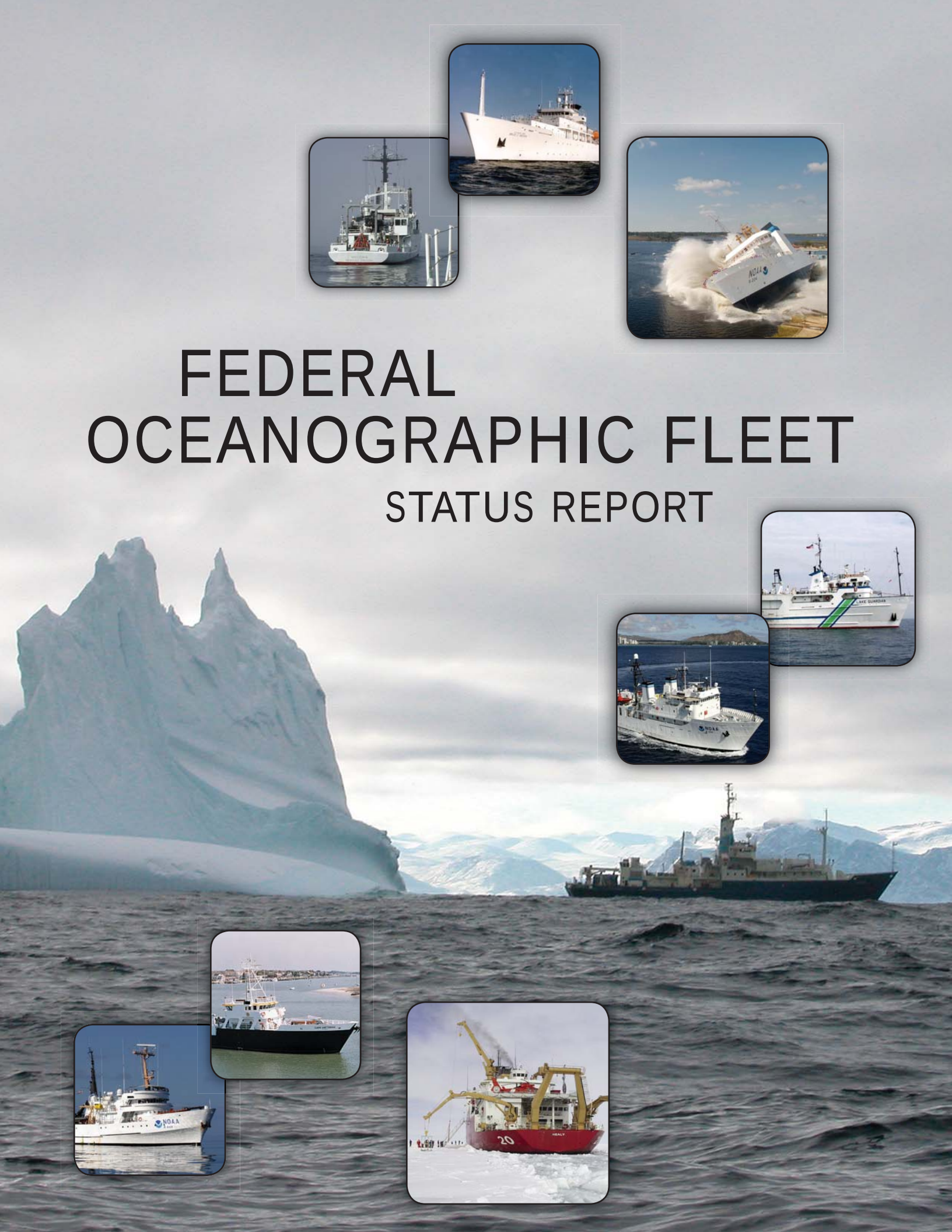

FEDERAL OCEANOGRAPHIC FLEET

STATUS REPORT

Cover Credits

Background photo: UNOLS Global Class ship, R/V *Knorr*, deploying moorings to measure freshwater flows between the Arctic and Atlantic Oceans that affect decadal-scale climate (Photo credit: Woods Hole Oceanographic Institution). Clockwise from top left: UNOLS Intermediate Class R/V *Wecoma* (Photo credit: Oregon State University). USNS *Bruce C. Heezen*, a Navy-owned Global Class survey ship (Photo credit: Navy). NOAA's new Ocean Class Fisheries Survey Vessel *Oscar Dyson* (Photo credit: NOAA). EPA Ocean Class research ship *Lake Guardian* (Photo credit: EPA). NOAA Ocean Class multi-purpose research vessel *Hi'ialakai* (Photo credit: NOAA). USCG Icebreaker *Healy* in the Arctic, with cranes extended, conducting research (Photo credit: PA3 Jamie Bigelow, USCG). UNOLS Regional Class R/V *Cape Hatteras* (Photo credit: UNOLS). NOAA Regional Class FSV *David Starr Jordan* (Photo credit: NOAA).

FEDERAL OCEANOGRAPHIC FLEET

STATUS REPORT

Prepared by the
Interagency Working Group on Facilities (IWG-Facilities)

for the Joint Subcommittee on Ocean Science and Technology (JSOST) and the
Interagency Committee on Ocean Science and Resource Management Integration (ICOSRMI)

July 2007

Council on Environmental Quality
Office of Science and Technology Policy
Executive Office of the President

Dear Partners and Friends in our Ocean Community,

We are pleased to transmit to you the *Federal Oceanographic Fleet Status Report*. This document presents the status of the national oceanographic fleet, which is a critical component of the infrastructure that supports federal research and operational marine missions.

In 2000, the U.S. Commission on Ocean Policy began the Congressionally-tasked process that led to over 200 recommendations for developing a national ocean policy. In response, in December 2004 the Executive Office released the U.S. Ocean Action Plan, which created a governance structure headed by the Cabinet level Committee on Ocean Policy (COP). Among other things, the Ocean Action Plan called for the development of a "National Oceanographic Fleet Renewal Plan that will define an interagency strategy for Federally-owned oceanographic ships operated by both Federal and academic organizations."

