

# Remedy Effectiveness and Restoration Effectiveness at Ponds Behind Erie Pier and Pickle Pond in the St. Louis River AOC

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## Remedy and Restoration Effectiveness Assessment

A Remediation to Restoration to Revitalization (R2R2R) approach is being implemented in Great Lakes AOC's. R2R2R refers to an observation that socioeconomic revitalization (R3) may be catalyzed by remediation (R1) of contaminated sediments and/or restoration (R2) of habitat.

Understanding conditions both before and after remediation and restoration is essential for assessing project outcomes. Place-based research to improve methods for the assessment of outcomes is being conducted at select case study locations. This presentation describes the collection of baseline condition data for two SLRE case studies to evaluate methods for assessing the effectiveness of pending remediation and restoration efforts at Pickle Pond (PP) and Ponds behind Erie Pier (PBEP).

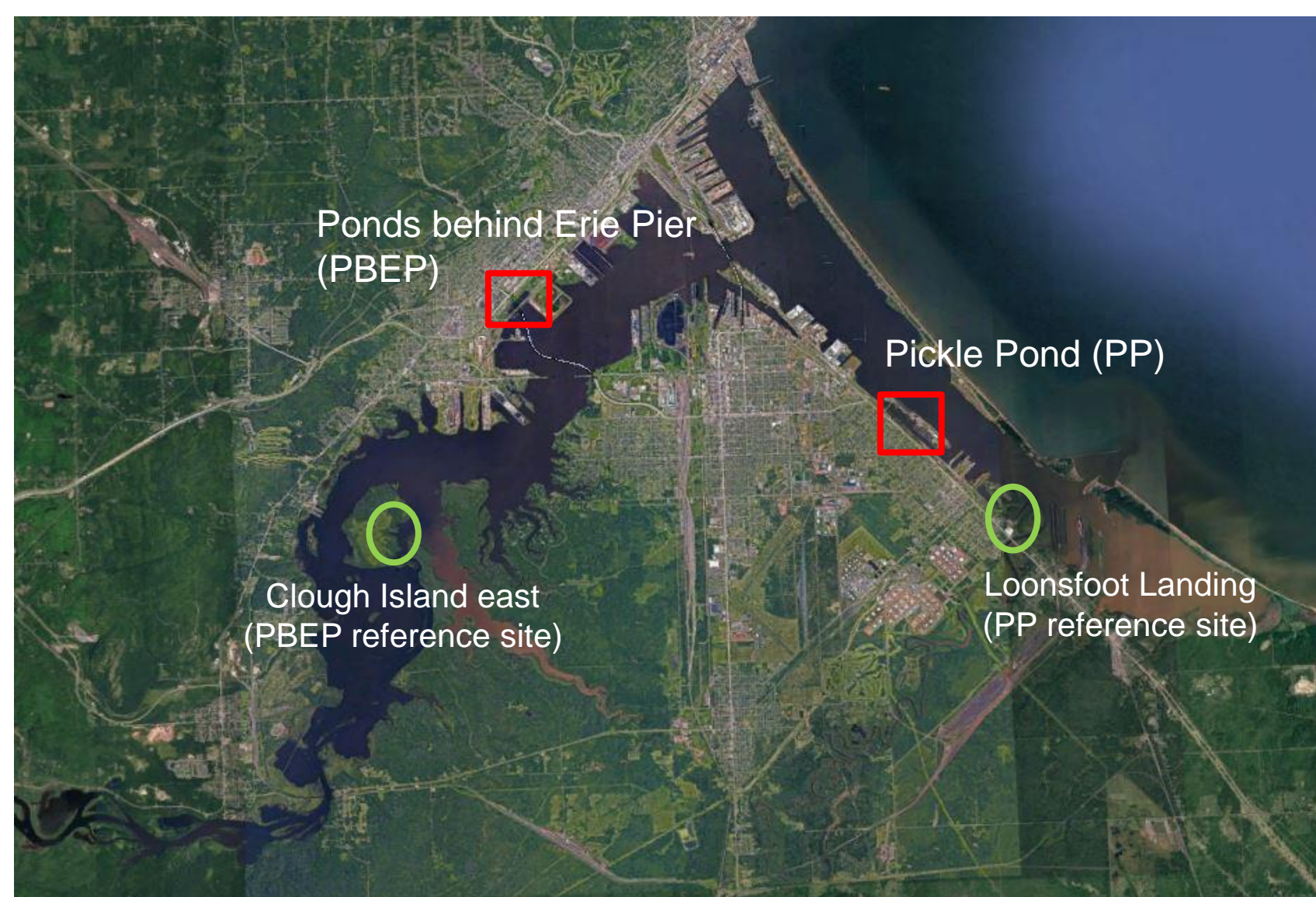
The objective of these studies is to evaluate and demonstrate a multi-indicators (multiple lines of evidence) approach to assessing AOC project outcomes.

