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Habitat Use by Lake Sturgeon (*Acipenser fulvescens*) Using Acoustics and Stable Isotopes

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Introduction

- Lake Sturgeon are a long-lived, migratory fish species native to the Great Lakes region that were extirpated from the St. Louis River during the early 1900s. Beginning in the 1980s, Minnesota and Wisconsin DNRs initiated intensive restocking efforts in the lower river.
- Despite these intensive efforts, there has only been limited evidence for successful natural reproduction. Understanding habitat use by Lake Sturgeon is an important step to address the potential environmental factors, including legacy contaminants, that are potentially limiting the recovery of Lake Sturgeon in the lower St. Louis River.
- Therefore, our goal was to use both physical (acoustic tags) and chemical (carbon and nitrogen stable isotopes) tracers to characterize habitat use, movements and diets of Lake Sturgeon.

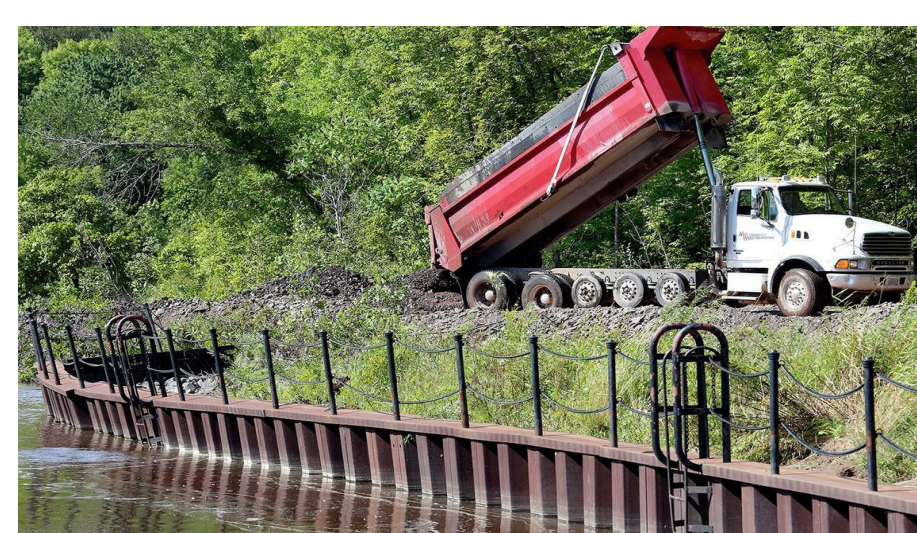
Why is the St. Louis River Estuary Important?



Chamber's Grove

A success story of habitat restoration

This lovely park nestled in the Fond du Lac community upriver of the estuary was the historic site of the Chambers family who built their mansion on this property and managed several businesses located nearby. Years of industrialization at this site lead to hardened shoreline and loss of habitat where previously Sturgeon could have spawned. In 2015, local agencies removed the hardened shoreline and restored the natural habitat, including adding in stone jetties that recreate the naturally occurring riffles that sturgeon seek out for reproduction. The hope is that with these types of changes we will see the return of a healthy Lake Sturgeon population and other native species.



