

Contemporary Bioaccumulation in Lake Erie: Results from the Great Lakes Fish Monitoring and Surveillance Program

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Great Lakes Fish Monitoring and Surveillance Program

GLFMS

Elements:

1. Open Lake Trends Monitoring

- Monitor contaminant trends in whole fish (trout and walleye)
- 50 size-selected fish collected from each lake
- Alternate between near and offshore sites every year
- 10 composites containing 5 fish each.
- Yearly Mega-composites created after 2008 integrating all 50 fish collected for each lake

2. Lake of the Year

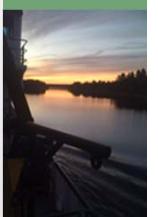
- Bioaccumulation/food web structure
- CSMI Schedule

3. Emerging Chemicals of Concern

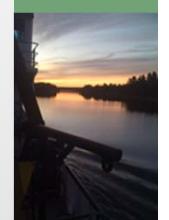
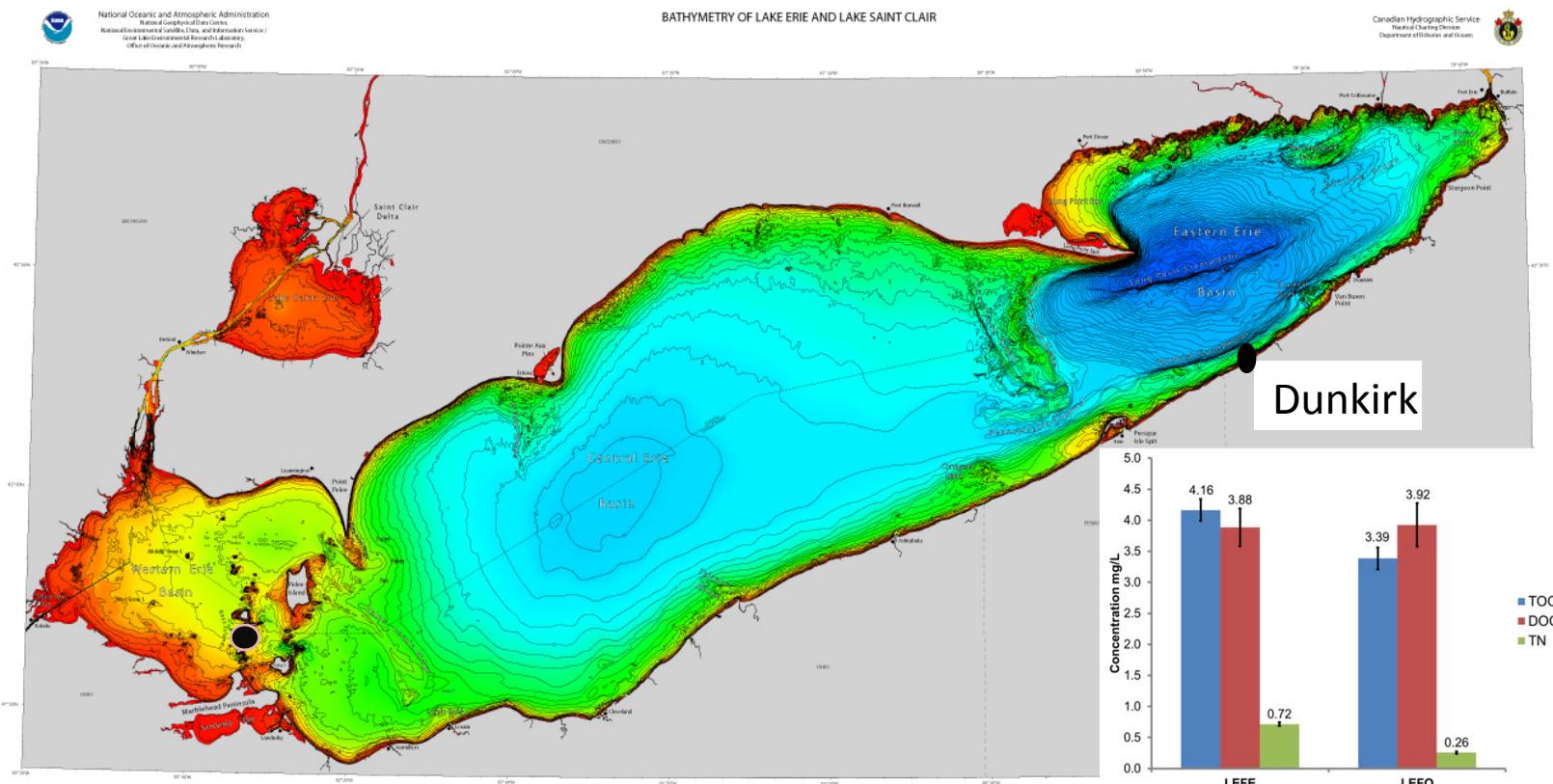
- New chemical discovery and monitoring



