National Association of Marine Laboratories

Testimony for the Record
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The National Association of Marine Laboratories (NAML) is pleased to submit testimony to the Subcommittee with a series of recommendations that we believe would strengthen the Nation's research and education enterprise – particularly as it relates to our oceans, coasts and Great Lakes.

NAML is a nonprofit organization representing the ocean, coastal and Great Lakes interests of member laboratories that employ thousands of scientists, engineers and professionals nationwide. NAML labs conduct high quality research and education in the natural and social sciences and translate that science to improve decision-making on important issues facing our country. In setting NAML's priorities, NAML recognizes the importance of the federal investment in the geosciences and related disciplines as contributory factors to the Nation's economic and national security, and public safety. NAML strongly supports two important reports from the National Academy of Sciences. They are: ***Sea Change: 2015-2025 Decadal Survey of Ocean Sciences (DSOS)***; and ***Enhancing the Value and Sustainability of Field Stations and Marine Laboratories in the 21st Century***. Specifically, NAML supports:

- Enhancing research, education and public engagement at marine labs for the continued development of the nation's workforce, expansion of opportunities for active learning and collaborative research, and improved public engagement;
- Increasing support for competitive, merit-based ocean, coastal, and Great Lakes research and education from relevant federal agencies to address research priorities and agency mission priorities; and
- Promoting a network of advanced connectivity among Federal and non-Federal laboratories that strengthens the Nation's research and education enterprise – including advanced cyber infrastructure, integration of environmental observing systems, and the co-location of federal scientists and infrastructure at NAML facilities.

Oceans, Coasts and Great Lakes -- Vital for Economic Growth and the Well-being of the Nation

Six economic sectors of the U.S. economy depend on the oceans, coasts, and Great Lakes, which provide an important and resilient part of the national economy: including marine construction; living resources; offshore mineral extraction; ship and boat building; tourism and recreation; and marine transportation. According to NOAA, in 2012, the ocean economy accounted for 147,000 business establishments, 2.9 million employees, $113 billion in wages, and $343 billion in gross domestic product. In 2012, the ocean economy's contribution to gross domestic product grew by 10.5 percent - more than four times as fast as the U.S. economy as a whole (which grew by 2.5 percent). During the same year, employment in the ocean economy increased 3.8 percent (adding 108,000 jobs). This was twice the national average employment growth of 1.8 percent.

Programs such as NOAA's Sea Grant program, NSF's geoscience and biological sciences research programs including the Field Stations and Marine Laboratories program, NOAA's National Estuarine Research Reserve System, ocean observing and education programs at NSF and NOAA, and other agencies' national estuaries and other water-related programs all contribute to either the continued

economic development of our coastal economies and/or the improved management of coastal and marine natural resources.

Research and Education: Commitment to Innovation

Innovation in the form of new goods, services, or processes builds new knowledge and technology, contributes to national competitiveness, improves living standards, and furthers social welfare. Research and development is a major driver of innovation. R&D expenditures indicate the priority given to advancing science and technology relative to other national goals.

According to the latest data, the U.S. science and engineering (S&E) enterprise still leads the world. The United States invests the most in research and development (R&D), produces the most advanced degrees in science and engineering and high-impact scientific publications, and remains the largest provider of information, financial, and business services. However, Southeast, South, and East Asia continue to rapidly ascend in many aspects of S&E. The region now accounts for 40 percent of global R&D, with China as the stand-out as it continues to strengthen its global S&E capacity. The National Science Board's (NSB) *Science and Engineering Indicators 2016* (*Indicators*) report highlights that China, South Korea and India are investing heavily in R&D and in developing a well-educated workforce skilled in science and engineering. *Indicators 2016* makes it clear that while the United States continues to lead in a variety of metrics, it exists in an increasingly multi-polar world for S&E that revolves around the creation and use of knowledge and technology.

At the same time that China and other Asian nations have continued to increase their R&D investments, the United States' longstanding commitment to federal government-funded R&D is declining. Federal obligations for the total of R&D and R&D plant were $129 billion in FY 2008, $145 billion in FY 2009, and $147 billion in FY 2010. But the years thereafter have been mostly marked by funding declines: FYs 2011 and 2012 were down $6–$7 billion from the FY 2010 peak and then declined further to $127 billion in FY 2013. In FY 2014, the total increased to $131 billion. Nonetheless, the drop from the FY 2010 level to that in FY 2014 is a current dollar decline of 11%—and when inflation is factored in, it is steeper still, at 17%. Since the Great Recession, substantial, real R&D growth annually -- ahead of the pace of U.S. GDP -- has not returned. Inflation-adjusted growth in total U.S. R&D averaged only 0.8 percent annually over the 2008-13 period, behind the 1.2 percent annual average for U.S. GDP.

NAML believes the nation is faced with a widening gap between the actual level of federal funding for research and education and what the investment needs to be if the U.S. is to remain the world's innovation leader. NAML believes the nation needs to increase its investments in research and education to develop the ideas, the people, and the innovations that power the nation's economy, create jobs, improve health, and strengthen our national security, ensuring the U.S. maintains its role as a global leader.

