

Project Title: Invasive carp communication and outreach in the Missouri River Basin
Geographic Location (Figure 1):

- One in person meeting in August 2023 and multiple virtual meetings.
- Kansas River from the confluence with the Missouri River (RKM 0) upstream to the WaterOne Weir at Edwardsville, KS (RKM 24)
- Mainstem Missouri River between Gavins Point Dam and the Big Sioux River.
- Bait shops across North Dakota, South Dakota, Nebraska, Kansas, and Iowa.

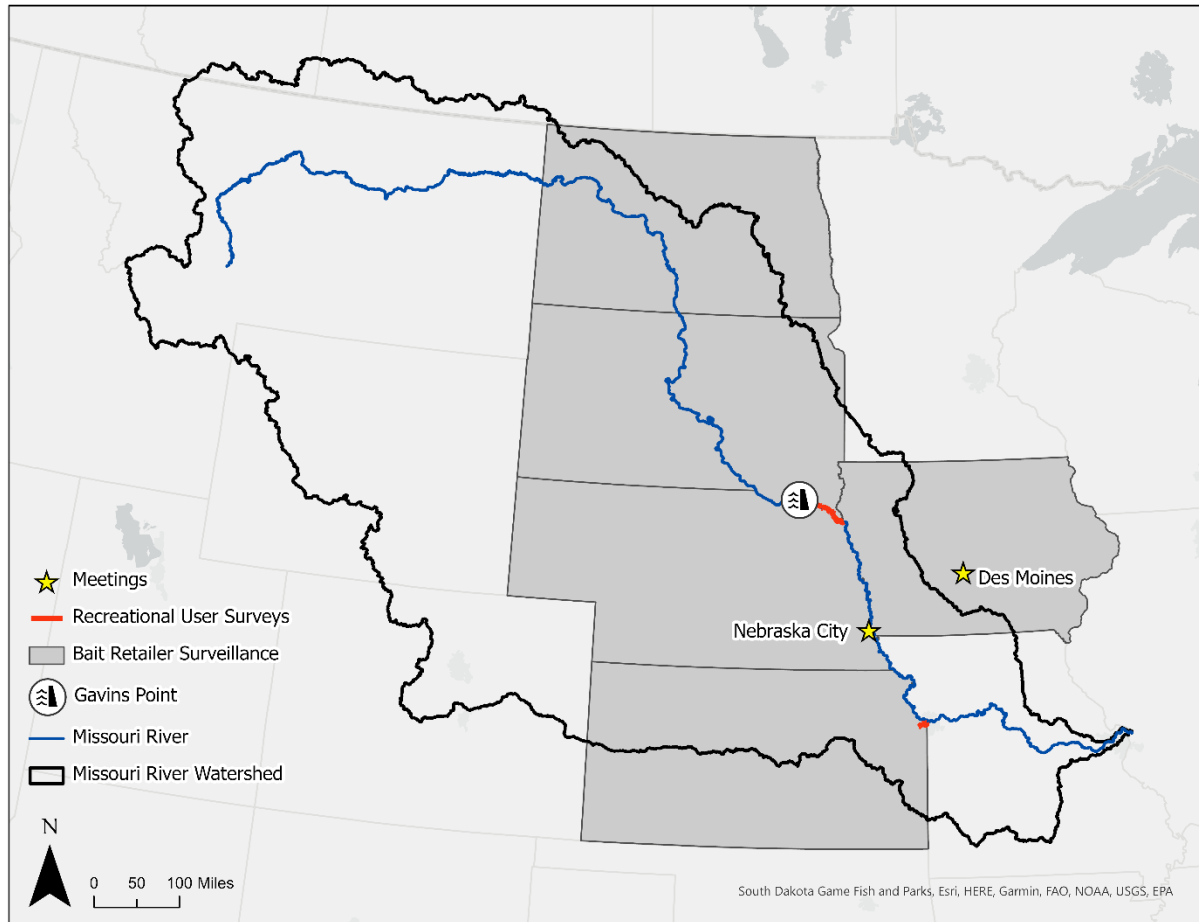


Figure 1. Activities in support of communication and outreach in the Missouri River Basin in 2023 including virtual and an in-person meeting, recreational user surveys, and bait retailer surveillance.

Lead Agency: Alison Coulter (Alison.Coulter@sdstate.edu), South Dakota State University Department of Natural Resource Management.

Participating Agencies:

- Iowa Department of Natural Resources (IDNR), Kim Bogenschutz, kim.bogenschutz@dnr.iowa.gov
- Kansas Department of Wildlife and Parks (KDWP), Chris Steffen (chris.steffen@ks.gov), Liam Odell (liam.odell@ks.gov)

- Nebraska Game and Parks Commission (NGPC), Kirk Steffensen, kirk.steffensen@nebraska.gov and Kris Stahr, kristopher.stahr@nebraska.gov; Nebraska Cooperative Fish and Wildlife Research Unit (NE CRU), Caroline LaPlante (claplane2@huskers.unl.edu); U.S. Geological Survey—Nebraska Cooperative Fish and Wildlife Research Unit (USGS), Kevin L. Pope kpope2@unl.edu & Jonathan J. Spurgeon jspurgeon2@unl.edu
- South Dakota Department of Game, Fish, and Parks (SDGFP), Tanner Davis, tanner.davis@state.sd.us, BJ Schall, benjamin.schall@state.sd.us; South Dakota State University (SDSU), Department of Natural Resource Management, Alison Coulter, alison.coulter@sdstate.edu, Hannah Mulligan hannah.mulligan@sdstate.edu.

