# Lake Michigan 2015 CSMI Field Year Overview

**Paul Horvatin**

**U.S. EPA Great Lakes National Program Office**

**LMMCC Fall Meeting**

**October 28, 2015**

# I. CSMI Overview

# II. 2015 Lake Michigan CSMI Surveys

- Lake MI Tributary PCBs, Brominated Flame Retardants, OPEs, Atrazine
- GLFMSP: Integrated assessment of ecosystem status and contaminant cycling
- Distribution, abundance and movement of nutrients and biota across a nearshore-offshore gradient
- Lake Michigan Benthos

# Coordinated Science Monitoring Program (CSMI)

# CSMI Objective

**An integrated, demand-driven Great Lakes Coordinated Science Initiative based on the knowledge needs of federal departments, provinces, states, First Nations, Tribes, Municipalities, and other stakeholders.**

# Why A Great Lakes Coordinated Science Initiative?

A Great Lakes Coordinated Science Initiative is setting the direction for future freshwater science by:

1. Aligning freshwater science with policy results
2. Establishing a focus for governance and management of freshwater science, based on multi-agency integration and capacity
3. Identifying priorities for an integrated and collaborative science program based on the knowledge needs
4. Ensuring alignment of science to support policy and operational needs, legal mandates and national and international commitments for water now and in the future

# Attending Agencies, Organizations, Programs

- U.S. EPA GLNPO
- U.S. EPA ORD Duluth
- U.S. Army Corps of Engineers
- USGS
- NOAA
- U.S. Fish and Wildlife Service
- Environment Canada
- Fisheries and Oceans Canada
- Agriculture and Agri-Food Canada
- Walpole First Nations
- Ontario Ministry of Environment and Climate Change
- Ontario Ministry of Natural Resources
- Ontario Ministry of Agriculture, Food and Rural Affairs
- Great Lakes Fishery Commission: Upper Great Lakes Management Unit
- Binational Toxics Strategy
- LAMP Coordinators
- Lake Erie Millennium Network
- LMMCC
- Council of Great Lakes Governors
- Council of Great Lakes Research Managers
- GLOS Board of Directors
- Binational Toxics Strategy
- GLEC Secretariat
- GLRRIN
- Council of Great Lakes Research Managers
- Illinois Environmental Protection Agency
- Michigan Department of Natural Resources and Environment
- Wisconsin Department of Natural Resources
- Minnesota Pollution Control Agency
- Indiana Department of Environmental Management
- New York Department of Environmental Control
- Pennsylvania Department of Environmental Protection
- Ohio EPA

# 4 Themes
# 18 Science Areas

## Human Health

- Source Water Protection
- Chemical Threats
- Microbiological Threats
- Water System Security
- Climate Change and Weather Impacts

## Ecosystem Health

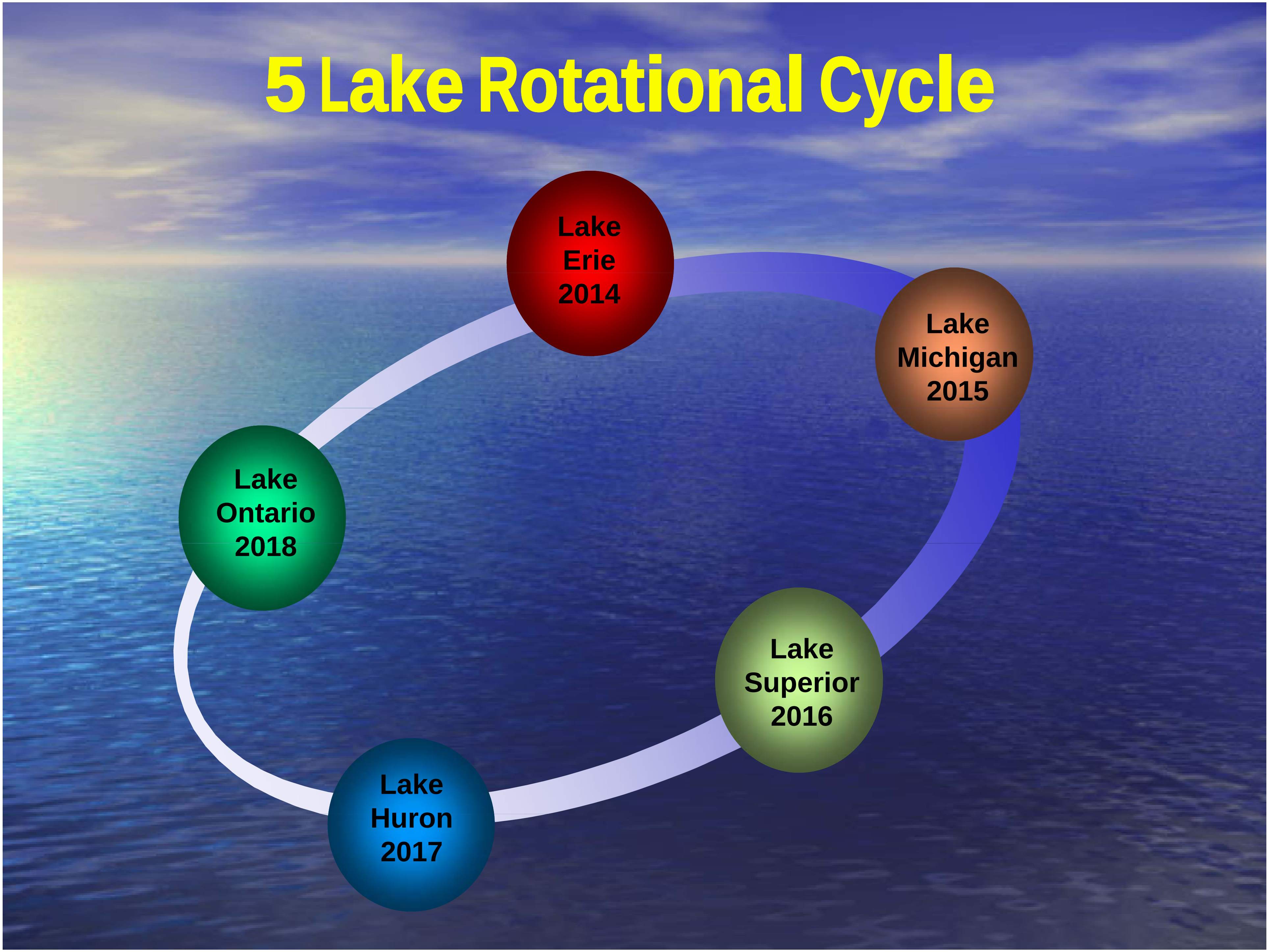
- Chemical Pollutant and Nutrient Impacts
- Impacts of Development
- Technology, Decision Tools & Information
- Biological Threats
- Climate Change Impacts

## Sustainable Use

- Quantitative Resource Inventories
- Water Cycle Models / Forecasting
- Aquatic Organisms and Aquatic Habitat
- Climate Change Impacts
- Socio-Economics
- Water Use & Efficiency

## Hazards and Environmental Prediction

- Understanding and Predicting Water Events
- Protection from Water Events


5 Lake Rotational Cycle
Lake Erie 2014
Lake Michigan 2015
Lake Superior 2016
Lake Huron 2017
Lake Ontario 2018

# Cooperative Science and Monitoring Initiative: What is it?

# Great Lakes Executive Committee

Binational Executive Committee

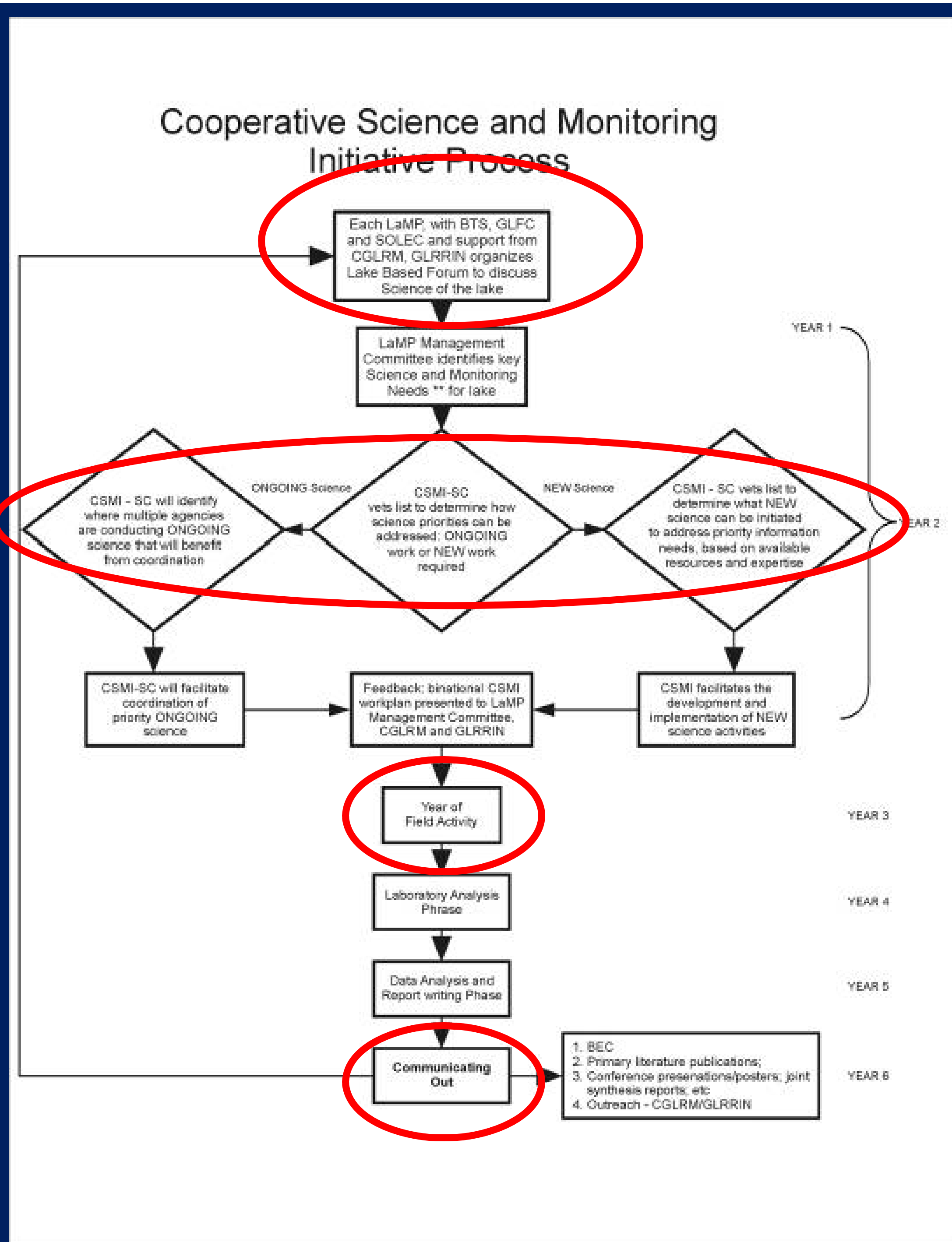
United States / Canada

| Basin-wide Programs | Lakewide Programs | Local Programs |
|---|---|---|
| ▪ State of the Lakes Ecosystem Conferences<br>▪ Cooperative Monitoring<br>▪ International Air Deposition Network<br>▪ Binational Toxics Strategy | ▪Lakewide Management Plans (LaMPs) | ▪Remedial Action Plans for Areas of Concern |

# Background

- Cooperative Monitoring Initiative (CMI) started in 2002 to coordinate monitoring
  - Simple premise: focus resources on a few key issues on one lake each year
- Expanded mandate to include research coordination with monitoring
- In 2009, connecting channels (including St. Lawrence) were added to CSMI process
  - Connecting channel addressed with downstream lake
  - Only issues that affect downstream lake will be included
- CSMI follows a 5 year rotational cycle
- CSMI does NOT set priorities

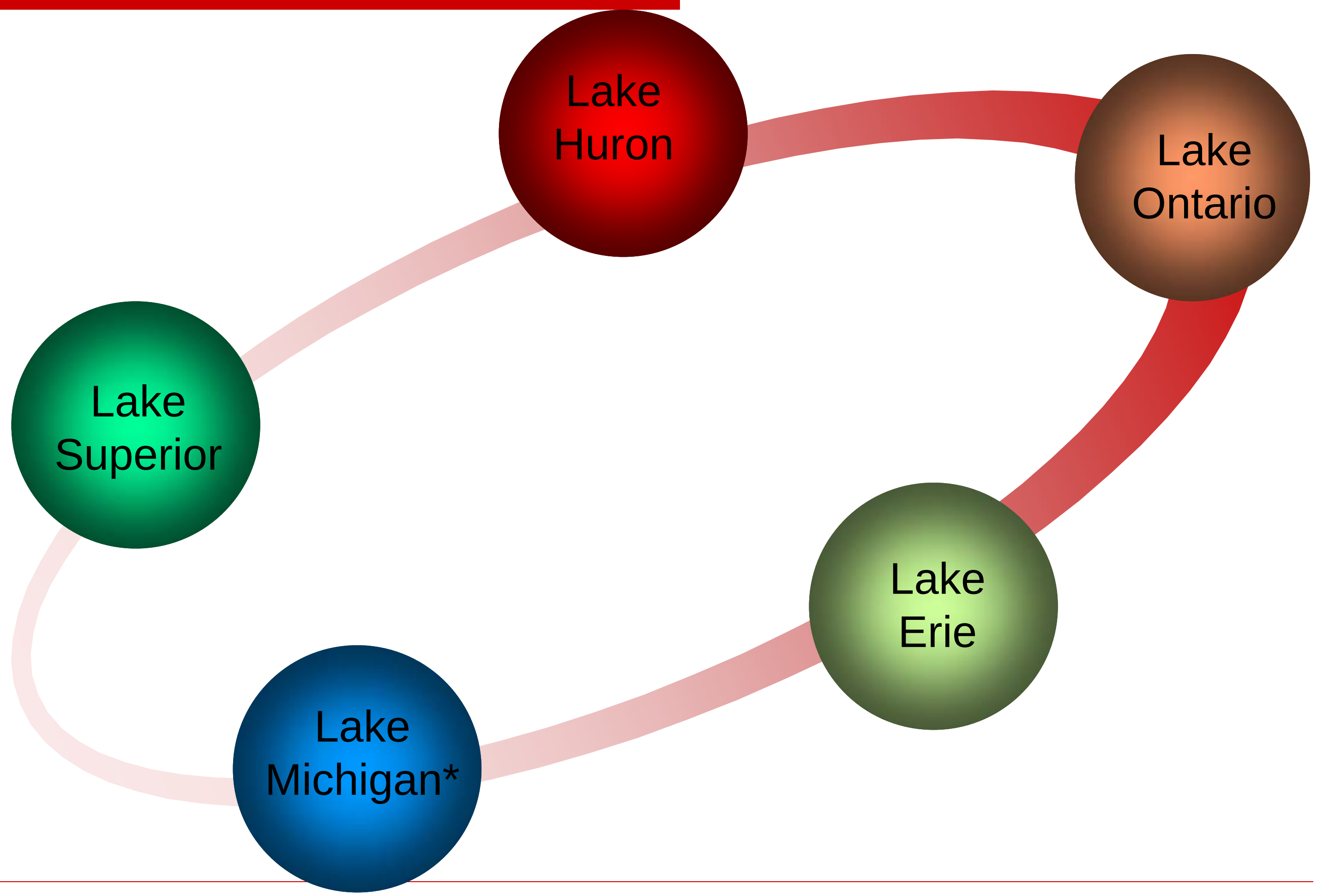
# CSMI Process:



