

NOAA Great Lakes Environmental Research Laboratory
Response to 2010 Lab Review

An external peer review of the National Oceanic and Atmospheric Administration's Great Lakes Environmental Research Laboratory (NOAA-GLERL) was conducted on 16-18 November, 2010, in Ann Arbor, Michigan. The last review of the laboratory took place in December 2000. Review panel members for the 2010 review included:

- Captain Bob Houtman, National Science Foundation, Chair
- Dr. Robert Beardsley, Woods Hole Oceanographic Institution
- Dr. G. Ross Heath, University of Washington
- Dr. Thomas Johnson, University of Minnesota, Duluth
- Dr. David Lodge, University of Notre Dame
- Dr. Shirley Pomponi, Harbor Branch Oceanographic Institution, Florida Atlantic University
- Dr. Steven Ramberg, Pennsylvania State University, Applied Research Laboratory

Review presentations and related information are available here: <http://www.glerl.noaa.gov/review/>

Following the review, the panel submitted a report outlining 15 recommendations for improving research and operations at GLERL. In general, reviewers recognized the highly skilled and talented workforce at the laboratory and its dedication to the GLERL mission. The review panel noted that GLERL is poised to serve as a leader in major advancements in NOAA mission-critical areas, but recognized that staffing and funding levels currently constrain the possibilities of GLERL research.

The laboratory's 2012 Strategic Plan (http://www.glerl.noaa.gov/about/history/strategic_plan.html), *Innovative Research for the Freshwater Seas*, was prepared in response to a recommendation by the review panel to develop "a cohesive strategic plan for the entire lab so the vision and future goals become clear and appropriate metrics can be developed to determine progress and inform management decisions." The plan includes the following new mission statement, and a vision statement that highlights elements of global lake and marine impacts of GLERL research, well beyond the regional impacts on the Great Lakes basin:

MISSION

GLERL and its partners conduct innovative research on the dynamic environments and ecosystems of the Great Lakes to inform resource use and management decisions that lead to safe and sustainable ecosystems, ecosystem services, and human communities.

VISION

Reliable predictions of changes in interconnected natural and human systems contribute to the improved management of large lakes of the world and similar coastal ecosystems.

Other Panel recommendations are addressed throughout the strategic plan. Responses to each of the 15 panel recommendations follow.

1. Develop bold, integrated, strategic plans with 1, 5, and 10 year milestones for individual research areas and GLERL as a whole

The 2012 Strategic Plan outlines the bold new vision for the laboratory. Short-term milestones and long-term goals are included in the plan and in the logic models in Appendix C of the plan. Short-term and mid-term tasks and actions required to reach these milestones are being incorporated into the FY2013 GLERL Annual Operating Plan and three integrated multi-year Research Project Plans.

2. Address staff issues through targeted additions in mission critical areas

GLERL recognizes the need for targeted staff additions to carry out its new mission and vision. The Implementation Strategy (Section 3) of the 2012 Strategic Plan lists priority additions in mission-critical areas that will help meet specific science objectives. A new physical scientist, Eric Anderson, with expertise in hydrodynamic modeling, was hired in 2012. Hiring actions are currently in process for four additional positions: a benthic ecologist, a planktic ecologist, and theme leads for both the Observing Systems and Advanced Technologies group, and the Integrated Physical and Environmental Modeling and Forecasting group, with expected start dates in 2013. Relationships with recent retirees have been maintained through emeritus and visiting scientist arrangements.

3. Increase collaboration with the Cooperative Institute for Limnology and Ecosystems Research (CILER), U.S. Geological Survey (USGS), and industry (through the Small Business Innovation Research program) to maximize funding and fiscal efficiency

Laboratory managers and senior scientists actively participated in development of the new CILER strategic plan in 2011, and serve as key members of the CILER Executive Board, Management Council, and the new CILER Council of Fellows. GLERL has supported the CILER director in strengthening the involvement of institutions beyond the University of Michigan in CILER, and facilitated a face-to-face meeting in the summer of 2011 between CILER and University of Michigan administrators and the NOAA Administrator, Dr. Jane Lubchenco, that resulted in commitments that significantly strengthen the NOAA-CILER partnership. Collaboration with CILER is vital to many GLERL science priorities; for example, GLERL's nutrient measurement and cycling needs are efficiently handled by a CILER colleague, and GLERL increased its access to autonomous monitoring technology by moving two new CILER staff with propelled and gliding autonomous underwater vehicle expertise and assets into the Ann Arbor laboratory in 2012.

