Lake Michigan Monitoring Coordination Council

Collaborative Monitoring in the Great Lakes: Sharing Monitoring Activities Around the Lake Michigan Basin

John Hummer, Great Lakes Commission

with special thanks to:
Judy Beck – U.S. EPA Great Lakes National Program Office
Charlie Peters – USGS WI Water Science Center (co-chair)
Gary Kohlhepp – Michigan Department of Environmental Quality (co-chair)

All monitoring partners around the Lake Michigan basin and those who supplied information for this presentation

National Water Quality Monitoring Council
Webinar
December 8, 2011

Great Lakes Hydrologic and Political Boundaries

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“An outstanding natural resource of global significance, under stress and in need of special attention.”

Outstanding Natural Resources

- Second largest by volume
- 307 miles from northern forest to southern dune and swale
- Several rare features and species

Lake Michigan LaMP Goals

1. Can we all eat any fish?
2. Can we all drink the water?
3. Can we swim in the water?
4. Are all habitats healthy, naturally diverse, and sufficient to sustain viable biological communities?

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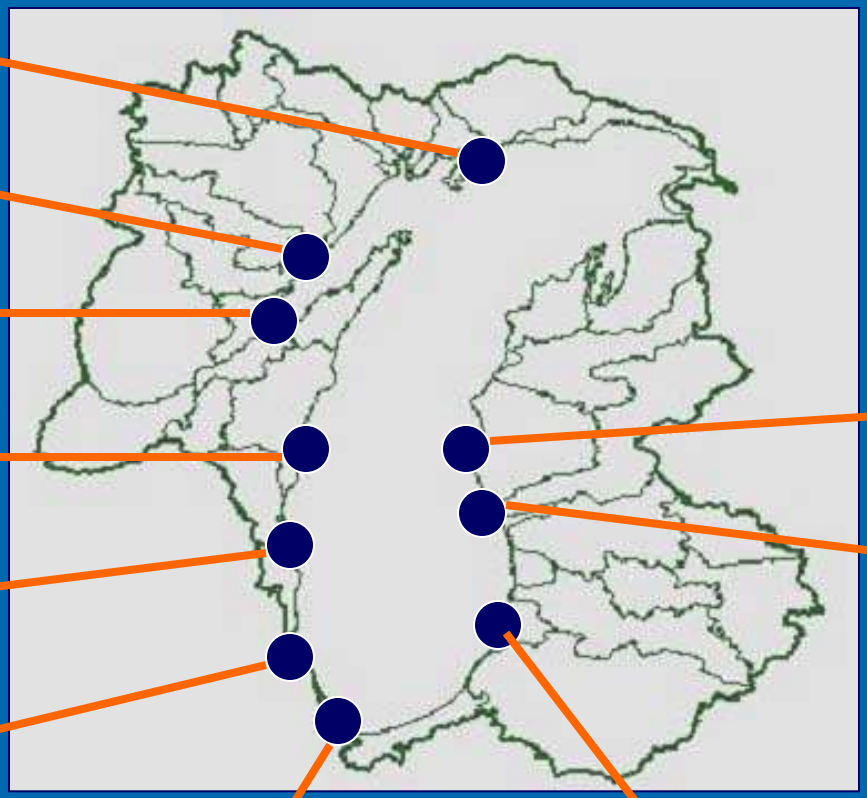
http://epa.gov/greatlakes/michigan.html

Watersheds and AOCs



Manistique River

Menominee River

Fox River /
Lower Green Bay

Sheboygan River

Milwaukee Estuary

Waukegan Harbor

Grand Calumet River/Indiana Harbor Canal

White Lake

Muskegon Lake

Kalamazoo River

33 sub-watersheds

10 Areas of Concern

Two Issues

1. Information collected according to political boundaries rather than resource boundaries

2. Information collection agencies focused on narrow fields of study

Key point from Great Lakes Regional Collaboration (2005) recommendations

Monitoring must be better coordinated through the existing Great Lakes management entities, both at the lake-wide and region-wide basis.

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From GLRC Indicators and Information Appendix

- **Detailed Action 3: Organize and support binational Great Lakes monitoring coordination on a lake-wide basis. Leadership should be provided by the LaMPs and Lake Committees.**

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Lake Michigan Monitoring Coordination Council (LMMCC) Background

- Inaugural meeting September 1999
- First Great Lakes council to be structured along watershed boundaries
- Broad ecosystem approach -- not only water quality monitoring

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LMMCC Mission

- *To provide a forum for coordinating and supporting monitoring activities in the Lake Michigan basin and to develop and make broadly available a shared resource of information, based on documented standards and protocols, that is useable across agency and jurisdictional boundaries.*
- Great Lakes Commission provides staff & organizational support

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➢ Council Objectives:

- Document activities, identify gaps and contribute to a shared monitoring effort for the basin
- Maintain collaborative partnerships
- Enhance data quality and comparability
- Link basinwide information systems
- Improve awareness of monitoring and Council member products

Monitoring / Tracking

- Air
- Aquatic Invasive Species
- Fisheries
- Groundwater
- Land Use
- Nearshore
- Open Lake
- Recreational Waters
- Tributaries
- Wetlands
- Wildlife

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LMMCC NEMO Workgroup

- Members: Federal, State, Municipalities, Universities, and Non-profits
- Goals:
  - Understand and inventory nearshore monitoring activities (developing a web mapper);
  - Coordinate implementation of a nearshore network;
  - Identify monitoring gaps;
  - Coordinate database approach;
  - Develop a nearshore conceptual model;
  - Integrate data reporting.

USGS science for a changing world

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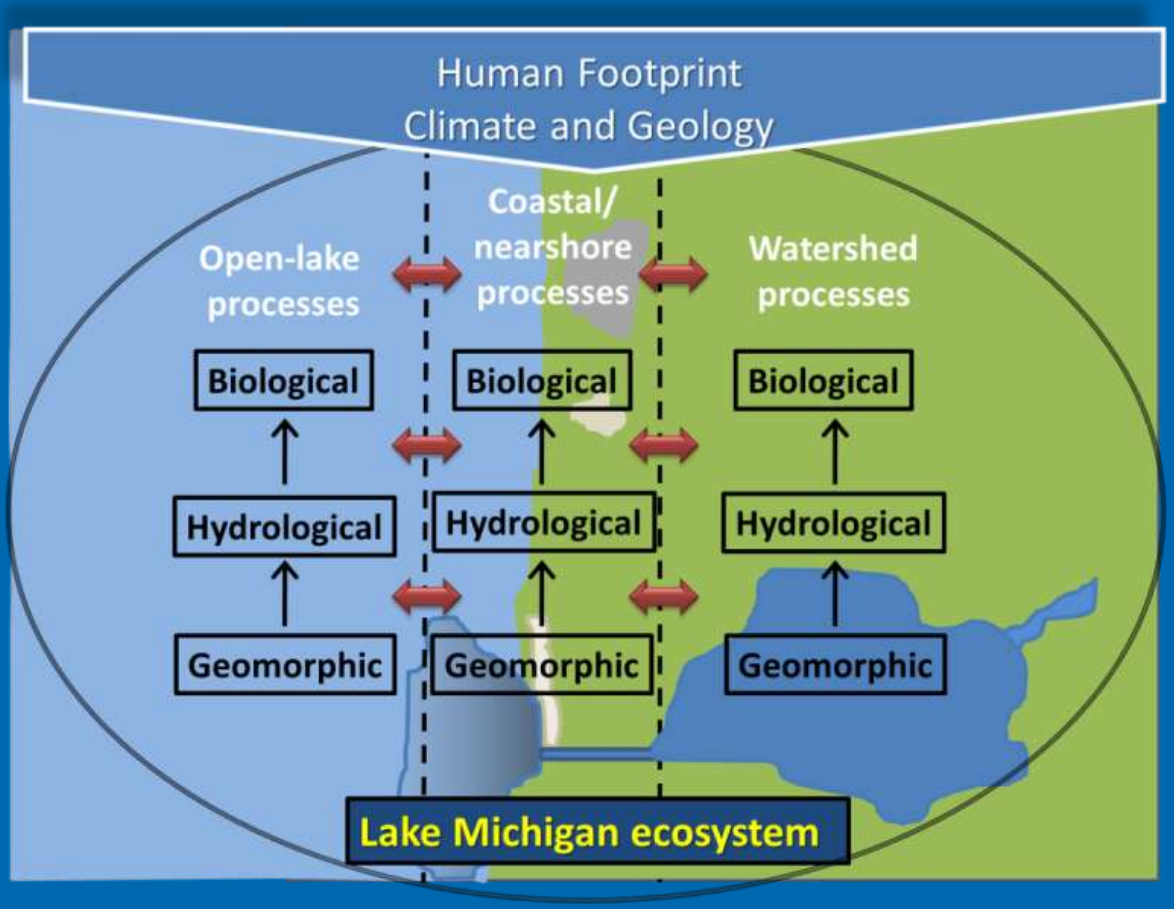
Gap Analysis

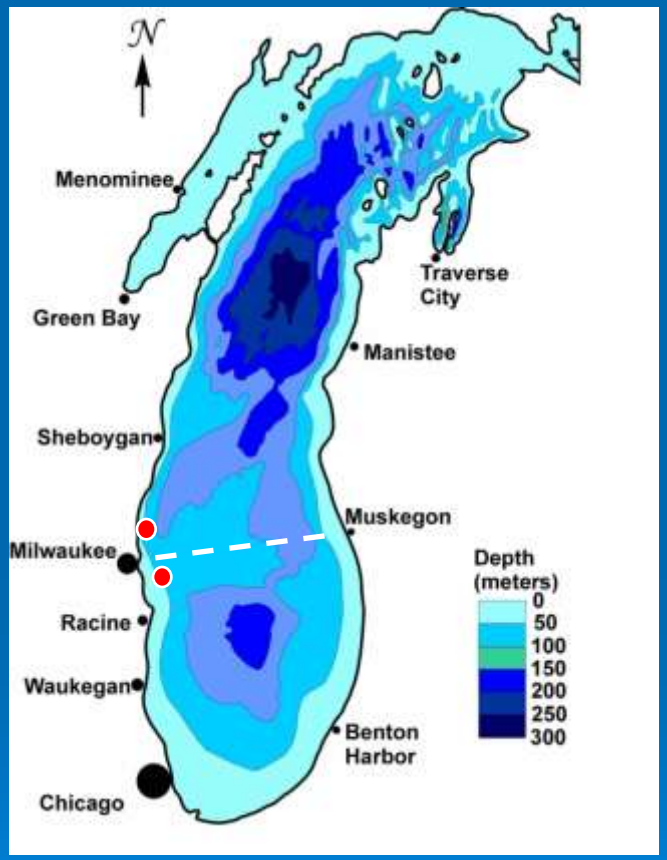
- Gaps in Monitoring
- Gaps in Understanding



