

**TORONTO & REGION
REMEDIAL ACTION PLAN**

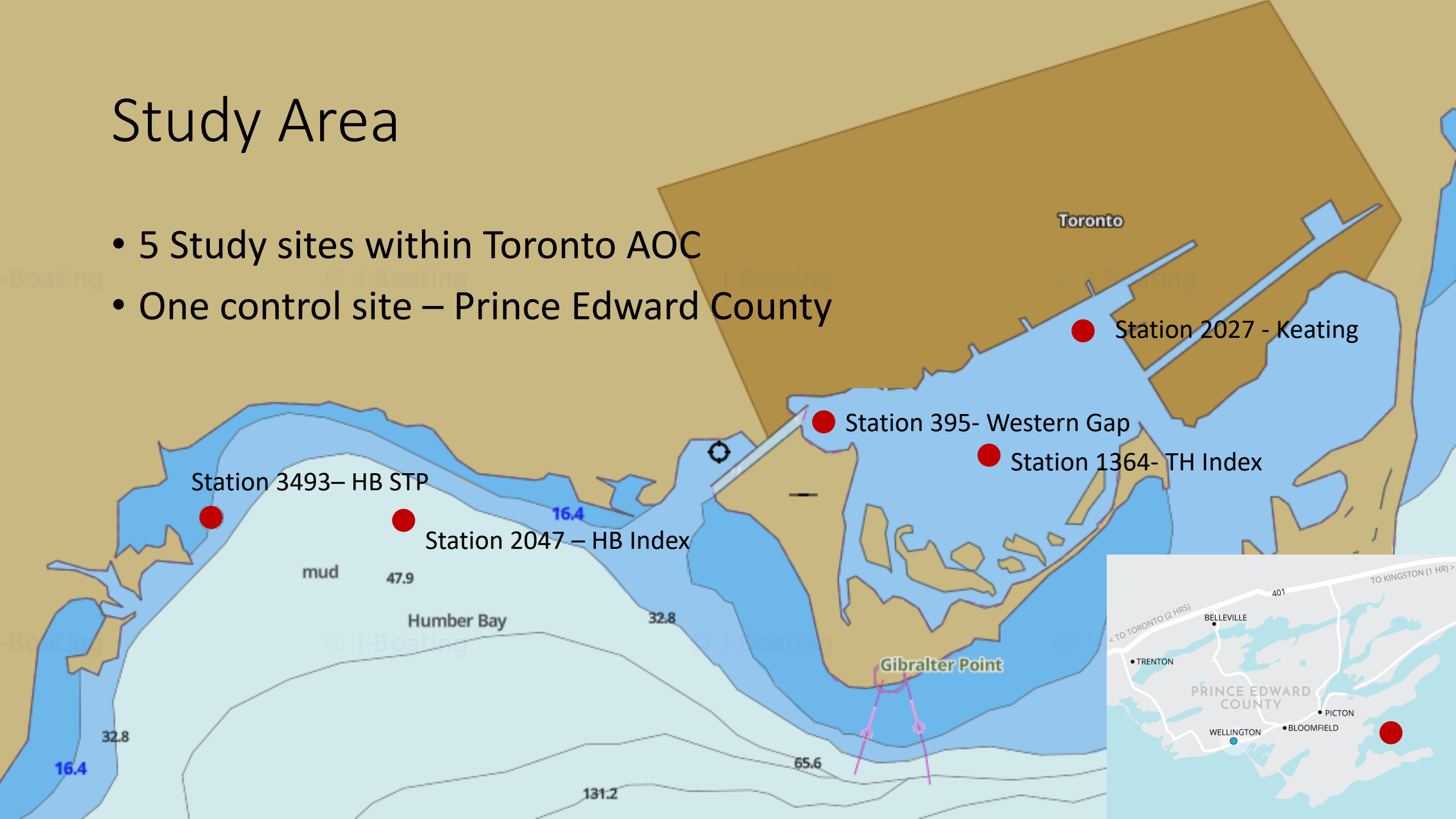


Assessing Sediment Quality Using a Tetrad Approach in the Toronto and Region Area of Concern

Kathleen Stevack – University of Guelph
Ontario Ministry of Environment and Climate Change

Study Area

- 5 Study sites within Toronto AOC
- One control site – Prince Edward County



Background

Beneficial Use Impairment	Status in 1989	
	Impaired	Requires Further Assessment
Restrictions on fish consumption	X	
Degradation of benthos	X	
Restrictions on dredging activities	X	
Eutrophication or undesirable algae	X	
Beach closings	X	
Degradation of aesthetics	X	
Degradation of fish and wildlife populations	X	
Loss of fish and wildlife habitat	X	
Fish tumours or other deformities		X
Bird or animal deformities or reproductive problems		X
Degradation of phytoplankton and zooplankton communities		X

Original status of Beneficial Use Impairments in the Toronto and Region AOC (1989)

Background

	Status in 2016		
Benthos			
Restoration			
Degradation			
Restoration			
Eutrophication			
Beach erosion			
Degradation			
Degradation			
Loss			
Fish			
Bird or animal deformities or reproductive problems			X
Degradation of phytoplankton and zooplankton communities		X	

Toronto & Region Remedial Action Plan

BUI Status Re-designation Document: *Degradation of Benthos* April 2013

Sediment Contamination

- Major impediment to AOC restoration (COA, 2008)

Contaminated sediment:

- Benthic invertebrates
 - Higher level consumers
 - Impairs water quality
- Historical and emergent chemical contamination
 - Source and Sink

