NATIONAL STRATEGY FOR MAPPING, EXPLORING, AND CHARACTERIZING THE UNITED STATES EXCLUSIVE ECONOMIC ZONE

Prepared by the

OCEAN SCIENCE AND TECHNOLOGY SUBCOMMITTEE

of the

OCEAN POLICY COMMITTEE

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About the Ocean Policy Committee

The Ocean Policy Committee was established in 2018 by Executive Order 13840, "Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States," to coordinate Federal actions on ocean-related matters and is co-chaired by the Director of the Office of Science and Technology Policy (OSTP) and the Chairman of the Council on Environmental Quality (CEQ). The Executive Order directed the Ocean Policy Committee to engage and collaborate with the ocean community on ocean-related matters, identify priority ocean research and technology needs, and leverage resources and expertise to maximize the effectiveness of Federal investments in ocean research. For more information about the work of the Ocean Policy Committee, please see the Ocean Policy page on the CEQ website: https://www.whitehouse.gov/ceq/.

About the Ocean Science and Technology Subcommittee

The Ocean Policy Committee established the Ocean Science and Technology Subcommittee (OST) pursuant to Section 4(b) of Executive Order 13840 to address ocean science and technology issues across agencies. This includes identifying priority ocean research and technology needs, participating as appropriate in the work of the National Oceanographic Partnership Program (NOPP), and supporting research and technology collaboration among the agencies and departments represented on the Ocean Policy Committee.

About this Document

Pursuant to Section 2 of the Presidential Memorandum of November 19, 2019, on "Ocean Mapping of the United States Exclusive Economic Zone and the Shoreline and Nearshore of Alaska," this document sets forth a national strategy for mapping, exploring, and characterizing the United States Exclusive Economic Zone (EEZ), and for enhancing opportunities for collaboration among interagency and non-United States Government entities with respect to those activities. These proposed actions are subject to the availability of appropriations.

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Abbreviations and Acronyms

AUV	Autonomous Underwater Vehicle
BOEM	Bureau of Ocean Energy Management
CEQ	Council on Environmental Quality
CRADA	Cooperative Research and Development Agreement
DOE	Department of Energy
DOI	Department of the Interior
DOT	Department of Transportation
eDNA	Environmental DNA
EEZ	Exclusive Economic Zone
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
FGDC	Federal Geographic Data Committee
FWS	Fish and Wildlife Service
IWG-OCM	Interagency Working Group on Ocean and Coastal Mapping
LIDAR	Light Detection and Ranging
MMC	Marine Mammal Commission
NASA	National Aeronautics and Space Administration
NCEI	National Centers for Environmental Information
NGA	National Geospatial-Intelligence Agency
NIH	National Institutes of Health
NMIO	National Maritime Intelligence-Integration Office
NOAA	National Oceanic and Atmospheric Administration
NOPP	National Oceanographic Partnership Program
NPS	National Park Service
NSF	National Science Foundation
OCS	Outer Continental Shelf
ODNI	Office of Director of National Intelligence
OMB	Office of Management and Budget
ONR	Office of Naval Research
OPC	Ocean Policy Committee
OSTP	Office of Science and Technology Policy
ROV	Remotely Operated Vehicle
S&T	Science and Technology
USACE	United States Army Corps of Engineers
USARC	United States Arctic Research Council
USCG	United States Coast Guard
USDA	United States Department of Agriculture
USGS	United States Geological Survey
USN	United States Navy

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Executive Summary

The ocean, coasts, and the Great Lakes are among the most treasured resources in the United States. They are an integral part of our national identity and our Nation's future. A comprehensive understanding of our oceans is fundamental to advancing science, building ocean-related industries, informing decisions that balance ocean use and conservation, and enhancing the Nation's prosperity and security. While technologies and understanding continually improve, the United States currently lacks critical information regarding many foundational characteristics of our Nation's oceans. To develop the knowledge and information necessary to address these gaps, improve our Nation's understanding of our vast ocean resources, and advance the economic, security, and environmental interests of the United States, President Trump signed a Presidential Memorandum[1] on November 19, 2019, titled "Ocean Mapping of the United States Exclusive Economic Zone and the Shoreline and Nearshore of Alaska." This Presidential Memorandum directs the Ocean Policy Committee to "coordinate the development of a national strategy for mapping, exploring, and characterizing the United States EEZ, and for enhancing opportunities for collaboration among interagency and non-United States Government entities with respect to those activities." [2]

Pursuant to the Presidential Memorandum, this document presents a strategy to map the United States EEZ, identify priority areas within the United States EEZ, and explore and characterize these priority areas, leveraging the expertise and resources of multi-sector partnerships. Deploying new and emerging science and technologies at scale, and doing so in partnership with private industry, academia, and non-governmental organizations, are essential components of the strategy.

While this document provides important guidance to Federal agencies on ocean science and technology (S&T) priorities and informs the policy development process, implementation of this plan is dependent on available resources and will vary year to year. This effort is a phased-strategy approach meant to address near-term priorities within the next 3 years. This Strategy will be updated in 2023, and may be similarly revised thereafter, to reflect advancements in S&T, partnerships, and the operational sophistication of the mapping, exploration, and characterization enterprise.

The Strategy advances five goals, each supported by strategic objectives that incorporate high-level actions, to accomplish the task of mapping, exploring, and characterizing the United States EEZ. An immediate action under the Strategy will be the development of an Implementation Plan that will characterize and direct specific actions to implement the Strategy.

[1] The Presidential Memorandum is available at: https://www.whitehouse.gov/presidential-actions/memorandum-ocean-mapping-united-states-exclusive-economic-zone-shoreline-nearshore-alaska/

[2] The United States Exclusive Economic Zone (EEZ) extends no more than 200 nautical miles from the territorial sea baseline and is adjacent to the 12 nautical mile territorial sea of the United States, including the Commonwealth of Puerto Rico, Guam, American Samoa, the United States Virgin Islands, the Commonwealth of the Northern Mariana Islands, and any other territory or possession over which the United States exercises sovereignty.

Goal 1: Coordinate Interagency Efforts and Resources to Map, Explore, and Characterize the United States EEZ: Federal agencies will align priorities in efforts to map, explore, and characterize the resources of the United States EEZ.

Goal 2: Map the United States EEZ: Federal agencies will coordinate mapping efforts to compile a complete map of deep water by 2030 and nearshore waters by 2040. Completing this goal will give the United States unprecedented detailed information about the depth, shape, and composition of the seafloor of the United States EEZ.

Goal 3: Explore and Characterize Priority Areas of the United States EEZ: Federal agencies will identify priority areas of interest for exploration and characterization, and coordinate interagency and cross-sector efforts to explore the ocean, make new discoveries, and characterize the ocean resources of the United States.

Goal 4: Develop and Mature New and Emerging Science and Technologies to Map, Explore, and Characterize the United States EEZ: New and emerging S&T is key to making ocean mapping, exploration, and characterization more efficient and effective. Federal agencies will coordinate efforts to promote and advance new technologies to support this effort.

Goal 5: Build Public and Private Partnerships to Map, Explore, and Characterize the United States EEZ: Fully mapping, exploring, and characterizing the United States EEZ will require efforts not only from Federal agencies but from State governments, private industry, academia, and non-governmental organizations. Federal agencies will participate in and support these partnerships in order to ensure all goals are completed by their target dates.

