The NOAA Fleet Plan

Building NOAA's 21st Century Fleet

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EXECUTIVE SUMMARY

Overview

This report assesses the current and future at-sea observational infrastructure needs of the National Oceanic and Atmospheric Administration (NOAA) in carrying out its mission of protecting lives, livelihoods, and valuable natural resources for the American public. We evaluate the status of the fleet and the current and future capabilities required to meet NOAA's public safety, economic, and stewardship missions, and set a plan of action for ensuring future needs will be met, while minimizing the risk of capacity gaps that would negatively impact mission-critical data needs. The NOAA Fleet Plan identifies an integrated approach consisting of best management practices and long-term recapitalization levers to extend and sustain our capabilities. This plan includes the critical long-term strategy of designing and constructing up to eight new ships specifically designed to meet NOAA core capability requirements within each mission objective.

NOAA's Mission

NOAA is America's environmental intelligence agency. From the surface of the sun to the depths of the ocean floor, NOAA keeps a finger on the pulse of the changing planet. Each day, nearly every American relies on the data, products, and services NOAA provides. These products and services include daily weather forecasts, navigational tools to support the country's nearly $4.6-trillion in economic activity generated by U.S. seaports[1], assessments on the health of the nation's $200-billion fisheries,[2] and disaster response. NOAA also provides daily and longer-term weather and marine forecasts critical for emergency management of $485-billion, plus or minus $240-billion, in yearly economic weather impacts,[3] agricultural planning, and $82-million annual impacts to public health, tourism and the seafood industry resulting from harmful algae blooms.[4] Through our network of observations, and our models, forecasts, and assessments, we put environmental information into the hands of people who need it.

NOAA's network of observational tools (e.g. satellites, radars, supercomputers, aircraft, and ships) is the foundation of the environmental intelligence we provide. Over the years, NOAA has made significant investments to ensure the agency can leverage new technologies to provide the best products and services possible. However, challenges to the agency's observational infrastructure still exist, especially for NOAA ships.

NOAA's Fleet

Currently, NOAA's fleet includes 16 research and survey ships, comprising the largest fleet of federal research ships in the country. Ranging from large oceanographic research vessels capable of exploring the world's oceans, to smaller ships responsible for charting shallow U.S. bays and inlets, the fleet

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[1] Martin Associates for the American Association of Port Authorities. March 2015 "2014 National Economic Impact of the U.S. Coastal Port System." Retrieved from http://www.aapa-ports.org.

[2] Fisheries Economics of the United States 2014: Economics and Sociocultural Status and Trends Series. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Memorandum NMFS-F/SPO-163. May 2016.

[3] Lazo, J.K., M. Lawson, P.H. Larsen, and D.M. Waldman. June 2011 "United States Economic Sensitivity to Weather Variability." *Bulletin of the American Meteorological Society*. 92: 709-720.

[4] Economic Impacts: Red Tide. Woods Hole Oceanographic Institution. Retrieved from https://www.whoi.edu/redtide/impacts/economic.

supports a wide range of activities, including fisheries research, nautical charting, and ocean and climate studies.

Every year, NOAA's ships conduct more than 100 missions for collection of data critical for nautical charts, fishery quotas, exploration of America's 4.3-million square mile Exclusive Economic Zone (EEZ), storm surge modeling, and weather forecasting. NOAA's line offices, other U.S. government agencies, communities, and businesses around the nation rely on this data to keep U.S. ports open to maritime commerce, understand changes to the planet, monitor the health of fish stocks, and plan for severe storm events.

While other federal and academic agencies perform marine research and collect specific at-sea data, NOAA is unique in its roles of collecting data that directly feeds products and services vital to the economy and health of the nation, as well as researching new technology and methodology to improve the reliability and accuracy of the products and services. NOAA is unique in the capabilities of its fleet and expertise of its maritime workforce trained specifically for these missions. The specific products and services NOAA delivers are, therefore, most efficiently met with ships designed for NOAA's mission. NOAA has adopted and converted, to the extent possible, ships that were built for other missions. These conversions diminished efficiency and increased maintenance costs and days lost due to maintenance and significantly limited standardization of equipment and rotational crewing. The most efficient model is for NOAA to design and build a minimal number of classes of ships that meet its unique mission requirements.

The age of NOAA's ships presents another pressing concern. At least three of NOAA's ships have been in service for more than 40 years. Between 2017 and 2018, eight of NOAA's ships will exceed their design service life and are due to retire by 2028. The loss of these eight ships will undermine NOAA's ability to meet its mission, resulting in: the total absence of mapping capabilities on the West Coast and in the United States Arctic, specifically in the Pacific Ocean, Bering Sea and Arctic Ocean; a 75 percent loss of its hydrographic survey capability on the East Coast and in the Caribbean; and the inability to conduct fishery and marine mammal stock assessments, monument and sanctuary stewardship in the Central, Southern, and Western Pacific, and trawl-based stock assessments in the Gulf of Mexico.

The loss of NOAA ships without recapitalization will directly impact the nation's $4.6-trillion in economic activity generated in U.S. seaports,[5] which relies on accurate nautical charts, as well as the $200-billion seafood industry.[6] The loss of capacity will significantly impact the millions of American jobs that depend on maritime and fishing industries, both directly and downstream. The nation's ability to map and protect its resources from exploitation, including illegal, unreported, unregulated (IUU) fishing will also be severely impacted. Moreover, the loss of data used to validate and calibrate satellites and feed weather forecasting models will result in less accurate planning for emergency response, agriculture, and coastal management that will increase risk to lives and property and have negative economic impacts.

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[5] Martin Associates for the American Association of Port Authorities. March 2015 "2014 National Economic Impact of the U.S. Coastal Port System." Accessed September 28, 2016 at http://www.aapa-ports.org.
[6] Fisheries Economics of the United States 2014: Economics and Sociocultural Status and Trends Series. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Memorandum NMFS-F/SPO-163. May 2016.

The lack of timely recapitalization will impact not only the mariners who operate the machinery, equipment, and instrumentation on NOAA ships, but also the commercial, academic, and other federal agencies that benefit from maritime professionals who train and acquire experience on NOAA ships. Impacts will not be limited to the maritime industry. NOAA Corps and civilian personnel who serve on NOAA ships carry that expertise and experience to NOAA, other federal, academic, and commercial programs. The lack of field-experienced personnel ashore will detrimentally impact development of new technology, and quality of products and services.

The Future of NOAA's Fleet

The demand for NOAA's environmental data continues to grow as more people live and work near or on the coasts and thus are affected by ocean-driven weather patterns. More than 1.2 million people move to the coast each year, with 39 percent of our nation's people now residing in coastal communities.[7] In 2013, tourism and recreation directly related to the oceans and Great Lakes accounted for $360 billion in the U.S. GDP; the ocean economy contributed to a larger share of the U.S. economy than other major natural resource industries including food products, farming, oil and gas extraction and forest products.[8] The ocean economy's share of employment in 2014 was nearly as large as the combined share of these other natural resource industries[9]. In 2014 alone, $1.75 trillion worth of U.S. goods moved through our ports, representing over 71% of U.S. imports and exports by weight[10]. The economies that rely on the oceans, lakes, and coastal communities have grown at a much higher rate than the national growth. In 2013, the ocean economy accounted for 149,000 business establishments, 3.0 million employees, $117 billion in wages, and $359 billion in gross domestic product. In 2013, employment in the ocean economy increased 3.0 percent (adding 87,000 jobs), as compared to the national average employment growth of 1.7 percent, and 5.5 percent higher than 2007 while the U.S. economy as a whole was still below pre-recession levels[11].

In order to meet this demand, the agency will have to continue to make significant investments in its observational infrastructure. Building new ships is NOAA's best long-term strategy for mitigating impacts and meeting its mission. This plan resources the agency's highest at-sea mission needs and is supported by the NOAA Fleet Independent Review Team based on their industry, federal and academia expertise and best practices.

In year one, NOAA plans, pending sufficient appropriations and authorizations, to begin acquisition of two vessels, utilizing an existing design specification, with the primary mission of oceanographic monitoring, research, and modeling and secondary missions of charting and surveying and assessment

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[7] "What percentage of the American Populations Lives Near the Coast?" Retrieved from http://oceanservice.noaa.gov/facts/population.html.

[8] Kildow, J.T., Colgan, C.S., Johnston, Farnum, M.G., and J. Scorse. State of the U.S. Ocean and Coastal Economies, 2016 Update. National Ocean Economics Program.

[9] Kildow, J.T., Colgan, C.S., Johnston, Farnum, M.G., and J. Scorse. State of the U.S. Ocean and Coastal Economies, 2016 Update. National Ocean Economics Program.

[10] U.S. Department of Transportation. "U.S. Ports: Investing in Engines of Economic Development and American Competitiveness". March 7, 2016. Posted by Foxx, A, Perez, t., and Pritzker, P. Retrieved from https://www.transportation.gov/fastlane/ports-engines-of-economic-development-and-american-competitiveness. Statistics available at http://www.rita.gov/bts/sites/rita.dot.gov.bts/files/data_and_statistics/by_freight_facts_2015/chapter2/table2_9_text.

[11] National Oceanic and Atmospheric Administration (NOAA), Office for Coastal Management. 2016. "NOAA Report on the U.S. Ocean and Great Lakes Economy." Charleston, SC: NOAA Office for Coastal Management. Available at http://coast.noaa.gov.

and management of living marine resources. These two new vessels will come on-line as the current capacity is retired; this is critical for data collection that feeds weather forecasts and fishery quotas, protects marine monuments, and maps our nation's EEZ. In addition, NOAA needs to proceed with the initial acquisition phase for a ship class with the primary mission of charting and mapping, and a ship class with the primary mission of assessing and managing living marine resources and near-shore areas. The planning and design phases for these ship capabilities will seek to leverage common hull, machinery, and configurations across vessel designs to gain economies during acquisition and to reduce life cycle costs and fleet management costs.

This is the first phase of what will be a multi-year strategy to recapitalize the NOAA Fleet to meet stakeholder needs and mission requirements. This plan includes a holistic approach, near- and long-term, to address these challenges, including construction of new ships, increased utilization of the current ships, maintenance investments, and increased use of charter vessels. The projection of new vessel construction, by mission capability, is laid out in Table 2.1.

If NOAA does not invest in recapitalizing its fleet, there will be significant economic, ecological, societal, and personnel impacts. Data required for accurate fishery forecasts will be lacking, resulting in decreased landings, loss of revenue for the seafood industry, and impact to the millions of jobs that rely on the industry. The accuracy of nautical charts will be reduced, placing ships at greater risk of groundings and increasing risk of ecological and economic impacts. Weather forecasts used for emergency management, agricultural planning, and coastal planning will be impacted. The health of marine and coastal ecosystems, a major driver to the nation's tourism industry, will be placed at greater risk. The loss of experienced field personnel integrated throughout NOAA, other federal agencies, academia, and industry will undermine the translation of at-sea data into products and services as well as the advancement of new technologies. In summary, the products and services directly fed by data collected on the NOAA Fleet will be severely diminished, increasing the risk to the lives, livelihoods, and natural resources of our nation's citizens.

I. INTRODUCTION

NOAA's Mission

The National Oceanic and Atmospheric Administration (NOAA) is a science-based federal agency within the Department of Commerce with regulatory, operational, information service, and public safety responsibilities. NOAA's mission is to understand and predict changes in the earth's environment and to conserve, protect, and manage coastal, marine, and Great Lakes resources to meet the nation's economic, social, and environmental needs. This mission is driven by NOAA's service and legislative responsibilities and the resultant social and economic implications for a wide range of industries and coastal communities.

NOAA's roots are planted in America's oldest scientific agency: the United States Coast Survey, which was founded by President Thomas Jefferson in 1807 to provide nautical charts to the maritime community for safe passage into American ports and along our extensive coastline. The Weather Bureau was founded 1870 and, one year later, the U.S. Commission of Fish and Fisheries was founded. These organizations were, respectfully, America's first physical science agency, America's first agency dedicated specifically to the atmospheric sciences, and America's first conservation agency. The cultures of scientific accuracy and precision, service to protect life and property, and stewardship of resources of these three agencies were brought together in 1970 with the establishment of NOAA. Conservation and stewardship legislation enacted during the 1970s, like the Magnuson-Stevens Fishery Conservation and Management Act, increased NOAA's role as a critical regulatory agency for marine resource management. Today, more than 50 major legal mandates and authorities underpin the mission areas that require at-sea data (a complete list is provided in Appendix G).

As America's environmental intelligence agency, NOAA provides timely, reliable, and actionable information - based on sound science - to communities and businesses for a wide variety of crucial services. These products and services include providing timely and precise weather, water and climate forecasts; monitoring the environment; managing fisheries; building resilient coastal communities; and making the nation more competitive through safe navigation. Performing these activities requires a large amount of underlying scientific data. Since NOAA's inception, it has relied on its ships to make critical oceanographic, atmospheric, hydrographic, and fisheries observations. Without this data, products and services like weather forecasts and warnings, nautical charts, accurate fishery quotas and stock assessments, harmful algal bloom warnings, climate outlooks, and a host of other products, services, and management activities would not be possible.

NOAA Fleet Planning

NOAA's ships face challenges similar to other observational infrastructure: expanding mission requirements, age and obsolescence, and finite resources for recapitalization. Since 2008, the NOAA Fleet has decreased from 21 ships to 16 currently operational ships. Without recapitalization, the NOAA Fleet will be reduced to half its current size by 2028. NOAA has continually worked to optimize its fleet capabilities by collaborating with other agencies in the Federal Oceanographic Fleet and by evaluating and implementing best operational practices and has planned for the future fleet through extensive requirements and capability reviews.

In 2008 NOAA developed *The FY 2010 to FY 2024 NOAA Ship Recapitalization Plan.* This plan, submitted to Congress in support of the FY 2010 NOAA budget submission, identified at-sea observation requirements, assessed current capabilities and capacities of the NOAA Fleet, and provided a plan to ensure the long-term sustainability of NOAA's at-sea data collection capabilities. Subsequent to the development of this plan, NOAA's Technology, Planning, and Integration for Observations Office led a validation process that created a baseline of objectively verifiable and prioritized at-sea data and observation requirements. Through analysis of the breadth and scope of NOAA's requirements and their link to the nation's economy, the 2008 plan confirmed the national need for NOAA to maintain a core fleet of vessels with unique capabilities to deliver critical products and services. While funding for NOAA ship construction has been limited since 2008 due to the nation's economic challenges, the 2008 plan justified NOAA fleet recapitalization. This 2016 report continues to demonstrate the critical need for NOAA ship recapitalization and infrastructure investment.

NOAA serves as a co-chair for the National Ocean Council's Subcommittee on Ocean Science and Technology (SOST). As part of the SOST, NOAA supports the Interagency Working Group on Facilities and Infrastructure (IWG-FI), a body composed of agencies that operate research and survey vessels collectively called the Federal Oceanographic Fleet.[12] In May 2013, the IWG-FI updated the *Federal Oceanographic Fleet Status Report* and in March 2016, produced the *Federal Fleet Status Report: Current Capacity and Near-Term Priorities*. These reports provide government-wide analysis of priorities, activities, and requirements to inform and ensure investments that support high-priority research and surveys. The IWG-FI has documented requirements for vessels that operate in near-shore and estuarine waters, as well as requirements for larger vessels, noting that right-sizing the federal fleet is a continuous effort and individual agencies must evaluate fleet conditions and plan for future capabilities.

In January 2016, NOAA established an Independent Review Team (IRT)[13] of senior-level scientific and industry experts to assess recapitalization planning for the NOAA Fleet, recommend measures required to address identified deficiencies, and identify ways to overcome organizational impediments. The IRT will release its recommendations, which are expected to be consistent with the findings in this report, in October 2016.

In May 2016, NOAA established a team of experts[14] from across the NOAA line offices to create a fleet recapitalization plan that documents the extent to which at-sea data requirements are currently being addressed and describes the capability gap that will exist absent fleet recapitalization. This report is the result of their work.

NOAA will update its fleet planning analysis periodically to adjust to changing conditions and requirements and to optimize the capability, performance, and affordability of the NOAA Fleet. This process will also consider vessel manning, workforce management requirements, and best business practices to match vessel capabilities to at-sea requirements.

Section II of this report focuses on NOAA's plan to recapitalize its fleet. Sections III - IV provide detail on the at-sea requirements, NOAA's ability to meet current and future requirements, and near-and long-term strategies for sustaining NOAA's critical national asset.

[12] Details on IWG-IF included in Appendix H.
[13] Details on IRT included in Appendix H.
[14] Details on NOAA Team included in Appendix H.

II. The NOAA Fleet Plan - Building NOAA's 21st Century Fleet

Construction of new ships is the best way for NOAA to reliably and consistently sustain its at-sea data collection capability. NOAA's ships need to be adaptable and extensible to provide the infrastructure and capabilities necessary to meet mission requirements now and in the future. The NOAA Fleet Plan outlined in this report represents the best comprehensive solution for long-term recapitalization of the NOAA Fleet.

In contrast to the wide variety of vessel types that currently comprise the NOAA Fleet, the future NOAA Fleet will consist of three to five[15] distinct vessel types that will each focus on a core mission with secondary missions that make the best use of the vessel's capabilities. NOAA will leverage aspects of previous designs to the extent possible to meet multiple core mission requirements. Standardization is critical for efficient maintenance, upgrades and optimal crewing models. Each vessel type will incorporate the latest technologies during construction and accommodate new technologies as they become available. Across the fleet, core equipment types will be standardized as much as possible to reduce operation and maintenance costs. The final decision on ship retirements will be based on the material condition of the ships and alignment with requirements.

Figure 2-1 shows the optimal timeline for design and construction of up to eight ships needed to replace vessels that will reach the end of their design service life between 2017 and 2028. An assumption of a sustained, flat funding profile at approximately the FY 2016 enacted budget level has been made for the purposes of developing the notional timeline that illustrates the sequencing of new ships. Table 2-1 identifies the primary and secondary missions met by each ship class. The phases of acquisition referenced in Table 2-1 are described in Appendix C.

[15] This will depend on the ability to leverage aspects of previous ship class designs, such as the FSV and AGOR, to meet mission requirements, regulatory and environmental requirements, regionally driven specifications, and acquisition regulations.

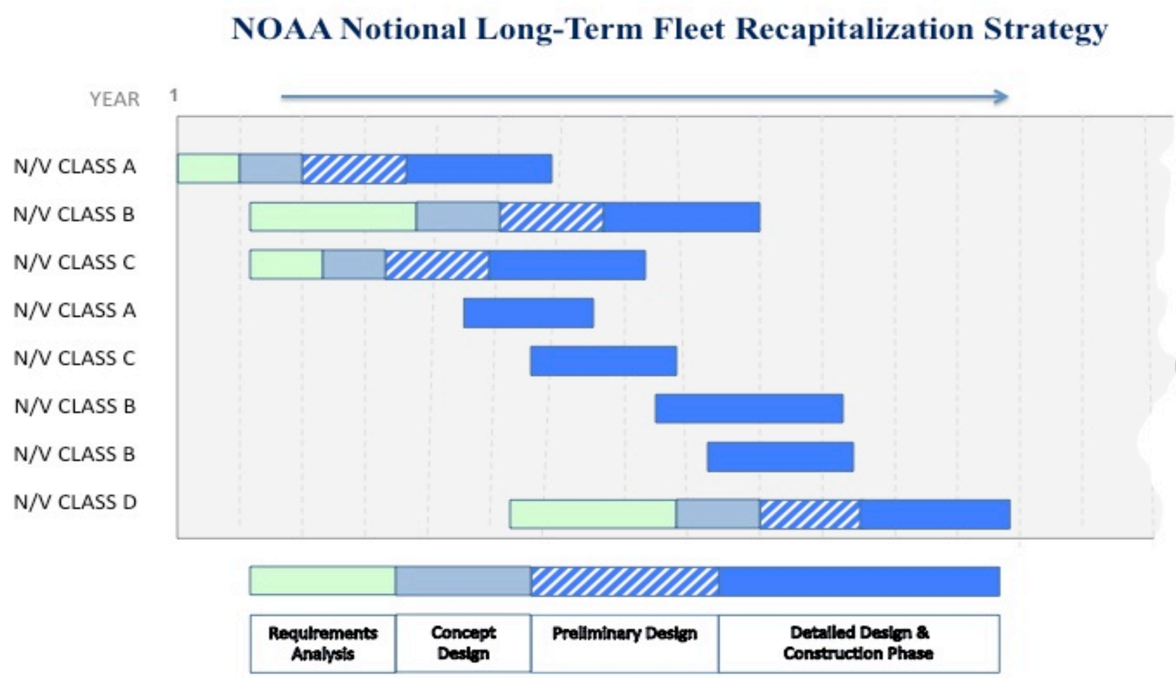

Figure 2-1: NOAA Notional Long-Term Recapitalization Strategy

Ship[16]	Primary Mission	Secondary Mission(s)
N/V CLASS A	Oceanographic Monitoring, Research & Modeling	Assessment and Management of Living Marine Resources (no trawl), Charting and Surveying
N/V CLASS B	Charting and Surveying	Assessment and Management of Living Marine Resources (no trawl), Oceanographic Monitoring, Research & Modeling
N/V CLASS C	Assessment and Management of Living Marine Resources (trawl-capable, shallow-draft)	Charting and Surveying
N/V CLASS D	Assessment and Management of Living Marine Resources (trawl capable, near-shore and deep ocean, longer endurance)	Charting and Surveying, Oceanographic Monitoring, Research & Modeling

Table 2-1: Ships and Missions

[16] Detailed descriptions provided in Appendix B.

The first two ships built will be the NOAA Vessel (N/V) Class A, which will be based on the U.S. Navy Auxiliary General Purpose Oceanographic Research Vessel (AGOR) specifications. The AGOR is a 240-foot ship designed to commercial standards and capable of oceanographic science and data collection in coastal and deep ocean areas. This multipurpose oceanographic vessel has primary capabilities for oceanographic monitoring, research, and modeling activities and secondary capabilities for assessment and management of living marine resources and charting and surveying activities. Based on the current material condition of the fleet, it is anticipated that the two AGOR vessels will meet requirements in the Western Pacific, a region that will lose all NOAA at-sea data collection capabilities by 2024. NOAA Ships *Oscar Sette, Hi'ialakai,* and *Okeanos Explorer* currently perform requirements in this region.

