A multiple stable isotope approach to determine how fish life-history effects mercury bioaccumulation

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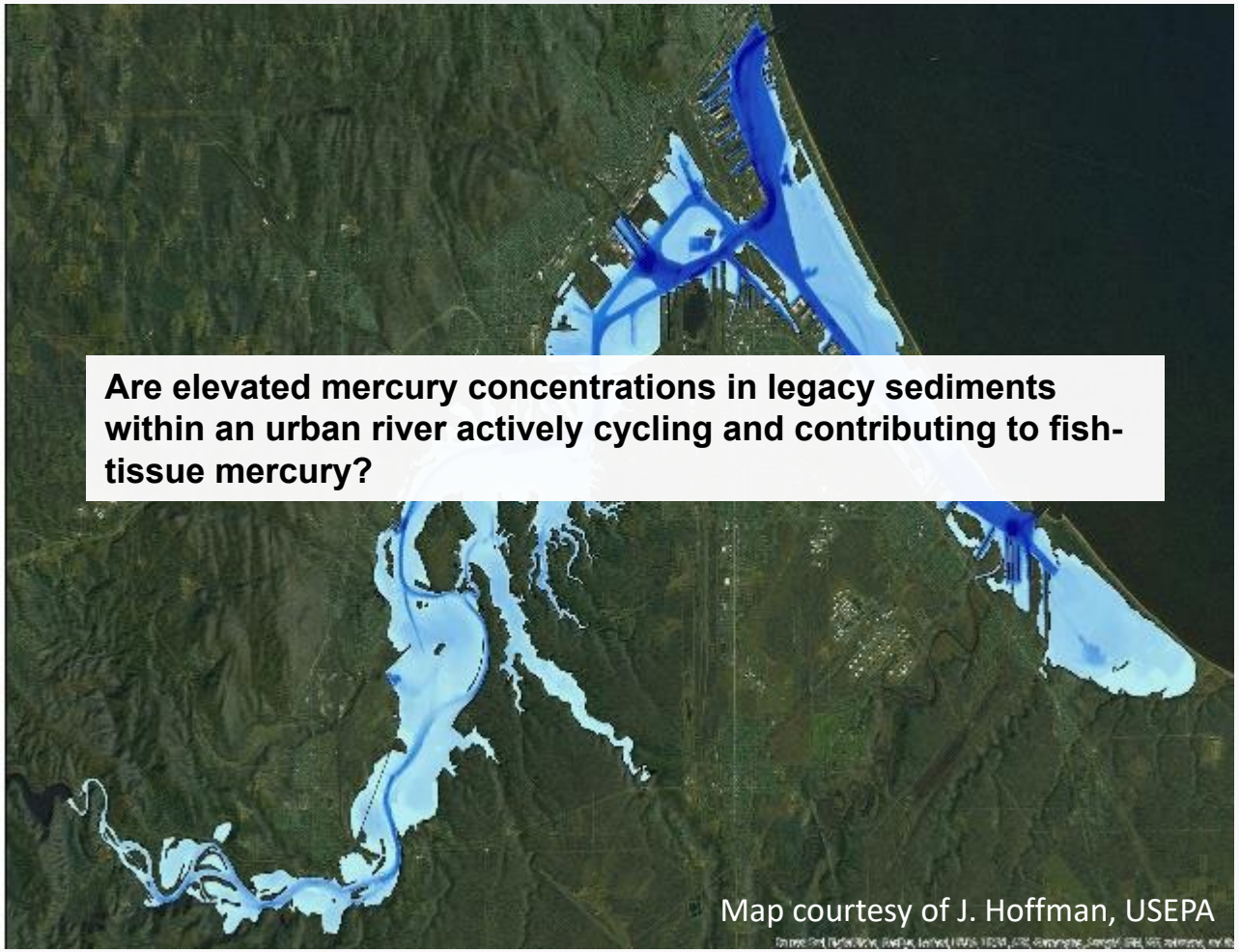
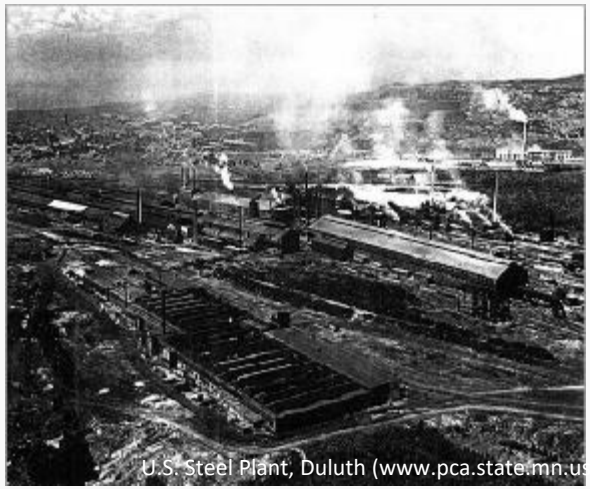
Talk 1.09.35

