National Association of Marine Laboratories

Position Paper: The Need for a Strategic and Sustained Federal Investment in Basic Research and Education in Support of the Great Lakes Ecosystem
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NAML believes it is essential that a sustained and strategic investment be made by the National Science Foundation (NSF) and other relevant federal agencies in fundamental science and engineering research and education associated with the Great Lakes ecosystem. Substantially enhanced investments will soon be made in the restoration of the Great Lakes. Such an investment can benefit greatly via a greater understanding of the fundamental science and engineering that underpins this vast ecosystem. NAML further recommends that NSF and other relevant federal agencies support a rigorous national workshop, a National Academies report, or other similar exercises that seek to integrate ongoing and planned restoration activities of the mission-oriented agencies with a strategic set of fundamental research, education, and related infrastructure priorities.

The Importance of the Great Lakes Region

The Great Lakes region is home to over 34 million people, with approximately two thirds of them in the U.S. and one third in Canada. The Great Lakes region includes eight states -- Minnesota, Wisconsin, Illinois, Indiana, Michigan, New York, Ohio, and Pennsylvania -- and two Canadian provinces -- Ontario and Quebec. The region supports an economy of approximately $3.5 trillion, including that of Chicago, the third largest economy in the U.S., and Toronto, the largest metropolitan economy of Canada. It is estimated that 25.8 million jobs—worth more than $1.3 trillion in wages and spanning countless industries, including 7% of all American farm production -- are directly supported by the region. In total, the Great Lakes account for 84% of North America's surface fresh water and contain about 21% of the world's supply. The Great Lakes are home to more than 175 species of fish, which contribute to the region's vibrant commercial and recreational fishing industries. There are over 10,500 miles of Great Lakes coastline in the U.S. and Canada, which is more than twice the length of the Atlantic, Gulf and Pacific coastlines of the lower 48 U.S. states combined.

According to the Office of Coastal Management at the National Oceanic and Atmospheric Administration (NOAA), for every dollar invested in Great Lakes protection, the return on investment is $3.35, or 335%. Furthermore, for every $1 million invested in Great Lakes restoration and protection, 16 jobs are created. The economic, human, and ecosystem health of the binational region relies on effective management of the Great Lakes for clean drinking water, healthy fish and wildlife, safe beaches and boating, a vibrant economy of innovative waterfront cities and companies, modern shipping and ports, and sustainable rural agriculture and forestry. Although annual expenditures on Great Lakes research and monitoring that support effective management approach $250 million, investments in fundamental research, research vessels, and related infrastructure necessary to understand and manage the Great Lakes ecosystem have not kept up with the needs of this region or the rapid advances in technology.

Recent Developments - the Need for a Fundamental Research Agenda for the Great Lakes Ecosystem

The importance of a robust fundamental research and education investment becomes even more important because of recent infrastructure and public policy decisions made in the U.S. with respect to the Great Lakes ecosystem. These developments include the following.
1. *The Great Lakes Restoration Initiative (GLRI)*
2. *U.S. Geological Survey Great Lakes Science Forum – Summary of Remaining Data and Science Needs and Next Steps*
3. *International Joint Commission (IJC)*
4. *Smart Great Lakes Initiative (SGLi)*

1. The Great Lakes Restoration Initiative (GLRI): GLRI was launched in 2010 as a non-regulatory program to accelerate efforts to protect and restore the largest system of fresh surface water in the world and provide additional resources to make progress toward the most critical long-term goals for this important ecosystem. Since FY 2010, Congress has provided approximately $3.8 billion to date for GLRI activities. Moreover, in the recently enacted *Infrastructure Investment and Jobs Act*, an additional $1 billion in new funding was appropriated for GLRI. This is supplemental funding to GLRI over five years and is in addition to the approximately $330 million in yearly funding the program receives through the annual appropriations process.

Through a collaborative planning process involving relevant federal, state and local agencies, tribes, and other non-federal stakeholders, GLRI has developed and is executing a strategic plan for the years 2020 to 2024 and the plan includes **several focal areas.**
● Toxic Substances and Areas of Concern
● Invasive Species
● Nonpoint Source Pollution Impacts on Nearshore Health
● Habitats and Species
● Foundations for Future Restoration Actions

2. U.S. Geological Survey Great Lakes Science Forum – Summary of Remaining Data and Science Needs and Next Steps: In 2021, in response to a request from the House Appropriations Committee, the USGS produced a report on Great Lakes Science which proposed an increase of funding to address known gaps in data describing and understanding of such areas as winter processes, nearshore ecosystems, groundwater discharge, tributary flow, and environmental socioeconomics. **Specifically, the USGS report called for**:
● Expanded data collection or monitoring to provide basic ecosystem, social, and public health data, enabling management of the Great Lakes system and development of test models and decision support tools.
● New science and advanced technologies (for example, sensors and high-performance computing capability) for improved understanding of critical threats, such as harmful algae blooms and high-water levels.

3. International Joint Commission (IJC): The IJC was created by the U.S. and Canada in recognition that each country is affected by the other's actions in lake and river systems along the border. The IJC is guided by the Boundary Waters Treaty, signed by Canada and the United States in 1909. The treaty provides general principles, rather than detailed prescriptions, for preventing and resolving disputes over waters shared between the two countries and for settling other transboundary issues. The specific application of these principles is decided on a case-by-case basis. The IJC has two main responsibilities:

approving projects that affect water levels and flows across the boundary and investigating transboundary issues and recommending solutions. The IJC's recommendations and decisions consider the needs of a wide range of water uses, including drinking water, commercial shipping, hydroelectric power generation, agriculture, ecosystem health, industry, fishing, recreational boating, and shoreline property.