GLFMSp Sites



Lake Erie GLMSP Sites



GLFMSP Lake of the Year

Top to bottom lake snapshot

Contemporary bioaccumulation and energy flow

- Surficial Sediments
- Water
- Invertebrates
- Mussels
- Forage fish
 - NY DEC and Ohio DNR
- Top predator fish
 - NY DEC and Ohio DNR
 - Individuals

Lake Superior in 2011

Lake Huron in 2012

Lake Ontario in 2013

Lake Erie in 2014

Lake Michigan 2015

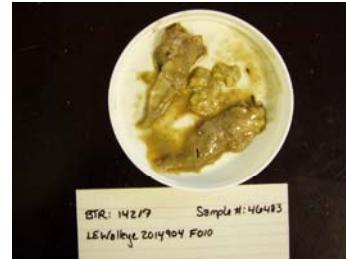


GLFMSP Lake of the Year

Top to bottom lake snapshot

Analyses

- Mercury
- Emerging contaminants – (i.e. perfluoroalkyl acids, BFRs)
- Stable Isotopes of N and C
- Fatty Acids
- Stomach Content (top predator fish)



Lake Superior in 2011

Lake Huron in 2012

Lake Ontario in 2013

Lake Erie in 2014

Lake Michigan 2015



GLFMS Lake Erie Collections

Invertebrates (US EPA Lake Guardian)

- Oligochaetes (Dunkirk)
- Amphipods
- Snails (MBI)
- Mayflies (MBI)
- Chironomids
- Zooplankton (500µm, 200µm, 153µm)
- Picoplankton (<10µm)
- Mysis

Abiotic (US EPA Lake Guardian)

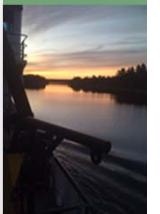
- Water
- Surficial Sediments

Forage Fish (NY DEC, Ohio DNR)

