

The Role of Ecological Research in Great Lakes Water Sustainability

A large-scale example...

“Development of a Great Lakes integrated coastal observing system”

Jack Kelly , US EPA Mid-Continent Ecology Division, Duluth MN
And literally dozens of others

>10,000 km of shoreline

Dynamic, variable, open boundary

Superior

Ontario

Huron

Erie

Michigan

Mississippi River



A Problem:

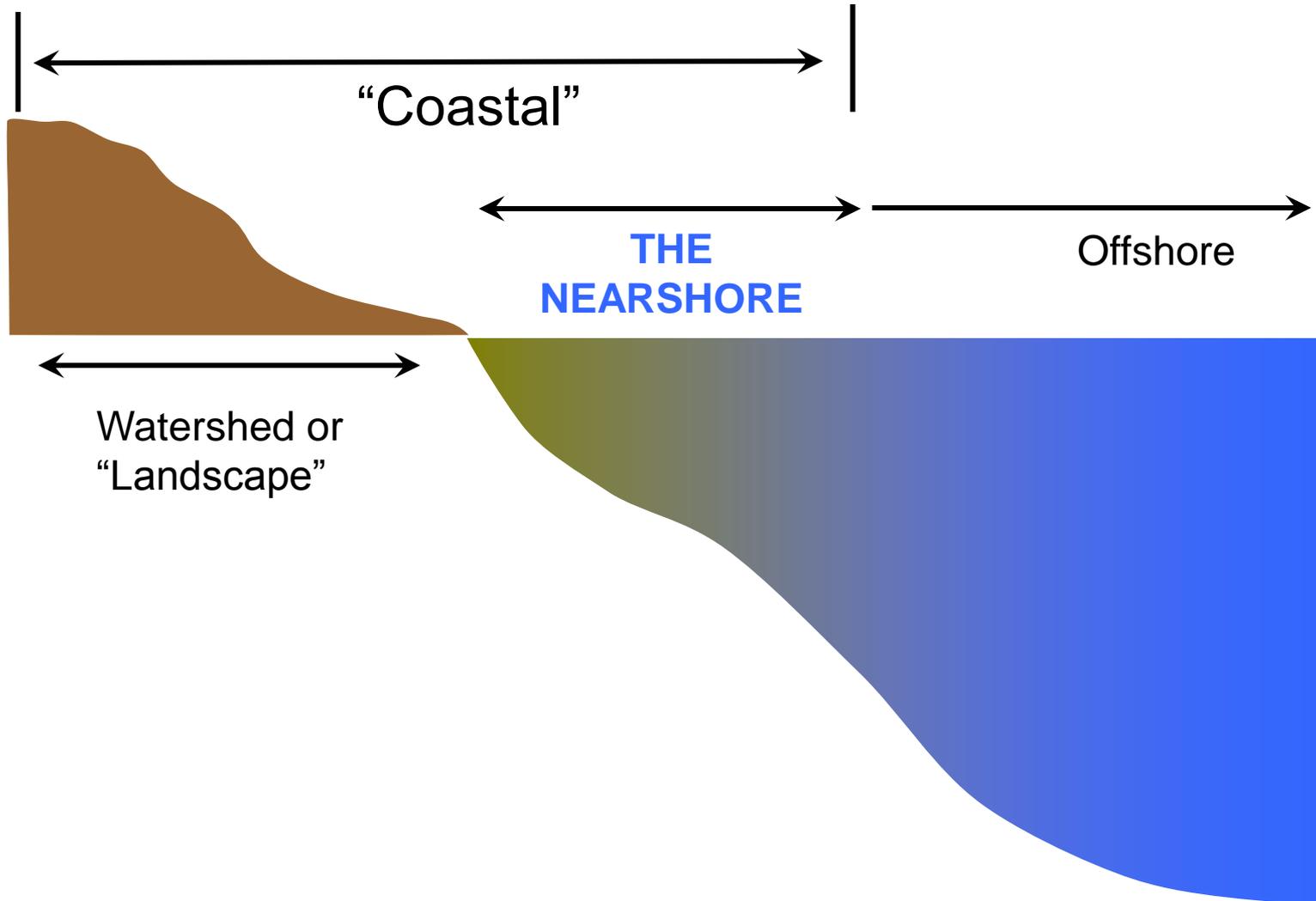
No existing GL
“Nearshore”
monitoring program

Two motivations:

