Main topic:
The need for better Phosphorus (P) modeling
Involves interplay of everything we do here
Emphasizes our place in the broader Great Lakes community

As an example:
Groups Craig Stow/GLERL is involved in:
Lake Huron panel last fall
Hosted Cladaphora workshops Great Lakes Water Quality Agreement (GLWQA) ANNEX 4 at GLERL

Working on Lake Erie (done more or less), Moving forward to Lake Ontario, will circle back to Lake Huron and Saginaw Bay again

Recent data on Saginaw Bay:
Saginaw Bay isn’t meeting P targets
1978 targets
When the dreissenid mussels invaded Saginaw Bay the P retention capacity went up. Mussel filtering results in more P retention in Saginaw Bay, P not circulating out to Lake Huron.
Sag Bay is main source of P for Lake Huron.
P levels in main body of Lake Huron have dropped (below L Superior).
The food web has effectively collapsed, from bottom up to birds.
Further proposed reductions of P in Saginaw Bay would further reduce amount of P available to Lake Huron.
Deciding on a regulatory P level for Lake Huron will be a complex decision once ANNEX 4 rotates back around to the lake.

Guest editor for JGLR special issue “Managing multiple stressors in Saginaw Bay, 2012."
Based on parallel development of 4 models. GLERL had an active part in one of them.
1986

Great Lakes water quality improvement

The strategy of phosphorus discharge control is evaluated

Joseph V. De Pinto
Thomas C. Young
Lynn M. McIver
Clarkson University
Potsdam, N.Y. 13676

The impressive size of the Great Lakes has not been enough to shield them from many of the water quality problems that have resulted from the tremendous human population explosion within their basin (Table 1). Over the past 180 years the population resident of either the U.S. or Canadian government, or both. These studies, designed to formulate recommendations to the two governments, are known as “references.”

Since its inception the IGC has issued more than 50 references; some of its
Data from Dave Dolan, University of Wisconsin Green Bay
2012 – New GLWQA

Annex 4 - Nutrients
Six Lake Ecosystem Objectives
Update Substance Objectives (target concentrations)
Update Phosphorus Load Targets
Do this for Lake Erie within 3 years (February 2016)

Annex 4 Subcommittee has been meeting regularly since late 2013
Recommended Phosphorus Loading Targets Report - May 2015
Developed using 9 parallel models
8

2012 – New GLWQA

A two-dimensional ecological model of Lake Erie: Application to estimate bloom impacts on large lake plankton populations

Hengxin Zhang,*, Daniel A. Cullen*, Lenn Bugnion*

Using a Bayesian hierarchical model to improve Lake Erie cyanobacteria bloom forecasts

Daniel R. Obenour1, Andrew D. Gronefeld6, Craig A. Stone1, and Donald Scavia6

1Water Center, University of Michigan, Ann Arbor, Michigan, USA; 2ROAA Research Lakes Environmental Research Laboratory, Ann Arbor, Michigan, USA; 3Graham Sustainability Institute, University of Michigan, Ann Arbor, Michigan, USA
Science Advisory Board – review modeling process - December 2014

The need for sustained, long-term phosphorus modeling in the Great Lakes

Thus, it would be prudent for the Great Lakes community to invest in a sustained, coordinated modeling effort to carry us into the future.

Ideally this endeavor would include:

- A suite of models of differing complexity and resolution, based on alternative assumptions.
- An ongoing skill assessment of model capabilities.
- Models with the capacity for rigorous uncertainty analysis.
- A home on the internet with documented code and supporting data available to make the process as transparent as possible and allow the community to use and vet the models.
- Regular updating.
- A standing committee to guide development and implementation.
- Support by well-designed monitoring program.

Stow (2015). JGLR
• Greater model complexity = greater predictive accuracy?

• Results equivocal

• As a community we are not very good about assessing, reporting accuracy/reliability
Future Directions

Develop, test models of differing complexity, evaluate relative performance
It is not appropriate to ask whether a model is right or wrong. Instead we should ask: What is its domain of utility?
GLERL has expertise in fine-scale, simulation modeling:

and contemporary, probabilistic approaches:

- Clear implications for developing models for transition to operations
- Draws on strengths (Modeling, Observations, Process Research)
- Supports our HABs program
- Serve a long-term need in the Great Lakes community
- Partners Essential – Federal, State, Provincial Agencies, Academia
**Overarching research statement:**
Understanding the drivers of bloom ecology will aid in enhancing predictive models that forecast bloom size, location AND toxicity.
Thank You Questions?