Development of a Coordinated Lake Erie Science Program

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Overview

A long-term goal of NOAA is to provide enhanced ecosystem forecasts (both ecological and environmental) that would benefit coastal communities, including the Great Lakes. Such benefits to society might include 1) improved decision-making for coastal stewardship, 2) mitigation of potentially hazardous human activities, 3) reduced impacts of natural hazards, 4) enhanced communication between scientists and managers, and overall, 5) more effective prioritization of science, particularly across disciplines. Some environmental forecasting capabilities already exist such as the Great Lakes Forecast System (http://coastwatch.glerl.noaa.gov/), which provides forecasts of lake thermal structure, wind fields, and waves. Enhanced ecosystem forecasts would predict patterns of biological and chemical variables as well as natural and human-induced changes (extreme natural events, climate change, land and resource use, pollution, invasive species, fisheries impacts and interactive effects) to the system across a variety of spatial and temporal scales.

It is now well recognized that continued and new water quality and ecosystem health issues persist within the Great Lakes that are of concern to the user community and researchers, and which remain a challenge to Great Lakes resource management. Clearly, development of systems to provide reliable forecasts of the Great Lakes ecosystem and/or modular components of chemical, biological, or physical subsystems would help resource agencies choose among potential management options. Improved hydrodynamic models are already providing reliable information on lake circulation, transport of nutrients, and system-wide thermal structure in these coastal systems. Improved understanding of how these ecosystems work, including fundamental changes in nutrient dynamics and food webs, the importance of episodic events, and land-lake coupling need to be incorporated into a next generation of lake management tools.

The Great Lakes region is ideal for conducting ecosystem-forecasting research for several reasons. First, these systems continue to experience numerous anthropogenic perturbations, including overfishing, land-use changes, eutrophication and subsequent oligotrophication, and exotic species invasions. Second, the Great Lakes have an economically important user base, who have needs for predicting impacts of excess nutrient loads, anoxia, microbial

contamination, harmful algal blooms, invasive species, and extreme natural events (e.g., storms, water level change). Third, this region has pioneered novel management strategies that have provided a testing ground for new science and management. For example, the Great Lakes region led the nation in developing successful nutrient control and contaminant cleanup strategies during the 1970s, and more recently, has agreed to adopt ecosystem-based approaches for the management of its fisheries. Finally, the Great Lakes region has a long history of interagency partnerships in monitoring/assessment and research, which has led to an extensive accumulation of physical, chemical, and biological data, and predictive models.

To improve our ability to provide reliable ecosystem forecasts in the Great Lakes, NOAA-GLERL has been working toward development of an integrated (multi-agency), multidisciplinary research program for Lake Erie (see GLERL's Great Lakes Issues Workshop Report, www.glerl.noaa.gov/rsch/erie). Four attributes make Lake Erie ideal for piloting the development of an ecosystem-forecasting framework. First, although Lake Erie is a large system, it is small relative to other coastal marine systems and the other Great Lakes. In turn, comprehensive, yet cost-effective, field sampling can be performed to test hypotheses (i.e., tractable questions can be asked). Second, a wealth of historical monitoring and research data has been compiled for this system, which can be used immediately for model parameterization/calibration, validation, and ecological scenario testing. Third, several predictive physical and biological models exist for Lake Erie (Maumee River watershed-hydrology model, Croley, 2002; Lake Erie hydrodynamics model; Schwab and Beletsky, 1998), or are ready to be tailored to Lake Erie (lower trophic level model; Bierman et al. in review). Finally, Lake Erie has experienced a wide array of simultaneous anthropogenic stresses, including habitat destruction, overfishing, altered nutrient regimes (both eutrophication and oligotrophication), chemical pollution, and invasive species introductions.

2005 Plans

During 2005, we plan to carry out a large-scale, interdisciplinary, research-based field program designed to improve our ability to understand and forecast two water quality impairments in Lake Erie: low dissolved oxygen levels in the central basin (aka the "dead zone") and harmful algal bloom formation (HABs) in the west basin. This "International Field Years on Lake Erie" (IFYLE) program will be supported by numerous agencies, including NOAA Ship Support, NOAA-GLERL, the National Sea Grant College Program, the U.S. Environmental Protection Agency, and Environment Canada. Additional support for this field effort will come from Ohio Sea Grant, New York Sea Grant, fishery management agencies of the Lake Erie Committee, and the USGS. In total, we expect that 30-35 researchers will be involved in this integrative, international field effort.

The primary goals of the IFYLE field program are to:

1. Quantify the spatial extent of hypoxia across the lake, and gather information that can help forecast its timing, duration, and extent;

2. Quantify the ecological consequences of hypoxia to the Lake Erie food web, including phytoplankton, bacteria, microzooplankton, mesozooplankton, and fish;
3. Identify factors that control the timing, extent, and duration of HAB (including toxin) formation in western Lake Erie, as well as enhance our ability to use remote sensing as a tool to rapidly map HAB distributions in the lake.

Ultimately, the information obtained through this collaborative, multidisciplinary research program would be used to enhance the ability of resource managers to understand and forecast variation in fish production, invasive species impacts, and hypoxia/anoxia in Lake Erie, and thereby improve decision-making. Research supported by this program is expected to focus primarily on three of the National Sea Grant College Program's 11 thematic areas: fisheries, ecosystems and habitats, and aquatic invasive species. This program also will address four of the Great Lakes Governor's nine priorities: protecting human health, non-point source pollution, aquatic invasive species, and restoring and protecting fish habitat.

Accomplishments

2004

As a major step in developing this Lake Erie program, GLERL hosted a large (over 50 attendees), international workshop on March 4-5, 2004 to identify and discuss three important Lake Erie issues that GLERL scientists thought were within the existing capabilities of the laboratory:

1. anoxia and hypoxia
2. harmful algal blooms (HABs)
3. coupling physics with fish forecasts

This workshop also provided an opportunity:

1. for GLERL scientists to learn about ongoing programs by U.S. and Canadian agencies and academics;
2. to discuss facilitation of communication and collaboration among GLERL and the other, ongoing research programs in Lake Erie;
3. for improving the focus and approach of GLERL's Lake Erie coordinated research program whose long-term goal is the development of models and other tools to better understand and forecast changes in the Lake Erie ecosystem.

At the workshop, invited presentations were given by five major Lake Erie research agencies summarizing their ongoing or planned Lake Erie research programs, which were followed by an invited summary presentation on each of the three focus issues. Subsequently, attendees were divided into three workgroups (Anoxia and hypoxia, Harmful algal blooms (HABs), and Fish recruitment) in order to identify 1) research hypotheses for the issues, 2) the critical processes, 3) identify ongoing and planned activities, and 4) identify potential contributions from GLERL areas of interest.

Several areas of potential and immediate collaboration were identified and mechanisms to implement them were initiated. In addition, numerous general and workgroup-specific recommendations were provided that could aid future efforts to develop multidisciplinary, integrative (multi-agency) research programs, which in the end, could improved NOAA-GLERL's ability to provide reliable ecological forecasts. Most important to this proposal were:

1. The need for collaboration and coordination among agencies is critical. Efforts to build useful forecasting models will fail in the absence of inter-disciplinary approaches. Efforts aimed at maximizing integration, collaboration should be supported.
2. Encourage the development of a user-friendly database that would provide general access to the large inventory of historical data.
3. Continued efforts to bring scientists from multiple disciplines together to focus on specific issues… develop the framework for forecasting.
4. Support an annual meeting to coordinate sampling among agencies/scientists. This way, redundancy can be reduced and we could maximize information collected (ships might have room for additional researchers).