



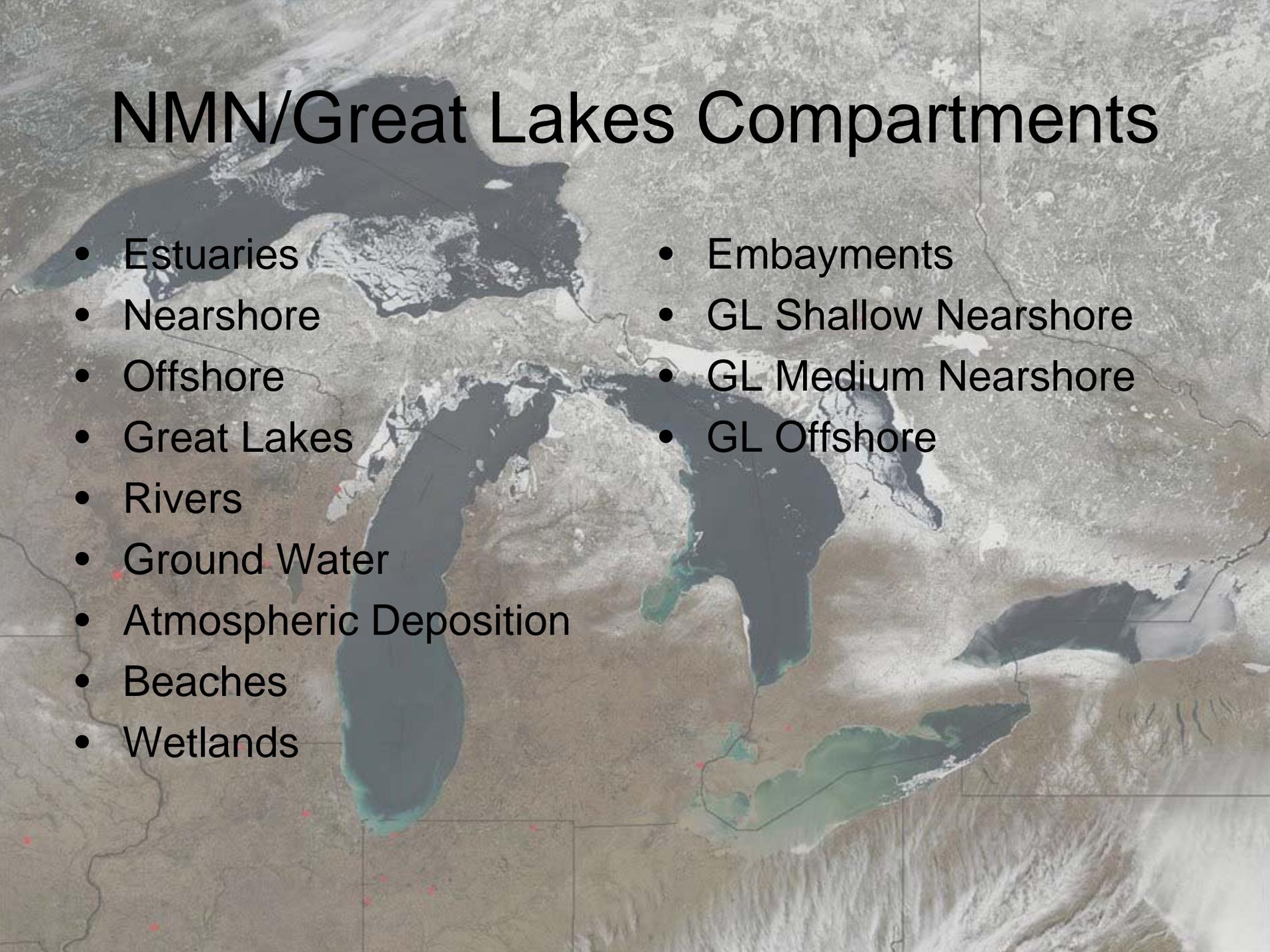
Lake Michigan Pilot

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The Lake MI Watershed



NMN/Great Lakes Compartments

A satellite-style map of the Great Lakes basin in North America. The map shows the five Great Lakes (Superior, Michigan, Huron, Erie, and Ontario) and the St. Lawrence River. Various compartments are highlighted with different colors: dark blue for the Great Lakes, light blue for nearshore areas, green for shallow nearshore areas, and brown for offshore areas. The surrounding land is shown in shades of brown and tan, with some red dots indicating specific locations.