This document describes current fleet capacity and renewal activities planned during the period 2007–2015. It addresses those oceanographic ships that are greater than 40 meters in length that are owned and operated by the government, along with those federally-owned ships operated by the member institutions of the University National Oceanographic Laboratory System. The report draws on the collaborative contributions of the member agencies of the Interagency Working Group on Facilities and the institutions of the University National Oceanographic Laboratory System and was prepared under the auspices of the National Science and Technology Council"s Joint Subcommittee on Science and Technology.

The Fleet Status Report will help agencies plan their fleet development strategies over the next decade, while also providing a baseline for future planning activities. The report identifies infrastructure capabilities also needed to assist in the implementation of the recently released "Ocean Research Priorities Plan and Implementation Strategy." The information presented here describes a national capability and partnership among federal agencies and academic institutions in support of the nation's vital interests in understanding and being effective stewards of the world's oceans.

Sincerely,

James L. Connaughton
Chair, Committee on Ocean Policy
Chair, Council on Environmental Quality

John H. Marburger, III
Director
Office of Science and Technology Policy

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Department of Energy
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Department of Homeland Security
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Department of Labor
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Department of Transportation
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Environmental Protection Agency
Homeland Security Council
Joint Chiefs of Staff
Joint Subcommittee on Ocean Science
National Aeronautics and Space Administration
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National Science Foundation
National Security Council
Ocean Research Advisory Panel (ex-officio)
Office of Management and Budget
Office of Science and Technology Policy
Office of the Vice President
Subcommittee on Integrated Management of Ocean Resources (ex-officio) and Technology (ex-officio)
U.S. Army Corps of Engineers

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*The Federal Oceanographic Facilities Committee (FOFC) was formed to advise the National Ocean Research Leadership Council (NORLC) on policies, procedures, and plans relating to oceanographic facility use, upgrades, and investments. This group has transitioned to the Interagency Working Group on Facilities (IWG-Facilities) under the Administration's Ocean Action Plan structure and now provides guidance on requirements and other matters relating to national oceanographic assets to its parent body, the Joint Subcommittee on Ocean Science and Technology (JSOST).

