

**Testimony of RADM Jonathan White, USN (Ret.)
President and CEO of the Consortium for Ocean Leadership
Before the House Appropriations Committee's Subcommittee on Defense
Regarding Naval Science and Technology Capabilities**

On behalf of the Consortium for Ocean Leadership (COL), I appreciate the opportunity to share our funding priorities for the Fiscal Year (FY) 2018 Defense Appropriations Act. COL represents the nation's leading ocean science, technology, and education institutions, with the mission to shape the future of ocean science. Ocean science strengthens our national security, supports a safe and efficient marine transportation system, underpins our economy, and furthers understanding of complex ocean and coastal processes important to our everyday lives – today and tomorrow. Aligning with like-minded security science organizations and coalitions, we respectfully request the Subcommittee provide no less than \$2.3 billion for the Defense basic research program elements, \$14.5 billion for the Defense Science & Technology program, and \$3 billion for the Defense Advanced Research Projects Agency (DARPA). **To ensure our nation can maintain maritime battlespace superiority in an increasingly unstable world, COL respectfully requests the subcommittee oppose the significant cuts in funding proposed in the President's FY 2018 budget request and provide the Navy with no less than the science and technology funding levels appropriated in the FY 2016 omnibus spending bill, which were \$671 million for basic research (6.1), \$967 million for applied research (6.2), and \$697 million for advanced technology development (6.3).** Ensuring robust and sustained funding for Navy science and technology programs and partnerships (which represent a small fraction of the overall Navy budget) is key to ensuring the culture of innovation and initiative that DOD has prioritized (internally as well as with its non-federal research partners). It is also needed to stem the erosion of the U.S. competitive advantage in ocean sciences and understanding and exploiting the ocean environment (USN Task Force Ocean Problem Statement).

Federal investment is required to meet the endstate goals of the U.S. Navy's Task Force Ocean:

- Navy-relevant ocean science infrastructure in the U.S. remains measurably ahead of our competitors
- The U.S. Navy's capability and capacity to understand and exploit the ocean environment remain measurably ahead of our competitors
- The U.S. Navy's capability and capacity to exploit the full range of science and technology development in the U.S. advance through increased permeability between the Navy and government, academia, and the private sector

The FY 2017 omnibus appropriations bill cut Navy's basic research funding more than 16 percent, below the FY 2010 enacted funding level. The FY 2017 omnibus funded the Navy's University Research Initiative below FY 2012 enacted funding, and Navy's Defense Research Sciences FY 2017 funding fell below FY 2011 levels (\$83 million cut from FY 2016 funding). Reductions such as these could mean 160-500 research project not receiving funding, effectively limiting the Navy's ability to "exploit the full range of science and technology development" occurring through partnerships with academia. Additional to losses in critical research areas like observations and modelling, unmanned vehicles, power generation, propulsion hydromechanics, bioinspired autonomous and surveillance systems, environmental quality, casualty care and management, and casualty prevention, the Navy may be forced to reduce its STEM activities. Whether decreasing support for the Young Investigator Program or sponsoring fewer graduate fellowships at HBCUs and HSIs, this is a major loss to the human capital and tactical workforce development identified as a key issue by Navy's Task Force Ocean.

An Ocean Planet; A Maritime Nation

Earth is an ocean planet, with saltwater covering more than 71 percent of its surface. The ocean sustains life itself – providing the oxygen we breathe, the food we eat, water for drinking and farming, energy to run our societies, and even the warmth that has allowed humanity to thrive. One half of the oxygen on Earth comes from marine phytoplankton. Seafood contributes 15 percent of animal protein for three billion people (another billion rely on fisheries for their main source of protein). The ocean holds 97 percent of Earth's water, which then becomes freshwater for drinking, farming, and manufacturing. Roughly 80 percent of global energy comes

from petroleum formed in ancient seas. Around the world, 350 million jobs are linked to the ocean, and coastal zones contribute \$26.8 trillion to the global economy each year.