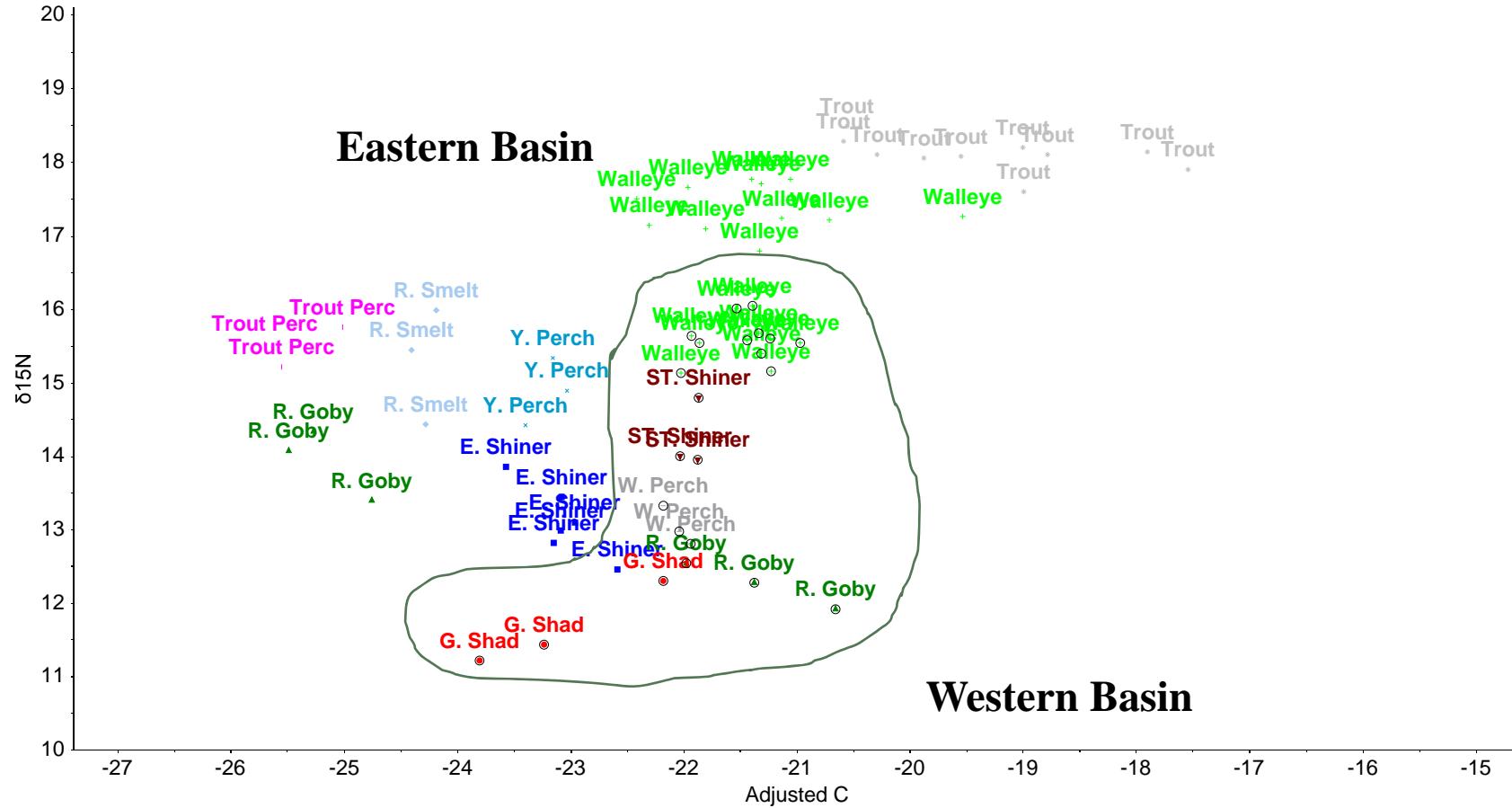
- Round Goby
- Rainbow Smelt (Dunkirk)
- Emerald Shiner
- Yellow Perch
- Trout Perch (Dunkirk)
- Spottail Shiner (MBI)
- Gizzard Shad

Top Predator (NY DEC, Ohio DNR)

- Walleye
- Lake trout (Dunkirk)