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Smithsonian Institution	Leonard Hirsch

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- Co-Chairs: Paul Sandifer, Lorrie Backer

JSOST Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM)
- Chair: John Haines

JSOST Interagency Working Group on Ocean Observations (IWGOO)
- Chair: Richard Spinrad

JSOST Interagency Working Group on Ocean Partnership (IWG-OP)
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- Chair: Ellen Prager

Subcommittee for Integrated Management of Ocean Resources (SIMOR)
- Co-Chairs: Mary Glackin, Chris Kearney, Gerhard Kuska, Diane Rega

Subcommittee on Ocean Policy of the Global Environment Policy Coordinating Committee (Oceans Sub-PCC)
- Chair: David Balton

IWG-FACILITIES AGENCY OCEAN MISSIONS

Ship Owners/Operators

The NATIONAL SCIENCE FOUNDATION (NSF) funds research activities that span the globe, from domestic coastal waters to remote polar regions, in support of its mission to promote the progress of science, basic research and education. NSF's research ships advance programs in biological, chemical, and physical oceanography; marine geology and geophysics; and oceanographic technology development. On behalf of the United States Antarctic Program, and to support NSF Arctic science, NSF contracts with national and international sources for icebreaking services. Two leased ice-capable vessels are operated to maintain ocean science efforts in Antarctica. NSF also leases a vessel for deep scientific ocean drilling activities. www.nsf.gov

The Navy's OFFICE OF NAVAL RESEARCH (ONR) funds basic and applied research and technology demonstrations in support of near-term and future naval capabilities needed for the preservation of national security. ONR research ships support its programs in coastal geosciences, ocean acoustics, ocean engineering, undersea signal processing, marine meteorology, physical oceanography, and ocean optics and biology, primarily carried out by university laboratories through funded grants. www.onr.navy.mil

The NAVAL OCEANOGRAPHIC OFFICE (NAVOCEANO) acquires multidisciplinary global oceanographic, hydrographic, and geophysical data, and analyzes these data at their world-class computer center to understand the ocean's volumetric physical oceanography and geoacoustic seabed properties in support of the Navy's undersea warfare and homeland defense activities. NAVOCEANO owns seven military survey ships in support of its mission. www.navo.navy.mil

The NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA), an agency of the Department of Commerce, assesses and predicts environmental changes, protects life and property, provides information to decision-makers, manages the nation's living marine and coastal resources, and fosters global environmental stewardship. NOAA's fleet of research and survey ships collect hydrographic and coastal assessment data, conduct fisheries scientific survey operations and ocean exploration, and collect sustained oceanographic and atmospheric data in various marine environments. www.noaa.gov

The UNITED STATES COAST GUARD (USCG) has five fundamental roles: maritime security, maritime safety, protection of natural resources, maritime mobility, and national defense. The USCG operates the nation's three polar icebreakers, which provide icebreaking services that support resupply efforts of polar facilities (thereby supporting both polar research and the State Department's policy of maintaining a national sovereign presence in the polar regions), as well as more direct support for NSF and the other federal agencies' research. In addition, the USCG supports NOAA with cutters, boats, and aircraft hours for their National Data Buoy system. www.uscg.mil

The ENVIRONMENTAL PROTECTION AGENCY (EPA) owns and operates two ships. The OSV *Bold* operates in the Atlantic and Pacific Oceans and the Caribbean Sea to monitor water quality, effects of dredged material, coral reef health, and other special assessments. The R/V *Lake Guardian* operates in the Great Lakes, monitoring water quality and studying the biological community. www.epa.gov

Ship Users

The NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA) mission is to pioneer the future in space exploration, scientific discovery, and aeronautics research. NASA uses observations and modeling to help answer scientific questions about the oceans and their role in the Earth system. The Federal Oceanographic Fleet is used to support *in situ* studies, calibration of space-based sensors, and validation of remotely sensed data products. www.nasa.gov