Hardened shoreline demolition and removal



Natural shoreline restored, stone jetties create riffle habitat



Possible Lake Sturgeon spawning habitat

Methods

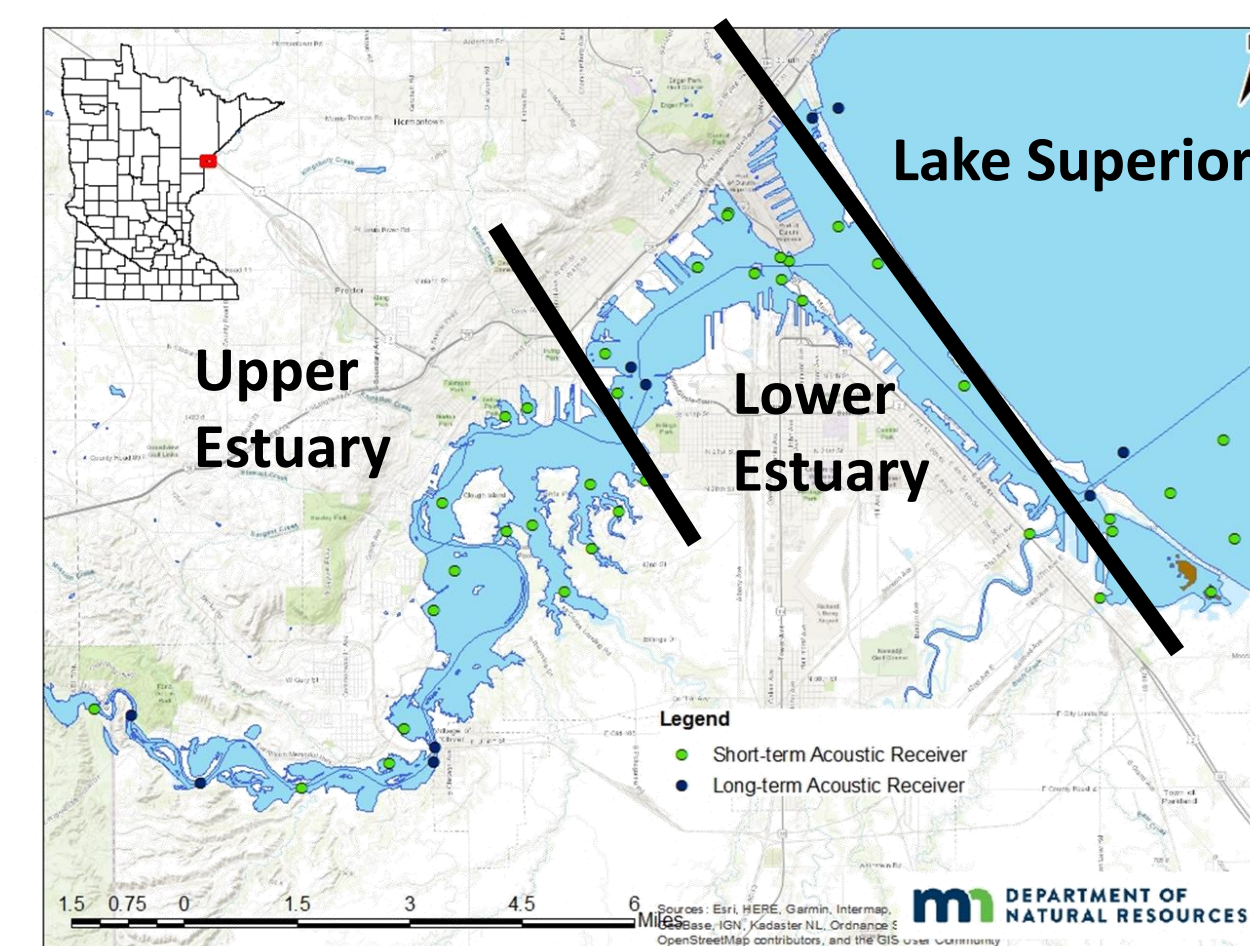


Figure. Map of the St. Louis River Estuary including the location of short and long-term hydroacoustic receiver deployments.