Examples of Lake Michigan Nearshore Activities

- USEPA National Coastal Assessment
- University and state nearshore buoys
- University and federal nearshore biology research
- USEPA Triaxus tows of nearshore zone
- USGS GLRI tributary, river mouth, beach, and nearshore monitoring (9 projects)
- State and local tributary and river mouth (embayments) monitoring
- UWM sensors on Ferry crossings

UW-Milwaukee Buoys and Ferry Sensors



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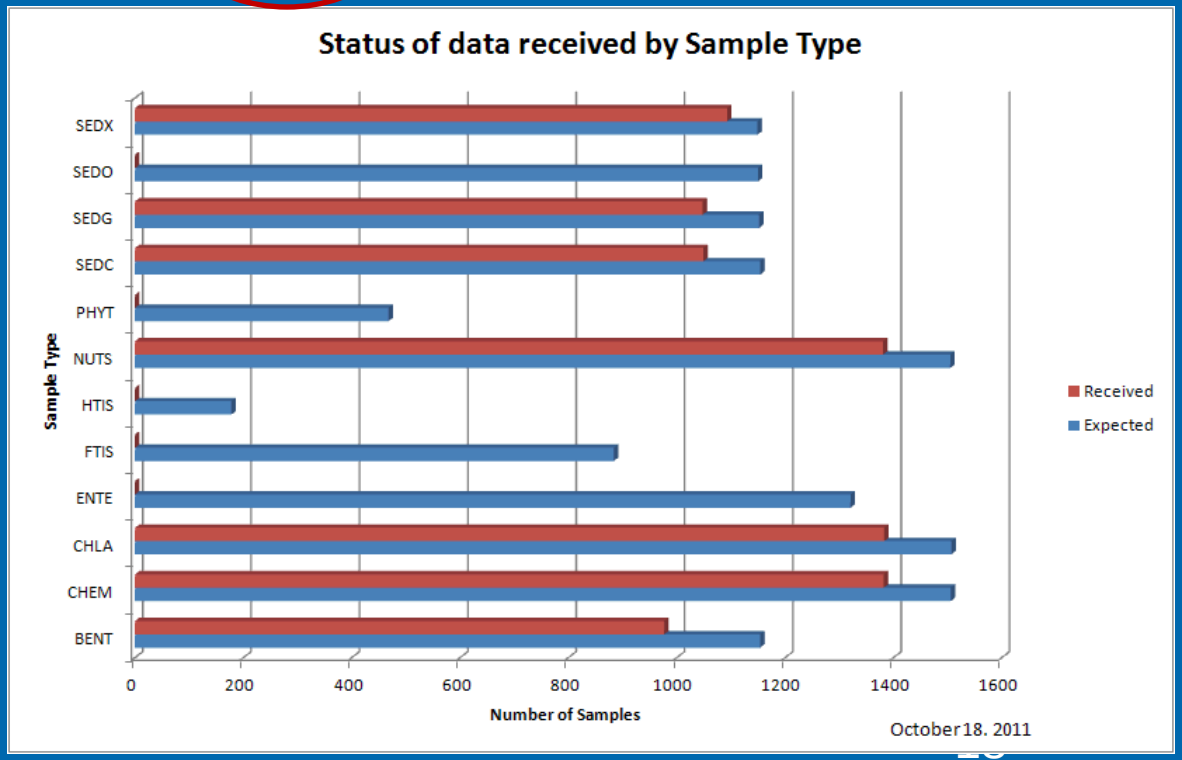
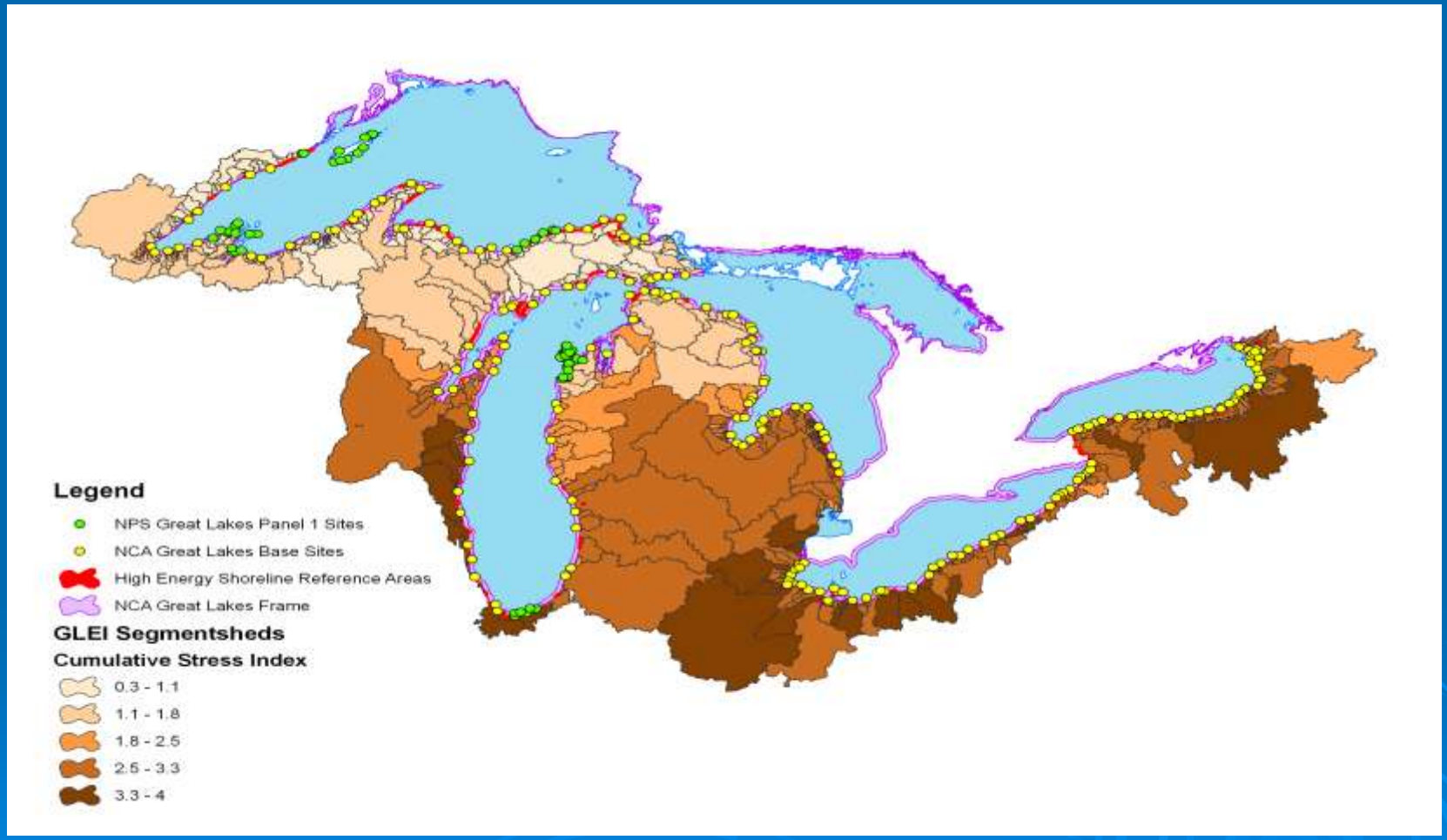
National Aquatic Resource Survey Schedule

	2010	2011	2012	2013	2014	2015
Coastal	Field	Lab,data	Report	Research	Design	Field



USEPA National Coastal Condition Assessment in the Great Lakes



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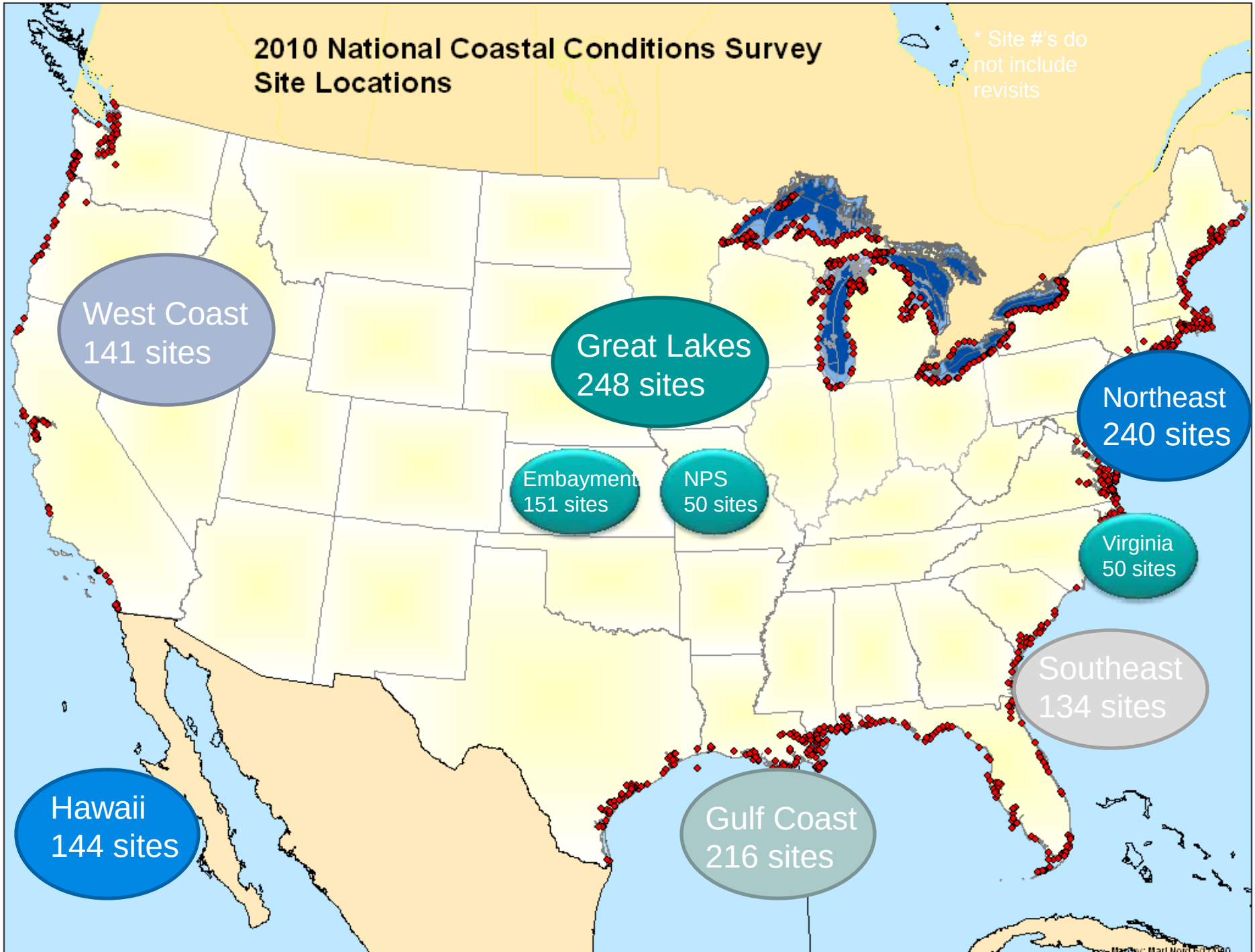
Sampling completed in 2010 - Analysis in progress.