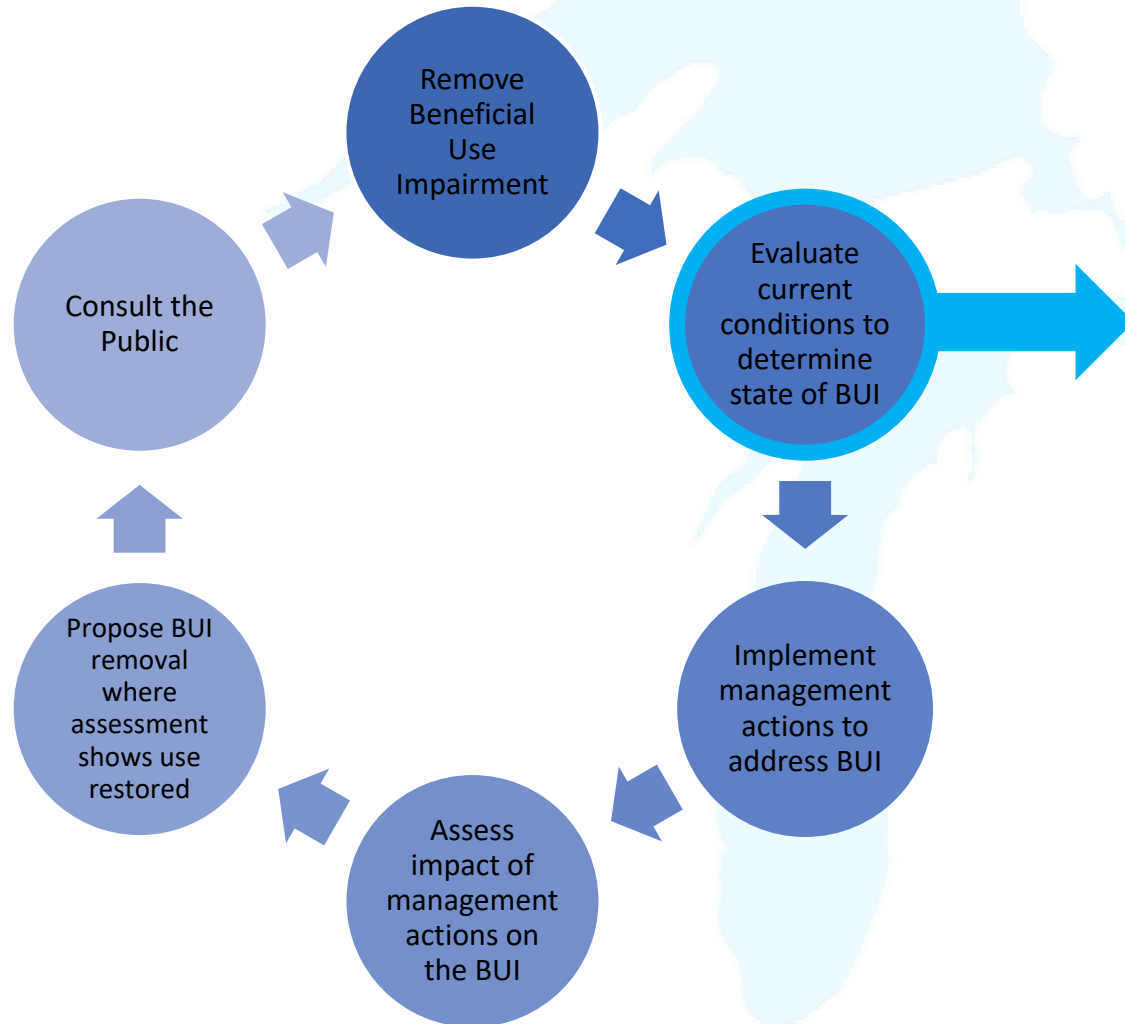


Sources of Contaminants

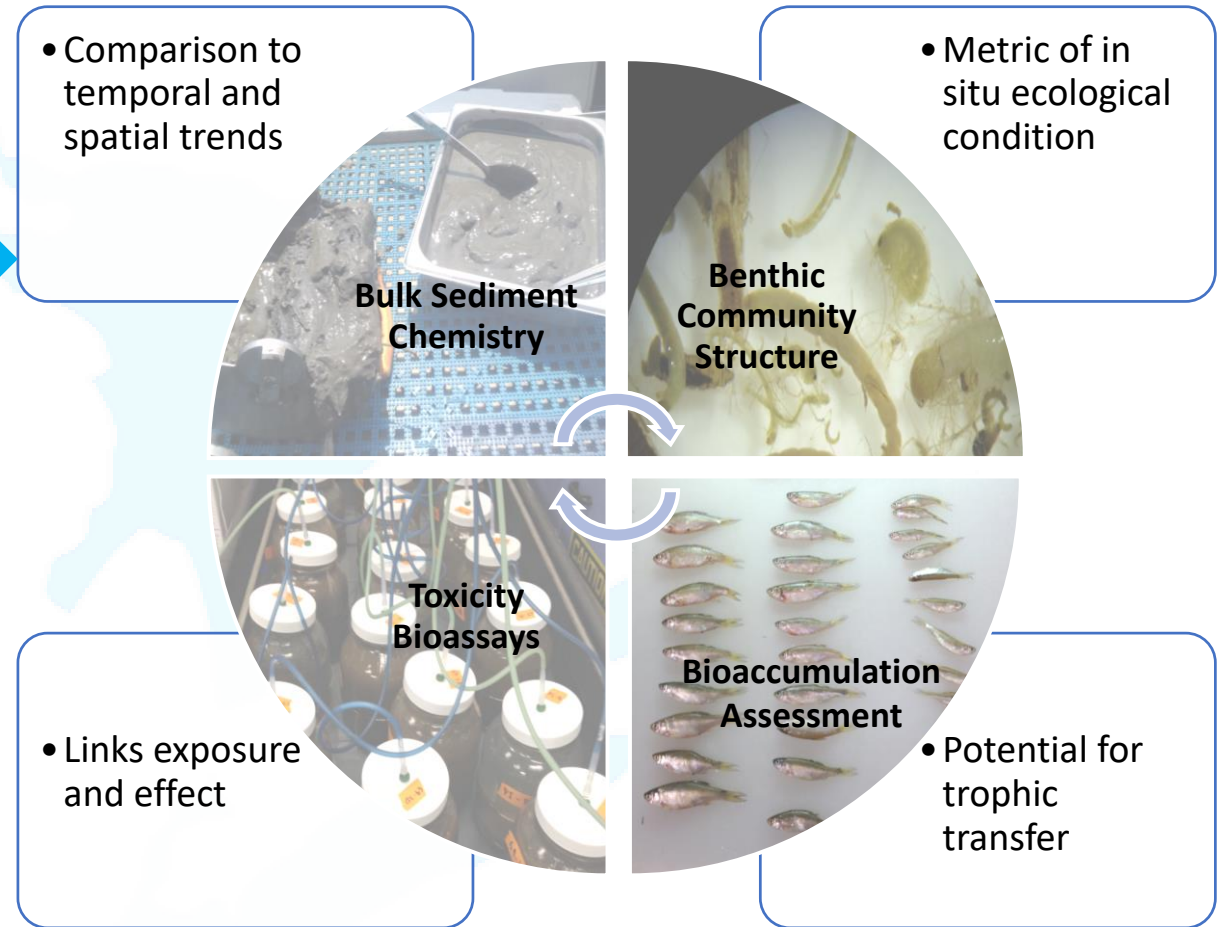
- Urban runoff
- Combined sewer overflows
- Elevated concentrations:
 - Nutrients
 - Metals
 - Organic contaminants



Delisting Process



Weight of Evidence for Evaluation

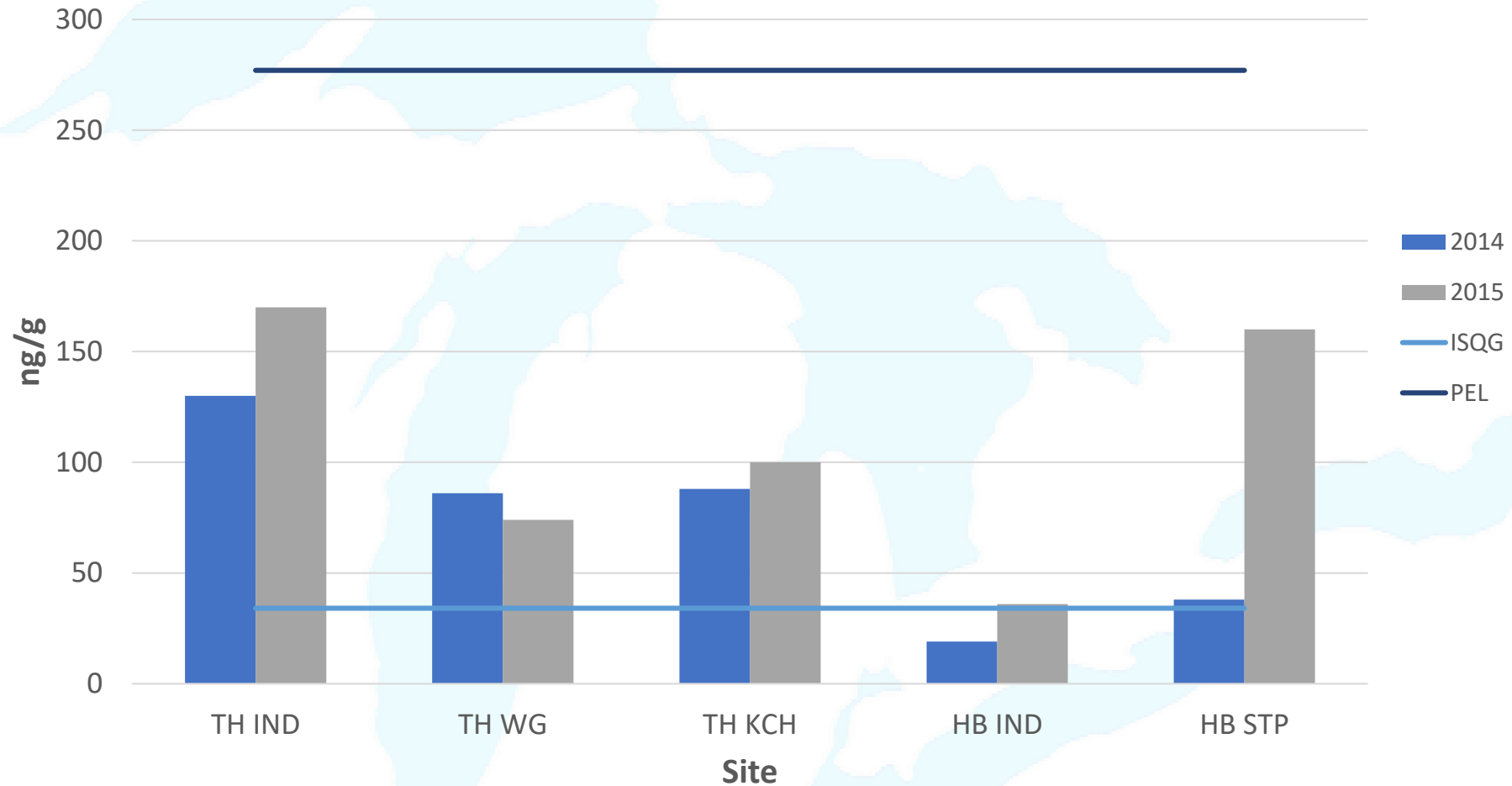


Methods – Field Collection and Processing

- Sediments collected using shipek grab (Toronto sites) or ponar (reference site)
- 3 replicate benthos samples per site
- Benthos screened (500 μ m), preserved in 80% ethanol
- Sediment submitted to Laboratory Services Branch of MOECC for analysis of contaminants