As of January 2022, the IJC is nearing completion of a comprehensive decadal science plan for a binational program of Great Lakes research. **The need for the plan is tied to the following developments:**
- Large scale changes in the Great Lakes ecosystem over a period of less than 20 years.
- Potentially far-reaching impacts of ongoing change, both known and unknown.
- Uncertainty driven by our current lack of understanding or quantification of many principal drivers and processes involved in these changes.
- Significant past, ongoing, and future investment deemed necessary to restore the Great Lakes and fulfill the promise of the Great Lakes Water Quality Agreement (GLWQA); and
- Lack of a contemporary, comprehensive science plan for the Great Lakes that is also broad in scope and perspective.

4. Smart Great Lakes Initiative (SGLi): In 2019, the idea to create a **common strategy** for using data to make decisions, or *Smart Great Lakes*, was developed by members of the Great Lakes Observing System, Cleveland Water Alliance, and the Council for the Great Lakes Region. The Smart Great Lakes Initiative (SGLi) is a consortium that convenes private industry, state, provincial and federal governments, academic institutions, and non-profit partners in Canada and the U.S. to lead the development and application of advanced data collection, analytics, and decision-support systems across the Great Lakes. SGLi seeks to improve awareness and response to changes in the Great Lakes, guide, support, and apply technological innovation in Great Lakes, sensing and data science and inform critical decision-making across political borders. As threats and pressures from climate change, invasive species, pollution, and urbanization continue to mount in the Great Lakes region, challenges to region-wide management continue in parallel. Comprehensive and sustainable management relies on critical information infrastructure, including accurate and resilient observing systems, cutting-edge science and research, analysis-ready data and information accessibility, and tools to equip decision-makers with current and relevant information. Capitalizing on the emergence and application of new technologies and partnerships is critical to keep pace with mounting pressures, challenges, and threats to the Great Lakes. SGLi's **Common Strategy for Smart Great Lakes** contains a set of goals and objectives designed to realize a vision of advancing technology applications that improve understanding, management, and use of the Great Lakes. **The initial goals of this common strategy include the following.**
- Development of novel and interdisciplinary research;
- Support of science, innovation, and technology that improve our ability to identify, assess, and respond to stressors and change; and
- Development of research infrastructure, including resilient and adaptable observing systems, in support of a swimmable, drinkable, fishable, and equitable future.

Summary: Restoration of the Great Lakes is complex, changing, and expensive, with the investment to restore the Great Lakes estimated to be more than tens of billions of U.S. dollars. The above listed four initiatives are promising, but also illustrate the complexity of issues and potential solutions. Restoring an ecosystem with the immense scale of the Great Lakes will require a solid scientific understanding of complex ecosystem interactions so that the appropriate evaluation of restoration costs versus benefits can be made. The complex attributes and demands of the Great Lakes ecosystem along with the speed with which climatic changes are taking place in this ecosystem present significant opportunities and challenges for the research enterprise, challenges that ultimately affect the management of this unique ecosystem. Realizing the vision for Smart Great Lakes requires significant advances in basic research and training. The research enterprise in the Great Lakes must be strengthened to meet the immense challenges presented by these vast, complex, and changing lakes. Research has been driven by reacting to crises, rather than being built upon a comprehensive strategy for fundamental understanding. There are important questions that remain to be answered. For example, how do we best combat invasive pest species, whose effects can fundamentally alter how these systems function? How do multiple nutrients combine to affect water quality and how can these be most effectively managed? Are the Great Lakes a source or a sink for atmospheric carbon? A key requirement for answering questions like these is federal support for understanding the *fundamental* processes that operate across the entire Great Lakes system. It is only by understanding these basic processes, that we can predict how this system will respond to a changing climate. Additionally, the scientific and technical workforce needed for such research and restoration activities must be adequately developed by our academic enterprise, including the outreach necessary to achieve objectives related to diversity, equity, and inclusion.

NAML Position Regarding Investing in Long Term Health of the Great Lakes

Given A. the importance of the Great Lakes ecosystem to the economic and environmental health of both the U.S. and Canada, B. the significant forthcoming expansion in Great Lakes restoration, and C. the multiple mission-oriented and international science plans for the Great Lakes ecosystem; it is essential that a sustained and strategic investment be made by the National Science Foundation (NSF) and other relevant federal agencies in the fundamental science and engineering research and education enterprise that underpins our understanding of the Great Lakes ecosystem. NAML therefore recommends that NSF and other relevant federal agencies support a rigorous national workshop, a National Academies report, or other similar exercises that seek to integrate ongoing and planned restoration activities of the mission-oriented agencies with a strategic set of fundamental research, education, and related infrastructure priorities. These activities should provide an estimate for the level of investment necessary to support these priorities.

About NAML: The National Association of Marine Laboratories (NAML) is a network of place-based marine and Great Lakes laboratories (https://www.naml.org). The geographic network of NAML includes estuaries, the coastal zone, the Great Lakes and inland watersheds, the global ocean including polar regions, and the sea floor. NAML labs provide scientists, students, public, and civic leaders with leading edge science, environmental and coastal intelligence, and professional training that contributes to the understanding, management, and stewardship of our ocean, coastal zones and Great Lakes. The research, observational, and educational activities of NAML contribute to the nation's economic, environmental, and national security.