**See companion poster by Williams et al. focused on revitalization (R3) research at these sites.**

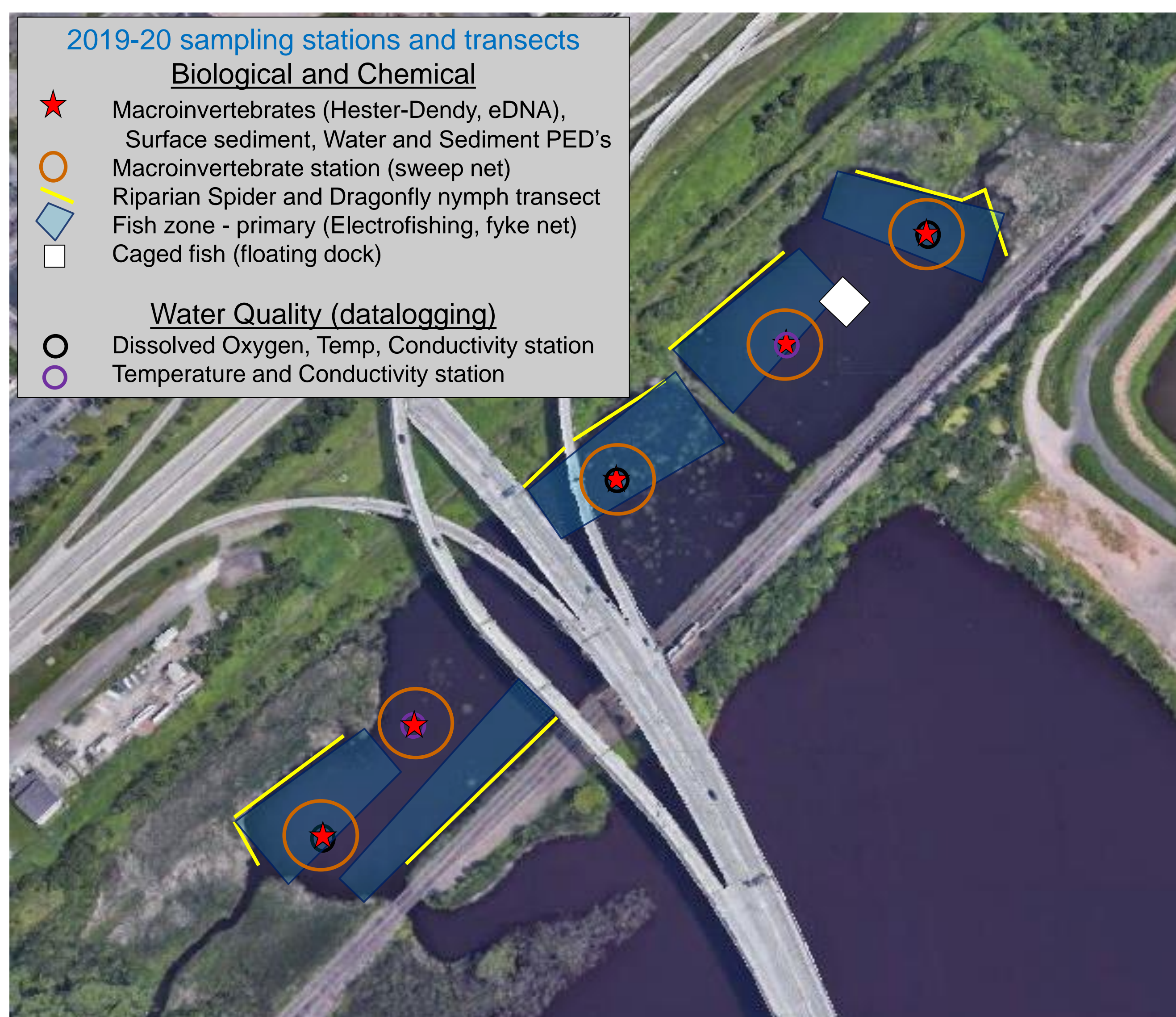
### Study Locations

Case study (red square) locations and associated reference (green oval) sites.

Comparable data collected from reference (control) sites help account for variability unrelated to R1 and R2 efforts.



## Ponds Behind Erie Pier



### Site and project description

This site is contaminated with industrial legacy pollution and is ecologically degraded. It continues to receive surface runoff and stormwater input. The ponds are connected to the estuary by a non-navigable channel.

### R1 and R2 effectiveness Research (this study)

- Multiple years of baseline data (2019 and 2020) prior to R1 and R2 activities
- Reference conditions assessed at Clough Island (east) site
- Follow up sampling to be done immediately after R1/R2 and long-term monitoring plan to be established

Remediation (R1) and Restoration (R2)	R1 and R2 effectiveness research (this study)
<b>R1 actions planned (2021)</b> Remove sediment polluted with organic contaminants (PCB's, PAH's, Dioxins/Furans), mercury and other heavy metals (chromium, lead, cadmium, copper, zinc)	<b>R1 target impacts</b> Sediment contamination Fish contamination Bug contamination
