Project Title: Effects of invasive carp and impoundment on food web structure and fish condition in Upper Mississippi River tributaries

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Location of Activities: UMR and tributaries to the UMR in Eastern Iowa.

Statement of Need: Invasive species and hydrologic alterations from navigation, flood control, and hydroelectric dams are among the most serious stressors present in the Upper Mississippi River basin. Both stressors can inflict ecosystem-level effects including the restructuring of food webs through increased competition, predation, habitat alteration, water quality degradation, and fragmentation. Bigheaded carp (*Hypophthalmichthys molitrix* and *Hypophthalmichthys nobilis*) are high-profile invasive species in North America that are continuing to expand upstream in the Mississippi River basin. In response, many state and federal agencies partner to reduce the undesirable effects of invasive carp through early detection, barrier management, and removal. Despite these programs, our understanding of the full consequences of bigheaded carp invasions is incomplete, hampering our ability to enact scientifically led decision-making to control their spread as well as understand the ecosystem impacts, they can have at different densities.

Previous research has focused mainly on trophic competition between bigheaded carp and three native planktivores: Bigmouth Buffalo (*Ictiobus cyprinellus*), Paddlefish (*Polyodon spathula*), and Gizzard Shad (*Dorosoma cepedianum*). These studies identified substantial dietary overlap between bigheaded carp and native planktivores (Harris et al., 2022), further implicating bigheaded carp in the declines in large crustacean zooplankton and native planktivores (Irons et al., 2007; Pyron et al., 2017; Sass et al., 2014; Tillotson et al., 2022). However, pilot data from the Des Moines and Iowa rivers suggest that trophodynamics of predatory fishes such as the Flathead Catfish (*Pylodictus olivaris*) may also be affected by carp abundances as well as impoundment (Weber, unpublished). Currently, bigheaded carp populations exist in all three stages of biological invasion, namely, arrival, establishment, and integration (Moyle & Light, 1996) across the upper Mississippi River basin pools and large tributaries. Gradients of bigheaded carp relative abundance exist, ranging from absent upstream of tributary dams to dominant in downstream reaches of southern tributaries such as the Lower Des Moines River. This establishes a spatially replicated natural gradient of relative carp abundance across the region and presents a unique and timely opportunity to acquire information about how serial disruptions to river continuity due to impoundment may interact with invasive species abundance to influence food webs dynamics for multiple native trophic guilds. This information is needed to adjust target density levels of bigheaded carp that can be attained through population suppression efforts. Therefore, we propose the following project.

Project Objectives:

1. Determine how fish condition and trophic position are related to individual and interactive effects of invasive species relative abundance and impoundment for multiple trophic guilds in tributaries to the Upper Mississippi River.

Project Highlights:

- Highlights are not available as the study is ongoing.

Methods:

We conducted boat electrofishing (Smith-Root VVP-15B shock box 45Hz frequency pulse DC) from May – October 2024 on the Des Moines, Skunk, Iowa, Cedar, Wapsipinicon, and Mississippi rivers (pools 16 and 19) to capture twelve species of fish (**Figure 1**). These species represent five trophic guilds: non-native planktivores, native planktivores, detrivores, benthic invertivores, and carnivores (**Table 1**) to more holistically assess the potential effects of invasive carp on native food webs. We measured length (mm) and weight (g) on 3,263 individuals and collected 1,068 of those individuals for our hepatosomatic index. We developed length bins to guide sampling by dividing the predicted length range of a species by our target sample size (n=15 individuals per species) and attempted to collect samples of individuals in each length bin. To collect each individual, we would place them in a lethal concentration of MS-222 solution (>250mg/L). Once the individual is humanely euthanized, we extracted the liver and weighed the whole liver to the nearest 0.01 g.

Bigheaded carp CPUE was also estimated to better understand the gradient of bigheaded carp densities throughout our study sites and establish categories of relative abundance for future comparisons. Relative abundance was estimated by conducting four random sampling events at each of our 12 sites with each sampling event being 15 minutes of active shocking time long. Relative abundance sampling was conducted using boat electrofishing with similar shock box settings as above. After the 15 minutes were up, all individuals were recorded with length weight measurements and muscles plugs or livers were collected if applicable. CPUE measurements we recorded as number of bigheaded carp caught per hour.