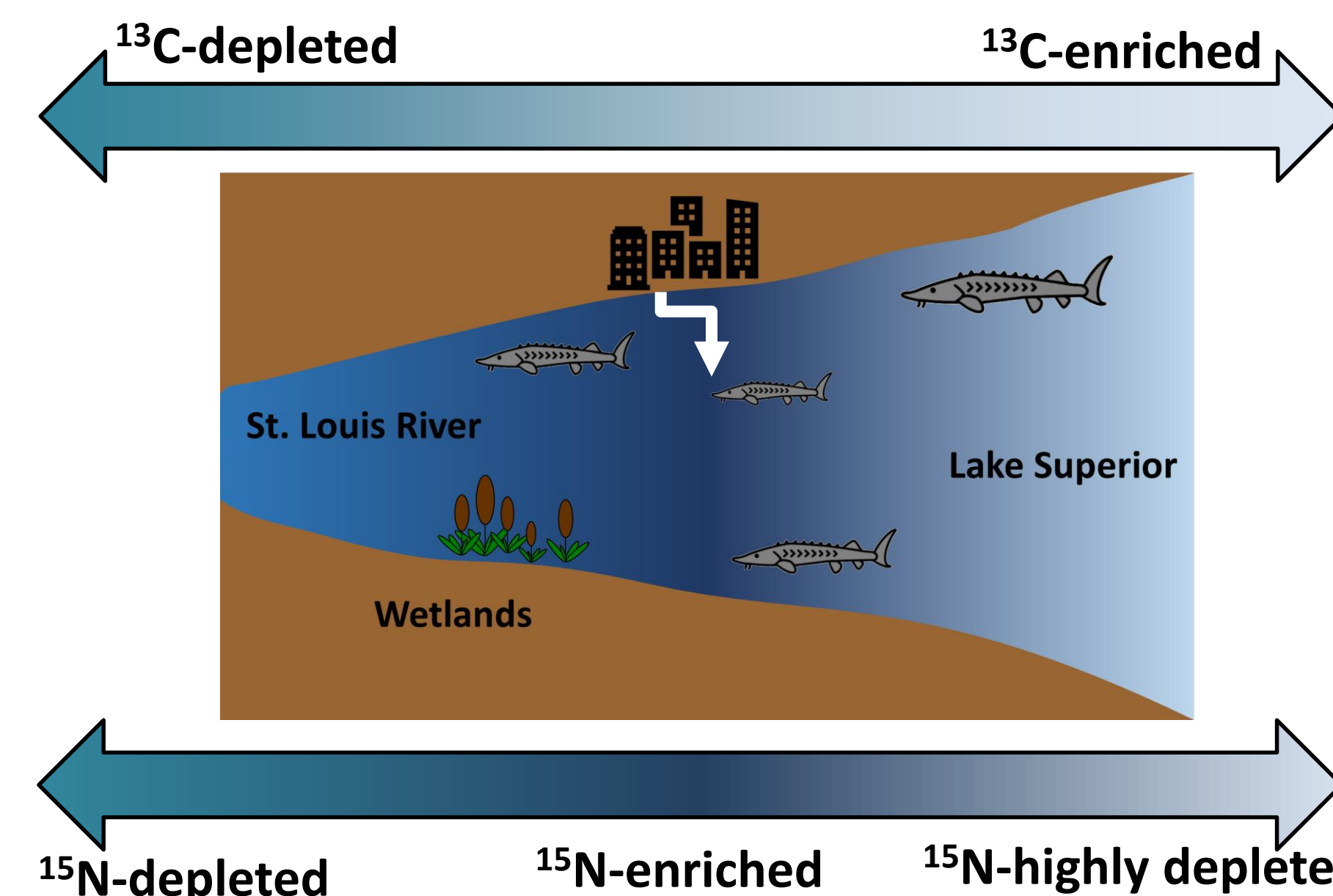


Figure. Graphical abstract of possible Lake Sturgeon habitat use in this study. There is an output of city effluent that creates a unique ¹⁵N-enriched area in the lower estuary, noted by the white arrow.

Acoustics



Figure. Lake Sturgeon were captured and implanted with an acoustic tag. Pelvic fin clips were taken for stable isotope analysis. **a** Walking back to the shoreline for biometric assessment. **b** Preparing the Lake Sturgeon for acoustic tag implantation. **c** Lake Sturgeon are surgically fit with an acoustic tag on the ventral side. **d** Surgical site is sutured. **e** Healed incision (red arrow).