Statement of Need:

Invasive carp are found in the lower Missouri River basin up to Gavins Point Dam and extending into states via connected waterways. Preventing range expansion of invasive carp in the Missouri River basin requires a basin-wide approach with communication among partners and agencies as a centerpiece. This annual technical report provides updates and results from partners in the Missouri River Basin on their efforts to communicate with each other, identify impacts to recreational activities, and understand risk of human-mediated activities to inform outreach and education in the basin.

It is most important for managers on the ground to effectively communicate with each other to ensure that the most up-to-date science and techniques are being shared. As more research is conducted in the Missouri River Basin on invasive carp, the results and recommendations must be shared across partners in an effective, useable manner to prevent the spread of invasive carp and to manage these species in their current localities.

Though invasive carp are believed to impact our aquatic resources, little is understood about how these species affect recreationalists and anglers who use these resources. As invasive carp impact waterways, users can be affected through several ways. Invasive carp may prevent boating or impact the quality of a fishery. Therefore, it is critical to obtain information from these users to not only better understand how invasive carp affects them, but to gain insight into potential management techniques. Information obtained can also be used to direct specific outreach efforts for all AIS and allow for increased dialogue with aquatic users and managers.

The Nebraska Game and Parks Commission (NGPC) in conjunction with the South Dakota Fish, Game, and Parks oversee two Paddlefish-fishing seasons annually in the mainstem Missouri River between Gavins Point Dam and the Big Sioux River. Invasive carp have steadily increased in abundance in this reach during the past several decades, anecdotally negatively affecting anglers' satisfaction. Currently, state managers rely on a postcard survey to monitor this fishery and judge anglers' satisfaction from the comment section of the returned postcards. NGPC and NE Cooperative Research Unit implemented an in-person creel survey during the June-archery and October-snagging seasons of 2022 and 2023 to quantify catches (target and non-target).

The Kansas River basin drains approximately the north half of the state of Kansas and flows East to its confluence with the Missouri River at Kansas City, Kansas. Invasive carp are abundant from the Missouri River confluence upstream to the Bowersock Dam at Lawrence, Kansas

(RKM 84). The Kansas River is one of only three rivers in the state of Kansas that is legally a publicly navigable river. The designation allows for public recreation such as kayaking/canoeing, fishing, hunting, wildlife viewing, etc. Additionally, the Kansas River was designated as a National Water Trail in 2012 by the National Park Service. This designation, as well as the recent nationwide surge of participation in kayaking, appears to have led to increasing use of the Kansas River by paddlers. A burgeoning trophy blue catfish population also appears to be increasing angler use of the Kansas River. The Kansas River is a unique and increasingly valuable destination for outdoor recreation in the State of Kansas. The impacts of invasive carp to recreationalists are not well understood. KDWP occasionally receives reports of unfavorable interactions between recreationalists and invasive carp, but it is likely that most of these interactions are unreported. Additionally, there is concern that some blue catfish anglers may be tempted to transport invasive carp to other waterbodies based on their belief that the presence of invasive carp lead to the development of the trophy blue catfish fishery. The prevalence of this perception is unknown, and education and outreach may be needed to address this issue.

One pathway for invasive carp expansion is human-mediated movement. Spread of aquatic invasive species (AIS) via dumping of live bait is a known vector for AIS spread. Invasive carp (primarily as young-of-year) closely resemble common baitfishes, such as Gizzard Shad *Dorosoma cepedianum* and Alewife *Alosa pseudoharengus*, used by anglers and sold commercially. Several Missouri River Basin states allow anglers and bait dealers to collect their own bait, resulting in a high risk of human-mediated movement of invasive carp especially if improperly released. In addition, even in localities with regulations restricting live bait collection, illegal collection and subsequent selling of live bait cannot be ruled out. Thus, it is imperative to not only investigate all methods of human-mediated movement of invasive carp, but to develop pragmatic management solutions to prevent or reduce the risk from this pathway.

Targeted educational campaigns, in specific regions or at particular bait shops, could help reduce the risk of AIS spread by anglers using live bait. Additionally, understanding the relative risks posed by bait shops regionally and how the characteristics of each bait shop (e.g., proximity to AIS established population, regulations of particular states, sources of baitfish) influence risk will help increase the effectiveness of educational programs by targeting interventions. In the Missouri River Basin, Silver Carp (*Hypophthalmichthys molitrix*) and Bighead Carp (*H. nobilis*) are particular AIS of concern. They are established in the Missouri River mainstem upstream into South Dakota where Gavins Point Dam has limited their expansion further upstream. Additional dams on tributaries to the Missouri River (e.g., Big Sioux River Falls and East Vermillion Lake spillway in South Dakota, the Jamestown Reservoir spillway in North Dakota, Bowersock, and Clinton dams in Kansas) have likely also inhibited upstream expansion of these AIS. However, introduction of these species above dams that currently inhibit their spread via bait dumping is a serious concern. In the Great Lakes region, Silver Carp eDNA was previously documented in bait shops that were located outside of the current range of Silver Carp (Nathan et al. 2014) indicating that Silver Carp were currently present or may have passed through bait shop tanks.

Project Objectives:

1. Support coordination and communication among partners regarding invasive carp outreach and management in the Missouri River Basin and beyond for the most efficient use of resources.
2. Evaluate recreational satisfaction and invasive carp knowledge in areas of the Missouri River Basin with invasive carp to inform management actions and increase the effectiveness of outreach messaging.
3. Assess human-mediated pathway risks for invasive carp movement to prevent the introduction and further spread of invasive carp into and within the Missouri River Basin.