This Strategy is a call to action for Federal agencies and non-Federal partners to build a national enterprise to map, explore, and characterize the United States EEZ. Meeting this challenge will require coordinated action and collaborative efforts that join scientific inquiry, entrepreneurial enterprise, philanthropic endeavor and public and private investment. It will also require a broadly defined but common direction to help guide our actions and ocean stewardship. In doing so, we will dramatically increase our knowledge of the Nation's ocean resources, and enhance our economic competitiveness, strengthen our national security, protect our environment, and preserve continued prosperity.

Introduction

The ocean covers 71 percent of the Earth's surface and supports global prosperity.[3] The United States Exclusive Economic Zone (EEZ) extends 200 nautical miles (NM) from shore and is larger than the land area of all 50 States combined, and is one of the largest in the world (Figure 1). Despite its vast expanse, most of this area is still unmapped, unobserved, and unexplored.[4] Mapping, exploring, and characterizing the ocean and coastal shoreline advances scientific understanding, safeguards the Nation's economic prosperity, and promotes the health and security of our people. This knowledge is essential to advancing America's understanding of the marine environment and addressing sustainable ocean resource management.

The United States has economic, security, and environmental interests in exploring and understanding its EEZ. In 2016, the National Oceanic and Atmospheric Administration (NOAA) estimated that the ocean economy produced more than $300 billion in goods and services and that there were approximately 154,000 ocean-dependent businesses, which employed more than 3 million people and paid $129 billion in wages.[5] Given the size of the United States EEZ and coastline, the energy, critical minerals, living resources, and ecosystems it encompasses may be worth many billions if not trillions of dollars.[5] The ocean science and technology (S&T) enterprise can provide the foundational knowledge needed to address many complex ocean-related challenges and inform decision-making that will ultimately strengthen our Nation and its communities.

In November 2019, President Trump signed a Presidential Memorandum on "Ocean Mapping of the United States Exclusive Economic Zone and the Shoreline and Nearshore of Alaska," (Presidential Memorandum) recognizing the value of mapping, exploration, and characterization to enhance our future prosperity, health, and national security. The Presidential Memorandum includes three directives which provide an interagency framework for how this effort will be implemented and executed: Section 2 directs a national strategy for mapping, exploring, and characterizing the United States EEZ; Section 3 directs a strategy for mapping the Arctic and Sub-Arctic Shoreline and Nearshore of Alaska; and Section 4 directs a strategy for efficient permitting of mapping, exploration, and characterization activities.

This document presents the *National Strategy for Mapping, Exploring, and Characterizing the United States EEZ* (Strategy). As directed under Section 2 of the Presidential Memorandum, the Strategy is a product of the Ocean Policy Committee (OPC), through its Ocean Science and Technology (OST) Subcommittee.

[3] More information on ocean and coastal resources is available at: https://www.noaa.gov/education/resource-collections/ocean-coasts-education-resources

[4] This strategy may apply to areas beyond the 200 NM limit in some circumstances, in particular to the United States extended continental shelf (ECS). Consistent with international law, the United States has sovereign rights and jurisdiction, including with respect to natural resources, over its ECS. More information on the United States ECS is available at: https://www.state.gov/about-the-u-s-extended-continental-shelf-project/

[5] National Oceanic and Atmospheric Administration (NOAA). 2019. NOAA Report on the United States Ocean and Great Lakes Economy. https://coast.noaa.gov/data/digitalcoast/pdf/econ-report.pdf

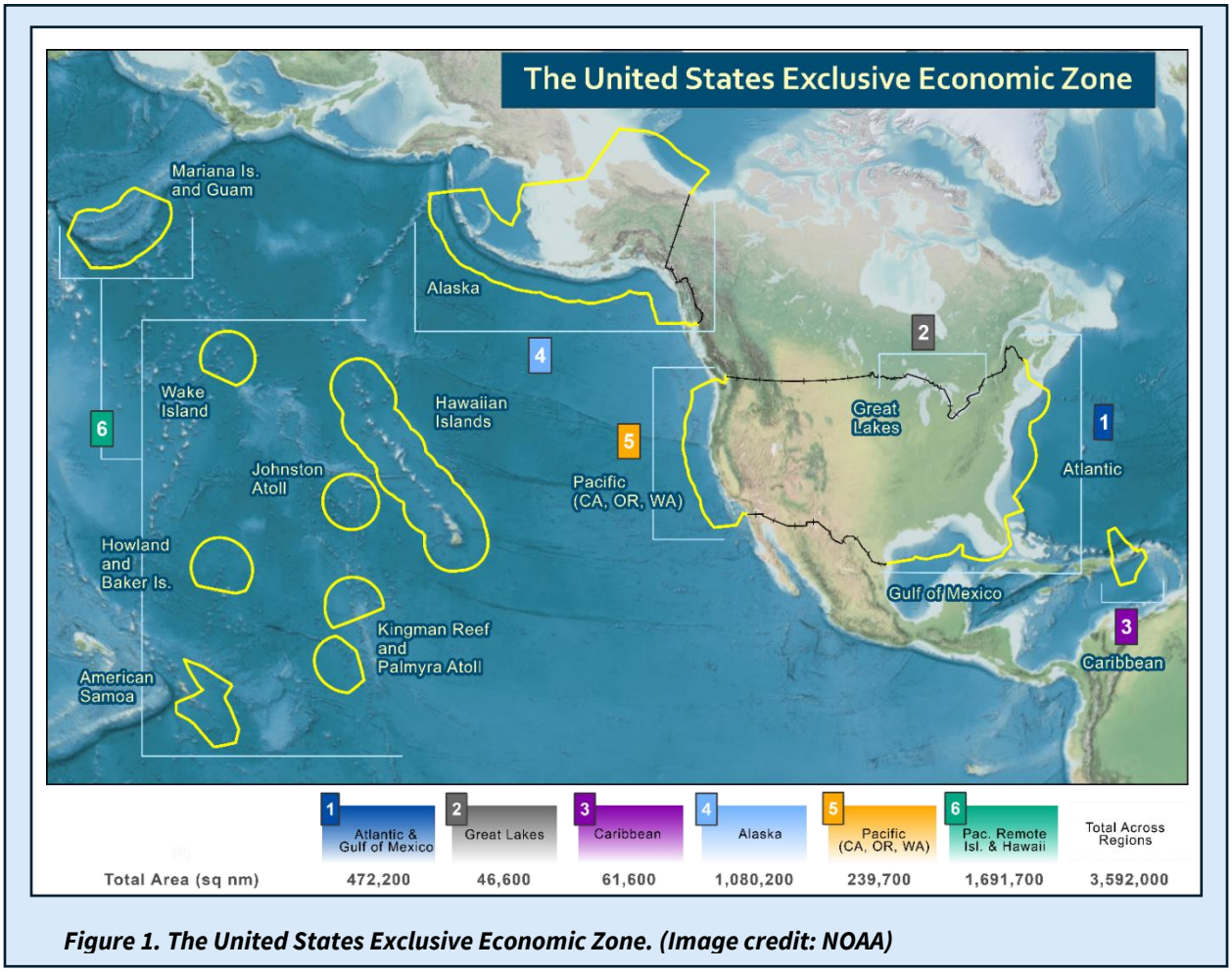

Figure 1. The United States Exclusive Economic Zone. (Image credit: NOAA)

Mapping, exploring, and characterizing the United States EEZ will require, and the Strategy strongly supports, the use of new and emerging S&T and the expertise and resources of non-Federal partners. New technologies will increase the scope, pace, and efficiency of mapping and sampling over an extremely large area. Similarly, partnerships with non-Federal entities engaged in ocean resource data collection will more efficiently accomplish these efforts, leverage common interests, and avoid duplication of effort.