- Estuaries
- Nearshore
- Offshore
- Great Lakes
- Rivers
- Ground Water
- Atmospheric Deposition
- Beaches
- Wetlands

- Embayments
- GL Shallow Nearshore
- GL Medium Nearshore
- GL Offshore

Lake Michigan Inventory

	Major effort	Minor effort
Embayments		11
Near-shore		6
Off-shore		3
Rivers	3	8
Ground Water		5
Atmospheric deposition	1	5
Wetlands	3	6
Beaches	1	5

Cost: Major is over \$1.0 million. Minor is less than \$1.0 million

Duration: Major is three or more years of ongoing monitoring. Minor is less than three years in duration.

Geographic Extent: Major indicates that an organization uses standard procedures and protocols over large areas

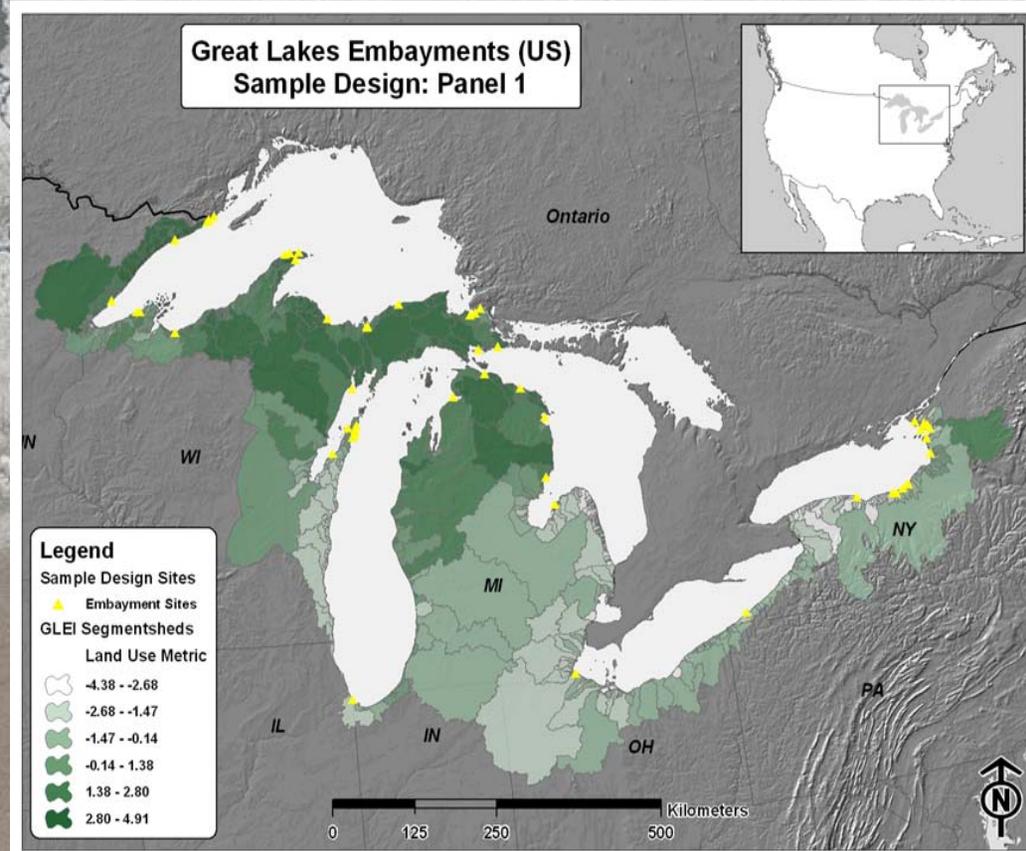
Great Lakes Embayments

- Lake Michigan (13)
 - Calumet Harbor, IN
 - Baileys Harbor, WI
 - Little Bay de Noc, WI
 - Moonlight Bay, WI
 - Ephraim, WI
 - Little Sturgeon Bay, WI
 - Rowley Bay, WI
 - Little Traverse Bay, MI
 - North Bay
 - Big Bay de Noc, WI
 - Milwaukee Harbor, WI
 - Suttons Bay, MI
 - Indiana Harbor, IN

- Sampling design not specified

- see

<http://glei.nrri.umn.edu>



Great Lakes Near-/Off-shore

Lake	Shallow Near-shore Boundary (m)	Medium Boundary (m)	% of Area	Near shore/Off- shore Bound- ary (m)	% of area within Near- shore	Mean Depth (m)
Superior	30		10.0	150	50.0	149
Michigan	30		25.9	80	51.4	85
Huron	20		25.1	50	51.9	59
Erie	10		19.5	20	54.8	19
Ontario	30		24.0	80	50.4	86

