

**EXTERNAL REVIEW
OF THE
COOPERATIVE INSTITUTE FOR GREAT LAKES RESEARCH**

**UNIVERSITY OF MICHIGAN (LEAD), CENTRAL MICHIGAN UNIVERSITY, CORNELL UNIVERSITY,
GRAND VALLEY STATE UNIVERSITY, MICHIGAN STATE UNIVERSITY,
UNIVERSITY OF MINNESOTA-DULUTH, OHIO STATE UNIVERSITY, UNIVERSITY OF WINDSOR,
UNIVERSITY OF WISCONSIN-MILWAUKEE, FONDRIEST ENVIRONMENTAL,
GREAT LAKES ENVIRONMENTAL CENTER, LIMNOTECH,
THE NATURE CONSERVANCY - GREAT LAKES,
NATIONAL WILDLIFE FEDERATION - GREAT LAKES REGIONAL CENTER**

ANN ARBOR, MICHIGAN

SUBMITTED TO THE

**NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
SCIENCE ADVISORY BOARD**

**ON
JUNE 11, 2021**

SUMMARY

A virtual external review of the research, education, and outreach programs of the Cooperative Institute for Great Lakes Research (CIGLR) at the University of Michigan (UM) was conducted on April 12-13, 2021. Guidelines for conducting the review were provided by the Oceanic and Atmospheric Research Great Lakes Environmental Research Laboratory (GLERL) within the National Oceanic and Atmospheric Administration (NOAA). The review was conducted under the auspices of the NOAA Science Advisory Board (SAB) and, therefore, is subject to the requirements of the Federal Advisory Committee Act (FACA). A list of Review Panel members is provided in Appendix I. The Review Panel's agenda is provided in Appendix II.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The Science Review Panel rates CIGLR as "Outstanding" and offers several recommendations in the interest of strengthening its critically important focus on Great Lakes research. These recommendations, presented in subsequent report sections, are categorized under Science Review, Education and Outreach, Science Management, and the four themes that characterize CIGLR's current focus (i.e., Observing Systems and Advanced Technologies, Aquatic Invasive Species and Food-Web Dynamics, Hydrometeorological and Weather Forecasting, Protection and Restoration of Resources).

The Panel found that recommendations involving Theme 4 (Protection and Restoration of Resources) are reflected in other themes. Consequently, no independent recommendations for this theme are provided here.

Progress in addressing each of these items should be assessed on a regular basis, with the use of quantifiable metrics as a means to determine the extent to which the recommended actions have been achieved.

I. OVERVIEW OF CIGLR

Established in 2017 (and previously known as the Cooperative Institute for Limnology and Ecosystems Research (CILER), the Cooperative Institute for Great Lakes Research (CIGLR) is focused on addressing NOAA's mission through four primary areas: 1) facilitating and leading primary research to address key sustainability challenges within the Laurentian Great Lakes; 2) fostering engagement with resource managers and decision-makers to facilitate the transfer of science into application; 3) providing a diverse workforce (e.g., natural and social scientists, engineers, designers) with "cutting-edge" career training that yields a diverse and adaptable cadre of researchers and practitioners for current and future Great Lakes challenges; and 4) promoting public Great Lakes literacy via outreach and communications. In addition to collaborative research, CIGLR operates an Engagement, Career Training, and Outreach and Communications (ECO) Program to advance its goals and facilitate the transfer of Great Lakes research and knowledge into actionable science.

CIGLR continues a long-standing relationship between the UM and GLERL within the NOAA Office of Oceanic and Atmospheric Research (OAR). Since CILER's establishment in 1989, NOAA has awarded seven consecutive Cooperative Agreements (CAs) to the UM for collaborative research on the Great Lakes with GLERL. CIGLR has been housed in the University's School for Environment and Sustainability (SEAS) since 2002 and, in so doing, has joined other NOAA-sponsored programs that include Michigan Sea Grant, Great Lakes Integrated Sciences Assessments (GLISA), Great Lakes Observing System (GLOS), and the Science Collaborative of the National Estuarine Research Reserves System (NERRS). The new name for CIGLR reflects the full breadth of its research and, in particular, its emphasis on interdisciplinary work that includes, among others, social science and engineering.

CIGLR is composed of a UM Research Institute embedded within GLERL and a Regional Consortium representing multiple universities, non-governmental organizations, and private companies. The Research Institute recruits and trains research scientists and scientific staff to work alongside researchers at GLERL in Ann Arbor, Michigan and the Lake Michigan Field Station in Muskegon, Michigan. Complementing the Research Institute is a Regional Consortium that builds upon and expands the expertise, capacity, and geographic footprint of NOAA's research programs. The Consortium is presently composed of the following members in addition to the University of Michigan: Central Michigan University, Cornell University, Grand Valley State University, Michigan State University, University of Minnesota-Duluth, Ohio State University, University of Windsor, University of Wisconsin-Milwaukee, Fondreist Environmental, Great Lakes Environmental Center, LimnoTech, The Nature Conservancy-Great Lakes, and the National Wildlife Federation-Great Lakes Regional Center.