For the purposes of this document:

- *Ocean mapping* provides comprehensive data and information needed to understand seafloor characteristics such as depth, topography, bottom type, sediment composition and distribution, and underlying geologic structure.
- *Ocean exploration* provides a multidisciplinary first look at an unknown or poorly understood area of the seafloor, sub-bottom, and/or water column and an initial assessment of an area's physical, chemical, and biological characteristics.

- *Ocean characterization* provides comprehensive data and interpretations for a specific area of interest of the seafloor, sub-bottom, and/or water column, in direct support of specific research, resource management, policymaking, or applied mission objectives.

The Strategy was informed by public comments provided in response to a request for information. The OST received a total of 23 public comments from Federal agencies, marine industries, academia, non-governmental organizations, and private individuals. Comments highlighted current technological capabilities, identified opportunities to incorporate S&T in mapping, exploration, and characterization, recommended considerations for identifying priority areas, and proposed community engagement strategies. All comments received helped shape the Strategy's goals, objectives, and actions.

This Strategy establishes five overarching goals for mapping, exploring, and characterizing the United States EEZ:

Goal 1: Coordinate Interagency Efforts and Resources to Map, Explore, and Characterize the United States EEZ

Goal 2: Map the United States EEZ

Goal 3: Explore and Characterize Priority Areas of the United States EEZ

Goal 4: Develop and Mature New and Emerging Science and Technologies to Map, Explore, and Characterize the United States EEZ

Goal 5: Build Public and Private Partnerships beyond Federal agencies to Map, Explore, and Characterize the United States EEZ

Each Goal is supported by strategic objectives that incorporate high-level actions. The objectives identify responsible agencies, and include either specific or ongoing timelines for completion. The designation of responsible agencies identifies primary responsibility for implementation but does not exclude or limit the participation of additional agencies, who will participate as appropriate. An immediate action under the Strategy will be the development of an Implementation Plan that will characterize and direct specific actions to implement the Strategy.

The Strategy recognizes that developing and implementing a new, more fully integrated and collaborative approach to mapping, exploring and characterizing the United States EEZ will require a period of transition as agencies, partners, and stakeholders establish priorities, adopt new S&T, and develop new practices. For example, technologies currently deployed at pilot scale are likely in the next several years to be deployed at scale, significantly increasing the ability to cost-effectively gather far more information than is currently possible. However, the practical details of how that will occur are not yet known. And at the same time, previously directed and authorized ocean research activities of all kinds are, and will continue to be, ongoing.

Therefore, this Strategy focuses initially on developing the capacity of, and relationships among, Federal agencies and non-Federal partners to accomplish the President's direction to map, explore, and characterize the United States EEZ, while also supporting ongoing and new work in the field. The Strategy will be updated in 2023, and may similarly be revised thereafter, to reflect continuing advancements in the implementation of S&T, the effectiveness of partnerships, and the operational sophistication of the collaborative mapping, exploration, and characterization enterprise.

Goal 1: Coordinate Interagency Efforts and Resources to Map, Explore, and Characterize the United States EEZ

Agencies across the Federal Government play a role, directly or indirectly, in mapping, exploring, and characterizing the ocean. These agencies also require the information derived from those activities to fulfill their missions and support non-government sectors that advance the economic, security, and environmental interests of the United States. Although aspects of mapping, exploration, and characterization activities are addressed by intragovernmental bodies or government participation with public advisory committees, informal consortia, or other means, there is no mechanism or process for strategically coordinating these activities as an integrated pursuit.[6] Therefore, the first goal of this Strategy is to promote efficient and effective coordination across the Federal government to better leverage and strategically align agency efforts to map, explore, and characterize the United States EEZ. The objective of this goal is to establish an interagency body that can accomplish the needed level of coordination across agencies and between agencies and non-government partners.

1.1 Establish a National Ocean Mapping, Exploration, and Characterization Council.

In June 2018, President Trump signed Executive Order 13840, titled "Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States." The Executive Order established the OPC to serve as a high-level body charged with coordinating Federal ocean-related matters[7] and directed it, in part, to advance ocean S&T, engage and collaborate with the ocean community, and leverage resources and expertise across sectors to maximize the effectiveness of Federal investments in ocean research.[8]

To coordinate agency policy and actions needed to advance ocean mapping, exploration, and characterization, and to support collaboration with non-government partners and stakeholders, the National Ocean Mapping, Exploration, and Characterization Task Force will be transitioned to a standing body, the *National Ocean Mapping, Exploration, and Characterization Council* (Council). The Council will develop and implement multi-disciplinary, collaborative, and coordinated approaches to mapping, exploring, and characterizing the United States EEZ. The Council will report to the OST, which will provide support and guidance for the Council's work as appropriate. The OPC will provide strategic direction and facilitate interagency resolution of policy issues as appropriate. (See **Figure 2.**)

[6] This Strategy does not eliminate any resources or funds from other agencies and does not conflict with legislative authorities.

[7] Executive Order 13840 defined "ocean-related matters" as those "involving the ocean, coastal, and Great Lakes waters of the United States (including its territories and possessions), and related seabed, subsoil, waters superadjacent to the seabed, and natural resources."

[8] The OPC is comprised of senior representatives of over twenty Federal agencies and offices within the Executive Office of the President, and is co-chaired by the Director of the Office of Science and Technology Policy (OSTP) and the Chairman of the Council on Environmental Quality (CEQ). The OPC is supported by two interagency subcommittees, including the OST Subcommittee and the Ocean Resource Management (ORM) Subcommittee, that address ocean science and technology, and regulatory and policy coordination, respectively, across the agencies.

The Council will oversee two working groups: the existing National Science and Technology Council (NSTC) Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM)[9] will focus primarily on ocean mapping. A new Interagency Working Group on Ocean Exploration and Characterization (IWG-OEC) will be established to focus on ocean exploration and characterization. These two bodies will report to the Council, which will coordinate mapping, exploration, and characterization activities.