Stable Isotopes of N and C in Lake Erie

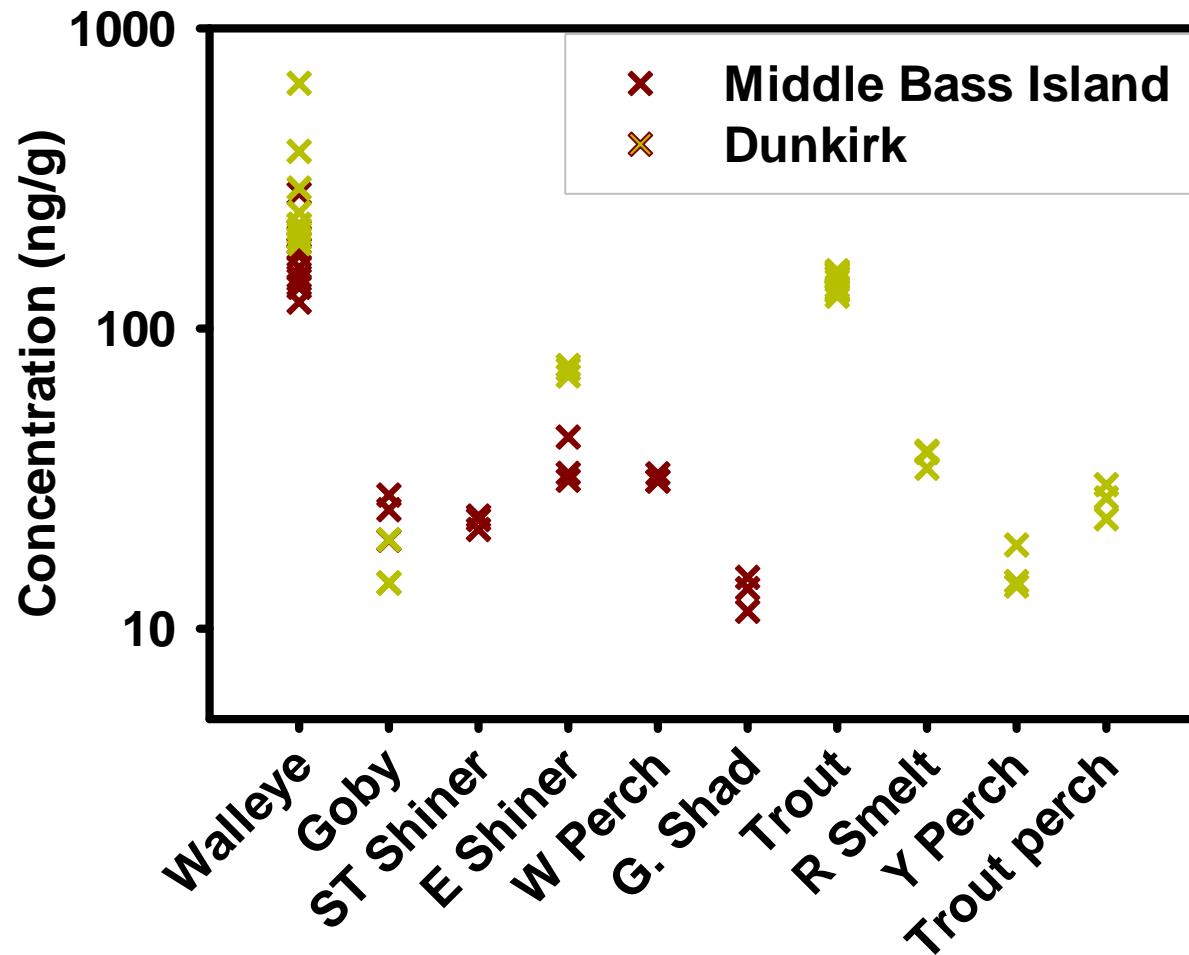


$\delta^{13}\text{C}$ values adjusted for lipid content (Post, D.M., et.al., 2007. *Oecologia* 152, 179–189)

Lower food web components currently being processed



Lake Erie Fish Hg Summary



Lower food web components currently being processed



Age Length Relationship

Lake Huron Port Austin

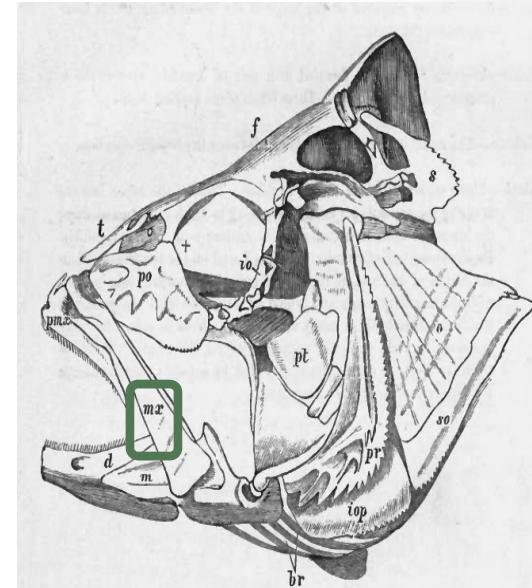
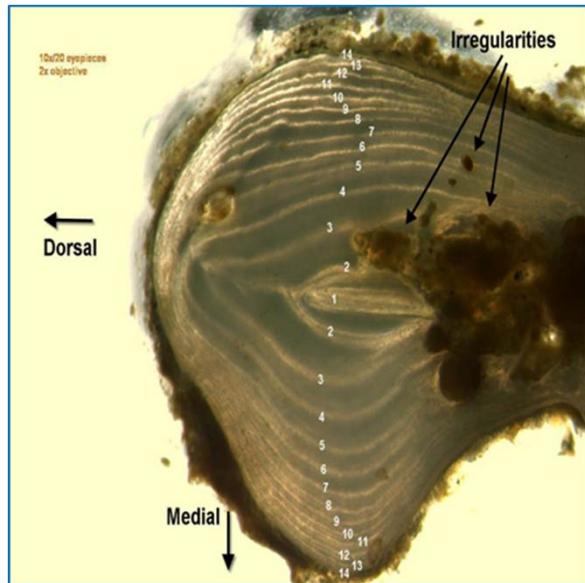


