

NOAA GREAT LAKES MUSSEL WATCH



Contaminant source tracking and assessment: Manistique River Area of Concern

Basin-wide Monitoring

- Dreissenid mussels found locally in U.S. Areas of Concern (AOC) are widely used as indicator species because of their ability to readily bioaccumulate contaminants.
- The Mussel Watch Program (MWP) monitored a suite of nearly 150 chemicals (trace elements, legacy organic compounds and select chemicals of emerging concern) from 1992 to 2010 using dreissenid mussels from Great Lakes nearshore zones (Fig 1).
- Under Great Lakes Restoration Initiative (GLRI), MWP expanded basin-wide monitoring to include U.S. AOCs in 2009/2010 (Fig 2). This basin-wide assessment was followed by spatially intensive sampling and multi-parameter assessments in priority AOCs.
- The 2009/2010 basin-wide assessment provides baseline contaminant concentrations at AOC river mouths and valuable comparisons to meaningfully interpret data from intensive contamination assessments at priority AOCs.

Manistique River AOC 2012-2013

- The major historical contamination impacts to the Manistique River are associated with sawmills and wastes from paper recycling and polychlorinated biphenyls (PCBs) used in de-inking processes. While sediment dredging removed PCB contamination, ongoing monitoring suggested a source of PCBs may still exist.
- MWP participated in a multi-agency PCB source tracking project to identify and distinguish potential PCB sources contributing to elevated concentrations in localized areas within the AOC.
- PCB body burdens and mussel health indicators (gene expression and histopathology) were assessed using caged dreissenid mussels.
- Bioaccumulation of PCBs by mussels is predictive of exposure and accumulation by fish and subsequently potential exposures to humans and wildlife.
- Concurrently, collaborators used a suite of indicators including Polyethylene Devices (PEDs), Hester Dendys, riparian spiders, sediment chemistry and groundwater chemistry.
- Data garnered from various biological lines of evidence will be used to determine if contamination sources are present and to support remediation effectiveness assessment.

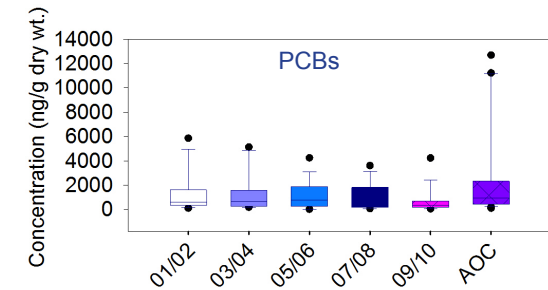


Fig 1. Example of basin-wide contaminant trends in mussels. Historic sites serve as reference sites for current AOC monitoring effort.

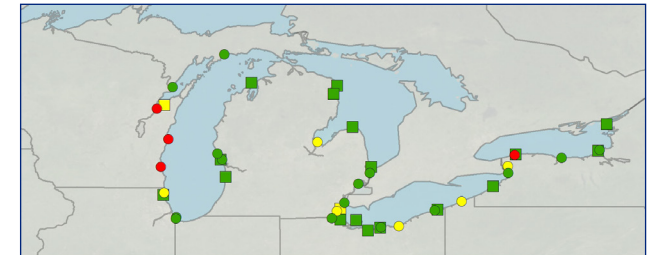


Fig 2. Basin-wide PCB measurements in mussels (2009/2010) in AOCs (■) and reference (●) sites clustered into high (●), medium (●) and low (●) groups.



Fig 3. Sampler with three indicators- caged mussels, PEDs and Hester Dendys on board



Fig 6. Caged mussel results from 2012 and 2013 Manistigue assessment. PCB concentrations were clustered into low (●; 286-3035 ng/g lipid), medium (●; 3036-14751 ng/g lipid) and high (●; 14752-39315 ng/g lipid) using Ward's hierarchical cluster analysis.

CAGED MUSSEL ASSESSMENT

Methodology

- Mussels harvested from the harbor breakwater were deployed in cages at pre-determined stations and retrieved after 6 weeks for processing and chemical analyses.
- PCB concentrations measured in caged mussels were clustered into low, medium and high concentrations and compared to basin-wide measurements (Fig 6 & 7).
- 39 PCB congeners were used for the comparisons, however, data for 83 PCB congeners are available for Manistigue samples.

Results

- PCBs measured in caged mussels deployed in the lower river reach and outer harbor area of the Manistigue River AOC indicate that elevated concentrations still exist in low-flow backwater areas close to a former waste lagoon known to have been contaminated with PCBs.