The current five-year CA award for CIGLR was signed on July 1, 2017 between the UM and NOAA. In January 2020, the university requested and received approval to increase the original funding ceiling (\$20M/five years) by \$10M given greater-than-anticipated funding volumes during the first three years of the CA. Major funding sources include the U.S. Environmental Protection Agency (USEPA) via the Great Lakes Restoration Initiative, and NOAA's 'Omics Strategy, Weather Program Office Joint Technology Transfer Initiative, National Center for Coastal Ocean Science (NCCOS), and GLERL base

funds. The university also contributes \$1.2M in cost share funding, as well as in-kind support (approximately \$1.4M) over the five year award period.

II. STRATEGIC PLAN

A. CIGLR VISION AND MISSION STATEMENTS

CIGLR's vision is "to be a trusted NOAA Consortium that brings an expanded research capacity with a multidisciplinary, multisector approach and broad geographic coordination, to inform decision makers and help meet grand sustainability challenges of the Great Lakes." The Institute's tagline is "Great Lakes Science for Society" and, as such, reflects an emphasis on multidisciplinary and multi-sectoral research that informs decision makers and the general public by advancing the application of research. This vision statement aligns with that of GLERL, which seeks to be "a trusted scientific enterprise to advance observation, modeling, understanding, and prediction of the Great Lakes and coasts to sustain resilient ecosystems, communities, and economies."

To achieve this vision, CIGLR has adopted a mission statement that directly complements GLERL's mission statement, as articulated in the agency's 2016 Strategic Plan: "Conduct integrated scientific research on the Great Lakes and coastal ecosystems; develop and transition products and services; and share knowledge and information to advance science, service and stewardship." CIGLR's stated mission is to "lead research, develop applications and products, and engage with stakeholders to achieve environmental, economic, and social sustainability in the Great Lakes."

B. RELATIONSHIP OF CIGLR TO THE NOAA STRATEGIC PLAN

CIGLR's mission is well-aligned with the NOAA mission to "understand and predict changes in climate, weather, oceans, and coasts, to share that knowledge and information with others, and to conserve and manage coastal and marine ecosystems and resources." This reflects a concerted effort within NOAA leadership to ensure such an alignment across all Cooperative Institutes (CIs) in the interest of meeting current and future challenges for NOAA's Research and Development programs. In fact, 18 such challenges are articulated in NOAA documents (i.e., 20 Year Research Vision, Next Generation Strategic Plan, Five Year Research and Development Plan), and many of those challenges are reflected in CIGLR's Great Lakes focus. For example, CIGLR has embraced the four over-riding themes that guide GLERL's current focus: 1) Observing Systems and Advanced Technology; 2) Ecosystem Dynamics; 3) Integrated Physical and Ecological Modeling and Forecasting; and 4) Information Services.

Among the multiple challenges referenced above are those that relate to a heightened emphasis on both the social sciences and interdisciplinary research. These are two of the areas that CIGLR has focused on in developing its Research and Development agenda.

C. CIGLR GOALS

CIGLR has identified six goals in support of its mission; goals that guide the selection and conduct of research topics. These goals are as follows:

- Operate a productive Research Institute that is well-aligned and integrated with the GLERL workforce and research focus;
- Maintain a Regional Consortium that builds partnerships (e.g., with academic, non-governmental and private sector organizations) in the interest of expanding GLERL’s intellectual capacity and research infrastructure;
- Assist GLERL in translating Great Lakes research into outcomes that address the needs of the user community;
- Engage with an array of stakeholders (including legislators and resource managers) to provide science-based information that promotes sound decision-making;
- Provide training for students (i.e., undergraduates, graduates) and post-docs in the interest of developing the workforce for future NOAA and Great Lakes science; and
- Undertake outreach and communications activities that advance Great Lakes environmental literacy by showcasing NOAA’s research and its applications.

D. CRITERIA FOR MEASURING SUCCESS

CIGLRL employs seven categories of performance measures in gauging the impact of its research efforts: Grant Success, NOAA-University Partnership, Regional Collaboration, Research Outcomes, Engagement, Career Training, and Outreach and Communications. These measures are tracked on an annual basis and, according to CIGLR, the Institute “is on track to meet or exceed nearly all of our performance targets.” Of particular note are successful efforts in grants acquisition; career training and placement within NOAA; host university cost-share and in-kind support; and outreach and communications (as measured by media followers and coverage). One performance target that has not been met relates to first-authored publications, with CIGLR anticipating that its publication volume will increase as a greater focus is placed on data analysis and writing.