The MINERALS MANAGEMENT SERVICE (MMS) of the Department of Interior manages mineral resources of the U.S. outer continental shelf (OCS) and collects and distributes revenues from their use. Passage of the Energy Policy Act of 2005 brings new responsibilities to MMS to manage the OCS renewable energy and alternative use program. MMS uses the Federal Oceanographic Fleet to acquire physical, biological, chemical, and geological data in support of safe and environmentally sound exploration; aid in the development and production of offshore natural gas, oil, and marine minerals; manage OCS renewable energy; and assess their environmental impacts. www.mms.gov

The U.S. GEOLOGICAL SURVEY (USGS) of the Department of Interior provides scientific information to describe and understand the earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life. The USGS uses the Federal Oceanographic Fleet and commercial vessels to characterize, monitor, and assess resource and hazard potential across state and federal waters and to conduct research on natural and human drivers of environmental change. www.usgs.gov

OTHER AGENCIES involved in ship issues include the Department of Energy (DoE), the Defense Advanced Research Projects Agency (DARPA), the U.S. Army Corps of Engineers (USACE), and the Department of State.

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EXECUTIVE SUMMARY

The Federal Oceanographic Fleet is valuable infrastructure that supports federal agency research and operational maritime missions. The Fleet enables scientists to conduct basic research on the oceans and seafloor, emplace and maintain sensors in support of climate studies and natural disaster warning programs, and respond to catastrophic events around the globe. The Fleet acquires important data for fisheries assessments, pollution monitoring, habitat protection, resource management, and national defense and is instrumental for the education of future oceanographic scientists. Policy-makers and the general public also benefit from the research conducted on the vessels.

The Fleet is mainly categorized into four classes of ships based primarily on size. Global Class ships are the largest and most capable, being able to work worldwide for long time periods with large scientific parties. Ocean Class ships are slightly smaller, have many of the same capabilities as those in the Global Class category, and are ocean-going, but typically are not globally ranging. Intermediate Class ships are older and less-capable vessels that are currently being considered for phase-out and replacement by technologically advanced Ocean Class vessels. Regional Class ships are smaller than Ocean Class vessels and are optimized for operation in coastal waters, bays, and estuaries. Local Class ships are the smallest in the Fleet and are used primarily in waters adjacent to their home ports.

This *Federal Oceanographic Fleet Status Report*, prepared by the Interagency Working Group on Facilities (formerly the Federal Oceanographic Facilities Committee [FOFC]), describes current Fleet capacity and renewal activities planned during the period 2007–2015. It addresses only the Global, Ocean-Intermediate, and Regional Class ships because the majority of the Local Class ships are not federally owned. By 2015, 17 of the 44 ships in the current Federal Oceanographic Fleet will reach their nominal 30-year End of Service Life dates. Thirteen new, technologically advanced ships have either received dedicated Congressional appropriations, are being funded within agency appropriations, or are in the 2008 President's Budget Request to Congress.

Based on End of Service Life estimates of the current Fleet and the new ships planned, overall Fleet capacity is projected to remain stable until 2015. Agencies will continue to take into account Fleet utilization and the impact of steadily increasing operational costs to ensure the most efficient and effective Fleet operations are conducted at the lowest possible life-cycle costs. Future Fleet capacity needed to support national ocean research priorities will be determined through an interagency infrastructure assessment process under the auspices of the Joint Subcommittee on Ocean Science and Technology (JSOST) and led by the Interagency Working Group on Facilities (IWG-Facilities).

1. INTRODUCTION

The federal oceanographic research and survey fleet consists of sophisticated ships that permit scientists to survey and conduct research on the complex ocean, seafloor, and sub-seafloor environment. Research vessels are instrumental in collecting observational data on Earth systems that provide a foundation for understanding how these systems work and for improved modeling. Research vessels are important educational platforms for graduate students and undergraduates in the marine sciences, providing valuable training and at-sea experience for young researchers. Research vessels also provide opportunities for teachers to acquire skills that translate into innovative class projects, thereby inspiring a new generation of scientists (Figure 1).