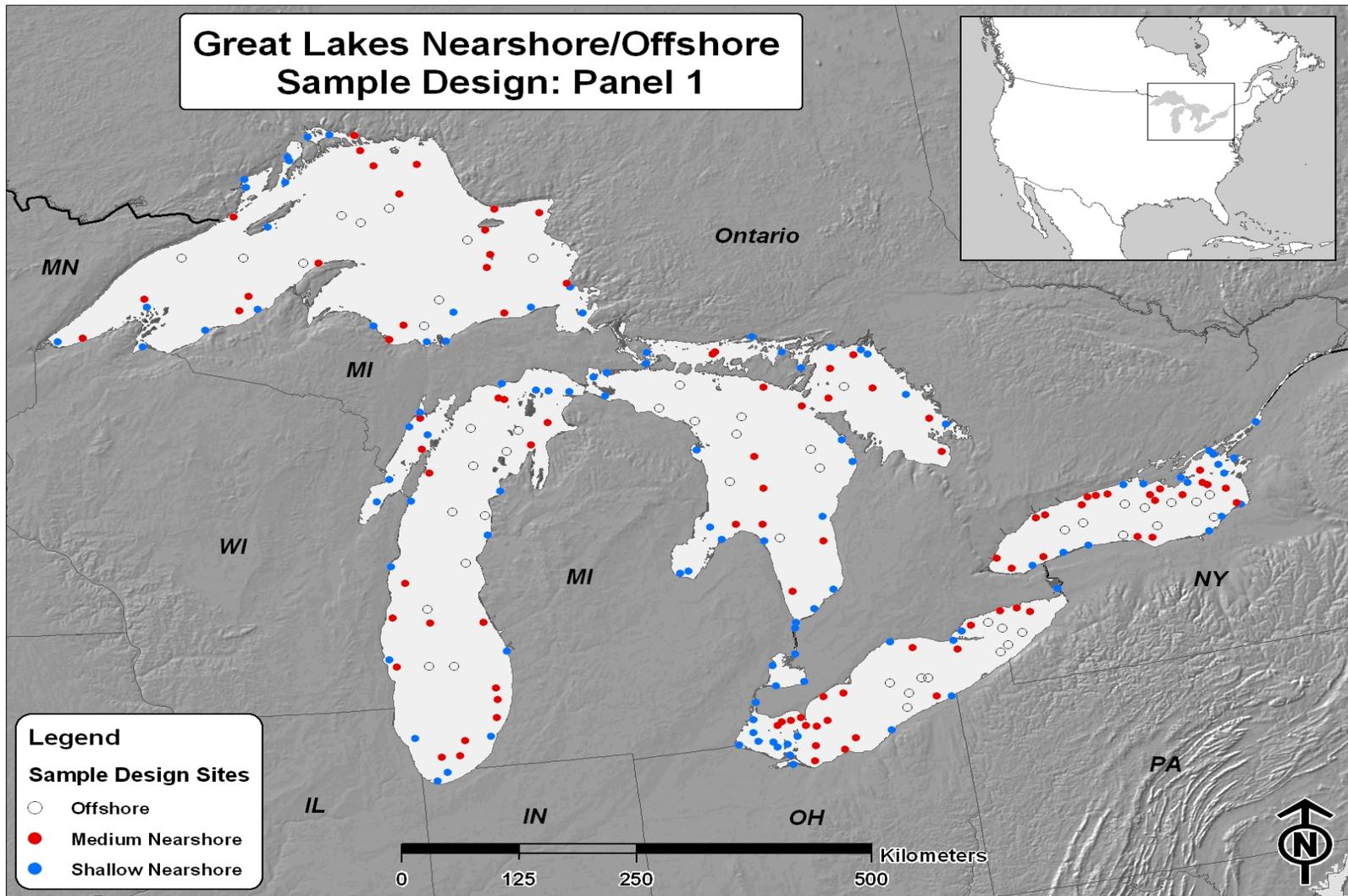
NMN Great Lakes Design

- Monitor condition of individual Great Lake and aggregate to GLOS reporting unit
 - 50 sample sites in each lake, depth stratified, 250 sites in GLOS per year, probability-based design assuring geographic coverage once per year on a five year rotation
- Monitor condition of individual lake
 - Variable number of sample sites per lake using existing shipboard surveys at fixed historical sites offshore; site selection by resource management agencies, sample frequency once or twice per year; ongoing (***No change to GLNPO limnology program***)
- Remote sensing and autonomous
 - Satellite, aircraft, in-water and shore-based sensors