E. CIGLR RESEARCH THEMES

CIGLR focuses on four research themes in approaching its vision and mission statements. These include:

- **Observing Systems and Advanced Technology** including developing and operating observing systems, advancing observing systems technology, developing products for the scientific community and the public, and focusing on high-risk projects with transformative potential.
- **Invasive Species and Food-Web Ecology** including a focus on invasive species, food-web dynamics, developing ecological ‘omics, and high risk projects with transformative potential.
- **Hydrometeorological and Ecosystem Forecasting** including a focus on hydrological and hydrodynamic models and forecasts, climate and weather forecasts, ecosystem state forecasts, and high risk projects with transformative potential.
- **Protection and Restoration of Resources** including valuing ecosystem services, protecting and restoring habitat, and the social adaptation and resilience of coastal communities.

These research themes relate to both GLERL's core research focus and to newer areas where CIGLR can facilitate expansion of NOAA's Great Lakes research. The four themes build upon one another and, as noted by CIGLR, "represent a robust mix of natural science, social science, and engineering and design sciences." These themes also link to and reflect NOAA research priorities as well as those of GLERL, as presented in its Research Plan and as evidenced by the focus of projects awarded to CIGLR.

Within these four over-arching research themes are various initiatives that focus on new and emerging areas of emphasis that include geodetics, metagenomics techniques for invasive species and Harmful Algal Blooms (HABs) research, and shoreline restoration. These areas of emphasis are determined via interactions with CIGLR partners, a competitive funding program open to Consortium members, input from CIGLR's Council of Fellows and All Partners meetings, GLERL research planning activities, basin-wide planning/interaction with multiple other Great Lakes public entities, and collaboration with GLERL on new funding opportunities.

F. SCIENTIFIC PARTNERSHIPS WITH NOAA ENTITIES

One of CIGLR's six goals is to operate a productive Research Institute that is well-aligned and integrated with the GLERL workforce and research focus. Toward that end, CIGLR's research scientists, postdocs, and technicians are UM employees housed at GLERL, where they are fully integrated into a "blended" university-federal workforce. Over the initial three years of the present CA, CIGLR comprises approximately 65% of the GLERL workforce. This arrangement has resulted in five CIGLR employees transitioning to NOAA employment over those initial three years.

More broadly, members of the Research Consortium benefit from CIGLR-facilitated collaborative research with NOAA; research that helps GLERL expand its research "footprint" across the Great Lakes Basin and provides access to additional research vessels, labs, and monitoring instrumentation. Among others, this includes CIGLR funding of 41 Regional Consortium principal investigators in the first three years of the current agreement.

Relationships with other NOAA programs and offices are extensive and, over the first three years of the current CA, collaborative projects have been funded by NOAA's NCCOS, Coastal Hypoxia Research Program (CHRP), NCCOS Monitoring and Event Response for HABs (MERHAB), Fisheries Restoration Center, Sanctuaries, Integrated Ocean Observing System (IOOS), Climate Program Office, Weather Program Office Joint Technology Transfer Initiative (JTII), Office of Weather and Air Quality (OWAQ), and the National Weather Service (NWS).

G. COOPERATIVE PLANNING

Cooperative planning between CIGLR and GLERL takes place at multiple levels (i.e., administrative, research, communications). Research planning and coordination occurs primarily through CIGLR's three Theme Leads, consisting of CIGLR principal investigators and senior engineering staff that address matters such as ongoing collaborative research, personnel needs, and new funding opportunities. In so doing, the Theme Leads represent CIGLR interests during GLERL's Annual Execution Plan process and Science Council meetings, as well as during monthly team meetings.

Cooperative planning also takes place via the CIGLR governance structure. Specifically, the CIGLR Executive Board and Council of Fellows, composed of Research Consortium members and GLERL scientists, provide recommendations on CIGLR's science plan and associated research priorities.

External to CIGLR, interactions with entities such as NOAA's Great Lakes Regional Collaboration Team (GLRCT), Line Offices, and core partners across the region (e.g., CIs, Sea Grant, Great Lakes Commission, GLOS, NERRS, GLISA) advance cooperative planning efforts.

III. SCIENCE REVIEW

The scientific work of CIGLR is of high quality, topical, and directly relevant to NOAA. CIGLR research directly contributes to improved understanding of HABs, effects of seasonal hypoxia, predicted impacts of invasive species, and long-term changes in ecosystem structure. Climate and hydrodynamic models allow greater ability to forecast ice cover and lake effect snow accurately.

CIGLR has attracted several productive early- and mid-career scientists to lead its programs, especially those focused on HABs, climate modeling, hypoxia, and effects of *Dreissenid* mussels. In addition, development of the 'omics strategy within CIGLR should facilitate development of productive scientists in this emerging research area. CIGLR Principal Investigators (PIs), cooperators, post-docs, graduate students, and biologists have published 121 peer-reviewed publications in the first three years of this five-year agreement.

