM146.1	115.4	115.4
CCC	new	A69-1602-48978	Gasconade	74.5	74.5
CCC	L26	A69-1602-48979	(UMR RM226.8 - UMR SC RM226.8 (x2)) - ILR RM3.2	62.0	36.6
CCC	Creve Coeur Lake	A69-1602-48980	Creve Coeur Lake	1.9	0.0
MR	Moreau Mouth	A69-1602-49117	Moreau Mouth	0.5	0.0
MR	Osage Mouth	A69-1602-49119	MOR RM131.3 - MOR RM128.5 - Osage Mouth	9.8	6.6
MR	Moreau Upper	A69-1602-49120	Moreau Mouth	0.5	1.3
MR	MOR RM131	A69-1602-49123	Moreau Mouth	0.5	7.8
MR	Osage Mouth	A69-1602-49126	Osage Mouth - Mari-Osa (x1.5) - MOR RM146.1 - Osage Mouth - MOR RM131.3 - (Osage Mouth - Mari-Osa (x1.5))	17.8	72.8
MR	Osage Mouth	A69-1602-49127	MOR RM146.1 - (Osage Mouth - Mari-Osa (x2.5))	17.8	69.1
MR	Moreau Mouth	A69-1602-49128	MOR RM146.1 - MOR RM250.2	111.9	112.4
MR	Moreau Mouth	A69-1602-49129	Osage Mouth - Mari-Osa (x1.5) - (MOR RM146.1 - Lamine Upper (x1.5))	67.5	163.3
MR	Osage Mouth	A69-1602-49130	Osage BTB - (Osage Mouth - MOR RM146.1 (x1.5)) - (MOR RM131.3 - Osage Mouth (x4)) - MOR RM129.5 - (Osage Mouth - Mari-Osa (x1.5))	17.8	73.1

MR	Osage Mouth	A69-1602-49133	Osage Mouth	8.6	0.0
MR	Moreau Mouth	A69-1602-49134	MOR RM146.1	7.8	8.3
MR	Osage Mouth	A69-1602-49135	Osage Mouth - MOR RM146.1 - Boonville - Grand Mouth - MOR RM250.2 - Grand Upper - Grand Mouth - MOR RM250.2 - (MOR RM368.3 - MOR RM367.3 (x1.5)) - MOR RM398.0 - (MOR RM368.3 - MOR RM367.3 (x2)) - Grand Mouth - MOR RM250.2 - MOR RM146.1 - (Osage Mouth - Mari-Osa (x1.5))	259.7	564.2
MR	Moreau Mouth	A69-1602-49136	MOR RM146.1	7.8	8.3
MR	Grand Mouth	A69-1602-49137	MOR RM146.1 - Boonville - MOR RM250.2 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - (MOR RM499.0 - MOR RM529.0 (x1.5)) - MOR RM477.2 - MOR RM452.0 - MOR RM425.0 - MOR RM398.0 - MOR RM291.1 - MOR RM289.0 - MOR RM281.0 - MOR RM280.3 - MOR RM279.2 - MOR RM275.0 - MOR RM271.0 - Grand Upper - MOR RM146.1	390.7	874.0
MR	Moreau Upper	A69-1602-49138	Mosenthein MC - Lower LD27	149.6	151.4
MR	Moreau Mouth	A69-1602-49140	Moreau Mouth - Moreau Upper (x1.5)	1.8	2.6
MR	Osage Mouth	A69-1602-49143	Osage BTB - (Osage Mouth - Mari-Osa (x1.5)) - MOR RM146.1	17.8	41.8
MR	Moreau Mouth	A69-1602-49144	MOR RM146.1	7.8	8.3
MR	Moreau Mouth	A69-1602-49145	Moreau Mouth - Moreau Upper (x1.5)	1.8	2.6
MR	Moreau Mouth	A69-1602-49146	Moreau Mouth - Moreau Upper	1.8	1.3
MR	Moreau Mouth	A69-1602-49147	MOR RM146.1 - Boonville - MOR RM250.2 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0 - MOR RM641.5 - MOR RM670.3 - MOR RM691.5 - MOR RM710.3 - MOR RM733.8	595.5	596.0

MR	MOR RM128.5	A69-1602-49150	MOR RM131.3 - Osage Mouth (x1.5) - MOR RM146.1	8.6	20.8
MR	Osage Mouth	A69-1602-49152	Osage Mouth - Osage BTB - (Mari-Osa - Osage Mouth (x2)) - MOR RM146.1 - Osage Mouth	17.8	69.6
MR	Moreau Mouth	A69-1602-49156	MOR RM146.1	7.8	8.3
MR	Osage Mouth	A69-1602-49158	Osage BTB - Osage Mouth - (MOR RM131.3 - MOR RM128.5 (x1.5)) - Osage Mouth - MOR RM131.3 - MOR RM146.1 - (MOR RM129.5 - Osage Mouth (x2)) - MOR RM146.1	12.1	68.8
MR	Osage Mouth	A69-1602-49159	Osage Mouth - MOR RM131.3 (x1.5) - Mari-Osa - Osage Mouth	17.8	21.6
MR	Moreau Mouth	A69-1602-49160	MOR RM146.1	7.8	8.3
MR	Jefferson City	A69-1602-49161	Osage Mouth - Mari-Osa (x1.5) - (MOR RM131.3 - Osage Mouth (x1.5)) - MOR RM129.5 - Osage Mouth - MOR RM131.3 - (Osage Mouth - MOR RM129.5 (x1.5)) - MOR RM131.3 - (Osage Mouth - Mari-Osa (x2))	17.8	75.7
MR	Osage Mouth	A69-1602-49164	MOR RM131.3 - Osage Mouth - MOR RM129.5	8.8	4.4
MR	Moreau Mouth	A69-1602-49165	Osage Mouth - Mari-Osa (x1.5) - MOR RM128.5 - MOR RM131.3 - (Osage Mouth - Mari-Osa (x1.5))	17.8	52.5
MR	Osage Mouth	A69-1602-49168	Osage Mouth - MOR RM131.3 (x2.5) - Mari-Osa - Osage Mouth	17.8	25.3
MR	Moreau Mouth	A69-1602-49169	MOR RM146.1 - Boonville - Lamine Upper - Lamine Mouth - MOR RM146.1	67.5	127.7
MR	Moreau Mouth	A69-1602-49171	MOR RM131.3	7.0	7.5
LR	Lamine Upper	A69-1602-49055	Lamine Upper - Lamine Mouth (x1.5)	2.1	6.6
LR	Lamine Upper	A69-1602-49056	Lamine Upper - Lamine Mouth (x1.5)	2.1	6.6
LR	Lamine Mouth	A69-1602-49057	(Lamine Upper - Lamine Mouth (x2.5)) - (Grand Mouth - Grand Upper (x2))	50.8	73.4
LR	Lamine Upper	A69-1602-49059	Lamine Upper - MOR RM250.2 - MOR RM368.3 - MOR RM398.0 -	327.7	666.2

			MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0 - MOR RM452.0 - MOR RM425.0 - MOR RM398.0 - MOR RM368.3 - (Lamine Upper - Lamine Mouth (x1.5))		
LR	Lamine Upper	A69-1602-49060	Lamine Upper - Lamine Mouth (x1.5)	2.1	6.6
LR	Lamine Upper	A69-1602-49061	(Lamine Upper - Grand Mouth (x1.5)) - Lamine Mouth - Lamine Upper	48.8	108.4
LR	Lamine Mouth	A69-1602-49062	Lamine Mouth - MOR RM250.2 - (Lamine Upper - Lamine Mouth (x1.5))	48.9	105.3
LR	Lamine Mouth	A69-1602-49063	Lamine Upper - Lamine Mouth (x2.5)	2.1	16.5
LR	Lamine Upper	A69-1602-49064	Lamine Upper - Lamine Mouth (x2.5)	2.1	13.2
LR	Kansas RM1	A69-1602-49065	MOR RM368.3	167.0	1.8
LR	Lamine Mouth	A69-1602-49066	Lamine Upper - MOR RM250.2 (x1.5) - Lamine Mouth - Lamine Upper	48.9	111.9
LR	MOR RM641.5	A69-1602-49067	MOR RM641.5 - MOR RM670.3 - MOR RM691.5 - MOR RM710.3 - MOR RM733.8	532.5	92.3
LR	Lamine Mouth	A69-1602-49068	Lamine Upper - Lamine Mouth (x3.5)	2.1	23.1
LR	Lamine Mouth	A69-1602-49069	Lamine Mouth - Lamine Upper (x2)	2.1	9.9
LR	Lamine Upper	A69-1602-49070	Lamine Upper - Lamine Mouth (x1.5)	2.1	6.6
LR	MOR RM710.3	A69-1602-49071	MOR RM775.5 - MOR RM808.0 - MOR RM751.5	606.7	154.2
LR	Lamine Upper	A69-1602-49072	Lamine Upper - Lamine Mouth (x2.5)	2.1	13.2
LR	Lamine Mouth	A69-1602-49074	Lamine Mouth - Lamine Upper (x8)	2.1	49.5
LR	Lamine Upper	A69-1602-49075	Lamine Upper - Lamine Mouth (x1.5)	2.1	6.6
LR	Lamine Mouth	A69-1602-49076	Lamine Upper - Lamine Mouth (x2.5)	2.1	16.5
LR	Kansas RM1	A69-1602-49077	MOR RM367.3 - Kansas RM1 - (MOR RM368.3 - MOR RM367.3	509.0	660.9