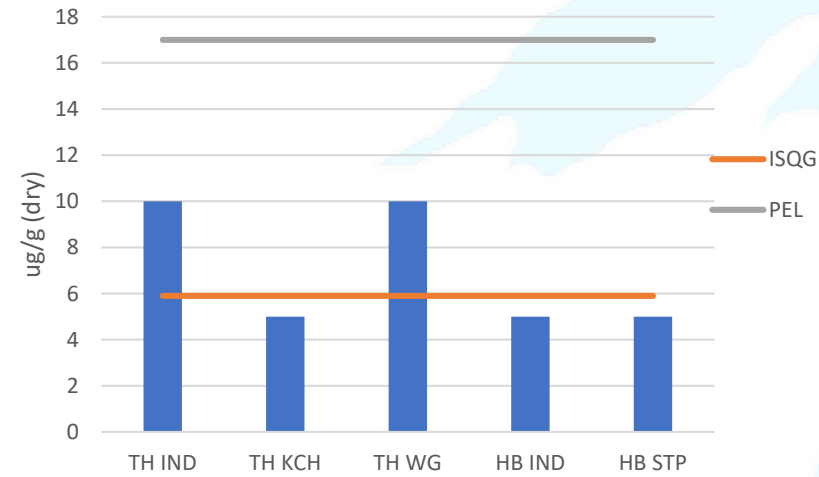


Sediment Chemistry – Polychlorinated Biphenyls

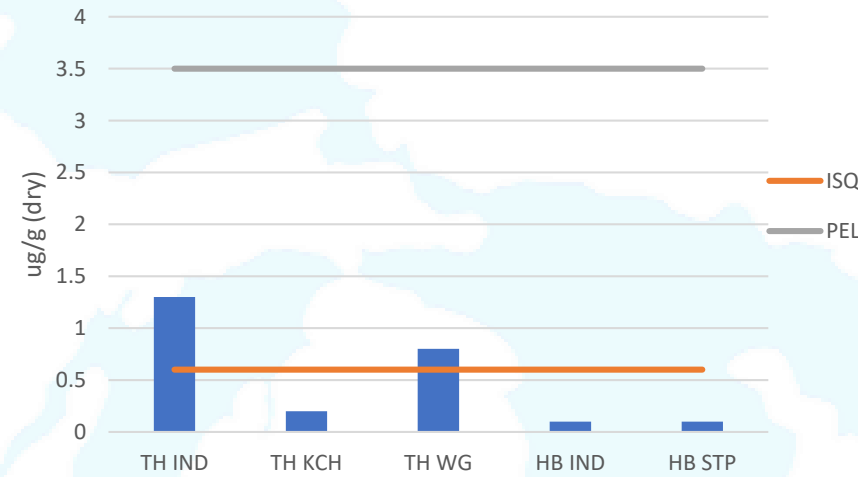


Sediment Chemistry - Metals

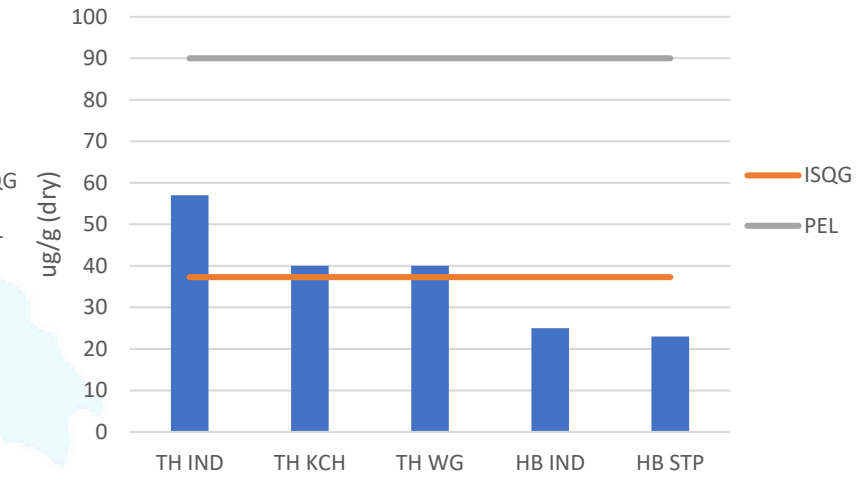
Arsenic



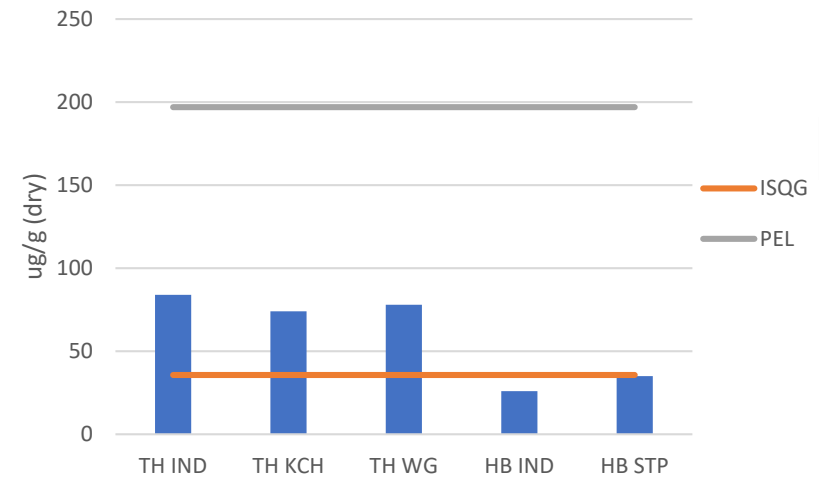
Cadmium



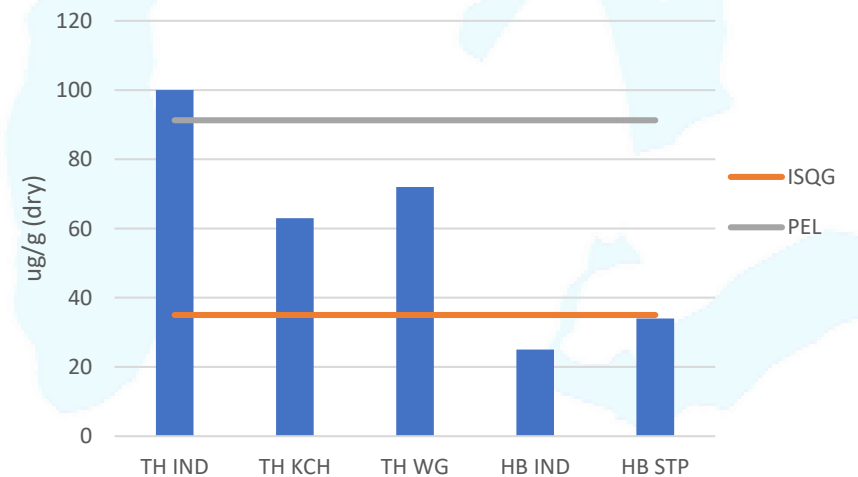
Chromium



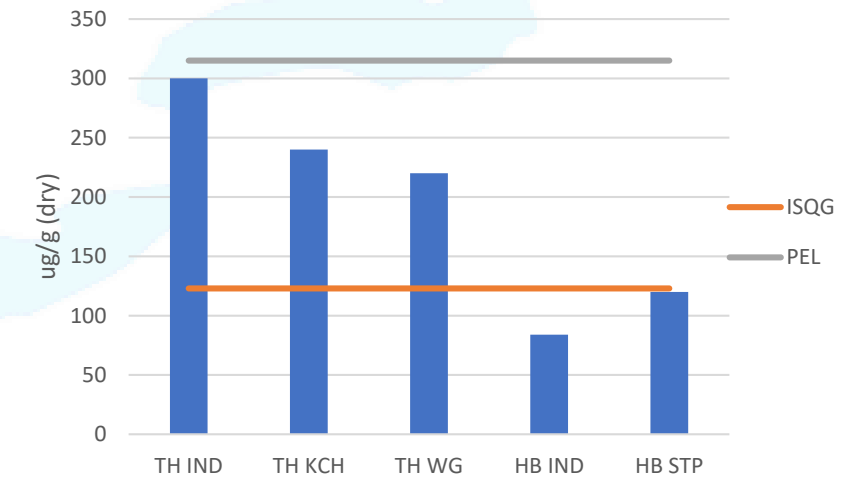
Copper



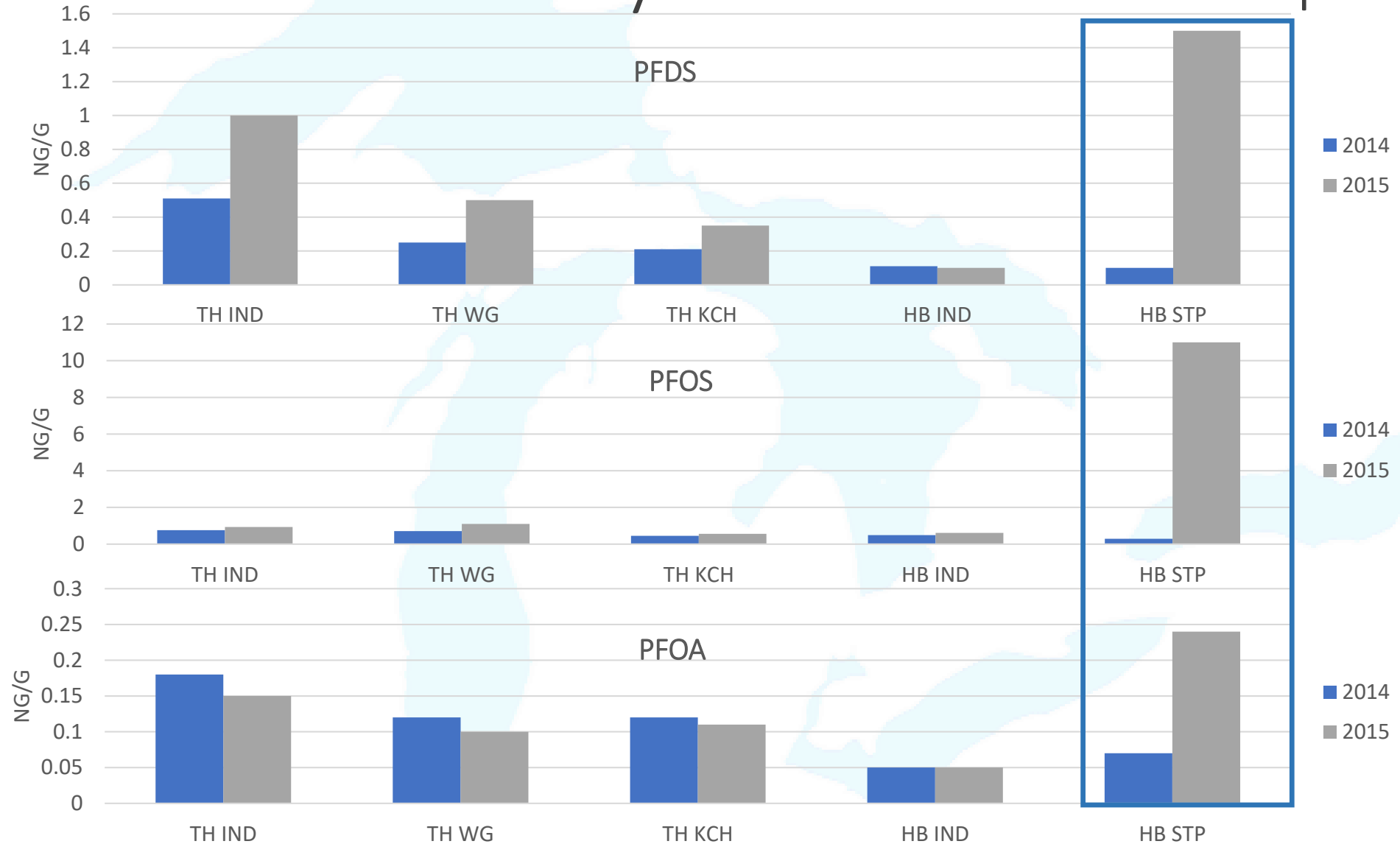
Lead