The Panel offers the following recommendations as a means to both maintain and strengthen CIGLR's stature as it relates to science review:

- **Consider establishing a “venture capital” fund that allows CIGLR to provide staff and students with funding support for new and emerging issues.** This type of fund will allow CIGLR to remain on the “cutting edge” of scientific research and provide “seed money” for investigations that may potentially result in a large-scale focus for CIGLR.
- **Generate additional first-authored publications by CIGLR PIs to further enhance CIGLR's stature.**

IV. EDUCATION/OUTREACH

CIGLR operates a coordinated Engagement, Career Training, and Outreach and Communications (ECO) Program that facilitates the transfer of Great Lakes research and knowledge into actionable science. Engagement (E) activities support informed decision-making and include occasional summits, working groups, and legislative interactions including those with local, State, and Federal legislators. CIGLR hosts an annual Science-Policy Nexus event, facilitates Great Lakes environmental awareness and action by supporting the “Take Action” portal on its website, and conducts regular stakeholder engagement focus groups. Career training (C) by CIGLR is designed to promote a skilled and diverse workforce. This involves numerous annual programs and includes Great Lakes Graduate Research Fellowships, Postdoctoral Fellowships, numerous graduate student projects with students at the UM and partner universities, and two annual Doris Duke Conservation Scholars. Notably, the annual 8-12 Great Lakes Summer Fellowships and 25-40 project-specific student and postdoc experiences are most

impactful for meeting diversity, equity, and inclusion initiatives. Outreach activity (O) advances environmental literacy and is realized through a range of real-time and social media, press releases and lay publications including the monthly Great Lakes Seminar Series and Outreach Events, quarterly E-newsletters, CIGLR Minute Videos, regular social media (e.g., Twitter), an up-to-date website, News releases including OAR Hot Items, and NOAA Great Lakes Regional Collaboration Team (GLRCT) Regional Highlights.

With respect to Education and Outreach, the Panel recommends that CIGLR:

- **Increase the diversity of CIGLR-affiliated staff and students via hiring practices and active outreach.** For example, a recent report¹ analyzed workforce data for seven science agencies and found that NOAA’s Black and African American STEM workforce only increased by 0.4% from FY 2016-2020 amidst a 13.6% increase in STEM employment among minority groups. Over the same period, CIGLR Summer Fellow opportunities were occupied by 70% White or Caucasian students, when the US population is 61% White or Caucasian. In 2020, approximately 20 applicants were Black and African American students yet none were hired. CIGLR must not miss opportunities to cultivate and support the next generation of great American Great Lakes scientists.
- **Focus outreach opportunities to benefit the informed use and health of the ecosystem, rather than focusing solely on the extent to which CIGLR/GLERL products are known and used by the public.**
- **Focus outreach opportunities across the entire Great Lakes region.** Much of CIGLR outreach is geared toward stakeholders that reside primarily in Michigan. However, numerous communities, including rights holders (i.e. Indigenous nations) across the Great Lakes Basin have important relationships with the Great Lakes environment that cannot be readily “targeted” for outreach, yet are important. In so doing, acknowledge issues of data sovereignty and sensitivities toward community engagement in both rural and urban regions.
- **In establishing ECO priorities, explicitly recognize the need to recognize geographic, racial (including environmental justice) and cultural considerations.** Tribal governments should be considered important constituents in legislative outreach. As a CI, CIGLR receives Federal funding and thus, should provide outreach across the entire Great Lakes region. Partnering with existing institutions (especially within NOAA, such as Sea Grant, and potential partners such as the International Association for Great Lakes Research- IAGLR) will maximize CIGLR’s ECO impact. Establishing relationships with historically Black colleges and Indigenous colleges in the Great Lakes Basin is highly encouraged.

V. SCIENCE MANAGEMENT

¹ *Scientific Brain Drain - Quantifying the Decline of the Federal Scientific Workforce*. A Majority Staff [report](#) prepared for Members of the Committee on Science, Space, & Technology. March 17, 2021, 24 pp.

The Panel recognizes that CIGLR has a central role in a rather complex scientific environment that spans not only GLERL and the UM, but many other collaborators and partners throughout the expansive binational Great Lakes Basin. While its science management efforts are exemplary, the Panel has identified several recommendations to build upon CIGLR's science management efforts.

With regard to Science Management, CIGLR should:

- **Urge NOAA to increase its funding ceiling to \$40M/5 years in the interest of maintaining its current efforts and responding to the various recommendations contained within this report.** The book *The Little Engine that Could* was used as an analogy for CIGLR, and the Panel finds that analogy to be quite appropriate. CIGLR is producing “outsized” results despite the fact that its budget is quite small when compared to other NOAA CIs.
- **Maintain its focus on ‘omics to advance this potentially transformative work.** The Panel observed that CIGLR has been responsive to opportunities to apply its work in many instances. A great example is the expansion of the CIGLR work activities into ‘omics, an area that is of moderate risk, but potentially transformative. CIGLR is using ‘omics to study the ecological succession of *Microcystis*. This research can potentially be applied to better understand why some blooms are toxic and other are not. If successful, this research could help resource managers and drinking water treatment plant managers make better decisions to protect human health.
- **Enhance relationships within the UM/GLERL realm by establishing and formalizing regularly scheduled coordination/collaboration meetings.** This should include (among others), the UM SEAS, Michigan Sea Grant (MISG), GLERL, the Water Center, GLISA, IAGLR, and GLOS. The Panel observed that CIGLR has forged a strong relationship with GLERL. It was noted that CIGLR represents approximately 63 percent of the research staff at GLERL and clearly has a formidable presence. CIGLR provides a skilled, permanent group of research scientists, technicians, and other staff to GLERL. CIGLR should look for additional opportunities to integrate and leverage efforts within SEAS. Also, given CIGLR's new focus on ‘omics, there are opportunities to collaborate and coordinate with the University's Department of Computational Medicine and Bioinformatics. The Panel noted that the University's investment and commitment to CIGLR is substantial, as it contributes up to 10% of time for research scientists.
- **Appoint a full-time, permanent CIGLR director.** The Panel observed that CIGLR has handled leadership changes quite well. The current CIGLR Acting Director is also the MISG Director, and this dual role is expanding opportunities for CIGLR in outreach and education.