# CSMI Steering Committee Membership

- Co-Chaired by EC and EPA-GLNPO
- Members:
  - DFO
  - MOE
  - MNR
  - EC
  - USGS
  - NOAA
  - USFW
  - EPA-GLNPO
  - EPA-ORD
  - States (as needed)

# Rotational Cycle



# *What is going on in ONE year?  2015*

- ☐ **Lake Huron** –Workshop to scope out issues
- ☐ **Lake Superior** – Planning year for field year
- ☐ **Lake Michigan** – Field Year
- ☐ **Lake Erie** – Data being worked up from field year
- ☐ **Ontario** – Reporting out

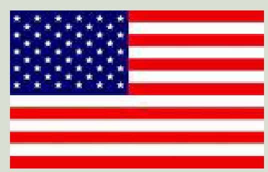
# Roles of Partners

- Workshop facilitation
- Communication in and out
- Assist with synthesis report – how do results address LaMP management priorities?
- Foster partnerships with academic community

# Our Partners

- IJC-CGLRM
- GLRRIN
- Sea Grant
- Industry
- NGO's

- Federal Agencies
- Provincial Agencies
- First Nations
- Regions
- Cities/Towns
- Academics



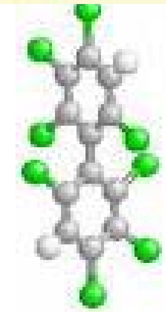
- Federal Agencies
- State Agencies
- Tribes
- Cities/Towns
- Academics

# Cooperative Science and Monitoring Initiative: Where are we?

*OBJECTIVE: Improve binational coordination of monitoring to achieve:*

- ☑ *Greater awareness*
  - *Sharing of technologies; enhanced networking; continued feedback to LaMP working groups*
- ☑ *Optimization of programs*
  - *Consensus among experts on project design; evaluation of new technologies; joint work planning and scheduling*
- ☑ *Improved reporting*
  - *Intercomparison studies (nutrients, trace organics in water and fish); data exchange; joint workshops and reporting*
- ☑ *Efficiencies*
  - *Extensive piggy-backing on cruises, surveys; sharing of sample extracts*

# Lake Michigan 2010



- CSMI Programs:
  - –Understanding nearshore issues:
    - role of nutrient inputs and/or cycling to cladophora growth
    - spatial variability in nutrient concentrations in the nearshore areas
  - –Understanding the role of invasives on the decline of the lower food web
  - –Status of contaminants in Lake Michigan waters, tributaries and sediment

- National Coastal Condition Assessment

# Lake Michigan CSMI Identified Needs

- Extension of Lake Michigan Mass Balance contaminant measurements – tributaries, water, food web where possible
- Nearshore -> Offshore nutrient and energy fluxes
- Tributary loading

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# Contaminants

- Contaminants in the food web – Clarkson University as part of Great Lakes fish contaminant monitoring
- University of Illinois-Chicago-contaminants in sediment
- Additional open water samples

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# Federal Partners

- USGS
  - Transects – spatially extensive
  - Tributary Loads
- NOAA
  - Transects – temporally intensive
  - Extending dreissenid and Diporeia long-term monitoring

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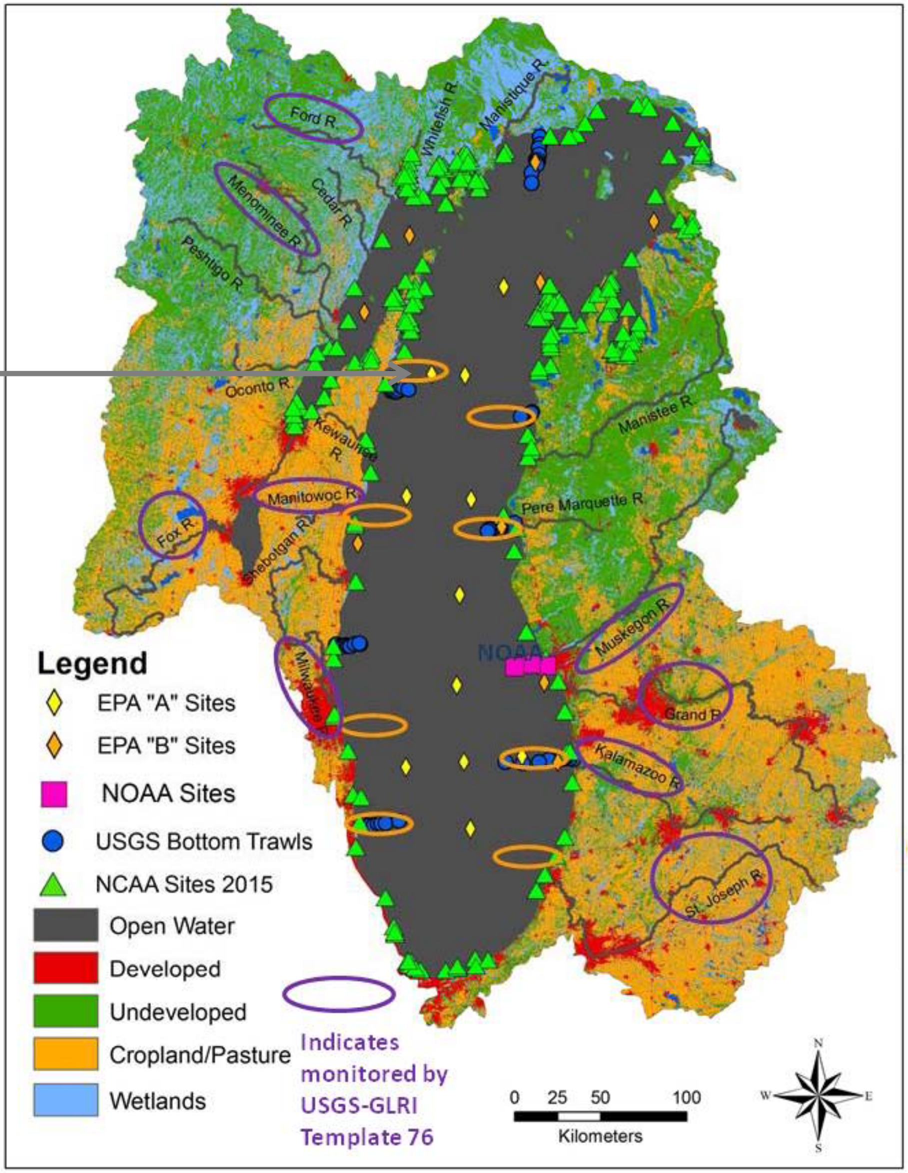
# Sampling Design

- Eight areas
- Within-area near-offshore gradient
- Target five depths per area
  - 15-130 m
- April/May, July, October



# Physical and Chemical Constituents in Water

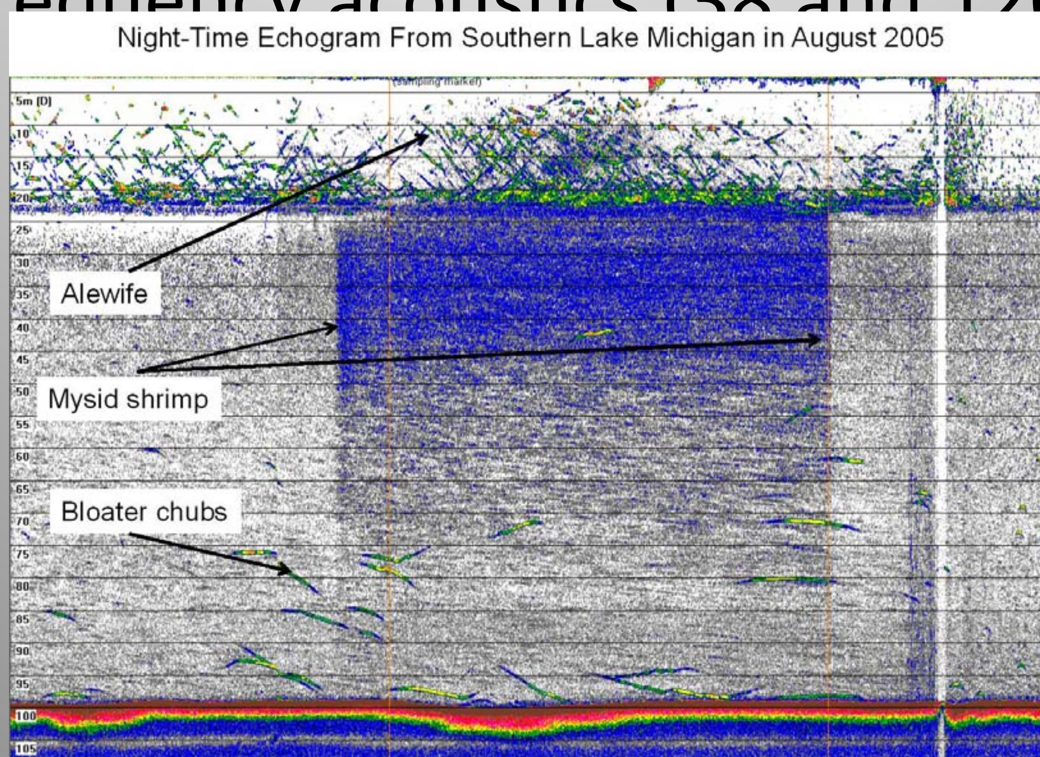
- TP, TDP, SRP, $NO_{3,}$ $NH_{4,}$ C, H, N
  - Multiple depths at each location
- Temp, cond., pH, DO, PAR, light transmittance
- CTD
  - 40-50 casts per month

# Biological Constituents in Water

- Chlorophyll-a
  - Same depths as nutrients plus CTD
- Phytoplankton
  - Whole water
  - Counts and sizes using Coulter or similar device
- Zooplankton
  - Vertical tows 153 micron mesh

# Mysids

- Vertical tows with 1 m diameter net
- Dual frequency acoustics (38 and 120kHz)

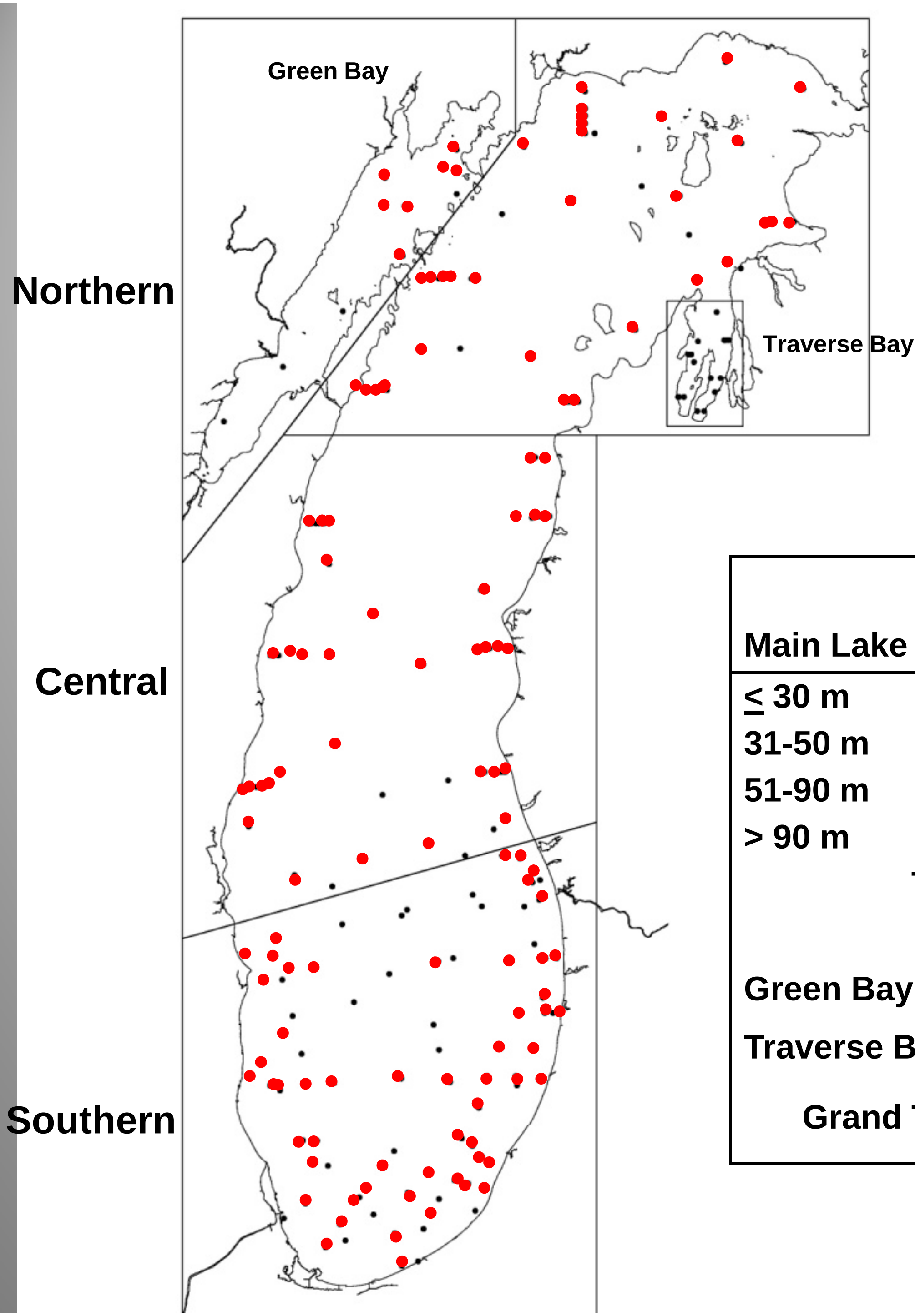


# Methods - Fish

- Abundance and community composition
  - Larval nets (when needed)
  - Bottom trawl
  - Midwater trawl
  - Acoustic
- Condition
  - [illegible] ergy dens[illegible]