Stable Isotopes

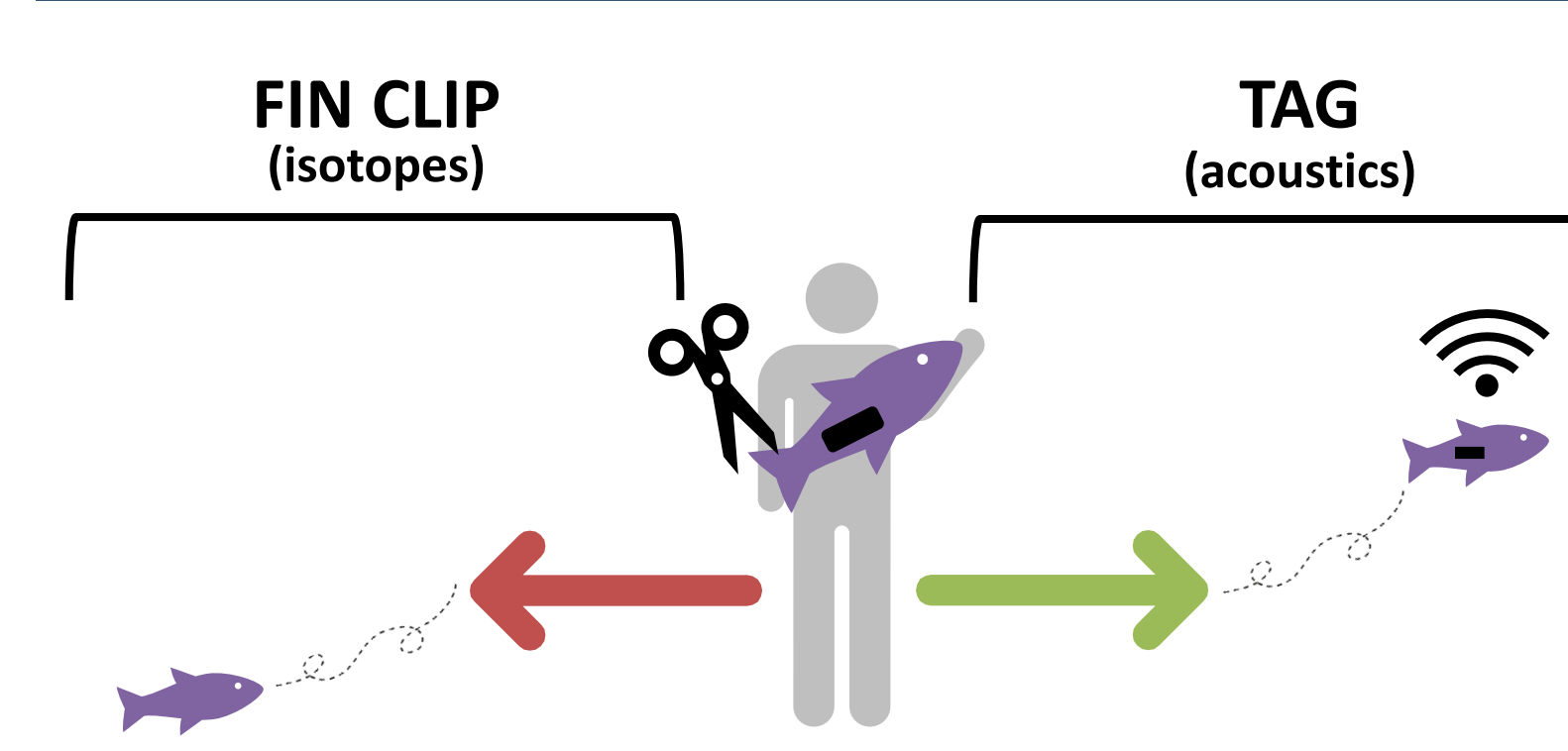


Figure. Upon capture a pelvic fin clip was taken and the fish was fit with an acoustic tag. Fin clips were processed and analyzed using a mass spectrometer. Analysis of fin clip isotope ratios yield diet prior to capture and tags are used for movement post capture.