National Coastal Condition Assessment Surveys

- The National Aquatic Resource Surveys are built on a random, probabilistic-based monitoring approach.

- The surveys are designed to yield unbiased estimates of the condition of a whole water resource, based on a representative sample of that resource.

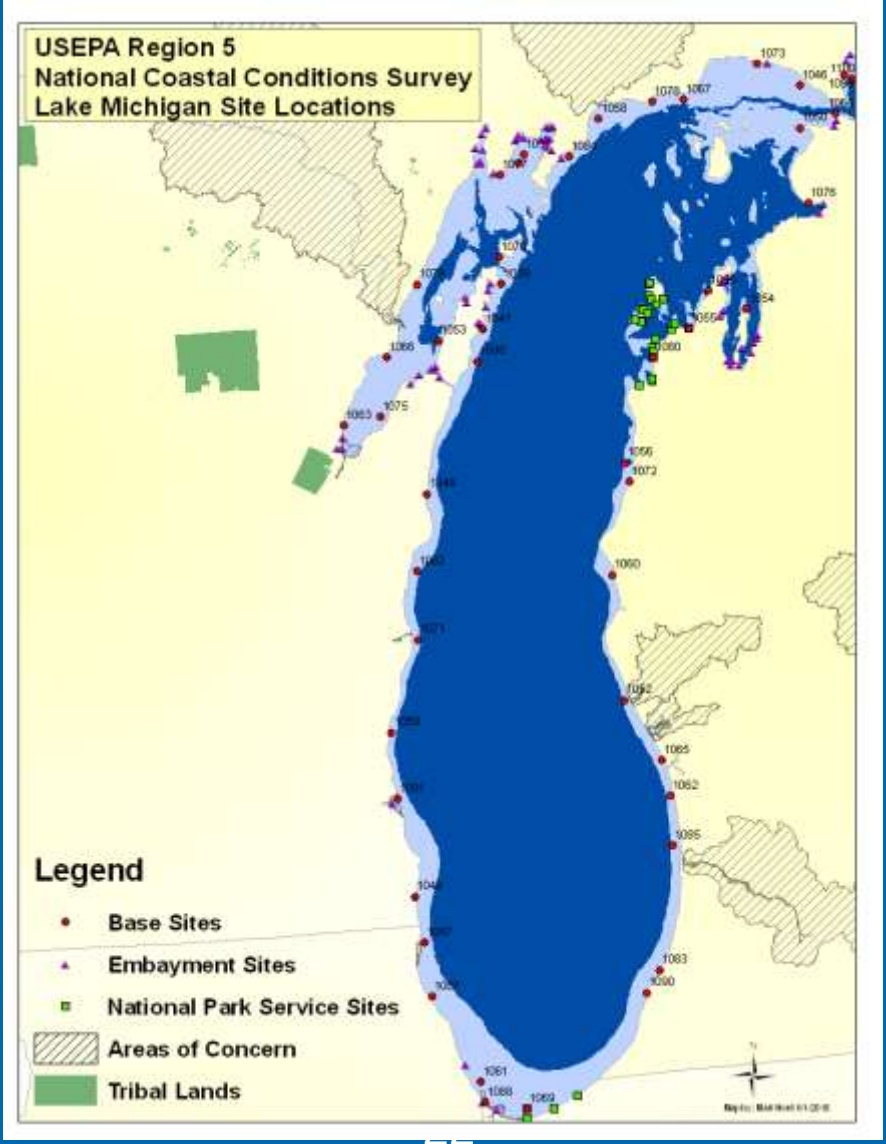

2010 National Coastal Conditions Survey
Site Locations
* Site #'s do not include revisits
West Coast
141 sites
Great Lakes
248 sites
Northeast
240 sites
Embayment
151 sites
NPS
50 sites
Virginia
50 sites
Southeast
134 sites
Hawaii
144 sites
Gulf Coast
216 sites

Freshwater Coastal Waters

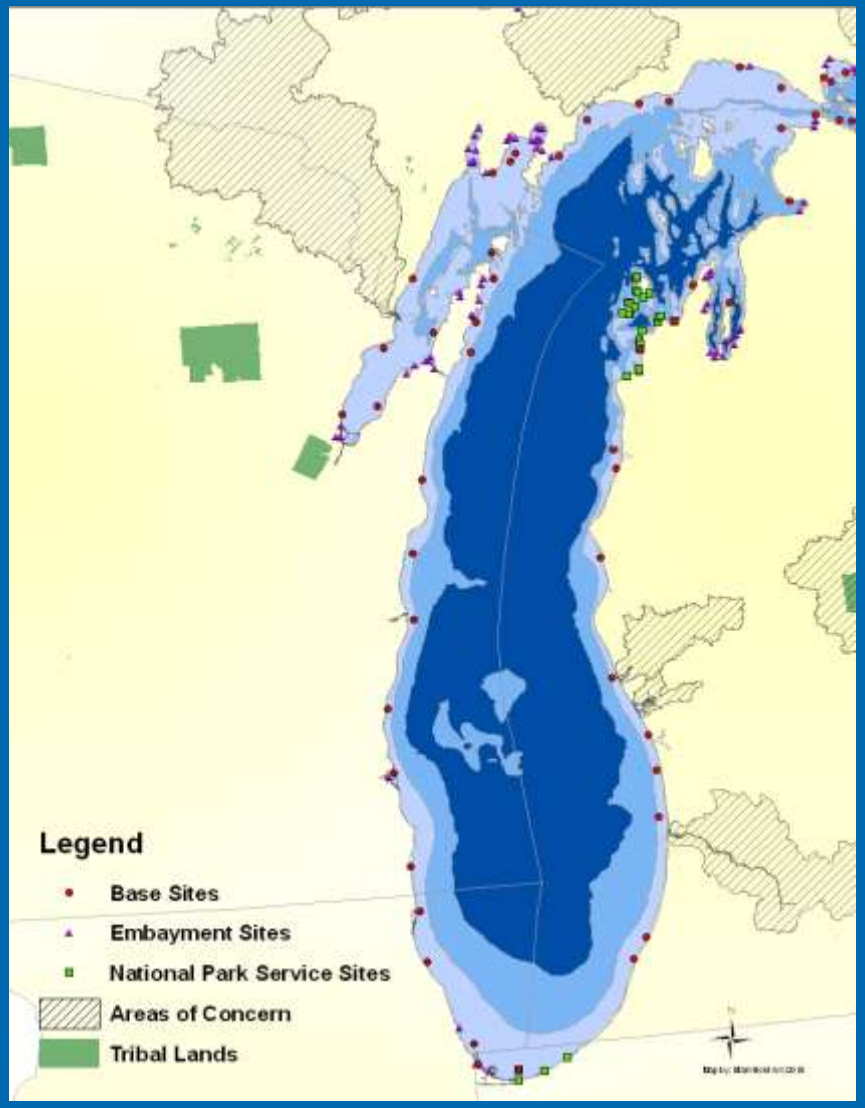
- No more than 5km out or 30m deep.
- 45 sites per Lake. 5 revisits each. U.S. waters.(225)
- 10% revisit

Additional Great Lakes Sites

- Embayment sites (151)
  - semi-enclosed no smaller than 1 km^2 and no larger than 100 km^2
- National Park Service Sites (50)
  - within 5 parks GL-wide.



Lake Michigan Sites

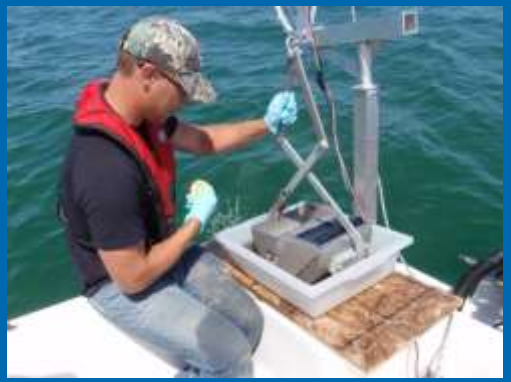


- 7,868 sq km of nearshore area.
- 137 total sites sampled
- 74 NCCA Base sites
  - 25 National Park Service Sites
  - WDNR added 3 sites
- 63 Embayment sites

Coastal Condition Indexes

Water Quality Index:
- Water Clarity – Seechi, PAR
- DO, Temp, pH
- Chlorophyll *a*
- Nutrients (DIN, DIP,TP, TN)
- Enterococci

Benthic Index:
- Community Diversity
- Pollution Tolerant/Sensitive Species

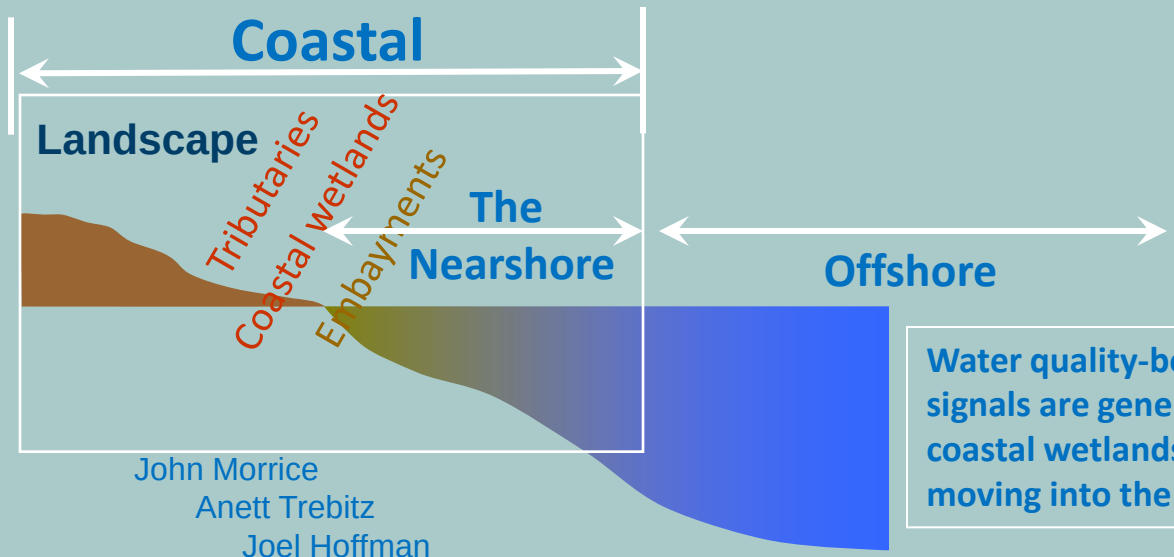


Sediment Quality Index:
- Toxicity (10-day amphipod survival)
- Contaminants
- TOC
- Grain Size

Fish Tissue Contaminant Index:
- Whole-Fish Contaminant Burden – same as Sed chem
- Fillet – Fish Contaminant Burden (Great Lakes Only)
  - Hg, PFCs, PBDEs, Pharmaceuticals

How do we efficiently assess the vast and diverse aquatic resources of the Great Lakes coastal zone?

