On behalf of the Consortium for Ocean Leadership (COL), I appreciate the opportunity to submit for the record the ocean science, technology, and education community’s fiscal year (FY) 2019 funding priorities for the National Science Foundation (NSF), the National Oceanic and Atmospheric Administration (NOAA), and the National Aeronautics and Space Administration (NASA). Geosciences, broadly, and ocean science and technology, specifically, strengthen our national security, support a safe and efficient marine transportation system, underpin our economy, and further understanding of complex ocean and coastal processes important to our everyday lives – today and tomorrow.

For these reasons, **COL (and the ocean science, technology, and education community we represent) calls on the subcommittee to make a $1 billion investment in the security of the nation by dramatically strengthening federal investment in ocean science and technology through NSF, NOAA, and NASA**.

In summer 2017, the first ship to traverse the Arctic Northern Sea Route without assistance from ice-breaking vessels completed its journey. This transformational moment drives home both the opportunity and the imperative for the United States to ready itself for the new Arctic. The region is warming at twice the rate of the rest of the Earth with far-reaching consequences for these polar residents and for those in the lower 48 states. On a global level, Arctic change will fundamentally alter climate, weather, and ecosystems in ways we do not yet understand, but we know there will be profound impacts on the world’s economy and security. Rapid loss of sea ice and other changes will also bring new access to the area’s natural resources, such as fossil fuels, minerals, and new fisheries, and this new access is already attracting international attention from industry and nations seeking new resources. Current Arctic observations are sparse and inadequate for enabling discovery or simulation of the processes underlying Arctic system change or to assess their environmental and economic impacts on the broader Earth system. One of NSF’s “Big Ideas” is the initiative **Navigating the New Arctic (NAA)**, which would establish an observing network of mobile and fixed platforms and tools across this polar region to document these rapid biological, physical, chemical and social changes, leveraging participation by other federal agencies.

Storm surge is often the greatest threat to life and property from coastal storms and hurricanes. Researchers are quantifying how future tropical storm surges may impact U.S. coastal properties, using past patterns of coastal sea-level change. From 1990 to 2008, population density increased by 32% in Gulf Coast coastal counties, 17% in Atlantic coastal counties, and 16% in Hawaii, according to the U.S. Census Bureau. In 2011, 45% of our nation’s gross domestic product (GDP) was generated in the coastal shoreline counties along the ocean and Great Lakes. A storm surge of 23 feet has the ability to inundate 67% of interstate highways, 57% of arterial roads, almost half of all rail miles, 29 airports, and virtually all ports in the Gulf Coast area. Information on coastal property risk is vital to owners, insurers, and government.

These two examples demonstrate the connection of our ocean science and technology enterprise with the security interests (national, economic, and public safety) of the nation. In addition:

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1 Aligning with like-minded science organizations and coalitions, we respectfully request the Subcommittee provide no less than **$8.45 billion for NSF** (including funding parity for all directorates or at least $1.4 billion for the Geosciences Directorate); **$6.5 billion for NASA’s Science Mission Directorate** (including at least $2.03 billion for the Earth Science Division); and **$6.2 billion for NOAA** (including research, extramural grant programs, and education). Additionally, the ocean science and technology community is deeply concerned by the Administration’s FY 2019 budget intention to drastically reduce non-defense discretionary funding (~$65 billion) with draconian cuts and outright program eliminations in the geosciences, education, and extramural grants.
• The U.S. coastal and ocean economy contributes $359 billion to our GDP (2% of total GDP), including marine construction ($5.8 billion), ship building ($17.3 billion), marine transportation ($59.1 billion, equaling 95% of all imports to the U.S.), offshore oil and gas ($167 billion), living marine resources ($7.3 billion), and tourism and recreation ($101.1 billion, which is 72% of the ocean economy contributions to GDP).

• 14 percent of U.S. coastal counties produce 45% of the nation's GDP, with close to one in 45 jobs directly dependent on the resources of the ocean and Great Lakes.