The U.S. is a maritime nation, with more ocean area in our Exclusive Economic Zone than in our terrestrial 50 states combined. From the very beginning, the U.S. has turned to the sea for protection, exploration, lifestyle, economic security, food, recreation, and energy. Our country is protected by a Navy battle force of 275 ships, 118 Army watercrafts, 245 Coast Guard cutters, and over 80 coastal military bases. The ocean is an economic driver to more than three million Americans who work in ocean and coastal industries (which are worth \$359 billion annually). The ocean's role in food security is critical – it provides 20 percent of the animal protein we depend on for food, provides fishmeal that fertilizes the nation's crops, and is the major driver of the weather and water cycle that bring warmth and water to inland farms. Our nation's competitive security advantage doesn't rest solely on the best charts and finest navigation technologies but also upon the ability to predict and plan for threats on the horizon. Changes in ocean and atmospheric systems can quickly snowball into disturbances in food supplies, human population migrations, and geopolitical instability.

Ocean Science: Vital To The Nation's Security

Ocean science and technology provide the nation with a knowledge advantage against myriad maritime threats we face, both now and in the future. Basic ocean research forms the critical foundation needed to ensure continuity of our superior knowledge of the ocean, which in turn generates warfare advantage and ensures homeland security. However, the Navy's competitive advantage over key military competitors in understanding and exploiting the ocean environment has diminished and can only be reestablished through investments in science and technology research across all agencies. Asian and European ocean education and research enterprises have, in many cases, matched or exceeded that in the U.S. Admiral James Watkins, former Chief of Naval Operations, often remarked that oceanography was a key determinant in the U.S. Cold War "victory," due to the knowledge advantage provided to our forward deployed maritime forces, especially our submarines. We are firmly convinced that ocean science and technology today can and must provide us with the same knowledge advantage against the myriad maritime threats we face today.

The academic research community has enjoyed a long and productive partnership with the U.S. Navy in helping to ensure maritime military readiness, domain awareness, and warfighting advantage. This success has its foundation in sustained investment in supporting science and technology programs implemented through the 6.1, 6.2, and 6.3 programs. The 3rd Offset Strategy highlighted by Secretary of Defense Carter and other service leaders in congressional testimony acknowledges the challenge to U.S. military superiority through increasing competition in science and technology by other nations. Investments in science and technology now are crucial to ensuring future capabilities, which take time and sustained funding to nurture through the research and development process and to integrate into the operational battlespace. A good example of this is the continued acceleration of Autonomous Undersea Vehicles (AUV) and other ground-breaking submarine technology usage in the undersea environment by the Navy and Department of Defense (DOD). The impact of the ocean environment on these systems is even more pronounced than it was for the manned and tethered systems of the past. Acoustic advantage; endurance and energy consumption; autonomy; and effective command, control, and communications for AUV are heavily influenced by ocean conditions. These must be measured, modeled, and accurately predicted to ensure undersea warfare advantage is maintained against a global undersea threat that is ever-growing in complexity and proliferation. Basic ocean research provides the critical foundation to ensure continuity of our undersea knowledge superiority that generates warfare advantage. Simply put, our undersea forces must be able to win every "away game," and we therefore must be able to exploit the ocean environment to ensure "home field advantage" at those "away games."

Intelligence Advantage Through Ocean Knowledge – Understanding, Modeling and Predicting

As defined by the Navy, Maritime Domain Awareness (MDA) is the "effective understanding of anything associated with the maritime domain that could impact the security, safety, economy, or environment of the

United States.¹ MDA is comprised of situational awareness (observable and known) and threat awareness (anticipated or suspected) – a mix of operational intelligence and environmental data and information. Whether it is basic oceanographic research or ocean modelling, a better understanding of the ocean system significantly enhances MDA. The security advantage gained through increased ocean knowledge is not limited to the warfighting arena. Beyond situational awareness, contributions of forward-deployed naval forces and information and intelligence capacities of Navy and the intelligence community (e.g., CIA, NSA, DIA, NGA) benefit from basic and applied research programs, as well as partnerships with academic institutions supporting robust ocean observations and monitoring to enhance threat awareness. Understanding the ocean system and modelling scenarios form the foundation of trustworthy predictions, which in turn improve our nation's security advantage by moving us along the spectrum from situational awareness to threat awareness and ultimately to threat prediction.