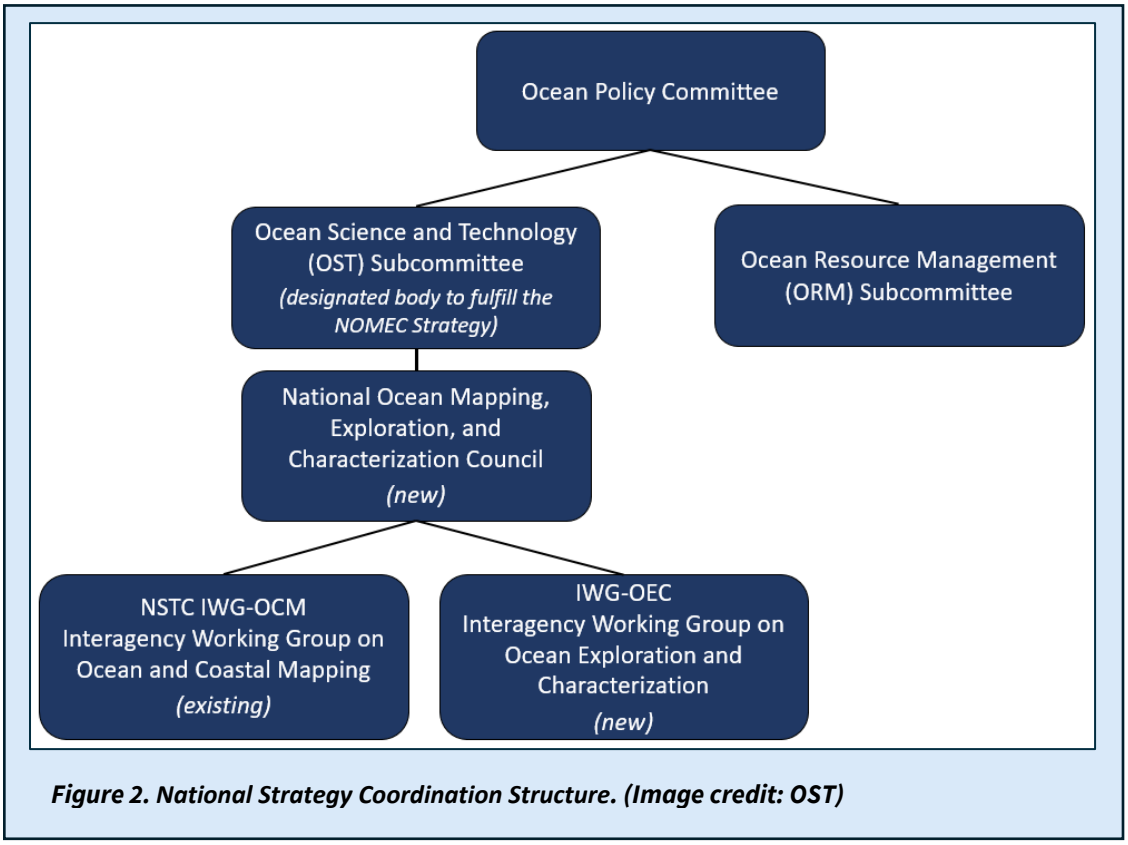

Figure 2. National Strategy Coordination Structure. (Image credit: OST)

Figure 2 depicts the proposed structure of the interagency coordinating Council and working groups in the context of the OPC, OST, and ORM. The Council will be co-chaired by Senior Executive Service members or General or Flag Officers of Federal agencies with primary mapping, exploration, and characterization responsibilities and authorities. Membership of the Council and working groups will represent Federal agencies which have programmatic responsibilities and resources needed to implement the Strategy. [Timeline: 90-days. Responsibility: OPC]

1.2 Develop an Implementation Plan for the National Strategy.

While this document provides strategic direction and identifies high-level actions, implementation of the Strategy will require the Council to develop a detailed approach to accomplishing the goals and objectives described below. Therefore, as an immediate action under the Strategy, the Council and subordinate bodies will develop an Implementation Plan that will characterize and direct specific actions to implement

[9] The IWG-OCM reports to the Subcommittee on Ocean and Science Technology (SOST) under NSTC. The IWG-OCM was established in 2006 to "facilitate the coordination of ocean and coastal mapping activities and avoid duplicating mapping activities across the Federal sector as well as with State, industry, academic, and non-governmental mapping interests" (National Ocean and Coastal Mapping Strategic Action Plan 2009).

the Strategy. The Implementation Plan will identify specific actions that describe how the goals, objectives, and associated timelines presented in this Strategy will be accomplished. Key issues to be addressed in the Implementation Plan include:

- Establish the processes for identifying national ocean mapping, exploration, and characterization priorities;
- Ensure effective coordination of mapping, exploration, and characterization activities with members of the national security and intelligence communities;
- Facilitate non-Federal input into national ocean mapping, exploration, and characterization priority-setting processes;
- Serve as a coordinating mechanism for all Federal and federally-funded programs conducting or supporting ocean mapping, exploration, and characterization activities under existing Federal agency programs and statutory authorities;
- Identify opportunities for combining multiple agencies' overlapping or complementary needs, activities and/or resources, and propose specific recommendations and solutions;
- Promote protocols for accepting data, equipment, or other resources that support national ocean mapping, exploration, and characterization priorities; and
- Promote partnerships among Federal and State agencies, private industry, academia, and non-governmental organizations to conduct or support ocean mapping, exploration, and characterization activities and technology development needs.

The Council will solicit public comment on the components of a draft Implementation Plan through workshops (such as the National Ocean Exploration Forum described in Section 5.2), requests for information, or other mechanisms, and will present a final draft to the OPC for its review and approval. [Timeline: 180 days. Responsibility: Council]

Goal 2: Map the United States EEZ

The United StatesEEZ is larger than the combined land area of all 50 states, spanning over 13,000 miles of coastline and containing 3.4 million square nautical miles (SQNM) of ocean.[10] Mapping the seafloor will increase our understanding of natural and cultural resources, physical hazards, and ocean-related processes related to climate, earthquakes, tsunamis, weather forecasting, ocean habitats, fisheries, and biodiversity.

For the purposes of this goal, mapping is defined as the comprehensive data and information needed to understand seafloor characteristics such as depth, topography, bottom type, sediment composition and distribution, and underlying geologic structure. In particular, bathymetry (measurement of water depth and seafloor shape) is a foundational mapping element for many activities, including nautical charting, sand and gravel assessments, habitat restoration, and wind energy siting. Collecting bathymetry is the first step in exploration and characterization activities and can help to identify promising sites for further investigation.

[10] More information on the United States EEZ is available at: https://www.gc.noaa.gov/documents/2011/012711_gcil_maritime_eez_map.pdf

In shallow, clear waters, bathymetry can be efficiently measured from aircraft and satellites using light detection and ranging (LIDAR)[11] and imagery. However, current estimates indicate that this technique can be used in less than 1 percent of United States waters. In deeper and murkier waters, the current best available technology for bathymetric seabed mapping is swath sonar,[12] which maps a strip of the seafloor on each pass. These modern mapping systems can also measure the acoustic properties of the seabed, from which seabed composition can be inferred, as well as backscatter from the water column. Additional sonars and sensors can be operated simultaneously during mapping operations to map the sediment layers beneath the seabed, as well as biological, physical, and chemical properties of the seawater. An effectively integrated ocean and coastal mapping approach seeks to simultaneously acquire multiple data types during continuous underway operations.

The Strategy addresses mapping United States waters based on ocean depth. The initial goal will focus on mapping water 40 meters and below, representing 90 percent of the United States EEZ, but only about one-third of the total level of effort. Currently, sonar-equipped ships and unmanned maritime vehicles are best suited for hydrographic data collection of deep ocean applications because they can capture a large area with minimal effort and therefore will be the initial focus of this Strategy. This goal to map the deep water can be met by 2030.[13]

In shallower waters, the level of effort for seabed mapping increases dramatically as sonar swath width decreases[14] and the value of new technology in LIDAR and unmanned maritime increases. Shallow water mapping work will continue at current rates through 2030 in support of existing agency mandates. In the second decade, the pace of mapping will accelerate as the deep water mapping efforts are completed and advancements in technology are deployed at scale. This higher difficulty region will benefit from airborne and satellite system measurements, along with future technology improvements in unmanned systems, communications, artificial intelligence, and sensors. Specific Federal agency strategies for developing new S&T and leveraging unmanned systems and artificial intelligence will also directly contribute to this Strategy. Mapping the waters less than 40 meters, nearshore waters, can be completed by 2040.

[11] LIDAR is a remote sensing method used to examine surfaces of the Earth. More information on LIDAR is available at: https://oceanservice.noaa.gov/facts/lidar.html

[12] More information on sonar for seabed mapping is available at: https://oceanexplorer.noaa.gov/technology/tools/sonar/sonar.html

[13] All timelines are based on current projected appropriations and current predicted vessel deployment schedule.