Best management practices were evaluated given the condition of the current fleet, projected end of service lives, and funding required versus return on investment. The most viable best management practices are to increase utilization of select vessels in the current NOAA Fleet; identify ships for maintenance design service life extension; integrate emerging technologies, as practical; and increase charter use where applicable. Given the eight to ten year timeline to analyze requirements, design and build a ship, it is critical that NOAA simultaneously proceed with best management practices and long-term strategies.

In addition to the ship infrastructure required to meet mission requirements, qualified and experienced personnel are *critical* to mission success. The diversity and specialty of NOAA's at-sea missions require a robust, technically competent, dedicated workforce. NOAA has taken significant efforts in the past few years to establish more flexible scheduling and enhanced compensation for crew. Specifically, the testing of alternate crewing on NOAA ships proved successful and is being implemented to the extent possible based on budget resources. Ultimately, NOAA seeks to offer these rotational schedule options on all ships and in all departments. Additionally, NOAA renegotiated collective bargaining unit agreements and made concessions to the extent possible, including shore leave to provide more time off after long deployments, and more compensation and benefits for crew. NOAA has also established training programs to support crew who seek advancement within a career field. NOAA will continue to solicit feedback from crew and implement workplace improvements aimed at recruiting and retaining our highly specialized and dedicated workforce.

Long-Term Recapitalization Strategy

Below are the recommended steps within NOAA's long-term recapitalization strategy, which hinges on the design and construction of new ships to replace vessels that will meet the end of their service lives between 2017 and 2028.

Design and Construct New Ships

The following are the distinct steps to execute the recapitalization strategy. New ship construction consists of four acquisition phases: requirements analysis, concept design, preliminary design, and detailed design and construction.[17] Efforts will be made throughout the process to leverage design aspects of previous ship classes and to create standardization across the fleet to meet multiple core mission requirements. The stable and continuous budget profile assumed for the notional sequencing of new ships is essential to proper planning. The merits of these requests, requirements, and opportunities will be evaluated in annual budget cycles.

[17] Descriptions of acquisition phases in Appendix C.

- First, proceed with design and construction of two NOAA general purpose oceanographic N/V Class A vessels. These vessels will have primary capabilities to conduct oceanographic monitoring, research, and modeling activities, and secondary capabilities for assessment and management of living marine resources (all capabilities except trawling) and for charting and surveying activities, including those that support development of benthic habitat and water column geospatial products. By utilizing the existing Navy AGOR design to meet NOAA's most immediate at-sea requirements, NOAA will minimize the impact of lost fleet capacity and capability and leverage government resources, saving four years of time and more than $10 million. The U.S. Navy has confirmed it has the personnel resources to support this effort.

- Second, proceed with preliminary requirements analysis and concept design for two to four N/V Class B vessels to meet the requirements not met by the N/V Class A vessels. This class will have a primary capability to perform all charting and surveying activities, with secondary capabilities for assessment and management of living marine resources and oceanographic monitoring, research, and modeling activities. Based on the eight to ten year timeline for new vessel acquisition, it is critical to initiate the ship design and acquisition process now. To the extent possible, NOAA will seek options to leverage aspects of the AGOR design in meeting mission requirements, regulatory and environmental regulations, regional requirements, and acquisition regulations.

- Third, proceed with preliminary requirements analysis and concept design of two multipurpose, low-endurance, shallow-draft, trawl-capable stock assessment vessels, N/V Class C. These specialized vessels will meet specific assessment and management of living marine resource requirements in coastal waters and the Gulf of Mexico.

- Fourth, proceed with preliminary requirements analysis and concept design for the N/V Class D vessels with capabilities not fully met by N/V Class A, B, or C vessels to support a primary mission of assessment and management of living marine resources that is trawl capable, with capabilities for secondary missions of charting and surveying, and oceanographic monitoring, research, and modeling. Depending on mission and regulatory (environmental) requirements at the time of design inception, this may utilize the current NOAA Fishery Survey Vessel (FSV) design.

- Establish a multi-year capital acquisition plan, which will enable NOAA to contract with multiple year ship options capitalizing on cost savings and lessons learned, and to increase standardization within the fleet. The ship classes developed in this plan enable this strategy.

- Design the future NOAA Fleet with three to five distinct vessel types that will each focus on a core mission and meet secondary missions that make the best use of the vessel's capabilities. Leverage aspects of other vessel class ship designs to the extent possible to minimize the total number of distinct ship classes. Each vessel type will incorporate the latest in technologies when they come on-line, and be able to accommodate new technologies as they become available. Across the fleet, core equipment types will be standardized to the extent possible to reduce operation and maintenance costs.

Fleet Management Best Practices

Below are fleet management best practices to maximize utilization of the existing NOAA fleet and mitigate the anticipated loss of NOAA vessels over the next decade. NOAA will implement these practices to the extent feasible.

Extend Service Life of NOAA Ships — The investment to extend design service lives of existing ships is only valid for the fisheries survey vessels (FSV), the newest vessels in the NOAA Fleet. Final service life decisions will be based on the material condition assessment of the ships, available functionality, required investment to update ship systems and instrumentation, the return-on-investment and long-term viability of the ship to meet current and future data collection requirements, and overall capacity of the fleet to meet mission requirements.

Increase Utilization of the NOAA Fleet — Based on analysis of maintenance data from FY 2015 to present, the rates of unscheduled maintenance, days lost due to crewing constraints, and the increased capabilities of the newer ships to collect multiple simultaneous data sets, the return-on-investment for increased utilization will be planned for 14 ships per year. The other two of the 16 ships will be in extended annual repair periods (ARP) to complete more robust maintenance and installation of emerging technologies. This strategy allows a maximum of 235 Days at Sea (DAS) per ship for 14 ships and 193 DAS for the two ships in extended ARP. As described in Section V, the most practical way to increase the current utilization rate to the fleet maximum of 3,676 is a phased approach scalable across three years. Recruiting and retaining a robust, technically competent, and highly qualified workforce is critical to increasing utilization of the NOAA Fleet.

Increase Use of Charters – NOAA continues to pursue additional opportunities for charters, and these collaborations will be an important part of the short-term mitigation strategy. NOAA will focus on charters to fill requirements gaps during the phase between ships coming off-line and new ships coming on-line, especially in the Gulf of Mexico. The focus will be on using charters to meet time-sensitive data requirements such as fishery stock assessments and weather buoy data collection required for development of fishery quotas and weather forecasts, respectively.

Increase Use of Small Boats — To increase regional utilization of small boat assets, NOAA will incorporate small boats into the Vessel Prioritization, Allocation, and Scheduling System. This will ensure priority requirements are being met, enhance fleet utilization, and inform the composition of the future fleet.

Integrate New Technology – NOAA will integrate new data collection and ship infrastructure technology, such as unmanned and remotely operated systems, into existing ships as feasible. To the degree possible, off-board instrumentation and environmentally efficient technologies will be deployed across the NOAA Fleet. Emerging technologies will be considered for potential integration during extensive repair periods alongside service life extension decisions. New ship designs will incorporate the latest ship systems and instrumentation technologies, including the ability to deploy, recover and maintain unmanned and remotely operated systems.

Expand Partnerships – NOAA will collaborate with the Federal Oceanographic Fleet to maximize utilization of all federal vessels to meet at-sea data requirements across federal and academic sectors. NOAA will continue to look for additional opportunities, including charter, data sharing, and vessel barters, for mutual requirement support. Such partnerships are useful to meet short-term needs but, given NOAA's need to assure the continuity of at-sea missions to support national priorities, NOAA requires a core in-house capability met only by a fleet of ships built and outfitted for NOAA requirements.

Ship Acquisition Capabilities – An in-house ship design and acquisition office with capital asset management and fleet introduction capabilities is necessary to analyze at-sea data requirements, monitor and lead recapitalization efforts, identify future requirements, collaborate with the Federal Oceanographic Fleet to integrate capabilities, collaborate with foreign partners to best leverage design, acquisition and mission related practices, and maintain expertise on industry best practices and standards. These best practices ensure the most efficient and effective utilization of government resources.

III. The Need to Go to Sea – Now and in the Future

NOAA's Current At-Sea Requirements

The oceans, coasts, inlets and Great Lakes support the lives, livelihoods, and lifestyles of all Americans. People fish from their waters, vacation on their edges, ship cargo on their surface, and extract oil, gas, sand, and gravel from their seafloors. Most ocean and Great Lakes-dependent activities are important contributors to the nation's economy. Oil and gas production provide energy. Seafood production and processing supports local economies and meet the demands of restaurants and seafood markets. Tourism and recreation are multibillion-dollar economies that support millions of jobs. Marine construction, marine transportation, and shipbuilding provide access to global markets. The oceans and Great Lakes also provide a wide range of economic benefits that do not lend themselves to traditional measures of jobs, wages, and gross domestic product. Coastal and ocean ecosystems sequester carbon from the atmosphere, protect communities from the harmful effects of coastal storms, and provide myriad other benefits that support human life and wellbeing.

NOAA products and services support these activities and rely on data collected by the NOAA Fleet. The four missions detailed below, **Charting and Surveying; Assessment and Management of Living Marine Resources; Oceanographic Monitoring, Research and Modeling**; and **Emergency Response**, encompass the activities that NOAA conducts to gather at-sea data. These missions and at-sea activities are detailed below.

Charting and Surveying – This NOAA mission includes safe navigation, management of coastal and ocean resources, restoration and response, and technical assistance for coastal zone management. Data collected by the NOAA Fleet in support of these missions has significant economic and societal benefits. Without recapitalization, the accuracy of nautical charts will be impacted placing ships at greater risk of groundings, impacting our economy and ecology. Additionally, decreased capacity will reduce the surveying of habitat, which will result in less accurate and conservative fishery quotas and stagnate the mapping of our Exclusive Economic Zone.

- **Navigation, Observations and Positioning:** Nautical charts, or maps, are *the* tool used by all sectors of the maritime industry (commercial, military, and recreational) for safe navigation in waterways and coastal areas. The value of accurate charts for commercial maritime activity alone is significant. Ocean currents, silt transport from rivers, passage of storms, tectonic activity, and impacts from commercial (one shipping container falls off a commercial ship every hour) and recreational uses result in changes to bottom topography that degrade the accuracy of nautical charts. Repeat surveys are required to keep charts accurate and navigation safe. Accurate charts of ports and waterways directly support imports and exports on ships, associated gross domestic product and jobs, as well as surface transportation industries. By value, vessels carry 53 percent of U.S. imports and 38 percent of exports, representing more than 62,000 port calls in 2010 and 7 percent of the nation's GDP. More than $1.9 trillion in imports came through U.S. ports in 2010, and U.S. commercial ports directly supported more than 13 million jobs.[18] Furthermore, traffic in deep draft ports, which accounts for more than 99 percent of all import and export traffic in the United States, supports the $570-billion dollar

[18] NOAA's State of the Coast Web site, Ports – Crucial Coastal Infrastructure. Retrieved from http://stateof thecoast.noaa.gov/ports/welcome/html.

railroad and motor carrier transportation industries.[19] The GDP from this surface transportation, supported directly by nautical charts, increased from $6 billion to $62 billion in less than 25 years (1984 to 2008).[20] In total, the economic impacts related to America's seaports in 2014 was $4.6 trillion or about 26 percent of the entire U.S. economy, compared to 20 percent in 2007. The importance of accurate charts will only increase given that the volume of traffic, and value of exports and imports via water, in U.S. seaports is expected to double by 2021 and double again shortly after 2030.[21]

- **Coastal Science and Assessment:** This activity gathers data for tsunami modeling, storm surge predictions, sanctuary management, ocean exploration, essential fish habitat mapping and characterization, and submerged cultural resources management. Accurate data directly impacts the more than 40 percent of the nation's population that lives in coastal shoreline communities, and more than $6.6 trillion (> 45 percent) of our GDP, 51 million jobs and $2.8 trillion in wages.[22] For reference, the U.S. coastal communities alone would rank number three in GDP globally, behind the U.S. as a whole and China.[23] Accurate mapping of our coastal areas is critical for urban planning and emergency management; every dollar invested in storm-surge effects on coastal communities saves the U.S. taxpayer four dollars in losses from natural hazards. Furthermore, mapping fish habitat is one of the main drivers for setting accurate catch limits for the $153 billion and 1.4 million jobs in the commercial seafood industry and $4.9 billion recreational fishing industry[24].

Assessment and Management of Living Marine Resources – NOAA is responsible for the stewardship of the nation's ocean resources and their habitat. Timely, geographically-driven, and capabilities-dependent access to the sea supports the sustainability and economic value of fisheries; resiliency of fishing communities and working waterfronts; protects and recovers threatened and endangered species; and maintains and restores healthy coastal habitats for living marine resources. NOAA uses at-sea data to identify, characterize, monitor, and evaluate living marine resources and their surrounding ecosystems through physical, chemical, and biological observations. Without recapitalization, the health, economic prosperity, and labor market for the seafood industry will be significantly impacted. Additionally, the loss of protected species and habitat data will impact ecological forecasting directly linked to coastal management, emergency planning, and tourism.

- **Protected Resources, Science and Management:** Accurate assessment of threatened and endangered marine and anadromous species, the ecosystems that sustain them, and the

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[19] Wolfe, K.E. 2010. Value Added to GDP from International Containerized Freight by Surface Transportation. Silver Spring, MD: National Oceanic and Atmospheric Administration.
[20] Wolfe, K.E. 2010. Value Added to GDP from International Containerized Freight by Surface Transportation. Silver Spring, MD: National Oceanic and Atmospheric Administration.
[21] National Oceanic and Atmospheric Administration (NOAA), National Ocean Service. 2015. "The Value of PORTS to the Nation: How Real-Time Observations Improve Safety and Economic Efficiency of Maritime Commerce."
[22] NOAA's State of the Coast website, The Coast- Our Nation's Economic Engine. Retrieved from http://stateofthecoast.noaa.gov/coastal_economy/welcome.html.
[23] NOAA's State of the Coast website, The Coast- Our Nation's Economic Engine. Retrieved from http://stateofthecoast.noaa.gov/coastal_economy/welcome.html.
[24] Fisheries Economics of the United States 2014: Economics and Sociocultural Status and Trends Series. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Memorandum NMFS-F/SPO-163. May 2016.

communities that value and depend on them is another economic driver. Nearly $4 billion annually and 50,000 jobs are generated in local economies from diverse activities related to national marine sanctuaries.[25] Additionally, measurement and prediction of resource abundance, distribution, habitat requirements, and related ecosystem components of protected resources directly impacts quotas for commercial and recreational fishery stocks, commercial shipping, (traffic lanes), and conservation.

- **Fisheries Science and Management:** Accurate, complete, and timely fishery related surveys are directly linked to commercial and recreational fishery stock quotas. In 2014, more than 9.5 billion pounds of fish were landed, valued at $5.4 billion, not including the downstream economic value.[26] Reduced surveys result in less precision in stock assessments which lead to more conservative catch limits, fewer fish to market, and economic losses to commercial fisherman and industries across the nation that rely on commercial and recreational fishing. In the pollock fishery alone, 3.1 million pounds of pollock valued at $400 million were landed in 2014.[27] Skipping one season of at-sea surveys would result in a quota reduction of 10 percent, a loss of $40 million per year, not including downstream economic effects.

- **Habitat Conservation and Restoration:** These activities protect and restore habitat to sustain commercial and recreational fisheries, recover protected species, and maintain resilient coastal ecosystems and communities. Habitat conservation and restoration directly impacts commercial and recreational fishery quotas, the communities that rely on sustained stocks, and the downstream industries fueled by fish and seafood landings.

Oceanographic Monitoring, Research and Modeling — NOAA conducts oceanographic research that increases knowledge of climate, weather, oceans, and coasts. Oceanographic monitoring, research, and modeling contributes to accurate weather forecasts, enables communities to plan for and respond to climate events such as drought, and enhances the protection and management of the nation's coastal and ocean resources. Weather data collected by NOAA ships including weather buoys, drifters, over-the-side and hull mounted instrumentation are directly fed into weather models, forecasts, and oceanographic circulation models. Without recapitalization, the accuracy of weather and climate forecasts will be impacted directly affecting severe storm and emergency planning, agricultural planning, and coastal management.

- **Climate Research**: NOAA ship data is fundamental to sustaining atmospheric and oceanic observations and research; understanding and predicting ocean and climate variability and change; and incorporating research into information and products. Data collected by NOAA ships directly feed into global models that forecast precipitation and extreme weather events (tropical cyclones, tornadoes, blizzards). The yearly economic impact of U.S. weather is $485 billion, plus or minus $240 billion, based on a study of 70 years' of weather records through

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[25] National Marine Sanctuaries Socioeconomics Factsheet. 2011. Retrieved from http://sanctuaries.noaa.gov/science/socioeconomic/pdfs/onmssocioeconomicsummary2011.pdf.

[26] Fisheries Economics of the United States 2014: Economics and Sociocultural Status and Trends Series. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Memorandum NMFS-F/SPO-163. May 2016.

[27] Fisheries Economics of the United States 2014: Economics and Sociocultural Status and Trends Series. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Memorandum NMFS-F/SPO-163. May 2016.

2008.[28] Weather variations cost as much as 3.4 percent of U.S. GDP. The severe weather impacts in the spring of 2011, alone, cost the insurance industry $15 billion.[29] Advancements resulting from the repeatable and complex data collected by NOAA ships directly leads to forecast improvements.

- **Weather and Air Chemistry Research:** Data collected by NOAA ships supports research and accurate, timely warnings and forecasts of high-impact weather events. Ship data were fed directly into El Nino and La Nina weather forecasts critical for safety of lives and property, emergency management, and economic planning. The 1997-98 El Nino caused property losses of $2.8 billion, including $700 million in agricultural impacts and $200 million in losses to the tourist industry.[30]

- **Ocean, Coastal and Great Lakes Research**: This activity investigates ocean, coastal, and Great Lakes habitats and resources to help manage and understand fisheries, conserve and restore the nation's coasts, and build a stronger economy. For example, data collected by NOAA ships is used to predict and respond to harmful algae blooms, a significant threat to coastal regions, especially in the Gulf of Mexico, Chesapeake Bay, Lake Erie, and Oregon — and costs approximately $50 million annually.[31] Data to predict, understand, minimize, and properly respond to harmful algae blooms is critical for the economic viability and health of coastal communities.

Emergency Response – NOAA ships routinely respond to natural and man-made national disasters. The data collected by NOAA ships is directly used by federal, state, and local agencies to minimize environmental and economic impacts of oil and chemical spills, vessel groundings, hazardous waste releases, and national security events. NOAA emergency response services include surveying major commercial ports following storm passage to ensure their channels are free from debris, modeling oil spill trajectories, assisting with shoreline cleanup activities, identifying sensitive resources, and managing information. The multi-disciplinary capabilities of the NOAA Fleet provide a highly adaptable and responsive national asset in our greatest times of need.

Specific examples of response include:

- Hurricane Sandy. Surveying the ports of New York and Hampton Roads making it possible for ship traffic to resume less than 48 hours after the passage of Hurricane Sandy. The Port of Hampton Roads loses $10 million per hour during a port closure; the Port of New York loses $23 million per hour during a port closure.

- Hurricane Katrina. NOAA ships surveyed the ports of Mobile, Pascagoula, and Gulfport to open them within 48 hours after the hurricane passage; replaced tide gauges critical for

[28] Changnon, S.. September 1999 "Impacts of 1997-98 El Nino- Generated Weather in the United States." *Bulletin of the American Meteorological Society*. 80: 1819-1827.
[29] Weather Costs U.S. Economy Hundreds of Billions Annually. June 29, 2011. Independent Study by Aon Benfield insurance company. Retrieved from http://accuweather.com/en/weather-news/weather-costs-the-us-economy-h-1/51526.
[30] Changnon, S.. September 1999 "Impacts of 1997-98 El Nino- Generated Weather in the United States." *Bulletin of the American Meteorological Society*. 80: 1819-1827.
[31] Economic Impacts: Red Tide. Woods Hole Oceanographic Institution. Retrieved from https://www.whoi.edu/redtide/impacts/economic.

oceanographic and meteorological forecasts; and conducted environmental and toxic contamination surveys critical for the Gulf of Mexico seafood industry and public health.

- Deepwater Horizon. Eight NOAA ships collected data in support of commercial and recreational fisheries, seafood safety analysis, oil trajectories, and protected species monitoring. Data directly contributed to the management of the Gulf of Mexico commercial fishing that lands 1.1 billion pounds annually and has a total seafood industry value greater than $24 billion.[32] Physical and chemical oceanography data were used to direct allocation of response resources.

- Position location for asset location and evidence collection. This is critical for safe emergency management response, accident investigation, and to gather evidence towards prevention of similar events (e.g. faulty aircraft equipment). NOAA ships created maps of debris fields for Egypt Air Flight 990, TWA Flight 800, and the downed aircraft flown by John F. Kennedy, Jr.

At-Sea Capacity Requirements

This plan resources the agency's highest at-sea mission needs and is supported by the NOAA Fleet Independent Review Team based on their industry, federal and academia expertise and best practices. In developing this plan, NOAA incorporated analyses of agency mission needs, chartering, maintenance, crewing and new technologies. The at-sea activities conducted to support NOAA's missions drive the line offices' requests for time on NOAA ships, which NOAA refers to as requirements. This section presents the process by which at-sea requirements are prioritized and managed.

The NOAA process for prioritizing at-sea requirements occurs at agency, line office and programmatic levels. The NOAA Technology, Planning and Integration for Observations Office (TPIO) baselines and validates the prioritized at-sea requirements. The at-sea requests submitted annually in the Vessel Prioritization, Allocation and Scheduling System (VPASS) are vetted through two levels of line office (LO) approvals and analyzed by the Fleet Working Group. The cross-agency representation on the Fleet Working group develops a proposed Fleet Allocation Plan (FAP) and charter assignments based on annual resources. The LO leadership on the Fleet Council approves the annual FAP as well as amendments during the course of a FY, as needed.