Maxillary Bone Aging

MI DNR developed a new aging technique using the maxillary bone

Advantages

- Accurate and quick to process
- Limited fluid loss compared to removing otolith
- Performed prior to compositing fish



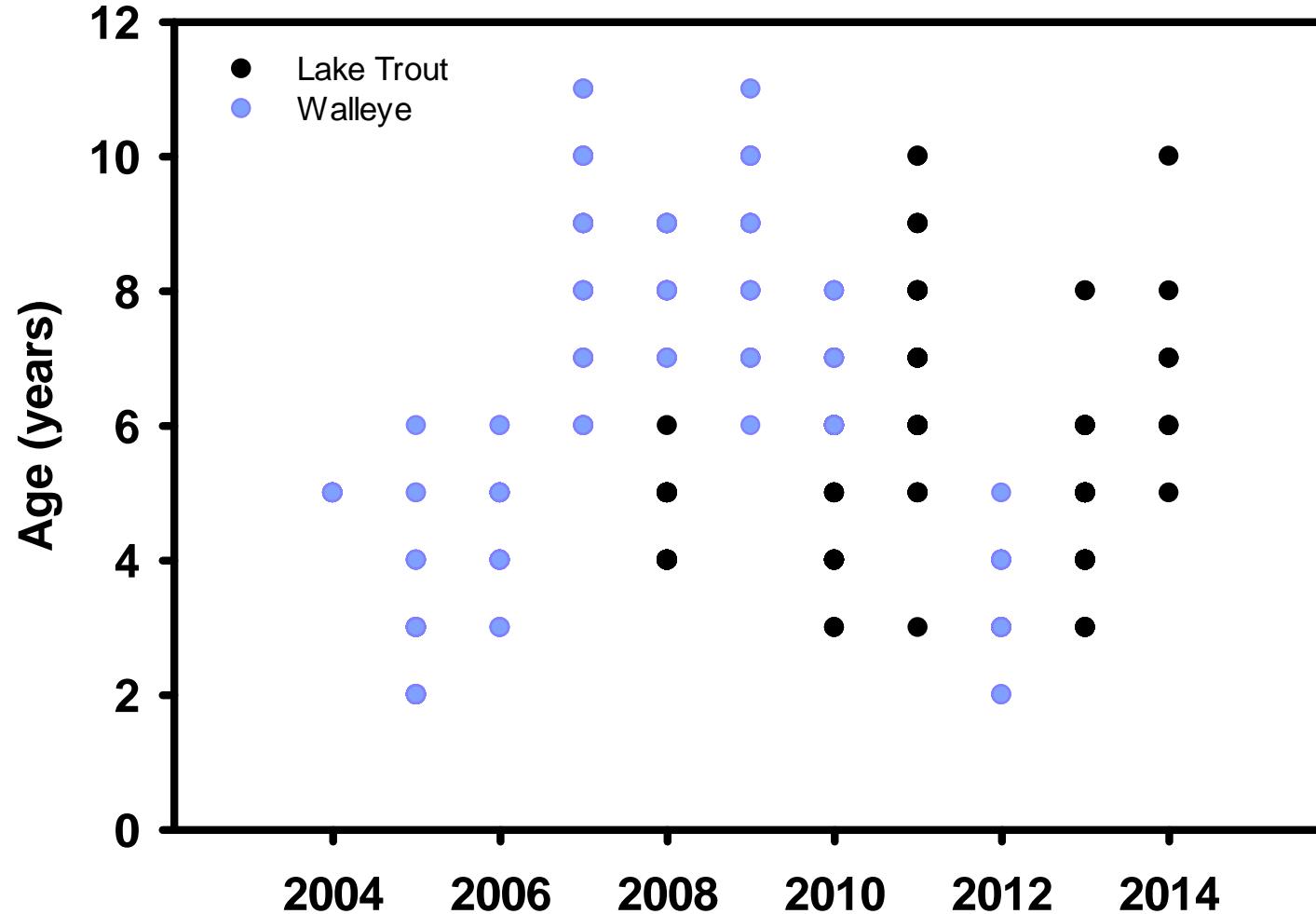
Skeleton of Head of a Perch.

f, frontal.	pt, posttympanic.
t, turbinal.	s, suprascapula.
po, preorbital.	o, opercle.
io, infraorbital ring.	so, subopercle.
mx, maxillary.	pr, preopercle.
pr, preopercle.	ip, interopercle.
m, mandible.	br, branchiostegal rays.
d, dentary bone.	