Nov 15-19, 2020

Study Question

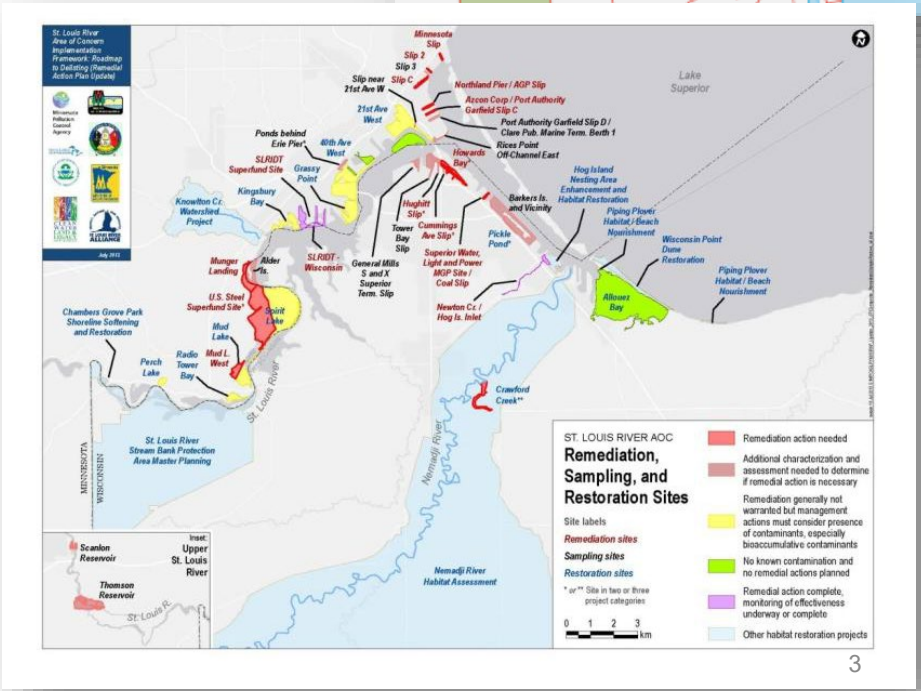



U.S. Steel Plant, Duluth (www.pca.state.mn.us

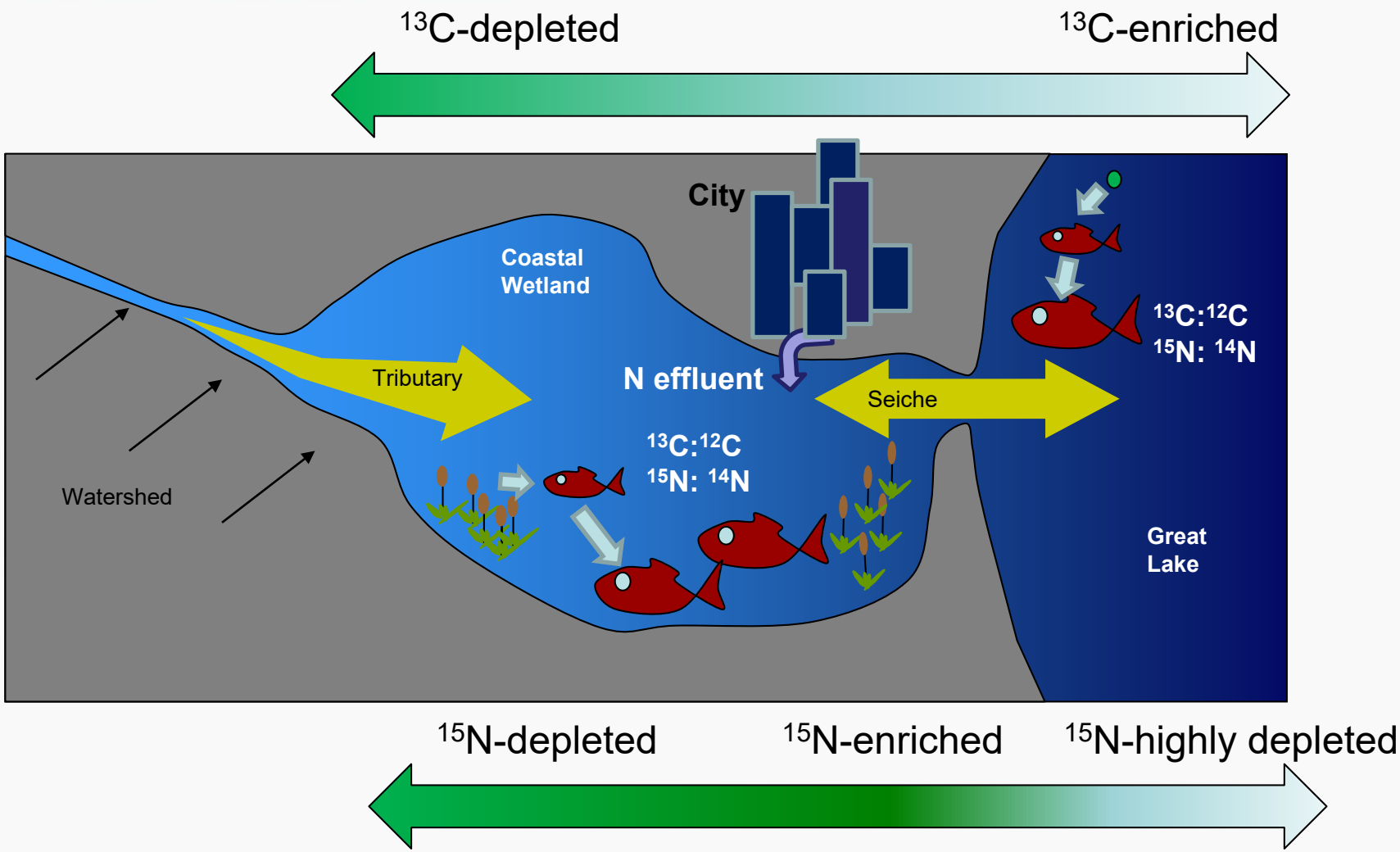
Johnson & Sons Fishery, Duluth (Duluth Public Library)

Restoring the St. Louis River

- Widespread need for sediment remediation
- Major goal is to reduce the fish consumption advisory
- For adaptive management, need a new approach
  - Integrates life-history
    - Habitat-specific
    - Diet-specific (littoral vs pelagic)
  - Tied to Hg source