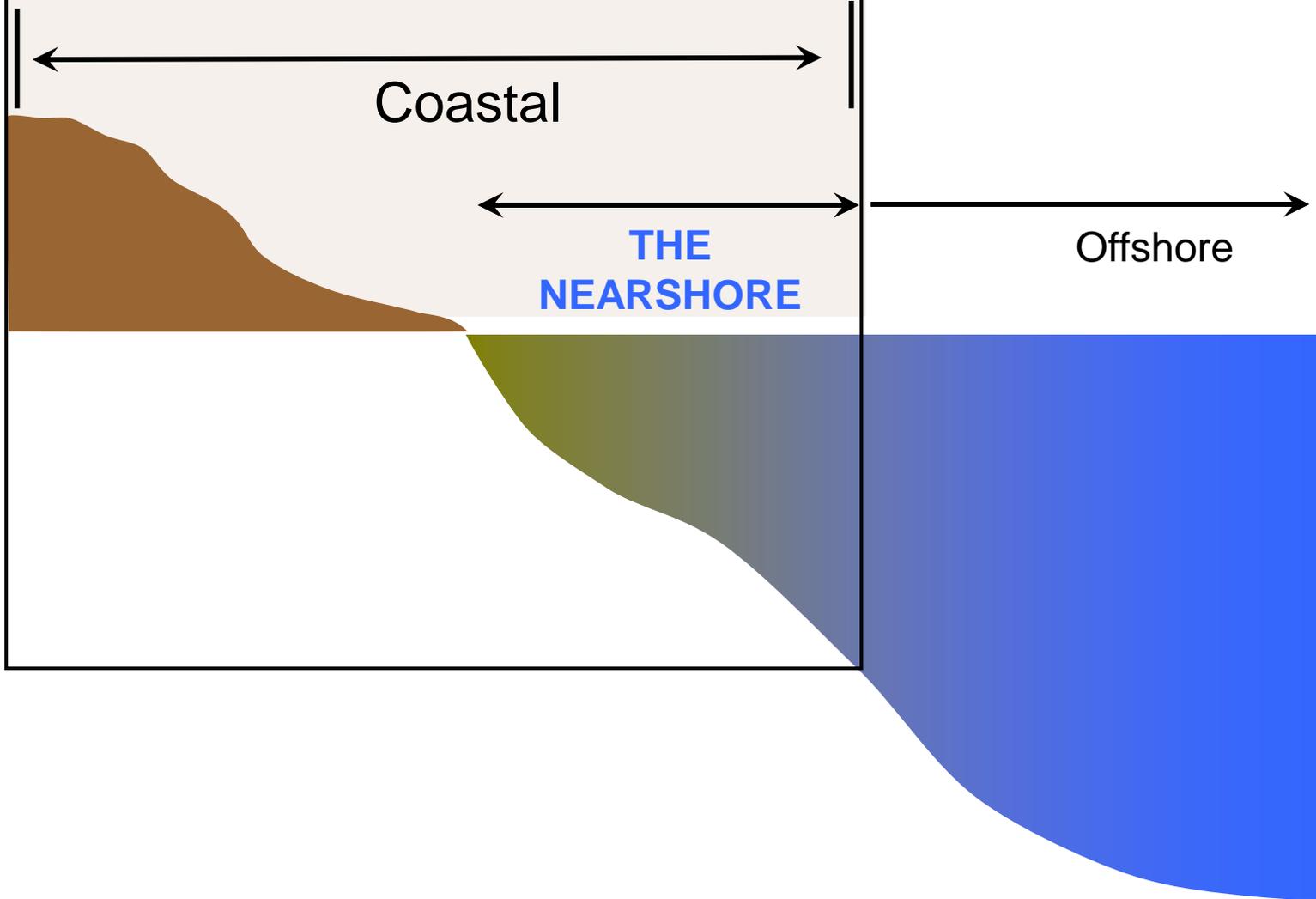
-Enable full lakewide
assessments

-Sentinel system,
vulnerable to
stressors from
watersheds

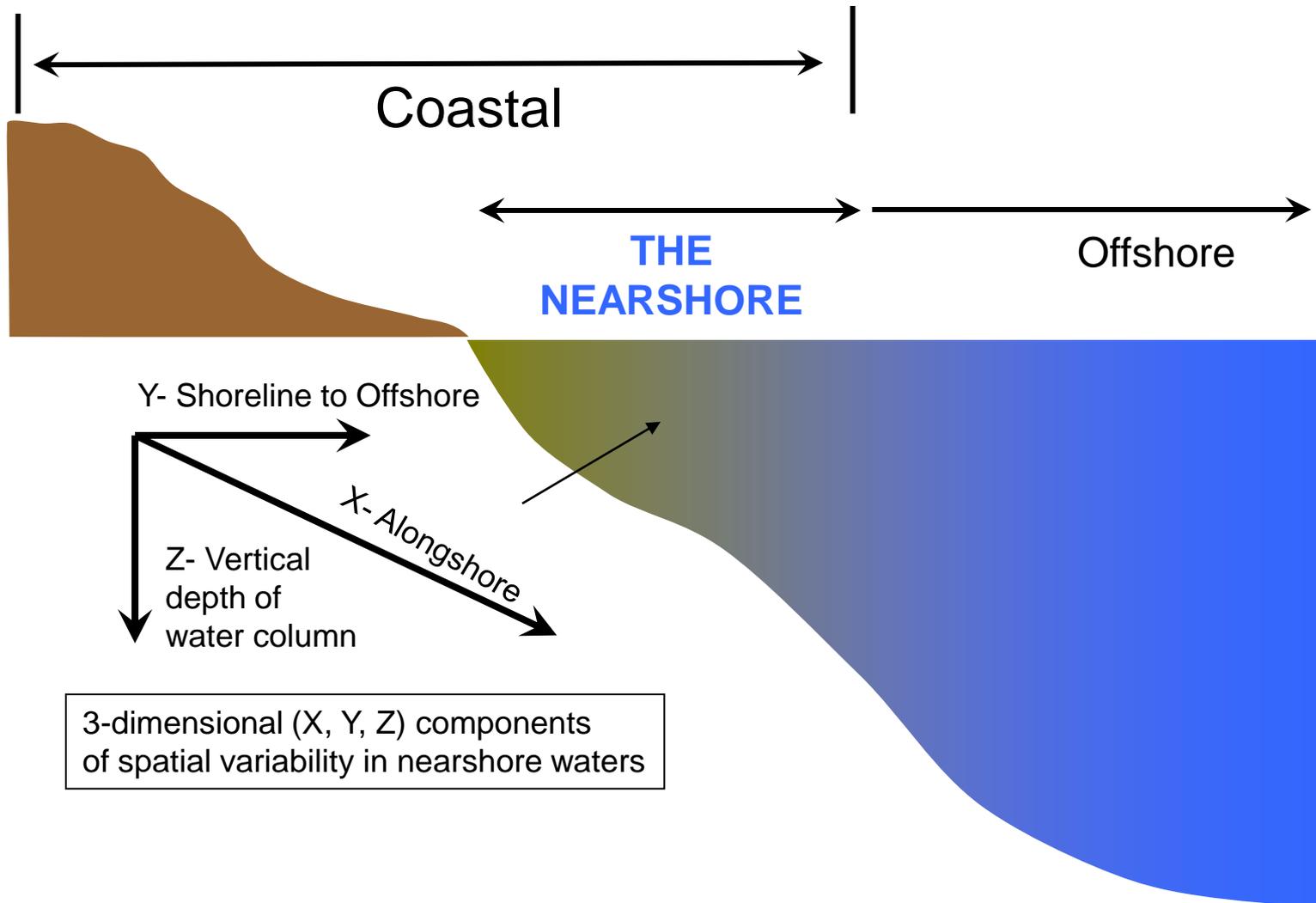
Humans flock to coasts and develop coastal watersheds
Coastal habitats are used for commerce, recreation, fishing, drinking water.
How do we sustain qualities of coastal systems?