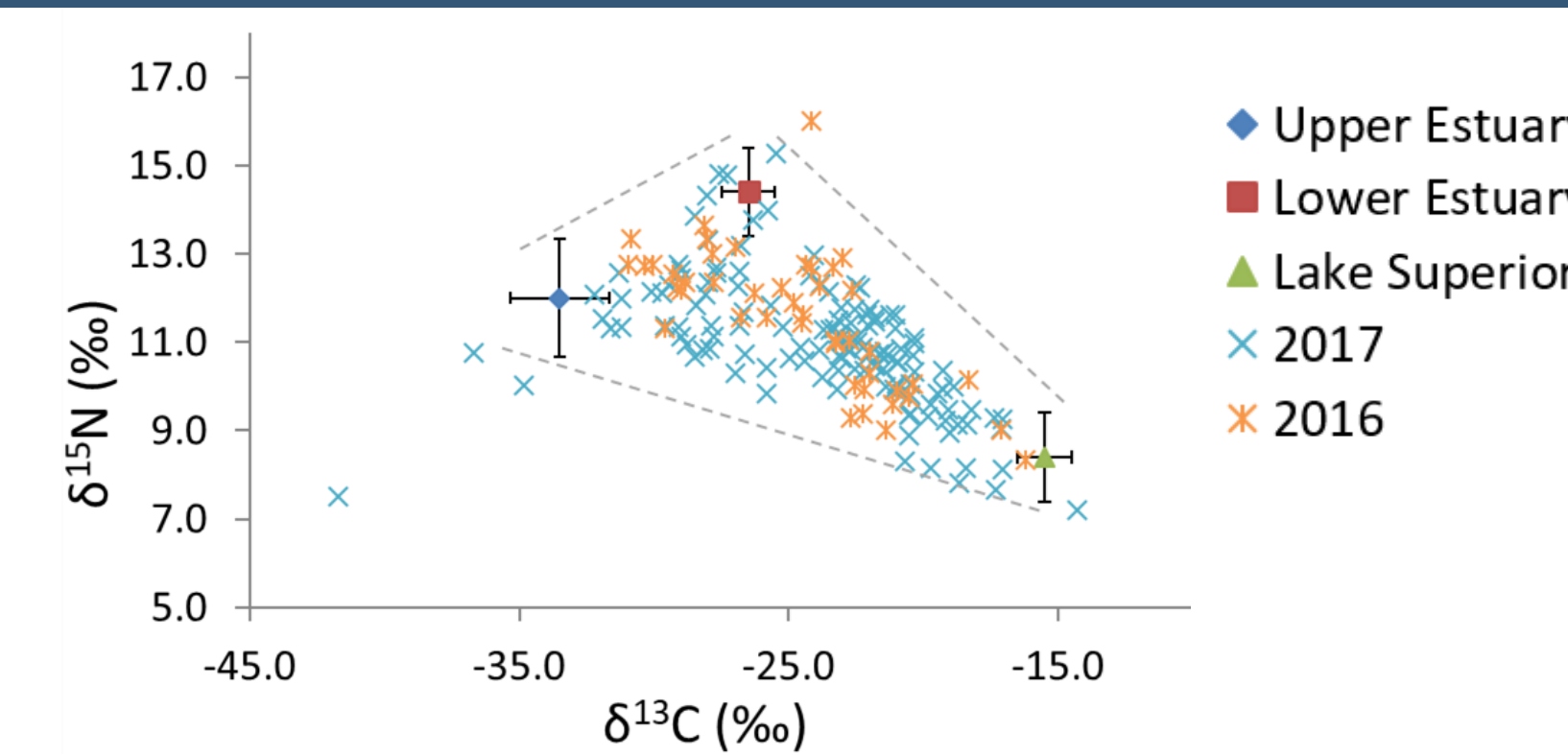


Figure. Mixing model for source proportions of Lake Sturgeon diet from this study. Dotted line represents the convex hull bounded by the three diet sources. Error bars show plus or minus 1 standard deviation. Diet source data are from benthic macroinvertebrate stable isotope ratio data from those three habitats (Hoffman et al. 2020).