Can we link conditions in watersheds and coastal receiving systems, to develop stressor/response relationships and to use coastal systems as lake sentinels?



Water quality-borne landscape signals are generally strongest in tributaries, coastal wetlands and embayments and become weaker moving into the "open" nearshore and the lake.

John Morrice
Anett Trebitz
Joel Hoffman
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Mike Knuth
Greg Peterson
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Peder Yurista
Jill Scharold

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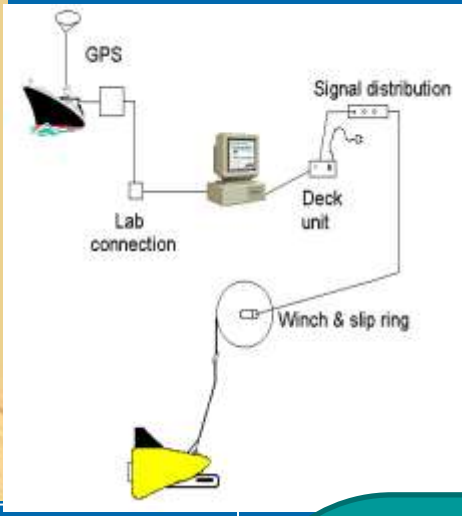
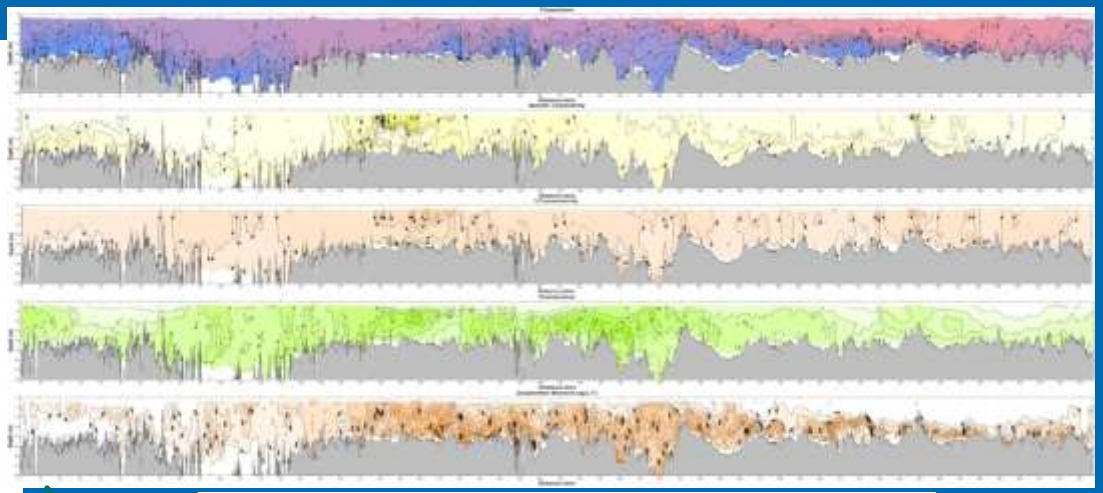
Nick Danz , Gerry Niemi, Lucinda Johnson, George Host, Rich Axler, Euan Reavie (NRRI/UMD), Jan Ciborowski (U Windsor)
Paul Horvatin, Glenn Warren, James Schardt, Paul Bertram, Karen Rodriguez (Region 5/GLNPO)
EPA Office of Water, Regions 2, 3, 5, 9
USGS, USFW, Ontario Ministry of Natural Resources, 8 GL States, many Academics
Bi-National Cooperation, Environment Canada, Division of Fisheries and Oceans
Lake Superior LaMP (EPA, States, Province), 5 Lakes Coordinated Science and Monitoring Initiative

Proof of concept

- Yurista and Kelly, 2004
  - use of towed sensors to monitor the nearshore defined as 20 m contour is feasible
  - gradients and spatial patterns are evident in tow data
- P. Yurista, personal communication
  - repeated tow over a transect, separated in time, displays qualitatively similar patterns

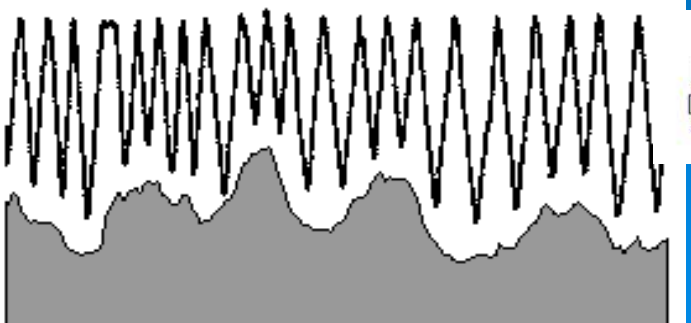




Sensors

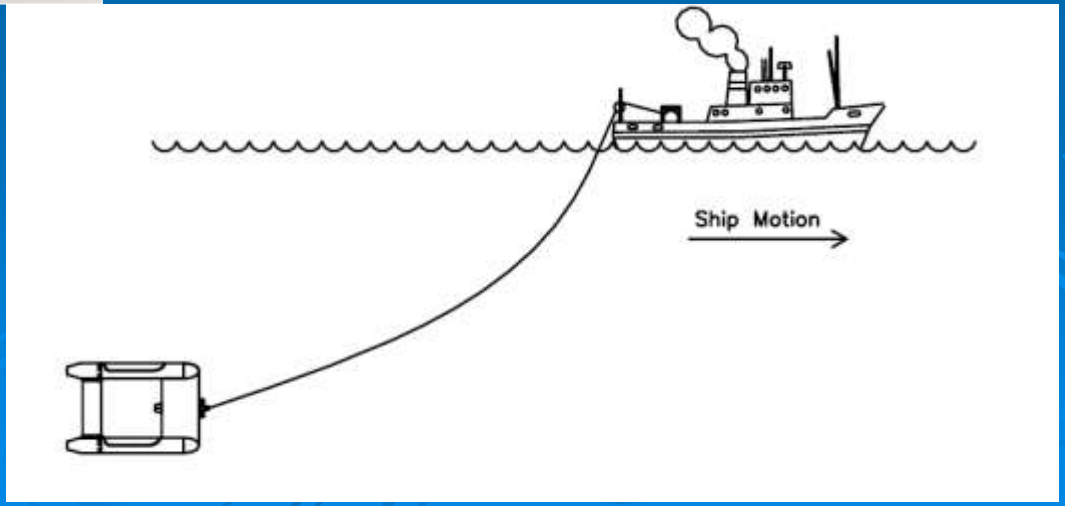
CTD
Fluorometer
(calibrated to Chl *a*)
Transmissometer
Laser Optical Plankton Counter
(Zooplankton >150 µm)
NO_3