We also collected muscle plugs and length-weight measurements from 2,472 individuals. We used a sterilized cylindrical biopsy punch (10 mm Robbins Instruments) to remove scales (if applicable) and extract muscle tissue from the anterodorsally body region. To collect a tissue sample from a bivalve mussel, we would first sterilize a scalpel and cut both the posterior and anterior abductor muscles to open the shell. After sterilizing the scalpel again, we would take a 10 mm section from the foot of the mussel. All tissue samples were stored on ice in Whirl-Pak Write-On Bags and then frozen at the lab for future processing.

We dried samples in a Thermo Scientific Heratherm OGS180 at 60°C for 24–48 hours. Once samples were dried, they are then cut into thin slices using a utility blade, ensuring sterilization with ethanol before moving on to the following sample. The material is then put into a 2.5 ml centrifuged vial and placed on the shelf till all the samples are ready to be weighed. We weigh 0.5–2.5 mg of each sample and encapsulate it in a 5 x 9 mm tin capsule for isotopic carbon (C^{13} and C^{12}) and nitrogen (N^{15} and N^{14}) ratio analysis at the Iowa State University Stable Isotope Lab.

Preliminary Results and Discussion:
We collected 3,263 fishes consisting of 504 Gizzard Shad (*Dorosoma cepedianum*), 341 Smallmouth Buffalo (*Ictiobus bubalus*), 216 Bigmouth Buffalo (*Ictiobus cyprinellus*), 207 Freshwater Drum (*Aplodinotus grunniens*), 375 Shorthead Redhorse (*Moxostoma macrolepidotum*), 188 Channel Catfish (*Ictalurus punctatus*), 255 Flathead Catfish (*Pylodictis olivaris*), 336 Emerald Shiner (*Notropis atherinoides*), 97 Sand Shiner (*Notropis stramineus*), 445 River Carpsucker (*Carpiodes carpio*), 170 Walleye (*Sander vitreus*), and 129 Silver Carp (*Hypophthalmichthys molitrix*) from twelve sites across six rivers in Iowa. Data has been organized and cleaned. Stable isotope processing of tissues samples collected in the first field season is almost complete. We also took photos of captured fish on a grid for a collaborative project with Emporia State University to compare traditional condition metrics with body shape analyses using image analyses.

We ran preliminary quantile regression analysis on Gizzard Shad, Smallmouth Buffalo, and Flathead Catfish to assess potential effects of bigheaded carp on native fish body condition. Quantile regression is a technique that allows for more flexibility with distributional assumptions of condition across length in comparing populations and permits the comparison of fish at various levels of relative condition. Preliminary results were presented at the 2025 Midwest Fish and Wildlife Conference and the 2025 Iowa Chapter of the American Fisheries Society Meeting. We have also networked with a new invasive carp food web working group to collate data on carp food-web interactions in different systems.

Over the next year, we plan to expand the quantile regression or other condition comparison analyses to the rest of our study species (excluding shiners) to detect differences in body condition in relation to bigheaded carp densities. In the summer of 2025, we will continue sampling to increase our sample size for our quantile regression and stable isotope analyses. We also plan to continue electrofishing surveys for bigheaded carp to refine our estimates of bigheaded carp relative abundance. After this point, final analyses will be completed, and manuscripts and reports will be prepared then released after the peer review process.

Tables and Figures:

Table 1: Species representing each trophic guild in our analysis of UMR basin food webs.