Project Highlights:

- Objective 1: Coordination and Communication
 - Multiple virtual online meetings Missouri River Basin Invasive Carp research and management
 - Contributed reports to MICRA as needed.
- Objective 2: Evaluate recreational satisfaction and invasive carp knowledge
 - KDWP user survey on the Kansas River was completed in 2022 and a final report is available (Appendix 1)
 - Survey results provide managers insight into how river users perceive and are impacted by the presence of invasive carp.
 - Identified shortcomings in invasive carp education and outreach efforts to be improved upon.
 - Only a small portion of Paddlefish anglers reported concerns about Invasive Carps and a subset of these has negative sentiments about Invasive Carp.
 - The importance-grid analysis revealed that at both the day-level and the season level, paddlefish fishers' satisfactions are strongly related to the harvest of a paddlefish and that factors relating to invasive carp and other invasive species are unimportant rather than detrimental.
 - There is no difference in how invasive carp factors are classified on the importance grid between methods of take, which is contrary to the hypothesis that archery fishers may have a stronger positive influence of invasive carp towards fishing satisfaction given the additional targets they create.
 - It is likely that bigheaded carp are becoming normalized to the point of leniency in fishers and thus they are not identifying them categorically as invasive species and are shifting their expectations in regard to dealing with their presence.
- Objective 3: Assess human-mediated pathway risk in bait shops
 - 15% of bait shops sold non-target species and some of these species were not legal bait in a particular state.
 - Only 12% of bait shops displayed educational signage.
 - 5.79% of water samples tested positive for Silver Carp/Bighead Carp eDNA.
 - Models revealed that distance to invasive carp was a major predictor of positive eDNA detections in bait water.
 - Results were published (Mulligan et al. 2023)
- Multiple presentations, publications, and reports resulted from this work. (Appendix 1)

Objective 1. Support coordination and communication among partners regarding Invasive carp outreach and management in the Missouri River Basin and beyond for the most efficient use of resources.

Planning, Coordination, and Communication

The Missouri River Basin managers and researchers prepare documents created as part of the annual planning and reporting process that were shared with MICRA for posting on their website, <http://micrarivers.org/invasive-carp-plans-and-reports/> (Figure 1).

The basin met in person August 7 – 10, 2023 in Millford, Iowa to give progress updates and discuss future work.

The basin also met several times virtually early in 2023 to finalize templates and work plans. Temporary Basin Coordinator Neal Jackson also facilitate planning and one virtual meeting to identify priority projects and submit proposals for funding.

Tables and Figures:

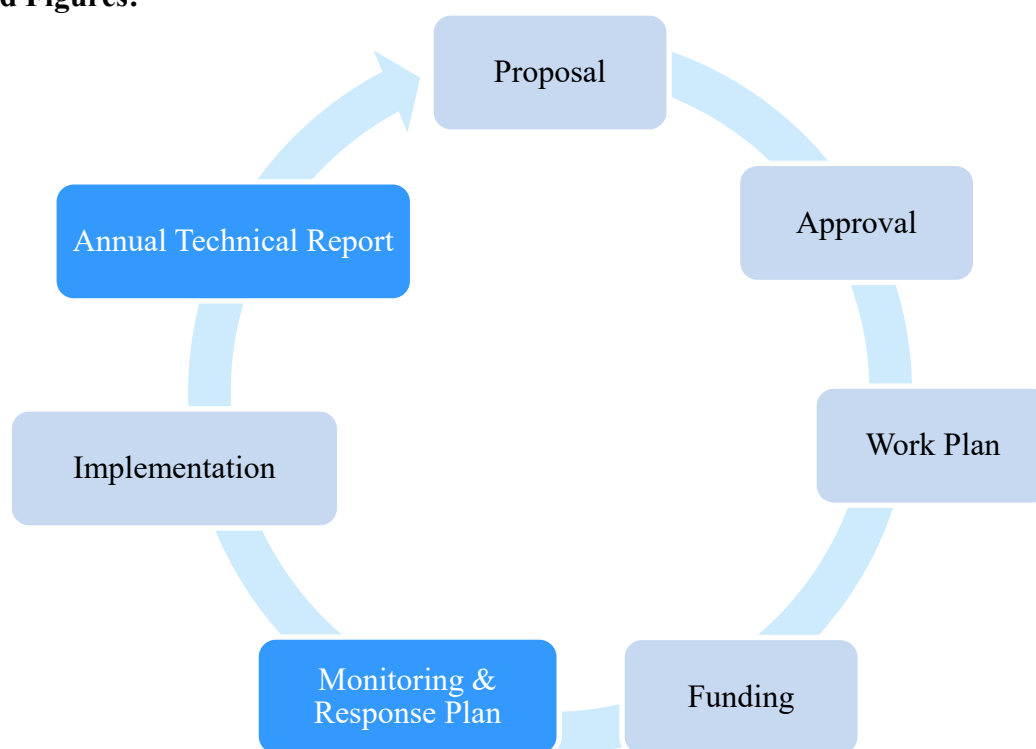


Figure 2. Annual planning, implementation, and reporting cycle for the Missouri River Basin Invasive Carp Partnership. Blue boxes represent documents posted to MICRArivers.org.

Objective 2. Evaluate recreational satisfaction and Invasive carp knowledge in areas of the Missouri River Basin with Invasive carp to inform management actions and increase the effectiveness of outreach messaging.