# Federal Partners

- USGS
  - Transects – spatially extensive
  - Tributary Loads
- NOAA
  - Extending dreissenid and Diporeia long-term monitoring
  - Transects – temporally intensive




● Station sampled in 2010

| Main Lake | Survey Year 1994/95 | 2000 | 2005 | 2010 |
|---|---|---|---|---|
| < 30 m | 11 | 44 | 47 | 48 |
| 31-50 m | 17 | 37 | 37 | 37 |
| 51-90 m | 32 | 41 | 41 | 41 |
| > 90 m | 25 | 13 | 13 | 18 |
| Total | 85 | 135 | 138 | 144 |
| Green Bay | 5 | 8 | 8 | 7 |
| Traverse Bay | 1 | 21 | 21 | 0 |
| Grand Total | 91 | 164 | 167 | 151 |

## Biomass (g AFDW tissue) determined from length-weight relationships and size frequencies

| | Stations | |
|---|---|---|
| Depth Interval | Length-Weight | Size Frequency |
| ≤ 30 m | 5 | 14 |
| 31-50 m | 6 | 12 |
| 51-90 m | 12 | 15 |
| >90 m | 3 | 11 |
| Total mussels | 650 | > 5,000 |

## For mussels at 31-90 m

| Lake (Year) | AFDW (mg) of a 15-mm Quagga Mussel |
|---|---|
| Lake Ontario (2013) | 4.3 |
| Lake Michigan (2010) | 5.0 |
| Lake Huron (2012) | 7.0 |

# Pelagic study

**Detailed spatio-temporal study of nutrient flow, capture, and utilization by entire food web in southeastern Lake Michigan**

Goals:

- Understand role of early stratification in Lake function—larval fish and climate interactions
- Model development for tributary-nearshore-offshore nutrient and food web interactions.
- Provide temporal context for USGS/EPA transects

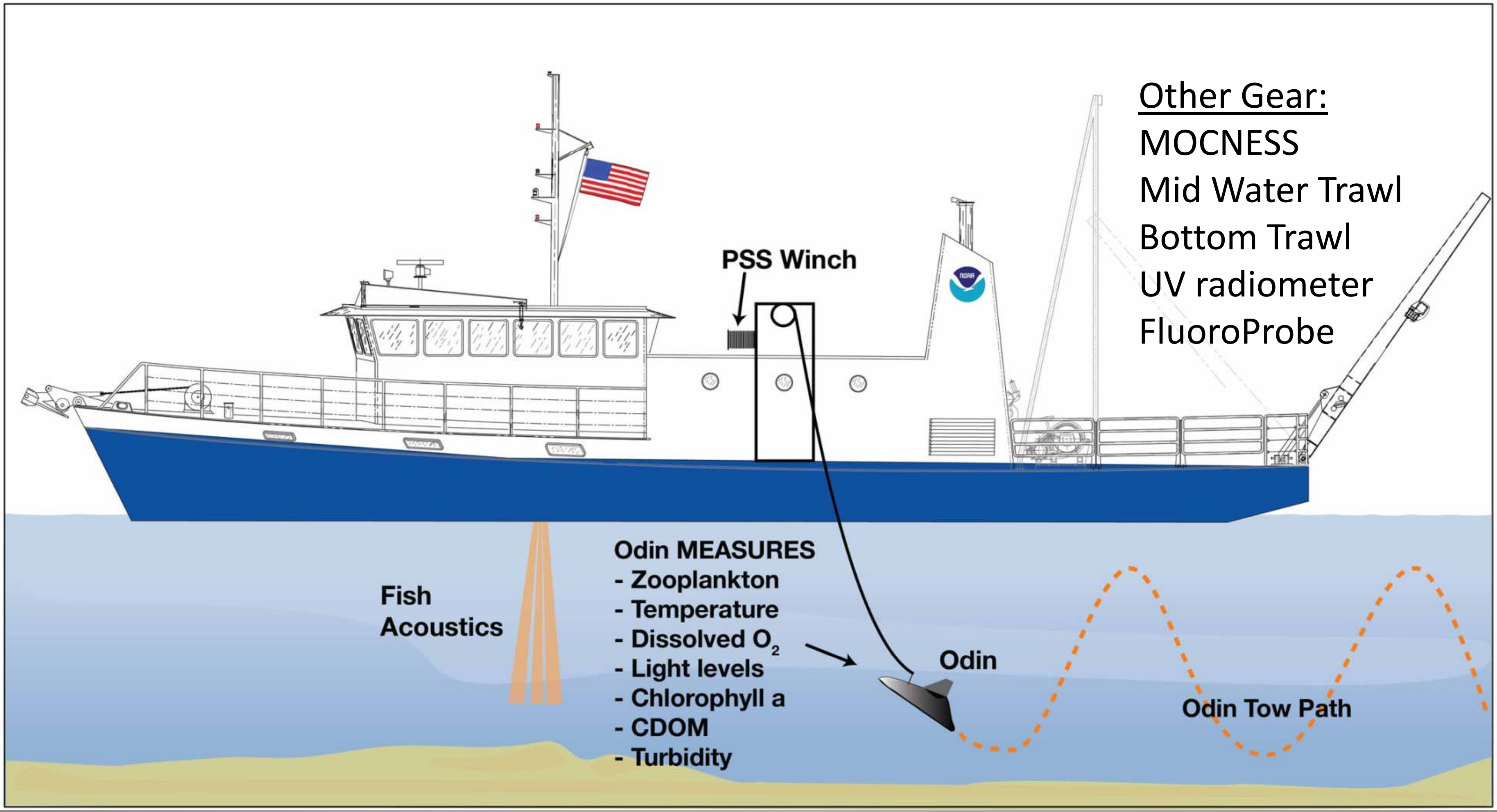
# Pelagic study

Spatial cruises (monthly in spring/early summer)

Coordination with biweekly/monthly LTR observations (M15, 45, 110)

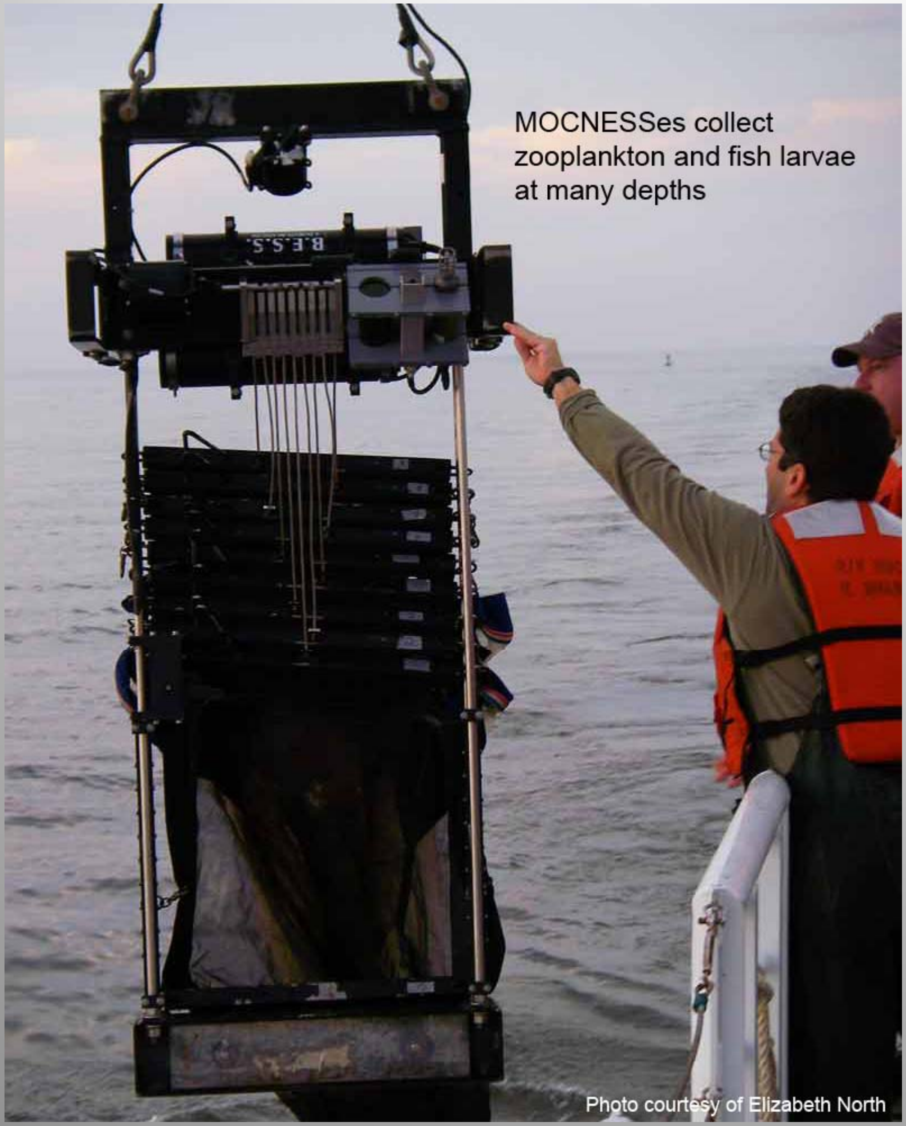
Enhanced observations on fish and nutrients

## Recent directions and technology: Spatial Studies & Microbes—spatial coupling of physical variables, nutrients and all food web components from microbes to fish over diel (day-night) cycle




On board measures include: nutrients as well as microbial food web abundance (microscopy and –omics), and function by GLERL Food Web Team and UM and CMU partners

# New purchase to improve spatial studies:
# 1-$m^2$ MOCNESS with laser strobe unit




<u>Fine-scale distribution of predators and prey:</u>

•Larval fish
•Bythotrephes
•Large and small zooplankton
•Mysis

# Lake Guardian

- Spring survey
- Summer survey
- Nutrient measurements

# Additional EPA-GLNPO monitoring

- Ship time – approximately 1 week/month
  - Tentatively scheduled for:
    - May 11 – 16
    - June 9 – 14
    - July 6 – 11
    - August – possible to add several days to summer survey
    - September 14 – 19
- Additional work to be done:

# Nearshore

- Triaxus tow of 20 m contour – 2014 and 2015
  - 2014 – partial tow of Lake Michigan, data not yet available
- Near Coastal Condition Assessment
  - 50+ stations
  - Nutrients, water quality, benthos, contaminants in fish
  - Perhaps additional stations and parameters

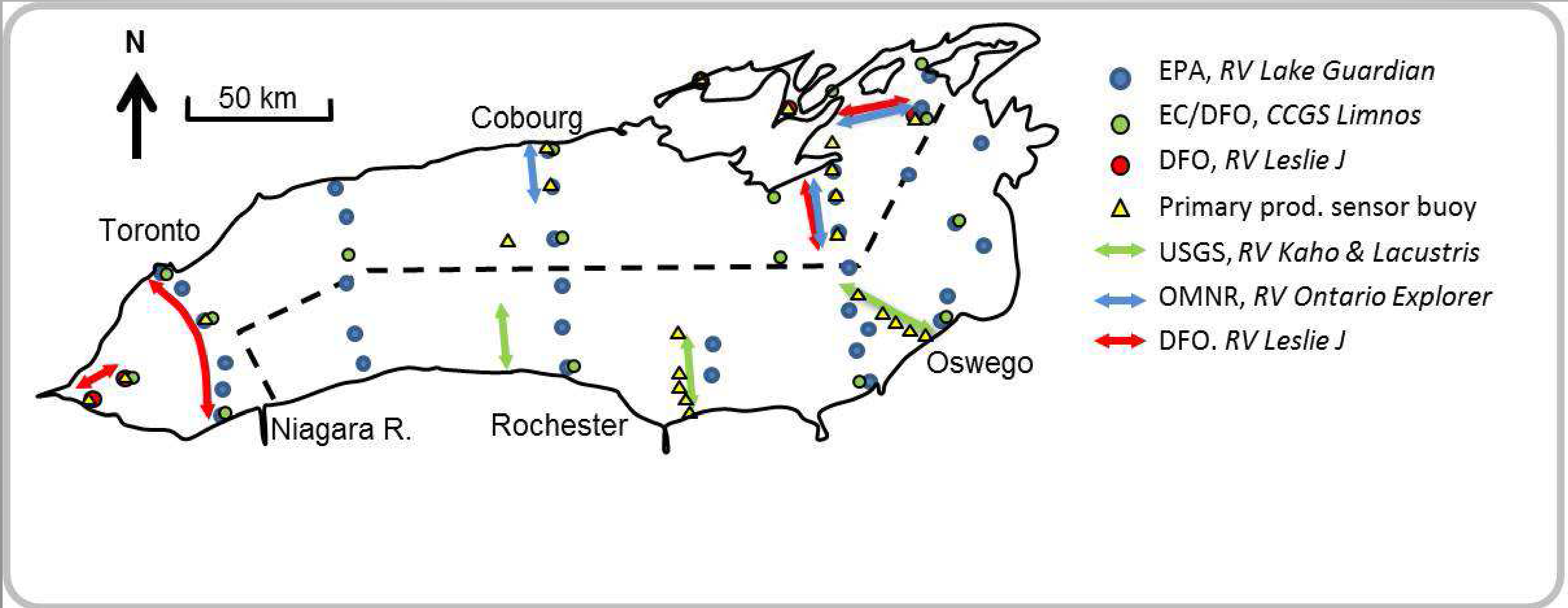
# Free oxygen primary production

- Continuing work begun in Lake Erie in 2014
- Several buoys with D.O. data loggers
- Need to determine best locations/areas of interest