The Panel notes that the Acting Director's efforts have been instrumental in CIGLR's commendable performance to date. Recognizing that CIGLR has traditionally had a 40-50% director appointment, the Panel also notes that CIGLR would benefit from a full-time, permanent director.

- **Enhance relationships with other entities with a Great Lakes Basin focus by establishing and formalizing regularly scheduled coordination/collaboration meetings.** This should include (among others), the International Joint Commission (IJC), Great Lakes Commission

(GLC), Great Lakes Fishery Commission (GLFC), GLNPO and other NOAA units such as the NWS. The Panel observed that CIGLR has taken steps to expand their geographic and scientific focus and impact. This is evident from the change in name from CILER to CIGLR. Yet, more could be done.

The Science Review Panel recognizes the strong relationship between CIGLR and both GLERL and the UM- all located in Ann Arbor, Michigan. However, the Panel also discussed that these relationships may have created a Michigan-centric focus with many of the research projects. Lakes Erie and Michigan seemed to be the focus of many of CIGLR's research projects. The Panel recognizes the challenges associated with distance and the ease and benefit of geographic proximity. However, CIGLR could benefit from expanding relationships with other Regional Consortium members, particularly on the eastern and western boundaries of the Great Lakes Basin. Waterways and rivers that contribute to the Great Lakes system may be another possible area for expansion. This may help foster new partnerships and strengthen relationships with other consortium institutions. CIGLR may also find benefit from reviewing its current membership in the interest of adding new members or re-energizing members not fully engaged in consortium activities. CIGLR should also use this opportunity to engage and build new strategic partnerships with Minority Serving Institutions, and also focus on bringing on Summer Fellows at their consortium member institutions.

- **Undertake a thorough review of current consortium members with the intent to a) add additional members (as appropriate) from the academic, private sector and NGO communities; and b) ensure that all existing members are fully engaged/involved in consortia activities and contribute to CIGLR's mission.** When coupled with the preceding recommendation, this will ensure that the consortium is active, vibrant, and geographically comprehensive. It will also promote research projects that are geographically distributed
- **Hire a permanent social scientist.** The Panel observed that CIGLR has made some strides to integrate human dimensions into their research portfolios, yet they would greatly benefit from hiring a permanent social scientist. CIGLR noted the importance of improving their understanding of human dimensions of Great Lakes natural resources and sustainability, as well as integrating human dimensions and ecosystem valuation throughout their four research portfolios. The addition of a social scientist on the CIGLR staff will benefit all program areas. A dedicated social scientist could also help to better integrate diversity, equity, and inclusion along with environmental justice into CIGLR's governance structure and programmatic activities. While challenges in obtaining a social scientist were acknowledged by the Panel, CIGLR should continue to pursue this endeavor.
- **Develop and implement a policy-related program to strengthen outreach to legislators at the State and Federal level.** The Panel observed that CIGLR could improve efforts to engage with policymakers and legislatures. CIGLR has demonstrated growth in many of their program areas, associated goals, and performance metrics over the last the last several years. One program area that continues to be a challenge is policy engagement. This category represents the number of laws/policies affected by CIGLR science, the number of legislative actions or policy documents referencing CIGLR research, and the number of policy white papers. CIGLR noted that only 17 engagements with policy makers were made over a three-year period. The Panel noted that this number may be on the lower side.

CIGLR has developed a small but robust outreach team. This team should begin to enhance relationships with other entities that frequently influence policy within the Great Lakes Basin by establishing regularly scheduled coordination collaboration meetings including (among others), the International Joint Commission (IJC), Great Lakes Commission (GLC), Great Lakes Fishery Commission (GLFC), GLNPO, GLOS and other NOAA units such as NWS. Engaging with these agencies will likely lead to more opportunities to influence policy in the region. CIGLR should also review internal practices for engaging policy makers directly. Further, CIGLR should look to new, more-engaging methods for reaching out to policymakers and legislators. Instead of developing white papers or policy documents (which are passive approaches), CIGLR should proactively work with the government relations staff in the University to identify and implement innovative approach to communicate the importance and relevance of their work to State and Federal legislators.