GLERL built on its relationship with USGS in several ways in 2011 and 2012, including informal meetings and exchange of information between GLERL and USGS laboratory and regional managers in Ann Arbor and Duluth, as well as with other USGS representatives from groups including the Coastal and Marine Geology Program laboratory in Massachusetts. The GLERL deputy director served on a USGS search committee in 2012 for a new principal investigator. GLERL scientists strengthened or developed new collaborations with USGS scientists, including a Coordinated Science and Monitoring Initiative (CSMI) project in Lake Huron that began in April 2012, and ongoing work with the USGS Center for Integrated Data Analysis in Wisconsin.

GLERL interaction with the private sector has included close work with LimnoTech (Ann Arbor office) on the Great Lakes Observing System (GLOS) Design Report, released in June 2011, and additional GLOS-related work since then. GLERL management initiated collaboration with faculty from the University of Michigan's Ross School of Business that will lead to an economic impact analysis of the laboratory and its research. Cooperative partnerships continue to develop with Nortek, Fondriest Environmental, SeaLandAire, and Blue Water Satellite that have helped advance real-time observation technology and high-resolution remote sensing in the Great Lakes region and at GLERL. GLERL's work to support conversion of federal and other vessels to biofuel and biolubricants has expanded to over 500 vessels, including a national feasibility study in 2011 by the U.S. Army Corps of Engineers that included GLERL participation. GLERL also participated in a Navy acoustics test of biofuel vessel powerplants in 2012.

The laboratory will continue to build on its strong partnerships as a strategic and essential way of leveraging its base support and accomplishing its mission in the Great Lakes and beyond.

4. Upgrade laboratory equipment and computing resources

Excellent progress has been made since the review in this area. To improve capabilities and efficiency, GLERL purchased the following equipment in 2011:

- A top-of-the line Leica inverted microscope and image analysis system with capabilities for fluorescent, phase, brightfield, and DIC optics; this microscope will advance our phytoplankton work, particularly with harmful algal bloom cyanobacteria such as *Microcystis*,
- A digitally imaging flow cytometer (FlowCam) for automatically counting and measuring phytoplankton and other seston in the 3 µm to 1 mm range,
- A new nutrient autoanalyzer system, which will increase sample output by a factor of three compared to the old system,
- A refrigerated centrifuge that can spin down liter quantities of algae and seston.

GLERL also developed the capability in 2012 to perform in-house testing of water samples for fecal indicator bacteria, in support of tributary and river plume modeling and forecasting efforts connected with beach health.

A internal process was developed at GLERL to prioritize capital equipment purchases, and priorities for the next several fiscal years have been identified by branch chiefs. Computing resources have been upgraded to support the modeling and forecasting objectives of GLERL through the Integrated Physical and Ecological Modeling and Forecasting branch, including installation of three SGI computing clusters totaling 572 cores, major memory expansion, and server and software upgrades.

5. Strategically expand observation and research to other Great Lakes as they fit into mission goals

Long-term goals of the Observing Systems and Advanced Technology branch include year-round and under-ice observations on all five Great Lakes. The Ecosystem Dynamics branch is leveraging the externally-funded Lake Huron CSMI program, as well as base funds, to establish a seasonal long-term research program on Lake Huron much like GLERL's program on Lake Michigan. Lake Huron is the least

studied of all the Great Lakes and faces many of the same stressors as Lake Michigan and the other lakes. GLERL is also exploring partnerships with Michigan Tech to expand research in Lake Superior, as resources allow, and will be collaborating on Lake Ontario benthic surveys in 2013. GLERL maintains active ice modeling research projects in the Arctic, and ecological modeling in the northern Gulf of Mexico.