Data collected by ships have led to the identification of new energy resources, the discovery of life in extreme environments at and below the seafloor, and have enabled the search for marine organisms with the potential to treat or cure human diseases. Through at-sea sampling and observing, researchers have begun to understand, model, and predict the responses of marine populations to both long-term and episodic changes in ocean conditions. Scientific ocean drilling and seismic reflection surveys have led to a deeper understanding of the physical state of the Earth that can generate small to great earthquakes. Mapping and analyzing ancient ocean sediments have revealed changes in deep ocean circulation and heat distribution around the planet, leading to a better understanding of the causes and consequences of current climate changes.

Figure 1. Maggie Hardgrave, a 7–9 grade teacher, sailed for 32 days on the R/V *Atlantis* in 2004. Among other tasks, she retrieved water samples from various depths along the Juan de Fuca Ridge (NE Pacific Ocean) to analyze the composition of hydrothermal fluids and track the extent of the hydrothermal plume through the water column. A long-term outcome of Ms. Hardgrave's research experience at sea is that she has developed field exercises and research protocols for her students in New York City. (Photo credit: REVEL Project, University of Washington)

Recording conditions at and below the ocean's surface over periods of years to decades has provided information that is fundamentally important to agriculture, fishing, and severe weather prediction, and will lead to a better assessment of the natural variability in Earth's climate system.

Major new scientific discoveries have been made possible as a result of operations conducted from ships of the Federal Oceanographic Fleet, including the discovery of rich biotic communities at seeps, thermal vents, and hot springs on the deep seafloor using the deep submergence vehicles *Alvin* and *Jason*. In 2000, scientists discovered a new kind of submarine hot spring environment, called Lost City, on the Mid-Atlantic Ridge in one- to two-million-year-old mantle rock (Figure 2)[1]. Numerous 30-m-tall limestone chimneys extended over an area more than 350 m in length. Dating of the chimneys showed continuous hydrothermal activity in this region for at least 30,000 years[2]. In 2004, while studying marine life in the Gulf of Mexico, scientists made the revelation that methane hydrates, a potentially important clean energy source, are fluorescent. This discovery could lead to unique new detection and harvesting techniques previously not possible, which would help make this energy more readily available[3].

Ships in the Federal Oceanographic Fleet enable basic and applied research in coastal regions of the United States, which are among our nation's most valuable natural resources. Holding more than 50% of the U.S. population on only 17% of the nation's land area, coastal regions make substantial contributions to economic growth, quality of life, and national security[4]. As users and stewards of coastal regions and of the deep ocean, we need to better understand and