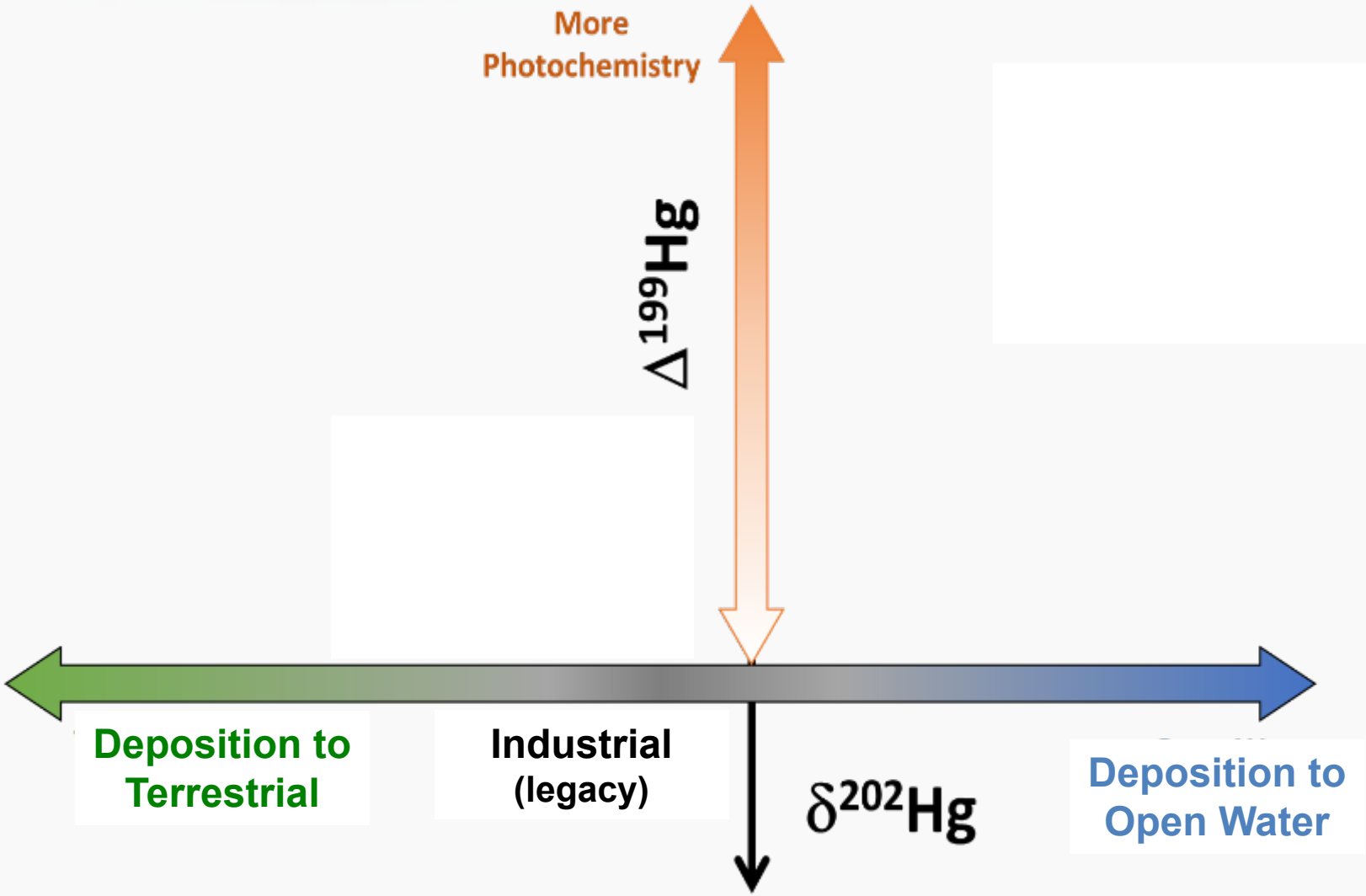


Habitat-Specific Diet Tracers

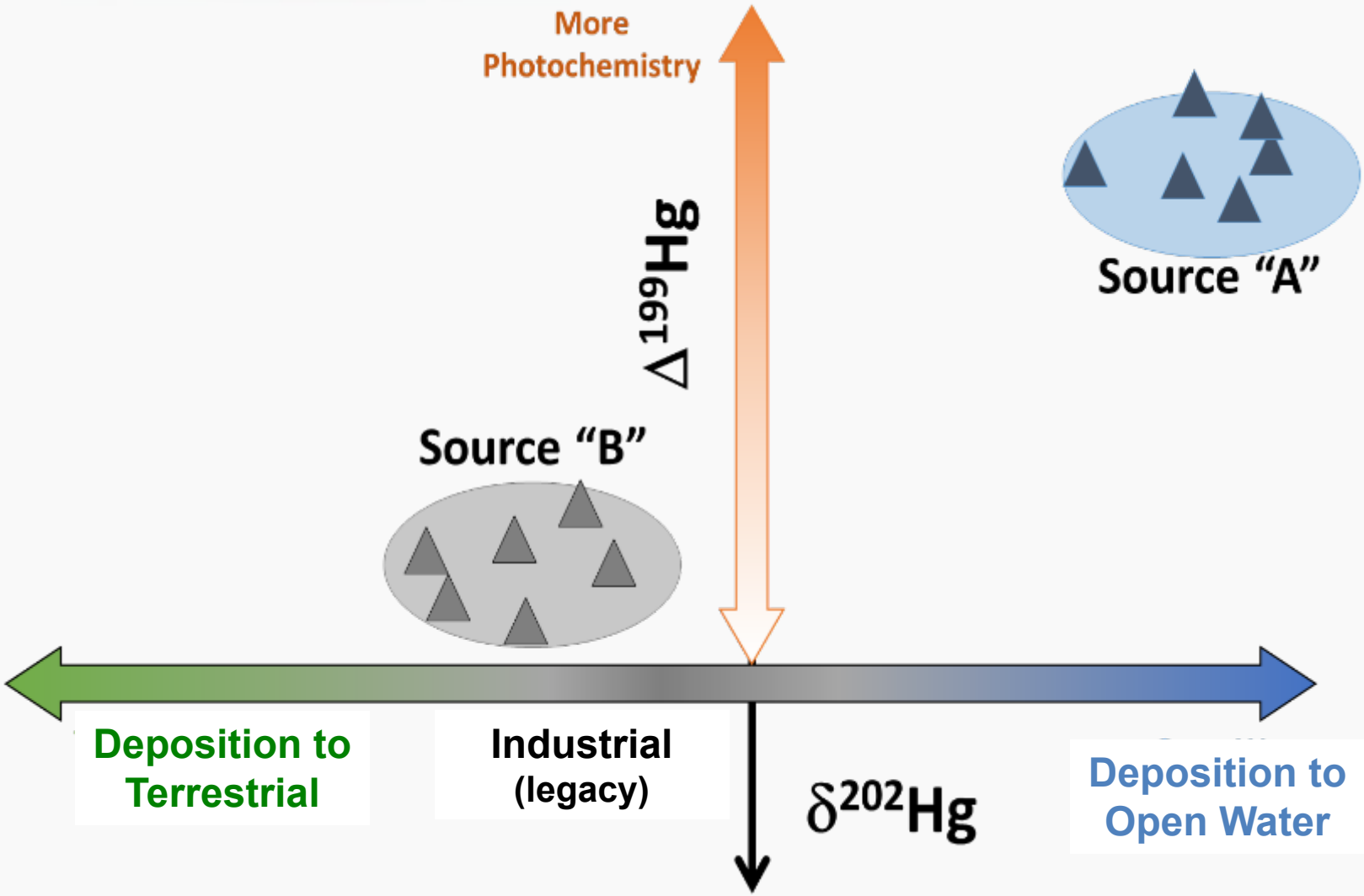


Hoffman et al., 2010, 2012, 2015

Source-Specific Hg Tracers

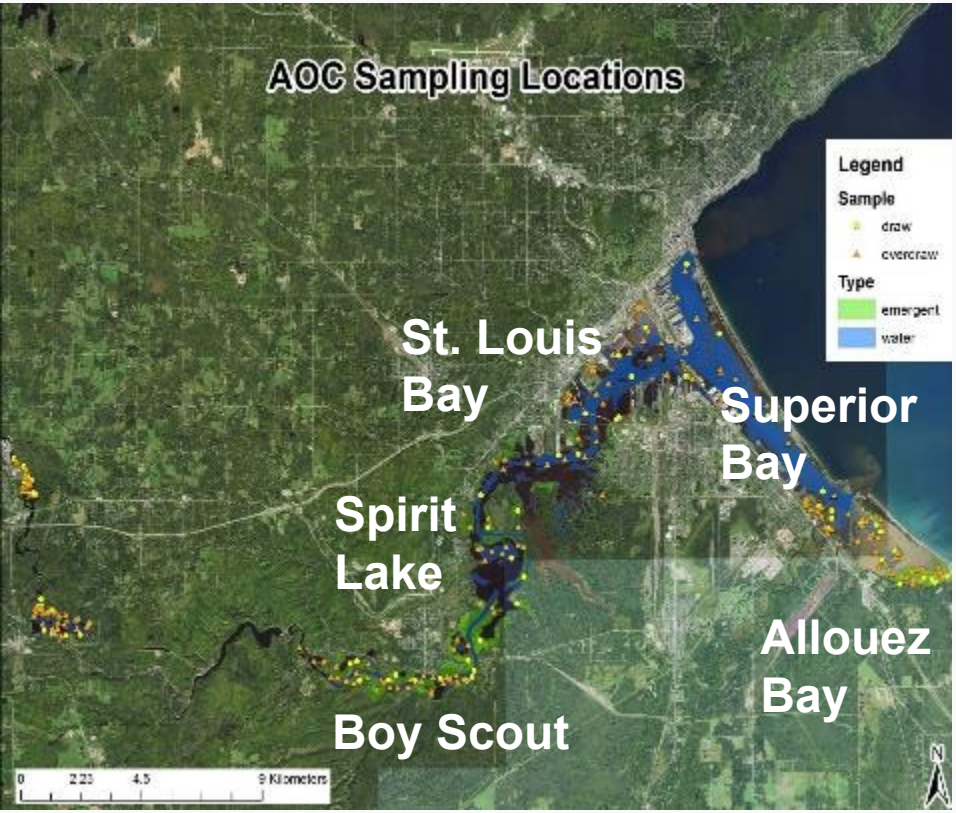


Source-Specific Hg Tracers



Design

Treatment



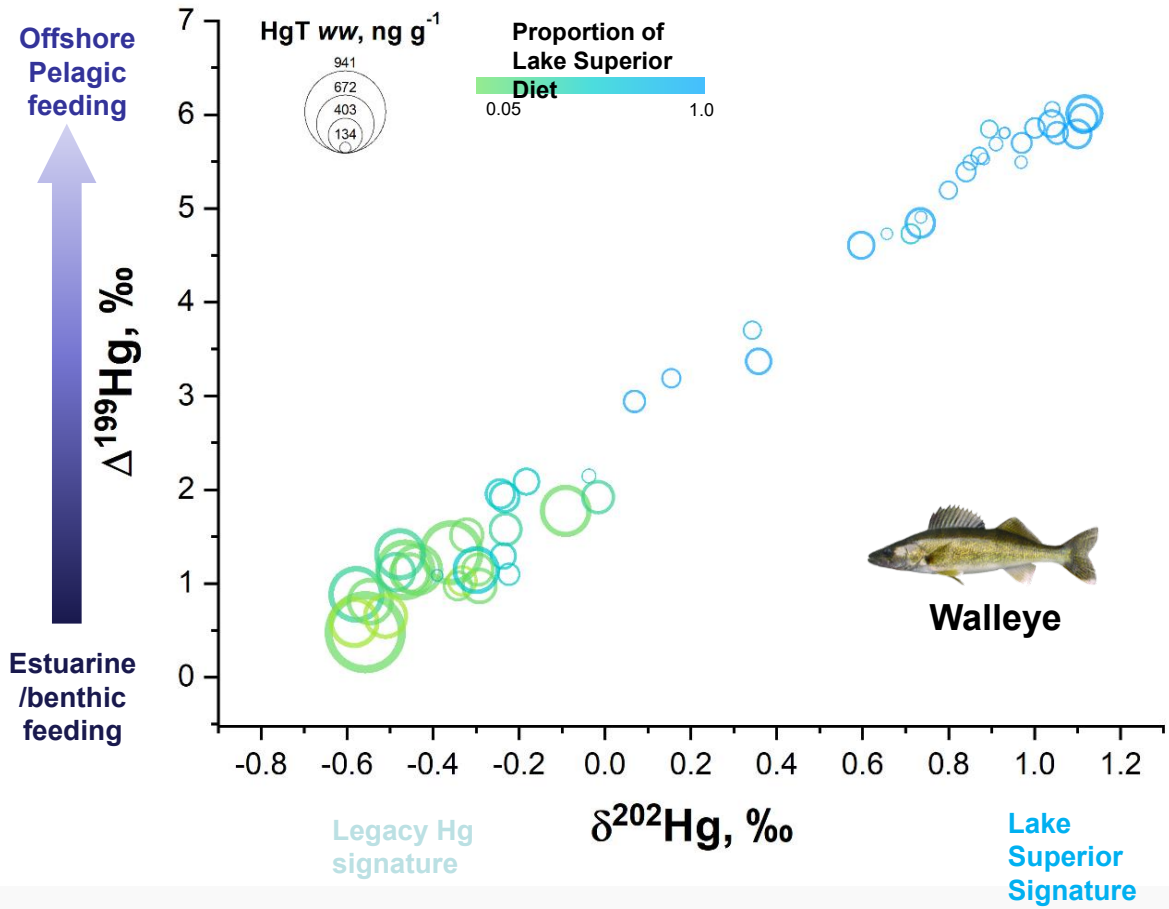
Control

Premise: Exposure varies among and within systems

Objective: Use small-scale variation to reveal factors influencing Hg sources in fish

- Trophic level?
- Food web?
- Habitat?