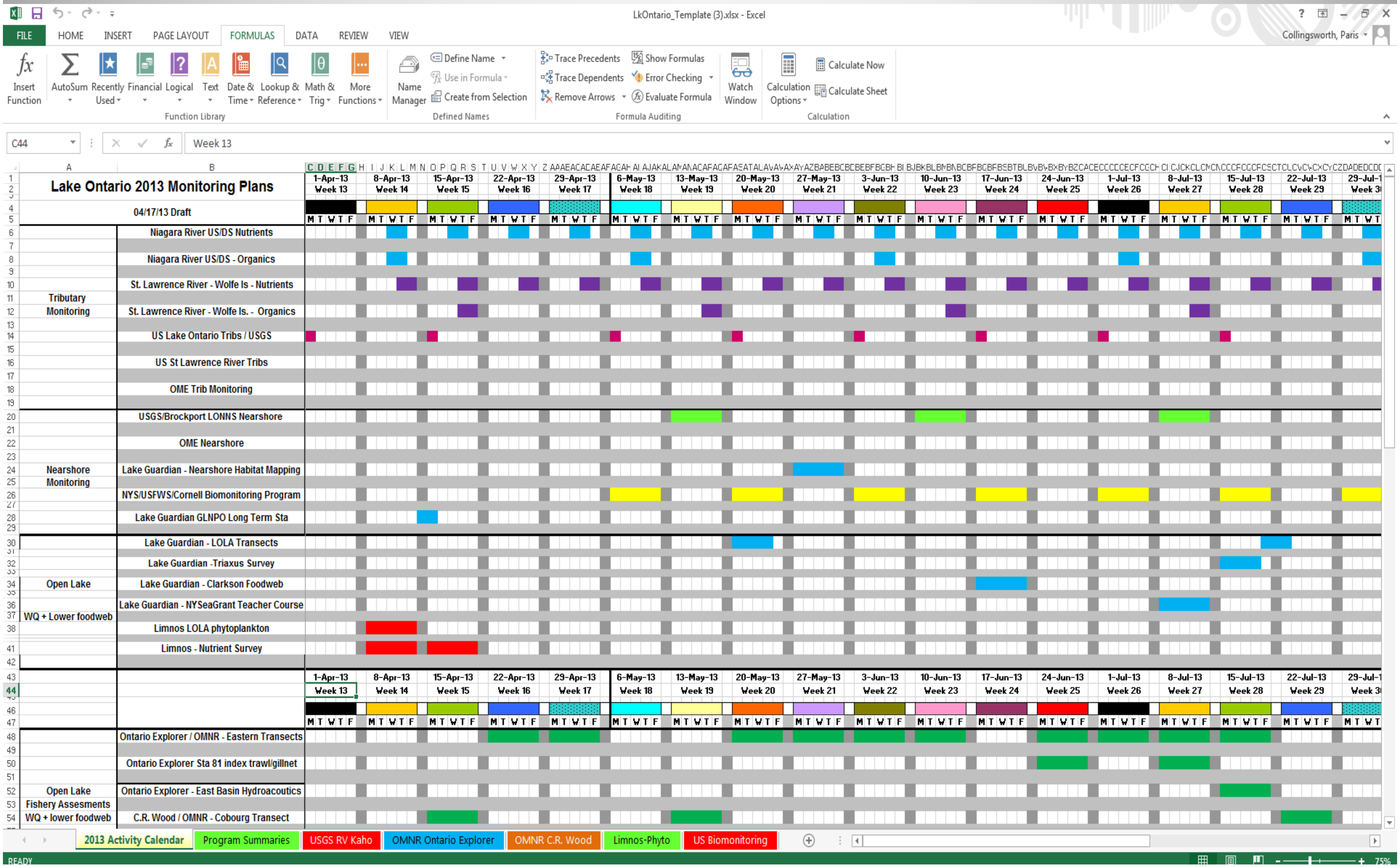
# Lessons learned from Lake Ontario

- Similar nearshore – offshore foodweb study in 2013
  - International cooperation
  - Prelimanary summaries are already public
- Planning and reporting started very early

# Lake Ontario food web study



# Lake Ontario coordination



# Lake Ontario reporting


## CSMI Supports Management Needs

The Cooperative Science and Monitoring Initiative (CSMI) is a binational effort that rotates through the Great Lakes on a 5-year cycle coordinating scientific monitoring and research to better understand the Great Lakes ecosystem. CSMI informs Great Lakes management programs such as Lakewide Action and Management Plans (LAMPs) and Great Lakes Fishery Commission's Lake Committees as well as provinces, states, tribes and Metis in support of US & Canadian Great Lakes Water Quality Agreement commitments. In 2013, the Lake Ontario effort took a collaborative approach to determine the source and fate of nutrients and food web production across trophic levels. Five research themes included:

- Nutrient loading and fate
- Nearshore and offshore linkages
- Dynamics of primary & secondary production
- Fish production, distribution & diet
- Trophic transfer & food web mass-balance

This research will address management and research priorities including nutrient loading and management, the role of invasive species, identifying energy pathways between offshore-and nearshore habitats, and the ability of the lake to sustain fisheries. **This progress report presents preliminary information; it should not be referenced and does not provide a complete representation of all CSMI or Lake Ontario related research.**

## Collaboration Is Key

This 2013 CSMI, system-wide investigation of Lake Ontario would not be possible without the direct and in-kind support contributed to CSMI 2013 from US Environmental Protection Agency (EPA), Canada Ontario Agreement (COA), Environment Canada (EC), New York State Department of Environmental Conservation (NYSDEC), US Geological Survey (USGS), US Fish and Wildlife Service (USFWS), Ontario Ministry of Natural Resources (OMNR), Fisheries and Oceans Canada (DFO), National Oceanic and Atmospheric Administration (NOAA), and academics from Cornell, University of Windsor, Buffalo State, University of Michigan, University of Buffalo, SUNY Brockport, Syracuse, SUNY ESF, Bowling Green, Clarkson, and Notre Dame.

## Thanks For Your Support

The tireless efforts of vessel crews, administrative, and technical operations staff were critical for ensuring a safe and productive work environment during 2013 in both laboratory and vessel settings. The EPA's *Lake Guardian* & Canadian Coast Guard research vessel *Limnos* and *Kelso* provided wide spatial sampling while the new vessels in the fleet, including the OMNR *RV Ontario Explorer* and USGS *RV Kaho*, sampled monthly along transects extending from nearshore to deep-water habitats. Smaller research vessels, such as the USGS *RV Lacustris* and DFO's *RV Leslie J.* played important roles collecting nearshore samples and filling in for offshore sampling when large vessels were unavailable.

A photo from the International Space Station highlights a late-summer "whiting event" in Lake Ontario Aug 24, 2013. These events occur at certain temperature and water acidity levels that cause fine particles of calcium carbonate to precipitate.

## Save the Date!

CSMI researchers will present more thorough assessments of Lake Ontario's changing ecosystem at the upcoming International Association of Great Lakes Research annual conference at Hamilton, Ontario on May 26-30, 2014. For more information visit www.iaglr.org.




## How we view CSMI

The recently updated Great Lakes Water Quality Agreement commits the United States and Canada to deliver a binational Cooperative Science and Monitoring Initiative (CSMI) for each lake on a five-year rotational basis to support Lakewide Action and Management Plans (LAMP) information needs. The 2013 Lake Ontario CSMI effort was collaboratively planned to meet management needs and science questions. The 2013 approach was developed through discussion among a broad spectrum of binational partner agencies and institutions with interest in Lake Ontario.

Wherever possible we coordinated 2013 efforts to take advantage of the many long-term agency sampling efforts already in place and projects funded outside the CSMI-framework. This resulted in an unprecedented lake wide, multi-trophic level, seasonal sampling effort of watershed, nearshore, and offshore habitats. The work could be broadly categorized under four themes: nutrient loading and fate; spatial distribution of primary and secondary production; fish abundance and behavior; and food web mass balance modelling. The design sampled nutrient loading, water quality, biodiversity, contaminants, lower trophic levels, invasive species, and fisheries to develop a mechanistic understanding of Lake Ontario ecology that informs the diverse interests of decision makers, the public, and scientists.

SUNY-Brockport and Canadian agencies continued research understanding how nutrients levels vary over the season in near shore habitats. This image, just north of Rochester, NY, illustrates how turbid river inputs remain close to shore, including the Genesee River plume (right side).

Herein we build on our first report (http://www.dec.ny.gov/docs/water_pdf/csmi2013progrpt.pdf), recognize our initial products, highlight select research, describe our path forward, and discuss future improvements. This effort is not possible without the collaborative effort and funding of the 25+ agencies and institutions involved.

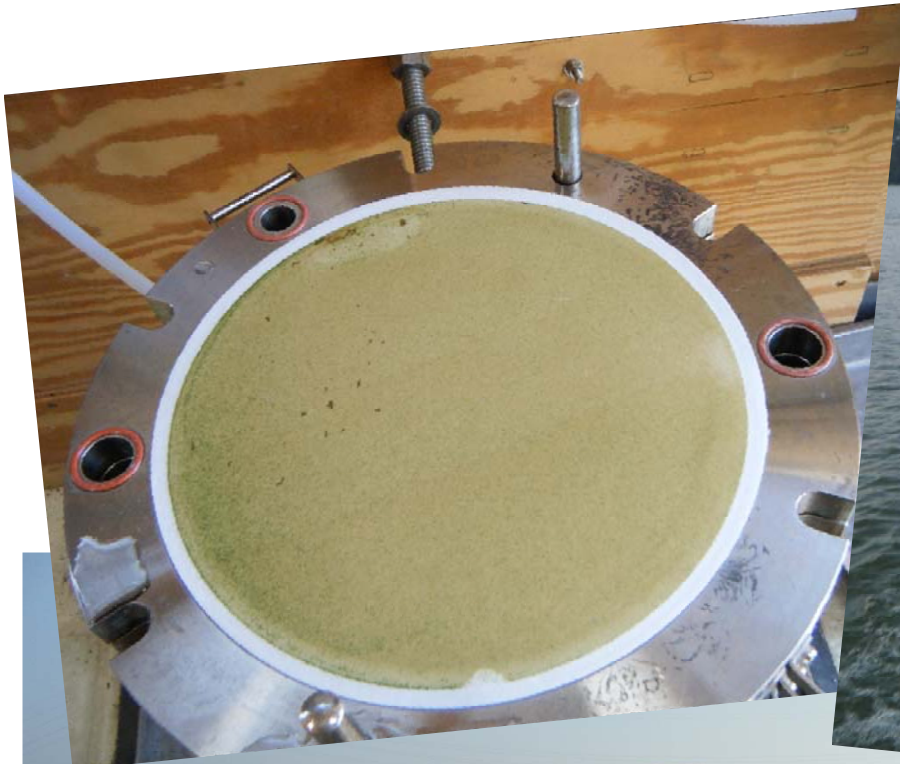
## Products to Date

| | | |
|---|---|---|
| Lake Ont. Tech. Committee (LOC), Pulaski, NY | Jan 2014 | 2 presentations |
| New York Chapter American Fisheries Meeting, Geneva, NY | Feb 2014 | 5 presentations |
| 2014 Great Lakes AOC RAP Implementation Workshop | Feb 2014 | 2 presentations |
| OMNR Food for Thought, Peterborough, ON | Mar 2014 | 1 presentation |
| COA 2013 Follow-up sampling, $141.9k, Johnson & Stewart | Mar 2014 | Funded |
| Int. Assoc. for Great Lakes Res. Annual Meeting, Hamilton, ON | May 2014 | 16 presentations |
| Lake Ontario Committee, Gr. Lks. Fishery Comm., Windsor, ON | Mar 2014 | 2 presentations |
| GLFC, Why Ontario alewife haven't collapsed, Stewart $121k | June 2014 | Full proposal |
| GLOS Data Management Proposal, $100k, Rudstam, et al. | Aug 2014 | Full proposal |

# 2015 Lake MI Tributary PCB Monitoring Objectives

- Characterize present-day water column contaminant loads and concentrations at five (5) of the original 11 Lake Michigan Mass Balance sampling sites.
- Contaminants of concern for this work include PCB, mercury, polybrominated diphenyl ether (PBDE), and other flame retardants including organophosphate (OPE) flame retardants.
- Estimate mass loading for each of the five sampled Lake Michigan tributaries.
- Compare present-day concentration and load estimates with those for 1994-1995 and 2005-2006.