KANSAS

Sub - Project Title:

Kansas FY2021 KS River recreationalist survey - Invasive carp communication and outreach in the Missouri River Basin

Sub - Project Objectives:

Objective 1: Conduct a survey of Kansas River recreationalists to understand user groups and assess invasive carp perceptions and impacts to inform future management decisions.

Objective 2: Raise awareness of invasive carp by distributing educational information to Kansas River recreationalists.

Results and Discussion:

No additional work was conducted for this project in 2023.

Final project report can be found at:

Steffen S.F., M.A. Parr, L. K. Kowalewski, L. M. Odell, and C. J. Steffen. 2024. At the Confluence of Diverse Users and Invasive Carp: the 2022 Kansas River User Survey. Kansas Department of Wildlife and Parks, Emporia, KS. 36 pp.

NEBRASKA

Sub - Project Title:

Assessment of Angler Satisfaction in the Mainstem Missouri River, Nebraska: Emphasis on Paddlefish Fishery below Gavin's Point Dam

Sub -Project Objectives:

Objective 1: Conduct angler satisfaction surveys in the Missouri River Basin to assess recreational anglers' reactions to Asian carp and use this information to inform management actions.

Objective 2: Conduct surveys of anglers and the general public to assess general knowledge about Asian carp and understanding of potential consequences of human-mediated spread and use this information to inform management actions

Results and Discussion:

No additional work for this project was conducted in 2023.

A final report is available at:

LaPlante, C. M. 2023. The Influence of Invasive Species on Fishers' Satisfaction. School of Natural Resources: Dissertations, Theses, and Student Research. 370.
<https://digitalcommons.unl.edu/natresdiss/370>

Objective 3: Assess human-mediated pathway risks for Asian carp movement to prevent the introduction and further spread of Asian carp into and within the Missouri River Basin.

SOUTH DAKOTA

Sub - Project Title: Assessing the risk of Asian carp spread posed by live bait trade

Sub - Project Objectives:

- 1) Collect and process samples to assess the risk of Asian carp (Silver Carp and Bighead Carp) spread in the Missouri River Basin via the live bait trade and identify risk factors associated with particular bait shop operations (e.g., state regulations, proximity to established Asian carp populations).

Methods:

A total of 112 retail locations in North Dakota, South Dakota, Nebraska, Kansas, and Iowa that sold live baitfish were randomly selected based on a gradient of Silver and Bighead Carp abundances, as well as to target locations where barriers have inhibited Silver Carp and Bighead Carp spread in the Missouri River Basin (Figure 1). Aquatic invasive species coordinators from each study state also provided a list of high-priority locations for sampling which was accounted for when selecting baitfish retailers. Google Map searches (i.e., “bait shop”, “live bait near me”, “live minnows”) and inquiries from state agencies provided a list of bait shops, convenience stores, and department stores that sold live baitfish for each state. Bait retailers were then randomly selected through a random number generator. However, there were cases when random selection was not possible due to the small number of bait retailers present in the area. We selected 20 bait shops per state for widespread regional surveillance and visited an additional 12 bait shops during fall South Dakota sampling.

Sampling methods were adapted based on previously described methodology (Nathan et al. 2015; Snyder et al. 2016; Mahon et al. 2010) where water is collected from bait retailers in sterile bottles and placed in a cooler of ice during transportation to limit eDNA degradation. For each sampling day, we filled a half-gallon milk jug (1.87L) with tap water and filtered it with the rest of the samples to serve as the negative field control to ensure contamination was not occurring. Additionally, all sampling equipment) was decontaminated and soaked in a 10% bleach solution for 10 minutes between samples. Nitrile gloves were also worn and changed between and during water and baitfish collection and filtering.

At each baitfish retailer, one unit of baitfish (either one dozen or one scoop depending on the retailer) was purchased and held in a decontaminated bucket. Advertised baitfish purchased were usually Fathead Minnows (n = 91 retailers) but Golden Shiners (n = 19 retailers), Red Shiners, (n = 1 retailer), or a combination of both Fathead Minnows and Golden Shiners (n = 1) were purchased if Fathead Minnows were not available. During the purchase, the presence of any educational signage about bait dumping and/or invasive species was also recorded. Baitfish were strained from water with a colander and the water was divided into two replicate 1 L water

samples which were funneled into sterile half-gallon milk jugs. The half-gallon milk jugs were immediately placed in a cooler with ice. The baitfish were euthanized (IACUC protocol 2109-056A), and placed in a labeled plastic bag (date, state, bait retailer) with 70% ethanol. Purchased bait was identified to species in the lab.

All water samples were filtered within 12 hours using a multiple vacuum pump filtration system (Whatman 10498762) onto a 1.5- μ m pore size glass fiber filter (Nathan et al. 2015; Snyder et al. 2016). To minimize bleach residue, 500 mL of tap water was run through the apparatus before filtering each sample. Filters were then placed into 15 ml Falcon tubes with 90% ethanol for shipment to the Bozeman Fish Health Center. In cases where the water sample would not filter through completely, the amount of water filtered was recorded and a new filter was placed on the filter funnel. In cases where the sample required more than 2 filters, a new vial was labeled, and the process was repeated for up to 4 filters. Vials were wiped with DNA AWAY™ (Thermo Scientific™, city, state) and shipped to the USFWS Bozeman Fish Health Center in Bozeman, Montana.