- **Develop a clearly-stated workplan and timeline for research activities.** The Panel observed that CIGLR has a strong portfolio of research activities that have been transferred to base operations within NOAA. Yet, CIGLR and GLERL could benefit from a clearly identified workplan and timeline for research activities that may be brought back into NOAA's base operations. It is imperative for both organizations to be on the same page.

VI. RECOMMENDATIONS ON RESEARCH THEMES

A. OBSERVING SYSTEMS AND ADVANCED TECHNOLOGY

CIGLR provides an important regional service regarding the technological development and application of remote sensing and *in situ* observational platforms. Observing systems operated by CIGLR support established programs such as Great Lakes CoastWatch, the Integrated Ocean Observing System (IOOS) and GLOS; all of which create educational and outreach opportunities and have potential to stimulate innovation. In this specific research theme, CIGLR is working closely and broadly with partner institutions to leverage expertise, resources, and opportunities in a rapidly advancing field.

The Panel recommends that CIGLR should:

- **Establish linkages between CIGLR's observing systems work and other new and emerging research.** The advancement of 'omics technologies (e.g., to understand ecosystem function of the Great Lakes system, including its exposome) is actively pursued at CIGLR. The marriage of remote sensing technologies with emerging technologies that support this research enterprise will provide rich observations across the breadth of the Great Lakes Basin, encompassing both spatial (e.g., all lakes and their key connecting waters) and temporal priorities (e.g., eliminating the gap in wintertime observations).
- **Fully document and publicize the benefits of observing system products and outcomes.** CIGLR personnel provide support for remote sensing operations, a mission primarily viewed as a service to GLERL. Incorporating an engineering approach to this

research theme will provide valuable outputs to demonstrate observing system utility. Performing a service role is valuable, but not as prized as demonstrating the hazards and challenges of these activities since risk initiates innovation. In other words, more innovative approaches to observing systems and advanced technologies is desired.

B. INVASIVE SPECIES AND FOOD-WEB ECOLOGY

The Panel finds that CIGLR has obvious strengths in food-web ecology and invasive species. CIGLR scientists have taken their strength in food-web ecology and used it to very capably demonstrate the role of *Dreissenid* mussels in facilitating HABs in Lake Erie, through combined small-scale experiments, field observations, and modeling. The dual strengths of food-web ecology and invasive species are also apparent when considering the contributions of CIGLR to understanding the potential risk of invasive carps to Lake Michigan. Models demonstrate that bighead carps can persist in Lake Michigan and that productive areas, such as drowned river mouths and Green Bay, are high-quality habitat for these invaders. These models also predict that a warming climate will make the growing season longer in Lake Michigan. The existing strengths within this research theme can be enhanced by close collaboration with NOAA's developing Great Lakes 'Omics Strategy. 'Omics research is already being integrated into the CIGLR work plan, and additional coordination with this research theme would benefit both groups. Additional collaboration with the ecosystem forecasting theme would help highlight the expected impacts of invasive species due to a changing climate.

With regard to the theme of Invasive Species and Food-Web Ecology, CIGLR should:

- **Broaden the scope of research to include all five Great Lakes, including the connecting channels and tributaries, where appropriate.** More of this excellent work, when focused on Lakes Ontario, Huron, and Superior (as well as the present Lake Erie and Lake Michigan focus) would enhance the stature and value of CIGLR throughout the Great Lakes Basin.
- **Collaborate with operational staff early in the research process where research products are likely to lead to operational outputs.** Specifically, enhanced collaboration with efforts such as the NOAA Lake Erie Harmful Algal Bloom Forecast, is recommended.
- **Enhance focus on, and attention toward, management and policy-relevant findings and recommendations.** This will enhance the impact of CIGLR science by directly benefitting resource managers and policy-makers.

C. HYDROMETEOROLOGICAL AND ECOSYSTEM FORECASTING

Based on its review, the Panel found that several CIGLR projects are focused on modeling, particularly in the ecological and biological fields. The work in this area is clearly one of the strengths of CIGLR. The work with HABs is particularly impressive, as the HAB tracker model has successfully transitioned as an operational tool for the NOAA Center for Operational

Oceanographic Products and Services (CO-OPS). Information was provided on several other models including hypoxia, ecological, hydrodynamic, ice forecasting and lake effect snow. However, limited information was provided regarding the incorporation of climate change into the ongoing research. The impacts of climate change are an important topic that should receive consideration with future research. While CIGLR's ecological and biological research is outstanding, a diversification of the research focus areas will benefit the region. In particular, CIGLR may be able to leverage the scientific expertise at the multiple surrounding NOAA-sponsored entities to expand research in the climate and meteorological fields.

With regard to Hydrometeorological and Ecosystem Forecasting, CIGLR should:

- **Ensure that climate change is an overarching CIGLR theme given its far-reaching implications for weather, hydrologic conditions, and ecosystem health.** This can be accomplished, among others, by incorporating climate change into its work, as appropriate.
- **Strengthen relationships with the NWS, particularly with regard to forecasting lake effect snow, ice cover and lake levels.** The Panel recognized the synergy between CIGLR activities and the NWS mission, yet also noted that these relationships were limited, and the full benefits and efficiencies of closer collaboration were not being realized.