Can this frame be a sentinel for observing broader change to inform sustainable landscape development?



It's tough to capture the "qualities" of a very dynamic coastal environment which is shaped by land and lake processes and exposed to multiple stressors



Landscape-water continuum

A mosaic of coupled habitats/ecosystems



A weak signal delivered into great variability, what are our odds?

Idea
Development



Provide sampling power to overcome variability by using synoptic sampling strategies, including high resolution in situ sensors towed through the nearshore



Monitoring & Assessment
Confident practice,
Condition/trends statements,
causal inference, models

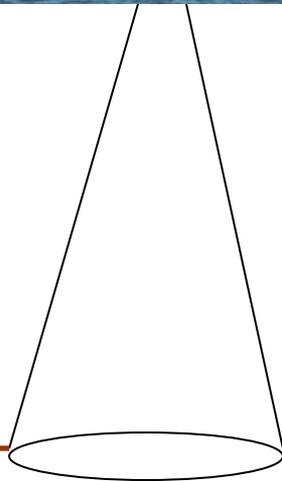
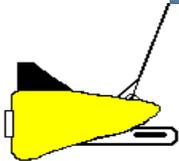
High-resolution Tools

- **Water** Towed body with in situ sensors, oscillated through the water from near surface to near bottom



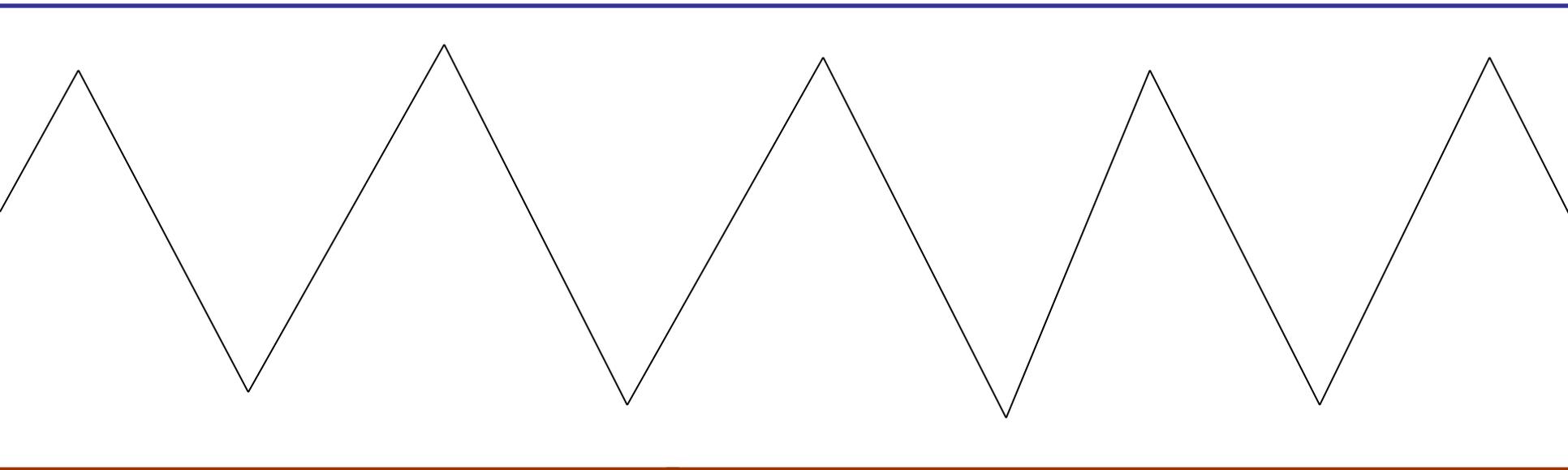
Sensors include

Conductivity, temperature, water clarity, Fluorometer (chlorophyll), Laser Optical Plankton Counter (OPC), Nitrate, adding others