[14] Several national coastal strategies, including the Alaska Coastal Mapping Strategy (Section 3 of the Presidential Memorandum) and the National Coastal Mapping Strategy developed by the IWG-OCM address the particular challenges of mapping shallow waters with airborne and satellite technologies.

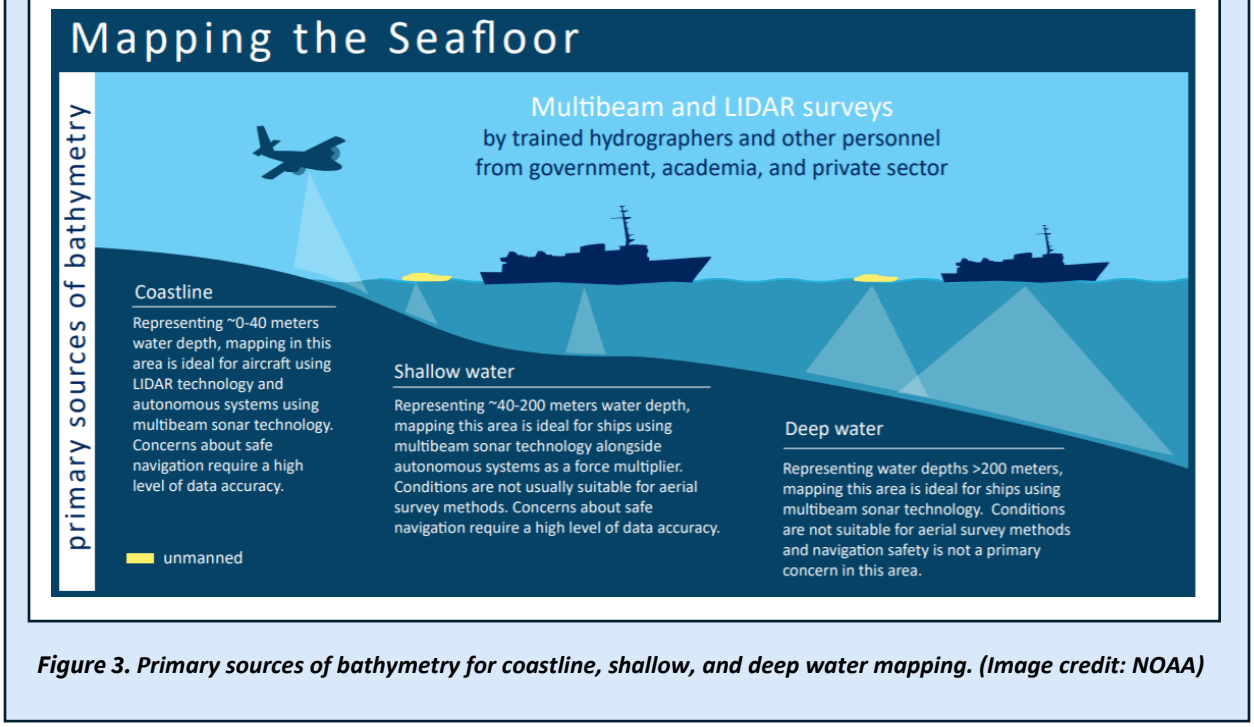

Figure 3. Primary sources of bathymetry for coastline, shallow, and deep water mapping. (Image credit: NOAA)

2.1 Establish a Standard Ocean Mapping Protocol.

Ocean mapping programs share many requirements, but the differences in sensors, calibrations, and corrections may make the data from one program less usable by others. In order to ensure that mapping conducted in support of this Strategy will be broadly applicable, a standardized collection protocol will be developed. This protocol will guide all the participants in data acquisitions and processing to ensure the widest access to and use of the data, minimize duplication of effort, and efficiently collect, process, and publish as much data as possible into archives and databases. National data standards and best practices will be used, as required by the Geospatial Data Act of 2018.[15] This protocol will include the following features:

- Specifications for bathymetry data;
- Specifications for seabed backscatter acoustic imagery;
- Specifications for water column backscatter;
- Specifications for sub-bottom profiling; and
- Timelines and protocols for data management and availability.

The IWG-OCM will develop and circulate this protocol for interagency review and seek public comment. This protocol will be reviewed and updated as necessary by the IWG-OCM every 5 years to take advantage of new technologies as they mature. [Timeline: 2-years. Responsibility: Council]

[15] More information on the Geospatial Data Act of 2018 is available at: https://www.fgdc.gov/gda

2.2 Coordinate and Execute Campaigns to Map the United States EEZ.

Under the direction of the Council, the IWG-OCM and partner groups will coordinate and execute the comprehensive mapping of the United States EEZ. Executing this objective will require:

- Cataloging and analyzing existing ocean data, using the United States Bathymetric Gap Analysis, to identify mapping gaps and seek out additional existing data from Federal agencies, industry, and other sources. Broader mapping analyses, such as the 3D Nation Requirements and Benefits Study,[16] will also be used to inform mapping gaps;
- Aggregating agency input on mapping priorities by ocean region. Resulting maps will highlight both areas of common interests and important but potentially isolated places in need of study. These priorities will then be shared publicly to inform mapping campaign sequencing;
- Designing a sequenced set of regional ocean mapping campaigns in manageable segments over time, and track and report on the progress of these campaigns. Clear delineation of agency priorities, plans, and performance will enable Federal and external partners to collaborate most effectively to address individual requirements; and
- Executing regional ocean campaigns, allowing for flexibility to move among annual planned areas as needed based on weather, equipment, and scientific cruise schedules. Agency geospatial contract vehicles, Federal/private/academic platforms, grants, and agreements can be assets to utilize in implementation.

The Council and the IWG-OCM will periodically review and deconflict, as needed, interagency mapping plans. [Timeline: 2-years. Responsibility: Council]

2.3 Make Data Usable and Available.

Consistent with and subject to national security considerations and any applicable law, Federal agencies and their partners will collect and archive data in standardized formats wherever possible. NOAA's National Centers for Environmental Information (NCEI) is responsible for hosting and providing access to comprehensive oceanic, atmospheric, and geophysical data. NCEI is also the national archive of the United States for multi-beam bathymetric data and will serve in that capacity as this Strategy is implemented. NCEI will provide discovery-level metadata to allow expert users to download and use data and information such as bathymetry, seabed backscatter, water column backscatter, and sub-bottom profiles in their original and processed forms. Other archives may also provide these services in a federated arrangement.

NOAA developed the National Bathymetric Source, a national database of bathymetry that operationally combines data from multiple repositories and contributes to NCEI. The bathymetry data and resulting services are updated daily and are available in a variety of forms suitable for different applications. This system will provide ready access to bathymetric services as a core part of the service delivery model for the bathymetry part of this Strategy. Similar curated services may be developed for other parameters. [Timeline: Ongoing. Responsibility: OPC agencies]

[16] More information on the 3D Nation Requirements and Benefits Study is available at: https://my.usgs.gov/confluence/display/3DNationStudy/3D+Nation+Requirements+and+Benefits+Study

Goal 3: Explore and Characterize Priority Areas of the United States EEZ

Just as mapping the seafloor at high resolution will reveal the characteristics of the ocean bottom, fine-scale exploration and characterization, combining direct visual observations and environmental sampling, are needed to discover and inventory the ocean's resources. This will enable scientists and resource managers to establish connections among the resources, to answer basic research questions, and to support our efforts to sustainably manage and use valuable resources.