Zinc

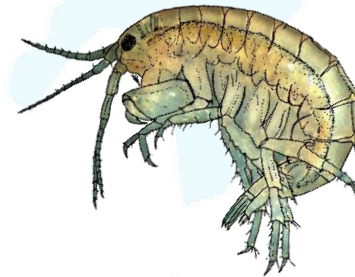


Sediment Chemistry – Perfluorinated Compounds

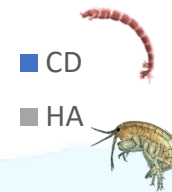
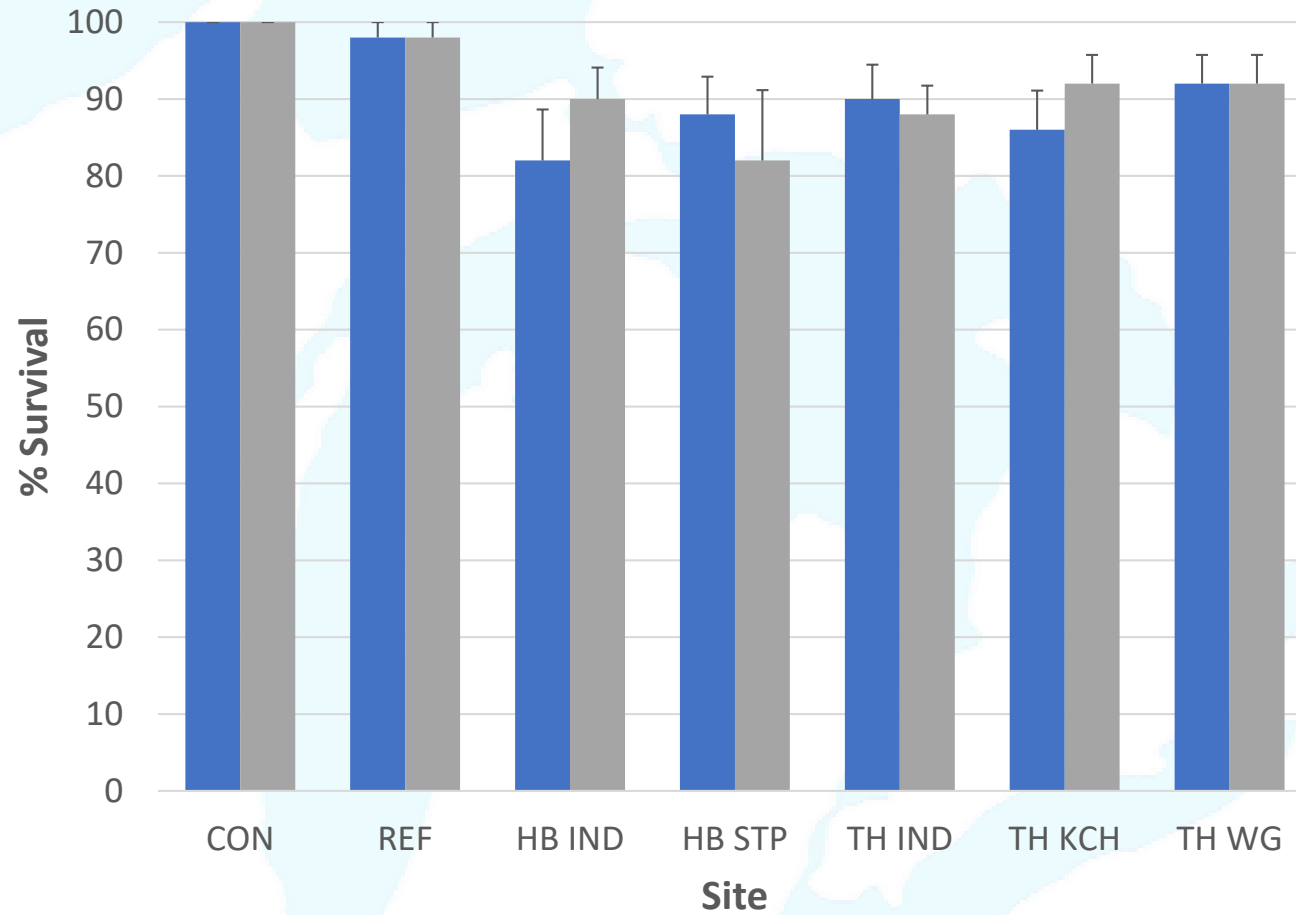


Methods - Acute Testing

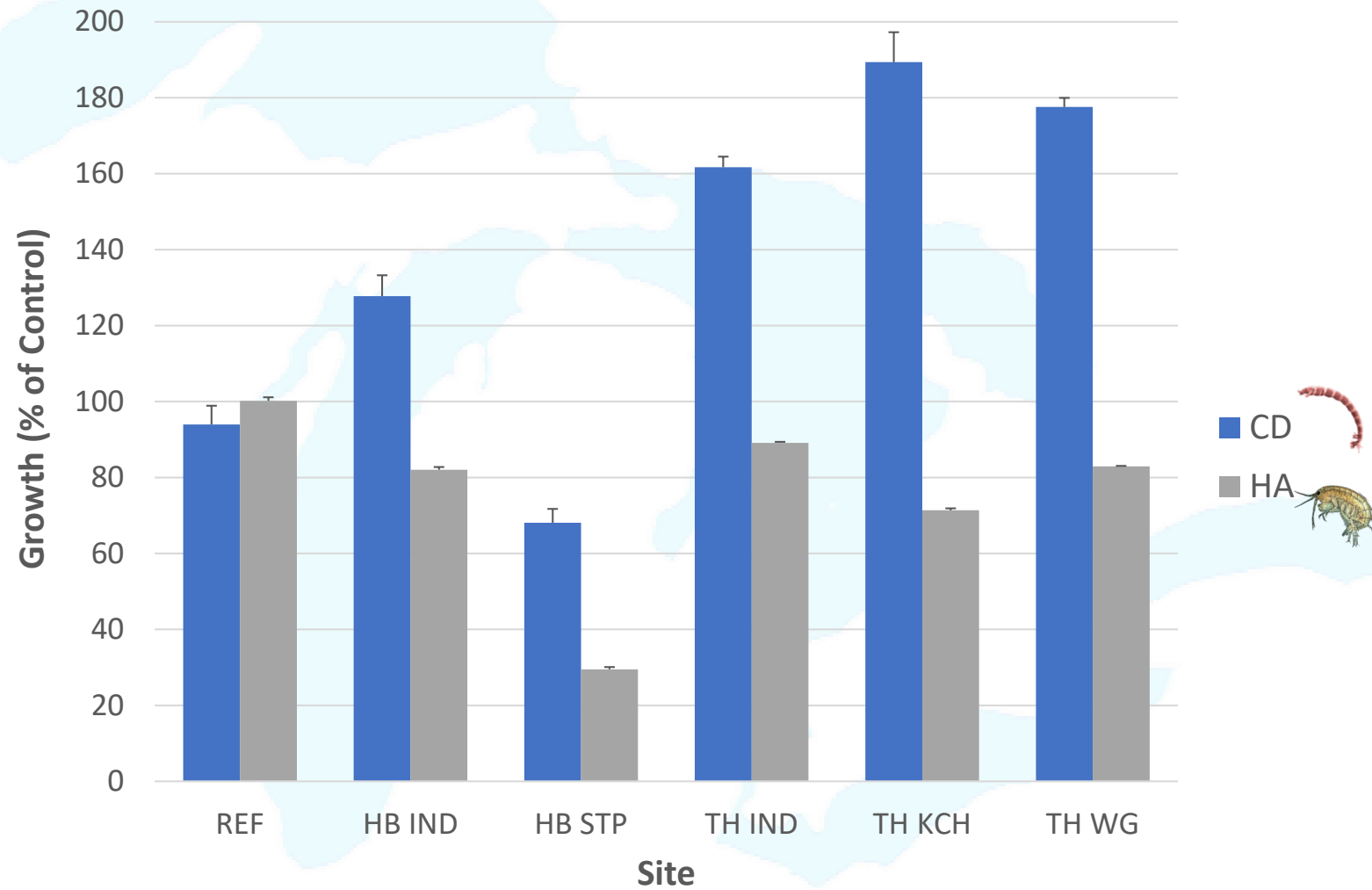
- Midge *Chironomus dilutus*:
 - 10 day survival and growth (ash free dry weight) **(EC)**
- Amphipod *Hyalella azteca*:
 - 14 day survival and growth (dry weight) **(EC)**