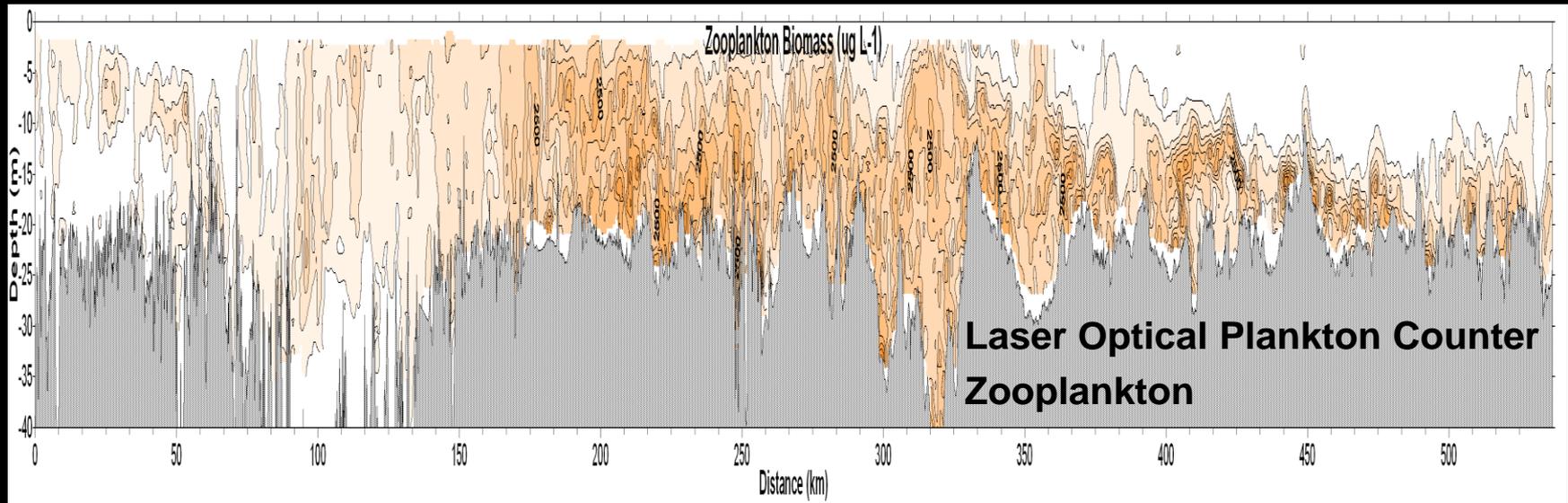


Result is semi-synoptic, spatially-referenced data to characterize:
Water properties, including biology