High-resolution data
along 500 to 1000 km of shoreline



Shoreline towing survey strategy
Evolved to be along constant depth contour

TRIAXUS 3D Towed Undulating Vehicle



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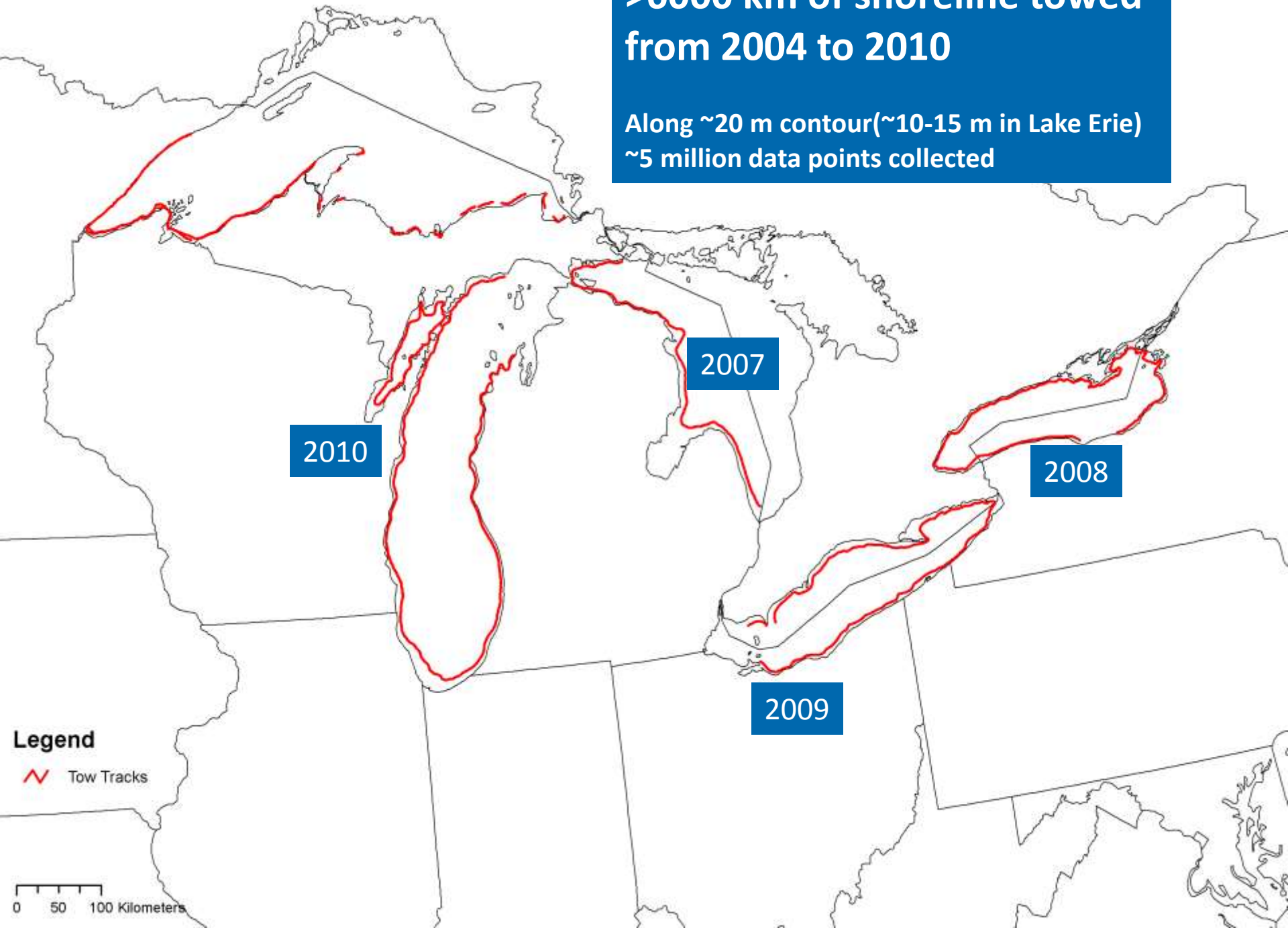
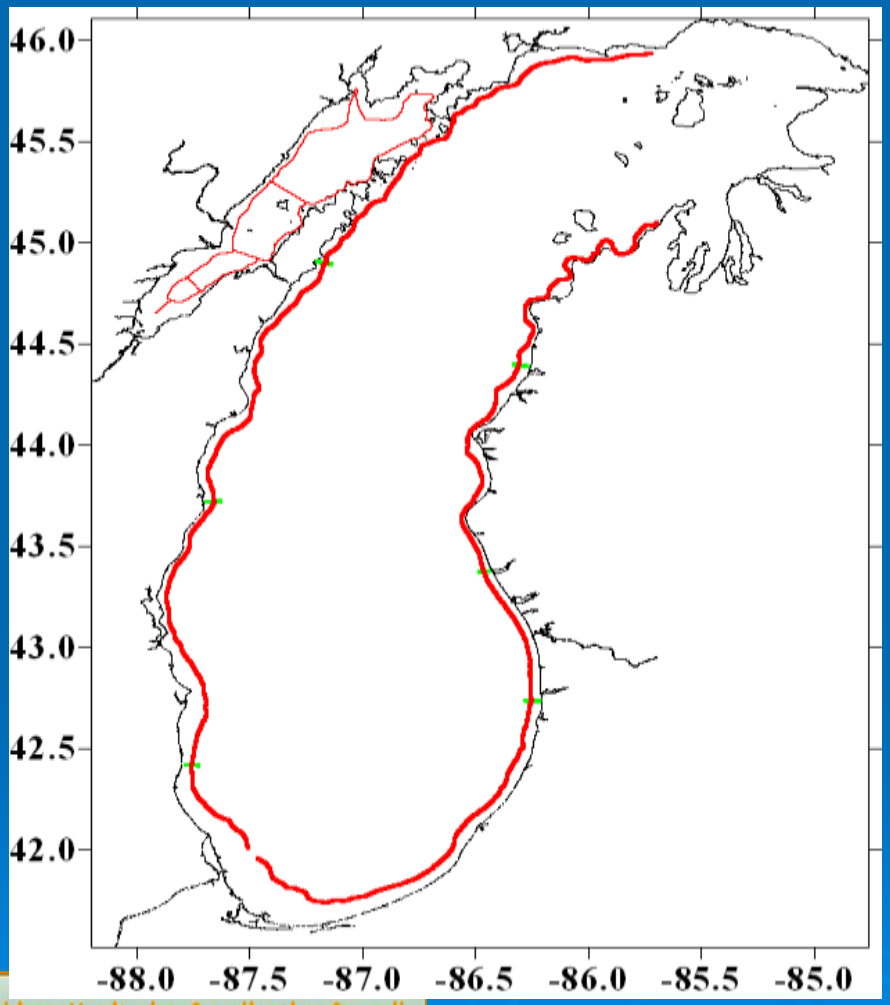
>6000 km of shoreline towed from 2004 to 2010

Along ~20 m contour(~10-15 m in Lake Erie)
~5 million data points collected



USEPA Lake Michigan 2009 20 m contour Triaxus tow



Sensor suit: CTD (conductivity, temperature, depth), Fluorometer, Transmissometer, Laser Optical Plankton counter , (and limited NO_3 sensor)

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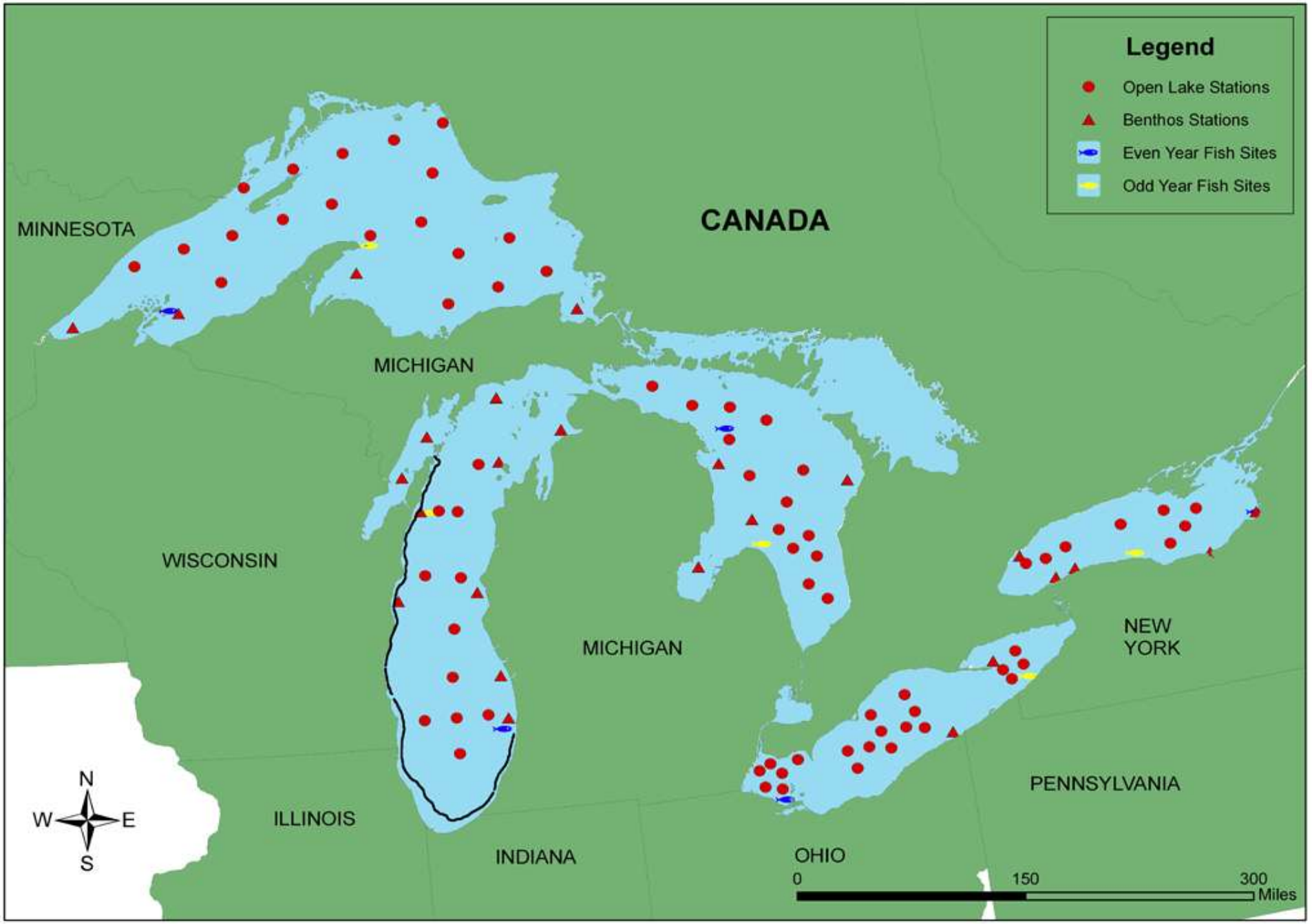
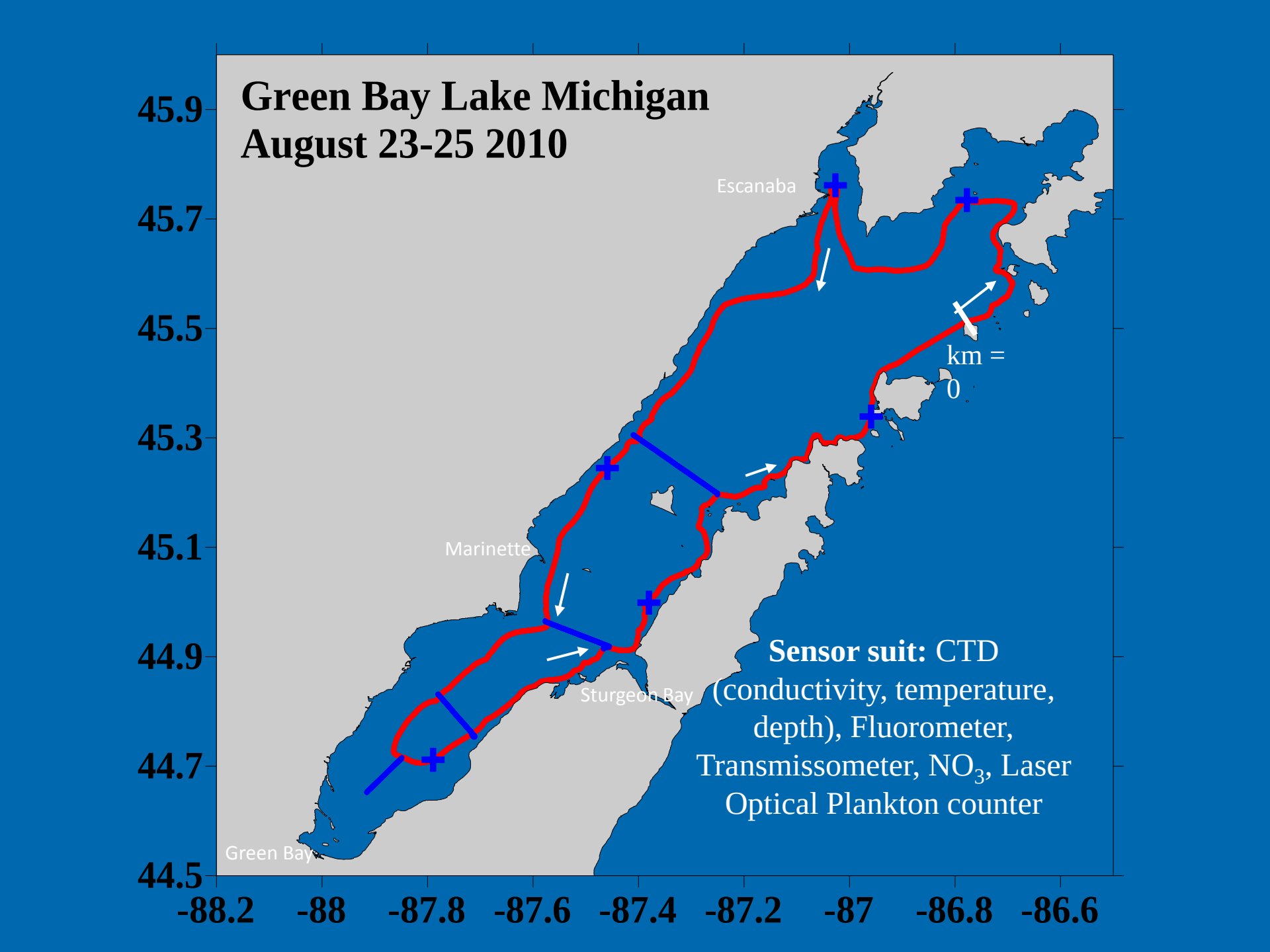
2009 Lake Michigan Nearshore Tow