# 2015 Lake Michigan Tributary PCB Monitoring Sites

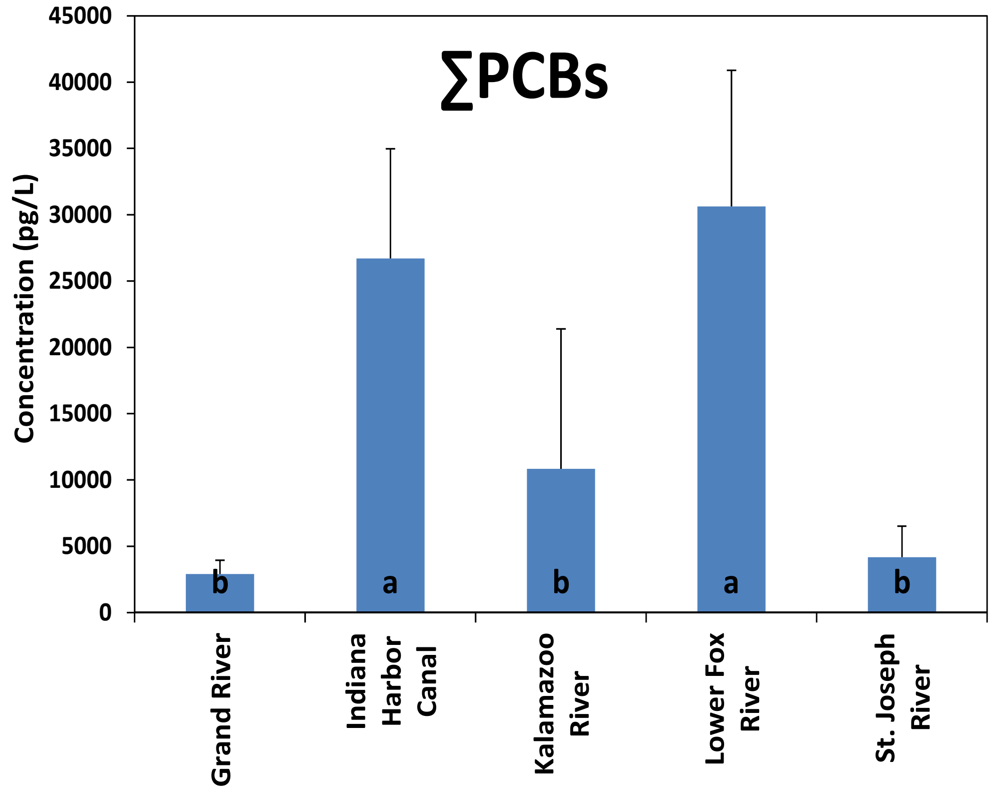


USGS

AXYS
4655
Glasswool: L6765-28
XAD: L13328-73

# PCBs in water

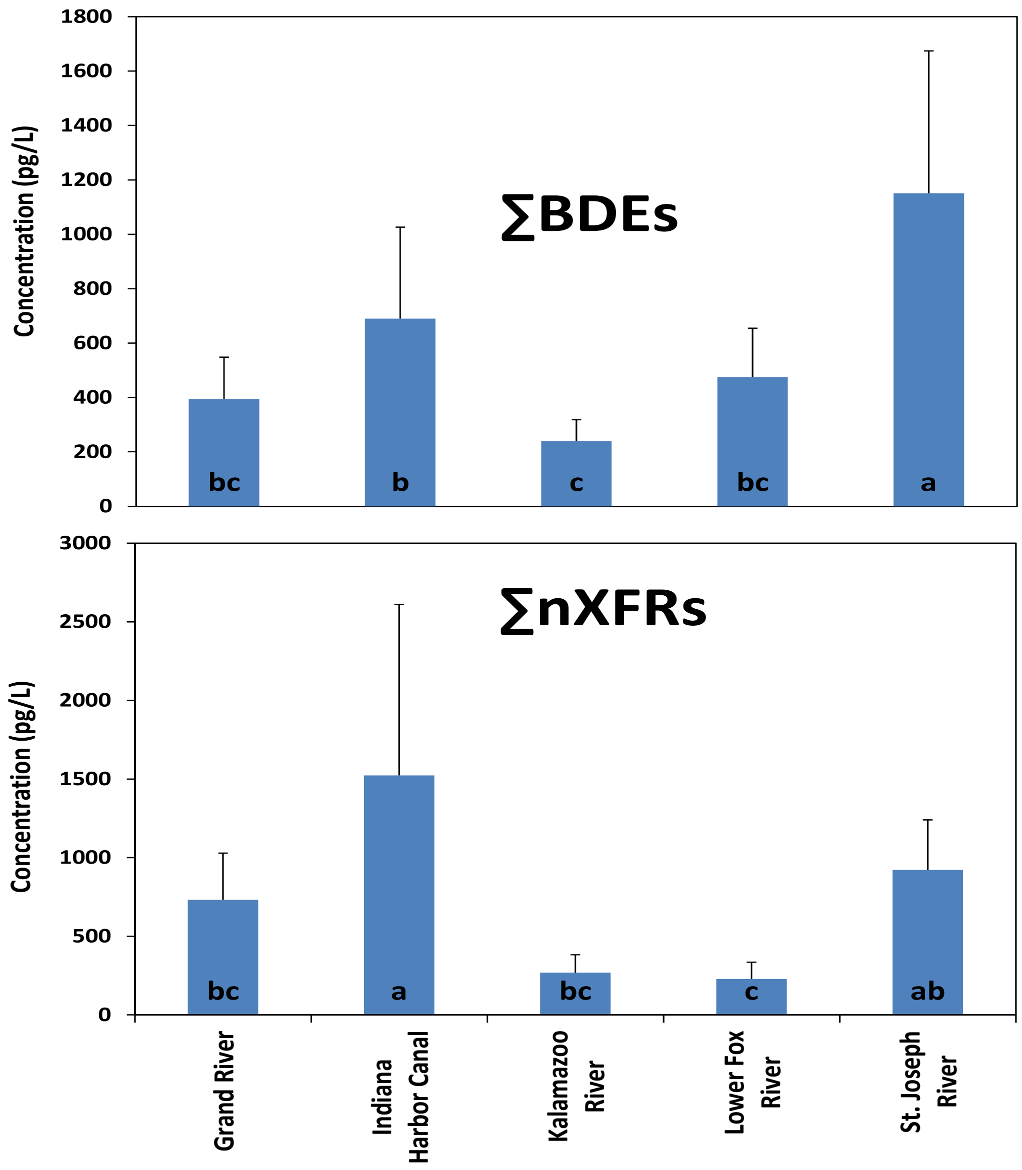
- PCBs concentrations in tributaries water ranged from 3,000 pg/L to 31,000 pg/L
- PCBs concentration are significantly higher in Indiana Harbor Canal and Lower Fox River than the other three rivers.




Note: Rivers that do not share a letter are significantly different at 95% confidence level.

# Brominated Flame Retardants

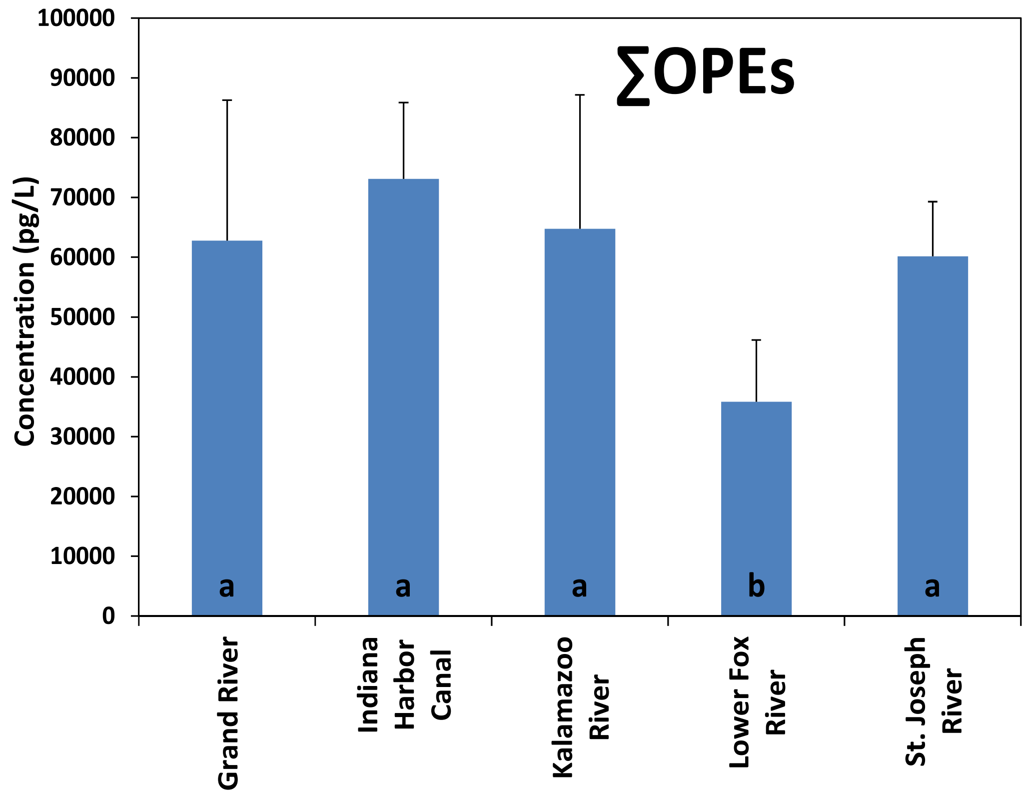
- For PBDEs, concentrations ranged from 240 pg/L to 1,150 pg/L and levels in St. Joseph river are significantly higher than in other rivers.
- For nonBDE flame retardants, the concentrations ranged from 230 pg/L to 1500 pg/L and Indiana Harbor Canal has the highest concentration




Note: Rivers that do not share a letter are significantly different at 95% confidence level.

# Organo Phosphate Esters

- OPEs are very abundant in water with concentration ranged from 36,000pg/L to 73,000pg/L
- OPE concentration is significantly lower in the Lower Fox River than in the other four rivers.

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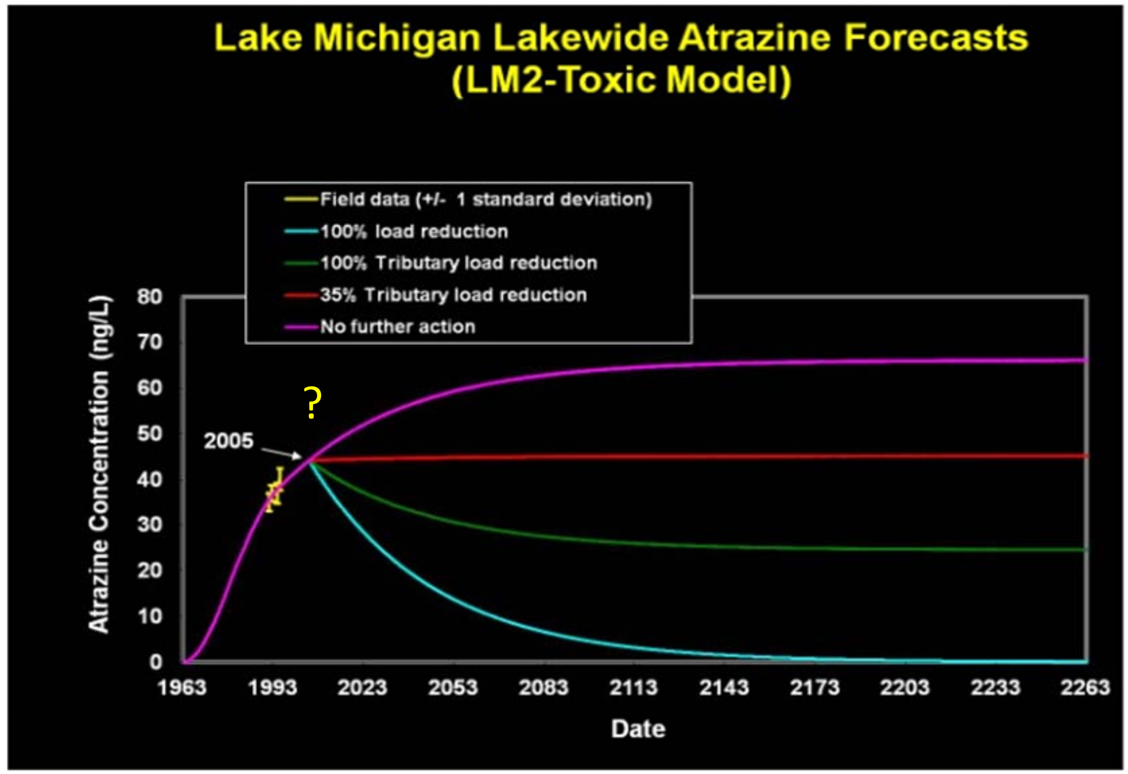
# Atrazine in open waters of Lake Michigan

Objective

Assess the present condition of atrazine concentrations in Lake Michigan and examine these results in comparison to model forecasts through a model post-audit.

11 EPA open water stations sampled in 2015 at 2 depths (middle epilimnion and middle hypolimnion)



# GLFMSP Lake of the Year (LOY): Integrated assessment of ecosystem status and contaminant cycling

Top to bottom snapshot

## Perform a detailed bioaccumulation study

- Water (dissolved and particulate)
- Phytoplankton
- Zooplankton
- Mussels
- Benthic macro invertebrates
- Forage fish
- Lake trout (individuals and composites)


Clarkson University
U.S. EPA GLNPO
NOAA Mussel Watch

# GLFMSP LOY: Datasets

## Water (dissolved and particulate matter)

<u>Legacy</u> - PCBs, PBDEs, OCPs

<u>Non-legacy</u> - Perfluoroalkyl carboxylic acids and sulfonated (PFOS, PFOA), pharmaceuticals

## Benthic and pelagic invertebrates, forage fish, mussels and trout

<u>Contaminants</u> - Mercury, PFOS/PFOA, PCBs (trout only), PBDEs, OCPs

<u>Ecosystem markers</u> - $^{13}C$ and $^{15}N$ stable isotopes, fatty acids, stomach contents (trout only), substrate video

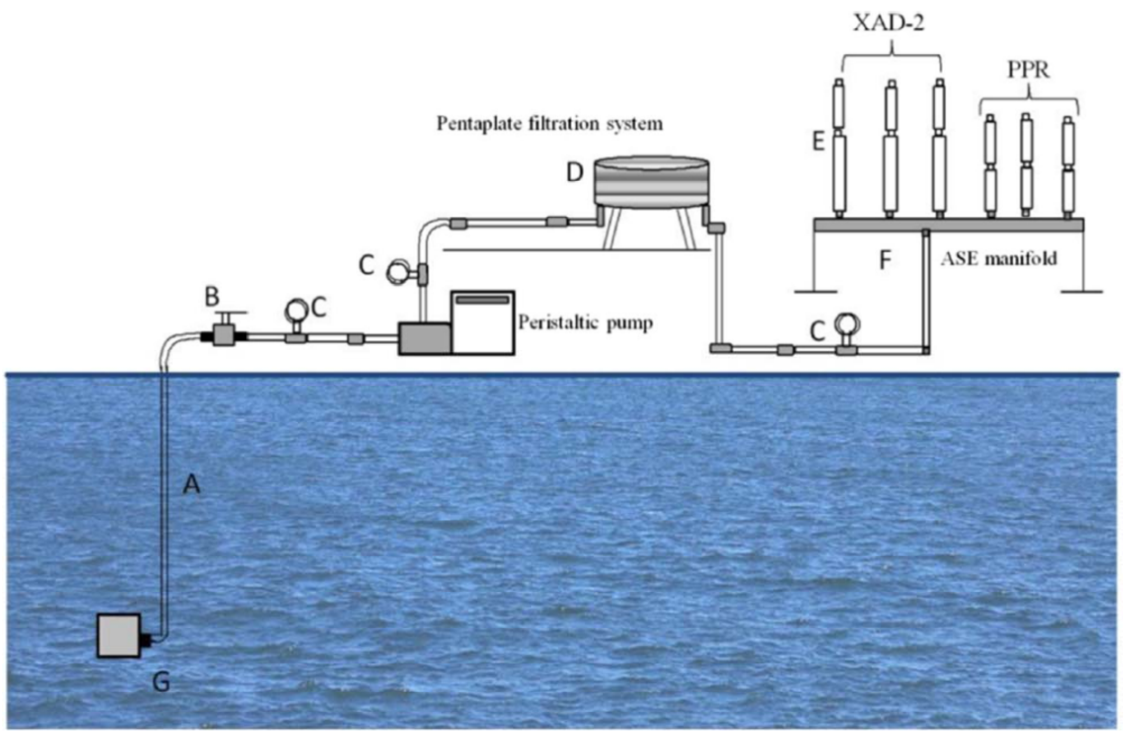
| <u>LOYs</u> | |
|---|---|
| Superior | 2011 |
| Huron | 2012 |
| Ontario | 2013 |
| Erie | 2014 |
| Michigan | 2015 |

# GLFMSP Lake of the Year: Better Sampling Practices

Environ Monit Assess (2014) 186:7565–7577
DOI 10.1007/s10661-014-3948-6

**Comparison of PoraPak Rxn RP and XAD-2 adsorbents for monitoring dissolved hydrophobic organic contaminants**

Mark Omara · Thomas M. Holsen · Xiaoyan Xia · James J. Pagano · Bernard S. Crimmins · Philip K. Hopke