The Department of Defense Climate Change Adaptation Roadmap² and both of the most recent Quadrennial Defense Reviews^{3,4} have recognized that changing climate is a threat to national security, and its effects must be assessed and addressed through adaptation. The melting of sea ice and permafrost, acidification of the seas, and decay of large ice sheets are just some of the ways the polar regions have responded to changing ocean and atmospheric conditions. Half of the world's population lives within 60 km of the ocean, 75 percent of all large cities are on the coast⁵, and the U.S. coastal population is expected to increase by an additional 10 million people by 2020.⁶ As many as 650 million people across the world are at risk from rising seas by the end of the century.⁷ Just this year, we've begun to see a slowdown of ocean circulation in the Atlantic,⁸ which is symptomatic of broader changes in global ocean circulation patterns that directly impact military operations (e.g., anti-submarine warfare) while also affecting storm and drought intensity (and the concomitant humanitarian response implications) and the chronic -but significant- concerns surrounding the rate of sea level rise on naval installations and facilities.

Through threatened freshwater sources (due to saltwater intrusion), loss of protein sources, submerged land, and increases in disease and other human health concerns,⁹ human populations living within coastal zones across the globe are the groups to be impacted most directly by a changing ocean. Whether abroad or at home, displacement or abandonment, mass migrations, and conflict over resources are real security threats both on the coasts and inland.

Navigating Changing Ocean Conditions – Sensing and Observing

The Navy and DOD have a distinguished history of fostering the science and technology that has been responsible for U.S. military success and superiority. There is growing concern that this superiority is being challenged by a significant increase in investment by our rivals, while funding support for science and technology within DOD and the Navy has languished. This is particularly apparent in the proposed reduction in the Navy 6.2 and 6.3 funding included in the president's budget request, which would result in an approximately 10-20 percent decrease in research and technology development resources.

With the ocean providing 20 percent of the animal protein in the human diet¹⁰ and 24 percent of global land degrading (25 percent rangeland, 20 percent cropland),¹¹ it is understandable that illegal, unregulated and unreported fishing (IUU) and desertification are not only food security issues but ultimately ones of national

¹ https://www.dhs.gov/sites/default/files/publications/HSPD_MDAPlan_0.pdf

² <http://www.acq.osd.mil/ie/download/CCARprint.pdf>

³ http://www.defense.gov/Portals/1/features/defenseReviews/QDR/QDR_as_of_29JAN10_1600.pdf

⁴ http://archive.defense.gov/pubs/2014_Quadrennial_Defense_Review.pdf

⁵ http://www.unep.org/urban_environment/issues/coastal_zones.asp

⁶ <http://oceanservice.noaa.gov/facts/population.html>

⁷ <http://www.climatecentral.org/news/new-analysis-global-exposure-to-sea-level-rise-flooding-18066>

⁸ Rahmstorf, S., et al. 2015. Exceptional twentieth-century slowdown in Atlantic Ocean overturning circulation. *Nature Clim. Change* 5, 475–480 (2015)

⁹ <http://widenerlawreview.org/files/2010/04/07-KUNDIS-CRAIG-Final.pdf>

¹⁰ http://www.education.noaa.gov/Ocean_and_Coasts/

¹¹ http://www.un.org/en/events/desertification_decade/value.shtml

security. Changes in ocean conditions directly associated with access in the Arctic lead to expanded navigation and commerce in the region (e.g., shipping, fishing, oil and gas exploration, bioprospecting, mining) and could result in disputes amongst nations or accidents requiring search and rescue or other response.

Whether considering ocean conditions to better understand drought forecasts or to model changes in fish distributions, data and information from the sea strengthen the Navy's awareness of conflict catalysts. However, these data and information must be gathered. Ocean observation platforms and sensor technology advancement allow for real-time characterization of ocean conditions as well as necessary data to assess trends. The basic and applied research lines, robust partnerships and collaborations with ocean science and technology institutions, and in-house surveying capabilities all support the increase of ocean knowledge for our nation's security advantage.