NOAA's ship scheduling system creates a disciplined and competitive environment that results in prioritization and corresponding allocation of ship time for the highest mission needs. This approach balances requirements selection rigor with core capability to flexibly and reliably meet planned and emergent requirements. NOAA will regularly revisit optimal fleet composition and capacity over the life of this plan as the number and types of validated mission critical requests fluctuate.

In FY 2017, NOAA is planning to support 3,096 DAS with the NOAA Fleet based on its current age and condition. Execution of this number of sea days is contingent on several factors including unscheduled maintenance requirements, fuel prices, and crewing. NOAA's current Fleet of 16 ships has a maximum total utilization of 3,676 days at sea (DAS) per year. Additional utilization may be gained with efficiencies of new vessels, designed specifically for NOAA missions, and changes in maintenance and crewing models.

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[32] Fisheries Economics of the United States 2014: Economics and Sociocultural Status and Trends Series. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Memorandum NMFS-F/SPO-163. May 2016.

In addition to NOAA ships, at-sea requirements are met with vessel charters, data buys, and partnership agreements. Chartering means a NOAA program has contracted for a private vessel crewed and operated by the contractor; while the NOAA program provides the science party, and in some instances the observational equipment. The vessel operator provides the basic shipboard infrastructure to conduct the at-sea operations, like winches, A-frames, cranes, etc. Data buys are used for hydrographic (charting) data; the contract assigns specific survey areas to the contractor and the contractor provides data to NOAA. Charters conduct approximately 2,300 DAS annually based on average data from FY 2012-2016. As shown in Table 3-1, about 40 percent of the DAS allocated annually for at-sea activities are provided by charters, including UNOLS vessels, bathymetric survey data buys, and commercial and international vessels. In total, NOAA ships and charters meet approximately 5,400 of the 8,000 DAS annually. Table 3-1 depicts the required DAS and the use of NOAA and charter ships to meet requirements.

			Capacity (DAS)			
			Total User Requirements (FY 17)[33]	Allocated: NOAA (FY 17)	Allocated: Charter[34] (FY 14 - FY 16 average)	Total Allocated (NOAA and Charter)
		Totals	**8, 063**	**3,096**	**2,320**	**5,416**
Missions & At-Sea Activities	**Charting & Surveying**	Navigation, Observations & Positioning	1,110	630	610*	1,240
		Coastal Science & Assessment	276	115	56	171
	Assessment & Management of Living Marine Resources	Protected Resources, Science & Management	959	299	53	352
		Fisheries Science & Management	3,036	962	864	1,826
		Habitat Conservation & Restoration	1,838	598	9	607
	Oceanographic Monitoring, Research & Modeling	Climate Research	716	248	472	720
		Weather & Air Chemistry	41	3	0	3
		Ocean, Coastal & Great Lakes Research	87	97	256	353
	Emergency Response		As required			
	Mission Support	OMAO Mission Support[35]	N/A	144	N/A	144

Table 3-1: Days-At-Sea Required and Allocated

* Includes an approximate equivalent of 610 DAS for 1,221-square nautical miles of hydrographic data. This DAS calculation was based on the NOAA Fleet average of two-square nautical miles of hydrographic data per day; it is not actually the number of DAS the vessel is contracted for the data collection.

33 FY 2017 requirements as submitted in the Vessel Prioritization, Scheduling and Allocation System (VPASS).
34 Most recent execution data available for charter DAS.
35 Mission support DAS include days for maintenance transit, ship equipment calibrations, sea trials, gear trials, underway fleet Inspections, patch calibration tests for multi-beam systems, training, and unmanned system testing/projects.

Current At-Sea Capability Requirements

At-sea data and activity requirements determine total DAS requirements.[36] At-sea data requirements drive ship capability requirements. Many missions and at-sea activities require ships with more than one capability to respond to these data requirements. With the need for multidisciplinary capabilities, there may be overlap in shipboard capabilities to support the temporal and spatial observational requirements demanded by NOAA's programs.

NOAA uses University-National Oceanographic Laboratory System (UNOLS), United States Navy (USN), United States Coast Guard (USCG), commercial and international vessels, and hydrographic survey data buys to cost-effectively manage its at-sea science data needs. NOAA historically uses an average of 2,320[37] charter DAS per year, which accounts for approximately 40 percent of all DAS. Charters support almost all aspects of NOAA's at-sea portfolio, including fisheries management, bottom mapping, ecosystem characterization, resource protection, and oceanographic research. Charters also support specialized deep-water, long endurance missions that require systems that the NOAA Fleet does not support, such as human occupied submersibles. Other charter missions use UNOLS global class research vessels, which are among the most capable and sophisticated research vessels in the world. Doing so allows NOAA and UNOLS to maximize geographic and logistical efficiencies, making the best use of the investment in UNOLS' and NOAA's fleets. Advantages to charters include lower costs for some missions, particularly when smaller vessels can be used, and reduced transit time when charters are based near the work site. Increasing use of charters, however, poses challenges too, such as availability at a specific time and place and varying levels of crew experience, ship capabilities, and federal contract requirements. Balancing these issues mitigates programmatic risks by ensuring high-quality science and providing short-term flexibility.

NOAA continues to coordinate with its maritime partners to optimize DAS by assessing and incorporating government and commercially-driven technologies such as unmanned, autonomously, and remotely operated systems, data analytics, and real-time data distribution and visualization that ensure a technological optimization of shipboard surveys. These operational assessments (OA) have included unmanned operations from the Arctic to Antarctic across NOAA's mission sets. The increased efficiency, effectiveness, and reach of the NOAA Fleet through manned-unmanned teaming efforts are consistent with the other maritime services and the changing operating environment. Whereas operational capacity is the quantity of existing NOAA's capabilities, having a multi-mission, inter-operable, and coordinated Federal Oceanographic Fleet with groundbreaking technologies will improve operational capacity.

NOAA has decommissioned five ships in the last eight years. Although new ships came on-line during this time there remained gaps in requirements that could not be met by the NOAA Fleet. To the extent possible, NOAA implemented mitigation strategies, including increased use of charters, changes to ships working grounds, piggyback projects, and new technology to minimize the requirements gaps. These mitigations are largely maximized in the current fleet. Mitigation strategies are limited regionally, by capability requirements and availability, and by project requirements, including temporal, berthing, and endurance needs. To assess the impact of the at-sea capabilities loss with the retirement of an

[36] More detail is provided in *The FY 2010 to FY 2024 NOAA Ship Recapitalization Plan*.

[37] 2,310 DAS is a FY 2014 - FY 2016 average and includes an approximate equivalent of 610 DAS for 1,221 square nautical miles of purchased hydrographic data. This DAS equivalent calculation was based on the NOAA average hydrographic data collection of two square nautical miles per day.

additional eight ships by 2028, the capabilities required by each mission and at-sea activity were identified. Table 3-2 illustrates the linkage between NOAA's missions and at-sea activities, and the ship capabilities needed to conduct those activities.

Missions & At-Sea Activities		Required Ship Capabilities[38]
Charting & Surveying	Navigation, Observations & Positioning	Moving Vessel Profiler, Survey Launches, Lab Space, Multi-beam and Side Scan Sonar, Communications, Endurance, Unmanned Systems, Dive, Zero Discharge, Ice Strengthening
	Coastal Science & Assessment	Same as above with requirement for work boats as opposed to hydrographic capable survey launches
Assessment & Management of Living Marine Resources	Protected Resources, Science & Management	Extensive Diving, Work Boats, Lab Space, Science Berthing, Communications, Endurance, Marine Unmanned Aerial Systems, Zero Discharge
	Fisheries Science & Management	Trawl, Longline Fishing, Lab Space, Science Berthing, Mooring Handling, Communications, Endurance
	Habitat Conservation & Restoration	Extensive Diving, Work Boats, Science Berthing, Communications, Remotely Operated Vehicles (ROV), Zero Discharge
Oceanographic Monitoring, Research & Modeling	Climate Research	Dynamic Positioning, Mooring Handling, Communications, Lab Space, Science Berthing, Endurance, Unmanned Systems
	Weather & Air Chemistry Research	Mooring Handling, Communications, Endurance
	Ocean, Coastal & Great Lakes Research	Lab Space, Science Berthing, Dynamic Positioning, Multi-beam Sonar, Mooring Handling, Communications, Endurance, ROV
Emergency Response	Various Activities	All in differing combinations specific to response

Table 3-2: Required Ship Capabilities by Mission and At-Sea Activities

Requirement to Maintain NOAA Fleet Capacity

While there are nearly 40 ships in the combined Federal and academic fleet, non-NOAA vessels are designed with other missions in mind and thus have limited ability to meet NOAA's full suite of requirements. As detailed in the Federal Oceanographic Fleet Report[39] and Federal Oceanographic Fleet Status Report,[40] ships operated by Federal agencies are designed to meet specific statutory requirements while the academic research fleet is designed to meet a wide array of academic research requirements. Ships across the Federal Oceanographic Fleet have some fundamental design elements

[38] Detailed descriptions of each ship capability can be found in Appendix B.

[39] Federal Oceanographic Fleet Report. Released by Executive Office of the President, May 24, 2013. Retrieved from https://www.whitehouse.gov/sites/default/files/federal_oceanographic_fleet_status_report.pdf

[40] Federal Oceanographic Fleet Status Report. Released by Executive Office of the President, May 2016. Retrieved from https://www.whitehouse.gov/sites/default/files/microsites/ostp/NSTC/federal_fleet_status_report_final.pdf.

such as endurance, speed, trawl capability, and high precision station keeping ability that are specific to their missions. This specialization within the Federal fleet enables it to most efficiently meet the broad array of mission requirements across the Federal government. For instance, the U.S. Coast Guard vessels are designed for maritime safety, security, and stewardship; the primary USCG ship support to the oceanographic fleet is through icebreaking services to provide access for research. In addition, USCG purpose-built buoy tenders perform buoy maintenance and servicing. The Naval Oceanographic Office ships are designed to collect data on oceanographic features in support of the warfighter, navigational safety, the Navy's Undersea Warfare, and Maritime Homeland Defense activities. The Navy's Office of Naval Research ships support requirements for national security including ocean acoustics, ocean engineering, undersea signal processing, and ocean optics. Similarly, NOAA must invest in its own ships to ensure they include design specifications capable of meeting NOAA's diverse and critical mission as efficiently as possible.

Federal agencies, academic institutions, and international bodies collect the majority of at-sea data with ships specifically designed and instrumented to meet their mission mandates, requirements, or areas of research focus.

Future At-Sea Requirements

The loss of ships in the NOAA Fleet will occur over time. To ensure replacement of appropriate capabilities this plan considered current and future requirements. NOAA has emerging requirements in four significant areas: (1) the Arctic, (2) extended continental shelf mapping, (3) ocean acidification, and (4) marine national monuments.

The Arctic – The Arctic has profound significance for climate and the functioning of ecosystems around the globe. This region and its communities are particularly vulnerable and prone to rapid change. National security concerns are increasing as reductions in sea ice and other climate-induced changes bring increased opportunities for economic development and increased access to Arctic resources. These economic drivers, in turn, can further threaten ecosystems and Arctic inhabitants already impacted by the rapidly changing climate. The risks to sound Arctic stewardship are intensified because the science that underpins many of the decision-making processes and support services is largely inadequate. NOAA has the responsibility to support these emerging issues and provide information and reputable indicators that describe the state of the Arctic ecosystem and climate. Additionally, commercial maritime traffic in the Arctic continues to increase as more and bigger ships enter the Arctic environment. This increased activity coupled with the fact that only a small portion of the Arctic is charted to modern standards poses a significant risk to economic viability in the region and the health and safety of life and property.

Extended Continental Shelf Mapping – In 2001, the United States initiated the extended continental shelf (ECS) project, one of the largest and most significant national marine mapping efforts ever undertaken. Using the procedures and criteria set forth in Article 76 of the United Nations Convention on the Law of the Sea of 1982, NOAA and a consortium of 13 other U.S. agencies and commercial entities have been gathering and analyzing data that describe the depth, shape and geophysical characteristics of the seabed and sub-sea floor to determine the maximum limit of the U.S. continental shelf off all states and territories. The United States will use ECS information to determine policies that establish jurisdiction over marine resources found within this maritime zone, through which NOAA and other federal agencies and institutions will have new at-sea responsibilities for identifying and characterizing ecosystems and habitats that warrant conservation, as well as new opportunities to identify resources of economic value.

Ocean Acidification – Ocean acidification – increased carbon dioxide levels in the oceans – is affecting communities and businesses globally, including the shellfish industry. It is necessary for NOAA to document ocean acidification in estuarine, coastal, and open-ocean environments and to understand the impacts of ocean acidification on living marine ecosystems so that it can provide actionable information for marine resource decision makers. Studies have shown that a more acidic environment has a dramatic effect on some species, including oysters, clams, sea urchins, shallow water corals, and deep-sea corals. When shelled organisms are at risk, the entire food web may also be at risk. Today, more than a billion people worldwide rely on food from the ocean as their primary source of protein. Many jobs and economies in the United States and around the world depend on the fish and shellfish in U.S. oceans. U.S. shellfish landings revenue in 2014 totaled $3.1 billion, not including downstream economic effects.[41]

Marine National Monuments – During a time of increased global use and demands on our nation's marine resources, it is increasingly important that we accurately map and protect these economically and ecologically fragile areas. Efficient management of our oceans and ocean resources is critical to preserve long-term viability threatened by increased pressures from illegal, unreported, and unregulated fishing; marine debris; future exploration and mining uses; hazardous cargo; invasive species; and recreational use. Economic losses from IUU fishing alone range from $10 billion to $23.5 billion annually.[42] In August 2016, the Papahānaumokuākea Marine National Monument was expanded by 442,781 square miles, bringing the total protected area to 582,578 square miles. NOAA is responsible for mapping, managing, protecting, and conserving monument resources against threats to allow uses that are compatible with resource protection.

These emerging issues bring a corresponding increase in requirements for NOAA at-sea activities. Ships are a primary source of observation data for providing in situ measurements and supporting NOAA's information and ecosystem assessment and management services. They reliably provide researchers and scientists the ability to collect data at required locations for extended periods. Despite the steady advancement of sampling and remote sensing technologies, ships are fundamental to at-sea data collection — for deploying systems that expand a ship's observational footprint such as the FISHPAC[43] sonar; and critical for testing, evaluating and transitioning innovative technologies to operations. Ships will remain fundamental to at-sea data collection for the foreseeable future. This finding is consistent with the National Academy of Science's *Ocean Science Priorities for 2015-2025*[44] report, which references *Scanning the Horizon: The Future Role of Research Ships and Autonomous Measurement Systems in Marine and Earth Sciences*.[45]

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[41] Fisheries Economics of the United States 2014: Economics and Sociocultural Status and Trends Series. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Memorandum NMFS-F/SPO-163. May 2016.
[42] Fisheries Economics of the United States 2014: Economics and Sociocultural Status and Trends Series. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Memorandum NMFS-F/SPO-163. May 2016.
[43] FISHPAC is an ongoing research project involving multidisciplinary field experiments and data processing.
[44] Committee on Guidance for NSF on National Ocean Science Research Priorities: Decadal Survey of Ocean Sciences Ocean Studies Board Division of Earth and Life Studies, 2015, pgs 43, 46 – 47.
[45] The Challenger Society and the National Oceanography Centre Association, 2013, pg. 10.

IV. Meeting the Need to Go to Sea

Current NOAA Fleet

NOAA operates, manages, and maintains a fleet of research and survey ships that provide a wide range of capabilities. NOAA's ships have been designed and equipped to support required at-sea activities. Many of the ships fulfill multiple missions, such as conducting fishery stock assessments, tending tsunami buoys, and acquiring data for oceanographic research and weather forecasts. The analysis for this report focuses on capabilities and mission requirements, rather than the traditional ship nomenclature of global, ocean, and regional classes. These arbitrary classifications are based on ship length, range, endurance, and science berths; they do not specify ship capabilities to meet scientific requirements.

The current NOAA Fleet (Table 4-1) is a mix of purpose-built ships and converted U.S. Navy ships. Six of the ships were acquired from the U.S. Navy and adapted to perform NOAA activities. The other ten were constructed specifically for NOAA missions. NOAA ships are stationed in homeports across the United States, and operate across the nation's EEZ and internationally.

Ship	Length	Class	Primary Mission	Homeport	Ship Age (years)
Rainier	231 ft.	Ocean	2	Newport, OR	49
Fairweather	231 ft.	Ocean	2	Ketchikan, AK	49
Oregon II	170 ft.	Regional	1	Pascagoula, MS	49
Hi'ialakai	224 ft.	Ocean	1, 2, 3	Honolulu, HI	32
Oscar Elton Sette	224 ft.	Ocean	3	Honolulu, HI	29
Okeanos Explorer	224 ft.	Ocean	1, 2	Davisville, RI	28
Gordon Gunter	224 ft.	Ocean	1	Pascagoula, MS	27
Nancy Foster	187 ft.	Ocean	1	Charleston, SC	26
Thomas Jefferson	208 ft.	Ocean	2	Norfolk, VA	25
Ronald H. Brown	274 ft.	Global	3	Charleston, SC	20
Oscar Dyson	209 ft.	Ocean	1	Kodiak, AK	13
Henry B. Bigelow	209 ft.	Ocean	1	Newport, RI	11
Pisces	209 ft.	Ocean	1	Pascagoula, MS	9
Bell M. Shimada	209 ft.	Ocean	1	Newport, OR	8
Ferdinand R. Hassler	124 ft.	Regional	2	New Castle, NH	7
Reuben Lasker[46]	209 ft.	Ocean	1	San Diego, CA	4

Mission 1: Assessment and Management of Living Marine Resources
Mission 2: Charting and Mapping
Mission 3: Oceanographic Monitoring, Research, and Modeling

[46] NOAA Ship *Reuben Lasker* did not start operations until 2014

Table 4-1: Current NOAA Fleet

While age is not an exact indicator of when a ship will reach the end of its design service life, the age of a ship serves as a good proxy for its condition for two reasons. First, the age is easily measured - the ship age is measured from the date the vessel is delivered until the current year. Second, a ship's age is also a primary factor in engineering fatigue analysis. The estimated design service life for the NOAA Fleet is shown in Figure 4-1.

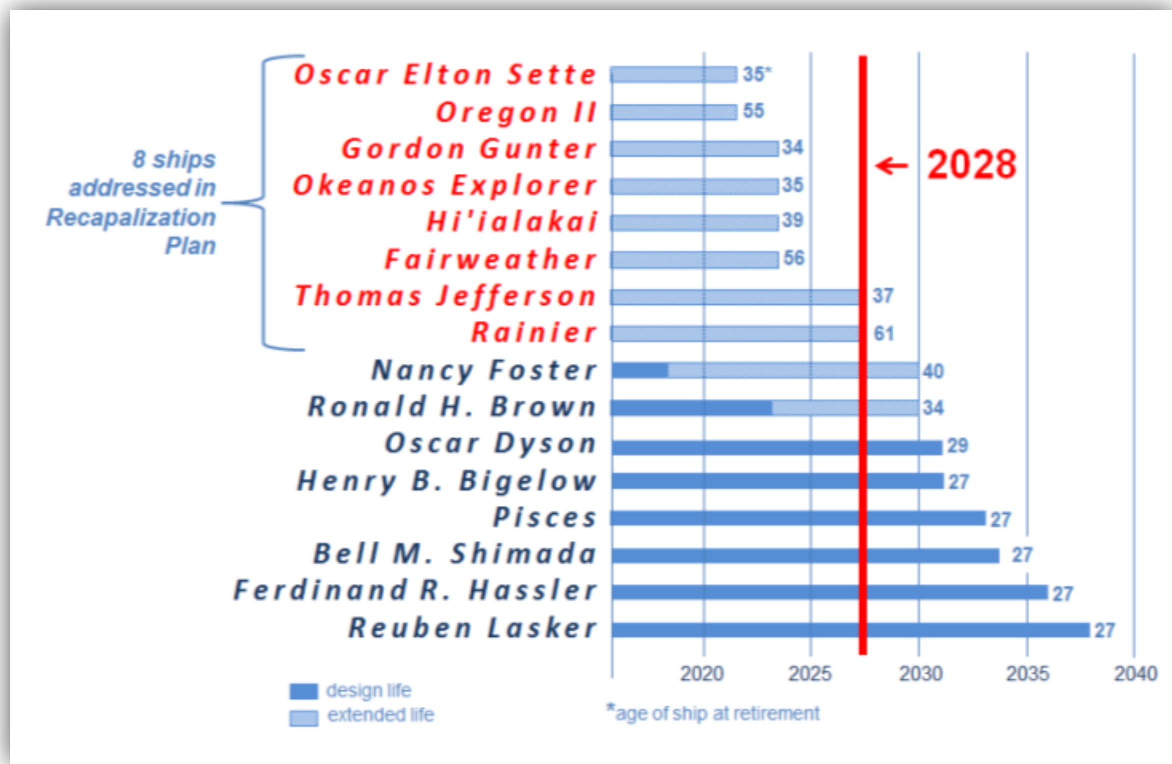

Figure 4-1: Estimated Service Life of NOAA Ships[47]

The 16 ships of the NOAA Fleet will have an average age of 30 years in 2017. NOAA Ships *Oregon II, Fairweather,* and *Rainier* will be 50 years old in 2017, while the NOAA Ship *Rueben Lasker* began support of NOAA projects in 2014. Based on industry standards, most ships in the NOAA Fleet were designed with design service lives of 20 to 25 years. NOAA Ships *Oregon II* and *Oscar Elton Sette* are estimated to reach the end of design service life by 2022, NOAA Ships *Hi'ialakai, Gordon Gunter, Okeanos Explorer,* and *Fairweather* by 2024, and NOAA Ships *Thomas Jefferson* and *Rainier* by 2028.