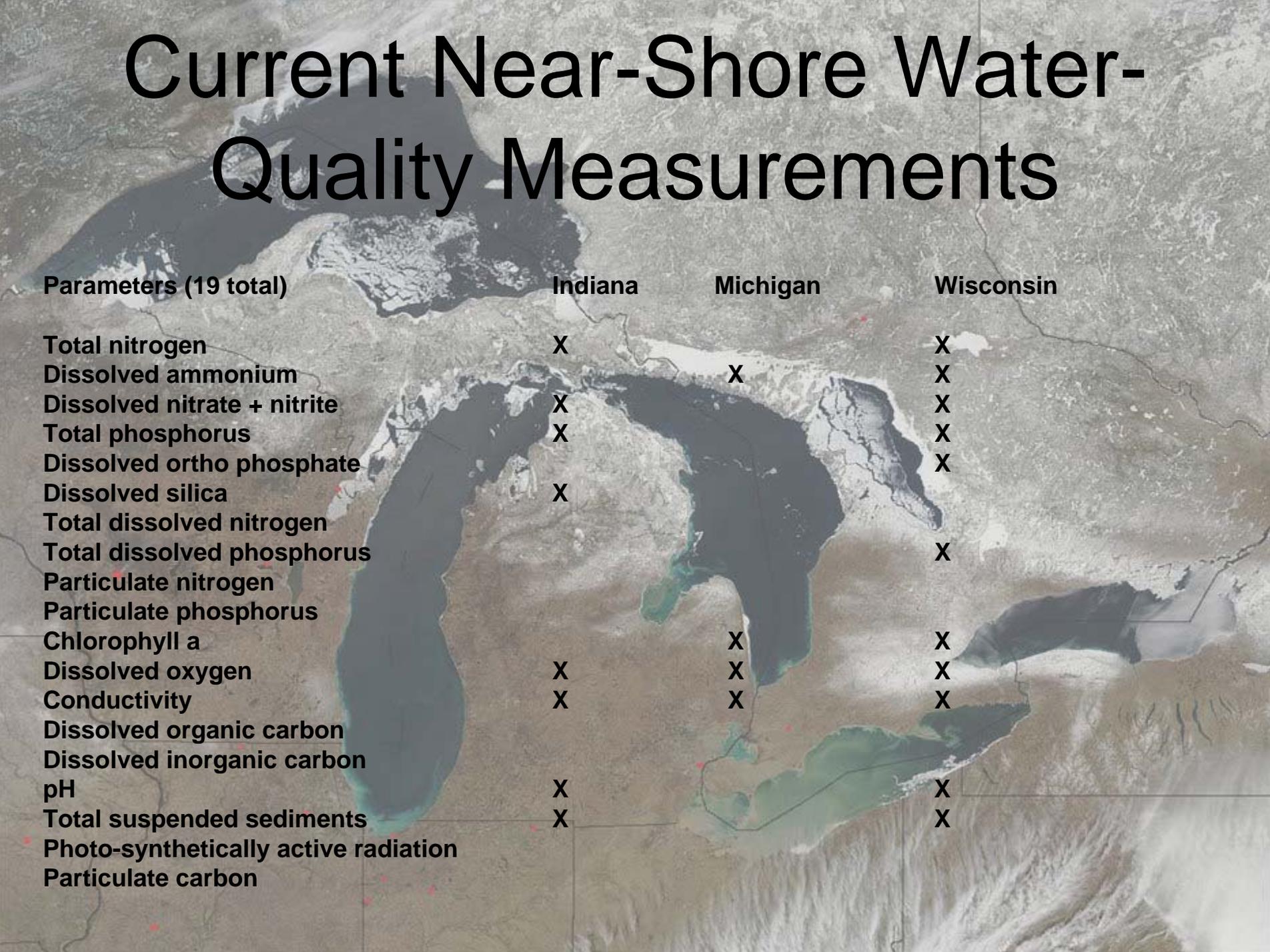
Near-Shore Design Measurements

- Lake stage, currents, wind, water-quality characteristics, major ions, nutrients, metals, total carbon, bulk organics, biological assessment
- Variable frequencies, some real-time
- Current monitoring entities: USEPA, NOAA, USGS, ILEPA, IDEM, WIDNR, UWGB, UWM, Grand Traverse Tribe, Oneida Tribe, GBMSD, MMSD, MDEQ