Green Bay Lake Michigan
August 23-25 2010
Escanaba
Marinette
Sturgeon Bay
Green Bay
km = 0
Sensor suit: CTD (conductivity, temperature, depth), Fluorometer, Transmissometer, NO_3, Laser Optical Plankton counter
45.9
45.7
45.5
45.3
45.1
44.9
44.7
44.5
-88.2
-88
-87.8
-87.6
-87.4
-87.2
-87
-86.8
-86.6

Difficulties with Nearshore Monitoring

- Highly variable region
- Need methods to quantitatively define features and spatial patterns
- Determine how sensor information is to be weighted
- Tows over same transect, separated in time, are not replicates - not quantitative

Nearshore Variability

- Horizontal and vertical variability
- Currents, internal waves and strong winds
- Persistent spatial patterns

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Addressing Monitoring Concerns of Annual Comparisons

- Spatially consistent patterns in time
  - survey periods consistent for each lake
  - Lake Michigan – immediately after July 4
  - Lake Superior – approximately August 30

Tributary Monitoring Project Objectives

- Provide baseline information on contaminant loads at major Great Lakes tributaries,
- Provide quantifiable measures of restoration progress on major Great Lakes tributaries,
- Model potential load changes throughout the Great Lakes,
- Begin to implement the National Monitoring Network (NMN) design for the Great Lakes.

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Monitoring Design - Rivers

- 59 NMN river sites - toxic contaminant baseline
- 30 NMN river sites - automated monthly plus high flow sample collection and continuous sensor measurements to forecast/nowcast sediment and nutrient loads
- 17 NMN river sites - chemicals of emerging concern baseline
- 15 AOC sites – Toxics in Sediments
- 8 NMN river sites – pathogens and virus baseline

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Hydro SPARROW

- USGS developed Hydro SPARROW – a GIS link between SPARROW (a water-quality model) and WATER/PRMS (water-quantity models)
- Use Hydro SPARROW to provide an estimate of phosphorus and nitrogen loading to the Great Lakes under a variety of land use and climate change scenarios

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Contaminants of Emerging Concern

- The goal is to better understand emerging contaminants with respect to source, routes of exposure and impact to fish and wildlife within the Great Lakes.
- A GLRI funded, landscape level effort conducted at AOCs across the Great Lakes and two FWS regions (7 sites in total). Working jointly with USGS.
- Fish collection for effects endpoints plus sediment, water and tissue for chemical analysis.
- Approx. 150 analytes that include pharmaceuticals, flame retardants, personal care products and more.
- Analyze Herring Gull eggs at select sites via MDEQ, FWS, and Clemson/Unv. of Maryland ongoing efforts.

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Contaminants of Emerging Concern

- Sample locations in the Lake Michigan Basin include Lower Fox River AOC and Milwaukee Harbor AOC.
  - 20 Smallmouth bass collected from the Lower Fox River site,
  - 20 Smallmouth bass and 20 white suckers collected at Milwaukee Harbor,
  - Sediment and water samples collected concurrently by USGS
- Analytical Results are pending

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Bald Eagle Monitoring in the Great Lakes Basin

- Long-term, cooperative effort between the FWS (Dave Best), MI DNR (Dennis Bush), Clemson/Unv.of Maryland (Bill Bowerman) and Michigan State University (Jim Sikarskie)
- Objective—Evaluate eagles as indicator of the environmental effects of contaminates and as a sentinel of Great Lakes water quality and health of the aquatic environment.
- Analysis of eagle blood for pesticides, PCB's, heavy metals, parasites and mercury, along with collection of eggs, feathers, and general health status.

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Bald Eagle Monitoring in the Great Lakes Basin

- Efforts in the Lake Michigan watershed in 2011 include*:
  - 65 breeding sites visited
  - 49 breeding areas where eaglets were sampled
  - 80 eagles banded
  - 79 eaglets yielding blood for contaminate and DNA analysis
  - 77 eaglets yielding breast feathers for Hg analysis
  - 33 adult feather samples

*Source: Bald Eagle Biomonitoring team: Dave Best, Bill Bowerman, Dennis Bush, Jim Sikarskie

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BEM: Conclusions of Ongoing Efforts

- ✓ Bald eagle population has recovered
- ✓ Organochlorine compounds have declined
- ✓ Mercury concentrations are increasing
- ✓ Fisheries management can impact reproduction on some nests
- ✓ HOWEVER, Still see a sink-source around the Great Lakes shoreline

*Source: Bald Eagle Biomonitoring team: Dave Best, Bill Bowerman, Dennis Bush, Jim Sikarskie

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Lakewide Management Plan Support: USGS Web Mapping of Existing Lake Metadata

- Lots and lots of data / data coordination

	A	B	C	D	E	
1	**Organization**	**Dates**	**Objective of monitoring/survey/research**	**Resource Component Sampled**	**Media Sampled**	**Pa**
2	U.S. EPA GLNPO	April 2010, August	Annual water quality survey; benthic sampling; TRIAXUS will be towed	Nearshore; offshore or connecting lakes (i.e. drowned river mouths)	Water; sediment	chloride, nitrate, phosphorus, chl depth, D.O., ma
3	U.S. EPA ORD Mid-Continent Ecology Division Duluth	Aug-Sept 2010	1-High-resolution nearshore sampling by towed in situ sensors; nearshore data will be examined relative to GLEI watershed charcaterization to formulate an Integrated Coastal Observing system that links landscape and nearshore conditions. Could benefit from related tributary efforts. 2-Additional sampling at subset of NCA sites for Lake Michigan	Nearshore. Towing will be coordinated with GLNPO to achieve maximize shoreline coverage. This will complete a cycle of ORD US shoreline coverage for all lakes 2004-2010	Water for towing. Some sediment and tissue samples at NCA sites; tbd	Sensors: CTD, LOPC. And ass stations/calibrati camera and do s components at N
4	USGS IN Water Science Center	Ongoing	Streamgages at mouth of a number of tribs:	Tributaries	Water	Streamflow and
5	USGS IN Water Science Center	Ongoing	Science data for NPS wetland restoration work	Surface and shallow ground-water level	Water	Water levels, su
6	MDEQ-USGS	2010	Long-term monitoring for trends and/or loads	All major tributaries	Water	Nutrients, metal

Sheet1 Sheet2 Sheet3

Ready 100%

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Three phased approach to collecting the Activities Data

1. Studies submit their spatially referenced data via Excel Spreadsheet (and other spatial files as needed)
2. Submitted data are uploaded to database as it is received and made available on the Web Mapping Application
3. Web Services will be developed and made available to link the Activities Data to other data records and to the GLRI Data Network

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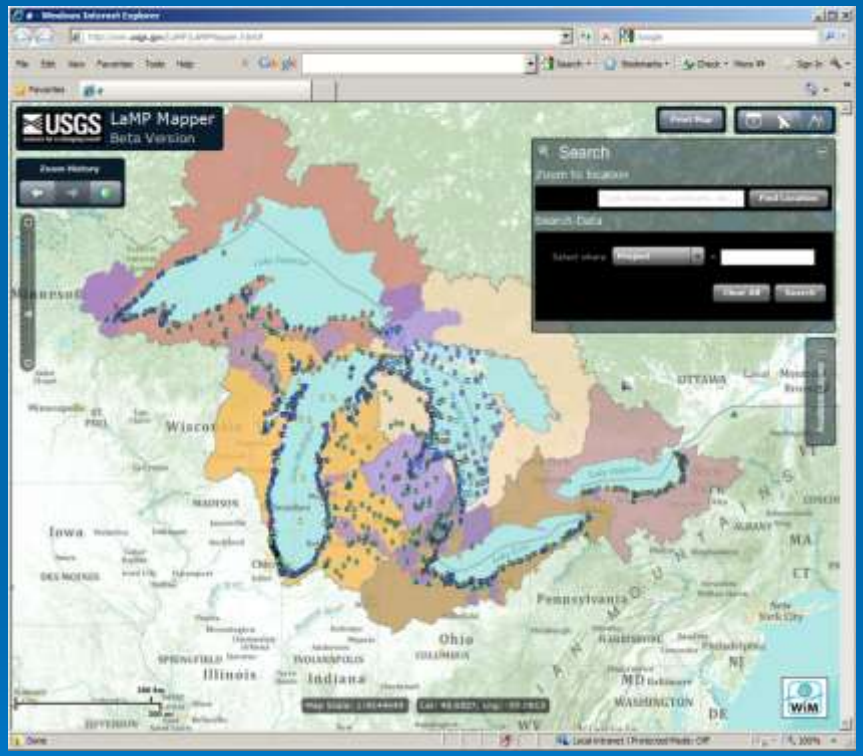
Lake Michigan data collection



- Studies have been loaded from the USGS GLRI effort
- Additional information will be added periodically
- Expanding to more lakes and Canada