Typically sample at 4-5 kts, to ~100-120 km per day



537-km continuous nearshore track, Lake Superior

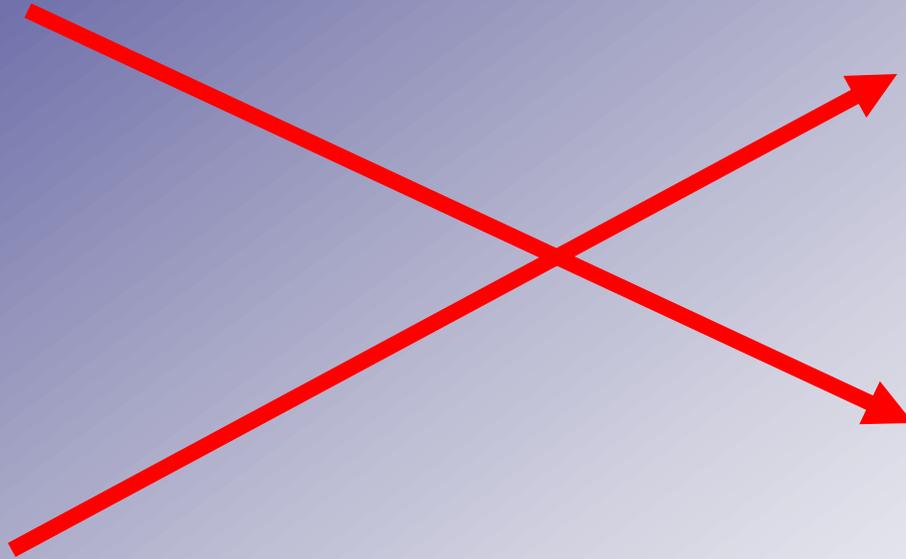


Environmental “CAT” scan or MRI

Continuous sampling, vessel-towed *in situ* sensors through water column

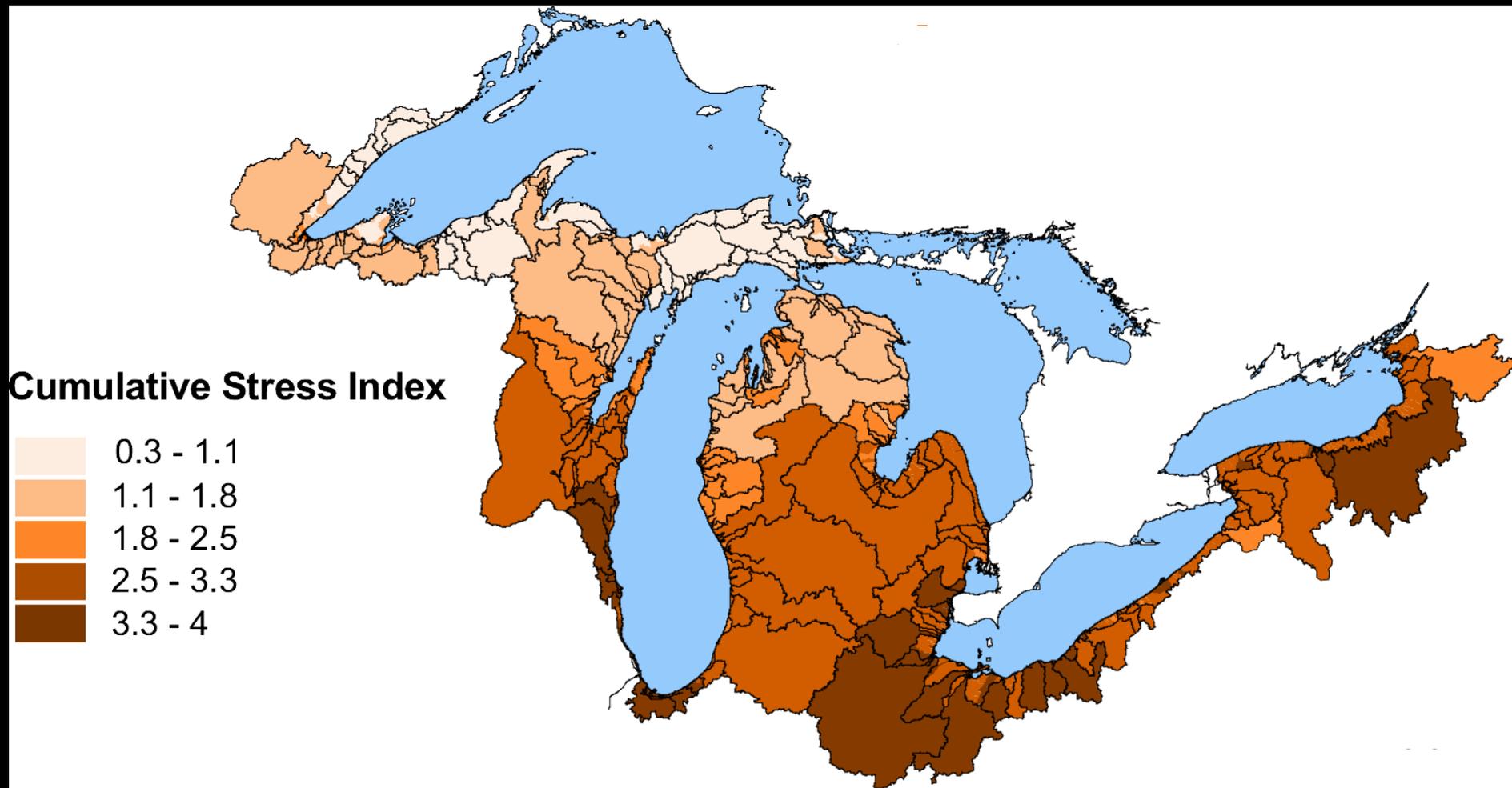


High resolution,
synoptic
in situ towing



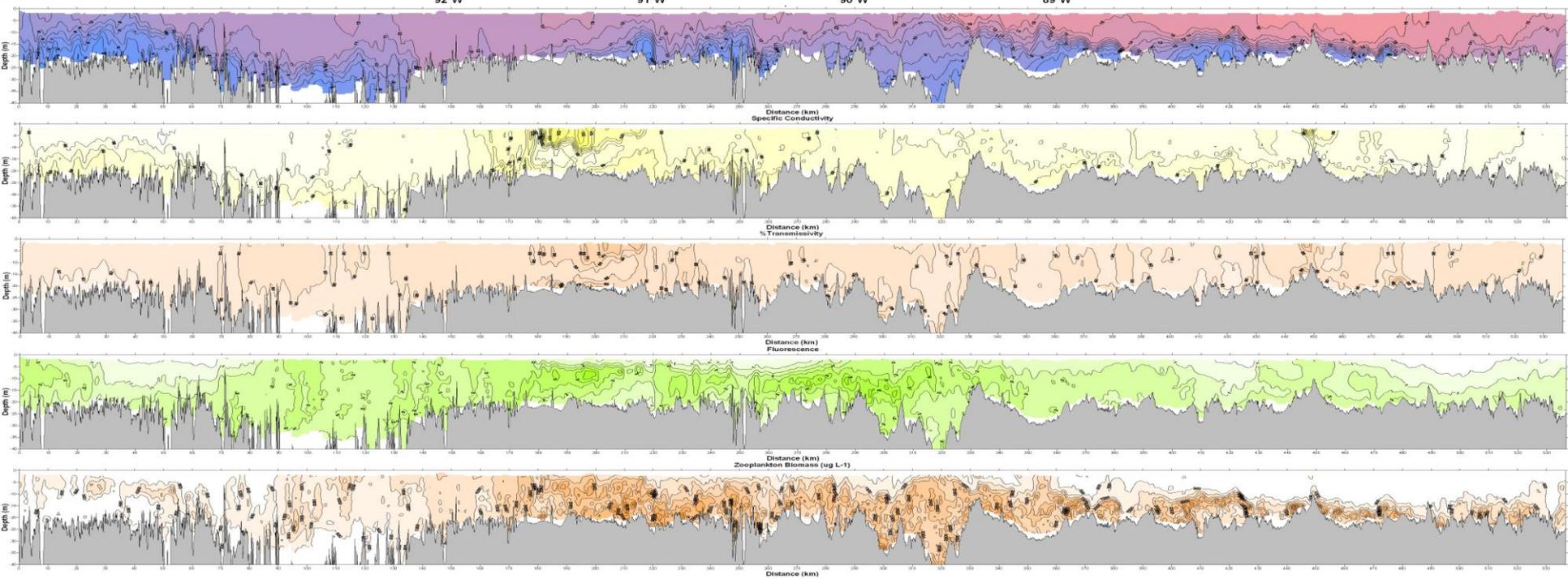
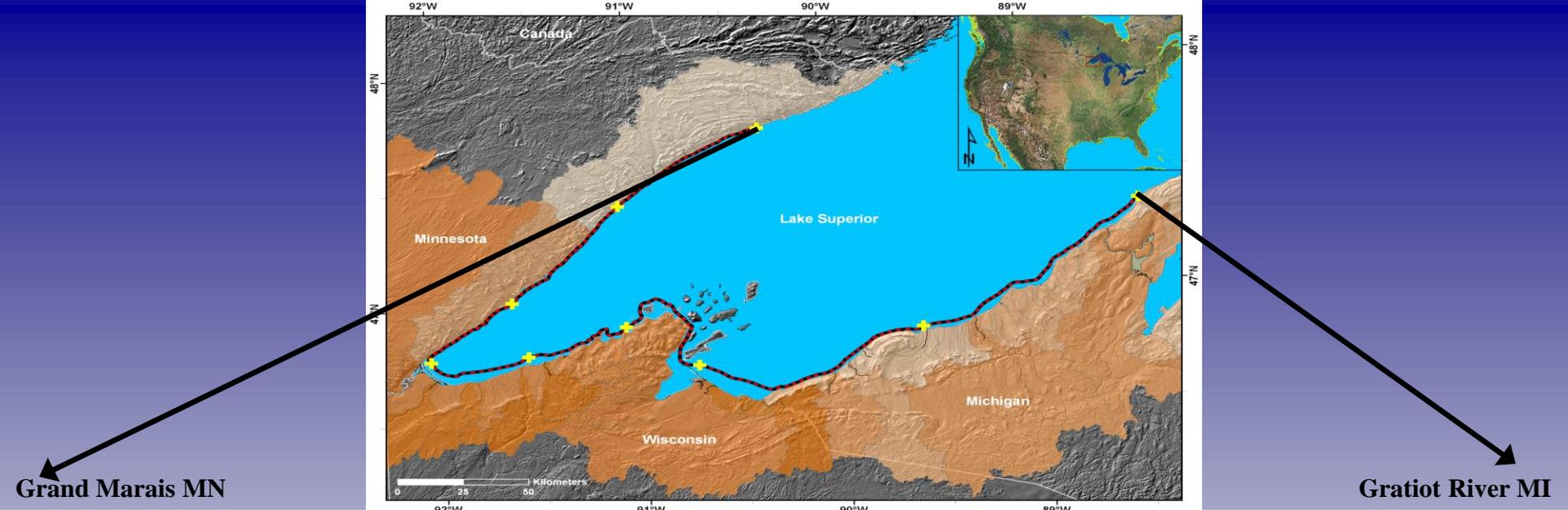
Integrated
Coastal
Observing
System