NOAA is doing a material condition assessment on all its vessels to determine if the steel used to construct the ship has been flexed and stressed beyond its safe structural life and what structural and systems maintenance investments are needed to continue operating the ship. The analysis will assess all the major components of the ship including its keel, frames, and hull sheathing to determine the remaining structural strength in the vessel.

[47] Additional detail can be found in Appendix D.

Without a major recapitalization effort, NOAA will lose an additional eight vessels in the next 12 years as they reach the end of their design service life. That loss of *capacity* as shown in Table 4-2 will have a significant impact on NOAA's ability to conduct its at-sea activities. By 2028, the NOAA Fleet capacity will be reduced by nearly 50 percent with the most significant reduction in the Navigation, Observation, and Positioning (-76 percent); Protected Resources Science and Management (-65 percent); and Habitat, Conservation, and Restoration (-56 percent) activities.

		At-Sea Capacity	NOAA At-Sea Capacity (DAS) 2017 – 2028			
			2017	**2022**	**2024**	**2028**
		Number of Ships	**16**	**14**	**10**	**8**
		Totals	**3,096**	**2,707**	**2,000**	**1,668**
Missions & At-Sea Activities	**Charting & Surveying**	Navigation, Observations & Positioning	630	630	453	150
		Coastal Science & Assessment	115	115	115	95
	Assessment & Management of Living Marine Resources	Protected Resources, Science & Management	299	168	94	94
		Fisheries Science & Management	962	763	687	687
		Habitat Conservation & Restoration	598	573	252	252
	Oceanographic Monitoring, Research & Modeling	Climate Research	248	228	218	218
		Weather & Air Chemistry	3	3	1	1
		Ocean, Coastal & Great Lakes Research	97	97	83	83
	Emergency Response	Various	As required	As required	As required	As required
	Mission Support[48]	OMAO Mission Support	144	130	97	88

Table 4-2: Loss of NOAA At-Sea Capacity Days at Sea 2017 to 2028

Impact of Loss of At-Sea Capability and Capacity

The loss of *capability* resulting from the eight ships reaching the end of their design service life will be distributed unevenly across mission, at-sea activity, and geographic region as shown in Table 4-3. This illustrative distribution is based on the current allocation of vessels to mission and region. Actual impacts could change depending on geographic and mission allocation decisions made in the future.

Nearly 90 percent of the 64 distinct mission-geographic impact areas will be significantly impacted by 2028. Charting and surveying will be the most detrimentally impacted mission; NOAA's ability to collect

48 Mission support DAS include days for maintenance transit, ship equipment calibrations, sea trials, gear trials, underway Fleet Inspections, patch calibration tests for multi-beam systems, training, and unmanned System testing/ projects

hydrographic data required to update nautical charts used by all maritime sectors for safe navigation will be devastated. Additionally, this loss will severely damage NOAA's ability to map benthic habitat, one of the critical drivers for accurate fishery stock assessments, habitat preservation, assessment of resources in the U.S. EEZ, and exploration. The complete loss of capability in the Pacific Islands and Tropical Pacific will negatively impact fisheries science and management; habitat conservation and restoration activities; and oceanographic and climate research and modeling. The losses cannot be readily mitigated. Charter options with right capabilities in the required regions are scarce beyond what is already procured by NOAA. The Arctic and Pacific Islands are highly vulnerable regions; the loss of capabilities in these regions will be detrimental to NOAA products and services.

			Regions							
			Northeast	Mid-Atlantic	Southeast Atlantic	Gulf of Mexico	Tropical Atlantic & Caribbean	West Coast	Alaska & Western Arctic	Pacific Islands & Tropical Pacific
Mission & At-Sea Activities	Charting & Surveying	Navigation, Observations & Positioning	🟠	🟠	🟠	🟠	🟢	🔴	🔴	🔴
		Coastal Science & Assessment	🟡	🟡	🟡	🟡	🟡	🟡	🔴	🔴
	Assessment and Management of Living Marine Resources	Protected Resources, Science & Management	🟡	🟡	🟡	🔴	🔴	🟢	🟢	🔴
		Fisheries Science & Management	🟡	🟢	🟡	🟠	🟢	🟢	🟢	🔴
		Habitat Conservation & Restoration	🟡	🟡	🟡	🟡	🟡	🟢	🟠	🔴
	Oceanographic & Modeling Monitoring, Research	Climate Research	🟡	🟠	🟡	🟡	🟡	🟡	🟠	🟠
		Weather & Air Chemistry	🟡	🟠	🟡	🟡	🟡	🟡	🟠	🟠
		Ocean, Coastal and GL Research	🟡	🟠	🟡	🟡	🟡	🟡	🟠	🟠

Table 4-3: Lost At-Sea Capability by 2028[49]

🔴 = 90 – 100% capability loss

🟠 = 60 – 89% capability loss

🟡 = 59 – 30% capability loss

🟢 = 0 – 29% capability loss

[49] Detail on which ships are impacted is provided in Appendix E.

Impact on Charting and Surveying

NOAA collects hydrographic data and produces nautical charts for safe and efficient navigation, critical for the $1.9 trillion in marine commerce.[50] NOAA currently has four vessels with the primary task of charting and surveying. By 2028, NOAA will lose the capabilities provided by three of these ships (NOAA Ships *Fairweather*, *Thomas Jefferson,* and *Rainier*) resulting in 92 percent reduction in NOAA's charting and surveying capacity. This disproportionate loss is because these three vessels carry 14 survey launches that serve as force multipliers, especially critical in remote areas.

- The retirement of two high-endurance, hydrographic NOAA Ships, *Rainie*r and *Fairweather*, will result in the loss of 100 percent of NOAA's mapping capabilities in the Pacific and Arctic Oceans and the Bering Sea. This loss will limit NOAA's ability to survey the Arctic when currently only 1.4 percent of the Arctic is surveyed to modern standards. When compounded by the significant increase in size and quantity of commercial and tourism ships, the ships' retirement exacerbates the potential for ship groundings, and, therefore, economic and environmental impacts. The Exxon Valdez accident showed that oneship grounding can significantly impact vital Arctic economies, including the $8-billion annual seafood industry and $4-billion tourism industry, for years to come.[51] The ships' retirement will also significantly delay or prohibit opening ports following natural disasters (hurricanes, tsunamis), and/or terrorist acts impeding safe and efficient navigation and increasing the cost of consumer goods at particularly critical times.

- The retirement of the NOAA Ship *Thomas Jefferson* will result in a 75 percent loss of hydrographic survey capability on the U.S. East and Gulf Coasts and in the Caribbean. NOAA will be unable to survey out to the edge of the continental shelf or conduct harbor and approach surveys from Maine to the Caribbean and Mexican borders. Additionally, the nation will lose mapping of natural resources in the Exclusive Economic Zone, a 4.3 million square mile area. In the event of a hurricane landfall on the Eastern Seaboard or in the Gulf of Mexico, there will be a very limited ability and significant delay in clearing major ports including Houston, the ports of Southern Louisiana, Miami, Hampton Roads, and New York.

- Bathymetry information from NOAA hydrographic surveys provides critical information for models that forecast storm surge and detect tsunamis. Outdated or non-existent data can result in under-predicting the effects of these natural disasters. Storm surge is the greatest threat to life and property from a hurricane. With 83 percent of the U.S. population residing in coastal areas, and 83 percent of the U.S. GDP, accurate storm surge forecasts are vital to the nation. During Hurricane Katrina 1,500 people lost their lives and there were $300 billion in damages. Bathymetric surveys also improve fishery stock assessment models, which result in increased catch limits and economic benefits specifically to Alaska's large commercial fishing industry. Just one year of lost data collection will result in a $40 million loss (10 percent) in fishing revenue for the pollock fishery.

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[50] FY 2017 Congressional Budget Justification, pg. 720.

[51] Fisheries Economics of the United States 2014: Economics and Sociocultural Status and Trends Series. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Memorandum NMFS-F/SPO-163. May 2016.

The loss of ship hydrographic capability will also detrimentally impact NOAA hydrographic expertise. Building, maintaining, and fostering hydrographic expertise is a primary concern of the Hydrographic Services Review Panel (HSRP) - a NOAA Federal Advisory Committee - and was identified in its *2010 Most Wanted Hydrographic Services Improvements* report:

> The HSRP believes it is in the best interest of the Nation for NOAA to maintain and build on its core competencies in hydrographic surveying in order to protect valuable coastal resources and promote safe maritime commerce. The Nation looks to NOAA for its expertise in hydrography – through hands-on experience aboard NOAA ships, providing educational opportunities to advance careers, and establishing a lifetime career path with set goals and milestones. NOAA must build a seasoned staff of dedicated hydrographers competent to not only conduct surveys and analyze tides, but also to provide oversight of contract surveys, evaluate new equipment, and provide national and international leadership. In the HSRP's view, maintaining NOAA's core hydrographic competency necessarily includes a fleet of modern hydrographic survey vessels.

Approximately 50 percent of NOAA Corps officers spend their first sea tour aboard hydrographic vessels. Many technicians who work in the hydrographic industry (including charters) acquire training and experience on NOAA ships. Hands-on experience provided aboard NOAA ships builds a seasoned staff of hydrographers competent not only to conduct surveys, but also to provide oversight of contract surveys, evaluate new equipment, assist and advise in ocean mapping projects across NOAA, and provide international leadership. These ships are the only platforms NOAA, and largely industry, has to train personnel, build expertise, and test new technologies for efficiency and capacity gains.

For Alaska in particular, the capability of new ships will be critical in addressing the significant charting requirements and supporting the state's maritime commerce. The dependence of Alaska tourism on cruise ships has increased significantly in recent years; in 2014 more than 50 percent of visitors to Alaska came via cruise ship. This same year, 2014, Alaska surpassed Las Vegas as the top visitor destination. This increase is due to increased cruise ship size rather than number of ships; these larger ships depend on nautical charts of Alaska for safe navigation. Only 1.4 percent of nautical charts in Alaska are surveyed to modern standards. A loss of 17 percent in cruise passengers results in an annual $165-million loss in revenues and 1,800 full-time jobs.[52] Compounding the increased size of ships with the relatively shallow areas, active tectonic region, decreasing Arctic ice coverage, and subsequent expected growth in commercial traffic create significant risks of environmental damage and economic loss. New ships are critical for NOAA hydrographers to update charts in Alaska, including areas in the upper Bering Sea and Arctic Slope; areas for which full-bottom coverage bathymetric data for nautical charts is nonexistent.

Hydrographic ships also test new technologies for efficiency and capacity gains. NOAA has been working with industry to develop new sonars like the Klein 5000 high speed - high-resolution side scan sonar, advanced seafloor detection algorithms in use by sonar manufacturers around the world, and advanced methods for dealing with high resolution bathymetric data. New techniques are routinely tested aboard NOAA platforms before their use by contract surveyors. This saves contractors time and money.

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[52] Alaska State Legislature. House Special Committee on Economic Development, International Trade and Tourism. March 9, 2010. 26th Legislature (2009-2010). Mr. Fred Reeder, Member, Alaska Alliance for Cruise Travel (AlaskaACT); Port Manager, Cruise Line Agencies of Alaska.

Impact on Assessment and Management of Living Marine Resources

The loss of capability from the retirement of the NOAA Ships *Hi'ialakai*, *Oscar Elton Sette, Oregon II,* and *Gordon Gunter* will directly impact the nation's $200-billion fishing industry.[53] The loss of these ships will result in the elimination of nearly all of NOAA's ability to conduct its assessment and management of living marine resources and charting and surveying missions across most of the Pacific U.S. Exclusive Economic Zone – including an ever increasing number of protected sanctuaries and marine monuments that span for thousands of miles across the Pacific Ocean. This will place at risk U.S. economic resources in an area that is seeing increasing illegal, unreported, and unregulated fishing by actors who have little or no regard for international maritime laws and no respect for the U.S. EEZ.

As these NOAA ships come off-line, there will be significant unmet requirements for non-trawl stock assessments, marine mammal management, and monument and sanctuary stewardship in the Central, Southern, and Western Pacific, and trawl-based stock assessments in the Gulf of Mexico. Without capability replacement, 66 percent of fishery stock assessment capabilities in the Gulf of Mexico and 50 percent of non-trawl stock assessments and marine debris recovery in the Western Pacific will be lost by 2023 with a significant increase in unmet stock assessments in the Central, Southern, and Western Pacific, and Gulf of Mexico are expected by 2028. This lack of fishery stock assessment data will impact commercial and recreational fishing quotas, placing adverse economic impacts on communities and industries that rely on annual fish landings. Specifically, the $101-million commercial fishery in Hawaii and $1-billion commercial fishery in the Gulf of Mexico, as well as the downstream commerce that depends on them, will be detrimentally impacted by the loss of NOAA ships.[54] A lack of fishery data will result in more conservative stock quotas and lost revenue for the fisheries and coastal economies that depend on them for their livelihood. Skipping one season of at-sea surveys by NOAA ships would require a reduction in quota of up to 10 percent, a loss of $40 million just for the pollock fishery, in a single year. Loss of sea time and subsequent reduced quotas in the Gulf of Mexico would impact the more than 3 million recreational anglers who average 23 million fishing trips per year and support coastal economies that rely on the tourism.[55]

Monitoring the health of coral reefs is also important for the health of the ocean's ecosystems. NOAA, as a steward of the oceans resources, protects the biodiversity of coral reefs and informs local officials on the best management practices to ensure that the reefs remain healthy and productive for economic, recreational, and cultural use. The $100-million commercial value of U.S. fisheries from coral reefs and billions of dollars to local economies through diving, recreational fishing, hotels, and restaurants will be detrimentally impacted if time series data collected by NOAA ships to assess reef health is not preserved.[56]

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[53] FY 2017 Congressional Budget Justification, pg. NMFS-85.
[54] Fisheries Economics of the United States 2014: Economics and Sociocultural Status and Trends Series. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Memorandum NMFS-F/SPO-163. May 2016.
[55] Fisheries Economics of the United States 2014: Economics and Sociocultural Status and Trends Series. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Memorandum NMFS-F/SPO-163. May 2016.
[56] "How Do Coral Reefs Benefit the Economy". National Oceanic and Atmospheric Administration (NOAA), National Ocean Service. Retrieved from http://oceanservice.noaa.gov/facts/coral_economy.html.

Impact on Oceanographic Monitoring, Research, and Modeling

Approximately 163 million Americans live near the coast and approximately 89 million people vacation on the coasts every year.[57] Growing coastal populations and competition for marine space and resources heavily stress ocean, coastal, and Great Lakes resources. Travel and tourism are estimated to provide $746 billion to the U.S. domestic product, the second largest contributor to GDP just behind combined wholesale and retail trade.[58] Of this, approximately 180 million people visit the coast for recreation, and 85 percent of tourist-related revenues are generated by coastal states. Further, America's coastal communities and shorelines face increasingly frequent and intense extreme weather events, causing dangerous conditions and dramatic economic losses. Increasing population density along the coast puts more people in the path of coastal storms. These challenges convey a common message: human health, prosperity, and wellbeing depend upon the health and resilience of coastal ecosystems. Managing this interdependence requires timely and usable information to make decisions. NOAA's ships collect data integral to addressing many of the challenges facing the ocean, coasts, and Great Lakes and preserving the economic prosperity in these regions.

With the loss of capabilities on the NOAA Ships *Oscar Elton Sette*, *Hi'ialikai,* and *Okeanos Explorer*, NOAA will lose its ability to conduct research and advance modeling. These at-sea activities:

- offer insights into climate variability and marine ecosystems;
- reveal new or unconventional energy, mineral, biological, and archaeological resources;
- provide information on harmful alga blooms, dead zones, and invasive species in Lake Erie;
- identify hazards resulting from extreme events, such as submarine volcanic eruptions, earthquakes, and tsunamis;
- deliver technology advancements that increase observational capabilities in the ocean; and
- improve weather forecasting models and the predictions of the onset, duration, and impact of significant weather and water events.

NOAA requires the capability to deploy buoys and conduct associated calibrations, validations and in-situ observations that provide critical data for climate forecast models. Climate forecasts have wide-ranging impacts from hurricane activity to productivity of fishing grounds off of South America's Pacific Coast. The success of the $985-billion agriculture industry, nearly 5 percent of the U.S. GDP, depends on accurate forecasts for planting, irrigation, and harvesting.[59] These agriculture decisions are informed by NOAA's forecasts, driven by models that receive air and water observation data from buoys serviced by NOAA ships. In addition to the direct economic benefit, maintaining and servicing the buoys protects NOAA's investment not only in this substantial ocean observation network, but also NOAA's satellites. Data collected by satellites are validated with in-situ data collected by NOAA buoys – ensuring that the satellites are providing accurate data and any errors are accounted for in climate models. With the

[57] NOAA's 2013 State of the Coast Report: National Coastal Population Report, U.S. Commission on Ocean Policy: An Ocean Blueprint, 2004.

[58] Cicin-Sain, B., R.W. Knecht. Trends and Future Challenges for U.S. National Ocean and Coastal Policy. August 1999. DIANE Publishing. Pg. 73.

[59] "Value Added to GDP by Agriculture and Related Industries, 2007-2014." U.S. Department of Agriculture, Economic Research Service using data from U.S. Department of Commerce, Bureau of Economic Analysis, Value Added by industry series. Retrieved from http://www.ers.usda.gov/data-products/chart-gallery/detail.aspx?chartId=40037.

compounded loss of the previous ships, NOAA currently retains limited ability both to deploy buoys and to conduct calibrations and validations and collect in-situ observations for vital buoy arrays. The inability to properly maintain buoy arrays, collect in-situ data, maintain continuity in critical time-series data, and perform calibration and validations diminishes data accuracy. This directly impacts the quality of products and services, such as weather and hydrological forecasts, which the American public depend on for daily activities, emergency planning, and their livelihoods. Weather data in a critical part of NOAA's environmental intelligence mission as it pertains to long term climate records and accurate observations into the future.

V. Long-Term Recapitalization Strategies and Fleet Management Best Practices for Maintaining NOAA's At-Sea Capabilities

Previous sections of this plan detailed NOAA's required missions and at-sea activities, related ship capabilities, and the DAS requested for delivery of NOAA's products and services. As discussed in Section III, by 2028 the design service lives of eight ships in the NOAA Fleet are projected to end and the associated at-sea capacity and capabilities lost if additional capital investments are not made.[60] *The FY 2010 to FY 2024 NOAA Ship Recapitalization Plan* included a detailed analysis of alternatives for maintaining the at-sea capabilities provided by ten of NOAA's ships that were nearing the end of predicted design by FY 2024. Six of the ships included in that analysis (NOAA Ships *Oregon II, Rainier, Hi'ialakai, Oscar Elton Sette, Gordon Gunter,* and *Fairweather*) are addressed in this recapitalization plan. NOAA Ship *Okeanos Explorer* is scheduled to reach the end of its design service life by 2024, and NOAA Ship *Thomas Jefferson* is scheduled to reach the end of its design service life by 2028. Both are also included in this recapitalization plan.

There are long-term strategies and fleet management best practices that can mitigate the impending loss of these capabilities and ultimately preserve NOAA's at-sea capabilities including: (1) design and construction of new ships, (2) extending the design service life of existing ships, (3) increased utilization of the NOAA Fleet, (4) integration of emerging technologies, (5) increased use of charters, and (6) utilization of small boats, to supplement the NOAA Fleet. This section addresses near-term strategies to address the loss of capabilities over the next 11 years, and longer-term economically efficient options for recapitalization. An overview of each strategy is provided below.

Strategy 1: Design and Construct New Ships

Construction of new ships is the best long-term strategy for sustaining NOAA's ability to provide the at-sea data essential to meet its legally mandated responsibilities. This finding was initially substantiated in the analysis of alternatives done for *The FY 2010 to FY 2024 NOAA Ship Recapitalization Plan*. This allows ships to be specifically designed to meet NOAA requirements, to take advantage of available and emerging technology and to meet environmental regulations (coastal, monument, polar code compliance, and state regulations). Construction of new ships will provide the best capabilities to meet NOAA's at-sea requirements and allow NOAA to retain a core capability in each mission area.

The outdated designs of many of NOAA's ships compromise NOAA's commitment to crew safety and environmental stewardship. Older ships meet the berthing requirement for their crews by placing staterooms below the waterline. New shipbuilding requirements place all shipboard berthing above the waterline to increase the likelihood that crew members can safely escape in the case of an emergency. Older ships were also designed so that the majority of their tank volume is reserved for fuel with limited capacity to carry waste water produced on board (grey water, black water and oily bilge water). Current discharge requirements are significantly more stringent requiring discharge of wastewater and production of potable water in offshore areas. These requirements limit the amount of time most ships in the fleet can operate in near-shore areas, often requiring frequent breaks (every two to three days for many vessels) in operations and transit to offshore areas. This limitation applies in coastal areas, national marine monument areas, and the Arctic. New ship designs provide tank capacity that allows

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[60] Shown in Figure 4.1

NOAA to "pack out what it carries in" and set the standard for marine stewardship without breaks in operations. Oceanographic at-sea capabilities require government-controlled and certified high endurance ships that have the range, endurance, berthing capacity, and holding tank capacity to operate for long periods in protected areas without doing harm to these protected areas - capabilities not available from charter vessels.

While there are eight ships scheduled for retirement in the next twelve years, NOAA's analysis indicates the best option for replacing capacity first lies in the design and construction of two NOAA general purpose oceanographic vessels, NOAA Vessel (N/V) Class A. N/V Class A should be designed to focus on requirements for oceanographic monitoring, research and modeling, with secondary capabilities for assessment and management of living marine resources (all capabilities except trawling) and charting and surveying to include benthic habitat, and water column geospatial products.