Given the critical importance of ocean knowledge in both the warfighting arena and in threat awareness, the ocean science community greatly appreciates the subcommittee's continuing recognition of the importance of the Auxiliary General Oceanographic Research (AGOR) research vessels fleet. COL strongly supports inclusion of adequate funds in the 6.2 account to complete the Service Life Extension Program of the AGOR-23 class, which adds 10-15 years of life to the vessels and ensures the availability of unique platforms capable of performing multidisciplinary, high endurance missions that support Navy information needs around the globe. There is also concern that the Navy does not have a long-term plan to recapitalize its operational oceanographic survey ship fleet. The T-AGS 60 Pathfinder class will begin to exceed their planned life expectancy within the next decade, and it is imperative that replacement ships be included in the Navy's long-term ship building plan.

Long-term Commitment to People, Platforms, and Partnerships – Human Capital and Tactical Workforce

It is hard to overemphasize the significant advantages that have resulted from Navy support for basic research, including highly trained people, cutting-edge technology, and innovative ideas. The advantage and benefits that have accrued to DOD and the Navy cannot be attributed solely to the amount of investment; equally important is the Office of Naval Research's culture that understood the importance of providing *sustained* support for technology development and the cultivation of researchers, including early career and established scientists (internally and among its academic partners). The cultivation of people and technology in support of national security priorities is well beyond the mission and role of other federal agencies supporting ocean science, such as the National Science Foundation and the National Oceanic and Atmospheric Administration. For example, the U.S. Navy's competitive advantage in undersea warfare research relies on the ability to execute unique data collection systems and sea-going expertise. The backbone for these programs is comprised of partnering scientists, expert engineers, and technicians with decades of experience in executing research at sea.

It is also important to recognize the important role science and technology funding plays in the development of new technology (e.g., sensors, platforms, models, data analytics) that are essential to helping the Navy meet its mission requirements. Much of the oceanographic equipment in use today, for defense and nondefense research, observations, and modeling, has resulted from Navy investment in its development, as well as its integration to defense and non-defense at-sea platforms and in research labs through the Defense University Research Instrumentation Program. Unfortunately, the level of investment in technology development has seriously declined in recent years, with greater focus being placed on the transition of applied technology into operations. The negative impacts of this shift in emphasis and support has been realized as the flow of new technologies and their application to Navy mission requirements slows, just as the increased investments by rivals begins to bear fruit. Task Force Ocean specifically targets ocean related technology development through and with the Navy, academia, and the private sector.

Additional to the technology shortfalls, there is a human capital issue. Forty-seven percent of American geoscientists in the private sector and 43 percent in the federal government are over the age of 55, making

them likely to retire in the next 10 years.¹² The Workforce Research team at the American Geosciences Institute calculated that there will be a shortfall of 135,000 geoscientists in the U.S. workforce over the next decade. Specifically Navy-focused, the Navy oceanography enterprise has lost more than half of its physicists and geophysicists and 12 percent of its physical scientists and oceanographers in the last decade alone. In the last 20 years, the Naval Research Laboratory has lost approximately 50 percent of its acousticians and 13 percent of its oceanographers. We can ill afford to have a shortage of these workers, both military and civilian, who are vital for the national security community.

Conclusion

Ocean science and geosciences *writ large* impact every American every day. Across the nation, across science disciplines, and across the federal family, it is clear that robust and sustained federal investments in ocean and geosciences are key to addressing global and national challenges; underpinning new and growing economies while maintaining and supporting existing ones; and improving technologies that preserve lives and livelihoods, persons, and property. As the subcommittee drafts the FY 2018 spending bill, we hope that you reflect on the Navy's concern with the erosion of competitive advantage in the ocean science and technology arena and the fact that the bulk of the intellectual capacity regarding the ocean resides within the academic research community. Peer-reviewed extramural research is the most efficient and effective vehicle for providing our policy makers and our commercial partners with the expertise, information, and data necessary to address the emerging challenges facing our nation.

To maintain global stability, it is critically important that the nation understands the factors of conflict catalysts. To successfully navigate a changing physical, chemical, and biological ocean while maintaining geopolitical establishments, the Navy must regain their competitive advantage in understanding the ocean and coastal baseline conditions, changing conditions, forecasted conditions, vulnerabilities of undersea and coastal infrastructure, and the threatened human population. The changing climate and ocean systems are altering when and where our military may be called to duty, but also *how* the military can respond. Rising sea levels affect amphibious landing opportunities, and extreme weather could impact deployment, intelligence, surveillance, and reconnaissance capabilities. It is through the robust federal support of the Navy's basic and applied research, maintaining superiority in technology development and integration, and through collaborative partnerships with ocean science and technology institutions that this will happen.