6. Develop observing systems for year round and extreme environment application

Long-term goals of the Observing Systems and Advanced Technology branch include direct or collaborative year-round and under-ice observations on all five Great Lakes. See the milestones in the 2012 Strategic Plan for more details. In winter of 2012-2013, GLERL will keep its largest research vessel operational throughout the winter to facilitate sampling in December and January. GLERL scientists collaborated on deployment of upward-looking lake-bottom instruments in Lake Erie over the winters of 2010-2011 and 2011-2012 to study ice formation and thickness. CILER-supported AUVs are also expanding GLERL's environmental measurement capabilities. Expanding collaborations on aircraft and satellite remote sensing with NASA, Blue Water Satellite, Environment Canada, and the Canadian Coast Guard are also underway (<http://www.glerl.noaa.gov/pubs/fulltext/2012/20120032.pdf>).

7. Develop detailed design/construction/maintenance plans for current systems and for future expansion plans

Existing design/build documentation will be augmented with operations and maintenance procedures with technology transition in mind, especially with systems such as Realtime Environmental Coastal Observation Network (RECON) (<http://www.glerl.noaa.gov/res/recon/>). One recent example of an integrated system design effort that GLERL spearheaded was the 2011 report, *Near-Term Design of the Great Lakes Observing System Enterprise Architecture* by LimnoTech (http://glos.us/sites/default/files/documents/GLOSEA_FINAL_REPORT-with-summary_063011.pdf). This effort has been highlighted by the leadership of the national Integrated Ocean Observing System (IOOS) program as an example for other regions to emulate.

8. Plan for publication in Science or Nature every few years to boost deserved recognition

As the laboratory hires new staff (both principal investigator and technical) and refreshes its laboratory and research equipment, this goal will become a reality. Papers on modeling and forecasting are currently being targeted for these high-profile publications. Observing systems research and development is currently underway with these journals in mind. Recent papers have appeared in the following journals that have international impact beyond the Great Lakes region: *Journal of Geophysical Research*, *Water Resources Research*, *Environmental Science & Technology*, *Geophysical Research Letters*, and *Journal of Oceanography*.

9. Develop and implement adaptive sampling programs that integrate new statistical sampling designs and new technologies

New technologies and equipment prioritized for purchase in the near term will enable the Ecosystem Dynamics group to address this recommendation. For example, GLERL will purchase a Multiple Opening-Closing Net with Environmental Sensing System (MOCNESS) that will improve pelagic food web sampling in 2013. New fish acoustics instrumentation was installed on the *R/V Laurentian* during a drydock overhaul in 2012 that permits collection of continuous acoustical data relevant to upper food web structure, and flow-through sampling systems are being installed on several GLERL vessels over the next few years to facilitate underway sampling during transits and surveys. New access to propelled and gliding AUVs was described previously. Coordinated, synchronous, multi-platform monitoring and experiments were performed in lakes Erie, Huron, and Michigan in 2012. Rapid-response sampling linked to an anomalous satellite-detected spring bloom in Lake Erie, and storm events in a Lake St. Clair tributary were performed in 2012. Increased sophistication of statistical sampling design is being realized by better integration of iterative modeling efforts and field monitoring and experiments. Two recent or planned examples are expansion of monitoring of the deep thermal structure of the lakes from Lake Michigan to Lake Huron in 2011 driven by model validation requirements, and expansion of over-lake evaporation measurements via upgrading and expansion of eddy correlation stations on fixed mid-lake platforms.

10. Develop a more comprehensive conceptual and methodological approach to the food web that can reasonably be expected to detect the presence and impact of new species

This research need is a primary driver for the development of an Integrated Ecological Modeling Framework, described in further detail in the Integrated Physical and Ecological Modeling and Forecasting branch section in the Science Strategy of the 2012 Strategic Plan. Recent project examples include modeling of multi-decadal impacts on food webs of Asian carp introductions to parts of the Great Lakes, and expansion of GLERL's larval fish sampling and modeling capabilities with hiring of contract technicians and planned MOCNESS acquisition and other field and lab upgrades. Planned 2013 hires of two new ecologists and retention of current postdoctoral fellows with this expertise will be significant boosts to these efforts.