			(x1.5)) - MOR RM398.0 - MOR RM425.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0 - Platte - MOR RM641.5 - MOR RM670.3 - (MOR RM691.5 - MOR RM710.3 (x1.5)) - MOR RM670.3 - MOR RM641.5 - MOR RM595.0 - MOR RM529.0 - MOR RM477.2 - MOR RM452.0 - MOR RM425.0 - MOR RM398.0		
LR	Boonville	A69-1602-49081	Lamine Mouth - Lamine Upper (x3)	2.1	22.4
LR	Lamine Upper	A69-1602-49083	Lamine Upper - Lamine Mouth (x4.5)	2.1	26.4
LR	Lamine Mouth	A69-1602-49085	Lamine Upper - Lamine Mouth (x3.5)	2.1	23.1
LR	Lamine Upper	A69-1602-49091	Lamine Upper - MOR RM250.2	48.9	51.0
LR	Lamine Mouth	A69-1602-49093	Lamine Upper - MOR RM250.2 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0 - MOR RM477.2 - MOR RM452.0 - MOR RM425.0 - MOR RM398.0 - MOR RM368.3 - MOR RM291.1 - MOR RM281.0 - MOR RM280.3 - MOR RM279.2 - MOR RM275.0 - MOR RM271.0 - Lamine Upper - Lamine Mouth	327.7	666.2
LR	Lamine Mouth	A69-1602-49095	Lamine Mouth - Lamine Upper (x3)	2.1	16.5
LR	Lamine Upper	A69-1602-49097	Lamine Upper - MOR RM250.2 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0	327.7	329.8
LR	Lamine Upper	A69-1602-49100	(Lamine Upper - Lamine Mouth (x1.5)) - MOR RM250.2 - MOR RM368.3 - (MOR RM398.0 - MOR RM425.0 (x1.5)) - MOR RM250.2 - Grand Mouth - Lamine Upper	223.7	458.4
LR	MOR RM128.5	A69-1602-49102	Mosenthein MC	212.0	136.8
LR	Lamine Upper	A69-1602-49103	Lamine Upper - Lamine Mouth (x3.5)	2.1	19.8

LR	Lamine Mouth	A69-1602-49104	Lamine Upper - Lamine Mouth (x2.5)	2.1	16.5
LR	Lamine Mouth	A69-1602-49105	(Lamine Upper - Lamine Mouth (x1.5)) - Boonville - (Lamine Upper - Lamine Mouth (x1.5))	7.1	34.9
LR	Lamine Upper	A69-1602-49106	Lamine Upper - MOR RM250.2 (x1.5)	48.9	102.0
LR	Lamine RM5.3	A69-1602-49109	Lamine Upper - Grand Mouth - Grand Upper - (MOR RM250.2 - Grand Mouth (x1.5)) - (MOR RM367.3 - MOR RM368.3 (x2)) - MOR RM398.0 - MOR RM425.0 - (MOR RM452.0 - MOR RM477.2 (x1.5)) - MOR RM425.0 - MOR RM368.3	275.9	395.7
LR	Lamine Mouth	A69-1602-49112	Boonville - Lamine Upper - MOR RM250.2 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0 - MOR RM594.0	392.7	409.9
LR	Lamine Mouth	A69-1602-49113	(Lamine Mouth - Lamine Upper (x4)) - (Grand Upper - MOR RM250.2 (x1.5)) - Grand Mouth - (Lamine Mouth - Lamine Upper (x3))	50.8	146.7
GR	Grand Upper	A69-1602-48989	Grand Upper - Grand Mouth (x13.5)	1.6	52.0
GR	Grand Upper	A69-1602-48990	Grand Upper - Grand Mouth (x10.5)	1.6	40.0
GR	Grand Upper	A69-1602-48993	Grand Upper - Grand Mouth (x6.5)	1.6	24.0
GR	Grand Upper	A69-1602-48994	Grand Upper - Grand Mouth (x6.5)	1.6	24.0
GR	MOR RM250.2	A69-1602-48995	MOR RM367.3 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0	280.7	278.8
GR	Grand Upper	A69-1602-48996	Grand Upper - Grand Mouth (x8.5)	1.6	32.0
GR	Grand Upper	A69-1602-48997	Grand Upper - Grand Mouth (x9.5)	1.6	36.0
GR	Grand Upper	A69-1602-48999	Grand Upper - Grand Mouth (x3.5)	1.6	12.0
GR	Grand Upper	A69-1602-49001	Grand Upper - Grand Mouth (x4.5)	1.6	16.0

GR	Grand Upper	A69-1602-49003	Grand Upper - Grand Mouth (x10.5)	1.6	40.0
GR	Grand Upper	A69-1602-49005	Grand Upper - Grand Mouth (x8.5)	1.6	32.0
GR	MOR RM250.2	A69-1602-49007	Grand Upper	0.4	2.3
GR	Grand Mouth	A69-1602-49008	Grand Mouth - Grand Upper (x2) - MOR RM250.2 - MOR RM367.3	119.0	125.4
GR	Grand Upper	A69-1602-49011	Grand Upper - Grand Mouth (x8.5)	1.6	32.0
GR	Grand Mouth	A69-1602-49012	Grand Mouth - Grand Upper (x3)	1.6	10.0
GR	Grand Upper	A69-1602-49013	Grand Upper - Grand Mouth (x5.5)	1.6	20.0
GR	Grand Upper	A69-1602-49014	Grand Upper - Grand Mouth (x8.5)	1.6	32.0
GR	Grand Upper	A69-1602-49015	Grand Upper - Grand Mouth (x6.5)	1.6	24.0
GR	MOR RM595.0	A69-1602-49017	MOR RM595.0 - MOR RM594.0	346.7	1.0
GR	Grand Upper	A69-1602-49018	Grand Upper - Grand Mouth (x2.5) - Ohio Cairo	447.7	456.1
GR	Grand Upper	A69-1602-49020	Grand Upper - Grand Mouth (x8.5)	1.6	32.0
GR	Grand Upper	A69-1602-49022	Grand Upper - Grand Mouth (x11.5)	1.6	44.0
GR	Grand Upper	A69-1602-49024	Grand Upper - Grand Mouth (x13.5)	1.6	52.0
GR	Grand Mouth	A69-1602-49025	Grand Mouth	1.6	0.0
GR	Grand Mouth	A69-1602-49027	Grand Mouth - Grand Upper (x6)	1.6	22.0
GR	Grand Upper	A69-1602-49029	Grand Mouth - Grand Upper (x19.5) - MOR RM250.2 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - (MOR RM452.0 - MOR RM477.2 (x1.5)) - MOR RM425.0 - MOR RM398.0 - MOR RM291.1 - MOR RM271.0 - (Grand Upper - MOR RM250.2 (x1.5))	228.9	539.2
GR	Grand Upper	A69-1602-49030	Grand Upper - Grand Mouth (x11.5)	1.6	44.0
GR	Grand Upper	A69-1602-49031	Grand Upper - Grand Mouth (x5.5)	1.6	20.0
GR	MOR RM250.2	A69-1602-49033	MOR RM280.3 - MOR RM275.0 - MOR RM271.0 - MOR RM250.2 - Grand Upper - MOR RM271.0 - MOR RM275.0 - MOR RM280.3 - MOR RM281.0 - MOR RM289.0 - MOR RM291.1 - MOR RM283.0	42.8	113.8
GR	Grand Upper	A69-1602-49034	Grand Upper - Grand Mouth (x5) - MOR RM250.2 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 -	250.7	267.1

			MOR RM452.0 - MOR RM477.2 - MOR RM499.0		
GR	Grand Upper	A69-1602-49035	Grand Mouth - Grand Upper (x6)	1.6	24.0
GR	MOR RM250.2	A69-1602-49038	Grand Mouth - Grand Upper (x4)	1.6	14.3
GR	MOR RM250.2	A69-1602-49039	Grand Mouth - Grand Upper (x2)	1.6	6.3
GR	Grand Upper	A69-1602-49044	Grand Upper - Grand Mouth (x10.5)	1.6	40.0
GR	Grand Upper	A69-1602-49045	Grand Upper - Grand Mouth (x8.5)	1.6	32.0
GR	Grand Mouth	A69-1602-49046	Grand Mouth - Grand Upper (x6)	1.6	22.0
GR	Grand Mouth	A69-1602-49047	Grand Mouth - Grand Upper (x4)	1.6	14.0
GR	Grand Upper	A69-1602-49048	Grand Upper - Grand Mouth (x3.5)	1.6	12.0
GR	Grand Upper	A69-1602-49049	Grand Upper - Grand Mouth (x5.5)	1.6	20.0
GR	Grand Upper	A69-1602-49051	Grand Upper - Grand Mouth (x6.5)	1.6	24.0
GR	Grand Mouth	A69-1602-49053	Grand Mouth - Grand Upper	1.6	2.0
GR	Grand Upper	A69-1604-27565	Grand Mouth - Grand Upper (x2) - MOR RM250.2 - MOR RM367.3 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0 - MOR RM641.5 - MOR RM595.0 - Platte	391.8	446.5
GR	Grand Upper	A69-1604-27567	MOR RM280.3 - MOR RM281.0 - MOR RM283.0 - MOR RM279.2 - MOR RM277.0 - (MOR RM275.0 - MOR RM271.0 (x1.5)) - MOR RM279.2	33.3	55.3
GR	MOR RM250.2	A69-1604-27569	MOR RM367.3 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM594.0	344.3	343.8
GR	Grand Upper	A69-1604-27570	Grand Upper - Grand Mouth (x8)	1.6	30.0
KR1	MOR RM425.0	A69-1604-27488	Below WaterOne - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0 - MOR RM452.0 - MOR RM398.0	162.5	370.0
KR1	Kansas RM1	A69-1604-27490	Kansas RM1 - MOR RM368.3 - Below WaterOne	9.0	12.6
KR1	Kansas RM1	A69-1604-27491	Kansas RM1 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - (MOR	162.5	293.5