The first two ships built would eliminate the capability and capacity gaps resulting from the estimated end-of-service life for NOAA Ships *Oscar Elton Sette* and *Hi'ialakai.* The NOAA Ship *Hi'ialakai* is a multi-mission platform that meets requirements from across NOAA. It is the only vessel in the region with a multi-beam system critical for mapping fishery and protected species habitats. Due to its highly specialized and capable scuba diving operations support, more than 5,000 dives (nearly half of all NOAA dives) were conducted from the vessel in FY 2015, which provided critical data for coral reef mapping, coral reef health, and fish stock studies and maritime heritage sites. In addition, the NOAA Ship *Hi'ialakai* supports time series mooring operations critical for short and long range weather and climate forecasts, as well as autonomous underwater vehicle (AUV) operations. The NOAA Ship *Oscar Elton Sette* conducts extensive marine debris removal in the Pacific, removing tens of thousands of pounds of debris per year, preserving the fragile monument habitats and ecosystems. It is the only vessel in the Pacific Islands equipped for species monitoring, and it supports AUV operations in support of protected species management. Maintaining the capabilities to conduct these oceanographic, charting and surveying, and living marine resource activities is critical. The development of this ship class should leverage existing ship specifications with limited modifications unique to NOAA's needs.

The best existing set of ship specifications to leverage is the Navy AGOR,[61] a mono-hull research vessel designed to commercial standards capable of integrated, interdisciplinary, general-purpose, oceanographic research in coastal and deep-ocean areas. The AGOR specification is based on the mission requirements from the Oceanographer of the Navy, Office of Naval Research (ONR) and UNOLS. NOAA can rapidly build two ships that meet a majority of NOAA requirements and capability gaps by leveraging the AGOR requirements and system specifications. Given that the AGOR design is not owned by the U.S. Government, the existing AGOR specifications will be used to solicit for preliminary design bids; the final design will be determined during the acquisition process. In utilizing the AGOR design, NOAA can leverage work done by the Navy (primarily requirements development, analysis, concept design, and acquisition planning) to achieve a reduction in the total procurement costs of approximately $10 million. The normal time for ship acquisition is eight to ten years, from initial planning to vessel delivery. This timeline will be accelerated by utilizing an existing ship specification, source selection approach, and solicitation package developed by the Navy and will take advantage of investments already made by NOAA. Also, by using proven designs, the risk and costs are reduced, compared to developing a new class from basic requirements.

[61] AGOR capabilities matrix provided in Appendix G.

In addition to the acquisition and procurement advantages, the AGOR is the best first step in NOAA fleet recapitalization for its capabilities and ability to meet a majority of NOAA at-sea requirements, especially those that will need capacity support soonest. The AGOR oceanographic data acquisition sensors and processing systems can collect data that feed global climate and weather forecasts. The hull-mounted instrumentation will collect mapping and charting data for critical benthic habitat surveys and ocean floor mapping in support of fishery management and nautical charts. The oceanographic and meteorological sensors can collect data that directly supports validation and calibration of ocean color sensors on satellites. The suite of deck equipment, including winches and A-frames, is essential for servicing weather buoys, equipment in support of marine debris and monument requirements, and non-trawl fishery surveys. The AGOR capabilities align it with the immediate requirements in the Pacific Islands and Western Pacific, where two of the first three NOAA ships are scheduled for retirement and trawling is not an essential capability.

Building two N/V Class A ships based on the AGOR design will quickly restore NOAA fleet capabilities to support those specific activities. Requirements analysis and design of N/V Class B and C vessels should be initiated in year one and initiation of N/V Class D in year eight, to provide capabilities that will be lost with the retirement of NOAA ships and that cannot be met by the N/V Class A vessels. In addition to design and construction of ships with similar or greater capabilities than the current fleet, NOAA should consider utilizing existing commercial design options for ships that are trawl capable, shallow draft, and designed to operate in near-shore areas. Specific programs within NOAA have analyzed available options and identified designs that can meet specific mission requirements. Specific ship capabilities for each design will be evaluated during preliminary design. Mission-driven requirements including ice strengthening and polar code requirements to operate in the Arctic; and near-shore and protected area regulatory requirements will be addressed. Each ship class will be driven by primary and secondary missions and by at-sea activities. Ships within each class will be designed to meet these regulatory requirements.

The NOAA Fleet of the future must be adaptable and extensible to provide the infrastructure and capabilities to evolve with future changes in technology and mission requirements. While it is impossible to predict all future advances in technology or changes in requirements, new ships must provide the infrastructure, (e.g. mission and berthing space), and power and endurance, to maintain adequate capability to support efficient operations, evolving requirements, and increasingly sophisticated technology.

Strategy 2: Extend the Service Life of Existing NOAA Ships

Extending the design service life of ships in the current NOAA Fleet is a confluence of economics, policies, and efficiency. There are three primary levels of maintenance: (1) design service life extensions that allow approximately 15 years of operation beyond the end of design service life, (2) repairs to extend overhauls or replace major systems to provide greater overall reliability and improve the suite of mission equipment, and (3) corrective maintenance that makes the most severely deteriorated major ship systems reliable. The significant amount of downtime required to perform the major repair period maintenance and the capital investment needed must be worth the return on investment for additional design service life, short-term loss of availability, and long-term relevance to efficiently and effectively perform mission requirements. Often, however, the ship cannot be transformed into a relevant high performing platform, even with significant capital investment.

Policies also play a major factor in deciding the relevance of design service life extensions. Most notably, current environmental regulations and policies are dramatically different than those in effect when ships were built in the 1960s, 1970s, and even the 1980s and 1990s. Ships older than ten years do not have the holding capacities for wastewater, sewage, and potable water to meet coastal water environmental regulations. For example, the National Pollutant Discharge Elimination System (NPDES) enacted in 2009 established more stringent controls on discharge pollutants and significantly affected how ships operate within three nautical miles of shore. As a result, ships operating in coastal or protected areas must break operations every two to four days to transit from the working ground to perform these necessary services. The requirement for a significant increase in holding capacity and double-hull tanks cannot be easily remedied structurally even with funding; and most of the ships in the current NOAA Fleet do not have capacity for the alterations without reducing endurance. Similarly there is also an emerging consensus that additional requirements are necessary for ships operating in an Arctic environment. Implementing these standards on existing ships is not feasible from a design or cost perspective. From an efficiency standpoint, the cost of installing new data collection and ship infrastructure technologies is often not feasible. For example, the lack of machinery control system automation will cost approximately $10 million to design and implement on eight ships. Additionally, many of the older vessels are limited in their ability to integrate data collection technology, including unmanned systems and updated instrumentation.

Extending the design life of a vessel has limitations in that it only addresses select ship infrastructure and instrumentation components. It is not all-inclusive. As a result, several of the mechanical systems, instrumentation suites, and infrastructure will not be updated. The remaining original systems will likely require significant maintenance to continue to be operational. The failure of any one system can result in the ship undergoing unscheduled maintenance. For example, NOAA Ship *Thomas Jefferson* has undergone one of three scheduled phases of a design service life extension during FY 2016. This work included major system upgrades including conversion of fuel tanks to tanks for potable water, greywater, and sewage to increase operational duration in coastal waters; mapping instrumentation suite upgrade; and navigation suite upgrade. Major system upgrades planned for FY 2017 include replacement of the heating, ventilation and air condition (HVAC) system, replacement of the sanitary and potable water piping system, and ship space configuration. Even with the planned work in FY 2017, a long list of necessary upgrades, such as the mechanical control system, remain. It is critical to recognize that design service life extensions require a significant investment of time and money; the return on investment is contingent on the weakest system in the ship; and even an older ship that is updated will be limited in efficiency and technological relevance to perform the mission.

The FY 2010 to FY 2024 NOAA Ship Recapitalization Plan performed an economic analysis, including the net present value (NPV) calculation, for replacing the capability of six of the eight ships (NOAA Ships *Oregon II, Rainier, Hi'ialakai, Oscar Elton Sette, Gordon Gunter,* and *Fairweather*) addressed in this recapitalization plan. The economic analysis included costs estimates to extend the design service lives of existing ships. In all cases, extending the service life of these six ships was not the most cost effective option. NOAA is currently performing material condition assessment surveys on all ships by the American Bureau of Shipping (ABS). The results of these surveys will supplement existing condition assessment information. The data from the surveys will drive future maintenance investments including design service life extensions, repairs and corrective maintenance. Based on the results of the material condition assessments, known gaps resulting from the loss of current capabilities as ship retire and in service dates of new ships should be included in the analysis of allocating available service life funding.

Strategy 3: Increase NOAA Fleet Utilization

Analysis indicates that full utilization of the NOAA Fleet could provide approximately 1,000 more DAS (to the average executed FY 2014 - FY 2015) for a total of 3676 annual DAS, nearly 235 DAS for 14 of 16 NOAA ships. This number was derived from the following analysis: each ship requires 70 days for an annual repair period (ARP) and 14 days for a mid-season repair period (MRP); 16 crew rest days are required; and 30 staging days are required for projects. Additionally, two of the 16 ships need extended ARPs to complete more robust design service life extension and installation of emerging technologies, which expand vessel productivity. This calculation accounts for an annual maximum fleet utilization of 3,676 DAS.

Successful completion of these additional DAS is contingent on several factors. First, the supplemental maintenance days and costs only account for scheduled maintenance; there is a significant risk of additional unscheduled maintenance based on the age of the older ships and the complexity of the newer ships. Added scheduled and unscheduled maintenance would require additional contracting actions, stressing a system that is already straining to meet current maintenance requirements. Second, these additional DAS are contingent on the scientific programs' needs for scientific personnel travel and other logistical requirements. Third, successful completion is contingent on the sustained availability of qualified crewmembers; ship staffing is very dynamic due to industry competition, specialization of personnel, and arduous duty associated with extended time at-sea. Considering these factors, the most practical way to increase the current utilization rate to the fleet maximum of 3,676 based is a phased approach, scalable across three years (one third of the total increase in each year). This strategy increases the immediate capacity of each vessel, but is only a short-term strategy for older vessels.

Strategy 4: Integrate New Technology

Any discussion of the future NOAA Fleet must consider the implementation of relevant data collection technologies and ship infrastructure advancements that can serve as force multipliers, increasing the efficiency and effectiveness of at-sea time.

Data collection technology includes instrumentation, sensors, and unmanned systems. The primary benefit from incorporating data collection technology into ships will be the increased quality and quantity of products and services that the agency can provide. An oft-proposed suggestion is to reduce capital costs while maintaining data collection capacity through the incorporation of technology. It is a fallacy, however, to assume that technology can replace ships. Ships are needed to transport data collection sensors to wherever they are needed at sea.

Advancements in ship infrastructure include mechanical automation systems, system efficiencies, and telepresence. NOAA has been implementing "green" initiatives into the current fleet where possible but large efficiency gains are limited by current ship mechanical systems. Significant capital investments are necessary to leverage available technologies. Implementation of available infrastructure advancements such as mechanical control systems provide system automation that improves efficiency and fuel consumption, frees engineers to perform maintenance rather than watch gauges, improves safety with repeatable displays, and creates standardization throughout the fleet. Implementing telepresence throughout the fleet could serve as a force multiplier by increasing data access and real-time interaction by scientists from multiple disciplines.

NOAA has successfully implemented new technologies on older ships to maintain efficient operations and to improve vessel effectiveness. For example, the NOAA Ship *Fairweather* recently completed a project using a sensor developed by NOAA and industry that collects mapping data in the Bering Sea vital for mapping benthic habitat in support of fishery stock assessments, while traditional hydrographic mapping missions are conducted. NOAA Ship *Thomas Jefferson* integrated an upgraded instrumentation suite during the FY 2016 maintenance period that will collect data for multi-spectral mapping of benthic habitat vital for stock assessments and ocean exploration during traditional hydrographic mapping missions.

Technology integration is critical for both near-term mitigation and long-term recapitalization of the NOAA Fleet. New technology will continue to play a critical role in shaping the capability and capacity of the future of the NOAA Fleet, but regardless of the technology, the end result requires continued support from NOAA's ships.

Strategy 5: Increase Use of Charters

Charters or contract vessels and shared time on partner platforms are and will continue to be an essential component of cost-effectively executing NOAA's at-sea activities and for building strong partnerships with institutions and stakeholders. Approximately 40 percent of the total DAS executed in recent years have been aboard charter vessels, providing a highly successful supplement to the NOAA fleet. For example, NOAA charters commercial fishing vessels to conduct cooperative research and fishery surveys and the National Data Buoy Center charters large, high-range, high-endurance (more than 30 days) ships with open decks to deploy and maintain its buoys throughout the South Pacific region. NOAA also contracts for hydrographic data — 1,221 nautical square miles in FY 2015, the approximate equivalent of 610 DAS. Although data buys differ from charters in that NOAA experts do not conduct the missions, they typically require strict adherence to NOAA specifications.

NOAA's demand for charter vessels is increasing in parallel with increasing requirements to conduct at-sea science. Advantages include lower costs for some missions, particularly when smaller vessels can be used, and reduced transit time when charters are based near the work site. Increasing use of charters poses challenges such as availability at a specific time and place, compatibility with NOAA missions, and required in situ response in support of the Federal Emergency Management Agency (FEMA) and U.S. Coast Guard Captains of the Port to national emergencies such and Hurricane Sandy and Deepwater Horizon. NOAA's nimbleness to pre-position survey ships prior to the passage of Hurricane Matthew enabled rapid response to survey and clear the ports of Savannah, Charleston, and Brunswick. There are also mission priorities to balance such as testing emerging technologies. For example, if charter collected all hydrographic data, NOAA's effectiveness would be diminished by lost expertise to certify data quality in a rapidly changing discipline.

On balance, charters provide a crucial capacity to mitigate the risks posed by an aging fleet and NOAA's finite capacity to deploy at-sea science. Maintaining a solid ability to effectively charter is good management for NOAA mission accomplishment and will remain a valuable avenue for meeting certain NOAA requirements. NOAA's use of charters may increase in the short-run, particularly to help close emerging gaps in capacity of the NOAA Fleet as ships reach the end of their design service life. NOAA will promote efficiencies in chartering through greater coordination of charter requirements, requests, and metrics.

Strategy 6: Expand Partnerships

In addition to charters, NOAA leverages domestic and international partnerships for sea time. For example, NOAA and the National Science Foundation conducted a no-cost exchange of ship time aboard equivalent ships for science missions in the South Pacific this year.

The Federal Oceanographic Fleet coordinates closely to maximize utilization of all federal vessels to meet at-sea data requirements across federal and academic sectors and leverage best practices through several venues. Through the Interagency Working Group on Facilities and Infrastructure (IWG-FI) federal agencies that own and operate vessels meet regularly and work together closely to advise the Subcommittee on Ocean Science and Technology (SOST) on the best policies, procedures and plans relating to oceanographic facility use, upgrades, and investments. NOAA leverages ship time on the UNOLS fleet to the extent possible through participation in the University- National Oceanographic Laboratory Systems (UNOLS) scheduling meetings and process NOAA. And through collaboration with the USCG, NOAA seeks opportunities to leverage ship time and capabilities. International collaboration is leveraged through meetings, such as the annual International Research Ship Operators' meeting, where owners and operators share best practices and identify ways to increase collaboration and partnerships. In addition, through scientific meetings and agreements, such as the Galway Statement on Atlantic Ocean Cooperation, NOAA works to continue building opportunities for data and asset sharing across the international community.

While NOAA will continue work to maximize partnerships, NOAA's need to assure the continuity of at-sea missions to support national priorities requires a core in-house capability met only by a fleet of ships built and outfitted for NOAA requirements.

Strategy 7: Utilize NOAA Small Boats

NOAA owns and operates more than 400 small boats, ranging in size from 10-foot kayaks to more complex small research vessels (SRV), ranging from 65 feet to 95 feet length over all (LOA). NOAA defines "small" boats as those with less than 300 gross registered tons displacement. These boats are owned and operated by NOAA's program offices. The Office of Marine and Aviation Operations provides administrative oversight, engineering support, operator training, and inspection services to ensure that small boats are safely maintained and operated. The overwhelming majority (more than 95 percent) of NOAA's small boats are less than 40 feet in length, similar in capability to commercially available recreational boats. They are typically used for basic mission requirements in near-shore waters requiring low endurance, day-long operations.

NOAA small boats do not support a significant near-term mitigation or long-term recapitalization strategy. SRV capabilities meet only a small percentage of requirements of the programs requesting time on the NOAA Fleet due to their limited instrumentation, endurance, range, and berthing. Small boats are used for very specific program purposes due to capability and geographic limitations. There are instances where small boats are used to meet some data requirements; however the NOAA at-sea requirements captured in this report represent capability requirements beyond those that can be met with the majority of NOAA's small boats. For the limited number of small boats that perform extended missions in deep water environments, it is often in locations where no NOAA ships are available (e.g. the *Laurentian* in the Great Lakes), are a lower cost alternative for advanced technology testing and development activities (e.g. the *Bay Hydrographer II, Sand Tiger*) or conduct projects that do not have heavy-duty gear or sampling equipment requirements (e.g. *Gloria Michelle, Southern Journey*).

It is important to acknowledge the role that small boats play in meeting NOAA requirements. In support of increasing efficiencies, NOAA will continually assess the use of smaller, more cost-effective vessels for its missions and take a more focused study to analyze the interface between small boat capabilities and at-sea data requirements.

Strategy Assessment Summary

Based on the dates current ships will be retired and the proposed acquisition schedule, there are three geographic regions and mission areas that will require targeted mitigation:

- Nearly two-year reduction of capability in the Gulf of Mexico for Assessment and Management of Living Marine Resources activities resulting from the retirement of the NOAA Ship *Oregon II* in 2021 and in-service date of the first N/V Class C in 2023

- Two-year reduction of capability in Alaska, the Western Arctic, and Pacific for Charting and Surveying, and Assessment and Management of Living Marine Resources activities resulting from the retirement of NOAA Ship *Fairweather* in 2023 and in service date of the first N/V Class B in 2025

- Reduction in capabilities in the Atlantic and Gulf of Mexico for Assessment and Management of Living Marine Resources, and Oceanographic Monitoring, Research, and Modeling resulting from the retirement of NOAA Ship *Gordon Gunter* in 2023 and in service date of the second N/V Class C in 2025 and in service date of the first N/V Class D in 2029

The following mitigations will address the significant gaps highlighted above:

Gulf of Mexico and Atlantic, Assessment and Management of Living Marine Resources:

- Increase utilization of the NOAA Ships *Pisces* and *Gordon Gunter*
- Prioritize service life extension funding for the NOAA Ships *Oregon II* and *Gordon Gunter* based on material condition assessments
- Increase use of charters between 2021 and 2025 to perform highest priority missions
- Pursue additional partnerships to collect data
- Utilize NOAA small research vessels to meet near-shore requirements, where possible

Alaska, Western Arctic, and Pacific, Assessment and Management of Living Marine Resources:

- Prioritize service life extension maintenance funding for the NOAA Ship *Fairweather* based on material condition assessment
- Implement emerging technologies where possible on the NOAA Ship *Rainier* to serve as force multipliers
- Increase use of charters between 2023 and 2025 to perform highest priority missions

Alaska, Western Arctic, and Pacific, Charting and Surveying:

- Prioritize service life extension maintenance funding for the NOAA Ship *Fairweather* based on material condition assessment

- Implement emerging technologies where possible on the NOAA Ship *Rainier* to serve as force multipliers

Atlantic and Gulf of Mexico, Oceanographic Monitoring, Research and Modeling:

- Increase utilization of the NOAA Ships *Ronald H. Brown*, *Nancy Foster* and *Okeanos Explorer*
- Pursue additional partnerships to collect data
- Seek opportunities for piggyback projects to collect discreet data sets on other NOAA ships

VI. Conclusion

NOAA ships face challenges similar to other observational infrastructure – expanding mission requirements, age and obsolescence, and finite resources for recapitalization. Between 2017 and 2028, eight of NOAA's 16 ships will exceed their design service life, and all eight are expected to be retired by 2028. This loss of capability will have a significant impact on NOAA's ability to conduct its missions and at-sea activities; the longer NOAA delays recapitalization efforts, the more significant the impacts will be. The NOAA Fleet Plan is based on current and projected at-sea data requirements and considered previous analysis conducted on fleet recapitalization planning, in-situ ocean observations requirements validation and prioritization, availability of charter assets, and the state of new technology for use in gathering and processing at-sea data.

Construction of new ships is NOAA's best long-term strategy for meeting its mission. To ensure a relevant NOAA Fleet that meets critical at-sea data collection requirements, NOAA will begin design and construction of two vessels [NOAA Vessel (N/V) Class A ships] with the primary mission of oceanographic monitoring, research and modeling, and secondary missions of charting and surveying, and assessment and management of living marine resources. To minimize the long lead time to deliver new ships, NOAA will use the AGOR design specifications to provide the required capabilities for these missions. NOAA will also begin acquisition to meet requirements not met by an N/V Class A vessel including:

- multipurpose charting and surveying vessels [N/V Class B] ;
- near-shore, low endurance, trawl capable living marine resource vessels [N/V Class C] ; and
- multipurpose trawl-capable stock assessment vessels [N/V Class D]

The planning and design phases for these ship capabilities will seek to leverage common hull, machinery, and configurations across vessel designs to gain economies of scale during acquisition, and reduce life cycle and fleet management costs.

The long-term recapitalization strategy combined with specific best management practices for more efficient use of the existing fleet will lessen the impact of losing these eight ships. The recapitalization plan balances all NOAA's ship assets and will:

- replace lost capability with new ships;
- maximize the use of NOAA ships and small boats;
- increase the use of charter ships;
- strengthen partnerships with other agencies of the Federal Oceanographic Fleet; and
- continually develop and integrate emerging technologies

NOAA's ships need to be adaptable and extensible to provide the infrastructure and capabilities necessary to meet mission requirements now and in the future. The NOAA Fleet Plan represents the best comprehensive solution for long-term recapitalization of the NOAA Fleet.