Mercury Isotopes in Migratory Game Fish



Janssen 1.09.02

Mercury isotopes reveal that concentration trends observed in walleye are a function of source

A subset of fish captured in SLRE are actually feeding in Lake Superior (as denoted by C/N/Hg isotopes)

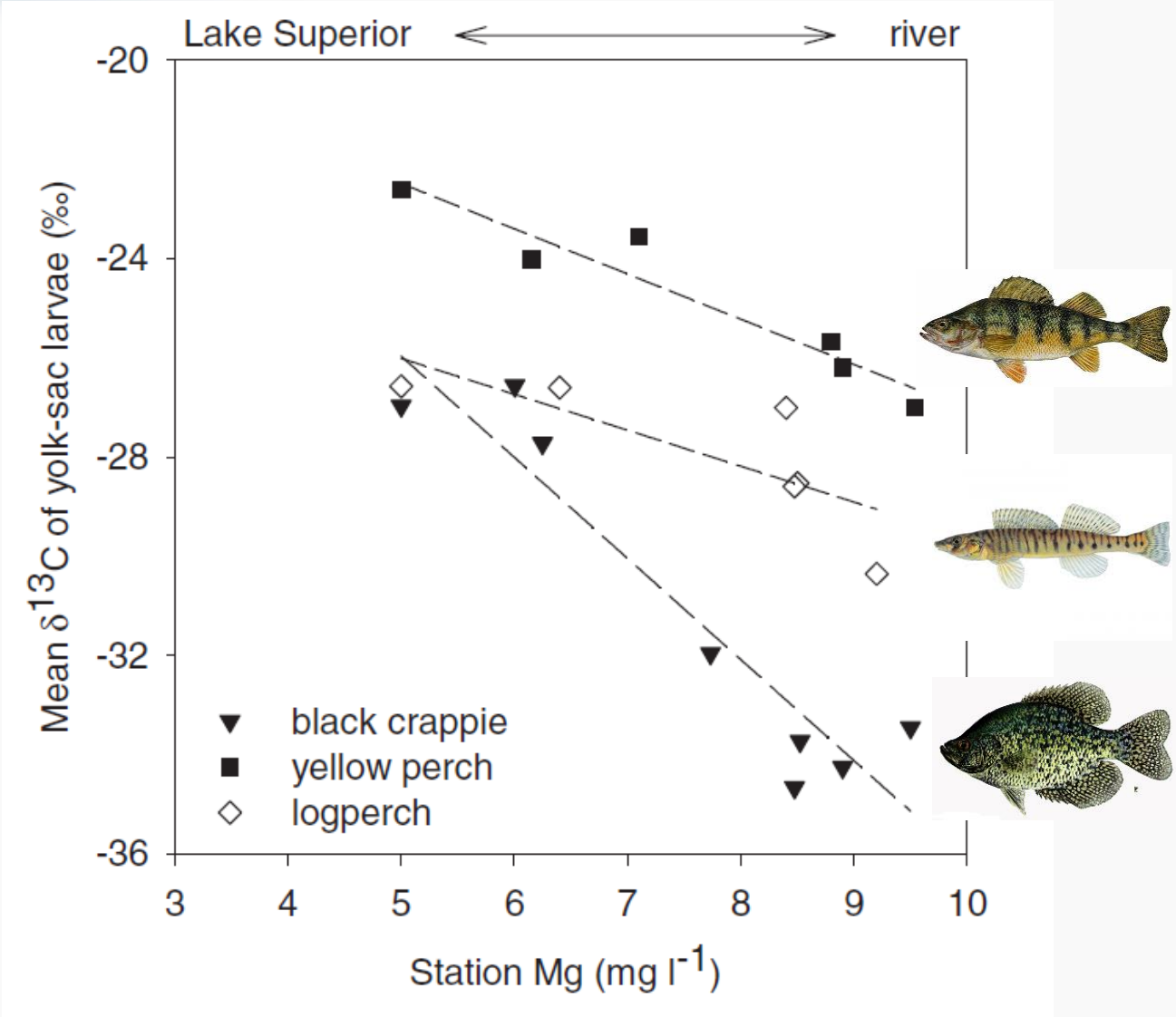
Walleye caught in the SLRE but from diet analysis mostly feed offshore in Lake Superior have lower mercury concentrations than those feeding in the estuary

Preliminary Information-Subject to Revision. Not for Citation or Distribution.

