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
A Problem:
No existing GL “Nearshore” monitoring program

Two motivations:
- Enable full lakewide assessments
- Sentinel system, vulnerable to stressors from watersheds

>10,000 km of shoreline
Dynamic, variable, open boundary
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.
Water quality-borne landscape signals appear generally strongest in tributaries and coastal wetlands and become weaker moving into the lake.

A weak signal delivered into great variability, what are our odds?
Provide sampling power to overcome variability by using synoptic sampling strategies, including high resolution in situ sensors towed through the nearshore.
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)
Similarly strong results for conductivity, transmissivity, and fluorescence sensors.

Best models are multivariate for landscape stressor categories.

Synoptic power to detect landscape influence on the pelagic food web in open nearshore waters?

Zooplankton = f (4 landscape stressors), $R^2=0.73$

From Yurista and Kelly, 2009
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

Increased % agriculture and nutrient export potential
Generally, increased human populations and development
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