Nearshore/Offshore



Current Near-Shore Water-Quality Measurements

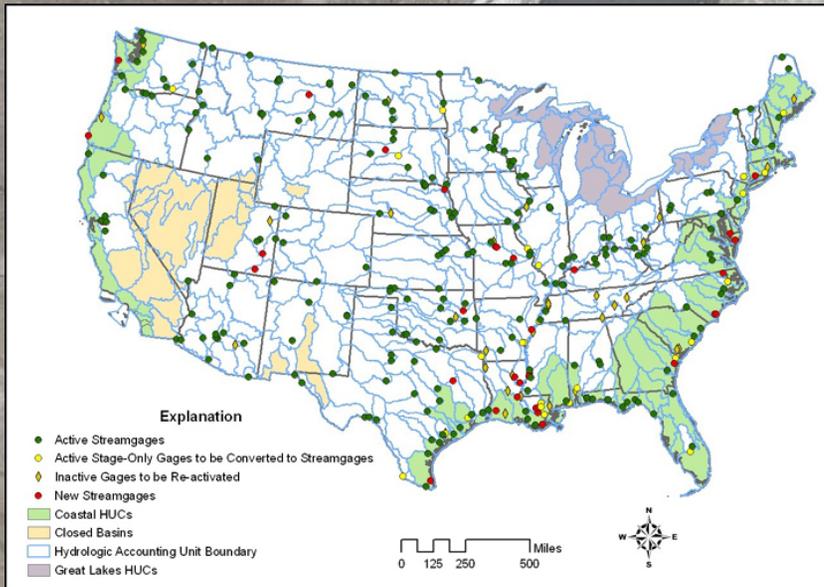


The background of the slide is a satellite-style map of the Great Lakes basin, showing the outlines of Lake Superior, Lake Michigan, Lake Huron, Lake Erie, and Lake Ontario. Red dots are scattered along the shorelines of the lakes, indicating the locations of water quality measurement stations. The map is overlaid with a grid of latitude and longitude lines.

Parameters (19 total)	Indiana	Michigan	Wisconsin
Total nitrogen	X		X
Dissolved ammonium		X	X
Dissolved nitrate + nitrite	X		X
Total phosphorus	X		X
Dissolved ortho phosphate			X
Dissolved silica	X		
Total dissolved nitrogen			
Total dissolved phosphorus			X
Particulate nitrogen			
Particulate phosphorus			
Chlorophyll a		X	X
Dissolved oxygen	X	X	X
Conductivity	X	X	X
Dissolved organic carbon			
Dissolved inorganic carbon			
pH	X		X
Total suspended sediments	X		X
Photo-synthetically active radiation			
Particulate carbon			