			RM499 - MOR RM529 (x1.5)) - MOR RM477.2 - MOR RM452.0 - MOR RM425 - MOR RM398		
KR1	Kansas RM1	A69-1604-27493	Kansas RM1 - MOR RM368.3	1.8	1.8
KR1	Kansas RM1	A69-1604-27495	Kansas RM1 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM529.0 - Platte - MOR RM499.0 - MOR RM477.2 - MOR RM452.0 - MOR RM425.0 - MOR RM398.0 - MOR RM368.3	228.7	455.6
KR1	Below WaterOne	A69-1604-27497	MOR RM367.3 - Below WaterOne	9.0	20.4
KR1	MOR RM367.3	A69-1604-27501	Kansas RM1 - (Below WaterOne - MOR RM368.3 (x1.5))	9.0	31.8
KR1	Kansas RM1	A69-1604-27504	Kansas RM1	0.0	0.0
KR1	Kansas RM1	A69-1604-27506	Kansas RM1 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - (MOR RM529.0 - MOR RM565.0 (x1.5)) - MOR RM499.0 - MOR RM477.2 - MOR RM452.0 - MOR RM425.0 - MOR RM398.0	198.5	365.5
KR1	Kansas RM1	A69-1604-27510	Kansas RM1 - (MOR RM368.3 - MOR RM367.3 (x1.5)) - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM498.0 - MOR RM529.0 - MOR RM595.0 - MOR RM641.5 - MOR RM670.3 - MOR RM691.5 - MOR RM710.3 - MOR RM734.8 - MOR RM733.8 - MOR RM710.3 - MOR RM691.5 - MOR RM670.3 - MOR RM641.5 - MOR RM529.0 - MOR RM499.0 - MOR RM477.2 - MOR RM452.0 - MOR RM425.0 - MOR RM398.0 - MOR RM368.3	368.3	736.8
KR1	Kansas RM1	A69-1604-27511	Kansas RM1 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - (MOR RM499.0 - MOR RM529.0 (x1.5)) -	162.5	334.0

			MOR RM452.0 - MOR RM425.0 - MOR RM398.0 - Below WaterOne		
KR1	Below WaterOne	A69-1604-27512	Below WaterOne - (MOR RM367.3 - MOR RM368.3 (x2))	9.0	12.2
KR1	Below WaterOne	A69-1604-27514	Kansas RM1 - Below WaterOne	9.0	18.0
KR1	Kansas RM1	A69-1604-27516	MOR RM368.3 - MOR RM398.0 - (MOR RM425.0 - MOR RM452.0 (x1.5)) - MOR RM398.0 - MOR RM368.3	85.5	169.2
KR1	Nishnabotna	A69-1604-27522	Kansas RM1	0.0	176.0
KR1	Grand Mouth	A69-1604-27523	Grand Mouth - Grand Upper (x1.5) - MOR RM250.2 - (MOR RM367.3 - MOR RM368.3 (x4)) - MOR RM291.1 - MOR RM289.0 - MOR RM281.0 - MOR RM280.3 - MOR RM279.2 - MOR RM275.0 - MOR RM271.0 - MOR RM146.1	222.4	350.6
KR1	Kansas RM1	A69-1604-27524	Kansas RM1 - MOR RM367.3 - MOR RM368.3 - MOR RM398.0	31.5	31.5
KR1	Kansas RM1	A69-1604-27525	Kansas RM1 - MOR RM367.3	1.2	1.2
KR1	Kansas RM1	A69-1604-27526	Below WaterOne - MOR RM368.3 - MOR RM398.0 - (MOR RM425.0 - MOR RM452.0 (x1.5)) - MOR RM398.0 - (Below WaterOne - MOR RM368.3 (x1.5))	85.5	219.6
KR1	Below WaterOne	A69-1604-27527	Below WaterOne - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - (MOR RM499.0 - MOR RM529.0 (x1.5)) - MOR RM452.0 - MOR RM425.0 - MOR RM398.0 - Below WaterOne	162.5	343.0
KR1	Kansas RM1	A69-1604-27528	Kansas RM1 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0 - Platte - MOR RM452.0 - MOR RM425.0 - MOR RM398.0 - Below WaterOne	228.7	466.4
KR1	Kansas RM1	A69-1604-27530	MOR RM398.0	31.5	31.5

KR1	Kansas RM1	A69-1604-27532	MOR RM368.3 - MOR RM367.3 (x1.5) - MOR RM398.0 - MOR RM368.3	31.5	63.2
KR1	MOR RM398.0	A69-1604-27533	MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0 - Platte - MOR RM594.0 - MOR RM529.0 - MOR RM499.0 - MOR RM477.2 - MOR RM452.0 - MOR RM425.0 - MOR RM398.0	228.7	453.8
KR1	Kansas RM1	A69-1604-27536	MOR RM367.3 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0	162.5	162.9
KR1	MOR RM368.3	A69-1604-27537	MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - (MOR RM477.2 - MOR RM499.0 (x1.5)) - (MOR RM452.0 - MOR RM425.0 (x2)) - MOR RM398.0 - MOR RM368.3	132.5	315.4
KR1	Kansas RM1	A69-1604-27538	MOR RM368.3 - MOR RM367.3 (x2.5)	1.8	5.8
KR1	Little Sioux RM1.1	A69-1604-27541	MOR RM670.3 - MOR RM691.5 (x1.5)	325.0	44.6
KR1	Kansas RM1	A69-1604-27542	Kansas RM1 - MOR RM368.3	1.8	1.8
KR1	Kansas RM1	A69-1604-27543	Kansas RM1 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0 - MOR RM477.2 - MOR RM452.0 - MOR RM425.0 - MOR RM398.0 - MOR RM368.3	162.5	323.2
KR1	Kansas RM1	A69-1604-27545	Kansas RM1 - MOR RM367.3 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0 - MOR RM641.5 - MOR RM670.3 - MOR RM691.5 - MOR RM710.3 - MOR RM734.8 - MOR RM751.5 - MOR RM775.5 - MOR	441.5	851.5

			RM786.8 - MOR RM808.0 - MOR RM786.8 - MOR RM751.5 - MOR RM733.8 - MOR RM710.3 - MOR RM691.5 - MOR RM670.3 - MOR RM641.5 - MOR RM529.0 - MOR RM477.2 - MOR RM452.0 - MOR RM425.0 - MOR RM398.0		
KR16	Below WaterOne	A69-1604-27547	Below WaterOne - MOR RM367.3 - MOR RM368.3 - Below WaterOne	16.8	22.0
KR16	Kansas RM1	A69-1604-27548	Kansas RM1 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - (MOR RM452.0 - MOR RM477.2 (x1.5)) - MOR RM425.0 - MOR RM398.0 - Below WaterOne - MOR RM291.1 - MOR RM289.0 - MOR RM287.0 - MOR RM281.0 - MOR RM279.2 - MOR RM275.0 - MOR RM273.0 - MOR RM271.0 - MOR RM275.0 - MOR RM283.0 - MOR RM291.1	112.5	357.0
KR16	Below WaterOne	A69-1604-27549	MOR RM367.3 - Kansas RM1 - Below WaterOne - MOR RM398.0 - MOR RM368.3 - Below WaterOne	46.5	101.4
KR16	Below WaterOne	A69-1604-27550	Below WaterOne	6.0	0.0
KR16	Above WaterOne	A69-1604-27551	Above WaterOne	1.1	0.0
KR16	Kansas RM1	A69-1604-27553	Kansas RM1 - (MOR RM367.3 - Below WaterOne (x2)) - MOR RM291.1 - MOR RM289.0 - MOR RM287.0 - MOR RM285.5 - MOR RM283.0 - MOR RM279.2 - MOR RM275.0 - MOR RM273.0 - MOR RM271.0	112.5	138.3
KR16	MOR RM368.3	A69-1604-27554	MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0 - MOR RM565.0 - MOR RM594.0 - Platte - MOR RM529.0 - MOR RM499.0 - MOR RM477.2 - MOR RM452.0 - MOR RM425.0 - MOR RM398.0 - Below WaterOne	243.7	464.6
KR16	MOR RM594.0	A69-1604-27555	MOR RM594.0 - MOR RM595.0 - MOR RM477.2 - MOR RM452.0 -	243.5	260.1

			MOR RM425.0 - (Below WaterOne - MOR RM368.3 (x1.5))		
KR16	Above WaterOne	A69-1604-27556	Above WaterOne	1.1	0.0
KR16	Kansas RM1	A69-1604-27558	Kansas RM1 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - (MOR RM477.2 - MOR RM499.0 (x1.5)) - MOR RM452.0 - MOR RM425.0 - MOR RM398.0 - Below WaterOne	147.5	274.0
KR16	Above WaterOne	A69-1604-27559	Below WaterOne - Kansas RM1 - MOR RM367.3 - MOR RM368.3 - MOR RM398.0 - MOR RM425.0 - MOR RM452.0 - MOR RM477.2 - MOR RM499.0 - MOR RM529.0 - Platte	243.7	245.2
KR16	Below WaterOne	A69-1604-27560	Below WaterOne	6.0	0.0