Acute Results - Survival

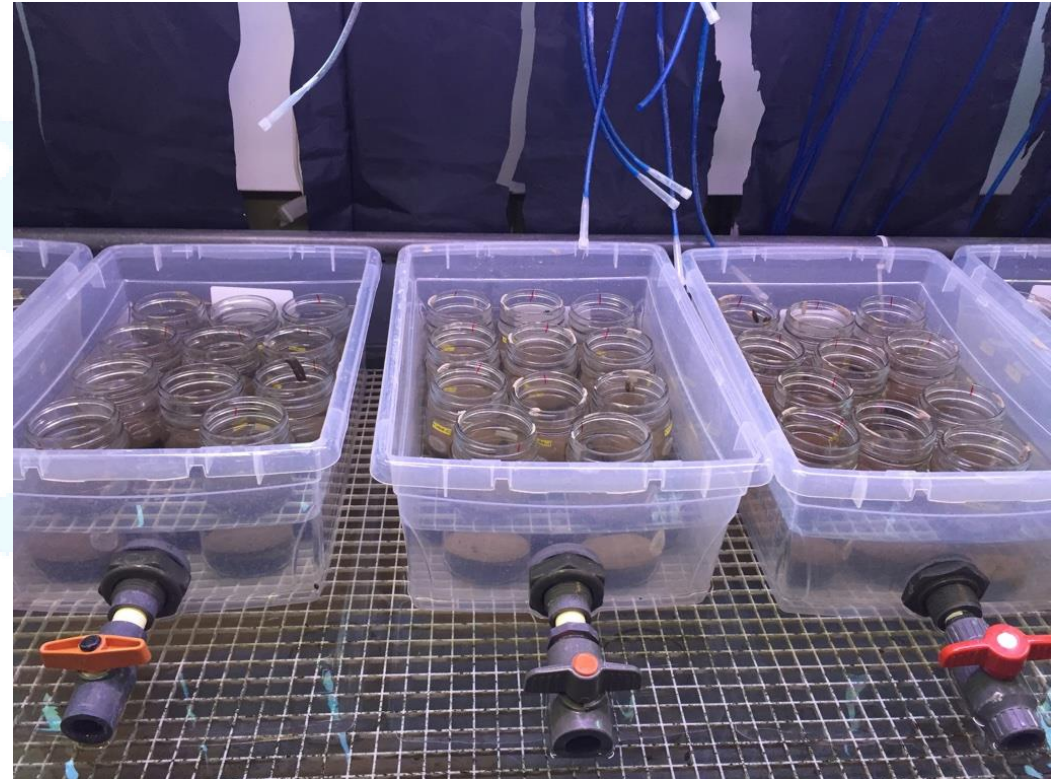


Acute Results - Growth

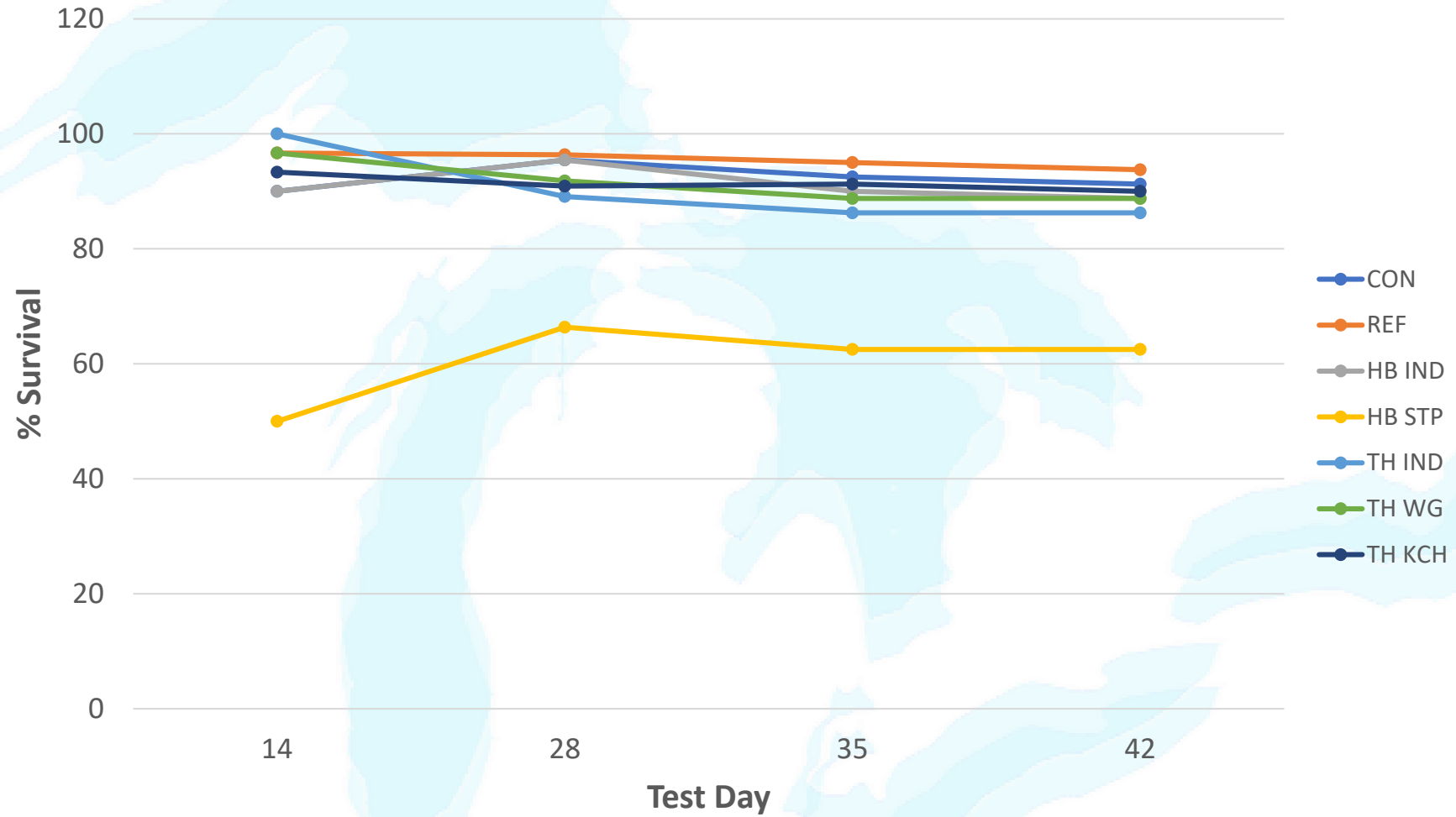
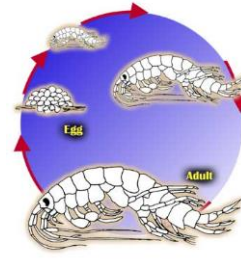


Methods – Chronic Testing

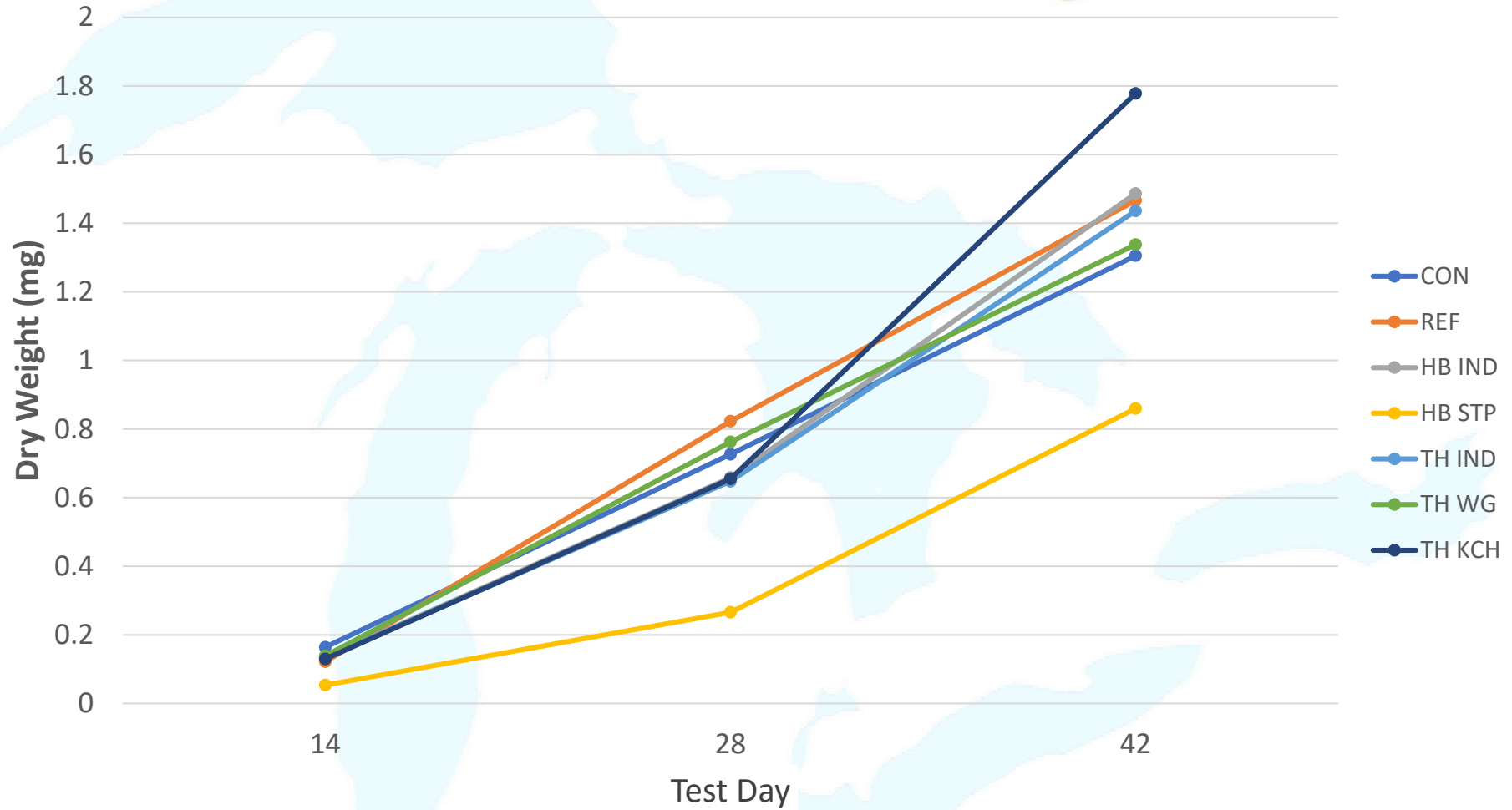
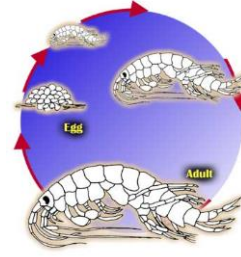
- Midge *Chironomus dilutus*:
 - Life-cycle test (**EPA**) 56 days
- Amphipod *Hyaella azteca*:
 - 42 day life-cycle test (**EPA**)
- 2 water renewals per day