D. PROTECTION AND RESTORATION OF RESOURCES

The Panel found that this theme summarizes and reflects the preceding three CIGLR themes. As such, no additional recommendations are provided here, as they are adequately captured above.

VII. SUMMARY AND CONCLUSIONS

The Science Review Panel rates CIGLR as "Outstanding," given its scientific excellence, productivity, focus on critical issues, and collaborative nature. In the interest of further strengthening its critically important work and focus on Great Lakes research, a series of recommendations are offered above, focused on Science Review, Education and Outreach, Science Management and the four themes that characterize CIGLR's current focus (i.e., Observation Systems and Advanced Research, Aquatic Invasive Species and Food-Web Dynamics, Hydrometeorological and Weather Forecasting, and Protection and Restoration of Resources.)

APPENDIX I

Review Panel Members

Michael J. Donahue, Ph.D., Chair

AECOM Technical Services, Inc. and SAB Member Emeritus

Gary Garnet

NOAA - National Weather Service

Todd Nettesheim

US Environmental Protection Agency

John Dettmers, Ph.D.

Great Lakes Fishery Commission

Michael Twiss, Ph.D.

Clarkson University

John Horne, Ph.D. (Advisor)

University of Washington

APPENDIX II

Science Review Agenda

Purpose: To maintain a long-term collaborative partnership with a CI beyond its initial five-year award period, an extensive review must be completed. The renewal review is conducted in two parts. The science review evaluates the quality of the research, using performance measures that were mutually agreed upon at the start of the CI, and the quality and effectiveness of science management by the CI. The administrative review examines the procedures associated with grants management at the CI and the parent institution(s).

Science Review Panel:

Michael Donahue - Review Panel Chair; AECOM Vice President and Director of National Coastal and Ecosystem Restoration Practice

John Dettmers - Great Lakes Fishery Commission Director of Fisheries

Management Gary Garnet -National Weather Service Meteorologist in Charge

John Horne - Cooperative Institute for Climate, Ocean, & Ecosystem Studies (CICOES) Director; University of Washington School of Aquatic and Fishery Sciences Professor

Todd Nettesheim - U.S. EPA Great Lakes National Program Office Deputy Director

Michael Twiss - Clarkson University Department of Biology Professor and Chair

Moderator: Thomas Johengen - CIGLR Acting Director

Day 1: Monday, April 12 (*All times in Eastern Daylight Time*)

8:30 a.m.	Introductions	<i>Thomas Johengen, Acting Director</i>
8:45 a.m.	Welcome	<i>Deborah Lee, NOAA GLERL Director Jonathan Overpeck, UM SEAS Dean</i>
9:00 a.m.	CIGLR Overview and Summary	<i>Thomas Johengen, Acting Director</i>
10:00 a.m.	Break	
10:10 a.m.	CIGLR Overview and Summary (<i>cont.</i>)	<i>Mary Ogdahl, Program Manager Thomas Johengen, Acting Director</i>
10:50 a.m.	Break	
11:00 a.m.	Review Panel Executive Session (<i>CLOSED</i>) <i>Review Panel discusses what they heard</i>	<i>Review Panel</i>
12:00 p.m.	Lunch on your own	

Science Presentations – Session 1

1:00 p.m.

Great Lakes Harmful Algal Blooms
Research & Decision Support

Casey M. Godwin, Assistant Research Scientist

Day 1: Monday, April 12 (cont.) *(All times in Eastern Daylight Time)*

1:20 p.m.	Impacts of Coastal Hypoxia on Lake Erie's Communities	<i>Casey M. Godwin, Assistant Research Scientist</i>
1:40 p.m.	Engaging Stakeholders in Research	<i>Devin Gill, Stakeholder Engagement Specialist</i>
2:00 p.m.	Break	
2:10 p.m.	Observing Systems and Advanced Technologies	<i>Russ Miller, Observing Systems Engineer</i>
2:30 p.m.	Ecosystem Observations, Modeling and Forecasting	<i>Michael Fraker, Assistant Research Scientist</i>
2:50 p.m.	Climate and Weather Modeling	<i>Ayumi Fujisaki-Manome, Assistant Research Scientist</i>
3:10 p.m.	Hydrologic/Hydrodynamic Modeling and Coastal Coupling	<i>Dmitry Beletsky, Research Scientist</i>
3:30 p.m.	Break	
3:50 p.m.	Review Panel Executive Session <i>(CLOSED)</i>	<i>Review Panel</i>

Day 2: Tuesday, April 13 (All times in Eastern Daylight Time)

8:30 a.m. Q&A with CIGLR Leadership *Review Panel*
(CLOSED) *Thomas Johengen, Acting Director*
Mary Ogdahl, Program Manager
Review Panel asks questions that
emerge during Day 1 Executive Session