In 2022, water samples were collected from 100 bait retailers (2x water samples per bait shop with exception of one that only supplied enough water for one sample; 20 retailers per state) in North Dakota, South Dakota, Nebraska, Kansas, and Iowa from June to September. Sampling moved from south to north to match when Bighead Carp and Silver Carp juveniles may be abundant and of similar size to native baitfish species. One bait shop in Kansas only provided enough water with baitfish for one 1 L sample. In September and October 2022, 60 additional water samples were collected in South Dakota from 30 bait retailers, including 18 bait retailers that were previously sampled and 12 additional bait retailers.

Staff at the USFWS Bozeman Fish Health Center performed DNA extraction and quantitative real-time polymerase chain reaction (qPCR) analysis on each sample and field control filter to identify the presence or absence of target species DNA. The USFWS eDNA sampling processing protocol, detailed in the 2022 Quality Assurance Project Plan, uses an assay with two general invasive carp markers (ACTM 1/3), two markers specific to Silver Carp (SCTM 4/5), and two markers specific to Bighead Carp during qPCR amplification (BHTM 1/2) (QAPP; USFWS 2020). A sample is considered positive if fluorescence is above a threshold for any of the primers, in at least one of the eight amplification replicates. Thresholds are determined by running standards during each amplification.

Results and Discussion: Out of the 259 water samples collected from bait retailers in June to October 2022, 15 (5.79%) tested positive for at least 1 of the Silver and/or Bighead Carp qPCR replicates in North Dakota (n = 1), South Dakota (n = 9), Kansas (n = 1), and Iowa (n = 4) (Figure 2). Nebraska did not have any positive detections for Silver and/or Bighead Carp in the selected bait retailers. The only detection for Bighead Carp was documented in 1 Kansas bait retailer. Out of the 15 positive detections, 2 bait retailers had educational signage and 5 bait retailers had non-advertised species present within purchased bait. All field controls were negative (n = 27 filters).

Out of the 112 bait shops sampled, 13 (12%) had educational signage about bait dumping and/or invasive species in Kansas (n = 2), Nebraska (n = 2), and North Dakota (n = 9) (Figure 3). We did not observe educational signage in South Dakota or Iowa in the bait shops surveyed. All educational signage present was in the form of posters; we did not observe educational signage or outreach in the form of pamphlets, bait bags, or verbal communication. Stop Aquatic Hitchhikers!™ (Clean, Drain, Dry) was the only signage recorded in Kansas and Nebraska. North Dakota educational signage was predominantly provided to bait retailers by North Dakota Game and Fish, and included posters regarding proper disposal of live bait, baitfish identification, and signage regarding the importation of bait. Bait retailers in North Dakota typically had more than 1 poster displayed.

Out of 112 bait shops, 17 bait shops (15%) had non-target species present within the purchased bait in Kansas (n = 1), Nebraska (n = 4), Iowa (n = 6), South Dakota (n = 5), and North Dakota (n = 1) (Figure 4). In South Dakota, 3 bait shops that did not originally have a non-target species had a non-target species present during the additional fall survey. One bait shop in South Dakota that originally had a non-target species did not have non-target species present during the second visit. Non-advertised species included the Rosy Red variation of the Fathead Minnow, Brook Stickleback, Black Bullhead, White Sucker, Topminnow, and River Carpsucker. We also observed a common mudpuppy in one South Dakota bait shop tank. There was also a bait shop in Iowa with multiple non-target species within one purchase (4 Brook Stickleback) and two instances where retailers within the basin sold bait species that was not legal in the state. Additionally, there were two instances where retailers sold more than the possession limit when 1 scoop or 1 dozen was requested.

Binomial models and model selection (distance to carp, educational signage, and non-advertised species; state and watershed as random effects) revealed that distance to invasive carp was a major predictor of positive eDNA detections in bait water. This means that managers can target surveillance towards the invasion front. Additionally, the low rates of educational signage in retailers coupled with the presence of positive eDNA detections and non-advertised species indicate that additional management attention to this pathway is warranted. In addition to targeting bait retailers near invasive carp for surveillance, managers should consider targeting education and outreach to these locations.

Although positive eDNA detections do not necessarily mean a live Silver Carp or Bighead Carp was present, positive eDNA detections coupled with the sale of non-target species indicates that the live bait trade is a potential vector for invasive carps in the Missouri River Basin. Lack of educational signage indicates an opportunity to work with bait shops to educate the public regarding invasive carps.

Graduate student Hannah Mulligan published the results of the bait retailer study in fall 2023 (Mulligan et al. 2023) and defended her MS in December 2023.