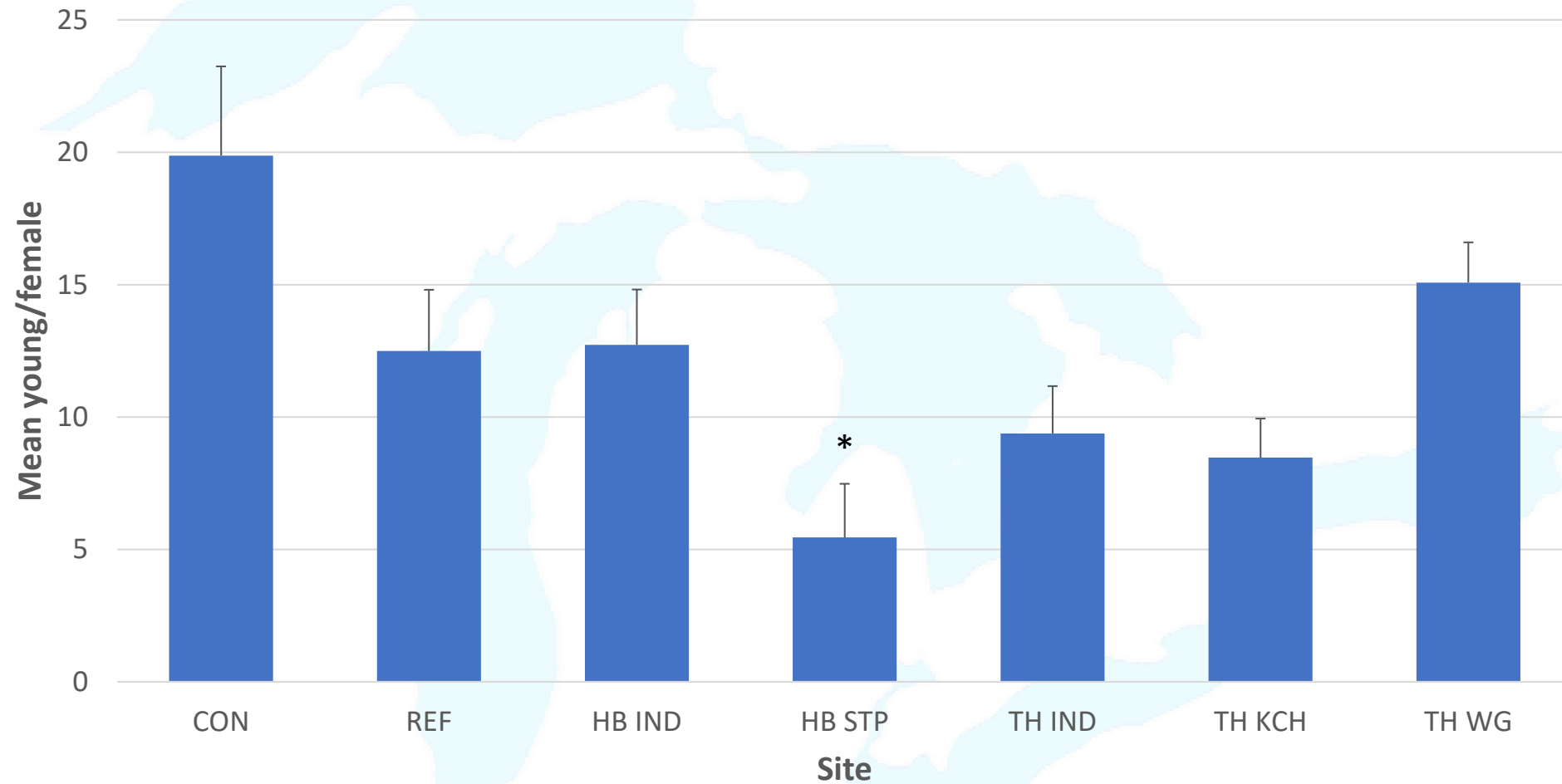
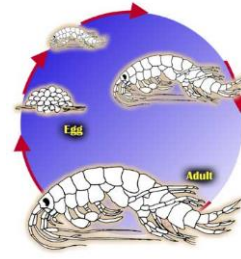
Chronic Results - *Hyalella*



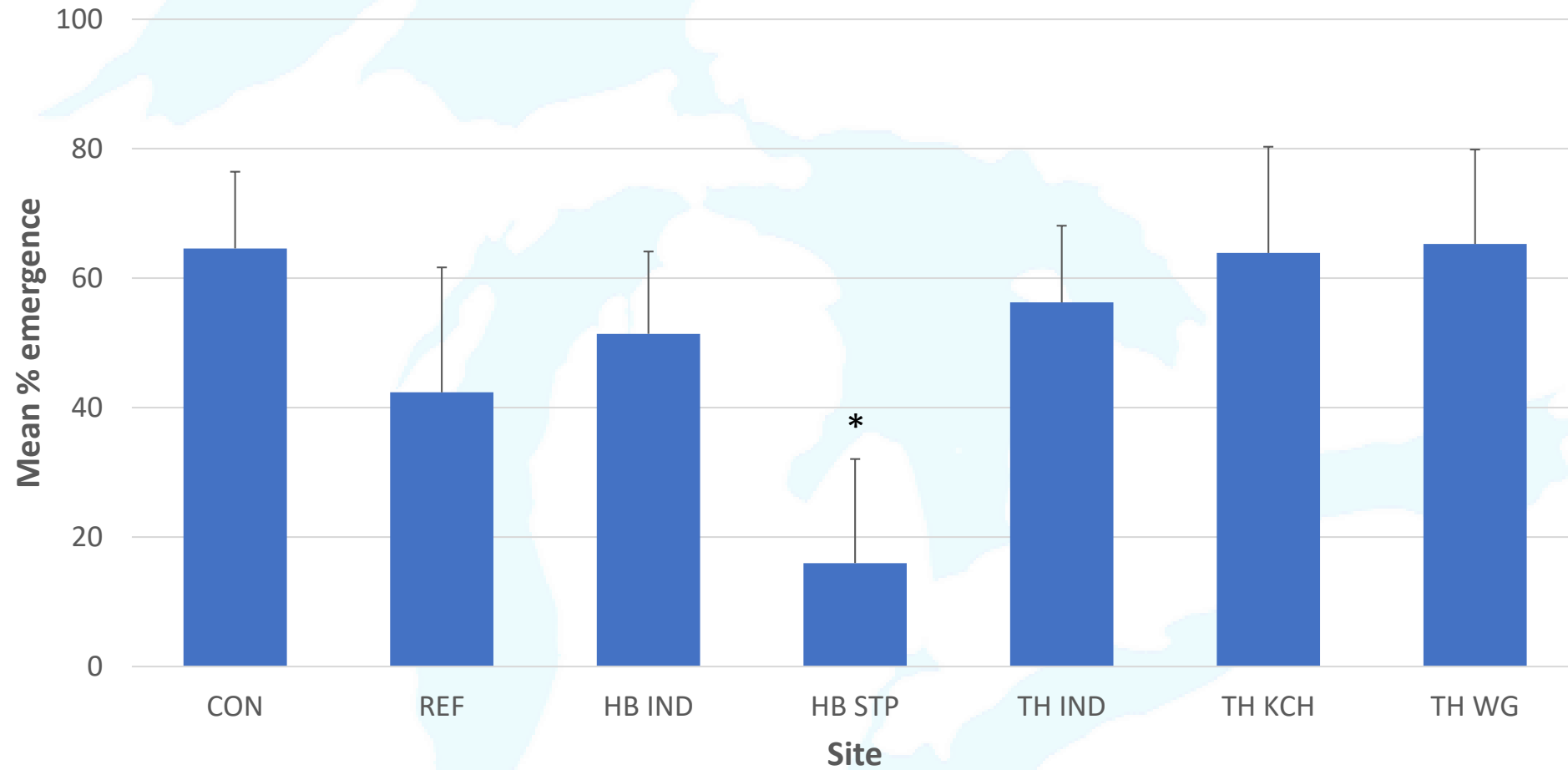
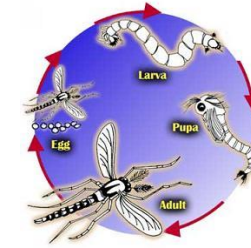
Chronic Results - *Hyalella*