Trophic Guild	Candidate Species
Non-native Planktivore	Silver Carp
Native Planktivore/Omnivore	Emerald Shiner, Bigmouth Buffalo, Sand Shiner
Detritivore/Herbivore/Planktivore	Gizzard Shad
Benthic Invertivore	Shorthead Redhorse, River Carpsucker,
	Freshwater Drum, Smallmouth Buffalo
Invertivore/Carnivore	Walleye, Channel Catfish, Flathead Catfish

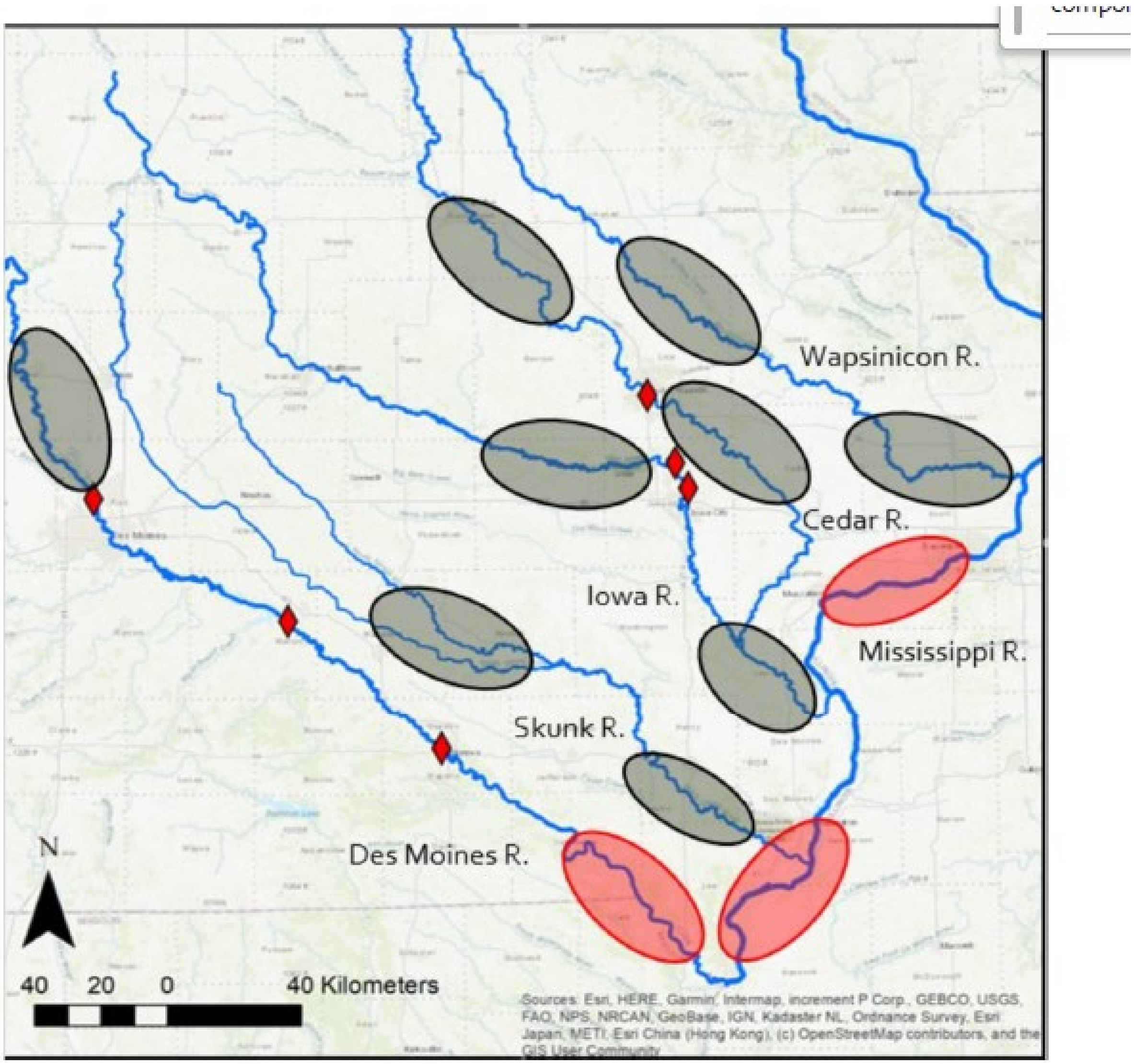

Figure 1. Categorical relative abundances of invasive carp across our 12 sampling sites throughout the Upper Mississippi River basin. Black areas represent hypothesized low/no relative abundance and red areas represent high relative abundance. Red diamonds represent major dams within rivers.

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