Resident Fish

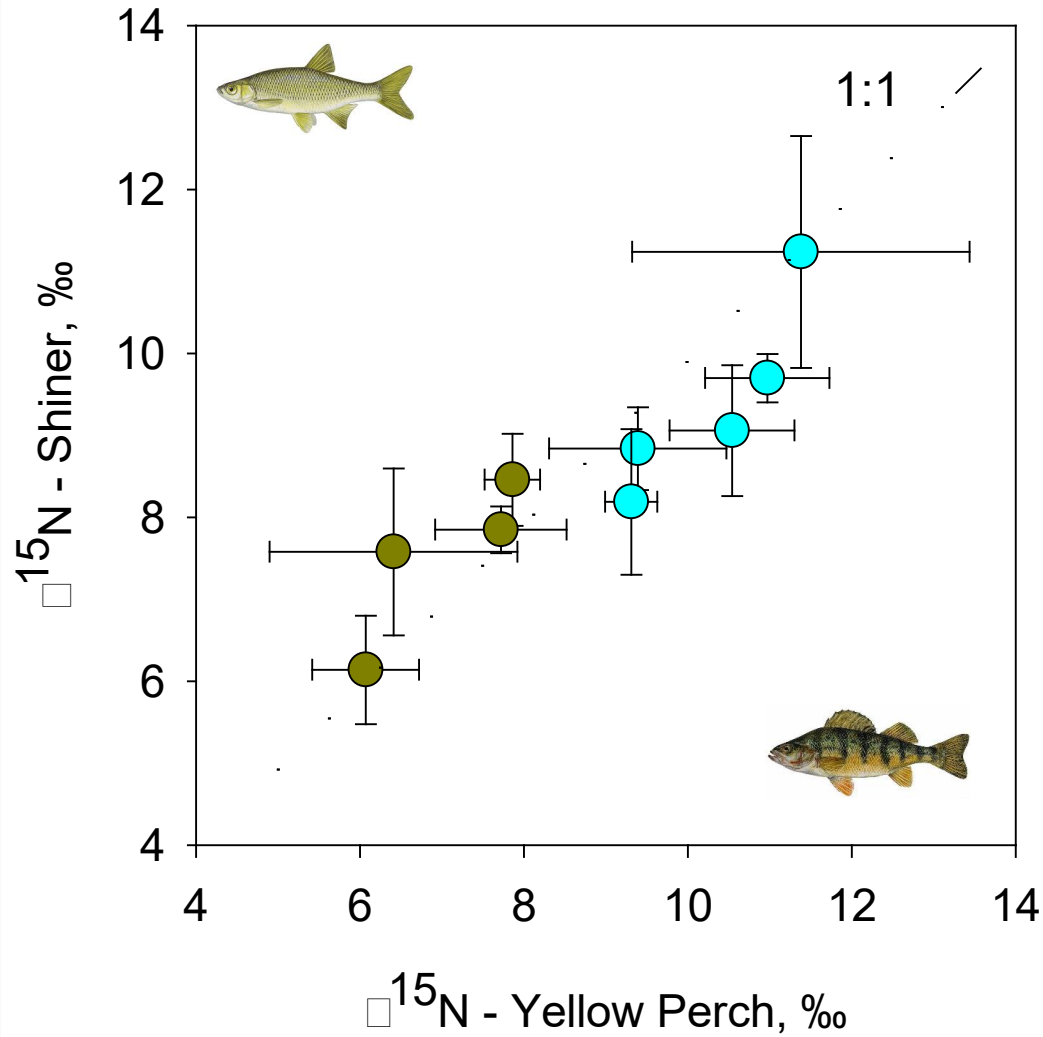
Resident fishes

Pattern reveals residency



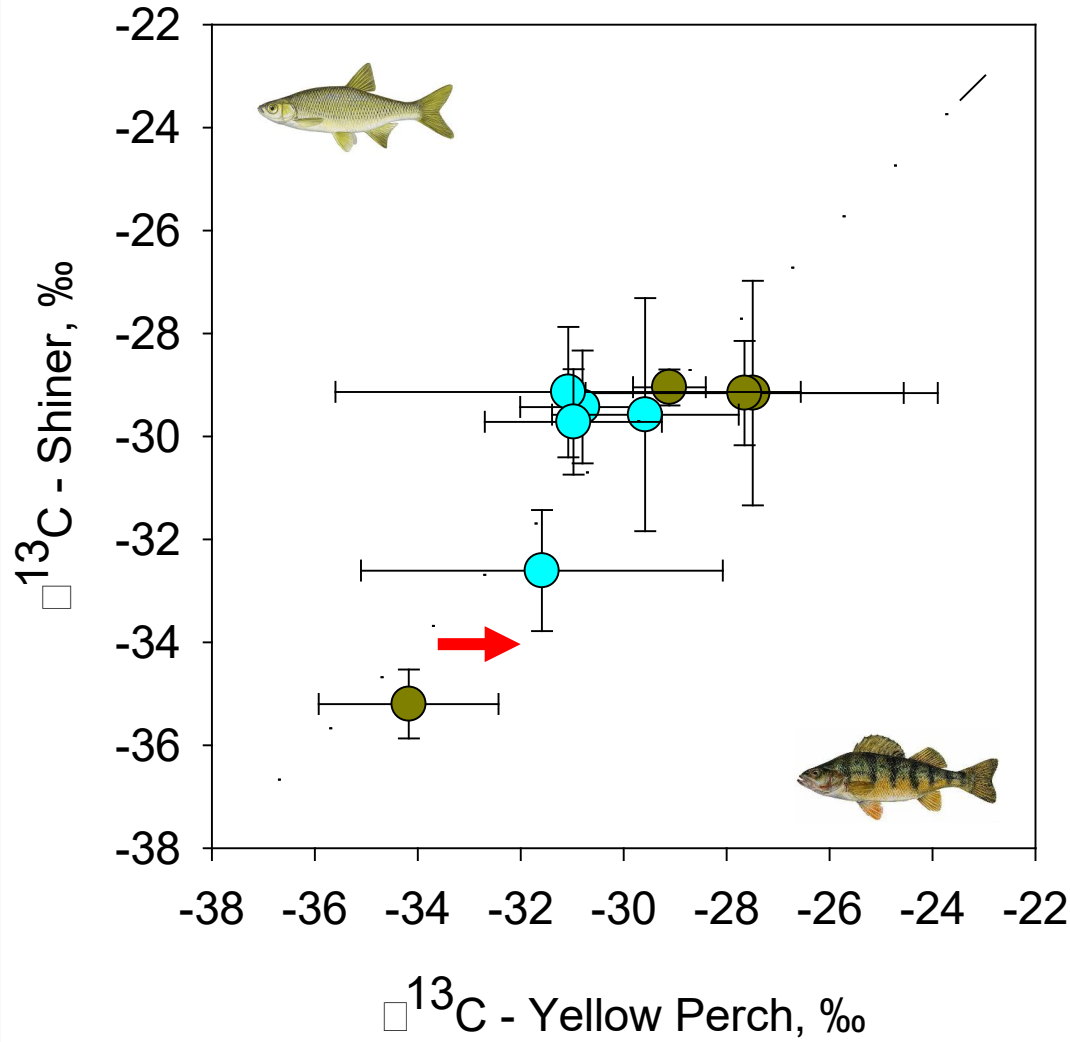
Hoffman et al., 2011

Trophic Level Comparison



Result: Trophic level similar among resident fishes sampled