Results

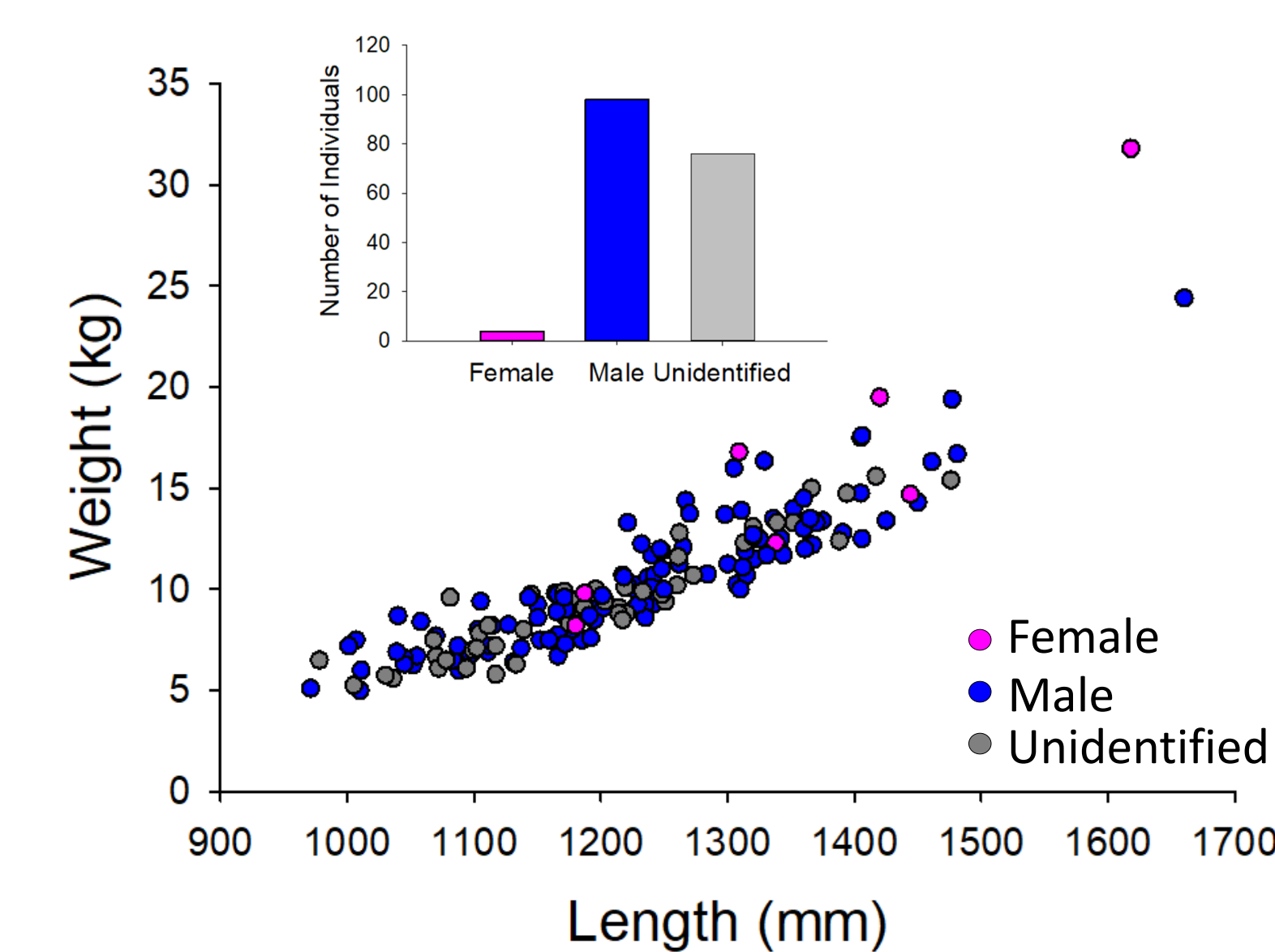


Figure. Length:Weight relationship, count of female (n=4), male (n=98) and unidentified (n=76) individual Lake Sturgeon from this study. There is a highly skewed sex ratio between males and females. Unidentified individual fish were not able to be sexed by field crews. Inset: sex ratios from this study.

For both 2016 and 2017, individuals demonstrate highly varied use of all three habitats.