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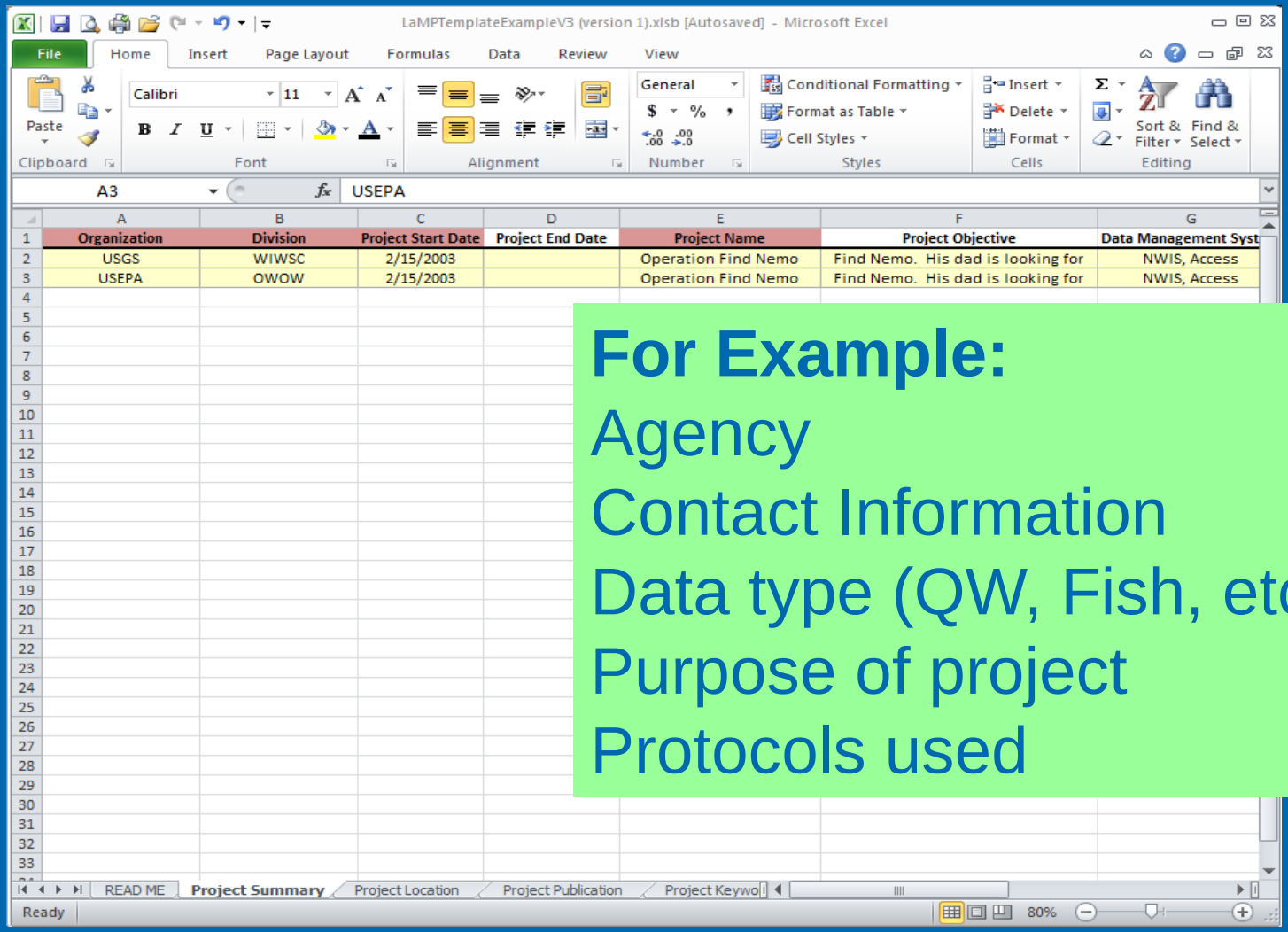
Project Summary Tab (project level)



For Example:

Agency

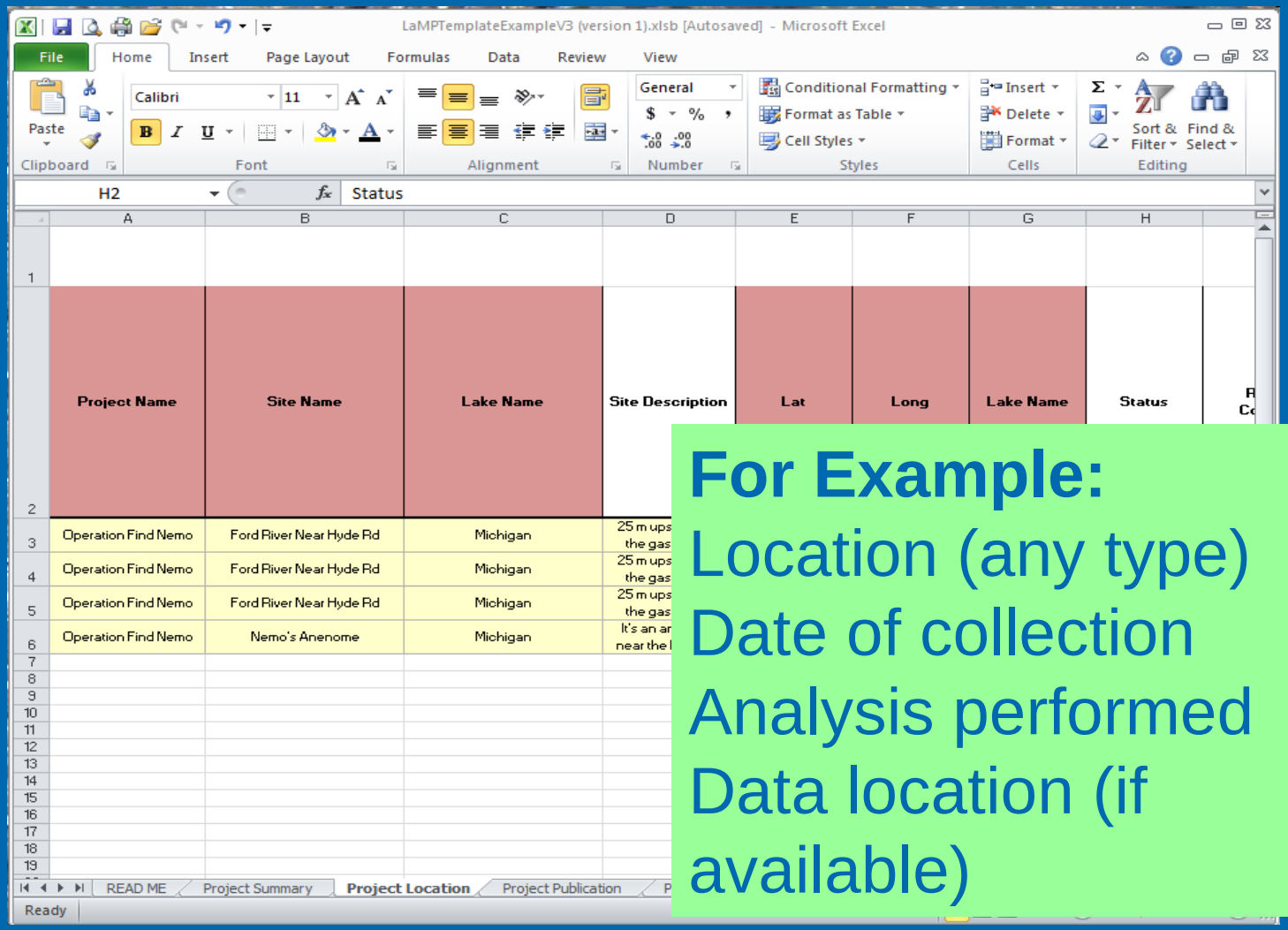
Contact Information

Data type (QW, Fish, etc.)

Purpose of project

Protocols used

Project Locations Tab (site level)



For Example:

Location (any type)

Date of collection

Analysis performed

Data location (if available)

Great Lakes Areas of Concern Beneficial Use Impairments

- Restrictions on Fish and Wildlife Consumption
- Tainting of Fish and Wildlife Flavor
- Degraded Fish and Wildlife Populations
- Fish Tumors or Other Deformities
- Bird or Animal Deformities or Reproductive Problems
- Degradation of Benthos
- Restrictions on Dredging Activities
- Eutrophication or Undesirable Algae
- Restrictions on Drinking Water Consumption or Taste and Odor Problems
- Beach Closings
- Degradation of Aesthetics
- Added Costs to Agriculture or Industry
- Degradation of Phytoplankton and Zooplankton Populations
- Loss of Fish and Wildlife Habitat

AOC Sampling Design and Data Management

- Application of existing designs (NMN, LMMB)
- Understand where the AOC is in the de-listing process
  - Knowledge of state and local de-listing targets/criteria
  - Use of appropriate indicators and methods
- Sampling locations
  - Consider establishing “control” sites
- Sampling duration/frequency
  - Must be aware of state and local de-listing criteria
- Quality assurance requirements
- Data generally entered into STORET
- No specific AOC database (but one being developed!)

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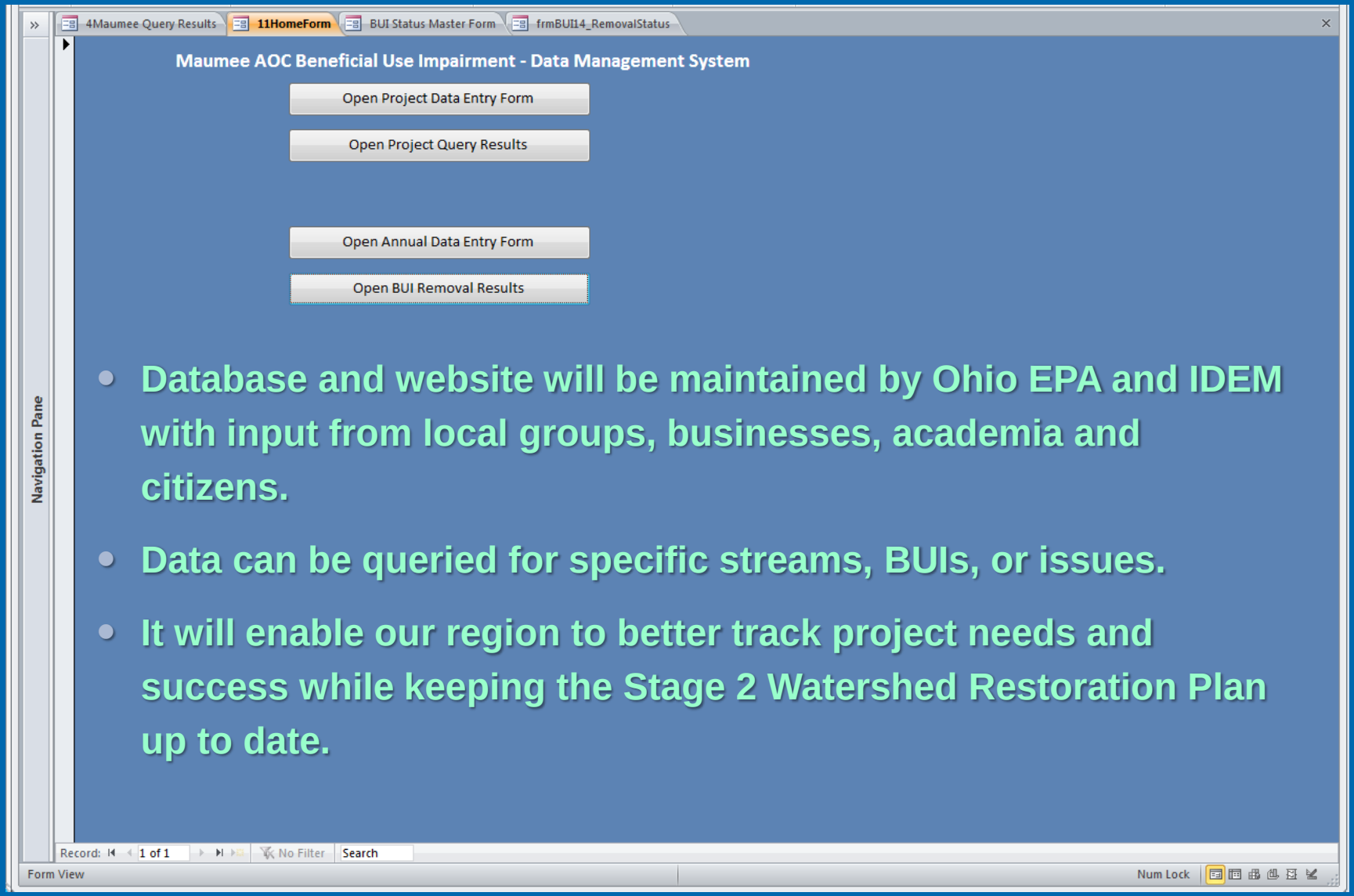
Data Management and Delisting System

- Goal of AOC program was to identify which stream segments or watersheds are impaired and guide the determination of projects needed for BUI removal and AOC delisting
- US EPA funded the development of Information Management Systems for AOC planning and management
- Newly designed system manages analytical data on AOC Beneficial Use Impairments
- Developed on a pilot basis for the Maumee River and Grand Calumet River AOCs

The Database Homepage



- Database and website will be maintained by Ohio EPA and IDEM with input from local groups, businesses, academia and citizens.
- Data can be queried for specific streams, BUIs, or issues.
- It will enable our region to better track project needs and success while keeping the Stage 2 Watershed Restoration Plan up to date.