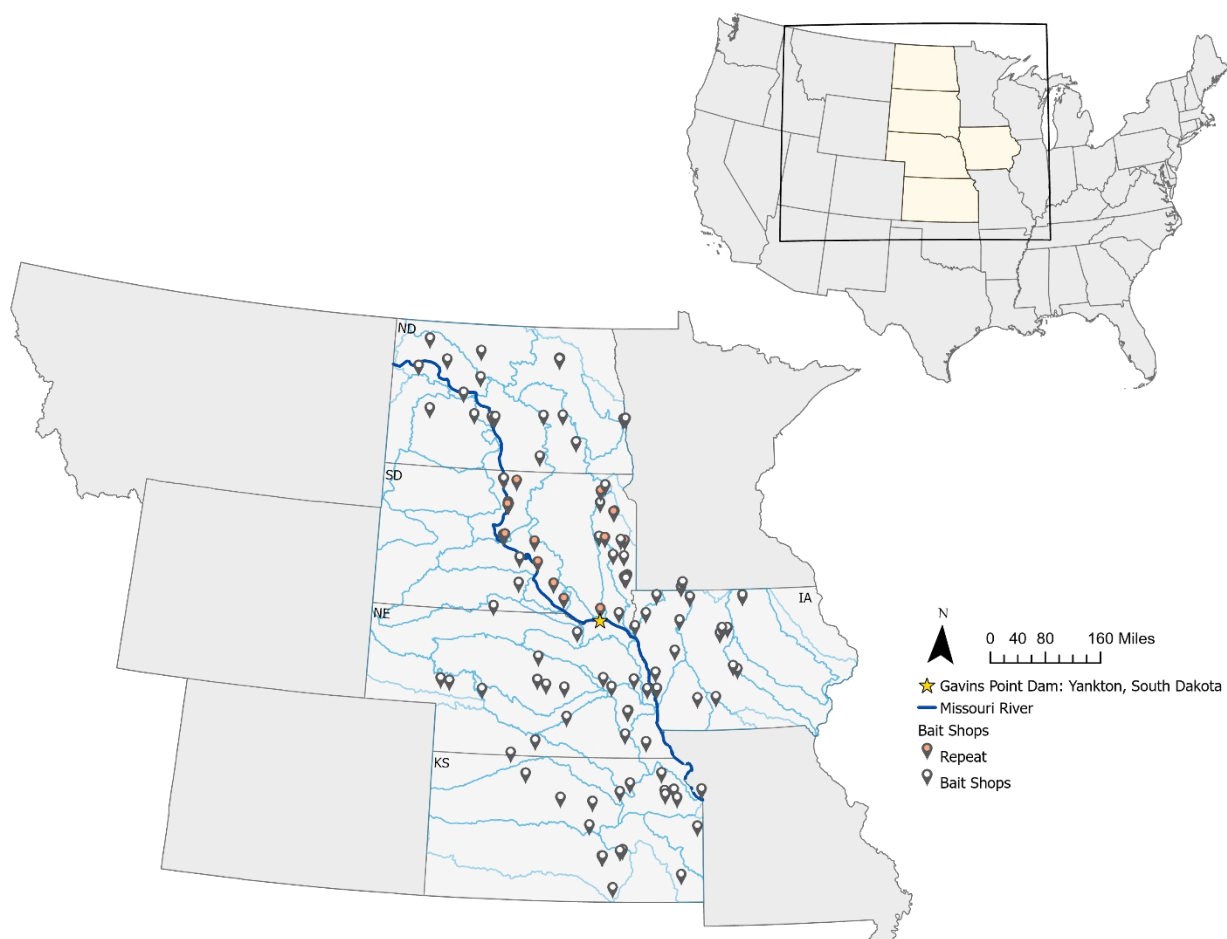
Tables and Figures:

Figure 3. Locations of the 112 bait retailers selected for eDNA surveillance in the Missouri River basin during June to October 2022. Bait retailers included bait shops, convenience stores, and department stores.