<u>**National Science Foundation**</u>

NSF's annual budget represents 25% of the total federal budget for basic research conducted at U.S. colleges and universities, and this share increases to 60 percent when medical research is excluded. In many fields NSF is the primary source of federal academic support. For example, NSF provides 61% of all federal support for basic research at academic institutions in the environmental sciences and 66% in biology (excluding the biomedical sciences). Although many federal agencies contribute to ocean, coastal, and Great Lakes research and education, NSF provides the broadest base of support, including funding for research in physical, biological, and chemical oceanography and marine geology and geophysics, and the development, implementation, and operational support for ocean, coastal, and Great Lakes research infrastructure. Research in ocean and coastal areas is supported via a highly competitive, merit-based process through a variety of modes of support at NAML laboratories involving individual investigators,

small interdisciplinary teams of researchers and students, and large collaborative efforts integrating several laboratories.

NAML strongly supports robust funding for NSF particularly in the geo and biological sciences. Since FY 2011, despite an increase of nearly 10% to the NSF research and related account, funding for the geosciences has remained nearly flat. This has exacerbated the budgetary pressures on core research programs and the support for infrastructure throughout the directorate and as specifically addressed in the Decadal Study on Ocean Sciences (***DSOS)***. The FY 2017 NSF budget request contains a proposed 6% increase for both the geosciences and the biological sciences, with a 6.5% increase for NSF's entire research budget. NAML strongly supports this requested investment in research and education through NSF.

Research emphases at NSF should reflect the priority science questions contained in ***DSOS***. NSF's support for ocean research infrastructure should be realigned with these research priorities. NAML is particularly supportive of the creation of new research networks that connect NAML laboratories and terrestrial field stations in ways that would enhance other ecosystem networks (e.g., LTERs) supported by NSF. NAML embraces this and other recommendations, which stem, in part, from ***Enhancing the Value and Sustainability of Field Stations and Marine Laboratories in the 21st Century***.

NAML notes the increasing share of NSF's division of ocean science's funding to support facilities and infrastructure, is approaching 50% of the total division's budget. This is up substantially from the historical 40% share. Advanced infrastructure, while expensive, is essential for the field to move forward. However, the support for infrastructure must be balanced with the need to support individual investigators – particularly young investigators – with the resources needed for high quality research activities. The ***DSOS*** considers marine laboratories and field stations **critical** for the research priorities related to coastal and estuarine oceans, biodiversity and marine ecosystems, and marine food webs. NAML endorses the recommendations of ***DSOS*** including:

- To sustain a robust ocean science community, holistic fiscal planning is necessary to maintain a balance of investments between core research programs and infrastructure. To maintain a resolute focus on sustaining core research programs during flat or declining budgets, NSF should strive to control operating costs of its major infrastructure programs over the next five years.

- NSF should reconsider whether the current regional class research vessels (RCRV) design is aligned with scientific needs and is cost effective in terms of long-term O&M pressures, and after doing so, should act accordingly.

- NSF should expand its partnership capabilities with other federal agencies and international partners, particularly with regard to shared community research priorities (e.g., climate change, ocean acidification, hypoxia, HABs, etc.).

National Oceanic and Atmospheric Administration

One of NOAA's key priorities is providing information and services to make communities more resilient to coastal hazards. America's coastal communities and shorelines are facing escalating risks from changes in storm intensity, precipitation, flooding, rising sea levels, and ocean ecosystems, as well as from earthquakes and tsunamis that can result in dramatic human and economic losses. Increasing population density along the coast will further intensify pressures on ecologically and economically important areas, and put more people at risk. Rising sea level can further escalate the costs and risks of inundation events. A study by the National Institute of Building Sciences on Federal hazard mitigation grants estimated that $1 spent on hazard mitigation potentially leads to avoidance of $4 in disaster relief

costs and lost Federal tax revenue. Smartly investing in resilience strategies and programs will reduce the economic impacts of these hazards and improve national economic security. Similarly, the Great Lakes region boasts a massive geographic footprint, and is a major driver of the North American economy. With economic output of $4.7 trillion in 2011, the region accounts for 28% of combined Canadian and U.S. economic activity. By comparison, the region's output ranks ahead of Germany, France, Brazil and the U.K., and it would rank as the fourth largest economy in the world if it were a country, behind only the U.S., China and Japan. Continued investments will be required to modernize the nation's critical infrastructure in the very near future. This represents an opportunity to incorporate green infrastructure materials and strategies into communication, transportation, water supply and other critical systems. Continued support for NOAA's coastal programs will be necessary to ensure that these systems are resilient to extreme weather, natural disasters and other hazards. Comprehensive resilience planning will help protect coastal communities and resources from the effects of hazards and land-based pollution to vulnerable ecosystems by addressing competing uses, improving water quality and fostering integrated management for sustainable uses. Geospatial services will support communities, navigation and economic efficiency with accurate, useful characterizations, charts and maps, and assessment and decision support tools. NOAA programs and services will help build capacity among coastal decision makers to adaptively manage coastal communities and ecosystems with the best natural and social science available. Resilient coastal communities and economies cannot be achieved without strong partnerships. NOAA should increase its outreach to and usage of NAML laboratories by increasing support of *existing programs* before embarking on the establishment of new, potentially duplicative, programs.