• In 2014, the ocean economy employed more people in the U.S. than the telecommunications, crop production, and building construction industries combined. Additionally, if the nation’s coastal counties were considered an individual country, they would rank number three in global GDP, behind only the U.S. and China. The Great Lakes alone generated nearly $5 trillion in economic output (about 30% of U.S. and Canadian production combined).

• In 2014, the ocean economy’s 149,000 business establishments employed about 3.1 million people, paid $123 billion in wages, and produced $352 billion in goods and services. This accounted for about 2.3 percent of the nation’s employment.

• The ocean’s role in food security is critical – it provides 20 percent of the animal protein we depend on for food, supplies fishmeal that fertilizes the nation’s crops, and is the major driver of the weather and water cycles that bring warmth and water to inland farms.

• The U.S. is the leading global importer of seafood, with 91% originating abroad – half of which is from aquaculture. Driven by imports, our seafood trade deficit grew to over $14 billion in 2016. Our ocean science research institutions are leaders in developing and supporting innovative methods to improve and encourage sustainable U.S. aquaculture that complements, not competes with, our existing commercial fisheries.

• Increasing numbers of people are calling the coast home, with populations in coastal watershed counties increasing 45 percent from 1970-2010.

• The U.S. marine transportation system is a major driver of the U.S. economy and its impact reaches into the heartland of the nation. America's seaports are crucial generators of economic development and jobs, regionally and nationally, throughout all supply chains using ports. Long-term sustainability of such critical oceanfront infrastructure in the wake of shifting—and dynamic—environmental conditions is a significant concern addressed by ocean research institutions (typically sharing the same geographic proximity to the water).

• A 12.5 percent projected growth of science, technology, engineering, and math (STEM) jobs in the U.S. is expected from 2012 to 2022, with a 14 percent projected increase in U.S. geoscience jobs in that same period. Coupled with the greying of America’s geoscience workforce (47 percent of American geoscientists in the private sector and 43 percent in the federal government were over the age of 55 in 2016), it is clear that our nation will experience major changes with our innovation workforce.

All the issues identified above—and more—can be addressed, in part, through a vibrant ocean science and technology enterprise. A diverse, well-educated, ocean-literate workforce provides the necessary base from which innovation grows. This will require a concerted effort to upgrade the infrastructure needed, which includes vessels, instrumentation, advanced computing, and observing and monitoring support. It requires an enhanced investment in at-sea and university-based research in our ocean sciences and technology enterprise. Finally, it requires a substantial and focused effort on the education and training of the next generation of scientists to ensure we have the intellectual resources to take full advantage of the new knowledge that will come from
this investment in ocean sciences and technology, but it also needs those who will train the following generation and those whose work supports novel and emerging science solutions. A dynamic workforce moves our nation forward. From business professionals who can commercialize scientific advances to technicians who maintain observing infrastructure and employees trained in scientific principles, our future depends upon how we will meet these demographic and educational challenges.

**COL is calling on Congress to increase federal investment in our national ocean science, technology, and education enterprise by $1 billion over the next year (within the resources available under the new spending cap for non-defense discretionary spending). The level of investment in non-defense research and development today (2018) is essentially the same as it was in 2002 (in constant dollars). Making a concerted, dramatic effort to increase and sustain the federal investment in technology, science education, research, and development will send a message to our global competitors that this country is determined to regain our science leadership position on the world stage while also addressing national, homeland, food, and economic security challenges.**

Below are some suggestions for how some of these additional funds could be invested to help achieve a more secure nation via our ocean science, technology, and education enterprise.