Science Presentations – Session 2

9:00 a.m. ‘Omics: HABs and Invasive Species *Gregory Dick, UM EES Professor*

9:20 a.m. Invasive Species Impacts and *Thomas Johengen, Research Scientist*
Risk Assessment *Peter Alsip, Ecological Modeling Data Analyst*

9:50 a.m. Human Dimensions *Tracy Boyer, UWM SFS Professor*

10:10 a.m. Final Q&A

10:20 a.m. Break

10:30 a.m. Review Panel Executive Session *Review Panel*
(CLOSED) *Discuss findings and generate*
report outline / first draft

12:00 p.m. Lunch on your own

1:00 p.m. Debrief CIGLR Leadership *Review Panel*
(CLOSED) *Jonathan Overpeck, UM SEAS Dean*
Thomas Johengen, Acting Director
Mary Ogdahl, Program Manager
Present preliminary findings and
recommendations

2:00 p.m. Review Panel Executive Session *Review Panel*
(CLOSED) *Continuation of report development*
and team assignments

5:00 p.m. Adjourn
NLT

Administrative Review Agenda

Purpose: To maintain a long-term collaborative partnership with a CI beyond its initial five-year award period, an extensive review must be completed. The renewal review is conducted in two parts. The science review evaluates the quality of the research and the administrative review examines the procedures associated with grants management at the CI and the parent institution(s). The panel reviews accomplishments since last review, and reviews processes and procedures for both pre- and post-award compliance of grant policies based on review questions.

Review Panel Members:

Deborah Lee, NOAA GLERL Technical Program Manager and Administrative Review Chairperson
Rita Williams, NOAA GLERL Federal Program Officer
Sandra Salyers, NOAA GLERL Administrative Officer
Katie Neupane, NOAA GMD Grants Management Specialist - Branch Chief
Jeff Joyner, NOAA Office of General Counsel Federal Assistance Law Division Senior Counsel

Other Key NOAA Participants:

Shannon Louie, NOAA Cooperative Institutes Administration Office (CIAO) Director
Arlene Simpson Porter, NOAA Grants Management Division (GMD) Director
Nadia Musa, NOAA GMD Deputy Director

University of Michigan Representatives:

Thomas Johengen, CIGLR Acting Director
Mary Ogdahl, CIGLR Program Manager
Jeff Keeler, School for Environment and Sustainability (SEAS) Director of Budget and Administration
Shelly Baczkowski, SEAS Business Manager
Teresa Herrick, SEAS Research Administration Senior Manager
D'Shaundra Payne, SEAS Director of Human Resources
Scott Culver, SEAS Research Administrator Senior
Craig Reynolds, Office of Research and Sponsored Projects (ORSP) Asst. VP for Research-Sponsored Projects
Kathy DeWitt, ORSP Managing Project Representative-Government Sponsors
Kullie Kennedy, ORSP Senior Project Representative
Dennis Poszywak, Office of Contract Administration (OCA) Lead
Bryan VanSickle, Office of Finance – Sponsored Programs Customer Service Assistant Director
Amanda Simon, Office of Finance – Sponsored Programs Customer Service Lead
James Craven, Office of Finance – Sponsored Programs Customer Service Intermediate
Bob Johnson, Office of Finance – Procurement Supervisor
Sue Knight, Office of Finance – Procurement Agent

Regional Consortium Representatives:

Michele Quick, Grand Valley State University Grants and Contracts Specialist
Tracy Burdett, Ohio State University Senior Sponsored Program Officer
Melinda Brakenberry, Central Michigan University Research and Graduate Studies Executive Director
Sarah Hall, Central Michigan University Post Award Sponsored Projects Manager
John Bratton, LimnoTech Senior Scientist
Claudine Hawthorne, The Nature Conservancy Senior Grants Specialist

Moderator: Deborah Lee

Wednesday, April 14 *(All times in Eastern Daylight Time)*

8:45 a.m.	Welcome	<i>Deborah Lee, NOAA GLERL</i>
9:00 a.m.	Organizational Overview	<i>Shelly Baczkowski, UM SEAS ORSP representative OCA representative Sponsored Programs representative Procurement representative</i>
9:30 a.m.	Business Process Discussion <i>Discuss answers to the administrative questions answered in the briefing book</i>	<i>Review Panel University of Michigan Representatives</i>
11:30 a.m.	Break	
11:45 a.m.	Regional Consortium Listening Session <i>(CLOSED)</i>	<i>Review Panel Regional Consortium Representatives</i>
12:45 p.m.	Lunch on your own	
1:45 p.m.	Review Panel Executive Session <i>(CLOSED)</i> <i>Discuss findings and recommendations, draft final Administrative Review report</i>	<i>Review Panel</i>
4:15 p.m.	Debrief CIGLR Leadership <i>(CLOSED)</i>	<i>Review Panel Thomas Johengen, CIGLR Mary Ogdahl, CIGLR Shelly Baczkowski, UM SEAS Teresa Herrick, UM SEAS Jeff Keeler, UM SEAS</i>