11. Expand and develop research in mission critical areas such as biogeochemistry, food web dynamics, and integrated bio-physical and ecosystem modeling

The addition of strategic staff, as outlined in the Implementation Strategy of the Strategic Plan, will allow GLERL to retain its position as a leader in food web dynamics and to strengthen its capabilities in bio-physical modeling. These research needs are also primary drivers for the development of an Integrated Ecological Modeling Framework at NOAA, in which GLERL is taking a leadership role. A critical impediment to progress in the area of food web dynamics is the need for updated shipboard sampling gear, which has been prioritized under the new capital equipment process. At this time, resource limitations have dictated that biogeochemical research at GLERL will primarily be conducted through numerical modeling rather than field work, laboratory analyses, and experimentation. That said, active collaborations in this area will through CILER and efforts such as a new NSF-supported effort on Biogeochemistry of the Great Lakes System (BOGLS). GLERL is contributing financially to this project and a GLERL scientist is a co-principal investigator on the proposal for a 2013 science planning workshop

partially funded by the NSF Chemical Oceanography program, along with other federal agencies and universities.

12. Better communication is necessary within and between the theme programs on the development and implementation of mission goals

This recommendation has been a major focus of lab management and branch chiefs since the reorganization of GLERL in 2011 into three science theme branches. All decisions on science are now made in conjunction with all branches during the annual project planning process and through monthly Science Council meetings. The integrated Science Strategy in the 2012 Strategic Plan outlines how the three science branches will work individually and collectively to fulfill GLERL's mission and meet specific science goals. Science goals in the 2012 Strategic Plan were developed with participation from all science branches, and internal resource allocations and external commitments (e.g., project budgets, staffing, vessel time, major equipment purchases, external proposal submissions) are jointly determined by the science theme leads and GLERL management.

13. Attention to the progress of Jorg Imerger and Jason Antenucci of CWR at the University of Western Australia in terms of coupling biogeochemical and physical models

GLERL scientists interact with CWR scientists at international conferences such as the International Society of Limnology and Physical Processes in Natural Waters. GLERL is currently exploring the possibility of exchanging seminars with this group.

14. Continue to develop the increasingly important connection to NOAA's National Ocean Service (including the Coast Survey Development Laboratory and Center for Operational Oceanographic Products and Services (CO-OPS))

Connections with the U.S. Integrated Ocean Observing System, the National Data Buoy Center, and COOPS are established and are being developed further. GLERL management met with NOS leadership in Ann Arbor and at NOAA headquarters in 2011 and 2012 to build on this relationship, and successfully advocated for establishment of a permanent position in Ann Arbor for an NOS-National Centers for Coastal Ocean Science scientist with the regional Ecosystems Research Branch. GLERL management, the GLERL hydrology research group, and those associated with the GLOS design project have had ongoing interaction with CO-OPS, including participation in workshops and other activities. The GLERL vessel operations group has worked with the NOS lab in Oxford, Maryland to secure a replacement for their research vessel that was destroyed in a fire, and is currently refurbishing the vessel in Michigan. GLERL will continue to build on the partnership with NOS, particularly with the Line Office's research programs and in joint Ecological Forecasting and Habitat Blueprint activities.

15. Continue to develop and communicate complex model forecast results and uncertainty in critical areas related to human health and safety

The focus of GLERL's bold new vision is to deliver ecosystem forecasts in critical areas including harmful algal blooms, hypoxia, water quality, and food web dynamics. An example of current work in this area is

a study using Bayesian statistical models to quantify uncertainty in fecal indicator bacteria measurements, which was completed in FY2011 and has been incorporated into forecast models in

FY2012. GLERL also began a field sampling program for fecal indicators to improve modeling approaches on a Great Lakes tributary, the Clinton River, in 2012. GLERL's Integrated Physical and Ecological Modeling and Forecasting branch continues to seek ways to effectively communicate uncertainty in model forecasts, in partnership with others, including U.S. EPA program managers, USGS scientists, researchers at the National Weather Service, Sea Grant program managers and grantees, and the GLERL Information Services branch.

Summary

With a new facility and director in 2009, helpful input from the 2010 review team, successful implementation of the proposed laboratory reorganization in 2011, release of the new Strategic Plan in 2012, and the recent hiring of the first of several new principal investigators, GLERL is in a strong position to move forward with realization of its bold new vision. The next GLERL laboratory review, planned for approximately 2015, is expected to document that progress.