APPENDICES

APPENDIX A
GLOSSARY, TERMS and ACRONYMS

ABS	American Bureau of Shipping
ACL	Annual Catch Limits
AGOR	Auxiliary General Purpose Oceanographic Research Vessel
DAS	Days-at-Sea
DOD	Department of Defense
ECS	Extended Continental Shelf
EEZ	Exclusive Economic Zone
FC	Fleet Council
FSV	Fishery Survey Vessel
FY	Fiscal Year
GIS	Geographical Information System
IRT	Independent Review Team
IUU	Illegal, Unreported, and Unregulated fishing
IWG-FI	Interagency Working Group, Facilities and Infrastructure
LMR	Living Marine Resources
LOA	Length Over All
N/V	NOAA Vessel
NPDES	National Pollutant Discharge Elimination System
NPV	Net Present Value
NSF	National Science Foundation
SRV	Small Research Vessel
TAO	Tropical Atmosphere Ocean
USCG	United States Coast Guard
UNOLS	University-National Oceanographic Laboratory System
VPASS	Vessel Prioritization, Allocation and Scheduling System

APPENDIX B
SHIP CAPABILITIES: PRIMARY and SECONDARY MISSIONS

The following are high-level descriptions of the future NOAA ship types needed to meet priority requirements, make progress on filling unmet priority requirements, and address emerging requirements. Given the diverse portfolio of NOAA program requirements and responsibilities, there is no one vessel type that can meet all NOAA mission requirements. Each type of vessel described below is intended to serve a primary mission and conduct all at-sea activities within that mission, as well as support secondary missions for which it is capable of fulfilling.

N/V Class A: Primary mission is Oceanographic Monitoring, Research, and Modeling; secondary missions are Assessment and Management of Living Marine Resources and Charting and Surveying. This vessel will have the capability to conduct all at-sea data collection activities for Climate Research, Weather and Air Chemistry, and Ocean, Coastal and Great Lakes Research. The ship design will focus on national requirements for collecting oceanographic and ecosystem information and include multiple ship-based sonar systems capable of producing a variety of geospatial products and support operations ranging from the sub-sea and seafloor, the water column, at the surface and atmosphere including passive sensors and instruments that can collect organic and inorganic samples from site-specific discrete locations. Key design requirements include accommodating mooring deployments and recoveries and dive operations, as well as dedicated long-term ROV, UAS and AUV operations. The Class A vessel will have flexible deck configuration (lab vans, launch and recovery systems) to meet emerging requirements.

N/V Class B: Primary mission is Charting and Surveying; secondary missions are Assessment and Management of Living Marine Resources and Oceanographic Monitoring, Research, and Modeling. This vessel will have the capability to conduct all at-sea data collection activities for Charting and Surveying including Navigation and Coastal Science and Assessment. This ship design will focus on national requirements for charting and surveying deep and shallow water areas and producing hydrographic, benthic habitat, and water column geospatial products. Key design requirements include the ability to incorporate multiple ship-based sonar systems, as well as the ability to deploy and recover multiple hydrographic survey launches both manned and unmanned and autonomous, providing force multipliers to expand the spatial extent of the area being surveyed. The design will accommodate ROV, UAS, and AUV operations on a periodic, transient basis.

N/V Class C: Primary mission is Assessment and Management of Living Marine Resources; secondary mission is Charting and Surveying. This vessel will have the capability to conduct near-shore, shallow-draft, limited range, trawl-based at-sea data collection activities for Assessment and Management of Living Marine Resources including Protected Resources, Science and Management, Fisheries Science and Management, and Habitat Conservation and Restoration. This ship will utilize existing commercial design options. This ship design will focus on capabilities for mid and bottom water trawling, with size-appropriate lab and sample sorting spaces and equipment. Based on preliminary vessel design, we propose a flexible design that can be outfitted with other near-shore mission instrumentation.

N/V Class D: Primary mission is Assessment and Management of Living Marine Resources; secondary missions are Charting and Surveying; and Oceanographic Monitoring, Research and Modeling. The vessel will have the capability to conduct all at-sea data collection activities for Assessment and Management of Living Marine Resources and will have significantly longer endurance than the N/V Class C. The ship design will focus on meeting national requirements for developing fishery stock assessment based upon synoptic scale and site-specific trawl surveys. This vessel will include multiple ship-based sonar systems capable of producing a variety of geospatial products, with particular emphasis on fishery stock assessment sonar. Key design requirements include requisite winches, net reels, autotrawl system to provide the ability to tow a variety of bottom, mid-water and surface trawl nets, as well as ample wet lab space and multiple refrigerator/freezers for scientific sample storage. These vessels will require a small boat and man-rated davit for marine mammal and sea turtle studies, in addition to observing stations for scientists. Oceanographic winches to support various scientific underway seawater sampling methods. Deepwater multi-beam sonar with bathymetric processing capability.

SHIP CAPABILITY DESCRIPTIONS

- **Trawl** - commercial size bottom and pelagic trawl nets, gear and sampling systems to meet fisheries survey requirements
- **Multi-beam** - Biomass and Bottom Mapping – a multi-beam sonar of adequate resolution mounted on hull and functioning to collect water column imagery and meet bottom mapping requirements
- **Single Beam** - a single beam echosounder is mounted and functioning on the ship to meet mission needs
- **Moving Vessel Profiler** – deployment system for oceanographic systems that allow for continuous water column profiling (e.g. conductivity, temperature, and depth (CTD) data) while underway
- **Instrumented Work Boats** (over 4, 1-4, none) - instrumented small craft, outfitted with a variety of sensors and deployed from a ship, to allow extension of research to inaccessible near-shore or shoal areas
- **Longline** - capability to implement fishing techniques that uses hundreds or even thousands of baited hooks hanging from a single line set and hauled from ship
- **Extensive Dive Capability** - ship has extensive diving if: (1) dive location is greater than 6 hours from a chamber, and (2) dives are greater than 60 FSW, and (3) there are more than 2 repetitive dives per day, and (4) there are more than 4 consecutive days of diving
- **Mooring Handling Capability** - ship has capability to safely recover and deploy deep-water oceanographic moorings with an experienced crew, appropriate machinery and sufficient deck space
- **Lab Space** (under 500 sq ft, over 500 sq ft, over 1000 sf) - space on ship for scientists to perform science, analyze results, prepare mission equipment
- **Scientific Berthing Space** (under 5 spaces, 5-15 spaces, above 15 spaces) - adequate habitability space for visiting scientists who are working on projects that meet requirements in area
- **Dynamic Positioning System** - a computer controlled propulsion system integrating rudder control and bow/stern thruster systems to allow a vessel to maintain its position in open waters against wind, waves and current
- **Endurance** - the ship currently has the ability to sustain at-sea operations (including food, fuel, etc) for 30 days or more
- **Marine Unmanned Aerial Systems (UAS) Configuration** - ship is presently configured to support UAS operations including appropriate launch and retrieval system, communication support, deck space and crew expertise
- **Autonomous Underwater Vehicle (AUV) Configuration** - ship is presently configured to support AUV operations including appropriate launch and retrieval system, communication support, deck and storage space and crew expertise
- **Remotely Operated Vehicle (ROV) Configuration** - ship is presently configured to support ROV operations including appropriate launch and retrieval system, communication support, deck and storage space and crew expertise; extensive capability supports tandem ROV operations such that one ROV can observe another ROV that is executing scientific mission requirements
- **Communications** - ship is presently configured to support scientific and ship operational data collection and transmission to and from shore, including telepresence
- **Zero Discharge Capability** - based on current holding tank capacities, crew size; capability of over 8,000 gallon holding tank capacity for both black (sewage) and grey (shower, kitchen) water
- **Ice Strengthening** - ice-classed under ABS; enhanced hull structure and plating, in select areas of the ship and increased protection for the rudder, propeller, and other appendages extends research capability into high latitude areas

APPENDIX C
ACQUISITION PHASE DESCRIPTIONS

Requirements Analysis
The overarching purpose of this phase is to collect, review, assess and determine the initial/general requirements for the vessel/class. These activities would guide the primary ship/mission capabilities, concept of operations, program plan, and initial cost estimates. Other elements would include technology assessments, trade off studies and analysis of alternatives. At this stage the focus is in gross terms that drive key parameters such as required power, volume, and cost.

Concept Design:
The purpose of this phase of acquisition is to conduct the necessary technical and engineering analyses to determine the viability of a possible design and further refine requirements/assumptions from the previous phase. A conceptual design of the proposed vessel will be developed to validate if and how the specifications can be accommodated. Acquisition documentation will be developed and meticulously reviewed for accuracy and completeness. These documents must ensure compliance with existing and forthcoming regulations and policies; address the source selection strategy and evaluation requirements for the procurement; and appropriately update risk, cost and other acquisition planning documents.

Preliminary Design:
The purpose of this phase is to support detailed design through a more thorough assessment of technology maturity, technical risk, and budgeting assessment. It is also the phase we solicit and award several contracts for their interpretation/proposed solution to our ship specifications. The evolution provides a number of key benefits: 1) helps to highlight potential misinterpretations of the requirements and mitigate/resolve prior to construction, 2) offers the Government best value options regarding different solutions that comply with the performance characteristics requested, 3) offers the design agents/shipyards the ability to design/incorporate functionality, performance and capability that would help to discriminate their solution over the competition, and 4) provides additional time as well as an opportunity for the design agents/shipyards to think and work through the necessary activities to submit a more precise/competitive cost estimate for ship fabrication/construction. This approach is especially relevant to the design and acquisition of new ship programs where early buy-in by higher authority is needed to prevent costly changes in direction and associated delays later in the program.

Detailed Design & Construction:
A best value down selection process, one of the preliminary design contractors will be awarded the effort to perform a detailed design of the ship and construct it. The Government will ensure all aspects of the performance specification are fulfilled within the time and cost agreed to by contract.

APPENDIX D
SERVICE LIFE HISTORY OF CURRENT NOAA FLEET

estimated remaining service life				age of ship						notes
ship	years remaining	de-commission date	basis of estimate [a]	age	age at de-commission	launched	delivered to others	delivered to NOAA	commissioned to NOAA	descriptions of Progressive Maintenance/Major Repair Periods/Material Condition Assessments
1. ***Oscar Elton Sette***	**6**	**2022**	*PM but no MRP*	**29**	**35**	**1987**	1998[d]	1992	2003	*AC ystem replacement, substanial metal replacement, navigation system upgrades, MCA*
2. ***Oregon II***	**6**	**2022**	*MRPs 1998, 2010 and PM*	**49**	**55**	**1967**	1967[b]	1970	1975	*analysis; air compressors and AC units; dry dock regularly replace hull plating*
3. ***Gordon Gunter***	**8**	**2024**	*2 conversion repair periods 1998, and PM*	**27**	**35**	**1989**	1990[d]	1993	1998	*prog. maint: last to upgrade mission and navigation systems, AC systems, metal replacement (tank tops)*
4. ***Okeanos Explorer***	**8**	**2024**	*PM but no MRP*	**28**	**36**	**1988**		2004	2008	*prog. maint. and routine dry dock in FY16 ($3.5M): O-winch controller upgrade, AC system, MCA*
5. ***Hi'ialakai***	**8**	**2024**	*PM but no MRP*	**32**	**40**	**1984**	1993[c]	2002	2004	*on-going prog. maint. includes AC Systems, davits, zero discharge system, upgrade dive systems, MCAS*
6. ***Fairweather***	**8**	**2024**	*$25M MRP, reactivated 2004*	**49**	**57**	**1967**		1968	1968	*de-activated 1989; reactivated in 2004 following $25M MPR, recently inc. capability to carry more hydro survey launches*
7. ***Thomas Jefferson***	**12**	**2028**	*most recent material assessment*	**25**	**37**	**1991**	1992[e]	2003	2003	*anticipate $12M in improvements via prog. maint. over next 3 years*
8. ***Rainier***	**14**	**2028**	*$13.1M MRP 2009, and PM*	**49**	**61**	**1967**		1968	1968	*upgrade generator, machinery control and alarm system, steering system, piping and regulatory upgrades*
9. ***Nancy Foster***	**14**	**2030**	*most recent material assessment*	**26**	**40**	**1990**	1991[e]	2001	2003	*planning stage*
12. ***Ronald H. Brown***	**14**	**2030**	*align with UNOLS AGORS mid-life plans*	**20**	**30**	**1996**		1997	1997	*align with mid-life plans for UNOLS AGORS; MCA*
10. ***Oscar Dyson***	**17**	**2033**	*launch date +30 yrs*	**13**	**30**	**2003**		2003	2005	*approaching 2018 (lead ship)*
11. ***Henry B. Bigelow***	**19**	**2035**	*launch date +30 yrs*	**11**	**30**	**2005**		2006	2007	*MRP scheduled for 2020*
13. ***Pisces***	**21**	**2037**	*launch date +30 yrs*	**9**	**30**	**2007**		2007	2009	*MCA supportability*
14. ***Bell M. Shimada***	**22**	**2038**	*launch date +30 yrs*	**8**	**30**	**2008**		2010	2010	*MCA supportability*
15. ***Ferdinand R. Hassler***	**23**	**2039**	*launch date +30 yrs*	**7**	**30**	**2009**		2011	2012	*none-new ship*
16. ***Reuben Lasker***	**26**	**2042**	*launch date +30 yrs*	**4**	**30**	**2012**		2013	2014	*none-new ship*

a. MRP = Major Repair Period, PM = Progressive Maintenance
b. Bureau of Commercial Fisheries
c. US Coast Guard
d. Marine Sealift Command
e. US Navy

APPENDIX E
IMPACT OF LOSS OF SHIPS

Lost Capabilities by 2028
(% lost from 2017 Capabilities)

Mission and At-Sea Activities	Northeast	Mid-Atlantic	Southeast Atlantic	GOM	Tropical Atlantic & Caribbean	West Coast	Alaska & Western Arctic	Pacific Islands & Tropical Pacific
CHARTING & SURVEYING								
Navigation, Observation and Positioning	TJ, (FH)	TJ, (FH)	TJ, (FH)	TJ, (FH)	(NF)	RA, FA	RA, FA	RA, FA ,HI
Coastal Science & Assessment	EX, TJ, (HB, NF)	EX, TJ, (HB, NF)	EX, TJ, (NF)	EX, TJ, (NF)	EX, (NF)	RA, FA, (RL, SH)	RA, FA, (SH)	FA ,RA, SE, HI
ASSESSMENT & MANAGEMENT OF LIVING MARINE								
Protected Resources, Science & Management	GU, (PC, NF, HB)	GU, (PC, HB)	O2, GU, (NF)	GU, O2	EX	(RL, SH)	(SH, DY)	SE, HI, (RL)
Fisheries Science & Management	GU, (PC, HB)	GU (HB, NF, PC)	O2, GU, (PC, NF)	GU, O2, (PC, NF)	(NF)	(RL, SH)	(SH, DY)	SE, HI
Habitat Conservation & Restoration	EX, TJ, (FH, HB)	EX, TJ, GU (FH, NF, HB, PC)	O2, GU, (NF)	GU, O2, (NF, PC)	(NF)	(RL, SH)	FA,RA, (SH)	SE, HI
OCEANOGRAPHIC MONITORING, RESEARCH & MODELING								
Climate Research	EX, (RB)	GU, EX, (RB)	GU, EX, (RB)	EX, GU, (NF)	GU, (RB, NF)	EX, (RL, SH)	FA, (SH, DY)	HI, SE, EX, (RB)
Weather & Air Chemistry	EX, (RB)	GU, EX, (RB)	GU, EX, (RB)	EX, GU, (NF)	GU, (RB,NF)	EX, (RL, SH)	FA, (SH, DY)	SE, EX, HI, (RB)
Ocean, Coastal and Great Lakes Research	EX, (RB)	GU, EX, (RB)	GU, EX, (RB)	EX, GU, (NF)	GU, (RB ,NF)	EX, (RL,SH)	RA, FA, (SH, DY)	HI, SE, EX, (RB)

Red = 90 – 100% capability loss
Orange = 60 – 89% capability loss
Yellow = 30 – 59% capability loss
Green = 0 – 29% capability loss
( ) indicates ships on-line in 2028

Ship Legend

Rainier (RA)	Fairweather (FA)
Oregon II (O2)	Hi'ialakai (HI)
Oscar Elton Sette (SE)	Okeanos Explorer (EX)
Gordon Gunter (GU)	Nancy Foster (NF)
Thomas Jefferson (TJ)	Ronald H. Brown (RB)
Oscar Dyson (DY)	Henry B. Bigelow (HB)
Pisces (PC)	Bell M. Shimada (SH)
Ferdinand R. Hassler (FH)	Reuben Lasker (RL)

APPENDIX F
AGOR CAPABILITIES

	MISSIONS						
	Charting & Surveying		Assessment & Management of Living Marine Resources			Oceanography, Monitoring, Research and Modeling	
CAPABILITIES	Navigation	Coastal Ocean Science (inc. bathymetry)	Protected Resources (marine mammals, turtles)	Fisheries Science & Management	Habitat Conservation & Restoration (inc. corals)	Climate Research (inc. mooring operations)	Ocean, Coastal, and Great Lakes Research
Trawl				●			
Moving Vessel Profiler	■ ●	■ ●					
Longline fishing				●			
Extensive Diving	■ ●			■ ●	■ ●		
Work Boats	●	●	■ ●		■ ●		
Lab Space	■ ●		■ ●	●			■ ●
Science Berthing			■ ●	■ ●	■ ●		■ ●
Dynamic Positioning	■ ●	■ ●			■ ●		■ ●
Multibeam Sonar	■ ●	■ ●			■ ●	■ ●	■ ●
Mooring Handling				■ ●		■ ●	■ ●
Communications	■ ●	■ ●	■ ●	■ ●	■ ●	■ ●	■ ●
Endurance	■ ●	■ ●	■ ●	■ ●		■ ●	■ ●
AUV	■ ●					■ ●	
ROV	■ ●				■ ●		■ ●
Marine UAS			■ ●				
Zero Discharge		■ ●	■ ●		■ ●		■ ●
Ice Strengthening	■ ●					■ ●	
% intersection	*91%*	*86%*	*100%*	*62%*	*100%*	*100%*	*100%*

● = existing capability on at least 1 of 8 ships scheduled to retire by 2028

■ = capability present in current NOAA variant of AGOR

APPENDIX G
LEGAL MANDATES and AUTHORITIES

NOAA products and services support management of federal trust resources, monitoring of marine ecosystems and their environment, production of weather warnings and forecasts, predictions of climate change, delivery of navigation information for safe, efficient transportation, and daily protection of the nation. This work is indicated by enabling legislation, executive orders, and administrative actions. In many of the enactments where the Secretary of Commerce is specifically authorized or directed to take action, NOAA has been delegated the authority to implement the provision or take specific action. An overview of the major legal mandates and authorities priorities that underpin the mission areas that require at-sea data is provided below.

Assessment and Management of Living Marine Resources

Coral Reef Conservation Act [62]

The Coral Reef Conservation Act, which served as the Congressional response to Executive Order 13089, Coral Reef Protection, establishes a national program to preserve, sustain, and restore the condition of coral reef ecosystems and to develop sound scientific information on the condition of coral reef ecosystems and the threats to such ecosystems. In addition to creating a National Coral Reef Conservation Grant Program and the Coral Reef Conservation Fund (in partnership with the National Fish and Wildlife Foundation), the Act authorizes mapping, monitoring, assessment, restoration and scientific research that benefits the understanding, sustainable use, and long-term conservation of coral reefs and coral reef ecosystems.

Endangered Species Act [63]

The Endangered Species Act (ESA) is a comprehensive attempt to protect identified species and to consider critical habitat protection as an integral part of that effort. In coastal and marine waters, NOAA administers its provisions for listed marine mammals, turtles, and other species. Species of plants and animals are listed as either "endangered" or "threatened" according to assessments of the risk of their extinction. Once a species is listed, legal tools are available to aid the recovery of the species and to protect its habitat. These tools include strict substantive provisions of law provided by Congress that are lacking in other laws such as the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSRA) and the Marine Mammal Protection Act, and which effectively trump most legal challenges to federal actions to conserve and rebuild listed species.

The determination of whether a species should be listed as endangered or threatened must be based on several scientific factors related to a species and threats to its continuance. The ESA expressly states that listing determinations are to be made "solely on the basis of the best scientific and commercial data available."[64] Economic factors cannot be taken into account at this stage because Congress directed that listing be fundamentally a scientific question: is the continued existence of the species threatened or endangered? When a species is listed, the Secretary must also designate critical habitat (either where the species is found or, if it is not found there, where there are features essential to its conservation).[65] The preparation of recovery plans for the conservation and survival of listed species is also required.[66] Congress requires a biennial report on the status of efforts to develop and implement recovery plans for all listed species and on the status of all species for which such plans have been developed.

[62] 16 U.S.C. §6401; PL 106-562
[63] 16 U.S.C. §§ 1531-1544; PL 93-205, reauthorized in 1992
[64] 16 U.S.C. § 1533(a)(1).
[65] 16 U.S.C. § 1533(b)(2).
[66] 16 U.S.C. § 1531(f)(1).

Executive Order 13158, Marine Protected Areas [67]

Executive Order 13158 establishes the Marine Protected Areas Center and a national system of marine protected areas, and strengthens the management, protection and conservation of critical marine resources by establishing a national system of marine protected areas (MPA) representing diverse marine ecosystems.

Harmful Algal Bloom and Hypoxia Research and Control Act [68]

The Harmful Algal Bloom and Hypoxia Research and Control Act, originally passed in 1998 to combat the growing threat of harmful algal blooms (HABs), reaffirms and expands the mandate for NOAA to advance the scientific understanding and ability to detect, monitor, assess, and predict HABs and to develop programs for research into methods of prevention, control, and mitigation of HABs. In addition to calling for the reestablishment of the Federal Interagency Task Force on HABs and Hypoxia, the Act enables NOAA to carry out research and assessment activities, including the Ecology and Oceanography of Harmful Algal Blooms project, research projects on management measures that can be taken to prevent, reduce, control, and mitigate harmful algal blooms, and to carry out federal and state annual monitoring and analysis activities.

Magnuson-Stevens Fishery Conservation and Management Reauthorization Act [69]

The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSRA) establishes a "national program for the conservation and management of the fishery resources of the United States…to prevent overfishing, to rebuild overfished stocks, to insure conservation, and to realize the full potential of the Nation's fishery resources." This law establishes a regulatory system applicable to management of domestic fisheries within the U.S. 200-mile Exclusive Economic Zone (EEZ).