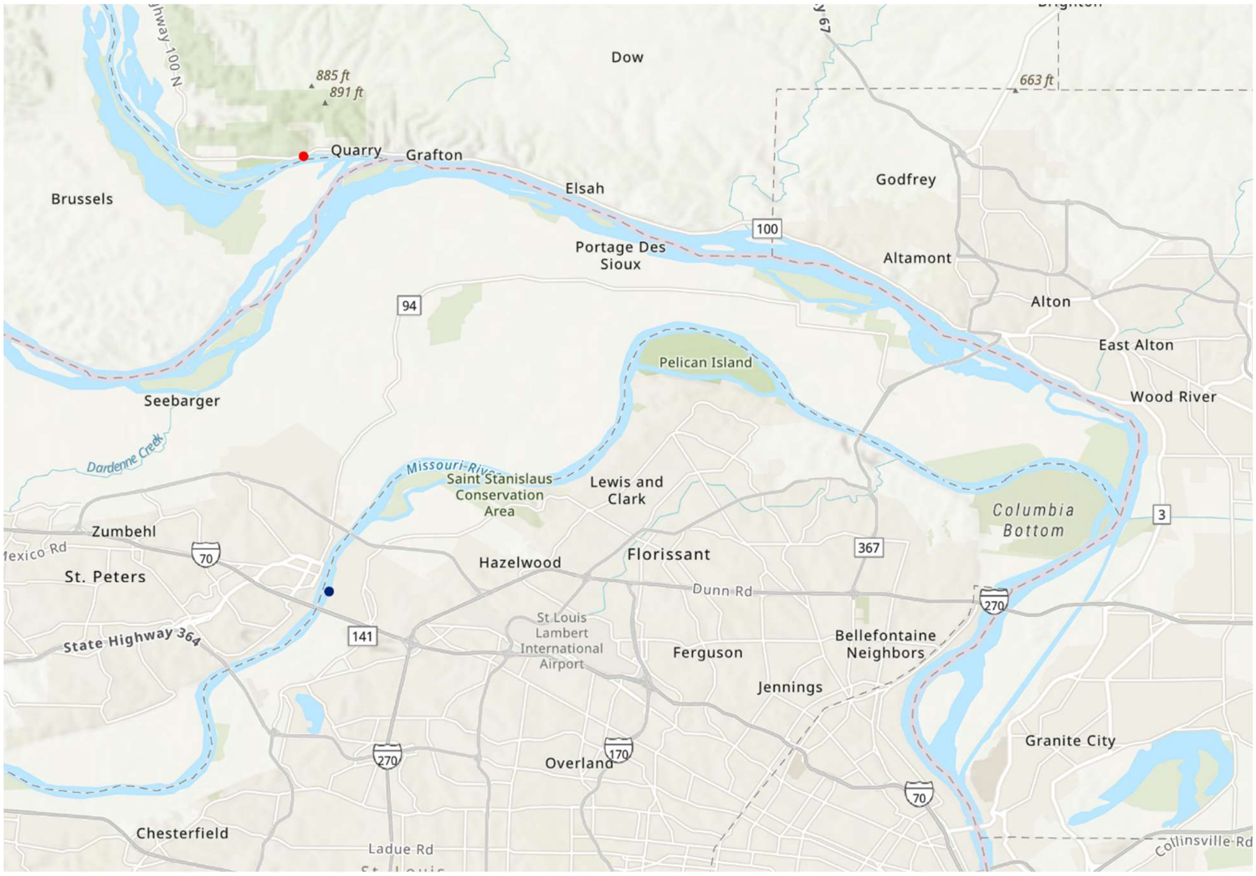

Figure 8. Relative locations of an invasive Silver Carp tagged in Creve Coeur Creek (blue dot) that traveled approximately 56.4 river miles from its original tagging location to river mile 3.2 of the Illinois River (red dot).

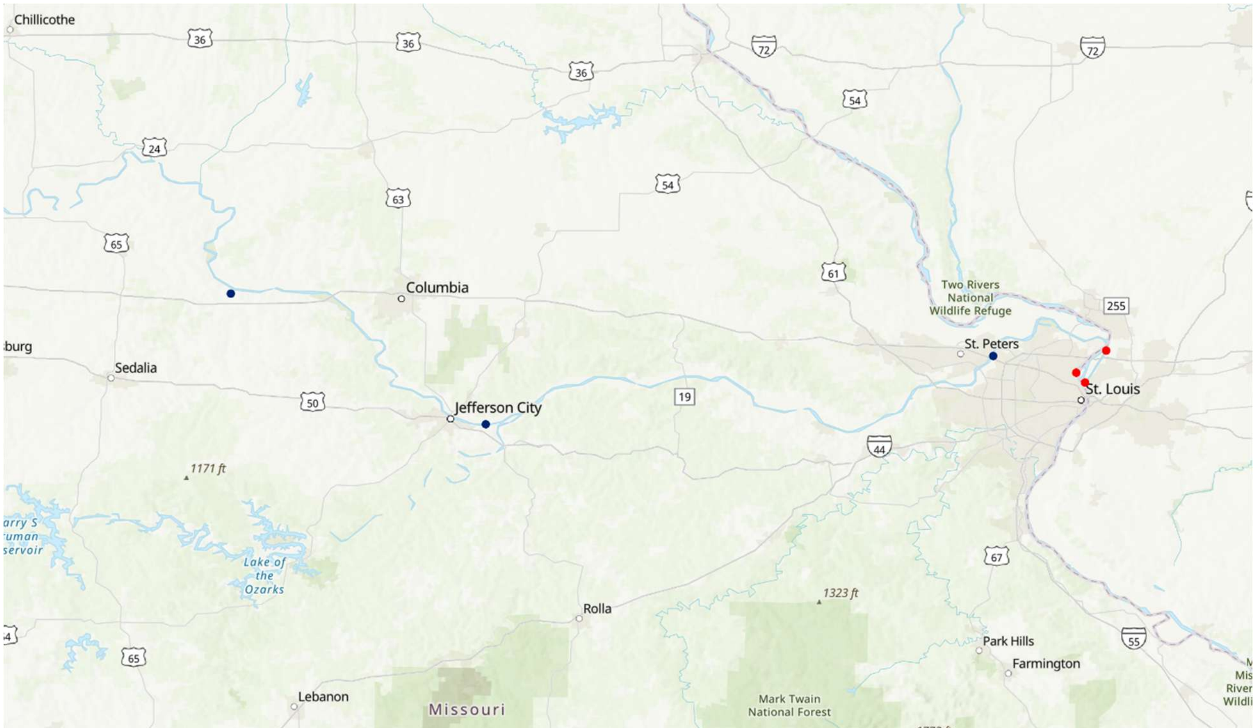

Figure 9. Relative locations of five invasive Silver Carp tagged in the MOR (3 tagged in Creve Coeur Creek, 1 tagged in the Moreau River, 1 tagged in the Lamine River) (blue dots) that traveled approximately 32.2 – 212.0 river miles from their original tagging locations to Mosenthein Island and the Lock and Dam 27 navigation canal (red dots).

Figure 10. Relative locations of an invasive Silver Carp tagged in Creve Coeur Creek (blue dot) that traveled approximately 66.0 river miles from its original tagging location to the Meramec River (red dot).

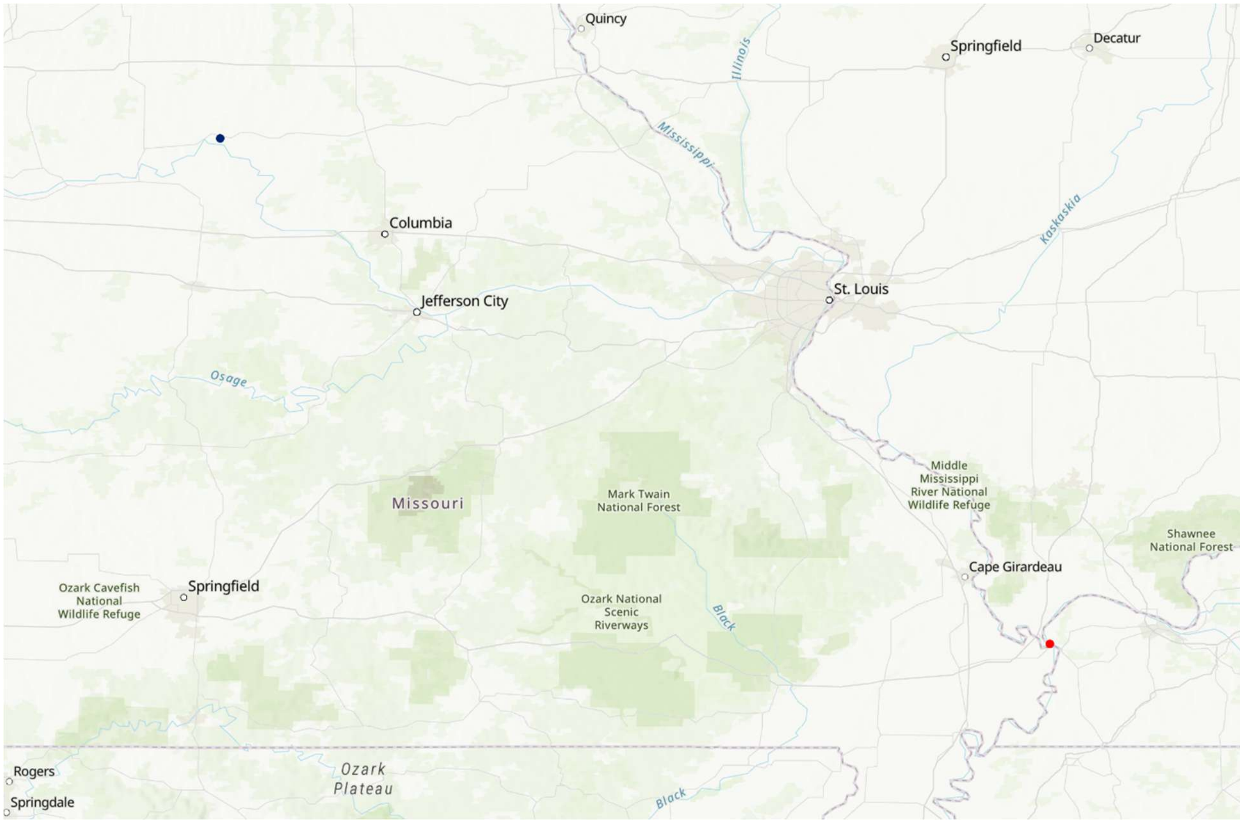

Figure 11. Relative locations of an invasive Silver Carp tagged in the Grand River (blue dot) that traveled approximately 447.7 river miles from its original tagging location to the Ohio River at Cairo, IL (red dot).

Recommendations: Removal efforts should be the primary focus while ongoing telemetry / demographic studies should help to inform those removal efforts.