Initial exploration and characterization will use seafloor and sub-seafloor maps and acquire the samples and/or sensor-based data that are purposely intended to provide a multidisciplinary first-look at an unknown or poorly understood area. This will provide insight into characteristics of the seafloor, sub-bottom, and/or water column, and an initial assessment of an area's physical, chemical, and biological environments. Observations may include a combination of multiple tools that identify the structure, processes, and components of the system of interest. This will facilitate discovery and provide an initial indication that a site or feature warrants further investigation. Once areas of interest are identified, additional information will be collected to more fully characterize or assess a location to support specific research and mission objectives, which could include hazard and resource assessment, habitat delineation, and a better understanding of the Earth system processes. Exploration and characterization may also include the use of Earth system and ecosystem models and remotely sensed data to support campaign and mission planning and serve as management decision support tools.

The tools available to explore and characterize the ocean will be matched to the bathymetric and physical, geological, chemical, and biological oceanographic environments of a given area. Exploring the water column requires a different approach than exploring a high-temperature hydrothermal vent situated in the high-relief bathymetry of a seafloor spreading center. Similarly, sampling delicate marine organisms for species identification and characterization of their biopharmaceutical potential requires a different approach than sampling hard substrates to gain information about the potential value of seafloor mineral deposits.

The following objectives will guide and support the exploration and characterization of priority ocean areas.

3.1 Identify Strategic Priorities.

Clear and focused strategic priorities for ocean exploration and characterization will guide decisions and actions that implement the President's direction to identify, explore, and characterize "priority areas" within the United States EEZ. To identify strategic priorities and priority areas, the Council will consider statutory requirements, Federal agency missions, strategic national issues, Administration policy priorities, and stakeholder perspectives. The Council will coordinate agency or Council-sponsored workshops (such as the National Ocean Exploration Forum described in Section 5.2), requests for information, and other mechanisms to engage partners and stakeholders in this process. Examples of potential strategic priorities include but are not limited to areas with features and resources subject to agency resource management and stewardship responsibilities, areas with potential for offshore energy, critical minerals, or biopharmaceutical resources, and areas or systems that may provide key insights into understanding ocean and Earth systems. Specific geographic areas that are consistent with strategic priorities will be identified on a mission and campaign-based basis through the process described above.

This process will be repeated periodically to account for improvements in understanding and advancements in technology, to increase stakeholder participation, and to allow for stakeholders to better coordinate their exploration and characterization efforts. [Timeline: 12-months. Responsibility: Council]

3.2 Establish Exploration and Characterization Standards and Protocols.

Common standards for the collection, storage, and control of data and information collected in exploration and characterization activites are needed in order to maximize the benefit of such data. Yet, there is no single suite of measurements, standards, or protocols that can address all identified priorities. For example, the measurements needed to consider an ocean area explored may only be a subset of and at a lower resolution to those needed to characterize that same area. Similarly, the standards and protocols needed to characterize an ocean area in support of living marine resource management are different from those needed to understand the critical mineral potential, and both are different than those needed to assess offshore energy or biopharmaceutical potential. In recognition of these issues, the Council will lead interagency efforts to establish a suite of standards and protocols for exploration and characterization that will meet the information needs of agency requirements.

In all cases, the standards and protocols will seek to maximize commonality, taking advantage of existing efforts to identify standards and protocols within the ocean science community, leveraging existing repositories for housing data and samples, and promoting consistency with standards and protocols of the Federal Geographic Data Committee, and other similar bodies and international efforts to standardize oceanographic data. Similar to the prioritization process identified in the previous section, established exploration and characterization standards and protocols may be periodically revisited to allow for improvements in understanding, advancements in S&T, and increases in or changes to stakeholder input. [Timeline: 2-years. Responsibility: Council]

3.3 Explore and Characterize Priority Areas.

Identified priority areas should be explored and characterized to inventory, observe, study, and assess living and non-living marine resources, ecosystems, and ocean processes. In some instances, priorities may be able to be addressed through a single at-sea mission supported by an individual agency or partner. However, full implementation of this Strategy will require the development of multi-mission ocean exploration and characterization campaigns executed and supported by a multitude of partners encompassing one or more years of effort and an assemblage of ships and other at-sea vehicles and technologies.

Once a campaign is defined by a broad geographic region and/or thematic discipline, a phased approach will identify campaign partners and participants, further refine specific exploration and characterization information needs, identify and secure required resources, including funding and seagoing assets needed to complete the campaign, target discrete campaign operating areas and individual mission objectives, establish data and sample delivery timelines, and develop strategies for participation and public engagement. In this phased approach, reports from recent workshops hosted by relevant communities will be consulted and the ocean science and stakeholder communities will be solicited to inform campaign objectives. Where necessary, workshops to establish campaign-specific goals and partner responsibilities will be conducted and will include a wide diversity of partners and stakeholders to understand the specific information needs.

To facilitate campaign planning and execution, the Council will collect information from Federal agencies about their planned exploration and characterization missions, as well as those of their non-Federal partners, in order to identify opportunities for collaboration, coordinating resources, and efficiency. Where appropriate, the National Oceanographic Partnership Program (NOPP)[17] and other similar

[17] The NOPP facilitates partnerships between Federal agencies, private industry, and academia to advance ocean science research and education. Through this collaboration, Federal agencies can leverage resources to invest in

interagency and non-Federal coordinating bodies will be used to execute the campaign. [Timeline: Ongoing. Responsibility: Council]

3.4 Make Exploration and Characterization Data Usable and Available.

Ocean exploration and characterization missions will typically collect very large amounts of data. While much of these data are used in real-time to inform and further refine at-sea mission operations, it is through the transformation of these data into useful information that the full value of these efforts will be realized. The more people who have access to the data, the richer the opportunities are for interpretation and transformation into information that is useful to a wider variety of stakeholders, from scientists to educators to policymakers to business owners.

Consistent with and subject to national security considerations and unless otherwise prevented by law, all data, including images and access to samples resulting from publicly supported, dedicated civilian exploration and characterization expeditions will be made widely available at little or no additional cost and in real-time or as soon as appropriate quality assurances have been completed. For ease of use, the data will conform to the standards developed in Section 3.2 and be in a form consistent with Federal Geographic Data Committee standards. Where practicable, ocean exploration and characterization data will reside within established data and sample repositories and their existence made widely known. Routine synthesis of the data and sample collections may be used to identify exploration and characterization gaps and refine future priorities. [Timeline: Ongoing. Responsibility: OPC agencies]

Goal 4: Develop and Mature New and Emerging Science and Technologies to Map, Explore, and Characterize the United States EEZ

The United States EEZ is vast and poses unique challenges to operations. Weather and other factors can create risk for the vessels and the people aboard, limiting the operating windows. Current sampling techniques often generate a limited picture of the biological, chemical, geological, and physical features of the ocean. Comprehensive mapping, exploration, and characterization of the marine landscape and water column require more detailed and efficient data collection and processing than has been used in the past. As such, more frequent and ambitious mapping, exploration, and characterization campaigns must include new ships, analytics, technologies, and other platforms capable of measuring, sampling, and imaging both yet-to-be-mapped, explored, and characterized areas, and those with insufficient data.