The MSRA gives primary responsibility to eight regional Fishery Management Councils to prepare and implement Fishery Management Plans (FMPs), any subsequent FMP amendments, and fishery regulations, all which are subject to prescribed national standards.[70] FMPs and FMP implementing regulations must "prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery."[71] The MSRA also defines overfishing as the rate at which mortality "jeopardizes the capacity of a fishery to produce the maximum sustainable yield on a continuing basis."[72]

The 2006 MSRA, signed into law on January 12, 2007, set new requirements to prevent overfishing, including setting new annual catch limits (ACL) and accountability measures (AM) on the basis of best scientific advice for federally managed fisheries. Ending overfishing of all stocks undergoing overfishing, preventing overfishing of all stocks, and rebuilding overfished stocks back to levels of abundance that can produce maximum sustainable yield (MSY) on a continuing basis are essential to achieving the objectives and goals of the MSRA. Section 104(b) directs that ACL and AM requirements take effect in fishing year 2010 for stocks subject to overfishing.

The MSRA also encourages development of direct fishery management policies and procedures toward a broader ecosystem-based approach. Ecosystem approaches require significantly more information including marine environmental data and information on species that may be the predators or prey of target species. The requirements for the next generation of fish stock assessments will necessitate continued improvements to data and refinements to models to allow managers to emphasize ecosystem considerations, such as multi-species interactions and environmental effects, fisheries oceanography, and spatial and seasonal analyses. Currently there are 530 species nation-wide that are managed under MSRA. At-sea data collections are essential for providing conservation information necessary for managment.

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[67] Executive Order 13158 of May 26, 2000
[68] 16 U.S.C. § 1451; P.L. 105-383, reauthorized in 2004
[69] 16 U.S.C. §§ 1801-1882; PL 101-627, as amended in 1996 and reauthorized in 2006, PL 109-479
[70] 16 U.S.C. §§ 1853, 1852(h), 1851(a)(1)-(7)
[71] 16 U.S.C. § 1851(a)(1)
[72] 16 U.S.C. §1802(29)

Marine Mammal Protection Act [73]

The Marine Mammal Protection Act (MMPA), specifically Section 117, is the legal mandate to "prepare stock assessment reports (SAR) for all marine mammal stocks occurring in U.S. waters…each stock assessment shall estimate potential biological removal (PBR)." PBR is calculated as "…the maximum number of animals, not including those lost to natural mortality that may be removed from a marine mammal stock while allowing that stock to reach or maintain an optimum sustainable population." SARs must be reviewed annually for all strategic[74] stocks and for stocks for which new information is available, and at least triennially for all other stocks.

Marine Protection, Research, and Sanctuaries Act [75]

The Marine Protection, Research, and Sanctuaries Act authorizes the Secretary of Commerce to designate and manage areas of the marine environment with special national significance due to their conservation, recreational, ecological, historical, scientific, cultural, archeological, educational, or esthetic qualities as national marine sanctuaries. The Act's primary objective is to protect marine resources, such as coral reefs, sunken historical vessels or unique habitats. Implementation of the Act and management of national marine sanctuaries is delegated to NOAA's National Marine Sanctuary Program (NMSP).

The Act provides several tools for protecting designated national marine sanctuaries. If a federal action is likely to destroy, cause the loss of, or injure a sanctuary resource, the NMSP recommends alternatives that will protect sanctuary resources if implemented by the agency in taking the action. The Act also allows the Secretary to issue regulations for each sanctuary designated and the system as a whole that, among other things, specify the types of activities that can and cannot occur within the sanctuary. The Act requires preparation and updating of management plans that guide day-to-day activities at each sanctuary in furtherance of the goals of that sanctuary. It also provides for the assessment of civil penalties and the assessment of damages against people that injure sanctuary resources.

National Sea Grant College Program Act [76]

The objective of the National Sea Grant College Program Act is "to increase the understanding, assessment, development, utilization, and conservation of the Nation's ocean, coastal, and Great Lakes resources by providing assistance to promote a strong educational base, responsive research and training activities, broad and prompt dissemination of knowledge and techniques, and multidisciplinary approaches to environmental problems."

The Act requires "extending and strengthening the national sea grant program, initially established in 1966, to promote research, education, training, and advisory service activities in fields related to ocean, coastal, and Great Lakes resources." The Act funds a national sea grant network with 30 Sea Grant state programs, which includes fisheries extension.

Presidential Proclamation 8031 – Establishment of Papahanaumokuakea Marine National Monument [77]

This Presidential Proclamation establishes the Papahanaumokuakea Marine National Monument and ensures the comprehensive protection of the coral reef ecosystem and related marine resources and species, as well as historic resources, of the Northwestern Hawaiian Islands. The Secretary of Commerce and the Secretary of the Interior jointly manage the Monument in accordance with the principal purpose of long-term conservation of historic and scientific objects. Presidential Proclamation 8031 made final the Monument, with conservation measures such as fishing prohibitions to take effect in the near future.

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[73] 16 U.S.C. §§ 1361-1421h, October 21, 1972, as amended 1973, 1976-1978, 1980-1982, 1984, 1986, 1988, 1990, 1992-1994 and 1996
[74] 16 U.S.C. §§ 1361-1421; PL 92-522, as amended in 2006
[75] 16 U.S.C. § 1431 et seq, as amended through P.L. 106-513
[76] 33 U.S.C. § 1121 et seq, as amended through P.L. 107-299
[77] 71 FR 36443, June 26, 2006, as amended by P.P. 8112, 72 FR 10031, March 5, 2007

The Convention for the Conservation of Antarctic Marine Living Resources[78]

The Convention for the Conservation of Antarctic Marine Living Resources is an international agreement of which the U. S. is a signatory (16 U. S. Code, chapter 44). The Secretary of State, with the concurrence of the Secretary of Commerce, the Director of the National Science Foundation and the Secretary of the department in which the Coast Guard is operating, is authorized to agree on behalf of the United States to the establishment of a system of observation and inspection, and to interim arrangements pending establishment of such a system, pursuant to article XXIV of the Convention. NMFS conducts an annual Antarctic Marine Living Resource (AMLR) survey to support ecosystem-based management of fisheries that impact krill, finfish, krill-dependent predators, and other components of the Antarctic ecosystem.

Resources and Ecosystem Sustainability, Tourist Opportunities, and Revived Economies (RESTORE) of the Gulf Coast States Act of2012 [79]

Resources and Ecosystem Sustainability, Tourist Opportunities, and Revived Economies (RESTORE) of the Gulf Coast States Act of 2012 authorizes NOAA to establish and administer the RESTORE Program, in consultation with the U.S. Fish and Wildlife Service. Identified in the RESTORE Act as the Gulf Coast Ecosystem Restoration Science, Observation, Monitoring, and Technology Program, the Program is commonly known as the NOAA RESTORE Act Science Program. The mission of the RESTORE Act Science Program is to carry out research, observation, and monitoring to support, to the maximum extent practicable, the long-term sustainability of the ecosystem, fish stocks, fish habitat, and the recreational, commercial, and charter-fishing industry in the Gulf of Mexico.

Arctic Region Policy[80] *and US National Strategy for the Arctic Region (NSAR)*[81]

The Arctic Region Policy is a Presidential directive that establishes the policy of the United States ·with respect to the Arctic Region and directs related implementation actions. In furtherance of this policy, the US National Strategy for the Arctic Region (NSAR) is intended to position the United States to respond effectively to challenges and emerging opportunities arising from significant increases in Arctic activity due to the diminishment of sea ice and the emergence of a new Arctic environment. NOAA's Arctic Vision and Strategy strategic goals are aligned with the three lines of effort in the NSAR: (1) Advance United States Security Interests (2) Pursue Responsible Arctic Region Stewardship and (3) Strengthen International Cooperation. NOAA provides the backbone of basic research, including providing a better understanding of climate issues necessary to address many aspects of the NSAR.

Oceanographic Monitoring, Research and Modeling

Global Change Research Act [82]

The Global Change Research Act mandates the development of a research program whose goal is to understand climate variability and its predictability. This Act ensures the establishment of global measurements and worldwide observations, and requires an early and continuing commitment to the establishment and maintenance of worldwide observations and related data and information systems.

Implementation Plan for the Global Observing System for Climate (GCOS-92, October 2004)

The United Nations Framework Convention on Climate Change (UNFCCC) endorses the Implementation Plan for the Global Observing System for Climate, which lays out specific recommendations for the ocean observing system for climate. The plan responds to the Second Report on the Adequacy of the Global Observing System for Climate in Support of the UNFCCC, which concluded that "the ocean networks lack global coverage and commitment to

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[78] 16 U.S.C. Chapter 44
[79] Public Law 112-141, Section 1604
[80] National Security Presidential Directive-66/Homeland Security Presidential Directive-25, January 2009
[81] White House, May 2013
[82] 15 U.S.C. § 2921 et seq.,

sustained operations . . . Without urgent action to address these findings, the Parties will lack the information necessary to effectively plan for and manage their response to climate change."

Magnuson-Stevens Fishery Conservation and Management Reauthorization Act [83]

The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSRA) mandates that NOAA manage commercial and recreational fishery stocks in the U.S. Exclusive Economic Zone and encourages an ecosystem approach to fisheries management. A sound ecosystem approach to management requires understanding of how climate fluctuations affect the ecosystem and significantly more information including marine environmental data. Requirements for the next generation of fish stock assessments will necessitate continued improvements to data and refinements to models to allow managers to emphasize ecosystem considerations, such as multi-species interactions and environmental effects, fisheries oceanography and spatial and seasonal analyses.

MSRA provides NOAA additional science and management authorities related to deep-sea coral communities. The MSRA directed the Secretary of Commerce, in consultation with the appropriate regional fishery management councils (councils), and in coordination with other federal agencies and educational institutions, to establish a Deep-Sea Coral Research and Technology Program. MSRA also authorized councils to designate zones to protect deep-sea corals from damage caused by fishing gear under fishery management plan discretionary provisions.

National Climate Program Act [84]

The National Climate Program Act authorizes global data collection, and monitoring and analysis activities to provide reliable, useful and readily available information on a continuing basis. In addition, the Act authorizes measures for increasing international cooperation in climate research, monitoring, analysis and data dissemination.

National Weather Service Organic Act [85]

The National Weather Service Organic Act directs NOAA to forecast the weather, issue storm warnings, collect and transmit marine intelligence for the benefit of commerce and navigation. The Act requires the establishment of meteorological observation stations in the Arctic Region and requires NOAA to establish the Institute for Aviation Weather Prediction to provide forecasts, weather warnings, and other weather services to the United States aviation community. And the nature of the prescribed duties "to develop adequate warning system for the severe hazards of nature – hurricanes, tornadoes floods, earthquakes and seismic sea waves" provides the requirement for tsunami (seismic sea wave) warning activities. The National Weather Service Organic Act also directs NOAA to take such meteorological observations as may be necessary to establish and record the climate conditions of the United States. The Act outlines NOAA's responsibility to produce climate forecasts as well as to monitor and record climate information used in assessment products.

Tsunami Warning and Education Act [86]

The Tsunami Warning and Education Act authorizes and strengthens the tsunami detection, forecast, warning, and mitigation program of NOAA. The Act expands tsunami forecast and warning capability for all U.S. coastlines and increases emphasis on tsunami education and outreach activities.

Ocean Research Priorities Plan (January 2007)

The National Science and Technology Council Joint Subcommittee on Ocean Science and Technology released the first national Ocean Research Priorities Plan, which calls for "deployment of a robust ocean observing system that can describe the actual state of the ocean."

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[83] 16 U.S.C. §§ 1801-1882; PL 101-627, as amended in 1996 and reauthorized in 2006, PL 109-479.
[84] 15 U.S.C. §§ 2901-2908, at 2904(d) (4), et,
[85] 15 U.S.C. § 313
[86] Public Law 109-424

Strategic Plan for the United States Climate Change Science Program (July 2003)

The United States Climate Change Science Program Strategic Plan articulates a number of climate observation objectives, including "complete global coverage of the oceans with moored, drifting, and ship-based networks," with the overarching goals of completing the required atmosphere and ocean observation elements in a manner consistent with Climate Monitoring Principles (GCOS-92).

Energy Bill Act of 2005 [87]

The Energy Bill Act provides the guidance to consider additional inter-satellite calibration of instruments and development of improved product suites that assist in the preparation of a national strategy to promote the deployment and commercialization of greenhouse gas intensity reducing technologies and practices.

Executive Order 13366, Committee on Ocean Policy [88]

Executive Order 13366 established the Committee on Ocean Policy. In January 2006 the subordinate Interagency Committee on Ocean Science and Resource Management Integration approved the First U.S. Integrated Ocean Observing System (IOOS) Development Plan which recommended NOAA take a leadership role in US IOOS development.

Arctic Region Policy[89] and US National Strategy for the Arctic Region (NSAR)[90]

The Arctic Region Policy is a Presidential directive that establishes the policy of the United States ·with respect to the Arctic Region and directs related implementation actions. In furtherance of this policy, the US National Strategy for the Arctic Region (NSAR) is intended to position the United States to respond effectively to challenges and emerging opportunities arising from significant increases in Arctic activity due to the diminishment of sea ice and the emergence of a new Arctic environment. NOAA's Arctic Vision and Strategy strategic goals are aligned with the three lines of effort in the NSAR: (1) Advance United States Security Interests (2) Pursue Responsible Arctic Region Stewardship and (3) Strengthen International Cooperation. NOAA provides the backbone of basic research, including providing a better understanding of climate issues necessary to address many aspects of the NSAR.

Marine Debris Research, Prevention, and Reduction Act[91]

The Marine Debris Research, Prevention, and Reduction Act **(**MDRPRA) established programs within the National Oceanic and Atmospheric Administration (NOAA) and the United States Coast Guard (USCG) to identify, determine sources of, assess, reduce, and prevent marine debris. MDRPRA also reactivates the Interagency Marine Debris Coordinating Committee, chaired by NOAA.

Omnibus Public Land Management Act of 2009[92]

Omnibus Public Land Management Act of 2009, Title XII-Oceans – Subtitle A Ocean Exploration, establishes the national ocean exploration program and the national undersea research program within the National Oceanic and Atmospheric Administration.

Part I – Exploration: Authorizes NOAA to establish a coordinated national ocean exploration program in collaboration with other federal agencies and programs, and other public and private institutions. Authorizes NOAA to conduct interdisciplinary expeditions to explore and survey poorly known areas of the marine environment giving priority to deep ocean regions. Includes enhancing the technical capability

[87] Energy Bill Act of 2005 PL 109-*58*
[88] Executive Order 13366 – Committee Ocean Policy
[89] National Security Presidential Directive-66/Homeland Security Presidential Directive-25, January 2009
[90] White House, May 2013
[91] S362 2006
[92] Public Law 111-11 Omnibus Public Land Management Act of 2009, March 30, 2009

of the United States to explore the marine environment, including continued development of broadband communications technology such as telepresence.

Part II – NOAA Undersea Research Program (NURP) Act 2009: While NURP was terminated by Congress in 2012, the programs authorized under subtitles B-E were not as these were established by NOAA as independent programs with dedicated lines of appropriation. These are:

Subtitle B – Ocean and Coastal Mapping Integration Act: Authorizes NOAA to establish a program to develop a coordinated and comprehensive Federal ocean and coastal mapping plan for the Great Lakes and coastal state waters, the territorial sea, the exclusive economic zone, and the continental shelf of the United States that enhances ecosystem approaches in decision-making for conservation and management of marine resources and habitats, establishes research and mapping priorities, supports the siting of research and other platforms, and advances ocean and coastal science.

Subtitle C – Integrated Coastal and Ocean Observation System Act: Authorizes NOAA to establish and maintain a national integrated system of ocean, coastal, and Great Lakes observing systems designed to address the need for ocean information in support of ecosystem management, national defense, marine commerce, navigation, and weather and climate forecasting. . This includes in situ, remote, and other ocean observation platforms and technologies, and communications systems for transmitting data.

Subtitle D – Federal Ocean Acidification Research and Monitoring Act: Authorizes NOAA to establish a NOAA research and monitoring program and creates an interagency working group co-chaired by NOAA to develop a comprehensive interagency plan to assess the ecosystem and socioeconomic impacts of ocean acidification. This Act calls on NOAA to establish a national ocean acidification observing network to track changes in ocean chemistry in response to rising levels of atmospheric CO_2.

Antiquities Act[93]

The Antiquities Act gives the President of the United States the authority to, by presidential proclamation, create national monuments from public lands to protect significant natural, cultural or scientific features. Within NOAA, The Marine National Monument program coordinates the development of management plans, scientific exploration and research programs within the Marine National Monuments in the Pacific Islands Region. Under NOAA's existing authorities and the Antiquities Act, the Marine National Monument Program works with federal and regional partners and stakeholders to conserve and protect the marine resources in these large marine protected areas.

United Nations Convention on the Law of the Sea

United Nations Convention on the Law of the Sea (UNCLOS) is the international agreement that resulted from the third United Nations Conference on the Law of the Sea, which took place between 1973 and 1982. The Law of the Sea Convention defines the rights and responsibilities of nations with respect to their use of the world's oceans, establishing guidelines for businesses, the environment, and the management of marine natural resources. Although not a signatory to UNCLOS at the direction of Congress and under the auspices of the Department of State, NOAA is co-leading the interagency initiative to determine the limits of the US Extended Continental Shelf (ECS) using the criteria set forth in Article 76, UNCLOS. This includes the acquisition of bathymetry, seismic data to determine sediment thickness, and geologic samples required for the analyses necessary to establish the ECS limit. Determining the limits for the eight regions of US interest has profound implications for marine resource exploration and development, ecosystem-based management, and national defense and security.

United Nations Educational, Scientific and Cultural Organization (UNESCO) Convention on the Protection of the Underwater Cultural Heritage and the National Historic Preservation Act

The Convention on the Protection of the Underwater Cultural Heritage is a treaty that was adopted on 2 November 2001 by the General Conference of the United Nations Educational, Scientific and Cultural Organization. The convention is intended to protect "all traces of human existence having a cultural, historical or archaeological character," which have been under water for over 100 years. This extends to the protection of shipwrecks, sunken

[93] Public Law 59–209, 34 Stat. 225, 16 U.S.C. § 431–433

cities, prehistoric art work, treasures that may be looted, sacrificial and burial sites, as well as old ports that cover the oceans floors. NOAA adheres to the principles for preservation, conservation, and information sharing specified in the Convention and section 304 of the National Historic Preservation Act as it seeks out or comes across submerged cultural resources in the course of conducting their mission

Executive Order 13547 -- Stewardship of the Ocean, Our Coasts, and the Great Lakes 2010[94]

Executive Order 13547 -- Stewardship of the Ocean, Our Coasts, and the Great Lakes 2010 adopts the recommendations of the Interagency Ocean Policy Task Force, and directs executive agencies to implement those recommendations under the guidance of a National Ocean Council. NOAA has specific responsibilities requiring ocean going capabilities with respect to: marine planning, coastal communities, recreational fishing and boating, commercial fishing, aquaculture, offshore renewable energy, offshore oil and gas, and shipping and ports.

Deep Seabed Hard Mineral Resources Act[95]

The Deep Seabed Hard Mineral Resources Act establishes within NOAA the authority to approve permits for deep sea mining exploration and development in specific situations, as well as to investigate "the ecological, geological, and physical aspects of the deep sea bed in general areas of the ocean where exploration and commercial development" may likely occur.

Aquatic Nuisance Species Program[96]

Aquatic Nuisance Species Program authorizes the Assistant Secretary, in consultation with the Task Force, to investigate and identify environmentally sound methods for preventing and reducing the dispersal of aquatic nuisance species between the Great Lakes-Saint Lawrence drainage and the Mississippi River drainage through the Chicago River Ship and Sanitary Canal, including any of those methods that could be incorporated into the operation or construction of the lock system of the Chicago River Ship and Sanitary Canal. The Great Lakes Environmental Research Laboratory of the National Oceanic and Atmospheric Administration shall provide technical assistance to appropriate entities to assist in the research conducted pursuant to this subsection.

Invasive Species [97]

The Invasive Species Executive Directive is designed to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause. "Each federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law, identify such actions; subject to availability of appropriations, and within the Administration budgetary limits, use relevant programs and authorities to : (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide environmentally sound control of invasive species…."

Study of Migratory Game Fish; Waters; Research Purpose[98]

The Study of Migratory Game Fish; Waters; Research Purpose directs "The Secretary of Commerce "to undertake a comprehensive continuing study of migratory marine fish of interest to recreational fishermen of the United States,….including fish which migrate through or spend part of their lives in the inshore waters of the United States. The study shall include, but not be limited to, research on migrations, identity of stocks, growth rates, mortality rates, variation in survival, environmental influences, both natural and artificial, including pollution and effects of fishing on the species for the purpose of developing wise conservation policies and constructive management activities."

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[94] The White House, July 19, 2010
[95] 30 U.S.C. §§ 1401-1473
[96] 16 U.S.C. § 4722
[97] Executive Order 13112 , February 3, 1999
[98] 16 U.S.C. § 760e

Hazardous Air Pollutants[99]

The Hazardous Air Pollutants act authorizes the Administrator, in cooperation with the Under Secretary of Commerce for Oceans and Atmosphere, to "conduct a program to identify and assess the extent of atmospheric deposition of hazardous air pollutants (and in the discretion of the Administrator, other air pollutants) to the Great Lakes, the Chesapeake Bay, Lake Champlain and coastal waters. As part of such program, the Administrator shall—

(A) monitor the Great Lakes, the Chesapeake Bay, Lake Champlain and coastal waters, including monitoring of the Great Lakes through the monitoring network established pursuant to paragraph (2) of this subsection and designing and deploying an atmospheric monitoring network for coastal waters pursuant to paragraph (4);

(B) investigate the sources and deposition rates of atmospheric deposition of air pollutants (and their atmospheric transformation precursors);

(C) conduct research to develop and improve monitoring methods and to determine the relative contribution of atmospheric pollutants to total pollution loadings to the **Great Lakes**, the Chesapeake Bay, Lake Champlain, and coastal waters;"

Great Lakes Water Quality Agreement[100]

Great Lakes Water Quality Agreement of 1978—amended 1987 is an International agreement between Canada and the United States which involves restoring and enhancing water quality in the Great Lakes. The purpose of the Agreement is to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem to achieve this purpose, the Parties agree to make a maximum effort to develop programs, practices and technology necessary for a better understanding of the Great Lakes Basin Ecosystem and to eliminate or reduce to the maximum extent practicable the discharge of pollutants into the Great Lakes System.