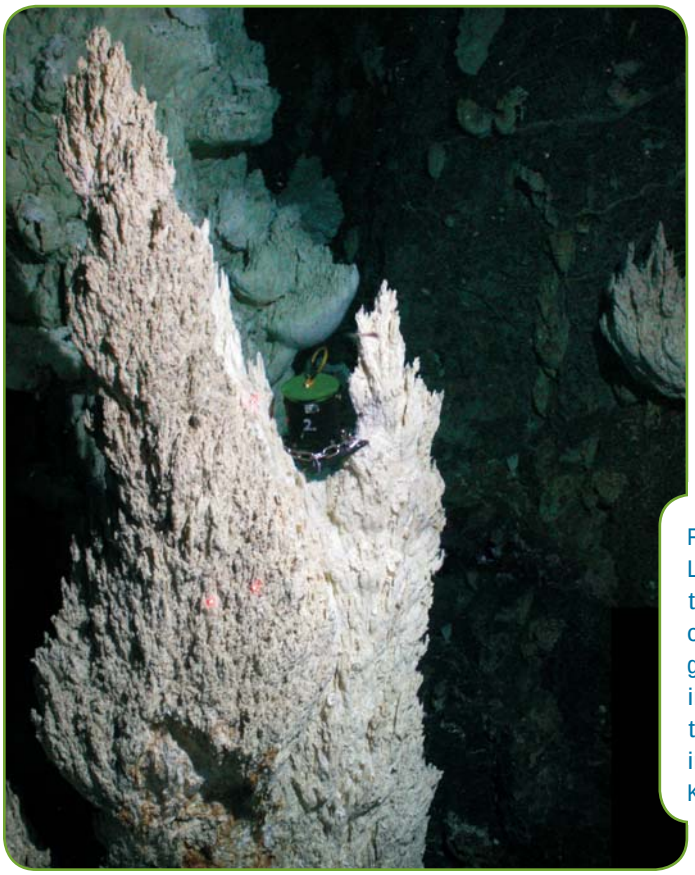


Figure 2. Isolated pinnacle located in the eastern portion of the Lost City Hydrothermal Field. The black and green container in the saddle between the two pinnacles is a biological experiment containing pieces of mantle rocks bathed in diffuse flow. The background shows near-vertical walls with active carbonate seeps. Mixing of the high-pH fluids with seawater forms a variety of deposits that include those resembling upturned hands. The red laser dots in the center-left of the image are 10 cm apart. Reprinted from Kelley, D.S. 2005. *Oceanography* 18(3):32-45, Figure 3.

predict how the ocean margin environment responds to environmental perturbations. The Federal Oceanographic Fleet enables scientists, managers, and decision-makers to monitor such things as pollution from industry that causes red tides, fish kills, and other harmful events; assess and enable the sustained use of our nation's fish stocks; evaluate permit applications for dredging and drilling; protect and restore coastal ecosystems; and improve the safety and security of our nation's harbors and maritime transportation routes.

The Federal Oceanographic Fleet provides rapid-response support for catastrophic events and natural disasters around the globe. For example, NOAA, NSF, and EPA ships played key roles in collecting water, fish, shellfish, and sediment samples in the wake of Hurricane Katrina (2005) to determine human-health risks caused by the devastation and potential environmental impacts of the hurricane on living marine resources. NOAA and Navy ships were instrumental in mapping coastal bathymetry changes immediately after the Southeast Asian tsunami (2004) to allow for safe navigation, and assisted in recovery operations for the Egypt Air Flight 990 (1999) and TWA Flight 800 (1996) aircraft disasters.

This *Federal Oceanographic Fleet Status Report* describes the current and planned fleet capacity for ships with an overall length greater than 40 m (130 ft) that are coordinated by the IWG-Facili-

OCEANOGRAPHIC SHIPS MAKE IT POSSIBLE TO:

- Conduct basic research on the ocean and ocean floor's physical, chemical, geological and biological processes and interactions.
- Support research and sensor placement that enable disaster warnings to be issued for hurricanes and tsunamis.
- Support biomedical research in the marine realm to enable discovery of new pharmaceuticals and therapies.
- Provide tactical and strategic oceanographic information in support of national defense and homeland security.
- Understand and assess the status of living resources (e.g., fisheries) to provide the best available information for use by quota and allocation resource and conservation managers and policy-makers.
- Map, sample, and monitor physical, biological, geological, and chemical ocean features that influence weather and climate.
- Map, sample, and monitor the ocean floor in geologically active areas to contribute knowledge about mineral deposition, life in extreme habitats, natural hazards, and plate tectonics.
- Construct Earth's geologic and/or climatic history as recorded in corals, the ocean floor, and polar ice.
- Discover and protect archeological resources to enable studies about how ancient civilizations used the sea.
- Assess ocean resources and renewable energy for sound management and development.
- Enhance ocean science educational programs and inspire teachers as well as the general public.
- Deploy new instruments and technology that extend ocean sensing to other platforms, such as remotely operated vehicles, autonomous underwater vehicles (undersea gliders and propeller-driven), drifters, and profiling floats.

ties through a long-standing interagency process. It incorporates all federal oceanographic research and survey ships into a coordinated and detailed approach for Fleet renewal and transformation from older, less-capable ships to highly advanced fully equipped vessels in the near-term years 2007–2015. This report recognizes the importance of continually assessing and defining the Fleet capacity and capabilities needed to support agency missions and the national priorities such as described in the *Ocean Research Priorities Plan and Implementation Strategy*[5]. A broad range of options will be considered when evaluating the most cost-effective ways to meet the national ocean research priorities infrastructure needs, including increased capabilities from new technology solutions and private-sector resources where appropriate.

A robust federal fleet of vessels and aircraft is required to conduct monitoring, mapping, enforcement, response, and safety activities in both coastal waters and the open ocean…the nation will always need to maintain a federal fleet that can quickly and effectively respond to environmental disasters, conduct assessments on a routine basis, and enforce applicable laws. Regular upgrades to these vessels and aircraft are needed to incorporate cutting-edge technologies, increase fleet capacity, and address both national and international safety requirements.