<b>R2 actions planned (2021)</b> Change depth profile Remove invasive plants stormwater/source control	<b>R2 target impacts</b> Water Quality Bathymetry Fish and wildlife habitat Invertebrate habitat Aquatic vegetation
	<b>Assessment Endpoints (Lines of evidence)</b> <ul style="list-style-type: none"><li>Water quality monitoring (<i>in situ</i> datalogging)</li><li>Water contaminants (chemistry, PED's, bioassays)</li><li>Sediment contaminants (chemistry, PED's)</li><li>Sediment toxicity and bioaccumulation (lab tests)</li><li>Contaminant bioaccumulation - resident biota (fish, macroinvertebrates, dragonflies, spiders)</li><li>Exposure Biomarkers (caged fish)</li><li>Community index (macroinvertebrates, eDNA, fish)</li><li>Source ID (Hg isotopes-biota and sediments)</li></ul>



Sweep netting for dragonfly nymphs

**Partners**  
US. EPA  
USGS  
US Army Corps  
MPCA  
City of Duluth



caged fish work on floating dock

## Pickle Pond



### Site and project description

This site is connected to Superior Bay and is adjacent to Barkers Island, an area important for recreation and tourism. Contaminated sediments and invasive species contribute to degraded water quality and habitat conditions. The site receives runoff from an active railroad yard and municipal stormwater outfalls. R1 and R2 actions aim to restore important fish nursery habitat and stopover for migratory birds.