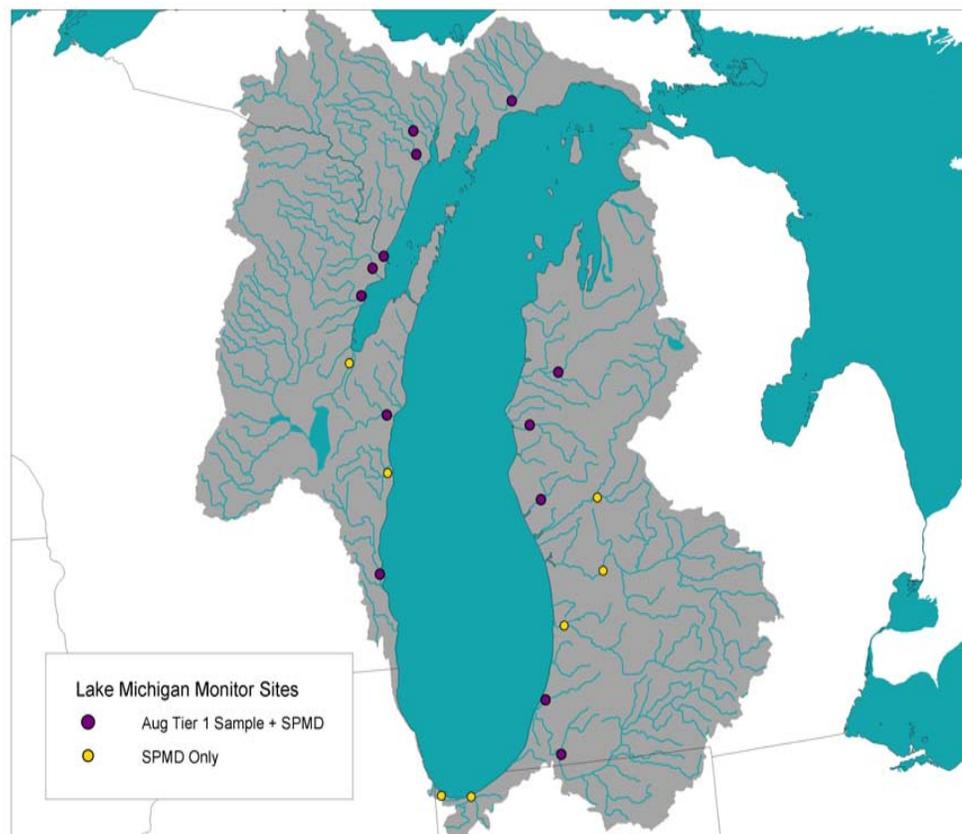
NMN Design Rivers

- HUC 6 national scale
- Lake Michigan HUC 8
 - (20 River Watersheds)



Lake Michigan Pilot Rivers Network

- Represent outflow of basins to the Great Lakes draining 250 square miles
- 20 sites in the network— Indiana (2), Wisconsin (6), Michigan (12)
- NMN Design – goal of 90% of inflow sampled (HUC 6 basins). The current design covers only 72% (HUC 8 basins).
- Primary river monitoring entities in the Lake Michigan Basin - USGS, States of Michigan (MDEQ), Wisconsin (WDNR), and Indiana (IDEM), and Illinois (IL EPA).
Secondary entities – Universities, Tribes, Sewerage Districts



Lake Michigan Pilot - Rivers

- None of the 20 sites include the complete analyte list and sampling frequency proposed in the NMN.
- All 20 sites have continuous flow monitoring (either at sampling location or upstream).
- 18 of the 20 sites have some water quality sampling.
- Currently about \$500,000 is spent by the Lake Michigan monitoring entities on flow and water quality monitoring.
- It is estimated to cost about \$1.2M (+) to reach the proposed NMN design.
- We are augmenting data collection (as much as we can with the USGS Pilot funds) to reach NMN Tier I Nutrient Level (full range of nutrients plus silica)

Atmospheric Deposition

Recommendations include:

- Passive sampling network – per Great Lakes Observing System (GLOS) recommendations.
- More urban data – per IADN peer reviews, national design, and GLOS.
- Screening and surveillance of newer chemicals (e.g. siloxanes) per GLOS, IADN, etc.
- Uniform or coordinated mercury network per the National Air Deposition Program (NADP), the Mercury Trends Network (See Appendix 10), GLOS, and the Great Lakes Air Deposition monitoring program (See www.glc.org/glad/pdf/MercuryReport_May07.pdf)

Embayments

- No comprehensive monitoring program focused specifically on embayments in the basin.
 - Currently, none of the Lake Michigan embayments are being measured for the suite of physical, chemical, and biological constituents recommended in the Network design report.
- Seven of 15 Lake Michigan embayments are not currently a part of any monitoring program.
- Various elements are sampled within a number of embayments as part of some other monitoring program.
- Recommendation: Continue planning for the 2010 National Coastal Assessment (the first to include the Great Lakes). Compare existing monitoring to national contaminant refinement workgroup recommendations.

Wetlands

- **Highly fragmented** – Not aware of any site that is conducting a complete wetland monitoring program in Lake Michigan and, thus, 100% of sites need to monitor additional analytes or parameters.
- More thorough monitoring and analysis: Great Lakes Coastal Wetlands Consortium (GLCWC) released GL Coastal Wetlands Monitoring Plan in March 2008 corresponding to the Tier III (intensive monitoring) recommended monitoring parameters.
- Protocols include assessment of wetland chemistry and landscape features, as well as biological indicators for fish, macroinvertebrates, vegetation, birds, and amphibians.
- With the establishment of these protocols, it is hoped that coastal wetland monitoring data will be less fragmented across the basin and more easily shared among agencies and organizations.
- **Needs funding – possibly coming from GLNPO**

Beaches

- Strategic monitoring that involves spatial, temporal, and source tracking methods is needed.
 - Improvements to beach water quality are accomplished with strategic monitoring in conjunction with a thorough knowledge of the beach and its watershed and a routine monitoring program.
- To develop more progressive monitoring strategies, limited funding for routine monitoring programs may need to be redirected towards start-up costs associated with improved technology, i.e., rapid testing methods

Groundwater – Drinking Water

The basic challenges and monitoring needs regarding drinking water are:

- To understand possible vulnerabilities in water sources and prepare protection plans (considerable challenges in southern Lake MI region due to growth/development)
- To monitor for possible new contaminants
- **To understand the implications of and monitor groundwater depletion in the basin as it relates to Lake Michigan**
- To educate the public on the hydrological cycle and the need for stewardship of both drinking water quantity and quality
- Need for Operations and Maintenance Plans for infrastructure
- Research needed on health effects of contaminants and safe levels established

Groundwater – Drinking Water

Management options include:

- Seek funding to develop a source water protection GIS system.
- Enhance local public water supply security
- Identify resources for public water suppliers to ensure that by 2011, 80% of the community water systems will be substantially implementing source water protection plans

NMN Management Questions

Lake Michigan Pilot Answers

- Where, how, and why are water quality conditions changing over time?
- States do river water quality monitoring
- Lake Michigan monitored >80 m
- Beach monitoring via Beach Act grants
- AOCs monitored via state 5 year rotation
- < 80 m depth at drinking water intakes and at southern end

NMN Management Questions Lake Michigan Pilot Answers Depends on Location

- Where/What are problems related to water quality?
- Beaches-pathogens
- Fish-contaminants
- Nutrient enrichment
- Nuisance algal blooms
- Habitat degradation
- Aquatic invasive species

NMN Management Questions

Lake Michigan Pilot Thoughts

- What is causing the problems?
 - Beaches-pathogens
 - Fish-contaminants
 - Nutrient enrichment
 - Nuisance algal blooms
 - Habitat degradation
 - Aquatic invasive species
- CSOs and SSOs
- Nonpoint sources of nutrients
- Increased loadings / changed P cycle in lake
- Legacy pollutants, limited testing
- Ballast water; migration; commerce
- Human society

NMN Management Questions

Lake Michigan Pilot Thoughts

- Are programs to prevent or remediate problems working effectively?



- **To date**, funding limited for AOC remediation – smattering of programs
 - Great Lakes Legacy Act funds contaminated sediment cleanup
- Limited monitoring data at remediation sites limits ability to answer management questions.
- TSCA ban on PCBs and FIFRA cancellations evident

NMN Management Questions

Lake Michigan Pilot Thoughts

An aerial photograph of Lake Michigan, showing the shoreline and surrounding land. Several red dots are scattered across the land, particularly in the western and southern parts of the lake, likely representing monitoring stations or research sites.

- What research activities are needed to support these important resources and ensure they are understood and sustainable?

- More nutrient monitoring of the shallow and medium nearshore for comparable metrics and source identification
- SPMD monitoring of regulated bioaccumulative toxic substances for a load metric not affected by changes in the food web
- Method development, computational toxicology, and rapid screening for pollutants

Lake Michigan Pilot Report

Contaminants Example

- Database began with NAWQA analyte list
 - WI Long Term Trends Ambient Water Quality Network
 - IL Lake Michigan Basin
 - IN Rotating Basin, Statewide Fixed Station
 - MI Water Chemistry Monitoring Program
 - GLNPO Limnology Program in Offshore
 - GLNPO Fish Monitoring Program
 - Integrated Air Deposition Network
 - NOAA Mussel Watch

Lake Michigan Pilot Report Contaminants

(cont.)

- All states monitor temperature, pH, chloride, cadmium, chromium, copper, nickel, sodium, zinc, PCBs in fish and/or water, and mercury in tissue and/or water
- Of these 11 common parameters, GLNPO reports total PCBs in its fish monitoring program, representing the off shore
- Mussel Watch and IADN reports on a congener-specific basis representing the shallow near shore and IADN also reports on a total PCB basis.