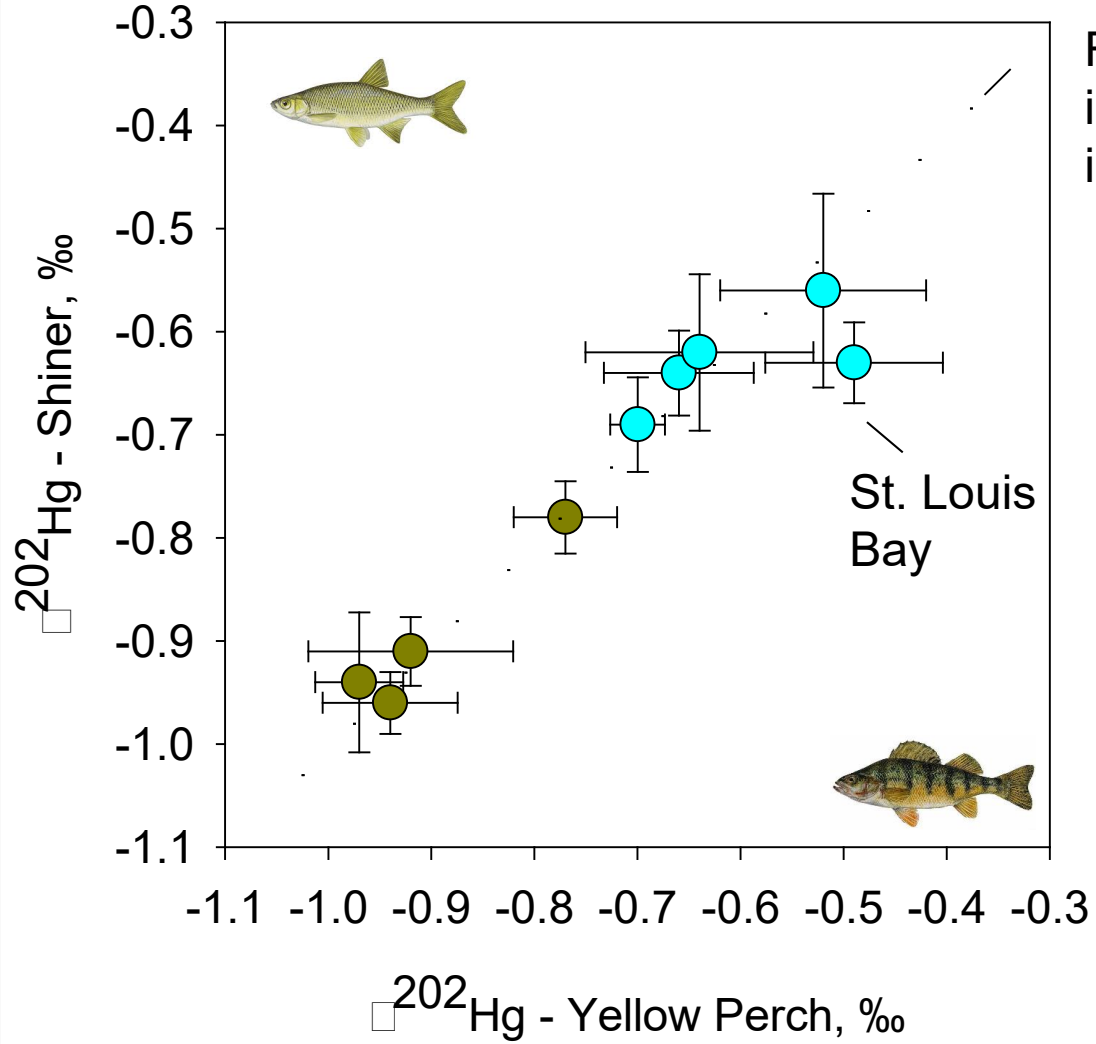
Trophic Role Comparison



Result: Diet sources similar.

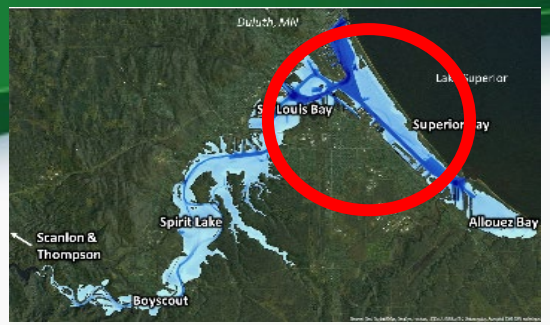
→ Yellow perch is slightly ^{13}C-enriched, implying greater benthic contribution to diet.