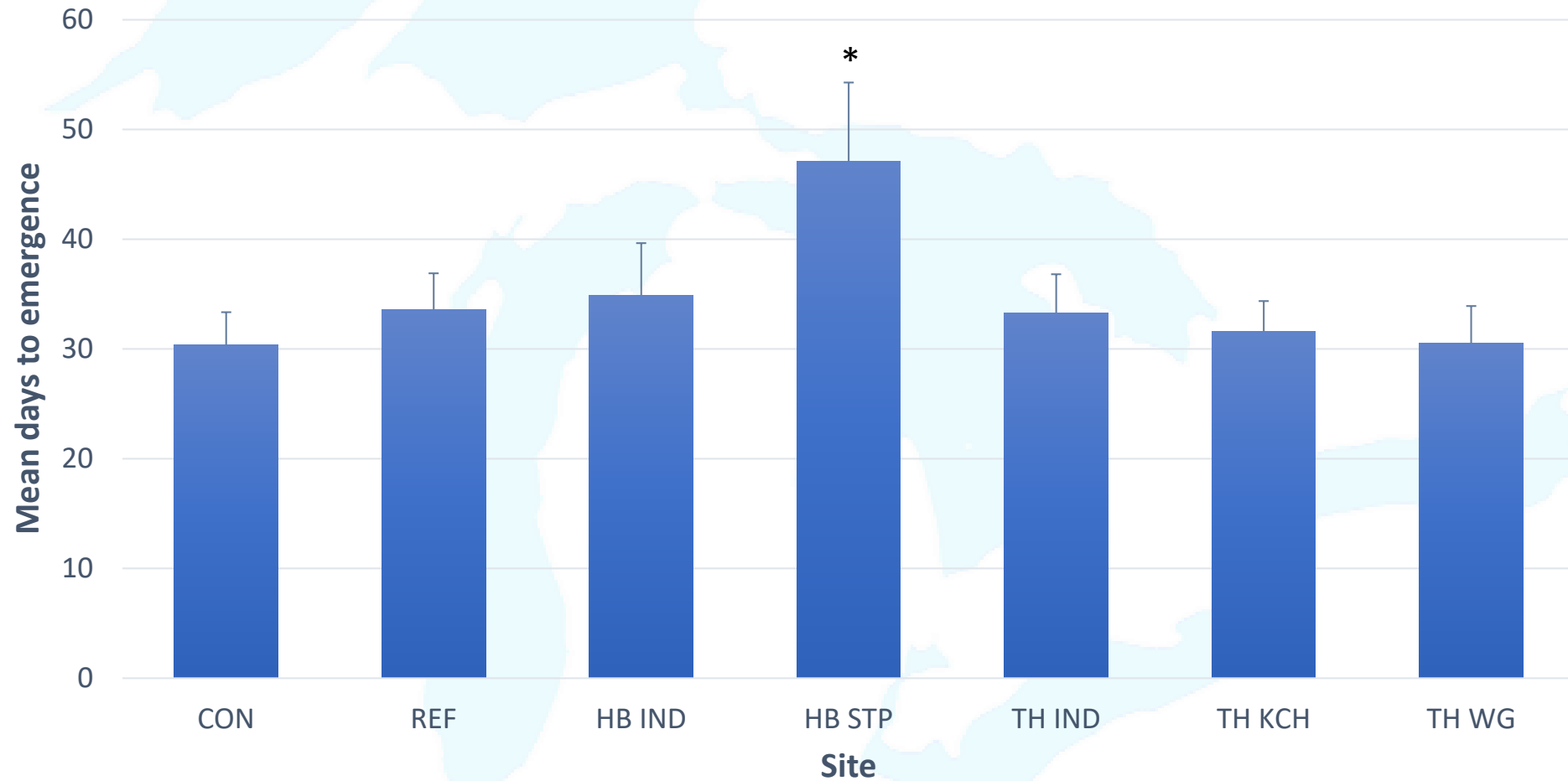
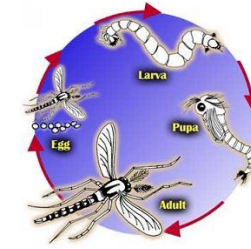
Chronic Results - *Hyalella*



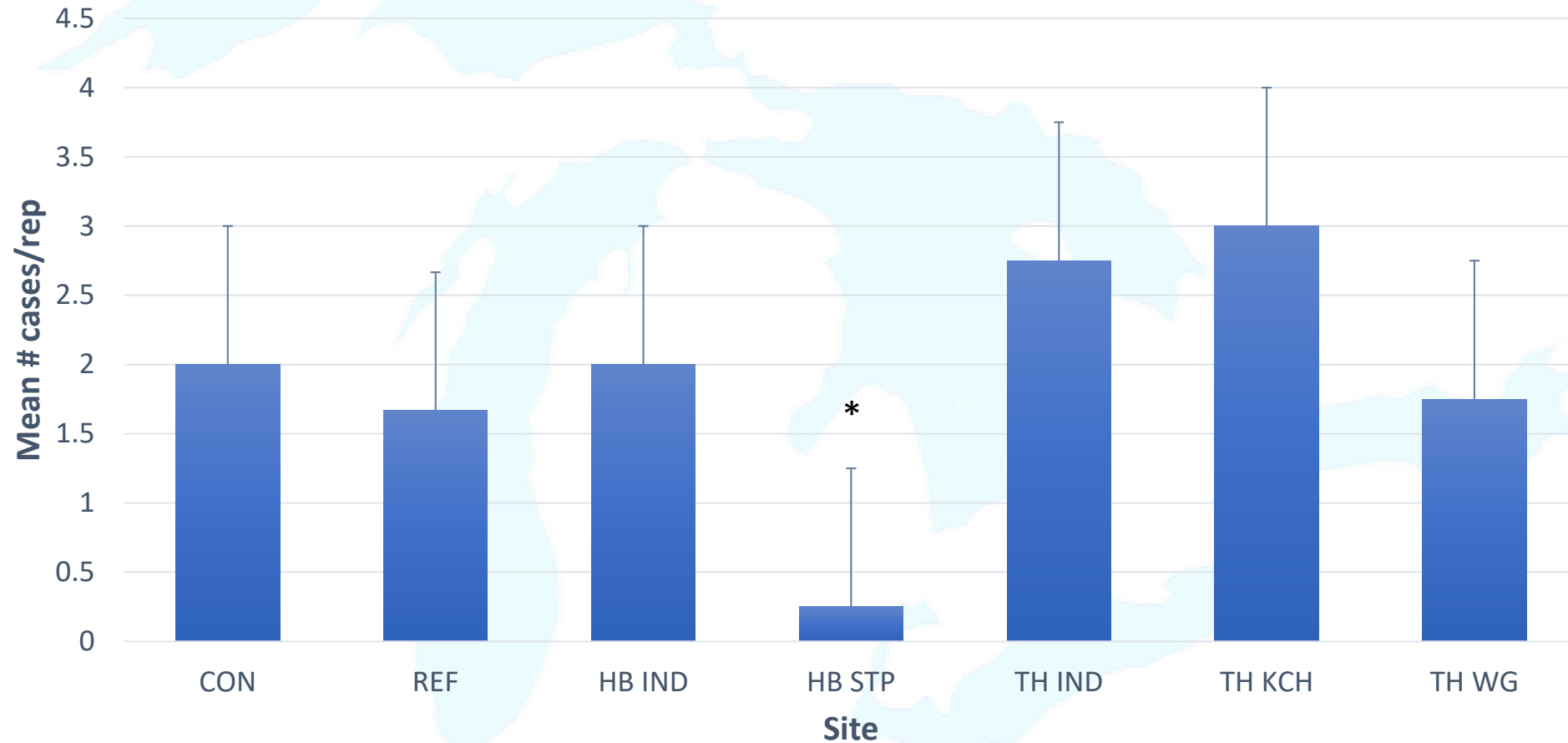
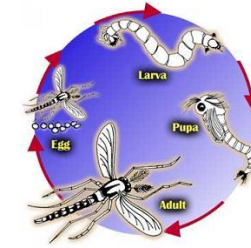
Chronic Results - *Chironomus*



Chronic Results - *Chironomus*

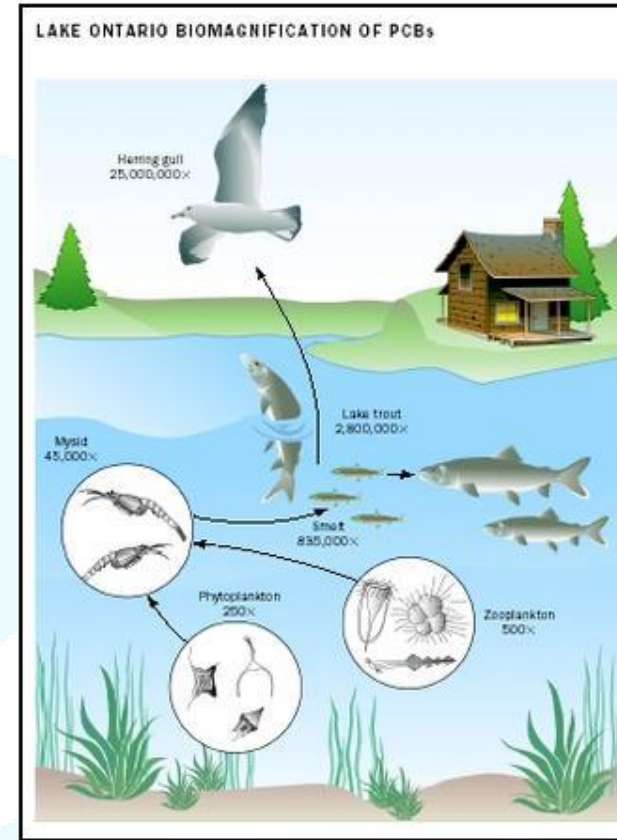


Chronic Results - *Chironomus*



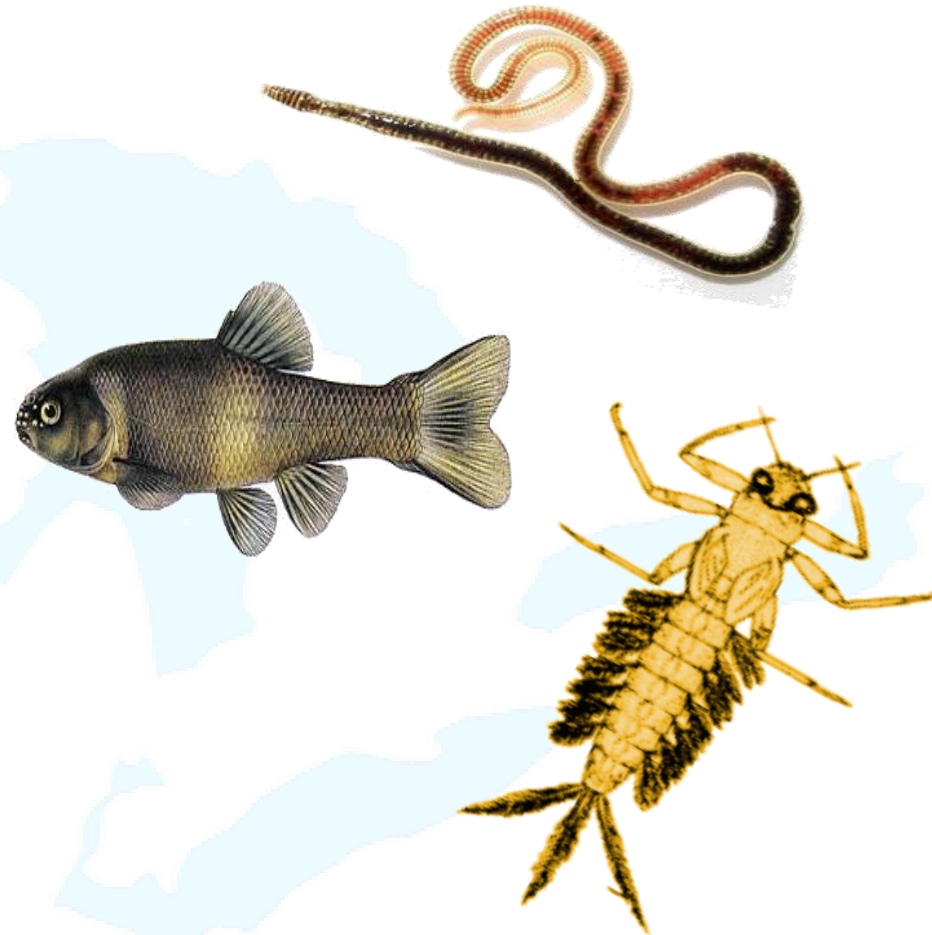
Bioaccumulation

- Certain chemicals persist in aquatic systems, may accumulate in tissues of aquatic organisms
- Exposure to bioaccumulative compounds may be through water, sediment, or diet
- Extent of bioaccumulation dependent on:
 - trophic structure
 - sediment characteristics
 - chemical characteristics of pollutant
 - lipid content of organism
- Within the sediment quality tetrad, bioaccumulation can indicate potential risks to higher level consumers