- NSF’s Division of Ocean Sciences (OCE) supports interdisciplinary research and technology, education, and cutting-edge infrastructure that advances scientific knowledge of the ocean to support the U.S. economy; provide vital information regarding national, economic, and homeland security matters such as sea level rise, coastal erosion, ocean influences on weather (e.g., hurricanes, winter storms, floods, extended drought, etc.); and to advance U.S. leadership in ocean science and technology relative to our international competitors. OCE supports basic scientific and technological research to better understand changing ocean circulation and other physical, chemical, and biological parameters. OCE also supports research on the geology of the ocean margins and sub-seafloor to investigate natural hazards such as earthquakes and volcanic eruptions. In addition to the NSF’s NAA initiative that COL supports, an additional $100 million allocation to support ocean and coastal research as it relates to risk and resilience due to natural hazard understanding and mitigation would be a strong step toward increased homeland and economic security. Funding should be used to support the operational costs of the current academic fleet and ocean observing initiative in their ocean and coastal research into natural hazards and to provide resources for additional graduate and undergraduate student training in research related to natural hazards through NSF traineeships, fellowships, and undergraduate research programs.

- Extramural programs within NOAA are well positioned to more fully engage the ocean science and technology community to assist federal entities in supporting coastal and inland communities through best practices to improve coastal economic and environmental resiliency. The National Sea Grant College Program (Sea Grant) is well equipped to work with state and local government decision makers and coastal community residents to apply sound science and technology principles to improve natural disaster preparation. The Office of Oceanic and Atmospheric Research (OAR)’s Cooperative Institutes can focus on large-scale systemic research issues related to our ocean, coasts, and Great Lakes. The National Marine Fisheries Service (NMFS) and OAR should collaborate to support aquaculture research and commercial development to help the nation address the seafood trade deficit. NOAA’s National Ocean
Service (NOS) has important assets that can be more fully exploited in areas related to coastal mapping, ocean and coastal observing and monitoring through the Integrated Ocean Observing System, coastal community economic resiliency grants, and research that can best be carried out within the National Estuarine Research Reserve System and National Marine Sanctuary System. Additionally, support for national-scale projects that improve environmental stewardship and informed decision-making is critical. As the longest-standing and most comprehensive national grants program with a focus on environmental literacy, NOAA’s Office of Education Environmental Literacy Program\(^2\) (ELP) grants keep our coastal communities, and therefore our nation as a whole, safe, secure, and prosperous. Increasing resources for ELP also contributes to the training of the next generation of ocean scientists through its education programs. A total of $400 million is recommended to support a package of time-tested NOAA programs related to natural hazard research impacting the ocean, coasts, and Great Lakes and the training of a diverse, ocean science literate, dynamic workforce. These actions support our nation’s national, homeland, food, and economic security, all with an eye to the future.

The ocean science, technology, and education community recognize the constraints facing the subcommittee when it comes to allocating scarce resources. The subcommittee has equally demanding and deserving needs in law enforcement, the census, and manned space flight program, to name a few. Nevertheless, growth in the annual investment in science and technology by this subcommittee is critical to support innovation, national security, economic competitiveness, improvements in living standards, and support for public and societal well-being. Research and development is a major driver of innovation, and these expenditures reflect a nation’s commitment to expanding capabilities in science and engineering, which in turn drives innovation. On January 18, the National Science Board released the biennial *Science and Engineering Indicators 2018*. The report finds that the world’s nations are continuing to accelerate the growth of their technology-intensive economies. It documents how the science and engineering landscape — historically concentrated in the U.S., Europe, and Japan — is rapidly shifting as China and other countries continue to increase their research and development investments. It makes clear while the U.S. remains the global leader now, China prioritizes science and continues its rapid rise in the rankings and looks to overtake us.

Adequate and sustained investment in science is the bedrock upon which this nation’s global science primacy and innovation economy are built. The U.S. is poised to maximize its maritime experience and potential to address security through science and increase competitiveness in the international marketplace, all while looking toward the long-term viability of our base resource — the ocean. Only through the subcommittee’s continued dedication to our nation’s science and education enterprise will this be possible.

Mr. Chairman, Ranking Member, and members of the subcommittee, we greatly appreciate the opportunity to share our recommendations, and I encourage bipartisan support for geoscience funding, including this $1 billion ocean science, technology, and education initiative, in the FY 2019 appropriations process and into the future.

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\(^2\) We recommend funding the Office of Education base account separately to adequately support staff without diminishing the grant program.