State Report: South Dakota

Agency: South Dakota Game, Fish, and Parks & South Dakota State University

Project Title: Silver Carp movement under varying environmental conditions in the lower James River

Note: Originally submitted under the Movement and Habitat Use Work Group

Methods:
A telemetry network of 16 VR2W and 5 VR2Tx InnovaSea receivers spans from river kilometer (rkm) 1 to rkm 356 in the James River, SD to detect movement of acoustically tagged fish (Figure 1). Fifty InnovaSea V16 acoustic coded transmitters were placed into Silver Carp in 2021, 2023, 2024, and 2025. Each year tagged fish were distributed throughout the lower 242 river kilometers of the James River. All surgeries were performed following previously reported protocols and according to the University of South Dakota's Institutional Animal Care and Use Committee (IACUC) protocols. A total of 21 stationary receivers are deployed from the James-Missouri River confluence to Huron, SD, to monitor the movements of tagged fish.

We evaluated movement patterns using all fish with at least one year of detections in the lower James River. We excluded fish (N = 3) from analysis that were consistently recorded on one receiver without being recorded at any other receiver, as we considered these to either be mortalities or have expelled their tag. We calculated displacement (km) for each fish as the absolute value of the difference in rkm between consecutive detections, and we summarized the mean weekly displacement for analysis. We summarized mean daily temperature at all temperature loggers and VR2Tx receivers and then calculated a weekly mean temperature for analysis. We also summarized mean weekly discharge after obtaining daily river discharge (m^3/s) at the Scotland, South Dakota, USGS river gage (#06478500) from the *dataRetrieval* package in Program R (De Cicco et al. 2024; R Core Team 2024).

We compared a series of generalized mixed effects models to determine the effects of mean weekly temperature, mean weekly discharge, and week of the year on mean weekly displacement of Silver Carp. We used the "*dredge"* function within the *MuMIn* package (Bartoń 2025) in Program R to run all possible model combinations and compare the outputs using Akaike Information Criterion corrected for small sample size (AICc). We included fish ID as a random effect in the model to account for individual-specific movement patterns. We then evaluated the model fit by calculating the conditional coefficient of determination for Generalized mixed-effect models using the*"r.squaredGLMM*" function within the *MuMIn* package.

Results and Discussion:
Detection data have been offloaded on multiple occasions annually from all receivers in the James River. Initial movement data following the first two years of telemetry work were summarized in LaBrie (2023). Generally, Silver Carp moved very little during 2021 under low water conditions (Figure 2). Analysis of weekly displacement indicates that mean weekly temperature and mean

discharge were significant ($P < 0.05$) factors in the top Generalized mixed-effects model. The fixed-effects estimates for the slopes related to the mean weekly temperature and discharge were 0.09735 (SE, 0.01105) and 0.03004 (SE, 0.00276), and the random intercept variance estimate was 17.08 (SD, 4.133). Follow up work will incorporate a large set of predictor variables and evaluate other movement metrics.

Tables and Figures:

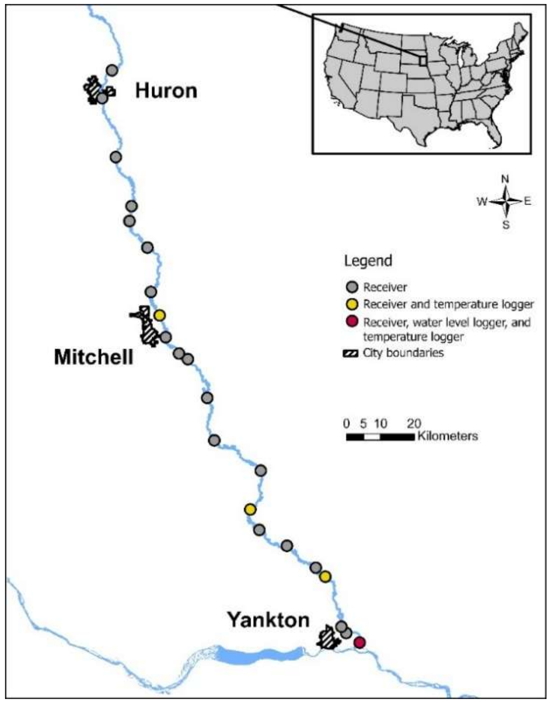

Figure 12. Locations of acoustic telemetry receivers and habitat loggers deployed in the lower James River, South Dakota.

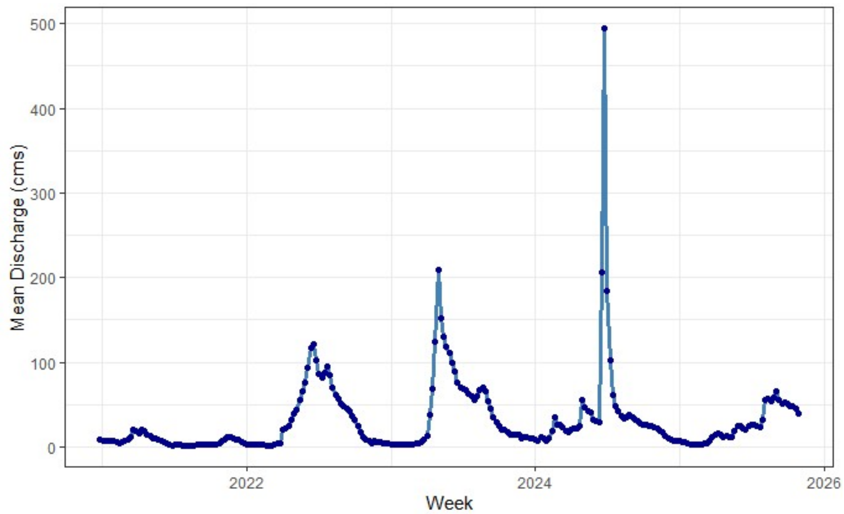

Figure 2. Mean discharge (m^3/s) from January 1, 2021 to October 31, 2025 at the Scotland, South Dakota USGS gage on the lower James River.

Recommendation: Movements, if examined across a variety of environmental conditions, can directly inform management actions (e.g., removal locations), and help judge the effectiveness of management efforts. Continued monitoring of movement is necessary as intensifying management efforts will alter invasive carp population dynamics, including density-dependent behaviors, and tracking these shifts will inform effective future actions.

References:

Bartoń, K. 2025. MuMIn: Multi-model inference. R package version 1.48.11. https://CRAN.R-project.org/package=MuMIn.

De Cicco, L.A., R. M. Hirsch, D. Lorenz, W. D. Watkins, and M. Johnson.2024. dataRetrieval: R packages for discovering and retrieving water data available from Federal hydrologic web services, v.2.7.17. doi:10.5066/P9X4L3GE

LaBrie, L. A. P. 2023. Monitoring movement and range expansion of Silver and Bighead Carp (*Hypophthalmichthys molitrix, H. nobilis*) in South Dakota tributaries of the Missouri River. Master's thesis. University of South Dakota, Vermillion.

R Core Team. 2024. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

State Report:

Agency: U.S. Fish and Wildlife Service

Project Title: Silver Carp residence time and movement in the Missouri River and its tributaries in association with season, environmental conditions, and barriers.

Note: Originally submitted under the Movement and Habitat Use Work Group

Methods:
The Great Plains FWCO maintained a passive telemetry receiver array in the Big Sioux River, Vermillion River, and Split Rock Creek to monitor movement and distribution of tagged silver carp (Figure 1). The array consisted of 12 Innovasea VR2W acoustic receivers (n=6 Big Sioux River, n=5 Vermillion River, n=1 Split Rock Creek). Each receiver was fastened to a steel frame, placed on the bottom of the river, and attached to a secure object on shore (e.g., large tree) with ⅛-inch steel cable.

In the Big Sioux River system, receivers were placed starting at one river kilometer (RKM) upriver from its confluence with the Missouri River to 240 RKM from the confluence where sufficient water depth was available. One receiver was placed in Split Rock Creek, approximately one kilometer upstream of Big Sioux River-Split Rock Creek confluence (Big Sioux RKM 226) to monitor fish use of this tributary.

In the Vermillion River, receivers were placed starting at 1 RKM upriver from its confluence with the Missouri River to 84 RKM from the confluence where sufficient water depth was available.

In 2025, 76 silver carp were tagged in April and July (N=38 in the Vermillion River and N=38 in the Big Sioux River). Four tags were retained in the laboratory to evaluate battery life. Fish were caught using electrofishing methods beginning at the confluence of each river. Captured fish were held in a tank with a continuous flow of fresh river water and were weighed (g), measured for total length (mm), sexed, and implanted with acoustic transmitter tags (Innovasea model V16-4H; 69kHz, 16 mm diameter, 68 mm length, 24 g). A Floy T-bar anchor tag (Model FD-94; Floy Tag & Mfg. Inc.) with a unique identification code and contact information (CARP@FWS.GOV) was attached to each fish near its dorsal fin base. Electro-sedation gloves (Smith-Root electric fish handling gloves) were used to facilitate the tagging process. Following surgery, each fish was released near its point of capture.

Receivers were deployed on March 31, 2025, and April 1,2025. Ten receivers were downloaded mid-season on July 9, 2025. The two receivers located at RKM 1 and RKM 2 in the Big Sioux River were not downloaded at that time. All receivers were scheduled for final download and retrieval in November to avoid loss or damage to equipment during winter. Final download and retrieval did not occur in 2025 due to the lapse in federal funding that occurred in October and November 2025.

Results and Discussion:
Tagged fish were detected at three of the ten receivers that were downloaded in 2025.