Fish head parts, 1889, Fauna of British India, Sir Francis Day



Lake Erie Trout and Walleye Age Summary

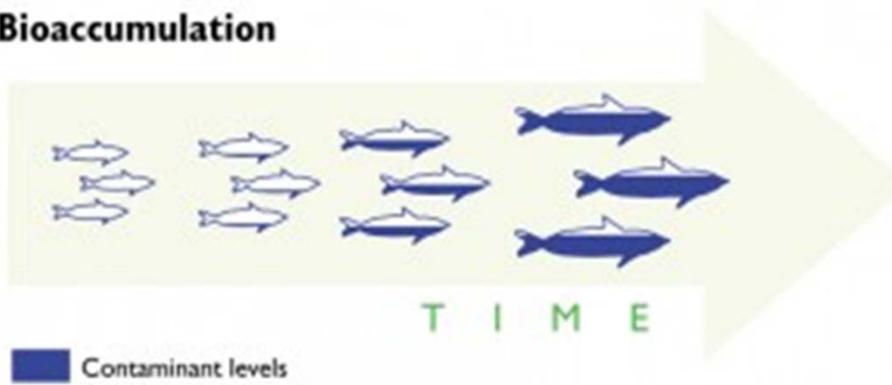


Monitoring Contaminant Trends

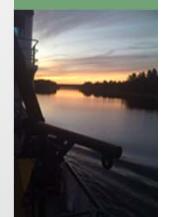
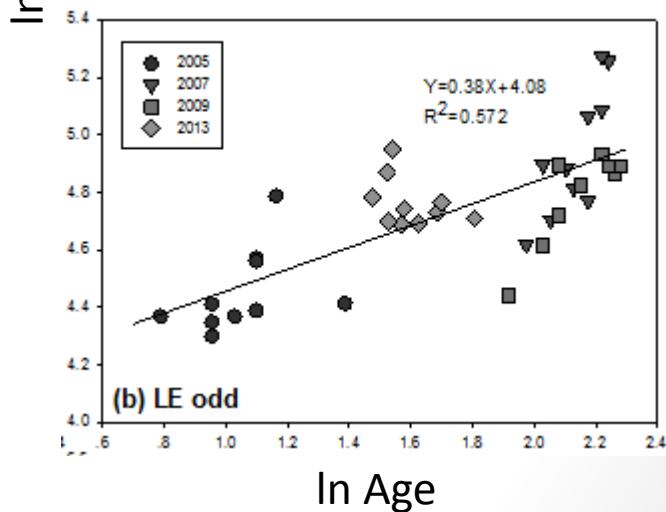
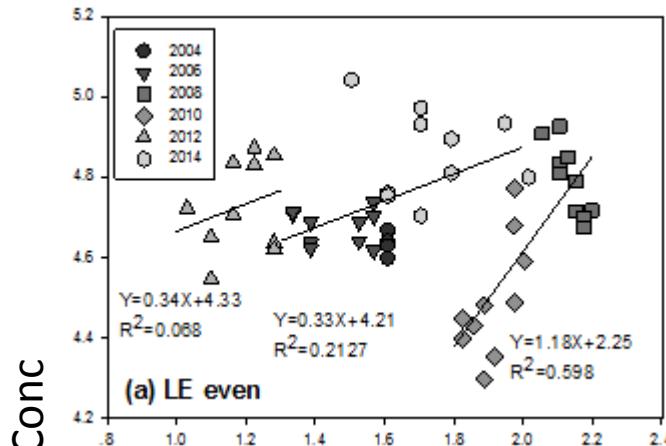
When the size/age relationship breaks down temporal trends are no longer valid or at least complicated by different contaminant exposure times.