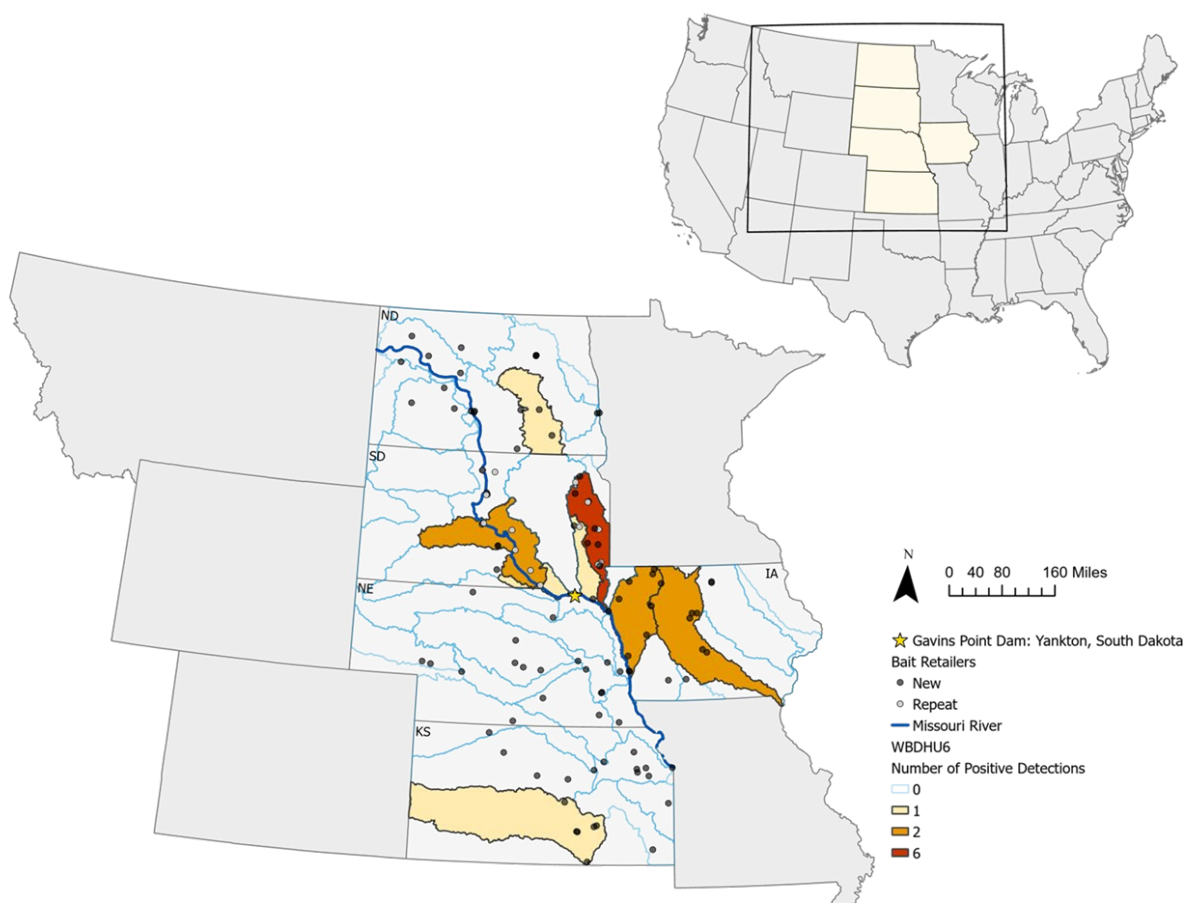


Figure 4. Locations of positive detections for Silver Carp and/or Bighead Carp eDNA during 2022 environmental DNA (eDNA) surveillance by hydrologic unit code 6 (HUC – 6), commonly referred to as basin.

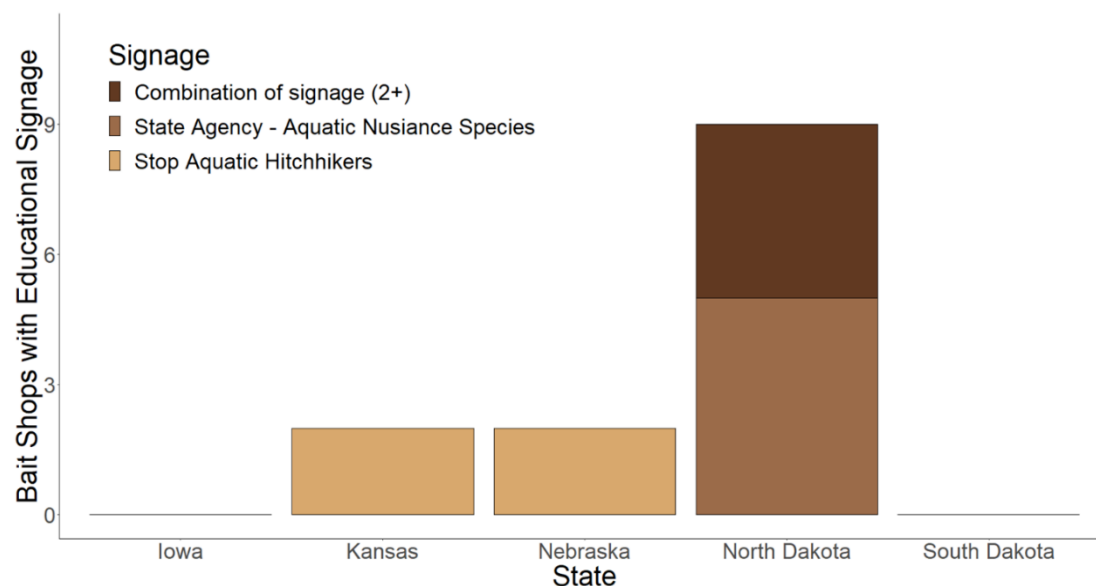


Figure 5. Quantity of Aquatic Invasive Species (AIS) signage by state in sampled bait shops ($N = 20/\text{state}$). Recorded educational signage included state agency- aquatic nuisance species, state agency- do not dump bait bucket (included in combination of signage) and stop aquatic hitchhikers.

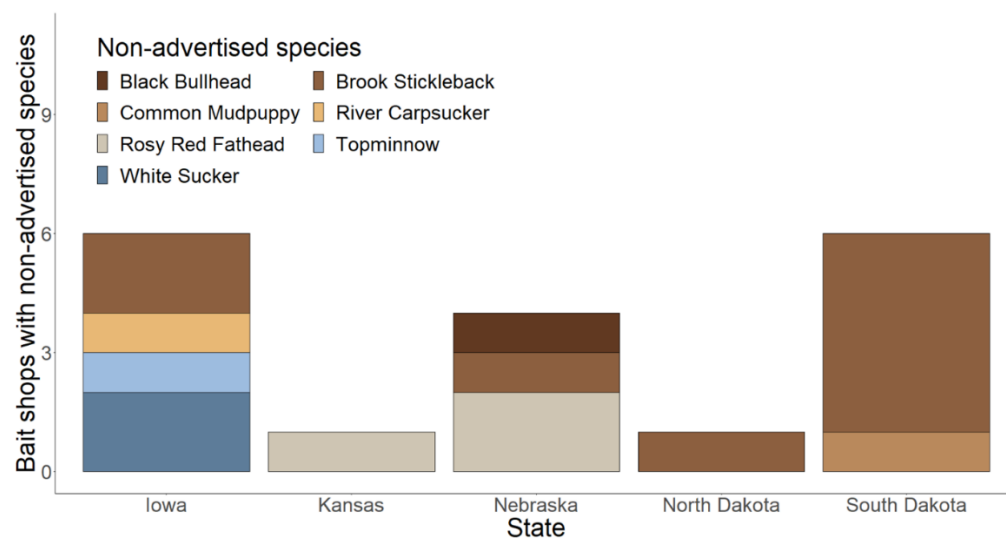


Figure 6. Quantity of non-advertised species present in purchased bait by state ($N = 20$ bait retailers/state, $SD = 32$ bait retailers and 18 repeated visits) in Iowa, Kansas, North Dakota, Nebraska, and South Dakota. Non-advertised species included the Rosy Red variation of the Fathead Minnow, Brook Stickleback, Black Bullhead, White Sucker, Topminnow, and River Carpsucker.