### R1 and R2 effectiveness (this study)

- Baseline conditions measured in 2020 prior to remediation and restoration activities anticipated in 2021
- Reference conditions assessed in 2020 at Loonsfoot landing, in Superior Bay.
- Follow up sampling to be done immediately after R1/R2 and long-term monitoring plan to be established

Remediation (R1) and Restoration (R2)	R1 and R2 effectiveness research (this study)
<b>R1 actions planned (2021)</b> Remove sediment polluted with organic contaminants (PCB's and PAH's), mercury and other heavy metals (lead, copper, zinc)	<b>R1 target impacts</b> Sediment contamination Fish contamination Bug contamination
<b>R2 actions planned (2021)</b> Enhance connectivity Change depth profile Remove invasive plants stormwater/source control	<b>R2 target impacts</b> Fish passage / access Water Quality Bathymetry Fish and wildlife habitat Invertebrate habitat Aquatic vegetation
	<b>Assessment Endpoints (Lines of evidence)</b> <ul style="list-style-type: none"><li>Water quality monitoring (<i>in situ</i> datalogging)</li><li>Water contaminants (chemistry, PED's)</li><li>Sediment contaminants (chemistry, PED's)</li><li>Sediment toxicity and bioaccumulation (lab tests)</li><li>Contaminant bioaccumulation - resident biota (fish, macroinvertebrates, dragonflies, spiders)</li><li>Exposure Biomarkers (caged fish)</li><li>Community index (macroinvertebrates, eDNA, fish)</li></ul>



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US. EPA  
USGS  
US Army Corps  
WDNR  
City of Superior



Nighttime spider sampling

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**Disclaimer:** The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government

## Multiple Lines of Evidence (Biological, Chemical and physical)

### Riparian spiders

- Contaminants (feed on emerging insects)
- Bioavailability link to terrestrial foodweb



tetragnathid spider

### Bioassays (molecular)

- Caged fish (in vivo genetic and biochemical biomarkers)
- Water (in vitro bioactivity assays)

### Fish

- Community metric (traditional and eDNA)
- Contaminant residue
  - Prey fish (foodweb impacts/pathway)
  - Gamefish (Human consumption)
  - Caged fish (early indicator, water exposure)
- Mercury isotopes (source identification)



Dragonfly nymph

### Prey fish

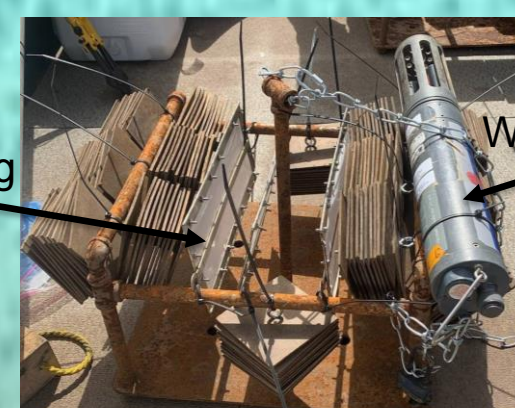
### Gamefish



Macroinvertebrate sample

### Water Quality (WQ)

- Flow, bathymetry (physical)
- H<sub>2</sub>O chem monitoring (DO, temp, cond.) (*in-situ* datalogging using WQ sensors)
- Contaminant analysis
  - Polyethylene devices (PED's) (organic contaminants)
  - Water samples (organics, metals)
  - Mercury isotopes (source identification)



WQ sonde deployment mooring

### Aquatic Macroinvertebrates

- Community index - IBI (HD's and eDNA)
- Contaminants (recent exposure, foodweb pathway)
  - Local invertebrate mix (sediment exposure)
  - Dragonfly nymphs (predator - integrate and biomagnify)



Sweep net sampling

- Local macroinvertebrate mix
- Dragonfly nymphs



Hester-Dendy (HD) artificial substrate samplers attached to mooring

- Local macroinvertebrate mix



Sediment cores

### Sediment

- Contaminants (organics, metals)
  - PED's (bioavailability; organics)
  - Cores (legacy pollution)
  - Surface (exposure pathway)
- Toxicity and bioaccumulation tests
- Mercury isotopes (source identification)



Sediment PED