Comprehensive
watershed
characterization
GLEI Project



From Danz et al. 2007, Great Lakes Environmental Indicators (GLEI) Project

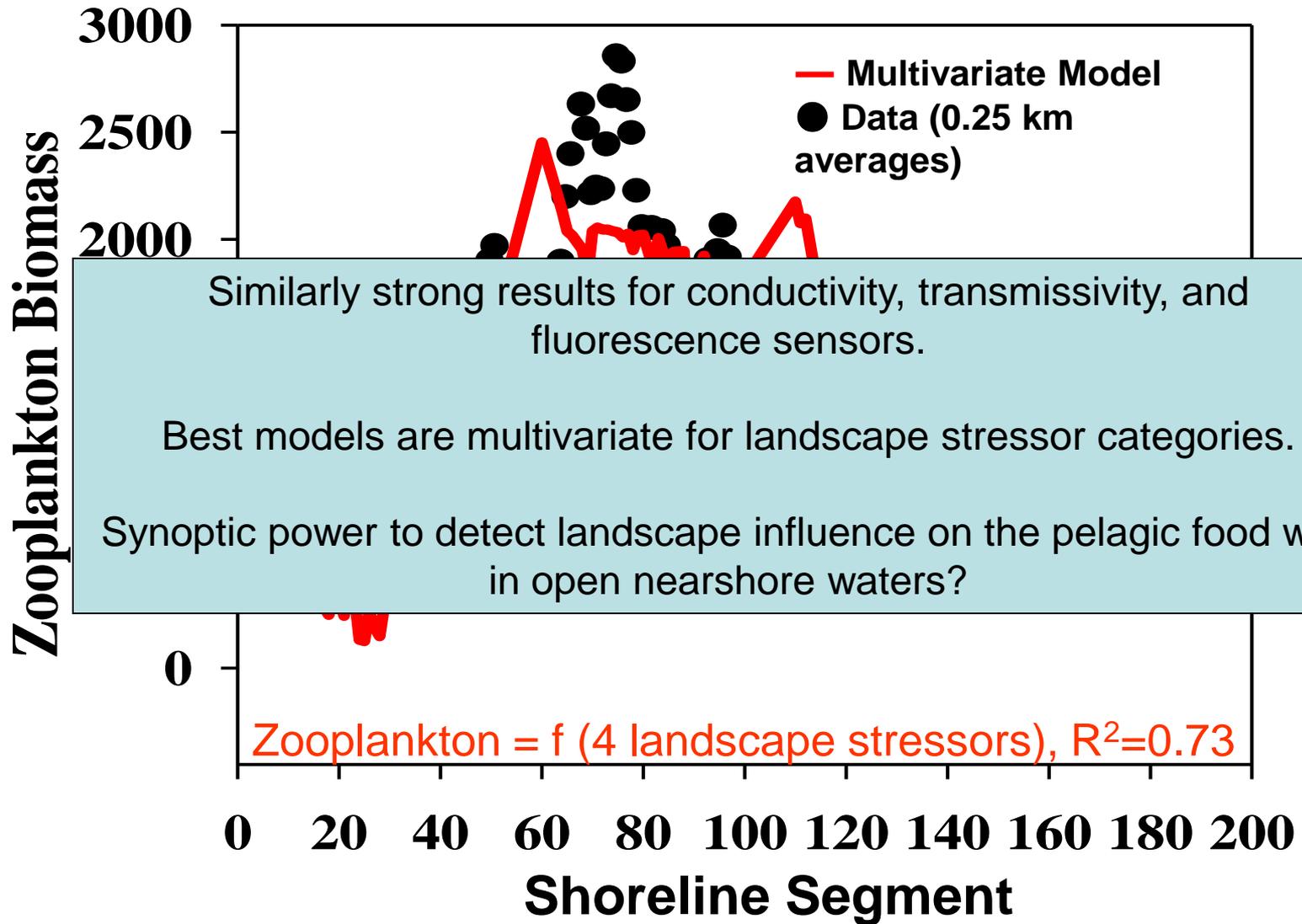
Derived from >150 individual variables, from publicly-available databases, aggregated in GIS for 762 U.S. shoreline segments and their associated $\geq 2^{\text{nd}}$ order watersheds (*Danz et al. 2005*)



Duluth/Superior

Bayfield WI

Ontonagon MI



From Yurista and Kelly, 2009

Idea

Development

Promise

Identified

Trials

Prototype tested, application explored
Preliminary Application
Bench to local and meso-scale field studies
Research uses further explored

Calibration phase

What scales, what utility, what application limits,
how to relate to previous and "traditional" measures