Several cutting-edge methodologies and enabling technologies in unmanned systems, high bandwidth communications, and artificial intelligence will contribute to a step-change in capabilities. To advance these efforts, new and emerging methodologies and technologies must be identified, adapted, and adopted by the greater ocean mapping, exploration, and characterization communities and integrated into the missions and campaigns envisioned in this Strategy. Specifically, the rapid advancement of autonomous tools, platforms, and technologies may provide for a more cost-effective and efficient acquisition of hydrographic mapping data. Often, efforts center on leveraging partner expertise in marine technology development, where private industry, academia, and non-governmental organizations are major contributors. As marine scientific and technology markets continue to grow, opportunities for contributions from and support to these partners will increase.

priorities that fall between agency missions or are too large for any single agency to support. More information is available at: https://www.nopp.org/

Emerging technologies allow us to investigate the ocean at unprecedented time and space scales that often yield fundamental scientific discoveries. For example, initial studies of the midwater section of the water column known as the twilight zone, enabled by new technologies, suggest that the biomass of fish in the twilight zone may be more than in all the rest of the ocean combined. The dark and cold ocean twilight zone is one of the least understood environments on the planet despite its importance to ecosystem services, including supporting ocean food webs and commercial fisheries, and transferring carbon dioxide to the deep ocean. Advancing scientific campaigns to answer questions about underexplored areas such as the twilight zone will propel ocean S&T into the next frontier.

Managing ocean S&T innovation is a long-term pursuit that requires both collaboration and the development of new methodologies and technologies. There is, however, a need for balancing short-term research efforts to address immediate needs or potential concerns, with long-term research and development efforts to understand the fundamental ocean system and inform major challenges and decision-making. As technologies advance and research priorities shift, it is important to ensure that a balanced approach is taken between longer-term goals and areas of immediate opportunities, such as deep water mapping.

4.1 Identify Science and Technology Needs in Mapping, Exploration, and Characterization.

The development of ocean mapping, exploration, and characterization standards and protocols will characterize the current state of the art for ocean technologies, and define the need for specific technologies and their application. New and emerging technologies may also be able to support the acquisition of additional kinds of information, and significantly improve current standards for accuracy and resolution. In addition, new technologies may provide opportunities to efficiently acquire data that have value beyond the immediate objectives of current mapping, exploration, and characterization activities.

For example, autonomous systems are continuously becoming smaller, more affordable and reliable, more energy independent,[18] and deployable for longer missions. Additionally, computing power is being applied to inform expedition planning, make real-time mission decisions, and analyze and visualize data; artificial intelligence and machine learning are being incorporated into autonomous vehicles and big data applications.[19] Identifying information needs and the technologies capable of addressing them will assist the government, private industry, academia, non-governmental organizations, and other stakeholders in guiding investments into new and emerging technologies.

The Council will develop and maintain a portfolio of S&T advancements that would improve the efficiency or performance of ocean observations and describe their potential applications. This portfolio can be used to guide and inform prioritizing investments in technology by the Federal Government and non-government partners. The Council will ensure that technical challenges are communicated across the government and to the broader public as they arise. The Council will produce the initial portfolio outlining S&T needs within 1 year and provide periodic reevaluations. [Timeline: Ongoing. Responsibility: Council]

[18] An initiative by the Department of Energy (DOE) called "Powering the Blue Economy" looks at opportunities for marine renewable energy in maritime markets. More information is available at: https://www.energy.gov/eere/water/powering-blue-economy-exploring-opportunities-marine-renewable-energy-maritime-markets

[19] For example, NOAA recently released four new S&T strategies on unmanned systems, artificial intelligence, 'omics, and cloud computing to guide transformative advancements in the quality and timeliness of NOAA's services. More information is available at: https://nrc.noaa.gov/NOAA-Science-Technology-Focus-Areas

4.2 Support Development, Testing, Deployment, and Use of New Technologies.

Performance testing and evaluation is a proven and essential process that necessarily precedes operational use to clarify and validate design specifications. This includes calibration of key instruments or sensors, evaluation of alternative configurations and payloads, and field trials to monitor overall vehicle-plus-sensor system performance. This process may also include simultaneous testing of multiple platforms in combination with traditional data collection methodologies, such as ships, to compare results, and may be conducted in partnership with other Federal agencies or non-Federal partners and stakeholders.

Through traditional contract and grant mechanisms, including those focused on small business and innovation, Federal agencies will support the development and transition of emerging marine observing technologies and applications. Agencies may also consider offering prizes or proposing challenges that will engage the private sector and the general public in the development of new technologies to solve ocean mapping, exploration, and characterization challenges. Past examples have led to significant improvements in mapping without the use of ships and current examples seek to integrate marine renewable energy with ocean observation platforms to allow for a longer duration or sustained data collection.

Agencies may use frameworks, proving grounds, and testbeds to conduct testing of advanced operations, services, and S&T capabilities that address the needs of users across the ocean community. Where appropriate, Federal agencies can enter into cooperative research and development agreements with non-Federal entities to support at-sea testing of existing technologies or those under development to assess operational readiness and provide mission-focused feedback to external partners. Incorporation and use of these new or emerging technologies during ocean mapping, exploration, and characterization activities may enhance the overall objectives of the campaign, accelerate private sector innovation, spur further innovation and discovery, and create a market for commercially developed technology applications. [Timeline: Ongoing. Responsibility: OPC agencies]

4.3 Support Partnerships with Organizations that are Promoting, Investing in, or Developing Ocean Methodologies, Technology, and Applications.

The United States has a robust ocean S&T industry that is organized into thematic and regional groups, supported by numerous professional societies and coordinated through local, regional, and national alliances. In all cases, these groups seek to promote awareness of the United States and international development in marine S&T, support information sharing, and facilitate cross-sectoral dialog among leaders of government and non-governmental institutions and their members. Engagement with these groups is essential to the success of this Strategy and will be used to address the methodology, technology, and application development on the needs identified in Section 4.1. Agencies will regularly engage in and support these groups to better understand the landscape of domestic and international methodology and technology developments, improve communication and coordination across sectors, and encourage partnerships aimed at advancing the methodologies and technologies required to map, explore, and characterize the United States EEZ, and to maximize the use of the resulting data. [Timeline: Ongoing. Responsibility: OPC agencies]

Goal 5: Build Public and Private Partnerships to Map, Explore, and Characterize the United States EEZ

Developing a comprehensive understanding of the United States EEZ is a national goal, and it will require a national effort to accomplish. Under this Strategy, Federal agencies will support and motivate the mapping, exploration, and characterization enterprise to advance economic, and environmental, and national security objectives, consistent with agency missions. However, the coordinated and sustained participation of non-Federal partners is critical to accomplishing this goal.

Building and maintaining partnerships in ocean S&T is a national priority, as articulated in Executive Order 13840, the Administration's ocean S&T priorities report,[20] and the Presidential Memorandum. In November, 2019, OSTP and the CEQ hosted The White House Summit on Partnerships in Ocean Science and Technology.[21] The Summit brought together over 100 leaders from the Federal government, the private sector, academia, and philanthropy to discuss opportunities for partnerships and how to collaboratively apply S&T for the conservation, management, and balanced use of America's oceans. The Presidential Memorandum underscored the importance of that discussion by stating, "to ensure that these [ocean mapping, exploration, and characterization] activities produce the broadest possible benefits and provide the greatest return on investment of Federal resources, it is the policy of the United States to support these activities, when appropriate, in collaboration with non-United States Government entities."[22]

5.1 Maximize Opportunities for Non-Federal Participation.

This Strategy provides a framework for coordinated efforts among Federal and State agencies and private industry, academia, and non-governmental organizations. There are a variety of mechanisms that will be used to enhance the planning, coordination, and successful implementation of mapping, exploration, and characterization activities within the United States EEZ. These include:

- *Cross-agency partnerships:* Interagency committees and working groups, such as the IWG-OCM, IWG-OEC, and the NOPP, support coordinated ocean and coastal mapping, exploration, and characterization activities as well as associated technology development across the Federal government.
- *Utilization of Federal platforms:* Federal vessels, including those from National Science Foundation (NSF)-funded research vessel fleet, the NOAA fleet, the United States Coast Guard (USCG) ice breakers, United States Navy oceanographic ships, the United StatesAcademic Research Fleet and industry partners, have the capabilities for mapping, exploration, and characterization and have successfully completed these missions. The NOAA Ship *Okeanos Explorer* is the only federally owned and operated vessel dedicated to ocean exploration. Dedicated platforms may also include current and planned satellites from NOAA, the United States Geological Survey (USGS), and the National Aeronatics and Space Administration (NASA), as well as from international and commercial satellite providers.
- *Multi-sector Partnerships:* Academic and non-profit institutions and cooperative institutes provide the expertise for ocean and coastal mapping, exploration, and characterization. These

[20] *Science and Technology for America's Oceans: A Decadal Vision,* Subcommittee on Ocean Science and Technology, National Science and Technology Council, November 2018.