- The receiver at RKM 1 in the Vermillion River (VER-1) recorded 50,0389 detections from 23 unique tagged carp in April, 117,474 detections from 19 unique tagged carp May and 115,082 detections from 19 carp in June (Table 1).
- The receiver at RKM 2 in the Vermillion River (VER-2) recorded 27,319 detections from 12 unique tagged carp in April, 52,351 detections from 15 unique tagged carp May and 33,027 detections from 11 unique tagged carp in June (Table 1).
- The receiver at RKM 88 in the Big Sioux River (BSR-88) recorded fourteen detections from one unique tagged carp in April, thirty-one detections from four unique tagged carp May and three detections from two unique tagged carp in June (Table 1).
- Twenty fish were detected at multiple recievers throughout the April through June study period (Table 2)
    - One fish was detected at all three recievers (VER-1, VER-2, and BSR-88) that recorded a detection from a tagged carp.
    - Nineteen fish were detected at both receivers in the Vermillion River (VER-1 & VER-2).

Identification of any movement or habitat use trends of tagged fish is not possible with the limited data available from 2025. Data was not avialable for the July through November time period due to staff biologist availability during the lapse in federal funding that occurred in October and November 2025. All receivers remained deployed through the 2025-2026 winter and will be retrieved and downloaded in the spring of 2026. Data will be analyzed and reported on the 2027 Missouri River Invasive Carp Partnership annual report.

Tables and Figures:

	April		May		June	
Receiver	Detections	#Fish	Detections	#Fish	Detections	#Fish
VER-1	50389	23	117474	19	115082	19
VER-2	27319	12	52351	15	33027	11
BSR-88	14	1	31	4	3	2
VER-30	0	0	0	0	0	0
VER-61	0	0	0	0	0	0
VER-84	0	0	0	0	0	0
BSR-61	0	0	0	0	0	0
BSR209	0	0	0	0	0	0
BSR-240	0	0	0	0	0	0
SRC-1	0	0	0	0	0	0
BSR-1	N/A	N/A	N/A	N/A	N/A	N/A
BSR-2	N/A	N/A	N/A	N/A	N/A	N/A

Table 13. *Number of detections and number of unique tagged carp detected at receivers in the Vermillion and Big Sioux Rivers in April, May and June 2025*

Transmitter	VER-1	VER-2	BSR-88
A69-1604-20384	X	X	X
A69-1604-20364	X	X	
A69-1604-20358	X	X	
A69-1604-20386	X	X	
A69-1604-20363	X	X	
A69-1604-20366	X	X	
A69-1604-20381	X	X	
A69-1604-20383	X	X	
A69-1604-20382	X	X	
A69-1604-20378	X	X	
A69-1604-20365	X	X	
A69-1604-20380	X	X	
A69-1604-20376	X	X	
A69-1604-20384	X	X	
A69-1604-20361	X	X	
A69-1604-20379	X	X	
A69-1604-20360	X	X	
A69-1604-20367	X	X	
A69-1604-20368	X	X	
A69-1604-20377	X	X	

Table 2. *Tag numbers detected at multiple receivers in the Vermillion and Big Sioux Rivers in April, May and June 2025. "X" denotes at least one detection event.*

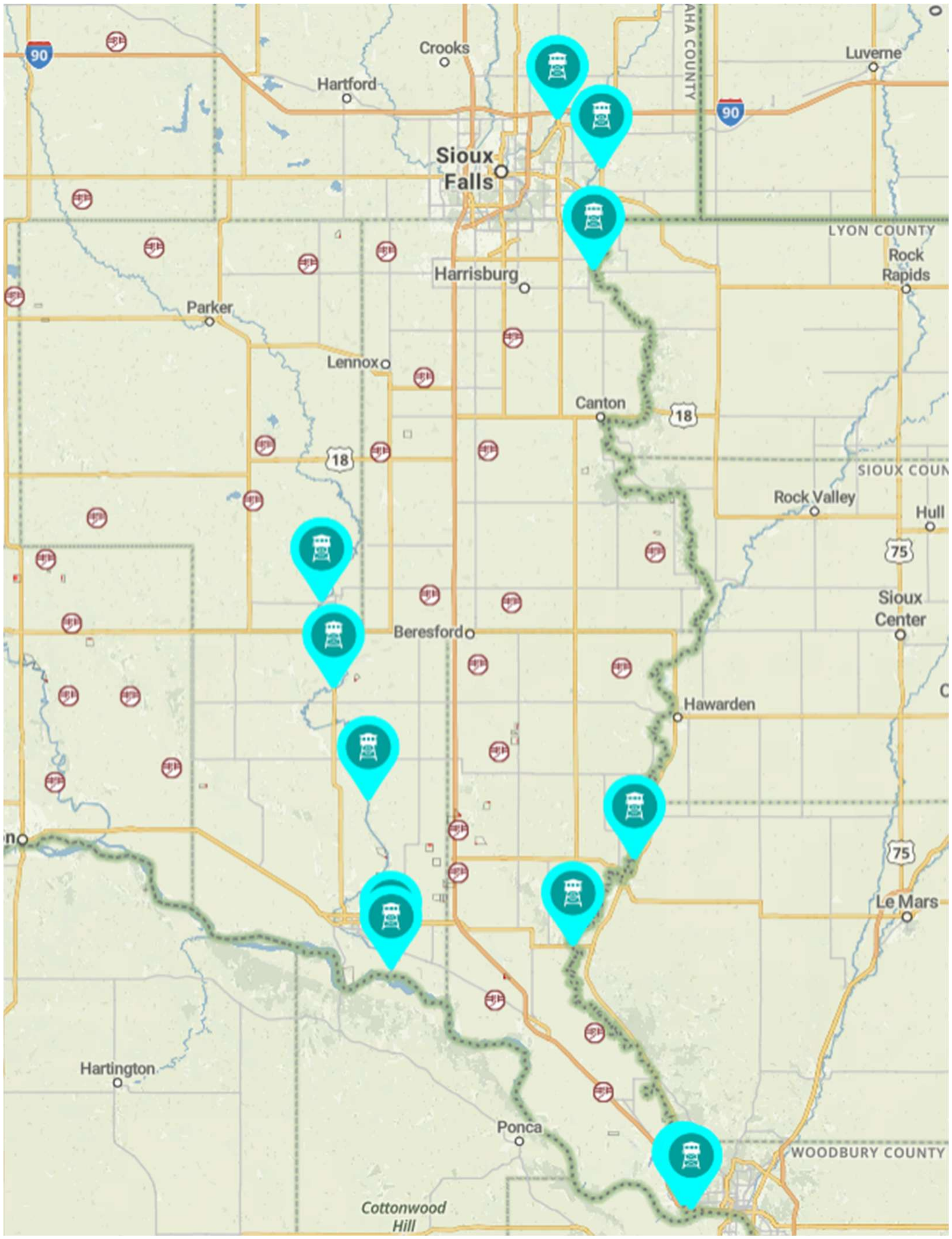

Figure 1. *Map presenting locations of passive receivers deployed in the Vermillion River, SD (N=5), Big Sioux River, SD & IA (N=6) and Split Rock Creek, SD (N=1).*

State Report: Nebraska

Agency: Nebraska Game and Parks Commission & University of Nebraska-Lincoln

Project Title: Seasonal Movements and Space Use of Silver Carp and Native Catostomids in the lower Platte River, Nebraska

Note: Originally submitted under the Movement and Habitat Use Work Group

Methods:

Study Area

The lower Platte River and its three major tributaries (i.e., Loup River, Elkhorn River, and Salt Creek) can be divided into distinct reaches based on differences in natural hydromorphology and levels of anthropogenic alteration (Peters and Schainost 2005). The central Platte River is the reach between the Platte River origin and the Loup-Platte River confluence near Columbus, Nebraska. Alterations to the natural flow regime in this reach (i.e., decreased magnitude and frequency of high flows) have resulted in drastic channel narrowing due to the progressive encroachment of woody vegetation (Eschner et al. 1981; Joeckel and Henebry 2008). Additionally, this reach experiences periodic drying during times of drought and increased demands for agricultural and municipal water use (Peters and Schainost 2005). The lower Platte River is the reach between the Loup-Platte River confluence and the mouth of the Platte River. This section has largely retained its pre-settlement channel morphology despite a number of physical anthropogenic modifications such as channelization and bank stabilization (Hamel et al. 2016). In addition to input from the central Platte River, much of the flow in this reach is derived from several large tributaries including the Loup River, Elkhorn River, and Salt Creek (Peters and Schainost 2005). The upper portion of this reach (i.e. the Loup-Platte River confluence to the Elkhorn-Platte River confluence) exhibits continuous flows from the Loup River; however, base flows are highly variable due to diel and seasonal releases from the Loup Power Canal near Columbus, Nebraska (Galat et al. 2005; Hamel and Pegg 2010). The lower portion of this reach (i.e. the Elkhorn-Platte River confluence to the mouth of the Platte River) also experiences oscillations in the hydrograph from Loup Power Canal returns, but base flows are comparatively stable due to the combination of inputs from the predominantly groundwater-fed Elkhorn and Loup Rivers (Peters and Schainost 2005; Hamel and Pegg 2010).

2025 Field Methods

Twelve passive receiver stations were deployed throughout the mainstem lower Platte River and approximately one kilometer upstream from the mouths of the Loup River, Elkhorn River, and Salt Creek (Figure 1). Each receiver station consists of a R4500CD coded receiver-datalogger (Advanced Telemetry Systems, Isanti, Minnesota), 12-volt lead-acid battery, antenna switchbox, and associated cables housed in a 70-quart cooler approximately ten feet away from the riverbank. Coolers were fixed to the base of a 6-8 ft wood post with two folding 3-element Yagi antennas mounted facing the river at 45-degree angles to each other. Receivers were programmed to a scan time of 10 seconds, time out of 3 seconds, and store rate of 60 minutes.