Lake Michigan Pilot Report Cost Summary

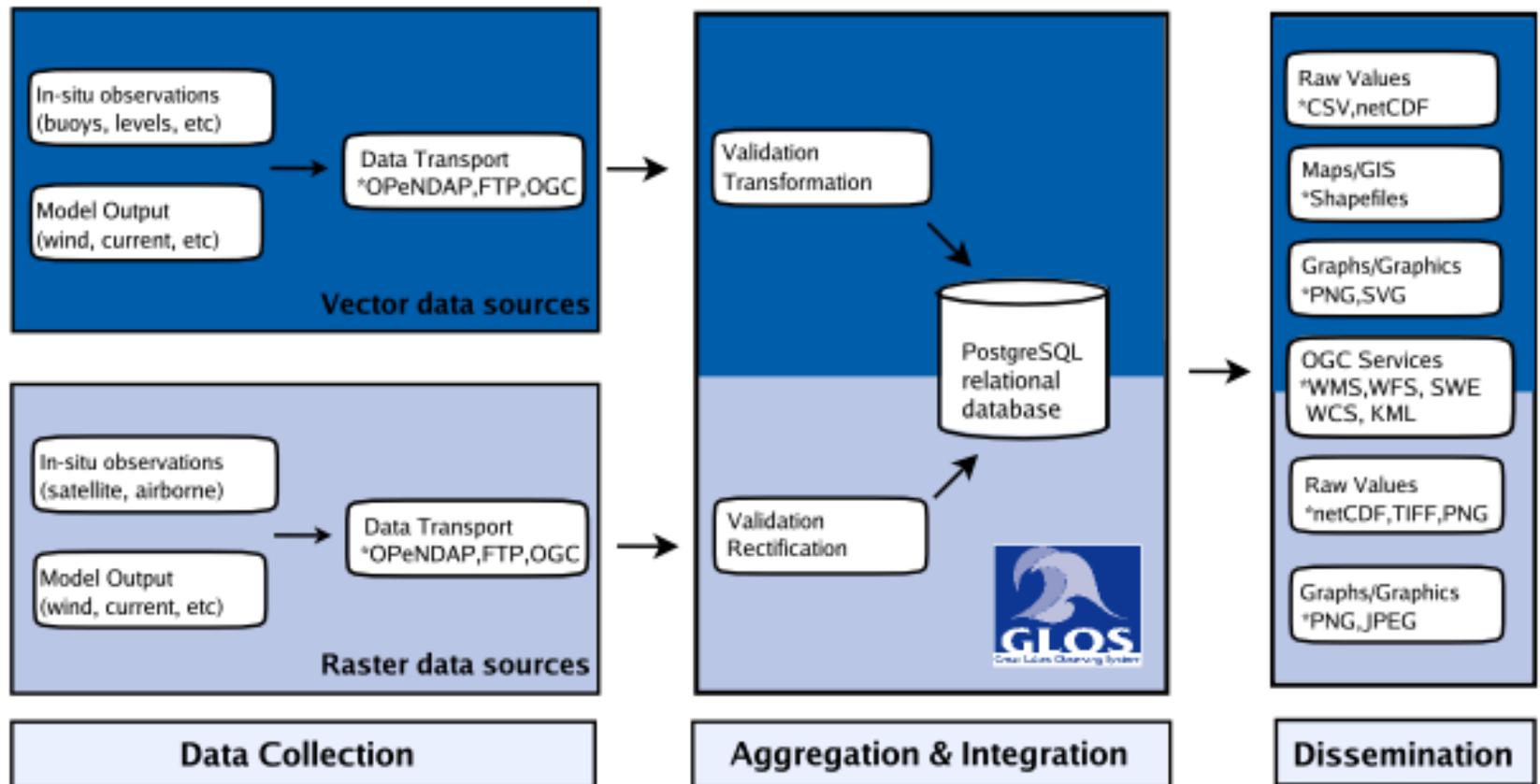
– \$25 million gap

- Shallow nearshore \$83,520 based on 21 IL EPA sites
- Medium nearshore unknown
- Offshore based on GLNPO <~ \$1 million/lake, unknown additional estimate for probabilistic
- Rivers \$500,000 being spent on 20 proposed sites, need \$1.2 million to fill gaps
- Groundwater \$12,000 for 5 existing wells, need 32 new wells – additional costs \$135,500
- Wetlands \$800,000 current estimate, unknown additional
- Beaches currently \$780,000, need \$2,528,400
- Atmospheric Deposition unknown

Relevance to IOOS - GLOS

- **GLOS Focus:** to meet critical information needs for priority issues that affect the health, ecological integrity and economic viability of the Great Lakes-St. Lawrence River region.
- Addresses some of the most pressing observing and monitoring shortfalls identified in recent reports from the U.S. GAO and within the Great Lakes Commission's Great Lakes Monitoring Inventory and Gap Analysis.
- The Data Management and Communications Plan of GLOS will serve as a blueprint and vehicle for implementing the data management and access recommendations of this Pilot Study. Rivers monitoring and specifically real time river monitoring will be an important addition to the GLOS-RCOOS.

GLOS Conceptual Data Flow



Acknowledgements

- USGS: Charlie Peters, Dale Robertson, Kevin Richards, Norm Grannemann, Gary Rowe, Sandra Morrison
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