Validation phase

What scales, what utility, what application limits,
how to relate to previous and "traditional" measures

Demonstration phase

Confirmation of reliability, consistency, continuity
continued "model" and application building

Pilot application phase

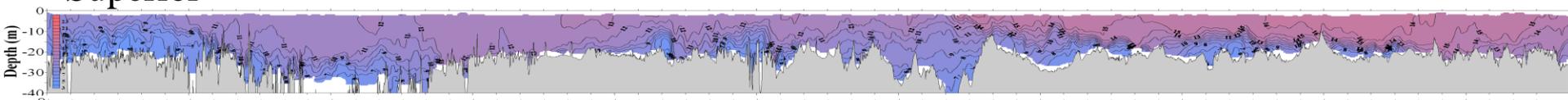
Technology transfer to users,
continued "model" and application building

Monitoring & Assessment

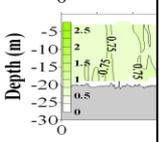
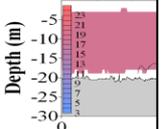
Confident practice,
condition and trends
statements



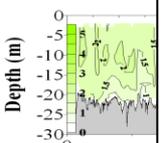
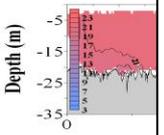
Superior



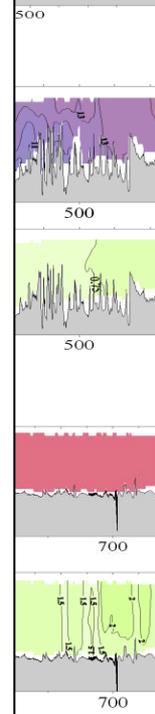
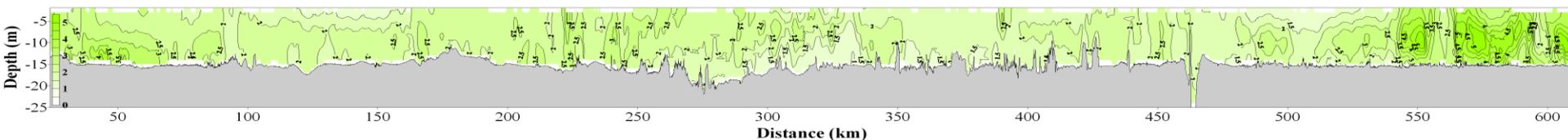
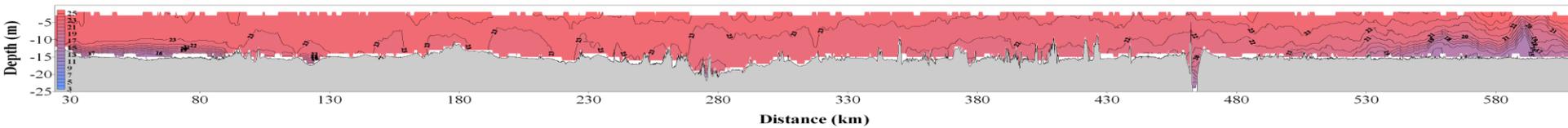
Hu



Ont



Erie



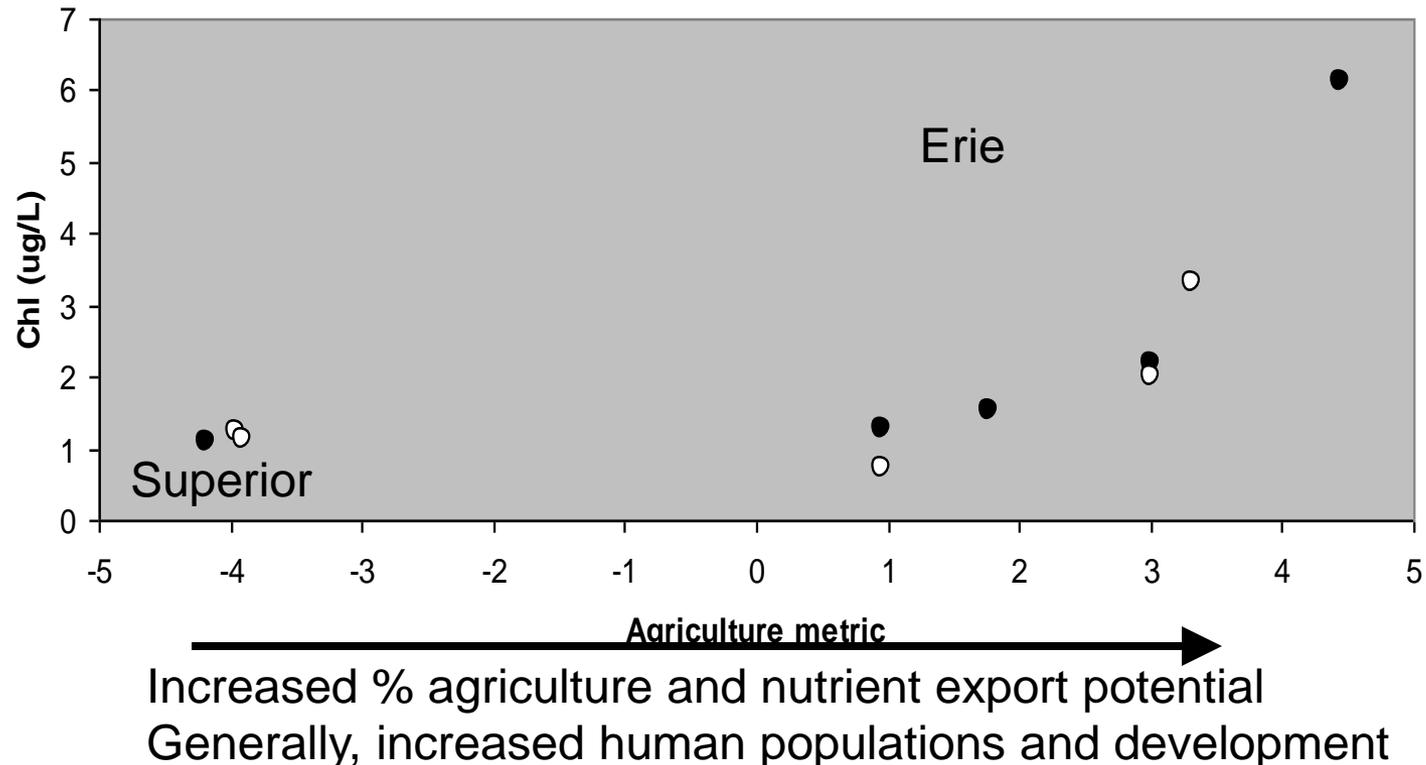
Towing strategy cost-efficient assessment---
 preserving spatial pattern
 from scales of 10s of meters to hundreds of kilometers.