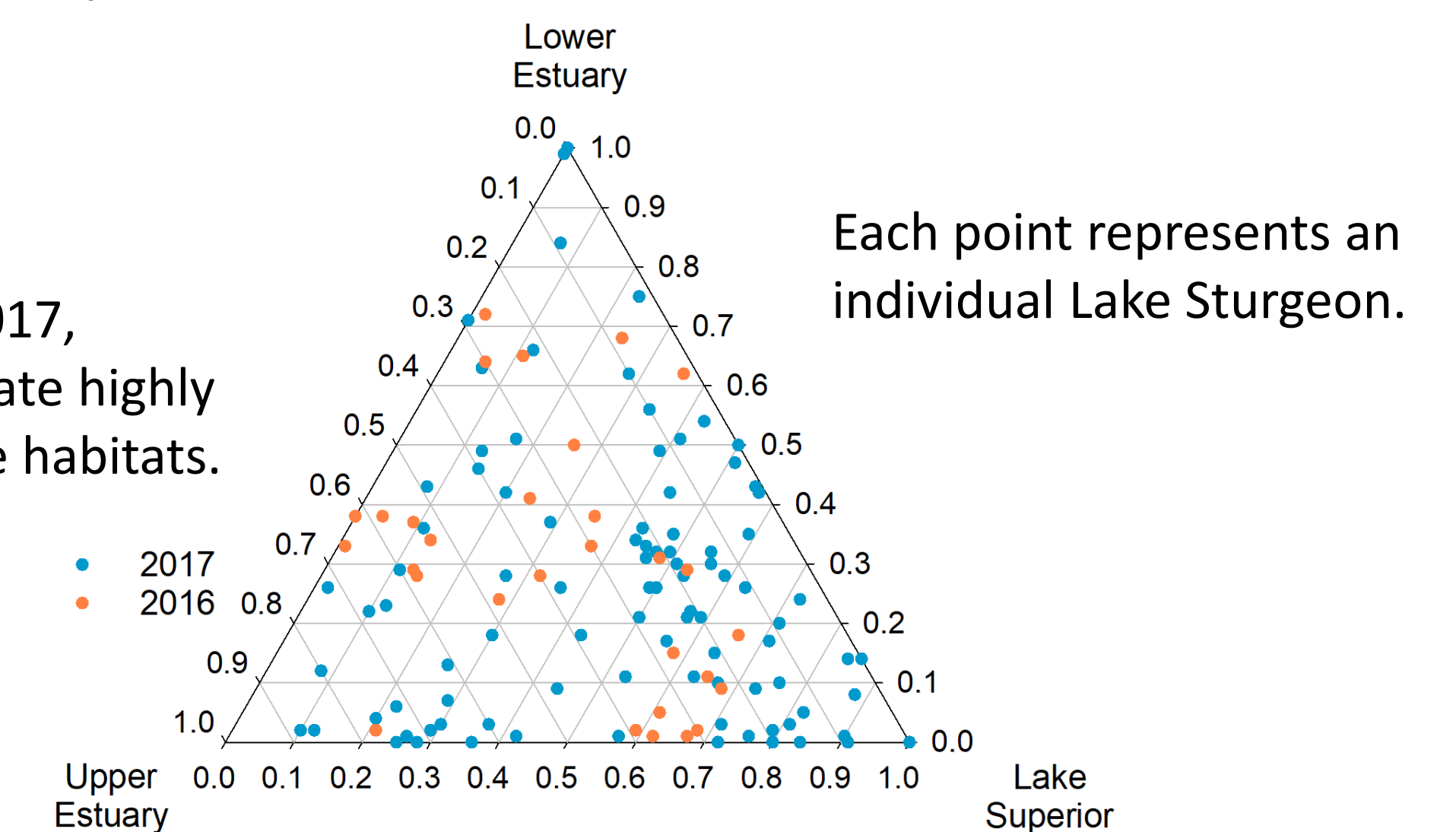


Figure. Three mixing component areas of diet sources in the St. Louis River estuary, (Upper Estuary, Lower Estuary and Lake Superior). Data is from stable isotope ratios.

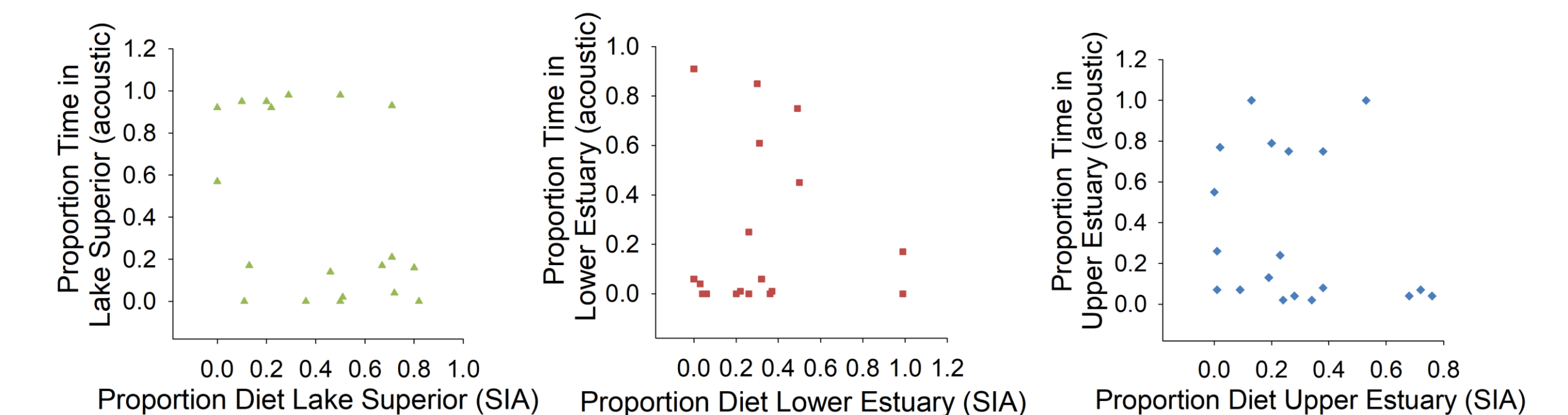


Figure. Diet proportions based on stable isotope analysis (SIA) compared to habitat use estimated as proportion days at large within each of the three areas based on acoustics. The correspondence is poor, indicating the habitat in which the individual was feeding prior to capture is not a good predictor of habitat use upon release.

Conclusions

- Stable isotope ratios revealed that adult Lake Sturgeon undertook a wide variety of foraging behaviors, routinely moving throughout the St. Louis River estuary and Lake Superior. The data reveal the importance of estuary habitat to adult foraging throughout the year.
- Fin clips and acoustic tag data show disconnect between the habitat signals from isotope data (long-term: seasons to years) and fish movement (short-term; days to weeks) inferred from acoustics. This is consistent with the interpretation that individual movements vary widely and that prior seasonal movements are not predictive of future short-term movements.
- To quantify how habitat restoration projects are impacting the population at various life-stages, a long-term approach is necessary given the Lake Sturgeon's life-history.