Madame Chair and members of the subcommittee, the ocean science and technology community appreciates the support that the subcommittee provided for oceanographic research and technology advancement, and we hope that you will continue to prioritize science investments to ensure the U.S. can maintain its superiority at sea. We greatly appreciate your consideration of our recommendations and are available to discuss these recommendations with you further at your earliest convenience.

Below is a list of institutions that are represented by the Consortium for Ocean Leadership:

¹² Distribution of Geoscientists, Fedscope, March 2015, <https://www.fedscope.opm.gov/ibmcoqnos/cqi-bin/coqnosisapi.dll>

Alabama

Dauphin Island Sea Lab

Alaska

Alaska Ocean Observing System

Arctic Research Consortium of the United States (ARCUS)

North Pacific Research Board

University of Alaska Fairbanks

California

Aquarium of the Pacific

Bodega Marine Laboratory

Esri

L-3 MariPro, Inc.

Liquid Robotics, Inc.

Monterey Bay Aquarium Research Institute

Moss Landing Marine Laboratories

Romberg Tiburon Research Laboratory

Stanford University

Teledyne RD Instruments

U.S. Naval Postgraduate School

University of California, San Diego Scripps Institution of Oceanography

University of California, Santa Barbara

University of California, Santa Cruz

University of Southern California

Colorado

Cooperative Institute for Research in Environmental Sciences

Connecticut

University of Connecticut

Delaware

University of Delaware

Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS)

Florida

Earth2Ocean

FAU Harbor Branch Oceanographic Institute

Florida Institute of Oceanography

Mote Marine Laboratory

Nova Southeastern University

University of Florida

University of Miami

University of South Florida

Georgia

Savannah State University

Skidaway Institute of Oceanography, University of Georgia

Hawaii

University of Hawaii

Illinois

John G. Shedd Aquarium

Louisiana

ASV Global, LLC

Louisiana State University

Louisiana Universities Marine Consortium

Maine

Bigelow Laboratory for Ocean Sciences

The IOOS Association

University of Maine

Maryland

Johns Hopkins University Applied Physics Lab

National Aquarium

Severn Marine Technologies, LLC

University of Maryland Center for Environmental Science

Massachusetts

Massachusetts Institute of Technology

University of Massachusetts, Dartmouth

Woods Hole Oceanographic Institution

Michigan

University of Michigan

Mississippi

University of Mississippi

University of Southern Mississippi

New Hampshire

University of New Hampshire

New Jersey

Monmouth University Urban Coast Institute

Rutgers University

New York

Columbia University Lamont-Doherty Earth Observatory

Stony Brook University

North Carolina

Duke University

East Carolina University

North Carolina State University

University of North Carolina, Chapel Hill

University of North Carolina, Wilmington

Oregon

Oregon State University

Pennsylvania

Pennsylvania State University

Rhode Island

University of Rhode Island

South Carolina

South Carolina Sea Grant Consortium

University of South Carolina

Tennessee

Eastman Chemical Company

Texas

Harte Research Institute For Gulf of Mexico Studies

Shell Oil Company

Sonardyne, Inc.

Texas A&M University

University of Texas at Austin

Virginia

College of William & Mary (VIMS)

Institute for Global Environmental Strategies (IGES)

Old Dominion University

Teledyne CARIS

U.S. Arctic Research Commission

Washington

Sea-Bird Scientific

University of Washington

Washington, D.C.

Marine Technology Society (MTS)

National Ocean Industries Association (NOIA)

Southeastern Universities Research Association (SURA)

Wisconsin

University of Wisconsin, Milwaukee School of Freshwater Sciences

Australia

Institute for Marine and Antarctic Studies (IMAS)

Bermuda

Bermuda Institute of Ocean Sciences

Canada

Dalhousie University

University of Victoria Ocean Networks Canada