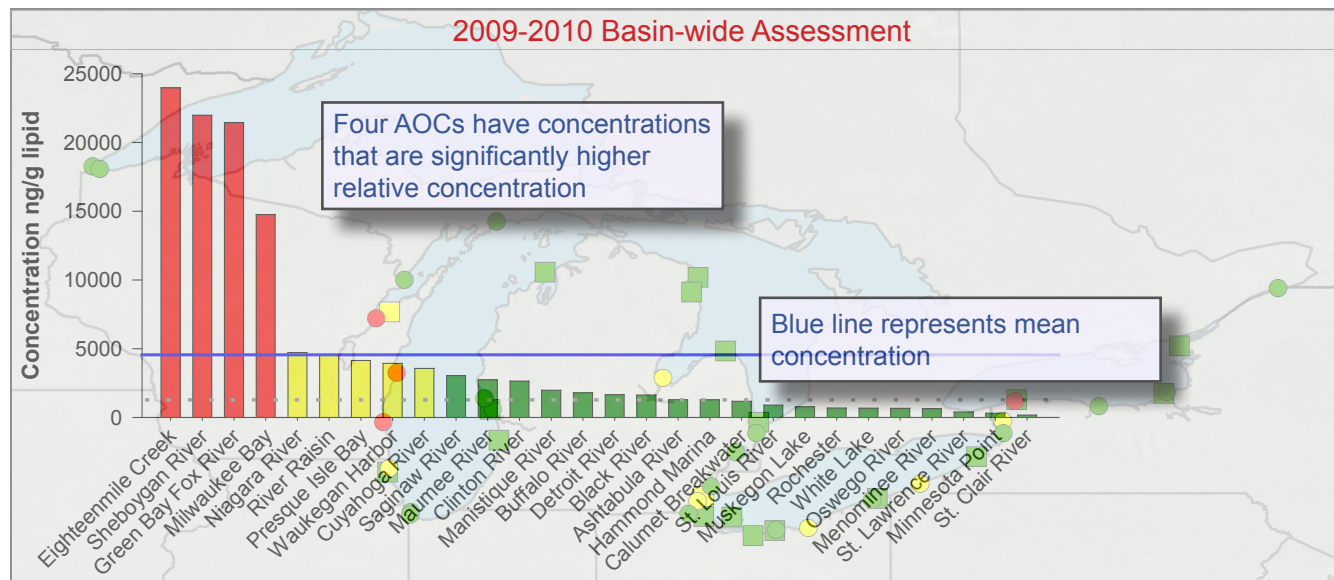


Fig 7. Basin-wide PCB measurements in mussels sampled from river mouths of AOCs (including Manistigue river AOC) in 2009/2010 represented a bar chart and as a map. These baseline PCB concentrations provide perspective to the results from caged mussel study (2012/2013) undertaken at Manistigue River AOC.

- When compared to basin-wide mussel samples from river mouths of AOCs, PCB concentrations in caged mussels from Manistigue are amongst the highest (Fig 6 & 7).
- PCB concentrations in caged mussels from harbor and river channel sites were not significantly different than the mussel harvest site located outside the breakwater.
- Relative concentrations of PCBs in caged mussels are consistent between year 1 (2012) and year 2 (2013) of this study, which is indicative of the robustness of the methods.

MUSSEL HEALTH GENE EXPRESSION (OMICS) STUDY

Rationale

- Gene expression is used as a signature of stress and is tied to physiological health of an organism.
- Can be used for long-term monitoring of health of aquatic ecosystems.



Background

- Mussel health was evaluated at a subset of sites that were used in the caged mussel study.
- Cages were retrieved after 6 weeks of deployment and simultaneously sampled for bivalve health and mussel tissue chemistry.
- Gene expression assays provide specific information on how an organism is responding to its environment and can potentially identify which stressors may be causing the greatest impact.
- Genes commonly expressed and linked to PCB exposure are Aryl Hydrocarbon Receptor (AHR), Cytochrome P450 (CYP-450), and Multixenobiotic Resistance (MXR).

Preliminary Results

- Significant differences in gene expression (Selenium Dependent Glutathione Peroxidase-Se-GPX and MXR) between sites were detected that support concomitant chemistry data (Fig 9).



Fig 8. Location of mussel health sampling sites.

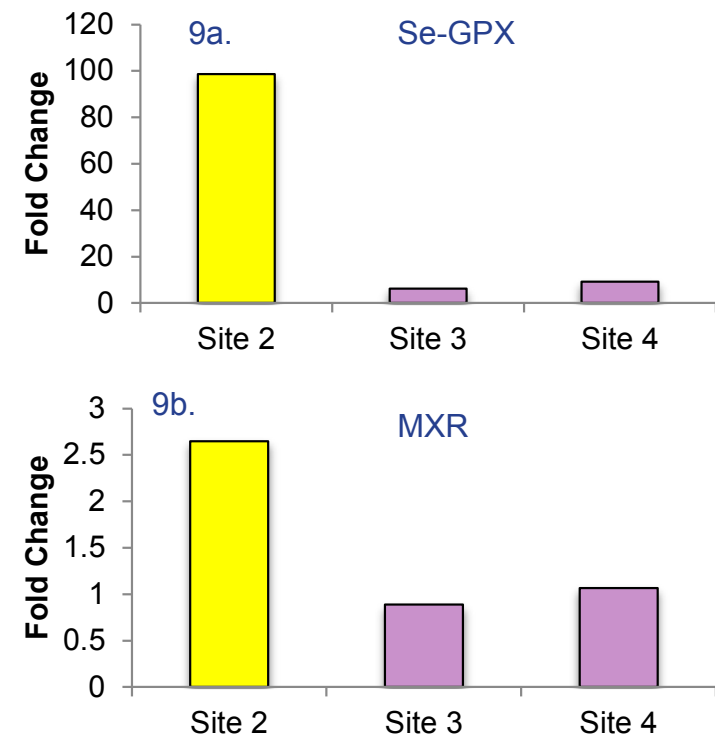


Fig 9. Se-GPX (9a.) and MXR (9b.) significantly upregulated in Site 2 compared to other sampled sites.

COLLABORATIONS AND PARTNERSHIPS

The Manistique River AOC contaminant source tracking project exemplifies the success of partnerships. Leveraged resources resulted in relevant data and science from multiple indicators to facilitate timely and informed decision making in a fiscally limited climate.

Office/agencies listed below:

EPA Great Lakes Legacy Act Program;
EPA Office of Research and Development;
EPA Great Lakes National Program Office;
NOAA Office of Oceans and Atmospheric Research;
NOAA Office of Habitat Restoration;
NOAA Office of Response and Restoration;
School of Freshwater Sciences, University of Wisconsin-Milwaukee;
US Geological Survey;
Michigan Department of Environmental Quality;
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