## Advanced water sampling technique

1. Uses PoraPak Rxn RP sorbent instead of XAD for dissolved phase HOCs

2. Increase water volumes collected (increased sensitivity).

3. Lower background compared to XAD.

4. Stronger analyte retention – higher flows, lower detection limits.

less sorbent → lower background
stronger retention → higher collection volume

→

Better numbers at lower levels

# GLFMSP Lake of the Year: Mercury Bioaccumulation

ELSEVIER

Contents lists available at ScienceDirect

Journal of Great Lakes Research

journal homepage: www.elsevier.com/locate/jglr

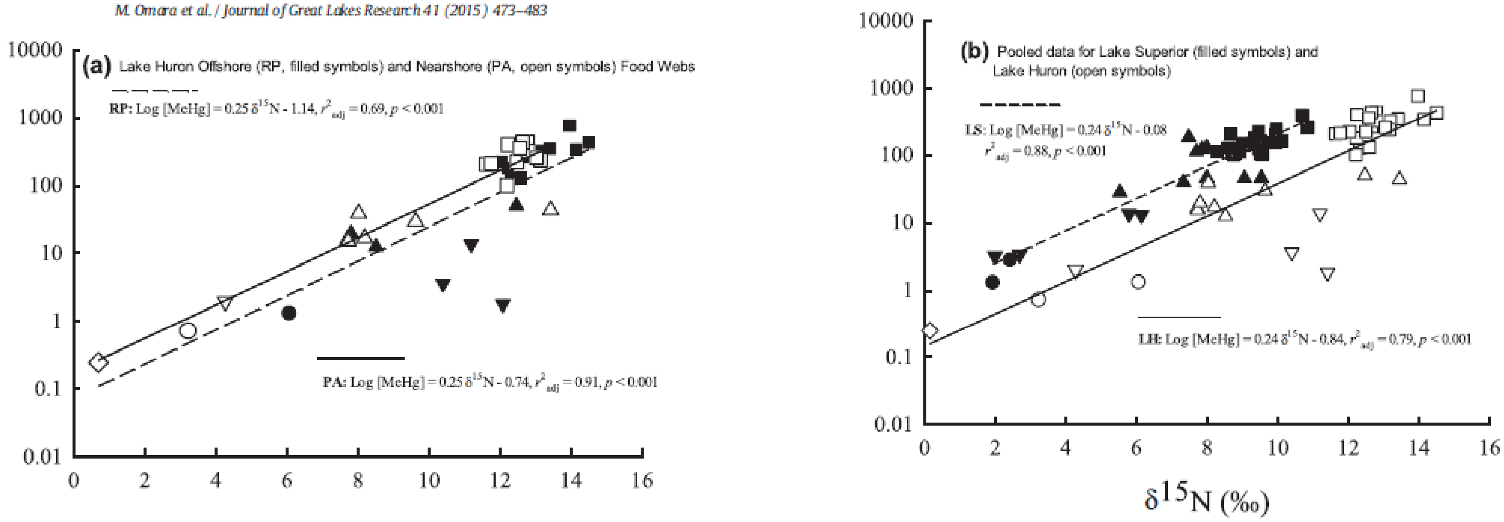
IAGLR

## Mercury biomagnification and contemporary food web dynamics in lakes Superior and Huron

CrossMark

Mark Omara [a,1], Bernard S. Crimmins [b,*], Richard C. Back [c], Philip K. Hopke [a], Feng-Chih Chang [b], Thomas M. Holsen [b]

M. Omara et al. / Journal of Great Lakes Research 41 (2015) 473–483




Similar mercury bioaccumulation rates among Lakes Superior and Huron

# GLFMSP Lake of the Year: Ongoing

Status

- Collections on the 5 lakes have been completed
- Currently processing LOY contaminants and ecosystem markers for Lakes Ontario, Erie and Michigan
- Clarkson U. to begin next CSMI / LOY cycle in 2016
- Routine Chemical monitoring and Surveillance in Lake Trout will continue

Publications

Delach, D., Crimmins, B., Xia, X., Hopke, P.K., Holsen, T.M., 2015. Fatty acid distributions across two Great Lake food webs, **in preparation**.

Delach, D., Crimmins, B., Xia, X., Hopke, P.K., Holsen, T.M., 2015. Bioaccumulation of Perfluoroalkyl carboxylic acids and sulfonates in Lakes Huron and Superior (2014), **in preparation.**

Delach, D.L., Crimmins, B.S., Holsen, T.M. PFC concentrations and accumulation potential among predator and prey fish in the Great Lakes. 2014. International Association of Great Lakes Research (IAGLR), 57th Annual Conference, May 26 – 30, 2014.

# U.S. EPA-ORD CSMI Particip


EPA-ORD R/V *Lake Explorer II*

- Distribution, abundance and movement of nutrients and biota across a nearshore-offshore gradient
    - Seasonal transect sampling
    - Integrated, *continuous* sampling with station sampling
    - *Along* transects using towed sensor array
    - *Among* transects using glider technology

- Characterize food web across nearshore to offshore gradient
    - Sampled zooplankton and benthos for stable isotope analysis
    - Coordinated with federal (USGS, USFWS, NOAA) and academic (Central Michigan University, Cornell University) partners

- Nearshore water quality effects from tributary loading
    - Tributary based water quality sampling for nearshore water quality modeling

## Key knowledge gap: How do nutrients and biota vary nearshore (relatively understudied) to offshore?

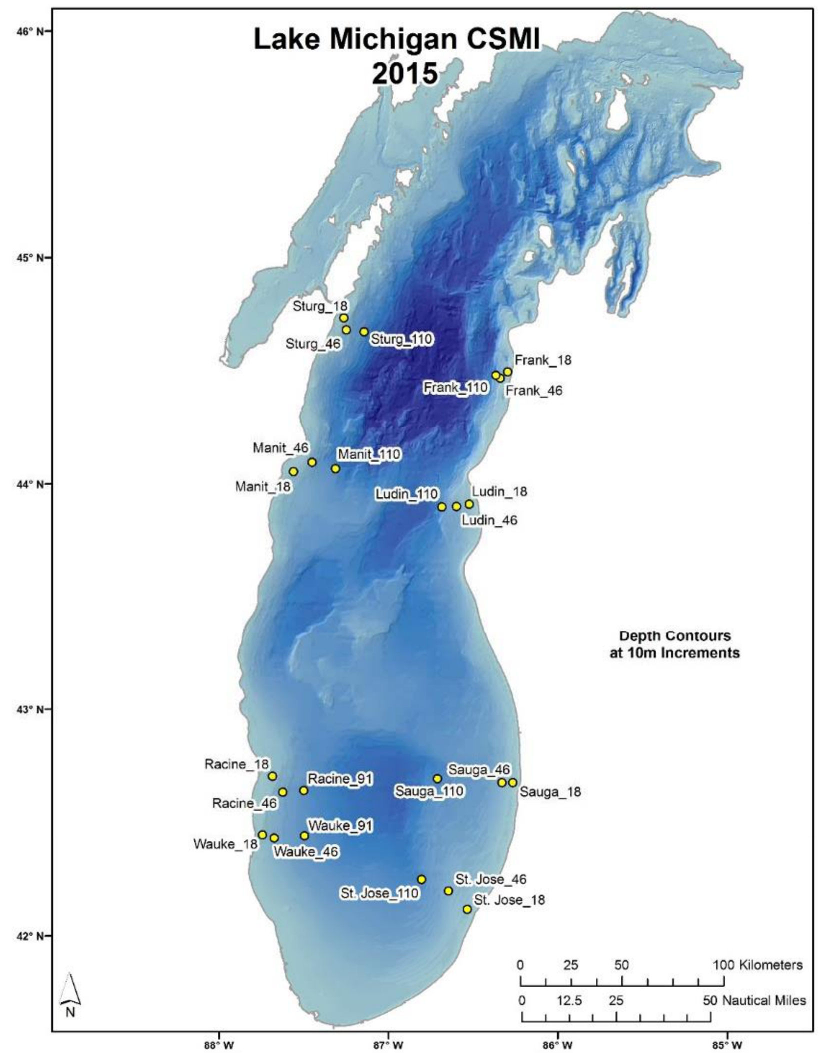
**Hypotheses to test:**

- [ ] **The nearshore (18 m bottom depth) is more productive (plankton, benthos, fish) than deeper (46, 110 m) sites.**

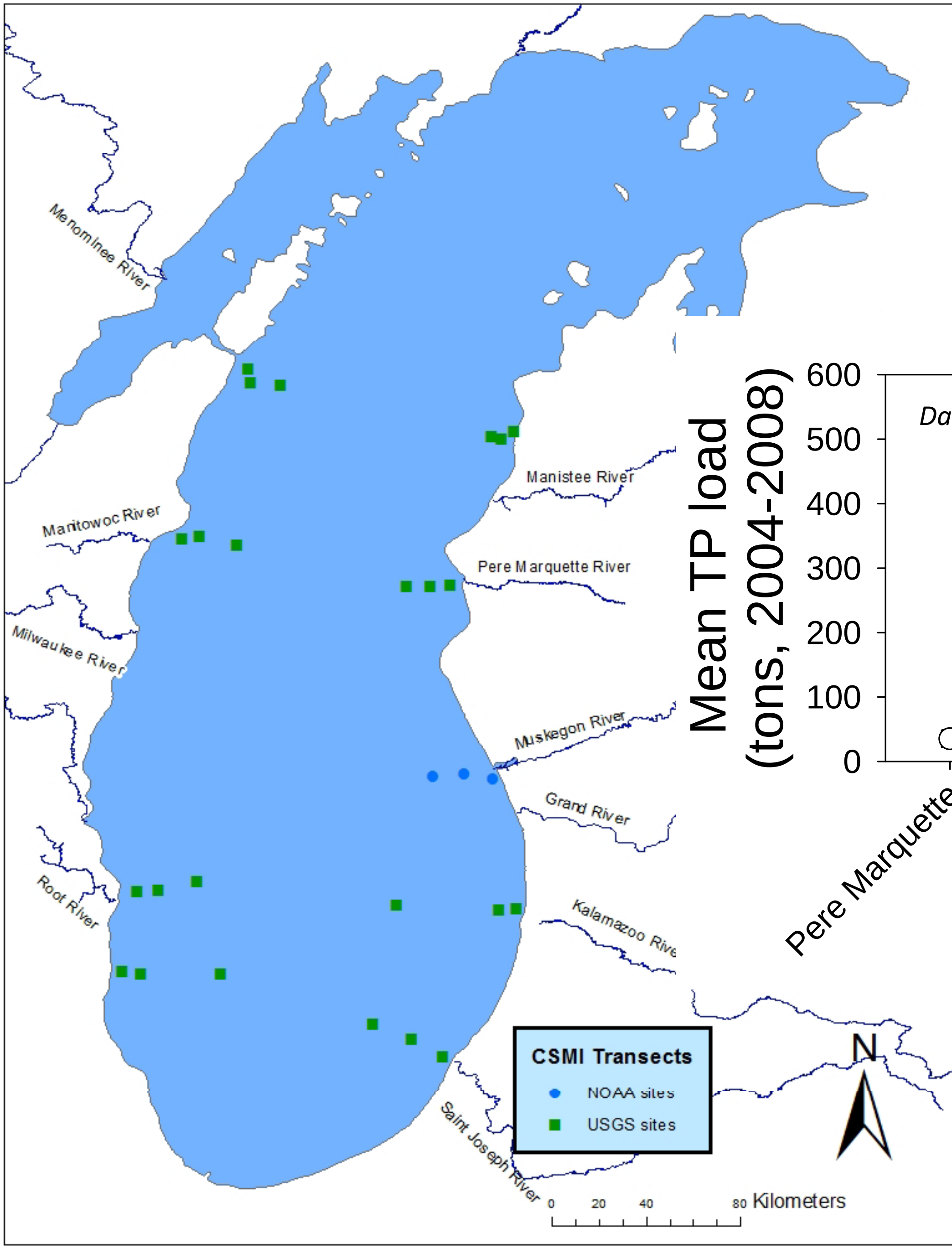
- [ ] **Among nearshore sites, those closest to tributaries with *high phosphorus input* will be more productive than other sites.**

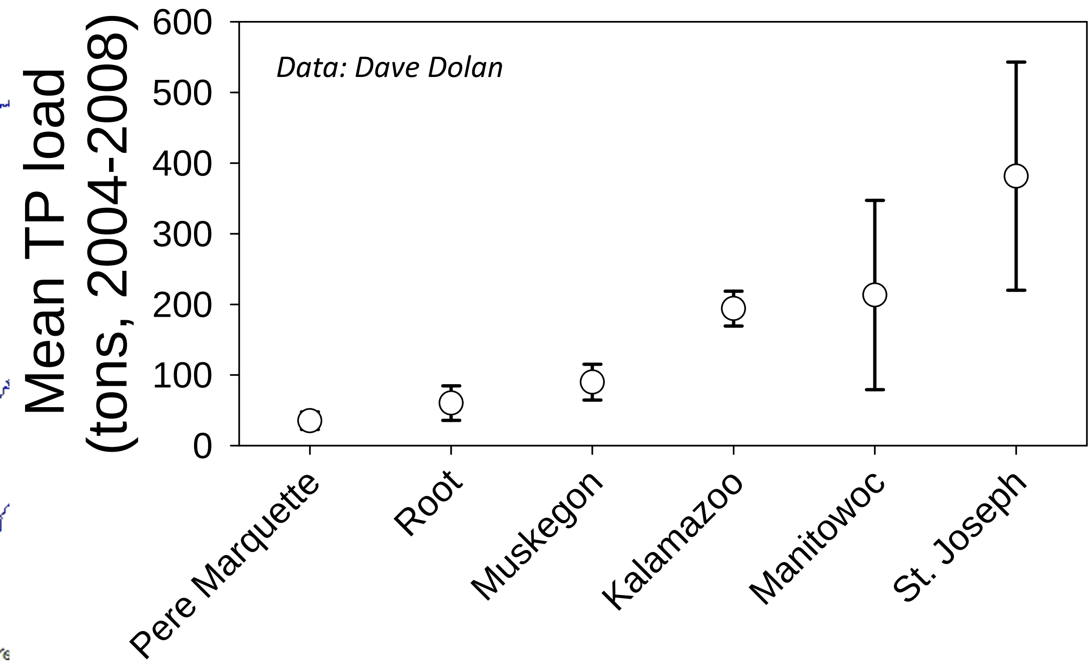
# Transects

- Cooperatively sampled by GLNPO, ORD, USGS
- Three depths @ each transect: 18, 46, 110 m
- Station Sampling
  - Seasonal: May, July, September
  - Sonde profiles
  - Water quality – epilimnion, DCL, hypolimnion
    - Nutrients (cations/anions, N, P)
    - Chlorophyll a
    - Particulates (C, N, P)
  - Zooplankton (water column, discrete depths), Mysis
  - Benthos
  - Larval fish (USGS), forage fish (USGS)

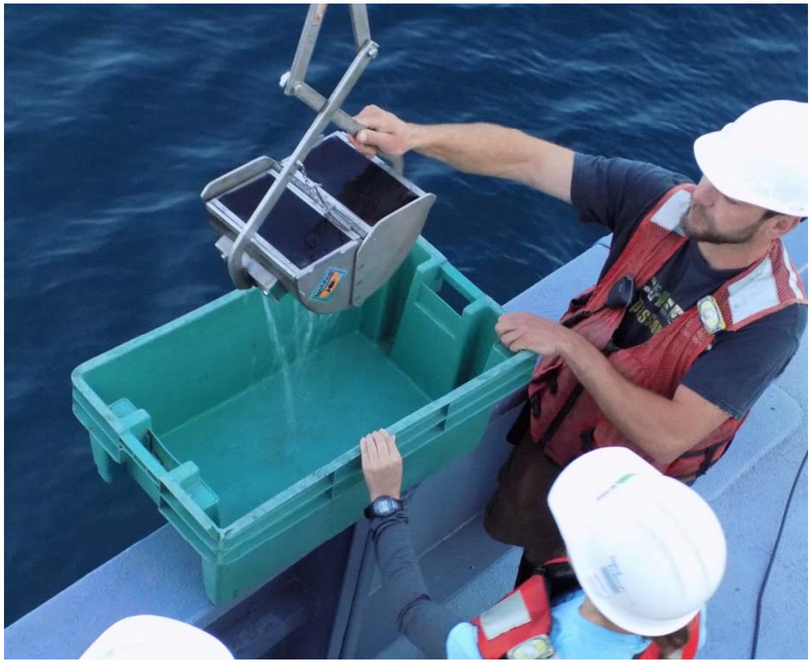


## Gradient of TP loading for transects adjacent to tributaries



Using a ponar to sample benthic invertebrates.