Table 1. Number of bait shops within different watersheds that tested positive for at least one of the three primers evaluated. Primers are fully described in the USFWS 2022 Quality Assurance Plan.

Hydrologic Unit Code 6	Detection of AC only	BH or BH and AC only	SC or SC and AC only
Middle Arkansas	0	1	0
Missouri-Little Sioux: IA	1	0	1
Des Moines	1	0	1
Big Sioux	4	0	2
James: ND	0	0	1
Lewis and Clark Lake	1	0	0
Fort Randall Reservoir	1	0	1

Recommendations:

- Continue to explore options to communicate results of invasive carp research to partners at all levels.
 - Planning a symposium at the 2025 Midwest Fish and Wildlife Conference.
- Results from Objectives 2 and 3 indicate that increased signage or educational materials regarding the risk of Silver Carp are needed.
 - Communicating with other ethnicities or user groups is essential. Signage at boat ramps or river access points to communicate with those who do not speak English is recommended. Options are signs in other languages (e.g., Spanish along the Kansas River) or creating signs without words that use images to convey the message, similar to pesticide or hazardous material labeling.
 - Bait shops had limited education materials, and what was there was often related to Stop Aquatic Hitchhikers!™ (Clean, Drain, Dry). Increased materials in bait shops, educational signage, and outreach in the form of pamphlets, bait bags, or verbal communication regarding proper disposal of live bait, baitfish identification, and the importation of bait is recommended.
 - Current organization in some state hunting and fishing regulations have bait regulations and AIS information in separate locations. It is recommended to house this information in similar locations of hunting and fishing regulations for anglers to easily access.

References:

- Mahon, A. R., L. R. Nathan, and C. L. Jerde. 2014. Meta-genomic surveillance of invasive species in the bait trade. *Conservation Genetics Resources* 6(3):563-567.
- Mulligan, H. M., B. J. Schall, T. Davis, and A. A. Coulter. 2023. Opportunities for regional collaboration and prevention: Assessing the risk of the live bait trade as a pathway of invasive species. *Biological Conservation* 287: 110342.
- Nathan, L. R., C. L. Jerde, M. L. Budny, and A. R. Mahon. 2015. The use of environmental DNA in invasive species surveillance of the Great Lakes commercial bait trade. *Conservation Biology* 29(2):430-439.
- Snyder, M. R., C. A. Stepien, N. T. Marshall, H. B. Scheppler, C. L. Black, and K. P. Czajkowski. 2020. Detecting aquatic invasive species in bait and pond stores with targeted environmental (e)DNA high-throughput sequencing metabarcode assays: Angler, retailer, and manager implications. *Biological Conservation* 245:108430

Appendix 1

Summary of research production from this project

Presentations

1. LaPlante, C. M., C. J. Chizinski, K. L. Pope, and K. D. Steffensen. 2023. Relevancy of fishing: the influence of invasive species on recreational fisher satisfaction. Annual Meeting of the American Fisheries Society, Grand Rapids, Michigan.
2. LaPlante, C. M., K. L. Pope, C. J. Chizinski, and K. D. Steffensen. 2023. Fisher satisfaction in the presence of invasive species. Midwest Fish and Wildlife Conference, Overland Park, Kansas.
3. Mulligan, H., B. J. Schall, T. Davis, A. Gerber, M. Kaemingk, and A. A. Coulter. 2023. Small but risky: Non-native fish introductions via the live bait trade. Annual meeting of the American Fisheries Society, Grand Rapids, Michigan. Oral.
4. Mulligan, H., B. J. Schall, T. Davis, A. Gerber, M. Kaemingk, and A. A. Coulter. 2023. Small but risky: Non-native fish introductions via the live bait trade. South Dakota Wildlife Federation Annual Meeting, Brookings, South Dakota. Oral.
5. Mulligan, H., B. J. Schall, T. Davis, A. Gerber, M. Kaemingk, and A. A. Coulter. 2023. Hidden invaders: Invasive species in live bait. Graduate Research, Scholarship, and Creative Activity Day, Brookings, South Dakota. Poster.
6. Mulligan, H., B. J. Schall, T. Davis, A. Gerber, M. Kaemingk, and A. A. Coulter. 2023. Assessing the live bait trade as a vector of non-native fish in the Missouri River Basin. Dakota Chapter of the American Fisheries Society, Virtual. Oral.
7. Mulligan, H., B. J. Schall, T. Davis, A. Gerber, M. Kaemingk, and A. A. Coulter. 2023. Hidden invaders: Invasive species in live bait. Midwest Fish and Wildlife Conference, Overland Park, Kansas.

Reports

1. Steffen, S. F., M. A. Parr, K. K. Kowalewski, L. M. Odell, and C. J. Steffen. 2024. At the Confluence of Diverse Users and Invasive Carp: the 2022 Kansas River User Survey.

Publications

1. Mulligan, H. M., B. J. Schall, T. Davis, and A. A. Coulter. 2023. Opportunities for regional collaboration and prevention: Assessing the risk of the live bait trade as a pathway of invasive species. *Biological Conservation* 287: 110342.

Theses

1. LaPlante, C. M. 2023. The Influence of Invasive Species on Fishers' Satisfaction. University of Nebraska – Lincoln, M.S. Thesis.
<https://digitalcommons.unl.edu/natresdiss/370/>
2. Mulligan, H. 2023. The Live Bait Trade as a Pathway of Inland Invasive Fish Species Introductions. South Dakota State University, M.S. Thesis.