NAML strongly supports recommendations that call for priority support for NOAA extramural programs. These include: the National Sea Grant College (NSGC) Program; Office for Coastal Management (OCM); Aquaculture Initiatives; Prescott Marine Mammal Program; Highly Migratory Shark Fishery Research Program; NOAA Cooperative and Joint Institutes; the Integrated Ocean Observing Systems; NOAA's Center for Sponsored Coastal Ocean Research harmful algal bloom, hypoxia, and ecological forecasting initiatives; the National Estuarine Research Reserve System (NERRS); the National Marine Sanctuary Program; and NOAA's Office of Education. NOAA should also join with NIH and NSF to revitalize its support for the Oceans and Human Health research program. Extramural funding enables NOAA to leverage its R&D and operational investments with the resources of the nation's leading university scientists resulting in greater and faster scientific advances at lower costs. A predictable and reliable partnership with the extramural research community is critical to NOAA's long-term success.

As available resources become scarcer and major program reorganizations may be considered, NOAA should expand its efforts to co-locate agency research staff and infrastructure at non-Federal marine laboratories. Such actions will not only result in significant cost savings, but also will achieve a greater return for its investment and increase scientific collaborations and productivity.

NAML also continues to express concern with NOAA proposals contained in appropriation language requests that would enable NOAA to compete with non-federal and private entities for private sector support (See proposed Sec 109 on p. 219 of the *Appendix to the Budget of the U.S. Government* for FY 2017). NOAA should adhere to its public-private partnership policy, which recognizes the distinct, yet cooperative, roles of the public and private sectors as it relates to environmental information.

The NOAA budget request for FY 2017 includes requested increases for OCM and the Coastal Science and Assessment, including the Competitive Research program that supports harmful algal blooms, hypoxia, and the coastal resilience management grants program which NAML is pleased to support. NAML is concerned, however, with proposed reductions in oceans, coastal, and Great Lakes research - including the National Sea Grant College Program, the Ocean, Coastal, and Great Lakes Cooperative Institutes and Ocean Exploration and Research.

National Aeronautics and Space Administration

Part of NASA's mission is to develop an understanding of the total Earth system and the effects of natural and human-induced changes on the global environment. Oceans play a major role in influencing changes in the world's climate and weather. Long-term ocean data from satellites make it possible to employ modeling techniques for global mapping of seasonal changes in ocean surface topography, currents, waves, winds, phytoplankton content, sea-ice extent, rainfall, sunlight reaching the sea, and sea surface temperature. Studying these patterns at a global scale can help forecast and mitigate the effects of floods and drought. Ocean observing satellite imagery informs us about the most fundamental climate changes. Satellite data have improved forecasting model capabilities to predict events such as El Niño and other global and regional climate cycles. Expanding NASA extramural support will further develop the ability to better predict ocean phenomena, particularly those impacting coastal environments (e.g. harmful algal blooms, hypoxia, ocean acidification).

Education, Diversity and an Ocean Literate America

The U.S. continues to be at risk with respect to student achievement in science, technology, engineering and math among industrialized nations, as well as, emerging industrializing nations. As reported in *Indicators*: in the international arena, the Program for International Student Assessment data show that the U.S. average mathematics and science literacy scores are below the average scores for all developed countries, and the United States has substantially fewer high scores and more low scores than other developed countries. U.S. students' average mathematics score of 481 in 2012 was lower than the average score for all developed countries, 501. The average science literacy score for U.S. students in 2012 was 497, lower than the average science score of 511 for all developed countries.

NAML continues to believe it is critically important that we improve ocean literacy and workforce development among all sectors of our nation. Place-based networks such as NAML offer unique opportunities to provide hands-on training in diverse field settings with advanced sampling and sensing technologies The importance of marine laboratories in support of coastal states' environmental literacy plans is essential in developing a literate public. Investment is needed today in coastal, ocean and Great Lakes education programs at NAML laboratories that support formal and informal learning at all age levels, in all disciplines and for all Americans.

NAML supports the Administration's proposed $7 billion investment in STEM education across the Federal Government – with its expansion of access to rigorous STEM courses, improving STEM teaching and support for active learning, and expansion of opportunities for all students in STEM education. NAML laboratories believe the mission agencies have a role in helping to educate and train the workforce they will need in the future to carry out their missions. Therefore, NAML strongly objects the proposed budget reductions to NOAA's education programs. NAML also continues to strongly support partnerships with Federal agencies to address the ocean education needs of the Nation. These include the NSF's Louis Stokes Alliance for Minority Participation, Research Experiences for Undergraduates and Research on Learning in Formal and Informal Settings programs; NOAA's Expanding Partnerships Program in the NOAA Education Office and Sea Grant's fellowships and K-12 STEM education programs; and EPA's Science to Achieve Results (STAR) Fellowship Program.

Thank you for the opportunity to submit this information for the FY 2017 appropriations process.