Lake Michigan Ecosystem Modeling and Forecasting Working Group

- Improve ability to implement ecosystem-based management
- Increase lakewide capacity to address issues
- Improve usefulness and functionality of models
- Improve decision-making
- Advance field of modeling and forecasting

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Slide Credit: Sarah Maples, GLOS

Participating Organizations

Fields of Expertise

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Recommended Activities

- Visioning and proactive management (modeling and forecasting)
- Share expertise, data and resources
- Identify best practices, gaps and continuities
- Set standards and priorities

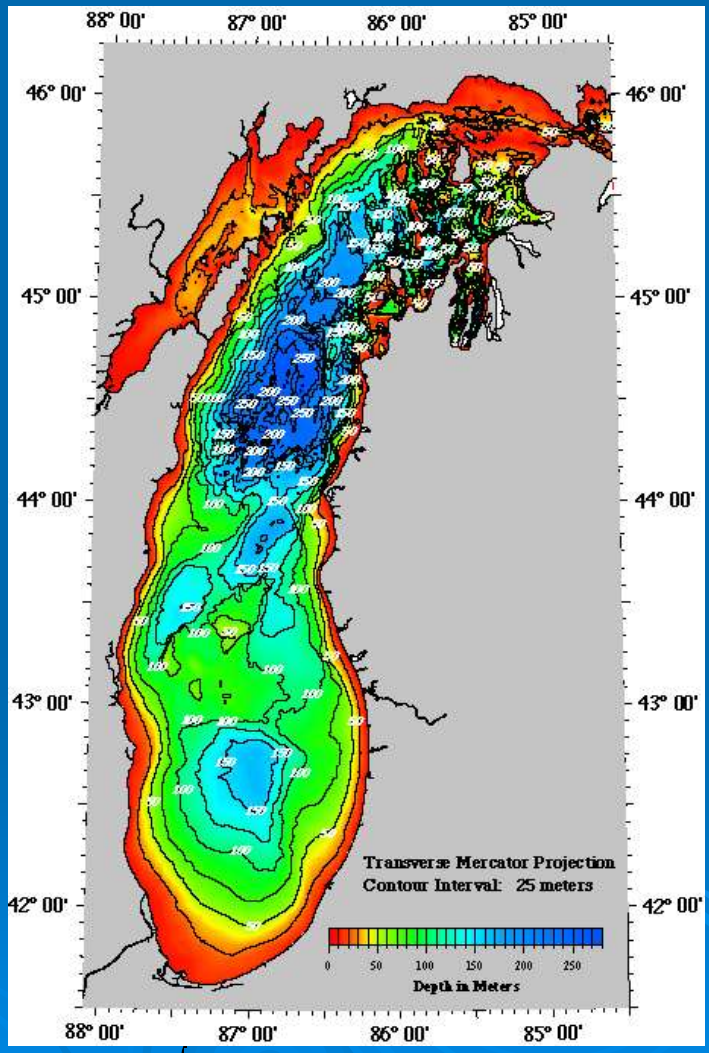

Image: NOAA Great Lakes Data Rescue Project

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Recommended Activities

- Provide forum for joint problem solving to:
  1. Meet resource manager needs
  2. Determine appropriate modeling approaches
  3. Support product development and delivery

Photo: EPA

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Investigating Botulism Mechanisms in the Lake Michigan Nearshore: Food Web Structure and Oxygen Dynamics

Emily Tyner, Harvey Bootsma,
Brenda Moraska Lafrancois, Chris Otto

Cooperating Agencies and Universities

Hypothesized Pathway

Adapted from Ruffing (2004)

Botulism Study: Summer 2011

- Benthic monitoring station: time lapse camera, temp, dissolved oxygen (DO), pH, current, turbidity, chlorophyll, light logger
- Monitor DO conditions in mussel beds and lab experiments
- High frequency testing of benthic material for presence of the botulinum toxin gene
- High frequency monitoring of gobies, cladophora, mussels, invertebrates along depth transects

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TMDLs and LMMCC could inform each other

LMMCC to TMDLs

- Flow Data under various climatic conditions and multiple years
- Water chemistry and biology data (ideally taken at the same time) and over space and time
- For Bacteria TMDLs- Wet weather flow and accompanying bacteria data.
- Where sediment toxicity is a suspected cause- sediment toxicity data and the pollutant species and quantity that occur in urban runoff.

TMDLs to LMMCC

- Identification of pollutant sources and their relative contribution to a water
- Watershed characterization (land use, soils, erodibility)
- Amalgamation of secondary physical, chemical, and biological data available in the watershed
- Modeled current loads of sediment, phosphorus, and/or bacteria discharging to Lake Michigan and its tributaries

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Ruddiman Creek, MI
Flow and Water Quality Sampling

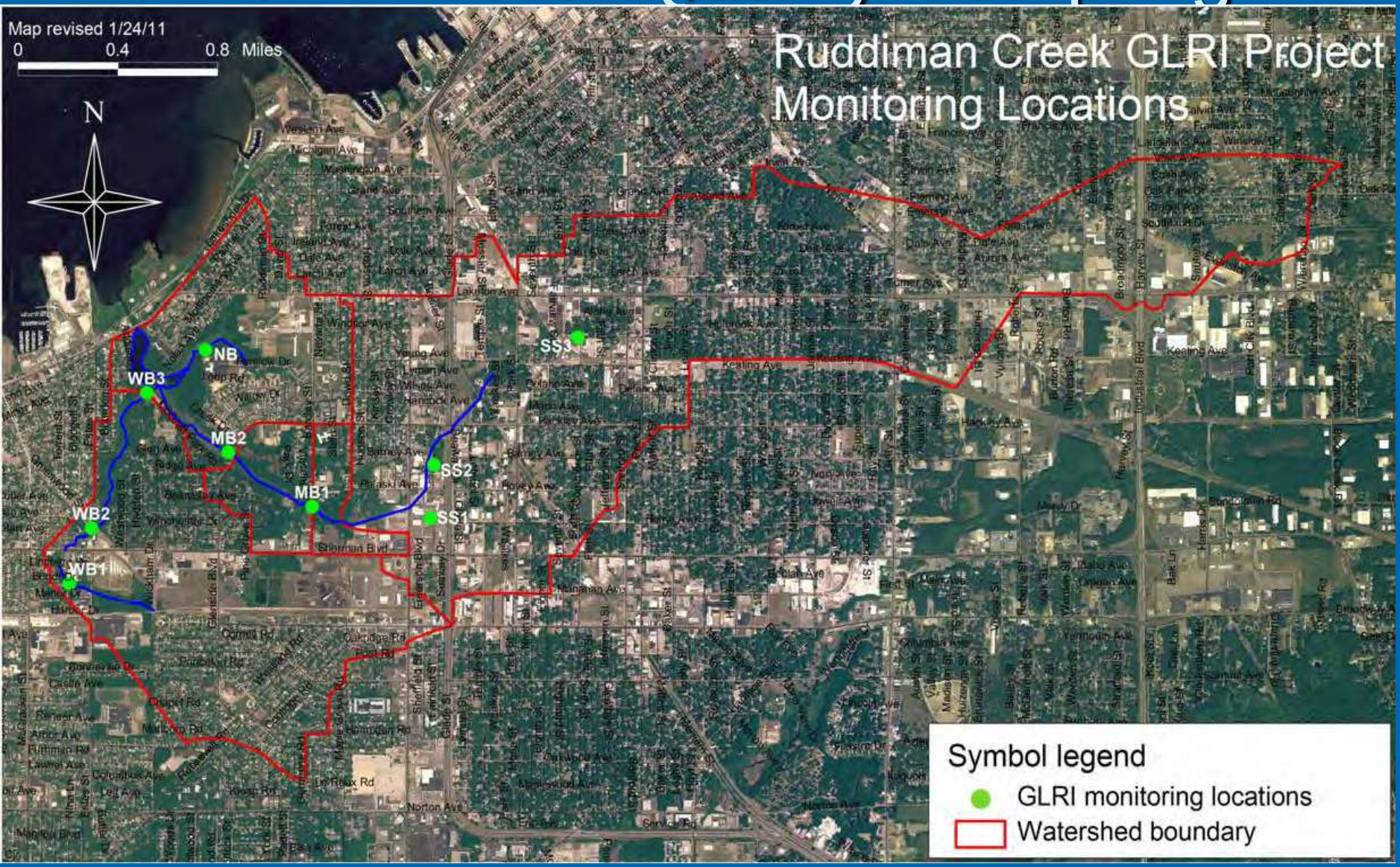

Image from AWRI-Grand Valley State University

Water Availability and Use: USGS Great Lakes Basin Pilot

- How much water is withdrawn and how much water is used in the Great Lakes Basin?
- How does use vary in time and space across the basin?
- Future water availability depends on groundwater, surface water, and current water use.

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For More Information

- **LMMCC new website**
  - **http://www.glc.org/lmmcc/**
- **John Hummer (GLC)**
  - **734-971-9135 or jhummer@glc.org**
- **Judy Beck (USEPA GLNPO)**
  - **312-353-3849 or beck.judy@epa.gov**
- **Charlie Peters (USGS)**
  - **608-821-3810 or capeters@usgs.gov**
- **Gary Kohlhepp (MDEQ)**
  - **517-335-1289 or kohlhepg@michigan.gov**

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