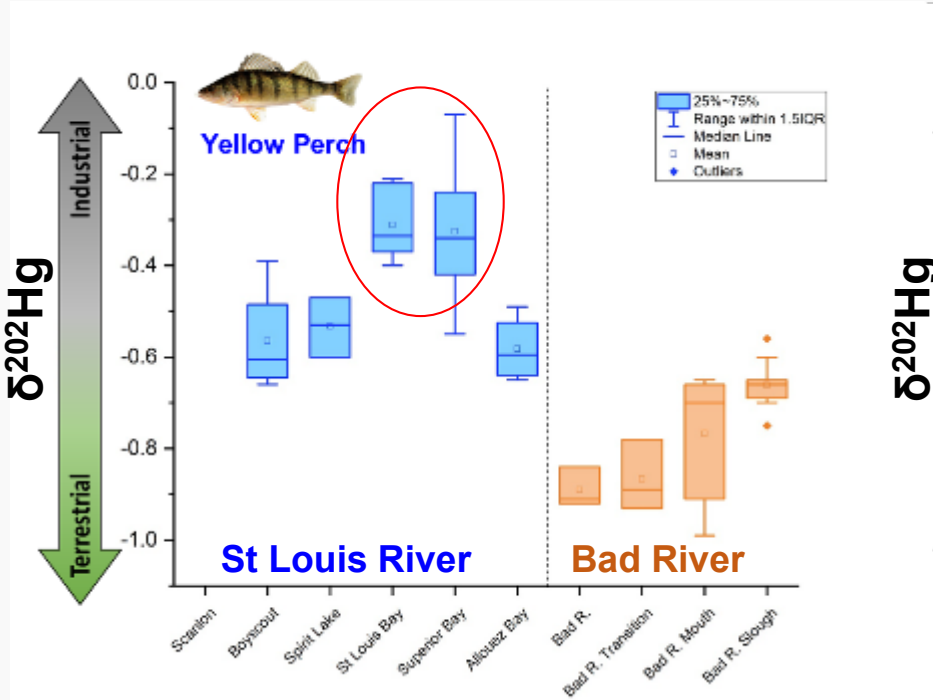
Mercury Source Comparison

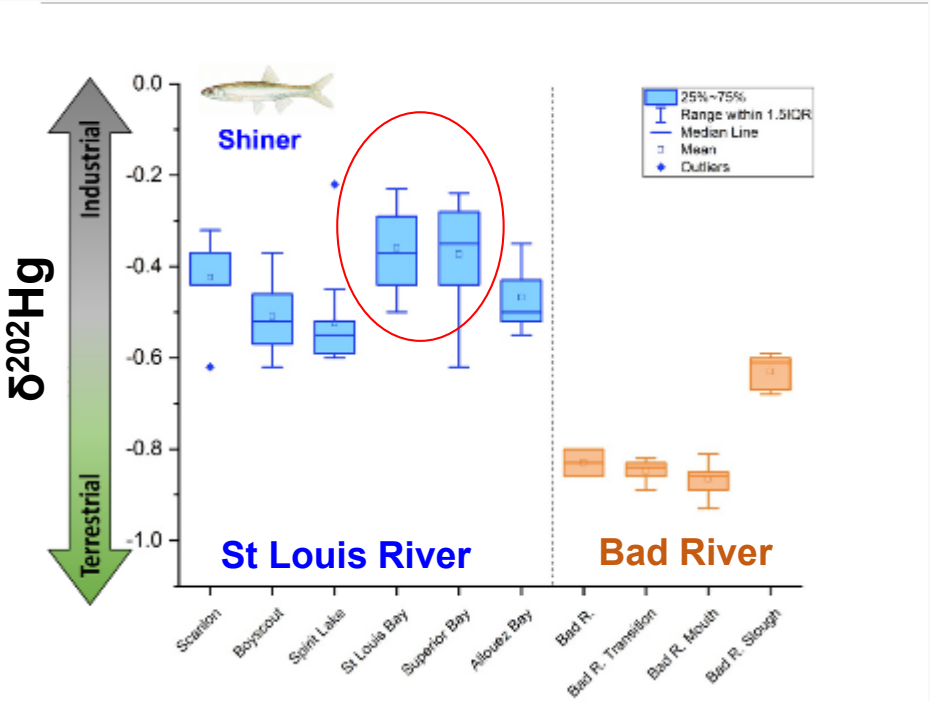


Result: Mercury isotopic composition is similar

Hg Sources





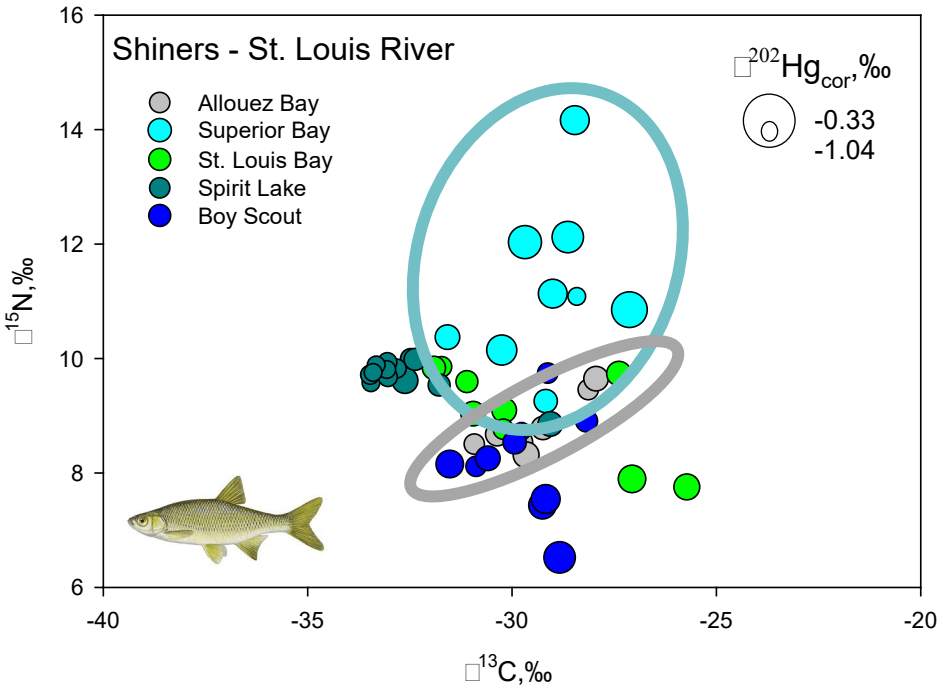


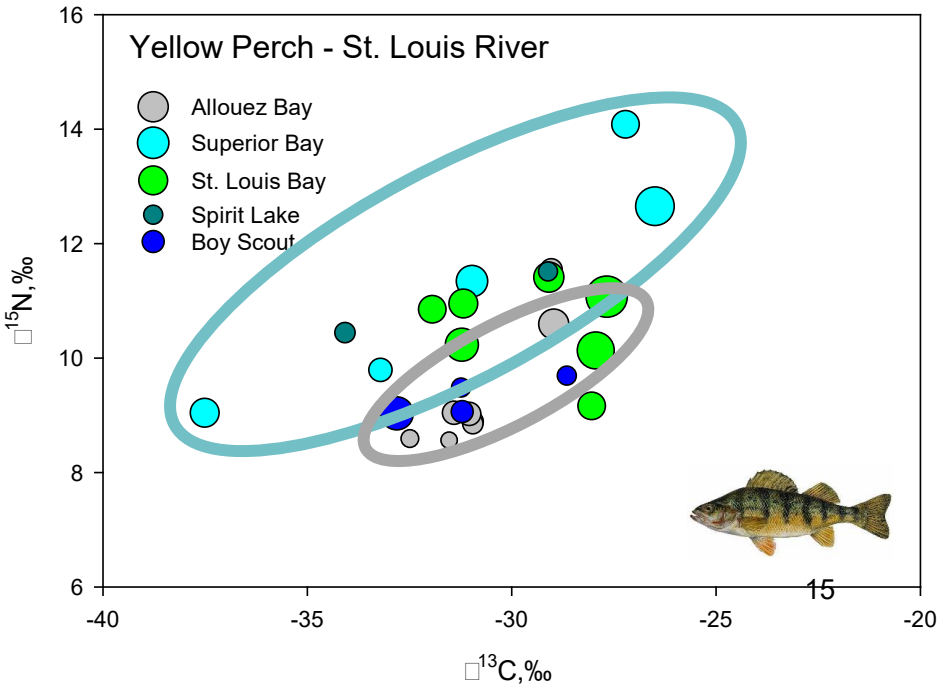
Results

- Local enrichment in the industrial harbor indicates localized influence of legacy Hg sources
- Generally higher $d^{202}Hg$ values in St. Louis River (vs. Bad River) indicates widespread, dilute influence of legacy Hg throughout the system