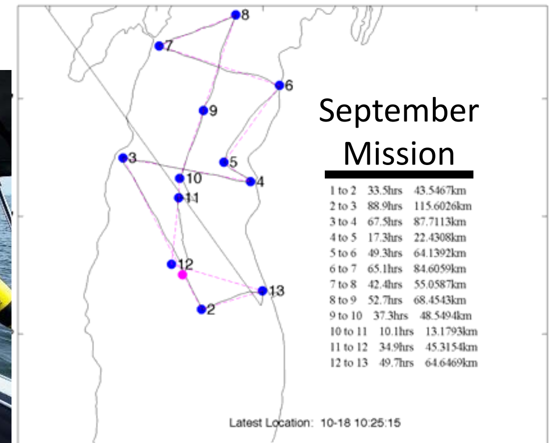
Sampling for larval fish.

Using a trawl to sample for juvenile & adult fish.

Native bloater captured in a trawl.

*Photo credits: Megan Ewald*

# Towed and Glider Sampling



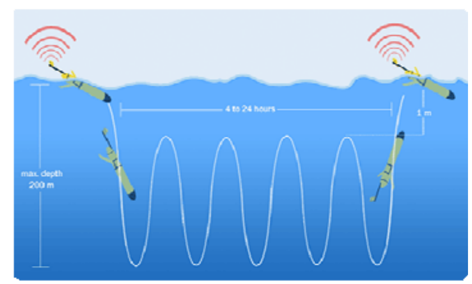

**Courtesy L. Fiorentino, UMD**

**<u>Tow Data</u>:**

- Dissolved Oxygen
- Conductivity
- Temperature
- Depth
- Fluorescence
- Nitrate
- Plankton abundance/biomass

**<u>Glider Data</u>:**

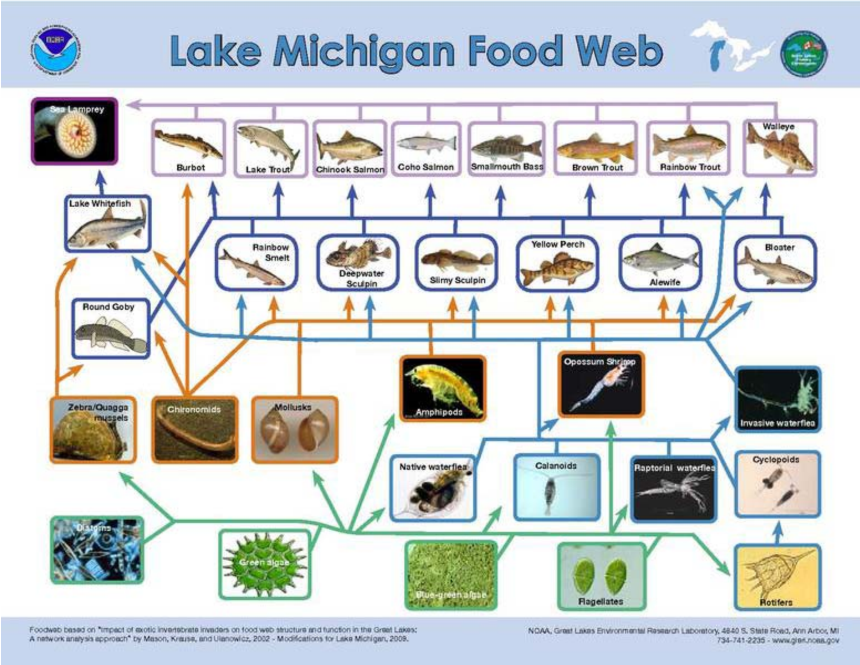
- Dissolved Oxygen
- Conductivity
- Temperature
- Depth
- CDOM
- Fluorescence
- Backscatter




http://beforeitsnews.com/alternative/2013/12/underwater-drones-us-navy-to-wage-new-war-with-sea-powered-machines-2859372.html

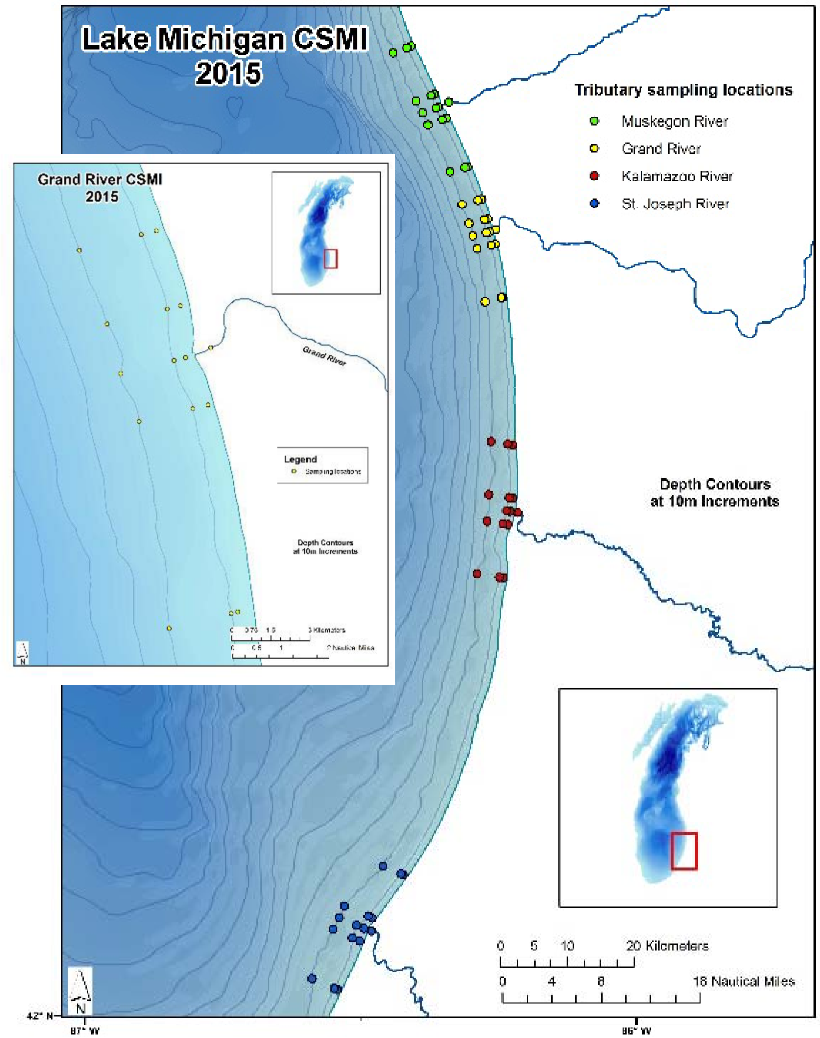
# Lake-Wide Food Web Study

- Stable isotope analysis of multiple food web compartments
- Sampled at all transects/seasons + inshore locations
- Higher trophic levels: piscivorous fishes
- Mid-trophic levels: Mysis, *Bythotrephes*, prey fishes, fish larvae
- Primary consumers: zooplankton (bulk; large and small size fractions), dreissenid mussels, *Diporeia*, oligochaetes
- Primary producers: particulate organic matter



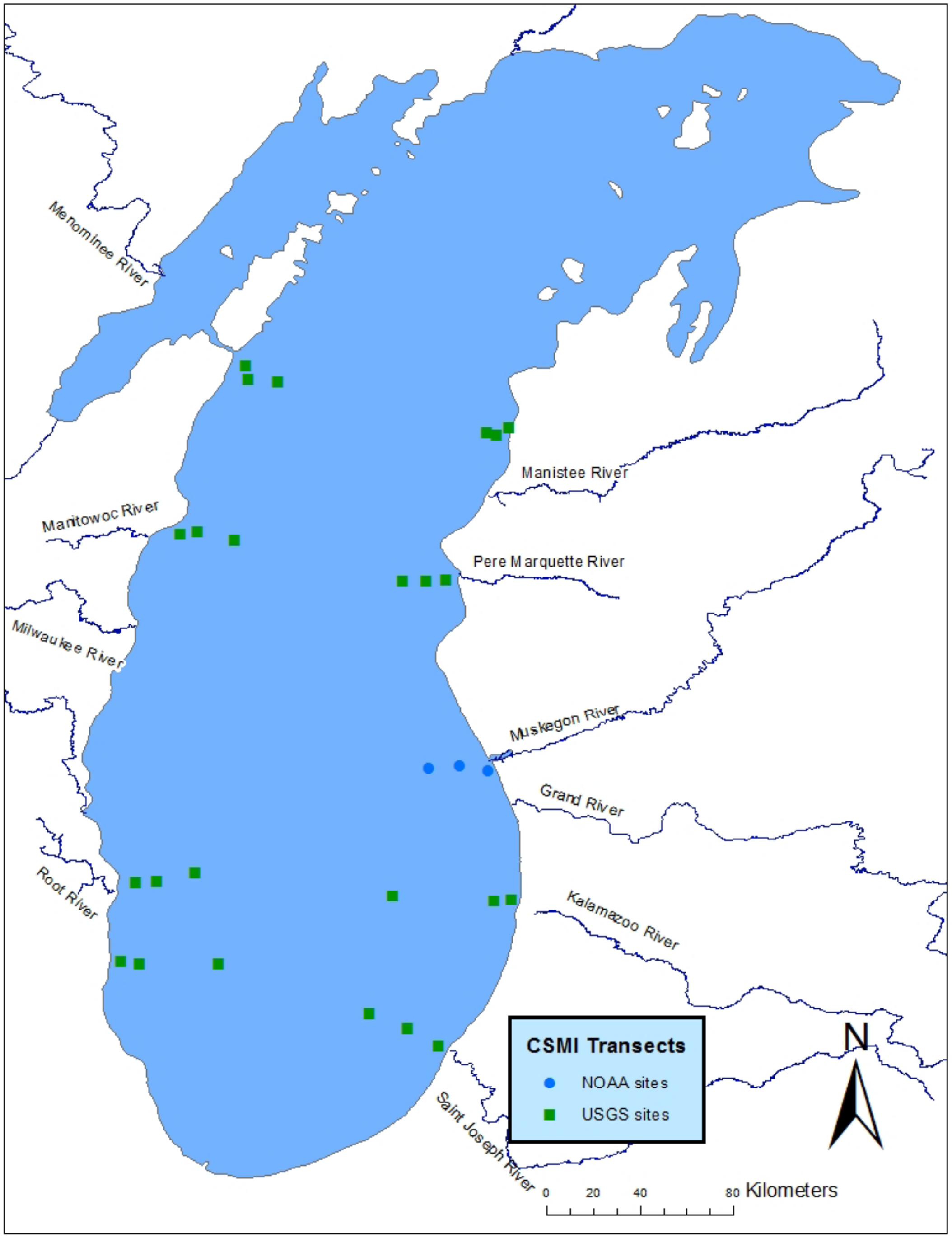
# Nearshore Water Quality Model

- Surface water quality sampling to validate nearshore water quality model
- Sampled in May (high flow) and July (base flow)
- At each tributary, sampled at 0, 2 and 10 km north and south of tributary
- Measured cations/anions, N, P, chlorophyll a



**Study design**: Sample 8 nearshore to offshore transects seasonally (EPA, USGS) and 1 transect bi-weekly (NOAA).

- ❑ Three depths @ each transect: 18, 46, 110 m.
- ❑ At each depth, sampled nutrients, zooplankton, larval fish (spring-summer), benthos (summer), *Mysis*, and forage fish.