<http://mercurypolicy.scripts.mit.edu/blog/?p=499>

Bioaccumulation

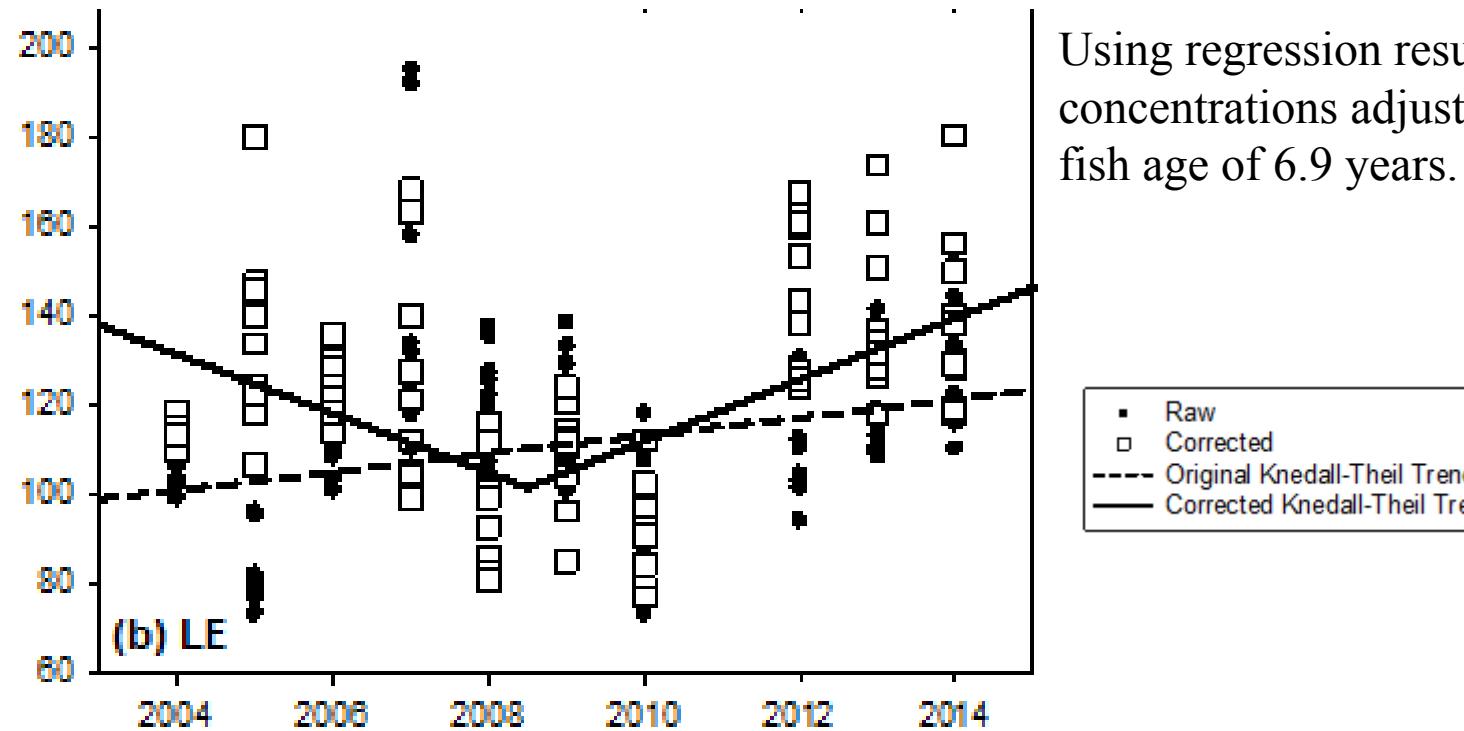


Homogenize data empirically

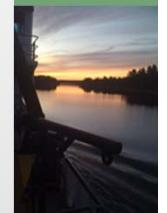


Monitoring Contaminant Trends

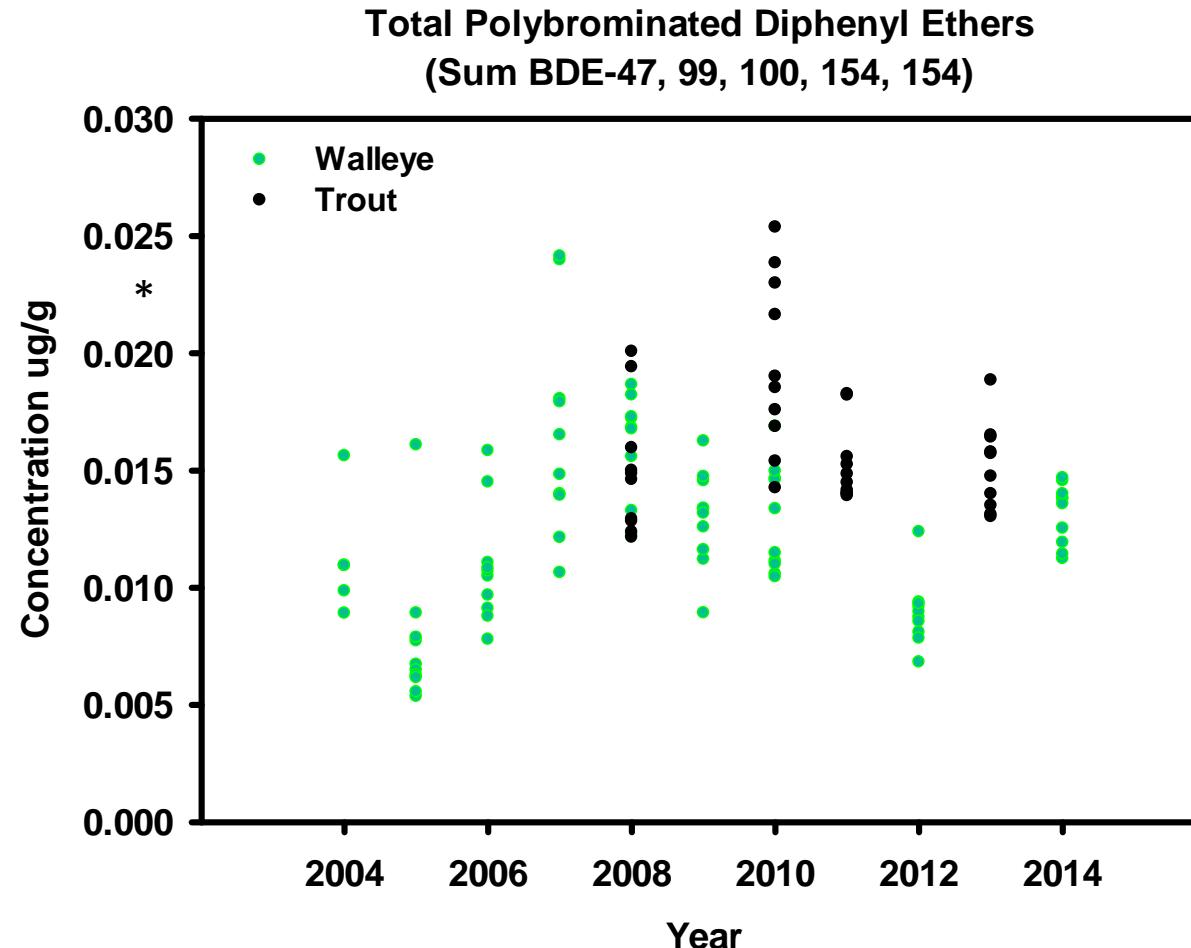
Apples to Apples



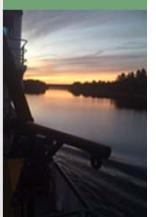
Zhou, C., Zhou, H., Johnson, T., Crimmins, B., Hopke, P., Holsen., T., *Mercury temporal trends in top predator fish of the Laurentian Great Lakes from 1999 to 2014: are global mercury inputs affecting the Great Lakes ecosystem?* ES&T submitted.



Organohalogen Evaluations Underway



* Data not age adjusted



Lake Erie Emerging Chemical Profiling

Emerging chemical screening and discovery

Script searching archived data files (chemical fingerprint database)

Fakouri Baygi, S., Crimmins, B.S., Hopke, P.K., Holsen, T.M. (2016) Comprehensive Emerging Chemical Discovery: Perfluorinated and Polyfluorinated Compounds in Lake Michigan Trout. *Environmental Science and Technology*, 50, 9460-9468.

Universal application to HRMS data (APGC and UPLC)

Crimmins, B.S., Xia, X., Hopke, P.K., Holsen, T.M., A Targeted/non-targeted Method for Perfluoroalkyl Carboxylic Acid and Sulfonate Analysis in Whole Fish using Quadrupole Time of Flight Mass Spectrometry and MS^e (2014) *Analytical and Bioanalytical Chemistry* 406, 1471-1480.

Comprehensive e-chemical screening using 2-dimensional GC coupled to a high resolution mass spectrometer (GCxGC-HRT)

Chemical contaminant database development using high resolution mass spectrometry (**Fish Fingerprints**)



Questions

