Stable Isotope Analysis and Fish Movement[1]

Reference SON: *2021-1340 Mapping Fish Origins to Inform Restoration using Microchemistry*

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Research Need

Understanding large-scale movement patterns of fishes coupled with defining important life history attributes, such as identifying natal rivers for fishes including species of high conservation merit, non-native species as well as commercially and recreationally important riverine species, is critical for developing appropriate ecosystem restoration directives for 77 target species as well as defining functional operational conditions for required O&M activities typical in large riverscapes. Resource managers have identified the need to prioritize restoration efforts that maximize ecosystem restoration benefits on a watershed scale and have emphasized the importance of developing a tool that would facilitate this task. Microchemistry and stable isotope analysis has revolutionized the study of fishes and other aquatic fauna. This innovative and developing technology can be developed as an effective tool for providing information about geographic origin, seasonal migration patterns, ontogenetic habitat shifts, and diet in target species within identified watersheds.

Project Objectives & Plan

The objective of this study is to identify unique water chemical signatures in fishes by incorporating elemental microchemistry analyses and stable isotopes of calcified structures. Isotopic profiles from target fish species will be compared to isotopic signatures obtained from water samples taken throughout the watershed to recreate movement history of the target species. Concordant patterns can be used to aid in the prioritization of restoration efforts focused on watershed connectivity, gauge success of ecosystem restoration projects related to fish passage issues and invasive species management and identify new restoration targets.

Value of Research and Development

Developing this approach across a broad geographic range such as the Mississippi River Valley, provides a unique perspective for addressing benefits from ecosystem restoration projects in addition to assessing impacts from USACE navigation and flood control missions. This broad

perspective will provide utility across multiple water resource projects, address fish migration in relation to passage limitations, and enhance our understanding of trophic dynamics and ecosystem services related to ecosystem restoration, in addition to providing restoration metrics for new river engineering projects. The results from this project will also greatly expand our understanding of the biological needs of migratory riverine fish species, and a unique framework for assessing connectivity of watersheds.

Products

Journal Articles (JAs)

Slack, W.T., G. Whitledge, A. Bednar and K.J. Killgore. (in prep). The utility of stable isotope analyses to address long-distance movement in fishes in a large riverscape with a focus on river sturgeon and invasive carp (proposed completion dates: DEC 2025).

Technical Reports (TRs)

Slack, W.T., A. Bednar and K.J. Killgore. Development of a trace element signature library across a large watershed for assessing large-scale fish movement patterns (currently with ITL editor 25 AUG 2025).

Slack, W.T., A. Bednar and K.J. Killgore. Development of a trace element signature library across a large watershed for assessing large-scale fish movement patterns: supplemental data. https://dx.doi.org/10.21079/11681/49787 (JUN 2025).

Tech Notes (TNs)

Slack, W.T., A. Scircle, A. Bednar and K.J. Killgore (in prep). Methodological approach for isotopic signature acquisition from fish structures to be utilized for elemental microchemistry studies in the Mississippi River Basin (proposed completion date: NOV 2025).

Conference Presentations/Webinars/Workshops

Slack, W.T., T. Bednar and J. Killgore. Incorporating trace element signatures across a large riverscape to assess fish movement patterns. EMRRP Webinar, 23 JUN 2025.

Software

Project Activities

Inventoried 300+ fin sections of River Sturgeon (Pallid and Shovelnose) and 350+ fin sections of Silver Carp from the Middle and Lower Mississippi rivers that are available for stable isotope analyses.

Seventy-seven spine sections from river sturgeon were submitted to Southern Illinois University (SIU) for processing with Laser Ablation (LA-ICPMS). An additional 25 samples of pectoral ray sections from Silver Carp were submitted to SIU and the ERDC Chemistry Lab for Laser Ablation processing. This effort will provide in-person training for the ERDC Chemistry team as well as provide a control condition to compare LA-ICPMS results.

Water samples from 49 stations (triplicate at each station) along Mississippi River and major tributaries extending from Dubuque, IA to Gramercy, LA (1387 river miles) were collected during low water conditions. Samples were submitted to ERDC Chemistry Lab for analyses to evaluate levels of Calcium, Iron and Lithium in addition to concentrations of Barium^{137} and Strontium^{86} isotopes.

[1]Project Alias – Work Unit Documentation Title: *Utility of Using Stable Isotope Analysis in Understanding Fish Movement in the Mississippi River Valley*