# Lake Erie and **Lake Michigan** Benthos: Cooperative Science and Monitoring Initiative

**Alexander Karatayev, Knut Mehler, and Lyubov Burlakova**

# Objectives

- Samples for total benthic macroinvertebrates will be collected at 90 stations (270 samples) located throughout northern and central Lake Michigan
- Sediment samples will be collected in triplicate at each station with a ponar grab
- Each sample will be washed separately into an elutriation device and then through a 500-um mesh screen. All retained organisms will then be washed into a collection jar and preserved in 10% formalin
- In the laboratory, all *Diporeia* spp. and dreissenids will be picked and counted. In addition, the Research Foundation for SUNY/Buffalo State will process the total benthos samples from the 40 southern basin stations sampled by NOAA
- Lake Michigan benthic habitat assessments will also be conducted using an underwater camera mounted on a towed benthic sled along a series of 6 transects. Video footage will be analyzed to map dreissenid abundance and confirmed with ponar grabs

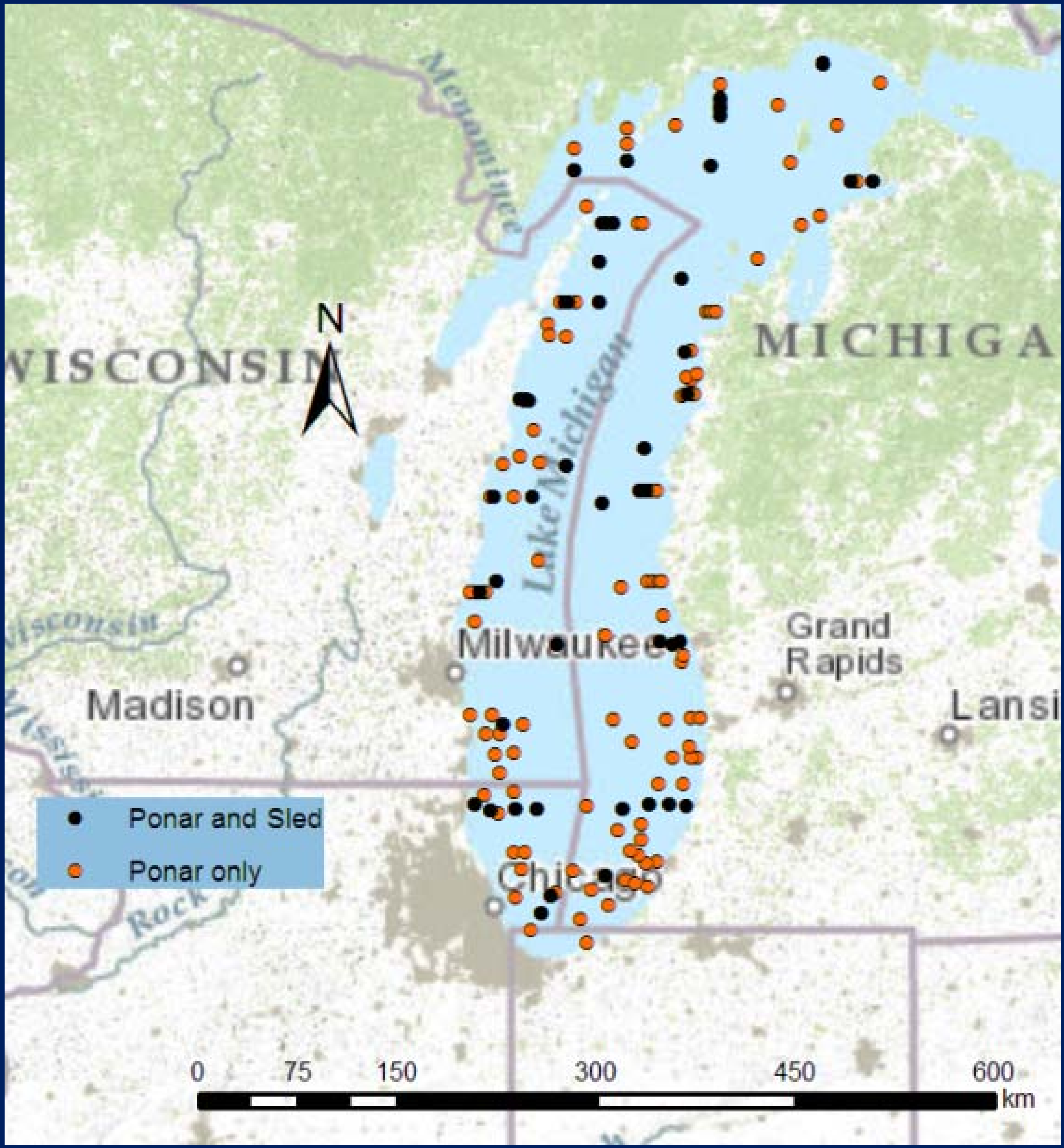
# Lake Michigan benthos (sample collection):

- 469 ponar samples of benthic macroinvertebrates from 158 sites were collected in July of 2015 via collaboration of Buffalo State University (Alexander Karatayev, Knut Mehler, Lyubov Burlakova), Tom Nalepa (University of Michigan), Ashley Baldridge (NOAA-GLERL), and U.S. EPA GLNPO scientists

| Sites | | Samples | |
|---|---|---|---|
| Planned | Collected | Planned | Collected |
| 130 | 158 | 390 | 469 |

- The total number of collected samples exceeds the number of planned samples by 25%

# Lake Michigan survey sites

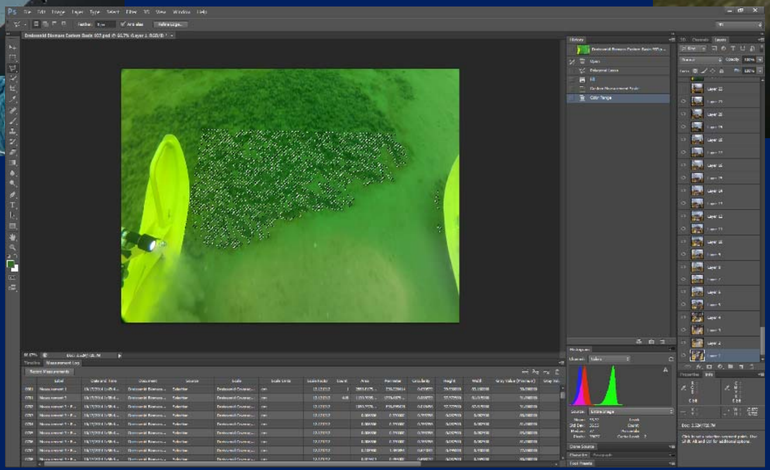


# Lake Michigan benthos (sample processing):

- 213 samples will be sorted by the NOAA lab and sent to Buffalo State for identification
- 256 samples will be sorted by Buffalo State
- From a total of 469 samples collected 426 will be identified by Buffalo State
- In the remaining 43 samples only *Dreissena* and *Diporeia* will be counted

# Video images analysis:

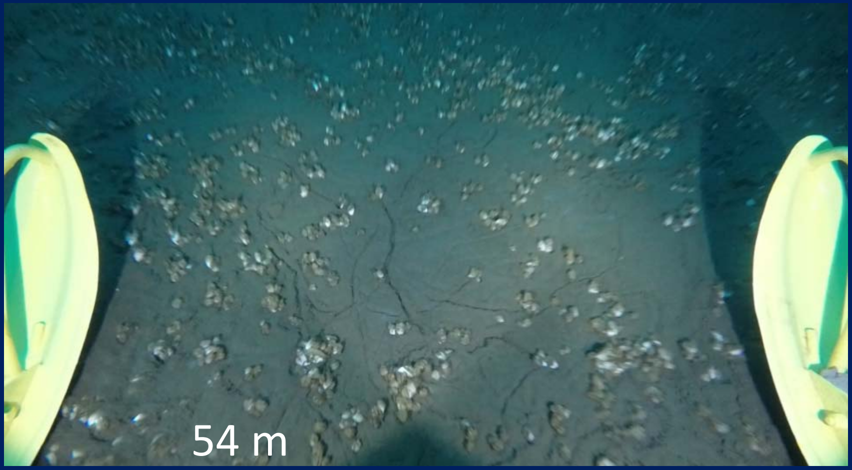
- Objective: “Lake Michigan benthic habitat assessments will also be conducted using an underwater camera”
- Buffalo State collected > 500 videos with a Go Pro camera mounted on a ponar grab and 47 videos from a Go Pro camera mounted on a benthic sled towed behind the boat for ~500 m transect

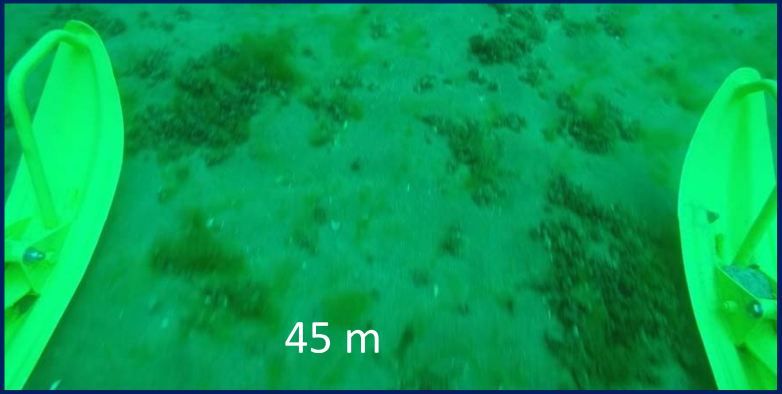


# Video images analysis:

- *Dreissena* coverage will be estimated from each usable video image



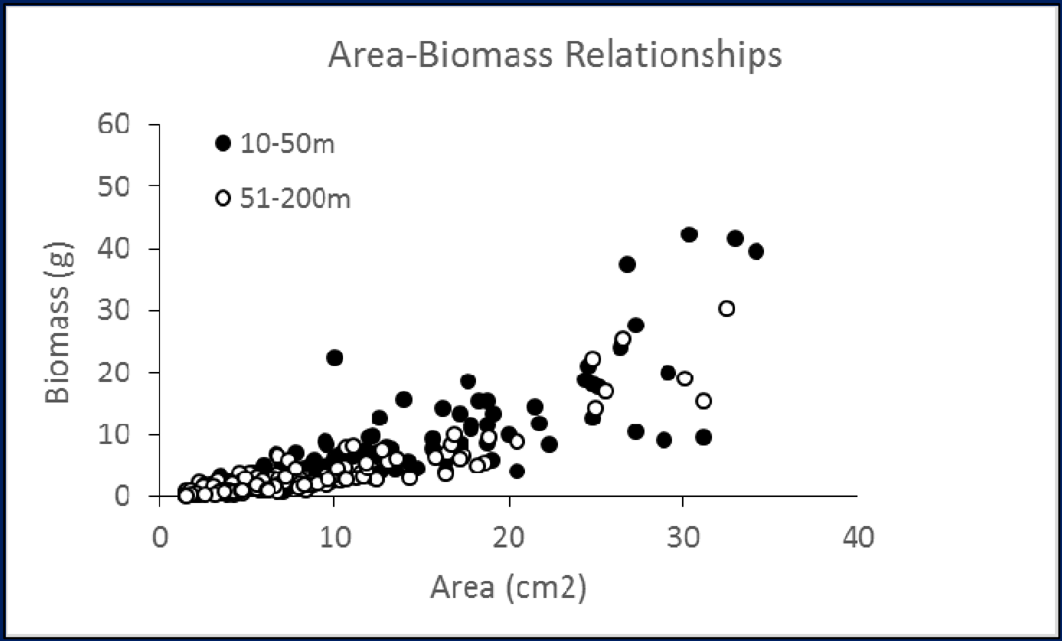



# Video images analysis

To convert coverage into biomass, Buffalo State measured surface area/biomass relationship for 309 *Dreissena* druses collected from different depths in Lake Michigan

Determining wet mass of each druse

Determining surface area of each druse in Photoshop



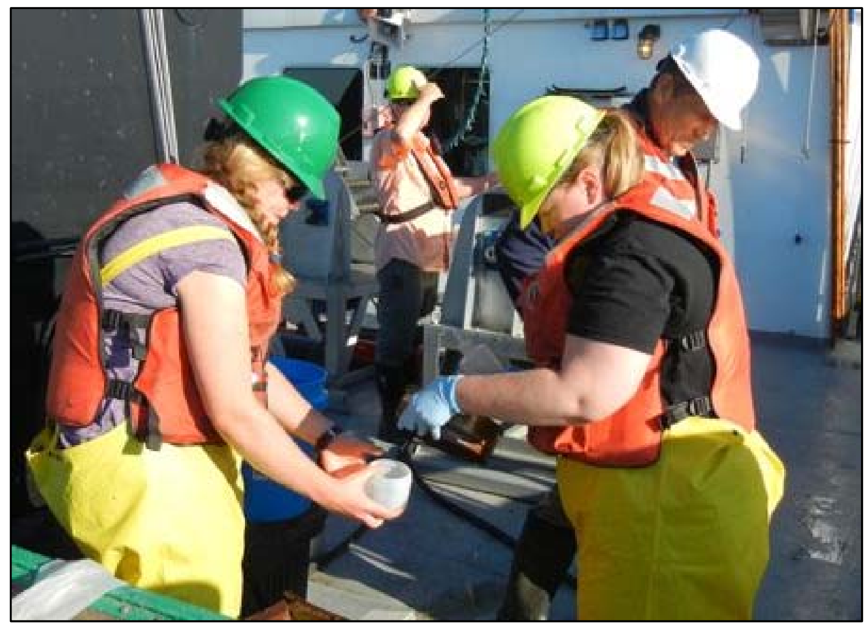
# An outline of the anticipated activities:

- Analyze all video footage for Lake Michigan by February 1, 2016
- Finish sorting all Lake Michigan samples by May 1, 2016
- Finish *Dreissena* measurements by July 1, 2016
- Finish mounting all chironomid and oligochaete slides by July 1, 2016
- Finish identification of chironomids in September 2016
- Finish identification of other than chironomids and oligochaetes invertebrates by October 1, 2016
- Complete the Lake Michigan benthos database after all taxonomic identification will be finished
- Analyze data, prepare and submit the Final Report

# Results of 2015 sampling will be presented at:

- EPA Great Lakes National Program Office, Chicago, January – February, 2016
- 59th Annual Conference on Great Lakes Research, June 2016
- The International Society of Limnology meeting, July 2016

# Many collaborators from several institutions

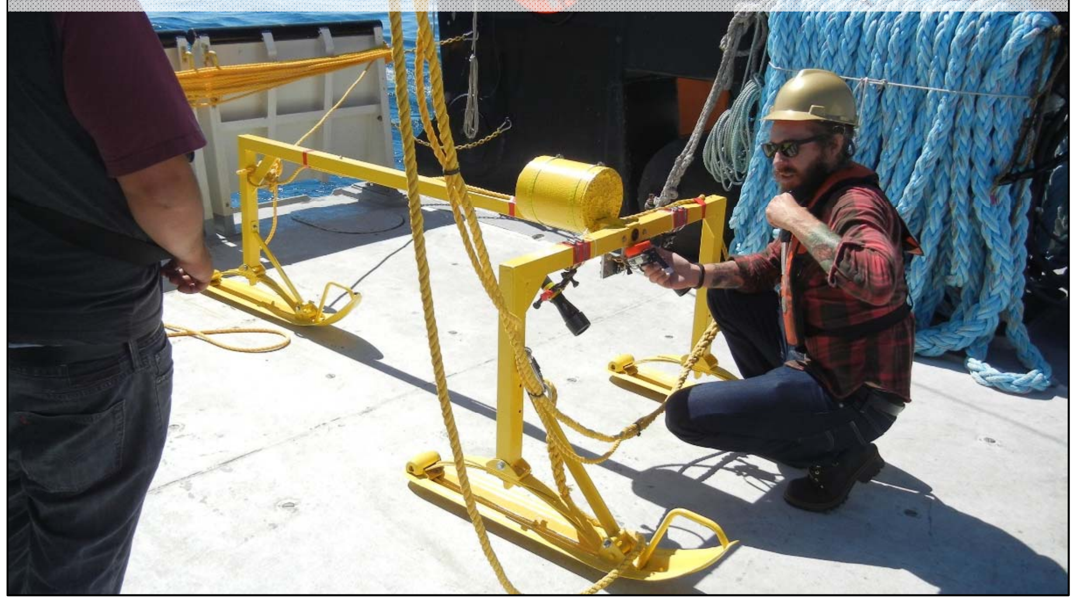



# We used multiple methods to collect sediments and video footage

Bringing in the Ponar

Elutriating a sediment sample

Deploying the benthic sled for a video transect



Diporeia were found at just a few sites- all very deep


Mussel druse


Low mussel density site


High mussel density site


Keep 'Em Great!