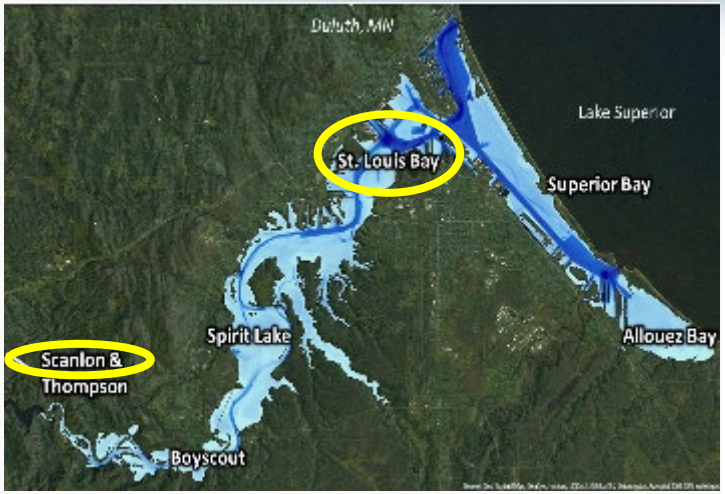
Multi-tracer Perspective

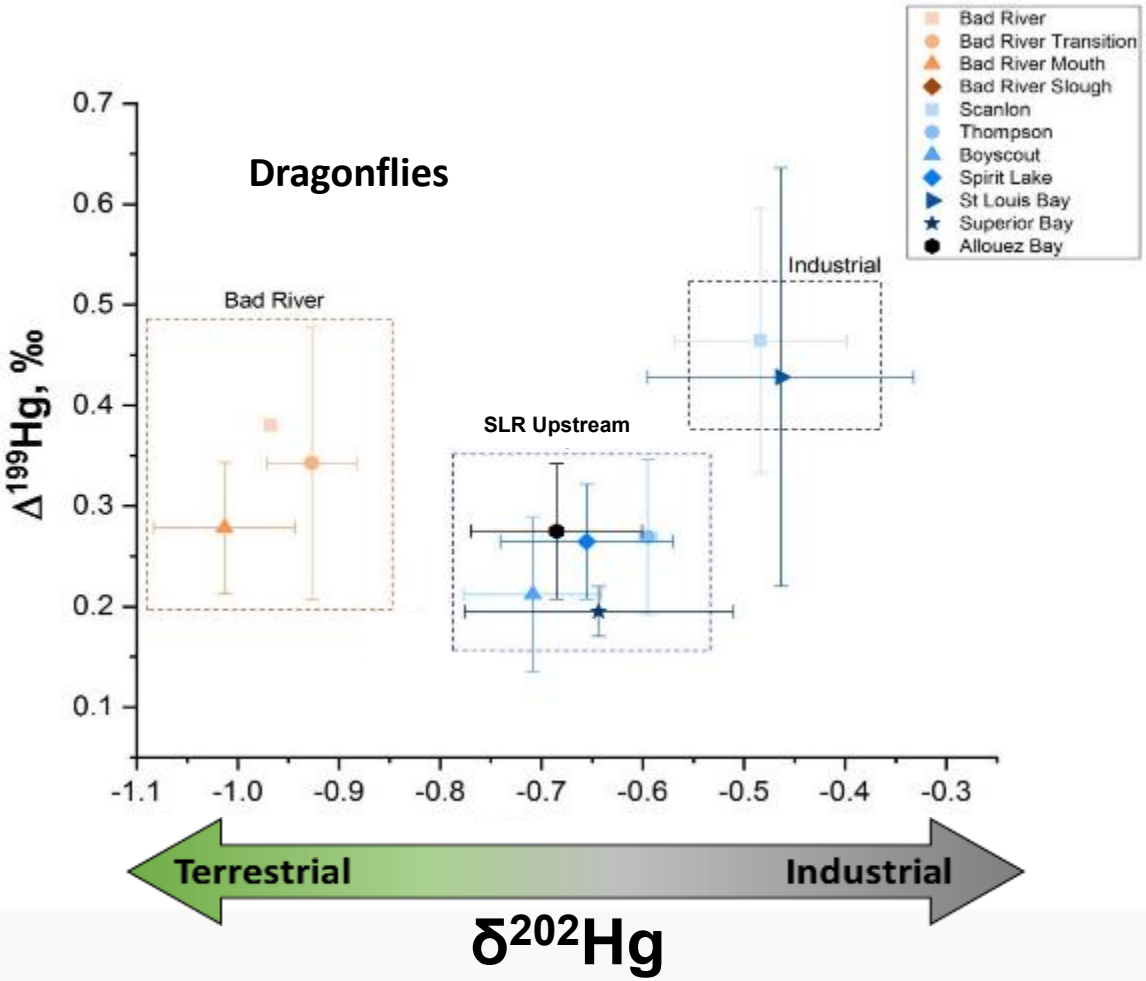
Result: Location and species-specific isotopic "fingerprints" demonstrate small-scale food web effect



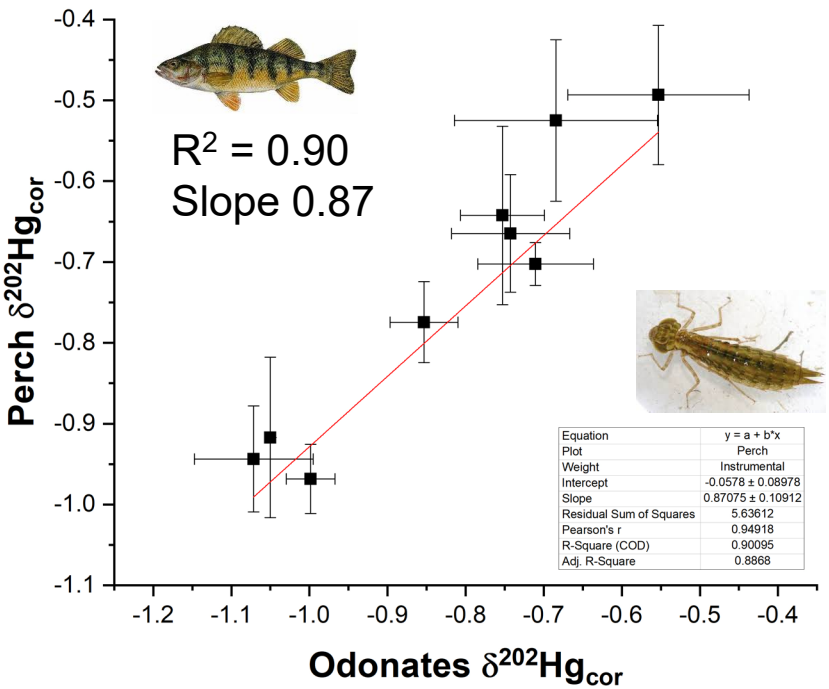


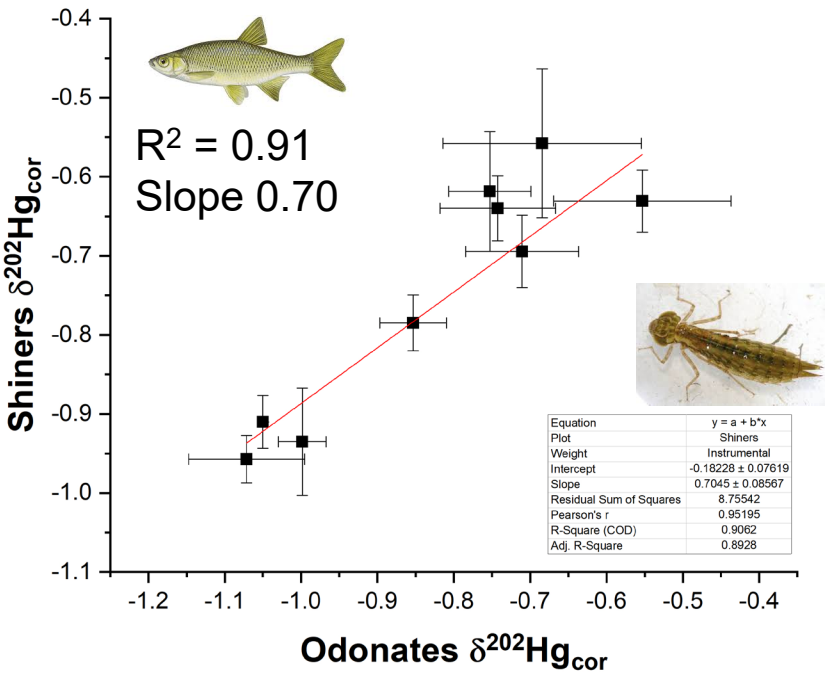
Defining the Sources- Invertebrates





Prey Fish - Odonate Comparison





Results

- High r2 indicates high fidelity to local food web
- Slope <1 indicates fish have higher exposure to industrial Hg

Summary

Scientific Impact

- Both local and estuary-wide effects (vs control) were evident
- Small-scale variation highlights the importance of habitat-scale (5-10 river km) processes for mercury bioaccumulation in urban ecosystems

Management Impact

- Multi-isotope approach applied to measure the effect of habitat restoration on source-specific mercury bioaccumulation
- Highlights need to identify sentinel species

Special thanks to:

Minnesota Pollution Control Agency

Wisconsin Department of Natural Resources

Bad River Tribe

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Watch these:

Janssen 1.09.02

Walters 1.09.03