Regional Marine Research Programs[101]

Regional Marine Research Programs Act authorizes the establishment of the Great Lakes Research Office which "shall be responsible for research in the Great Lakes region and shall be considered the Great Lakes counterpart to the research program established pursuant to this chapter."

Authorization of Appropriations (Conservation)[102]

Authorization of Appropriations authorizes (1) $1,625,000, which shall be made available from funds otherwise authorized to be appropriated if such funds are so authorized, to fund aquatic nuisance species prevention and control research under section 4722(i) of this title at the Great Lakes Environmental Research Laboratory of the National Oceanic and Atmospheric Administration, of which $500,000 shall be made available for grants, to be competitively awarded and subject to peer review, for research relating to Lake Champlain and (2) $1,125,000 to fund aquatic nuisance species prevention and control research under section 4722(i) of this title at the Great Lakes Environmental Research Laboratory of the National Oceanic and Atmospheric Administration.

Federal Ocean Acidification Research and Monitoring Act[103]

The Federal Ocean Acidification Research and Monitoring Act (FOARAM) 2009 allowed for the establishment of NOAA's Ocean Acidification program. The act outlined a coordinated process for federal agencies to create a plan for effective monitoring of processes and consequences of ocean acidification on marine organisms and ecosystems through the creation of an Interagency Working Group on Ocean Acidification. Also included in this legislation, is the requirement to develop adaptation strategies to conserve ecosystems (both at regional and national levels) vulnerable to the effects of acidification, and the associated socio-economic impacts.

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[99] 42 U.S.C. § 7412
[100] Great Lakes Water Quality Agreement of 1978, amended 1987
[101] 16 U.S.C.§ 1447b, section 1268(d) of title 33
[102] 16 U.S.C.§ 4741
[103] S173

Strategic Plan for Federal Research and Monitoring and Monitoring of Ocean Acidification[104]

The Strategic Plan for Federal Research and Monitoring provides a strategic approach to understand and address the rapidly emerging problem of ocean acidification. It's intended to guide federal ocean acidification investments and activities over the next decade and beyond. It will provide a better understanding of the process of ocean acidification, its effects on marine ecosystems, and the steps that must be taken to minimize harm from ocean acidification. Seven priority areas were identified 1) research, 2) monitoring, 3) modeling, 4) technology development, 5) socioeconomic impacts, 6) education and outreach and 7) data management.

National Materials and Minerals Policy Research and Development Act[105]

National Materials and Minerals Policy Research and Development Act details that technological innovation and research and development are important factors which contribute to the availability and use of materials, encourages Federal agencies to facilitate availability and development of domestic resources to meet critical material needs, and directs the President to coordinate with agencies on advanced science and technology for the exploration, discovery, and recovery of nonfuel materials, as well as other items.

Water Resources Development Act of 1996[106]

Water Resources Development Act authorizes specified water resources development and conservation projects for navigation, flood control, flood and storm damage reduction, environmental preservation and restoration, shoreline erosion protection, hydropower, and hurricane damage reduction. The Act established the South Florida Ecosystem Restoration Task Force, which shall include the Secretary of Commerce. Additionally, the Secretary of Commerce, acting through the Administrator of the National Oceanic and Atmospheric Administration shall cooperate with the Secretary of the Army in the Chesapeake Bay Environmental Restoration and Protection Program.

Charting and Surveying

Coast and Geodetic Survey Act [107]

The Coast & Geodetic Survey Act (CGSA) is the organic authority for NOAA to "provide charts and related information for the safe navigation of marine and air commerce and to provide basic data for engineering and scientific purposes and for other commercial and industrial needs…" The CGSA authorizes the Secretary of Commerce, and by extension NOAA, to conduct the following activities for safe marine navigation:

a. Hydrographic and topographic surveys
b. Tide and current observations
c. Geodetic-control surveys
d. Field surveys for aeronautical charts
e. Geomagnetic, seismological, gravity, and related geophysical measurements and investigations, and observations for the determination of variation in latitude and longitude

This mandate covers all U.S. territorial waters and the U.S. Exclusive Economic Zone, a total area of 3.4 million square nautical miles which extends 200 nautical miles offshore from the Nation's coastline. NOAA is designated as the central depository for geomagnetic data, and the Secretary is authorized to collect, correlate and disseminate such data. The Act authorizes the Secretary to conduct developmental work for the improvement of surveying and cartographic methods and instruments and to conduct investigations and research in geophysical sciences. The Secretary is authorized to enter into cooperative agreements with states, federal agencies, public or private organizations or individuals, for surveying, mapping and publication activities, and to contract with qualified organizations for National Geodetic Survey functions. The Act provides for a permanent authorization of appropriations to perform these functions, as well as to acquire, construct, maintain, and operate ships, stations, equipment, and facilities as needed to meet the mission.

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[104] Interagency Working Group on Ocean Acidification, March 2014.
[105] 30 U.S.C.§§1601, 1602, 1603
[106] 33 U.S.C. § 2201 Public Law 104-303-Oct. 12, 1996
[107] 33 U.S.C. § 883a et seq

This Act also authorized the Department of Commerce to conduct geodetic control surveys; field surveys for Federal Aviation Administration aeronautical charts; developmental work for the improvement of surveying and cartographic methods, instruments, and equipment; and investigations and research in geophysical sciences, including geodesy and seismology.

The Coast and Geodetic Survey Act (CGSA) provides the authority for coastal seismic and sea level monitoring, including the Pacific Tsunami Warning Center (PTWC). The specific duties of the Coast and Geodetic Survey included operation of the National Geomagnetism Program and Honolulu Geomagnetic Observatory (established 1902) and the U.S. Seismic Sea Wave Warning system established at the Honolulu Observatory (established in 1946). In 1949 the PTWC in Ewa Beach, Hawaii was established to provide warnings from tsunamis to most countries in the Pacific Basin as well as to Hawaii and all other U.S. interests in the Pacific outside of Alaska and the U.S. West Coast. The language in the Act is generally permissive: The Secretary is "authorized" to do various functions. But the statute, passed in 1947, stated as its purpose: "To define the functions and duties of the Coast and Geodetic Survey, and for other purposes." Mapping of coastal areas; observance, analysis and prediction of tide and current data support tsunami hazard mitigation.

Navigation and Navigable Waters Act [108]

The Navigation and Navigable Waters Act states that the NOAA Administrator shall take such actions, including the sponsorship of applied research, as may be necessary to assure the future availability and usefulness of ocean satellite data to the maritime community. Section 883d, Improvement of methods, instruments and equipments: investigations and research, of the Navigation and Navigable Waters Act, authorizes the Secretary to conduct developmental work for the improvement of surveying and cartographic methods and instruments, and equipments; and to conduct investigations and research in geophysical sciences (including geodesy, oceanography, seismology, and geomagnetism) to increase engineering and scientific knowledge. The Navigation and Navigable Water Act authorizes NOAA to acquire, construct, maintain and operate ships, and authorizes NOAA to "…procure…vessels, equipment and technologies…" to acquire hydrographic data.

Coast Guard Navigation Safety Regulations [109]

Federal regulation requires that self-propelled vessel of 1600 or more gross tons and/or foreign vessels operating in the navigable waters of the United States must have current, updated nautical charts produced by NOAA, as well as the NOAA Coast Pilot and NOAA tide and current tables. The requirement derived from this regulation is that NOAA produce and update said materials for navigation safety use.

Hydrographic Services Improvement Acts (HSIA) [110]

The Hydrographic Services Improvement Acts also reiterate NOAA's responsibilities "to fulfill the data gathering and dissemination duties… [of] acquiring and disseminating hydrographic data, promulgate standards for hydrographic data…" and the authority to "operate vessels, equipment, and technologies necessary to ensure safe navigation and maintain operational expertise in hydrographic data acquisition and hydrographic services." The 2002 HSIA also authorizes NOAA to "carry out activities authorized under this title that enhance homeland security, including…hydrographic surveys…"

United States Ocean Action Plan and United States Ocean Action Plan Implementation Update (January 2007) [111]

The United States Ocean Action Plan includes immediate and long term actions that provide direction for ocean policy. Included is the action to: "Build a Global Earth Observation Network, Including Integrated Ocean

[108] 33 U.S.C. § 883d
[109] 33 CFR 164.33
[110] Hydrographic Services Improvement Acts (HSIA) of 1998 and 2002 U.S.C. 851 note (Public Law 104-384, 112 Stat. 3451 and Public Law 107-372, 116 Stat. 3078
[111] U.S. Ocean Action Plan – The Bush Administration's Response to the U.S. Commission on Ocean Policy

Observation." The United States is playing a lead role in bringing the international community together to develop an integrated, comprehensive, and sustained global earth observing system of systems that includes a substantial ocean component, known as the Global Ocean Observing System (GOOS). The U.S. Integrated Ocean Observing System (IOOS) will be a major element of GOOS. The plan addresses many recommendations of the U.S. Commission on Ocean Policy, including those for establishing an IOOS with an emphasis on regional development, developing the capacity for ecosystem-based management, and linking IOOS data and information to applications.

Charting the Course for Ocean Science in the United States for the next decade: An Ocean Research Priorities Plan and Implementation Strategy (NSTC Joint Subcommittee on Ocean Science and Technology - January 26, 2007)

This plan identifies the need to acquire, manipulate, analyze, and deliver requisite information about the ocean and calls for the development of an integrated ocean-observing system that includes coupled observational and research components.

Interagency Working Group on Ocean Observation Charter

In accordance with the Ocean Action plan requirement for interagency collaboration to achieve ocean science and technology priorities, NOAA was designated "the lead federal agency by the Administration, accountable for administration and implementation of IOOS."

Arctic Region Policy[112] and US National Strategy for the Arctic Region (NSAR)[113]

The Arctic Region Policy is a Presidential directive that establishes the policy of the United States ·with respect to the Arctic Region and directs related implementation actions. In furtherance of this policy, the US National Strategy for the Arctic Region (NSAR) is intended to position the United States to respond effectively to challenges and emerging opportunities arising from significant increases in Arctic activity due to the diminishment of sea ice and the emergence of a new Arctic environment. NOAA's Arctic Vision and Strategy strategic goals are aligned with the three lines of effort in the NSAR: (1) Advance United States Security Interests (2) Pursue Responsible Arctic Region Stewardship and (3) Strengthen International Cooperation. NOAA provides the backbone of basic research, including providing a better understanding of climate issues necessary to address many aspects of the NSAR.

Ocean and Coastal Mapping Integration Act of 2009

The 2009 Ocean and Coastal Mapping Integration Act (Subtitle B of Public Law 111-11) states the need for the development of integrated mapping plans and activities at the national level as well as for National Oceanic and Atmospheric Administration specific activities. The act also recognizes that a successful mapping plan spans the entire spectrum of activities from data planning to collection to access and use to archive.[114]

***Executive Order 13574, Stewardship* of the Ocean, Our Coasts, and the Great Lakes**

The President's Executive Order 13547 Stewardship of the Ocean, Our Coasts, and the Great Lakes,
adopts the recommendations of the Interagency Ocean Policy Task Force, including Priority Objective 9, which includes mapping. The executive agencies are directed to implement the recommendations under the guidance of the National Ocean Council. Priority Objective 9 states that for "Ocean, Coastal, and Great Lakes Observations, Mapping, and Infrastructure: Strengthen and integrate Federal and non-Federal ocean observing systems, sensors, data collection platforms, data management, and mapping capabilities into a national system, and integrate that system into international observation efforts."[115]

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[112] National Security Presidential Directive-66/Homeland Security Presidential Directive-25, January 2009
[113] White House, May 2013
[114] Public Law 111–11, Subtitle B OCMIA, March 30, 2009
[115] White House, July 2010

Emergency Response

Executive Order 12656, Assignment of Emergency Preparedness Responsibilities [116]

Executive Order (E.O.) 12656, Assignment of Emergency Preparedness Responsibilities, assigns national security emergency preparedness responsibilities to federal departments and agencies. Under this order, agencies are required to have capabilities to meet essential defense and civilian needs during any national security emergency. The head of each agency shall provide for: 1) succession to office and emergency delegation of authority in accordance with applicable law; 2) safekeeping of essential resources, facilities, and records; and, 3) establishment of emergency operating facilities. In addition, this E.O. assigns the Department of Commerce the lead responsibility for developing plans to provide meteorological, hydrologic, marine weather, geodetic, hydrographic, climatic, seismic, and oceanographic data and services to federal, state, and local agencies, as appropriate, and developing overall plans and programs for the fishing industry's continued production during an emergency.

Homeland Security Act of 2002 [117]

The Homeland Security Act of 2002 established the Department of Homeland Security (DHS). It establishes the primary mission of the DHS to prevent terrorist attacks within the United States; reduce the vulnerability of the United States to terrorism; to minimize the damage, and to assist in the recovery, from terrorist attacks that do occur within the United States. NOAA supports DHS in its functions through information sharing, complying with Continuity of Operations guidance, and providing response and recovery assistance.

Homeland Security Presidential Directive #5, Management of Domestic Incidents [118]

Homeland Security Presidential Directive (HSPD) #5, Management of Domestic Incidents, tasks the Secretary of Department of Homeland Security to develop a comprehensive National Incident Management System (NIMS) and the National Response Plan (NRP) which integrates federal government domestic prevention, preparedness, response, and recovery plans into one all-discipline, all-hazards plan. All federal departments and agencies, including the Department of Commerce and NOAA, are required to adopt the NIMS and assist and support with the development of the NRP.

Homeland Security Presidential Directive #7, Critical Infrastructure Identification, Prioritization and Protection [119]

Homeland Security Presidential Directive (HSPD) #7, Critical Infrastructure Identification, Prioritization and Protection, establishes a national policy for federal departments and agencies to identify and prioritize United States critical infrastructure and key resources and to protect them from terrorist attacks.

Homeland Security Presidential Directive #8, National Preparedness [120]

Homeland Security Presidential Directive (HSPD) #8, National Preparedness, establishes policies to strengthen the preparedness of the United States to prevent and respond to threatened or actual domestic terrorist attacks, major disasters, and other emergencies by requiring a national domestic all-hazards preparedness goal, establishing mechanisms for improved delivery of federal preparedness assistance to state and local governments, and outlining actions to strengthen preparedness capabilities of federal, state, and local entities.

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[116] Executive Order 12656, Assignment of Emergency Preparedness Responsibilities, November 18, 1988
[117] Homeland Security Act of 2002
[118] Homeland Security Presidential Directive (HSPD) #5, Management of Domestic Incidents, February 28, 2003
[119] Homeland Security Presidential Directive (HSPD) #7, Critical Infrastructure Identification, Prioritization and Protection, December 17, 2003
[120] Homeland Security Presidential Directive (HSPD) #8, National Preparedness

National Response Plan [121]

The National Response Plan (NRP) aligns federal coordination structures, capabilities, and resources into a unified, all-discipline, and all-hazards approach to domestic incident management. The Department of Commerce is a signatory partner in the plan and NOAA has direct or supporting responsibilities in 10 of the 15 Emergency Support Functions (ESF). NOAA is also listed in the Nuclear/Radiological Incident Annex as the point of interaction for international coordination for hydrometeorological responses. NOAA's services are utilized in ESF #1, #9, #10, #11, and #13, to protect people, resources and transportation by providing:

- Trajectory/dispersion forecasts and scientific support for marine spills
- Information on ice and oceanographic conditions for coastal waters
- Charts and maps for coastal and territorial waters and the Great Lakes
- Emergency hydrographic surveys, search and recovery, and obstruction location to assist safe vessel movement
- Aerial mapping and satellite remote sensing for damage assessment

National Security Presidential Security Directive #51/Homeland Security Presidential Directive #20, National Continuity Policy [122]

National Security Presidential Directive (NSPD) #51/Homeland Security Presidential Directive (HSPD) #20, National Continuity Policy, establishes a comprehensive national policy on the continuity of federal government structures and operations and a single National Continuity Coordinator responsible for coordinating the development and implementation of federal continuity policies. This policy establishes "National Essential Functions," prescribes continuity requirements for all executive departments and agencies… in order to ensure a comprehensive and integrated national continuity program that will enhance the credibility of our national security posture and enable a more rapid and effective response to and recovery from a national emergency.

[121] The National Response Plan (NRP), December 2004

[122] National Security Presidential Directive (HSPD) #51, Homeland Security Presidential Directive (HSPD) #20, National Continuity Policy

APPENDIX H
WORKING GROUP MEMBERSHIPS

Interagency Working Group on Facilities and Infrastructure (IWG-FI)

The Interagency Working Group on Facilities and Infrastructure (IWG-FI) was established in 2010 by the White House's Joint Subcommittee on Ocean Science and Technology (JSOST) of the National Science and Technology Council (NSTC) Committee on Environment and Natural Resources (CENR) and Committee on Science (CS). The IWG-FI advises SOST on policies, procedures, and plans relating to oceanographic facility use, upgrades, and investments. This working group also provides guidance on requirements and other matters relative to national oceanographic assets to the SOST. The SOST advises and assists the CERN within the White House Office of Science and Technology Policy on national issues of ocean science and technology. In that capacity, the SOST is the lead interagency entity for Federal coordination on ocean science and technology. The SOST identifies ocean science and technology priorities, fosters and facilitates ocean science and technology activities, and contributes to Federal goals and agency missions in this area, including through collaborative interagency strategies.

IWGFI Member Agencies and current designees:

National Oceanographic and Atmospheric Administration (NOAA)
RADM David Score, Co-Chair
Charles Alexander
Chris Van Westendorp
Jon Andvick
Becky Baltes
Rick Brennan
John Coffey

National Science Foundation (NSF)
Bob Houtman, Co-Chair
Tim McGovern
Rose DuFour
Brian Midson

United States Coast Guard (USCG)
Jonathan Berkson
Eric Peace

United States Navy (USN)
Scott Livezey
Phillip Vinson
Tim Schnoor
Erika Sauer

Department of Interior (DOI)/Bureau of Ocean Energy Management
Guillermo Auad
Brian Zelenke

Department of Transportation(DOT)/Committee on Marine Transportation Services
Jaya Gosh

Staff: Barbara Bischof
Caitlan Adams, Margaret Lee, Brian Lane

NOAA Fleet Independent Review Team

In January 2016 NOAA established a senior-level independent review team (IRT) of outside experts to assess the health of the NOAA Fleet of research vessels, requirements for recapitalization, and analysis of operational, maintenance practices and technology infusion. The IRT is considering the compelling data-collection requirements that need access to the oceans; the applicable technologies and how they change the requirements; the appropriate fleet size and composition to meet needs; and best approaches to meet this need. Towards this objective, the IRT is assessing the NOAA Fleet for:

- Current Fleet composition and capabilities;
- Long-term recapitalization planning based on NOAA's at sea data-collection requirements;
- Utilization of alternatives to the NOAA Fleet (commercial contracting, Academic Research
- Fleet, other public-funded vessels) to meet requirements;
- Analysis of current operational systems (crewing, scheduling);
- Analysis of current maintenance practices;
- Technology readiness and infusion (instrumentation and mechanical);
- Risk identification, mitigation and management planning.

The IRT will provide a final report by the end of October, 2016 that addresses the task objectives.

Dick West (Co-Chair)
RADM, US Navy (ret)

Robert Winokur (Co-Chair)
Senior Advisor
Michigan Tech Research Inst / Michigan Tech Univ

Members:

Fred Byus
RDML, US Navy (ret)
Vice President & General Manager
Battelle Mission and Defense Technologies

Dr. John Hughes-Clarke
Professor
University of New Hampshire

John Crowley
RADM, US Coast Guard (ret)
Executive Director
National Association of Waterfront Employers

Bauke (Bob) Houtman
Head, Integrative Programs Section
National Science Foundation, Ocean Sciences

Dr. Steve Murawski
Professor
University of South Florida

Blake Powell
President
JMS Naval Architects

Nancy Rabalais, Ph.D.
Executive Director and Professor
Louisiana Universities Marine Consortium

Dr. Steve Ramberg
Distinguished Research Fellow
Center for Technology and National Security Policy,
National Defense University, Penn State Univ

Robert (Tim) Schnoor
Ocean Research Facilities Manager
Office of Naval Research

Dick Vortmann
President and CEO (retired)
National Steel and Shipbuilding Company

NOAA Fleet Recapitalization Team

NOAA established a team of senior subject matter experts from across NOAA to summarize the relevant legal, policy and programmatic at-sea mission needs to describe the NOAA Fleet core capabilities to support NOAA's missions. The Team documented the extent to which these needs are currently addressed and describe the capability gap that will exist absent fleet recapitalization. The Team developed a Fleet Plan, sequencing the planned end of service life (ESOL) of current vessels, and acquisition of new vessels (to include all phases of acquisition). This Plan addresses the composition and capabilities for NOAA's future fleet including the number and types of ships needed, when new ships would come on-line, where they would be deployed (regionally), and broadly what capabilities would be needed to support which missions. The Plan assessed capabilities and availability of charter vessels, as well as impacts of emerging technologies to the future fleet composition and provide specific recommendations on the composition and capabilities for NOAA's future fleet.

National Marine Fisheries Service
Captain Kurt A. Zegowitz, NOAA
Michael Gallagher

National Ocean Service
Captain Richard T. Brennan, NOAA

National Weather Service
Helmut Portmann

Office of Oceanic and Atmospheric Operations
John McDonough
Commander Daniel M. Simon, NOAA

National Environmental Satellite, Data, and Information Service/ Technology, Planning and Integration for Observation
David Helms
Aaron Pratt

Office of Marine and Aviation Operations
Captain Nancy L. Hann, NOAA
Charles Alexander
Lieutenant Jon D. Andvick, NOAA
Lieutenant Zachary P. Cress, NOAA

Office of the Under Secretary
Erika Brown