Fish were captured at 7 sites in the lower Platte River basin (Figure 1) using a combination of pulsed-DC boat electrofishing (60 Hz, 25% duty cycle) and gillnetting (12 ft hobbled to 10 ft, 7.6 cm mesh) before being placed in a live well irrigated with river water. Fish were sedated prior to tagging using a Smith-Root Portable Electroanesthesia System (Smith-Root, Inc., Vancouver, WA, USA) at 60 Hz, 25% duty cycle, 150 V for 5 seconds. Voltage was reduced to 100-125 V in highly conductive water. Once sedated, fish were weighed, measured, and placed in a padded v-shaped trough where a modified bilge pump circulated river water over the gills. Sex of Silver Carp was determined by the presence of pronounced ridges on the dorsal surface of pectoral fins (Wolf et al. 2018). A 5x3 cm patch of scales was removed from the ventral left side of the fish posterior to the pelvic fin, and a 3 cm incision into the coelomic cavity was made at the site. For Blue Suckers, this incision was made approximately 3 cm adjacent and parallel to the midventral line about halfway between the pelvic and pectoral fins (Neely et al. 2009). One F1840C radio transmitter (Advanced Telemetry Systems, Isanti, Minnesota, USA) was inserted into the body cavity using a modified shielded-needle technique (Ross and Kleiner 1982), which enabled the antenna to exit the body wall posterior to the incision site. Incisions were closed using 3-4 simple interrupted sutures (Ethilon, Inc., Somerville, New Jersey, USA, FSLX non-absorbable). Fin clips were taken from the ventral margin of the caudal fin and preserved in 100% ethanol for future analyses. Prior to release, fish were placed back into the irrigated live well where their recovery was monitored until equilibrium was regained and active swimming resumed. All surgical instruments and tags were sterilized in a 2% chlorhexidine solution for a minimum of 15 minutes between surgeries, and all tagged fish were released in water temperatures < 20° C. Tagging information and biometrics data for each tagged fish can be found in Table 1.

Active tracking sweeps were conducted at approximately one-month intervals (excluding winter months) to increase spatial resolution of detection data and verify individuals' locations in the mainstem Platte River or tributaries. Active tracking was conducted while traveling on plane via airboat in the mainstem Platte River between the Highway 81 bridge near Columbus, Nebraska to its confluence with the Missouri River and approximately 1-10 kilometers upstream from the mouths of the Loup River, Elkhorn River, and Salt Creek. During river sweeps, one forward-facing 3-element Yagi antenna was mounted approximately 6 feet high to the captain's deck with an associated R4500CD datalogger/GPS sensor set to aerial mode. This method ensured that transmitter ID, signal strength, and latitude/longitude were recorded with positive detections while active tracking. The strongest signal logged from each transmitter per active tracking day was used in further analyses.

Results and Discussion:

Preliminary Results

Passive and active tracking efforts recorded 4,240 daily unique detections from 88 transmitters in 2025. Of individual fish with documented movement in 2025, cumulative movement distance of Silver Carp (n=55) averaged 65.13 rkm (range: 0.24- 303.18 rkm). Cumulative distance for Blue Sucker (n=12) averaged 92.85 rkm (range: 22.39- 165.09 rkm), and cumulative distance for Smallmouth Buffalo (n=11) averaged 40.83 (range: 0.45- 96.46 rkm). The one Bigmouth Buffalo in this study moved 47.36 rkm. Linear movement ranges in 2025 averaged 36.76 rkm for Silver Carp (range: 0.2-169.38 rkm), 85.91 rkm for Blue Sucker (range: 21.16- 165.09 rkm), and 30.83 rkm for Smallmouth Buffalo (range 0.45- 81.9 rkm). The one Bigmouth Buffalo occupied a range of 41.98 rkm. Observed cumulative movement and linear movement range for Silver Carp, Blue Sucker, and Smallmouth Buffalo are plotted in Figure 2.

Future Data Analyses

Space use will be calculated with the program R (R Core Team 2025) packages Actel (Flavio and Baktoft 2021) and Refined Shortest Paths (RSP; Niella et al. 2020). The Actel package relies on inputs of study information (i.e., biometrics, deployments, spatial, and detection files) to clean and summarize detection data. The RSP package allows for a more realistic estimation of movement paths by incorporating the complexity of water-body shape (e.g., river bends, islands, etc.) into possible movement routes (Niella et al. 2020). Using the RSP package, dBBMMs will be constructed to identify spring (March–May), summer (June–August), and fall (September–November) home ranges and core areas of all individuals corresponding to the 95% and 50% UD isopleths (Kraft et al. 2023). UDs will be evaluated from detections spanning from the initial release date to the date of the last detection. This method ensures that space use is calculated based on the period that the fish is alive with an operational transmitter (Kraft et al. 2023). Kruskal-Wallis tests will be used to test seasonal differences in 95% and 50% space use areas between species, and post-hoc Dunn's tests will be used to determine how space use areas compare between species. River Area shapefiles used in these analyses will be obtained from the State of Nebraska Geographic Information Office website.

Hierarchical cluster analysis will be performed with detection data to identify similarities in residency patterns between and among all tagged individuals using the "hclust" function in the stats package in R. The mainstem lower Platte River and its three major tributaries will be divided into six discrete sections (Platte upstream of the Loup River confluence, Platte River from the Loup River confluence to the Elkhorn River confluence, Platte River from the Elkhorn River confluence to the Missouri River, Loup River, Elkhorn River, and Salt Creek) based on differences in hydrology and morphology. Twelve variables will be calculated to assess section fidelity and inter-section movements (i.e., total residence time and total unique visits to each of the six sections). A Manhattan distance matrix will be computed based on the total duration of each fish in each river reach and the number of visits to each river reach (Arostegui et al. 2017). This matrix will be used in cluster analysis with a Ward linkage to determine if there are specific groups with similar seasonal river reach fidelity or movement patterns. Jaccard bootstrap values will be calculated to determine the stability of cluster groups, and Kruskal-Wallis tests will be used to determine differences in reach residency and visits across clusters (Taylor et al. 2021).

Observed linear movement distances, cumulative movement distances, and weekly movement rates will be calculated for all individual fish per season with sufficient detection data using the riverdist package in R. Cumulative distances and average movement rates will be calculated based on successive detections between the first and last detection of each unique transmitter, and linear movement distances will be calculated as the difference between the transmitter's most upstream and downstream locations. Kruskal Wallis tests with post-hoc Dunn's tests will be used to test seasonal differences in all movement metrics among species, between 10 mm binned length categories among species, and between Silver Carp sexes.

Discussion and Future Directions

Preliminary results show a wide range of cumulative movement distances and linear home ranges both between and among tagged species. Blue Suckers exhibited both the highest mean cumulative movement and linear home ranges in the lower Platte River system in 2025 (92.85 and 85.91 rkm, respectively). However, Silver Carp were responsible for the largest observed movement in both cumulative movement and linear home ranges (303.18 and 169.38 rkm, respectively). This seems to be consistent with previous Silver Carp telemetry studies that have documented a small proportion of highly-mobile individuals despite an overall sedentary population. Additionally, several Silver Carp appeared to have disproportionately large observed cumulative movement compared to catostomid species. This suggests that these carp made more frequent, bidirectional movements throughout the monitoring duration while catostomids tended to exhibit stronger degrees of site fidelity to specific river reaches.

We plan to expand upon the 2025 tagging effort by implanting 100 additional transmitters in the spring of 2026, with greater effort focused on the mainstem lower Platte River above the Salt Creek confluence. In doing so, we hope to capture a larger proportion of the more mobile Silver Carp in the population for their implications in upstream range expansion and barrier passage. The Nebraska Game and Parks Commission is funding several ongoing Silver Carp projects in the Platte River system, including a range expansion risk assessment and early life-stage drift dynamics study, both of which may be benefitted by an enhanced knowledge of the movement and residency patterns of Silver Carp in the basin. Additionally, it is our hope that by evaluating seasonal space use and residency patterns of Silver Carp and catostomids concurrently in the lower Platte River, managers may be better informed as to when and where to conduct carp removal efforts while minimizing the potential effects on our native catostomid species.

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Table 1. Tagging information including species (SVCP = Silver Carp, BSKR = Blue Sucker, SMBF = Smallmouth Buffalo, BMBF = Bigmouth Buffalo), total length (mm), weight (g), sex (M = Male, F = Female, UK = Unknown), transmitter ID, tagging site, and tagging date.

Species	Length (mm)	Weight (g)	Sex	Transmitter ID	Tagging Site	Tagging Date
SVCP	506	1624	F	150011A20	Platte at Leshara	5/23/2025
SVCP	517	1831	F	150011A21	Salt Creek	5/29/2025
SVCP	536	1812	M	150011A22	Platte at Plattsmouth	5/16/2025
SMBF	541	2637	UK	150011A23	Platte at Louisville	5/26/2025
BSKR	594	1544	UK	150011A24	Platte at Louisville	5/24/2025
SVCP	613	2656	M	150011B45	Platte at Loup Canal Return	5/22/2025
SVCP	661	3128	F	150011B46	Platte at Salt Creek	5/28/2025
SVCP	622	2713	M	150011B47	Platte at Salt Creek	5/28/2025
BSKR	543	1364	UK	150011B48	Platte at Louisville	5/24/2025
SMBF	479	1600	UK	150011B49	Platte at Louisville	5/26/2025
SVCP	623	2976	M	150032A20	Platte at Plattsmouth	5/16/2025
SVCP	623	2828	M	150032A21	Platte at Loup Canal Return	5/21/2025
BSKR	561	1326	UK	150032A22	Platte at Leshara	5/23/2025
SVCP	522	1836	F	150032A23	Salt Creek	5/17/2025
BSKR	593	1536	UK	150032A24	Platte at Loup Canal Return	5/22/2025
BSKR	641	1846	UK	150032B45	Platte at Louisville	5/24/2025
BSKR	590	1242	UK	150032B46	Platte at Plattsmouth	5/16/2025
SVCP	612	2738	M	150032B47	Platte at Louisville	5/24/2025
SVCP	580	2164	M	150032B48	Salt Creek	5/29/2025
SVCP	492	1378	M	150032B49	Platte at Loup Canal Return	5/21/2025
SVCP	659	3110	M	150052A20	Salt Creek	5/29/2025
BSKR	655	2040	UK	150052A21	Platte at Louisville	5/24/2025
SVCP	647	3039	M	150052A22	Salt Creek	5/29/2025
SMBF	534	2198	UK	150052A23	Platte at Louisville	5/26/2025
SVCP	616	2567	M	150052A24	Salt Creek	5/29/2025
SVCP	651	3086	M	150052B45	Platte at Loup Canal Return	5/22/2025
SVCP	615	2528	M	150052B46	Platte at Loup Canal Return	5/21/2025
SVCP	655	2902	M	150052B47	Platte at Louisville	5/24/2025
SVCP	596	2652	F	150052B48	Salt Creek	5/17/2025
SVCP	621	2750	M	150052B49	Platte at Loup Canal Return	5/21/2025
SVCP	626	2852	M	150070A20	Platte at Loup Canal Return	5/22/2025
SMBF	589	3384	UK	150070A21	Platte at Salt Creek	5/28/2025
SVCP	688	3236	M	150070A22	Salt Creek	5/29/2025
BSKR	656	2082	UK	150070A23	Platte at Loup Canal Return	5/22/2025
SVCP	655	2912	F	150070A24	Salt Creek	5/29/2025