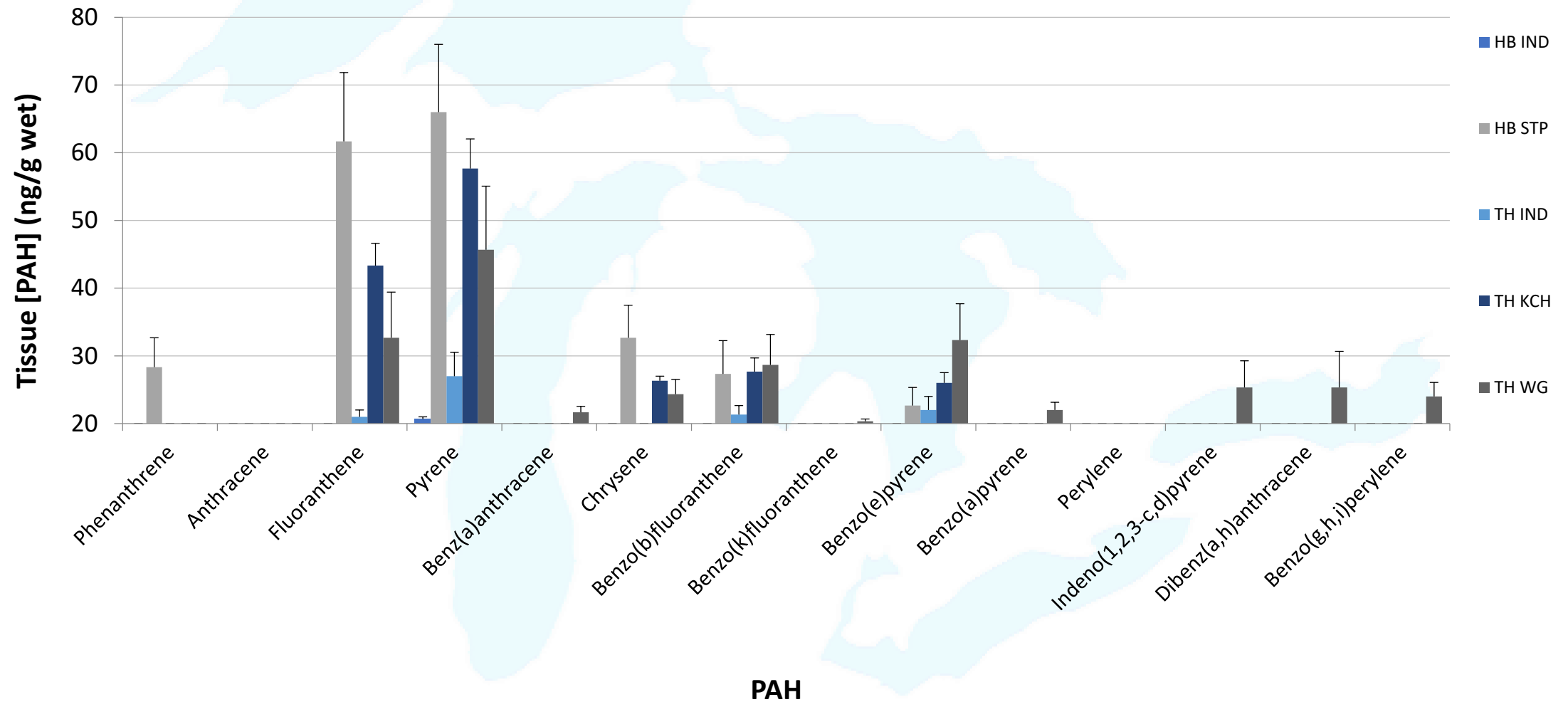
Methods

- 28-day laboratory bioaccumulation test:
 - mayfly nymph (*Hexagenia* spp.)
 - fathead minnow (*Pimephales promelas*)
 - oligochaete (*Lumbriculus variegatus*)
- Tissue submitted for chemical residue analysis
- In situ bioaccumulation assessed with forage and sport fish collections for tissue analysis (forthcoming data)



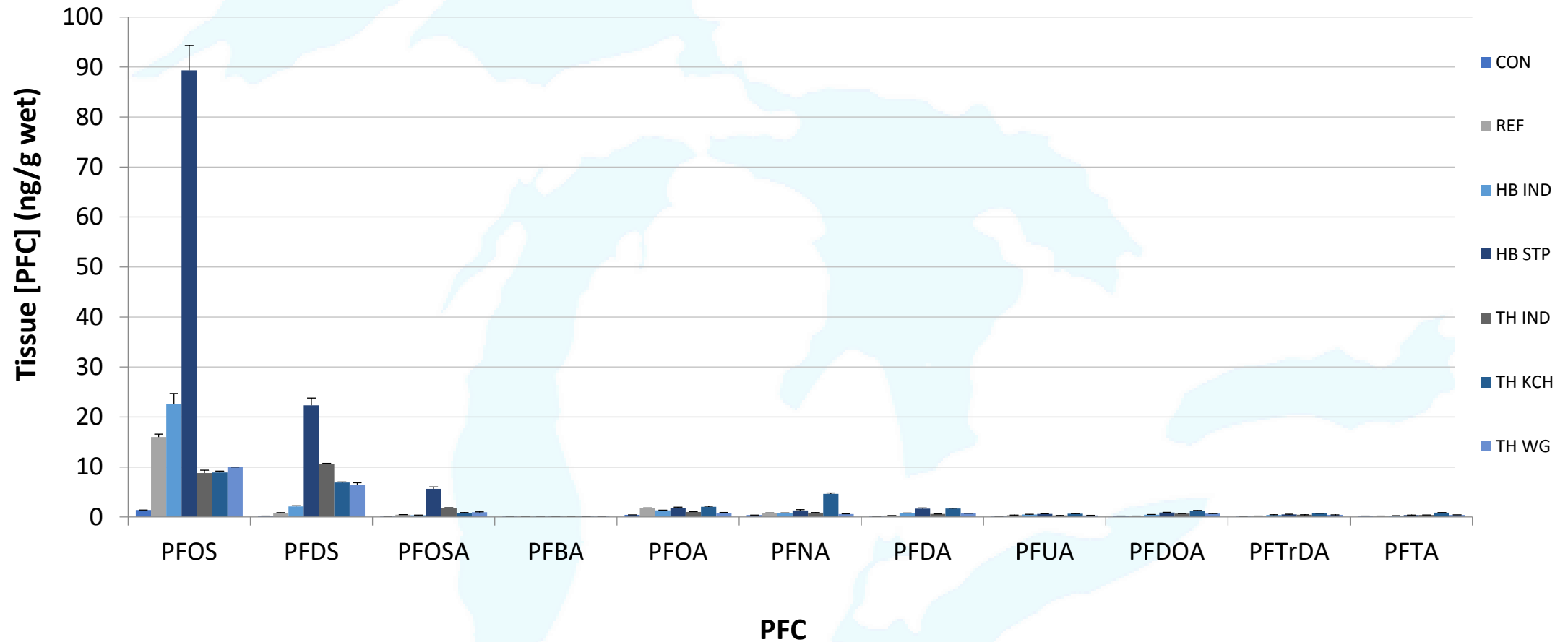


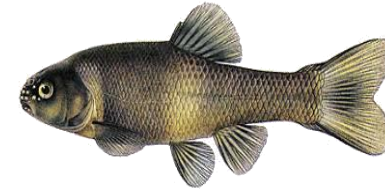
Results – Polycyclic Aromatic Hydrocarbons





Results – Perfluorinated Compounds





Results – Polychlorinated Biphenyls



Conclusions

- Degradation of Benthos BUI – removed in 2013 based on reductions in metals and organic contaminants below guidelines
- The current study identified toxicity in sediments collected near the outflow of the Humber Bay Sewage Treatment Plant, suggesting continued issues with combined sewer overflows and aging infrastructure
- Emerging contaminants such as elevated PFOS concentrations in Humber Bay STP samples pose an interesting question for the delisting process, and may need to be addressed under other programs
- Further lines of evidence (benthic community data) will be incorporated to determine current remedial state
- As this BUI has already been designated “unimpaired,” continued monitoring is necessary for the maintenance of sediment quality.

Acknowledgments

- NSERC CREATE Great Lakes
- University of Guelph
- Ontario Ministry of Environment – Laboratory Services Branch & Environmental Monitoring and Reporting Branch



NMDS of STN 1364 Historic Benthic Communities