Supplements (now) “traditional” probabilistic
 monitoring surveys of stations
 including measurements for which no sensor exists.

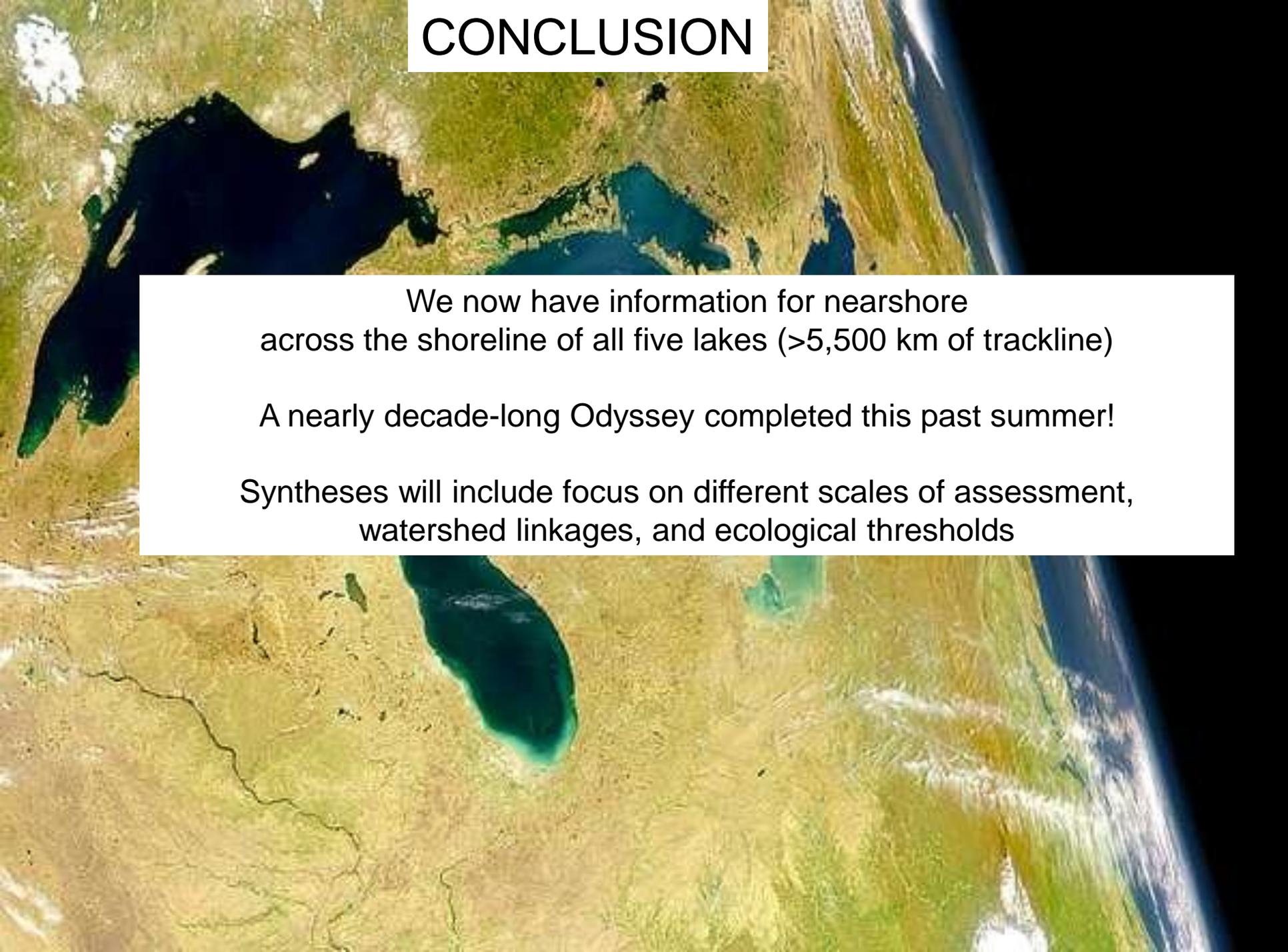
-EPA’s National Aquatic Resource Surveys
 2010 brought a National Coastal Survey to Great Lakes

Landscape-nearshore system and sustainability issues

- Thresholds that link cause and response, basis for actions
- Examine at local to broader scales
- Working on quantification of ecosystem services lost with disturbance



CONCLUSION

A satellite-style map of the Great Lakes region in North America. The map shows the five Great Lakes (Superior, Michigan, Huron, Erie, and Ontario) and the surrounding landmasses. The water bodies are dark blue, while the land is shown in shades of green and brown. The map is viewed from a high angle, showing the curvature of the Earth on the right side.

We now have information for nearshore
across the shoreline of all five lakes (>5,500 km of trackline)

A nearly decade-long Odyssey completed this past summer!

Syntheses will include focus on different scales of assessment,
watershed linkages, and ecological thresholds