[21] Ocean Policy Committee. 2019. Summary of the 2019 White House Summit on Partnerships in Ocean Science & Technology. https://www.whitehouse.gov/wp-content/uploads/2019/11/Ocean-ST-Summit-Readout-Final.pdf

[22] See Presidential Memorandum of November 19, 2019 on "Ocean Mapping of the United States Exclusive Economic Zone and the Shoreline and Nearshore of Alaska," Sec. 1.

partnerships provide access to a wealth of ocean exploration resources, including ships, autonomous and remotely operated vehicles, expertise, and opportunities for technology testing and development.

Multi-agency and multi-sector partnerships can be employed through existing mechanisms such as Federal contracts, competitive grants, and cooperative research and development agreements (CRADAs). Agencies will increase their use of commercial ocean mapping contracts and encourage close engagement with the NOPP and other partnership mechanisms. [Timeline: Ongoing. Responsibility: OPC agencies]

5.2 Foster Cross-Sector Engagement.

The Council will convene an annual ocean mapping and exploration forum among Federal agencies, State, territorial, tribal, private industry, academic, non-governmental organizations, and private constituents with diverse backgrounds, sectors, and interests. The forum will strengthen existing relationships, encourage new partnerships, and promote better communication and sharing of expertise and knowledge. As appropriate, the Council will also engage with the ocean community at regional settings across the country such as convening Town Hall sessions at relevant societies, conferences, and scientific and technical gatherings. Interaction is a critical component of maintaining an open dialogue with stakeholders and relevant sectors in advancing ocean mapping, exploration, and characterization.

Partnerships provide an opportunity for multiple sectors to align the strengths of their respective agency or organization to achieve results that cannot be accomplished individually. To be successful, partners require a platform to communicate and strengthen the understanding of each other's interests and capacities. The Council will provide direction for enterprise partnerships among Federal agencies and private industry, academia, and non-governmental organizations. Executing this objective will require the Council to:

- Promote mechanisms to strengthen collaboration between Federal and non-Federal stakeholders;
- Conduct interdisciplinary exploration activities to meet national priorities efficiently, expeditiously, and cost-effectively;
- Advance and make available new exploration technologies, techniques, and approaches that may benefit the national community;
- Accelerate the private or non-Federal development and use of assets, infrastructure, platforms, and innovative approaches to complement existing assets and capabilities of Federal agencies;
- Advance processes for ocean exploration data management, access, synthesis, and visualization that all sectors can benefit from; and
- Support the use of NCEI as a primary, centralized repository for ocean exploration data obtained through publicly funded activities, and the use of the Smithsonian Institution and other publicly accessible repositories for biological and geological samples.

[Timeline: 2-years. Responsibility: OPC]

5.3 Inspire and Involve the Public.

An inclusive science, technology, education, and mathematics (STEM)-literate and ocean-literate workforce that is prepared for the future is fundamental to ocean innovation and for the Nation to best harness the potential benefits gained from this Strategy.

The expected increase in mapping, exploration, and characterization activity in support of this Strategy will also support job growth in many supporting sectors. New technology will not be useful without trained operators and technicians. Agencies should take every opportunity to communicate the importance of

ocean S&T and the potential for STEM careers in this field. Agencies should support educational outreach programs and grants that encourage the advancement and participation of underrepresented groups in ocean S&T. Community and technical colleges can help expose a more diverse body of students to job opportunities in the blue workforce. Special degree programs geared toward ocean work, hands-on experience, and professional development offered through these institutions can prepare students for marine occupations, including marine forecasters, ocean instrument technicians, scholars, and underwater remotely operated vehicle (ROV) developers. Continued investments in outreach and STEM-education is critical for ensuring United States leadership and that the next generation of Americans remains competitive in the growing international field of ocean S&T.

Federal agencies will take action to expand the reach of existing ocean mapping, exploration, and characterization partnerships focused on disseminating results to all sectors and communities. Agencies will also promote and strengthen educational and professional development communities of practice relevant to ocean mapping, exploration, and characterization. Agencies will increase opportunities for individuals from under-represented groups, undergraduate and graduate students, and early career professionals to participate in Federal and non-Federal ocean exploration activities. Special consideration will be given to Alaska Native Organizations[23] in order to minimize potential conflicts with subsistence and cultural activities. For example, mapping, exploration, and characterization activities will avoid bowhead whale migration and other important subsistence time periods. [Timeline: Ongoing. Responsibility: All Federal agencies]

Conclusion

The United States EEZ represents one of the largest ocean and coastal shorelines in the world, and the knowledge gathered from mapping, exploring, and characterizing our EEZ is essential to advancing America's economic, security, and environmental interests. This Strategy provides a roadmap for Federal agencies, in partnership with other sectors and the ocean community broadly, to comprehensively map, explore, and characterize the United States EEZ, and identifies five goals and supporting objectives that will guide the Nation’s efforts to do so.

These goals and objectives were designed to advance global leadership of the United States in ocean S&T, unleash discovery and innovation within the ocean S&T enterprise, and support stewardship of our oceans to advance the Nation’s economic, security, and environmental interests. The success of this national Strategy requires an engaged, informed, and coordinated ocean community pursuing a concerted effort to advance ocean S&T and improve the application of that understanding for the benefit of the Nation. The information gathered through this collaborative effort will expand the Nation’s ocean S&T enterprise, build ocean industries, and bolster conservation efforts.

Successful implementation of this Strategy depends on two key factors: the development of new and emerging S&T that will allow us to accelerate ocean data collection, and partnerships with non-Federal entities who will contribute their efforts to this important national goal. Without both of these factors, it may not be possible to accomplish mapping of the entire United States EEZ and the exploration and characterization of priority areas within a reasonable timeframe.

[23] For the purposes of the Strategy, “Alaska Native Organizations” includes Alaska Tribes, Alaska Native Corporations, Alaska Native Consortia, and Alaska Native Co-Management Organizations.

Accordingly, it is critical that Federal agencies and non-Federal partners prioritize the development of new and emerging technologies to accelerate data collection and pursue partnerships to achieve the Strategy's objectives. The successful implementation of this Strategy requires coordination and collaboration among mapping, exploration, and characterization efforts across Federal agencies and among private industry, academia, and non-governmental organizations.

By implementing this Strategy, the United States will dramatically increase our understanding of the Nation's EEZ and ocean resources, enhance our economic competitiveness, strengthen our national security, protect our environment, and preserve continued prosperity.