SVCP	675	3188	M	150070B45	Platte at Plattsmouth	5/30/2025
SVCP	604	2492	M	150070B46	Salt Creek	5/17/2025
SMBF	529	2119	UK	150070B47	Platte at Plattsmouth	5/30/2025
BSKR	587	1718	UK	150070B48	Platte at Leshara	5/23/2025
SVCP	659	3386	M	150070B49	Salt Creek	5/17/2025
SVCP	555	2076	F	150091A20	Salt Creek	5/29/2025
SVCP	674	3344	M	150091A21	Platte at Louisville	5/24/2025
SVCP	627	2866	M	150091A22	Platte at Plattsmouth	5/30/2025
SVCP	574	2332	M	150091A23	Salt Creek	5/17/2025
SVCP	656	3196	M	150091A24	Platte at Plattsmouth	5/30/2025
SMBF	584	3135	UK	150091B45	Platte at Louisville	5/26/2025
SVCP	536	1836	F	150091B46	Salt Creek	5/17/2025
BSKR	565	1371	UK	150091B47	Platte at Fremont	5/27/2025
SVCP	592	2278	M	150091B48	Platte at Loup Canal Return	5/22/2025
SVCP	559	1894	M	150091B49	Platte at Loup Canal Return	5/22/2025
SVCP	683	3486	F	150112A20	Platte at Plattsmouth	5/30/2025
BSKR	712	2912	UK	150112A21	Platte at Louisville	5/24/2025
SVCP	604	2152	M	150112A22	Salt Creek	5/29/2025
SMBF	578	2896	UK	150112A23	Platte at Loup Canal Return	5/22/2025
SMBF	606	3450	UK	150112A24	Platte at Leshara	5/23/2025
SVCP	655	3438	M	150112B45	Platte at Loup Canal Return	5/22/2025
SMBF	693	5006	UK	150112B46	Salt Creek	5/17/2025
BMBF	625	4168	UK	150112B47	Platte at Salt Creek	5/28/2025
SVCP	676	3470	M	150112B48	Platte at Loup Canal Return	5/21/2025
SVCP	647	3468	M	150112B49	Platte at Plattsmouth	5/16/2025
SVCP	662	3067	M	150132A20	Platte at Plattsmouth	5/30/2025
SVCP	699	3770	M	150132A21	Platte at Salt Creek	5/28/2025
SVCP	666	2944	M	150132A22	Platte at Louisville	5/24/2025
SMBF	580	3110	UK	150132A23	Platte at Plattsmouth	5/30/2025
SVCP	704	3865	F	150132A24	Salt Creek	5/29/2025
SVCP	667	3140	M	150132B45	Platte at Louisville	5/15/2025
SVCP	622	2597	M	150132B46	Platte at Plattsmouth	5/30/2025
SVCP	653	3255	F	150132B47	Salt Creek	5/29/2025
SVCP	616	2614	F	150132B48	Platte at Loup Canal Return	5/22/2025
SVCP	624	2689	M	150132B49	Platte at Plattsmouth	5/30/2025
BSKR	659	2218	UK	150151A20	Platte at Loup Canal Return	5/22/2025
SVCP	625	2818	M	150151A21	Platte at Plattsmouth	5/30/2025
SVCP	649	3118	F	150151A22	Salt Creek	5/29/2025
SVCP	595	2470	M	150151A23	Platte at Plattsmouth	5/16/2025
SVCP	654	2186	M	150151A24	Salt Creek	5/29/2025
SVCP	668	2956	M	150151B45	Platte at Louisville	5/24/2025

SVCP	651	3302	F	150151B46	Salt Creek	5/29/2025
SVCP	578	2011	M	150151B47	Platte at Plattsmouth	5/30/2025
SVCP	634	2548	M	150151B48	Platte at Fremont	5/27/2025
BSKR	595	1385	UK	150151B49	Platte at Plattsmouth	5/30/2025
BSKR	598	1508	UK	150172A20	Platte at Louisville	5/24/2025
SVCP	665	3354	M	150172A21	Platte at Loup Canal Return	5/21/2025
SMBF	658	3567	UK	150172A22	Platte at Plattsmouth	5/30/2025
SVCP	667	3216	F	150172A23	Salt Creek	5/29/2025
SVCP	636	2836	M	150172A24	Salt Creek	5/29/2025
SVCP	712	3990	F	150172B45	Salt Creek	5/29/2025
SVCP	676	3482	M	150172B46	Platte at Loup Canal Return	5/22/2025
SVCP	677	3694	F	150172B47	Platte at Loup Canal Return	5/22/2025
SVCP	608	2872	M	150172B48	Platte at Plattsmouth	5/16/2025
SVCP	632	2852	M	150172B49	Platte at Salt Creek	5/28/2025
SVCP	703	3671	F	150192A20	Salt Creek	5/29/2025
SVCP	804	5722	F	150192A21	Salt Creek	5/29/2025
BSKR	630	1802	UK	150192A22	Platte at Loup Canal Return	5/21/2025
SVCP	680	3725	F	150192A23	Salt Creek	5/29/2025
SVCP	613	2614	M	150192A24	Platte at Loup Canal Return	5/22/2025
SVCP	641	2978	M	150192B45	Salt Creek	5/17/2025
SVCP	602	2577	F	150192B46	Salt Creek	5/29/2025
BSKR	610	1622	UK	150192B47	Platte at Louisville	5/24/2025
SVCP	659	4241	M	150192B48	Platte at Plattsmouth	5/16/2025
SVCP	618	2422	M	150192B49	Platte at Loup Canal Return	5/21/2025

Figure 1. Map of the study area including locations of passive receivers and tagging release sites in 2025. Receivers are denoted by a red triangle and release locations are denoted by a blue “x”.

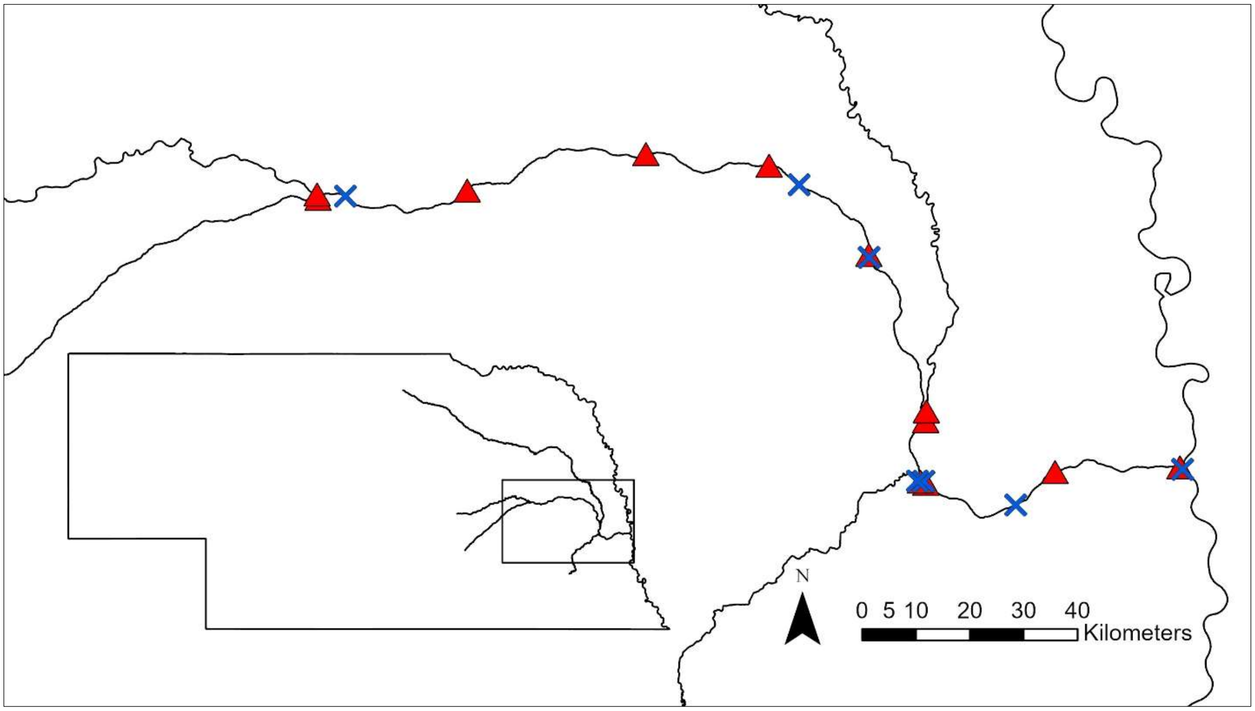

Figure 2. Observed cumulative movement and linear home range (in rkm) of tagged Blue Sucker, Smallmouth Buffalo, and Silver Carp in the lower Platte River basin in 2025.