An Ocean Blueprint for the 21st Century: Final Report of the U.S. Commission on Ocean Policy[6]
September 2004

The U.S. Ocean Action Plan[7], the formal response by the Administration to the Ocean Commission's final report, calls for, "… a National Oceanographic Fleet Renewal Plan that will define an interagency strategy for Federally-owned oceanographic ships operated by both Federal and academic organizations. The ship renewal plan will provide a vision for the future composition and size of the Fleet to meet projected needs for research, for deployment and operation of observing systems, and for agency mission-oriented oceanographic operations."

2. THE FEDERAL OCEANOGRAPHIC FLEET

A. FLEET COORDINATION

Federal agencies have coordinated closely on Fleet-related issues through the FOFC and, as the transition to the IWG-Facilities is completed, will continue these efforts through this new Interagency Working Group. Established in the early 1980s by federal agencies with an interest in oceanographic infrastructure and brought under the National Oceanographic Partnership Program in 1999, the FOFC provided a forum to discuss relevant Fleet-related matters. Included in these discussions have been the transfer and conversion of surplus ships between agencies to meet specific mission needs. Although funding for ship acquisition occurs through specific agency budget requests and associated appropriations, agencies coordinate scheduling and, when practical, share ship time, ship designs, equipment, and technicians. FOFC members included Navy, NOAA, NSF, NASA, USCG, EPA, MMS, USGS, DoE, DARPA, USACE, and Department of State. Of the ships coordinated by the FOFC, most NSF ships, all institution-owned ships, and some Navy, NOAA, and USCG ships are scheduled through the University National Oceanographic Laboratory System (UNOLS)[8]. Similar to the FOFC, the IWG-Facilities meets several times per year, with UNOLS representation, to discuss and resolve Fleet-related issues as they develop. Subcommittees and subgroups in both the IWG-Facilities and UNOLS organizations will continue to coordinate activities associated with efficient operation and maintenance of the Fleet, including vessel designs, mission requirements, and International Safety Management (ISM) requirements such as vessel and port security, enhanced vessel safety equipment, and crew training.

B. RESEARCH AND SURVEY SHIPS

Currently, there are 44 ships in the Federal Oceanographic Fleet with overall length greater than 40 m (130 ft) (Appendix 1). Of these 44 ships, 42 are owned by the federal government and two are leased long term. In this Fleet status report, the IWG-Facilities grouped the ships into Research and Survey categories, based on their primary purpose and capabilities. Vessel support for agency missions requires a mix of both categories of ships, which vary in size and capability, with a full array of tools to provide cost-effective oceanographic and living-marine resource surveys and scientific research.

Each ship in the Federal Oceanographic Fleet should generally have multiple basic capabilities to enable agencies to carry out their missions. Laboratory spaces should provide good working conditions for scientific and technical staff, even in rough weather, with excellent communication and computer facilities. Laboratories should have clean, reliable electrical power for instruments, computers, and other equipment. The ships need to be safe, habitable, self-sufficient, and capable of accomplishing their missions, which may also include supporting ocean observing systems and calibrating space-based sensors. Certain ships may require a unique design, instrumentation, or capability that sets them apart from others in their class and from commercial vessels, such as the eight Fisheries Survey Vessels (FSVs) listed in Appendix 1.

- Research ships carry a broad array of scientific instrumentation capable of supporting activities such as water-column and seafloor sampling, monitoring, and acoustic and photographic mapping. Laboratories equipped with sophisticated analytical equipment and computers allow preliminary data analysis and sample storage while underway. Data collected often provide real-time input into cruise execution, enabling scientists to make adjustments to mapping or sampling plans. Most vessels are multi-purpose and able to conduct a variety of research activities during a single expedition. Some research ships are specialized, having the ability to conduct multichannel seismic operations, deploy and recover human-occupied vehicles (HOVs), recover long sediment and rock cores, and conduct ocean drilling experiments in all parts of the ocean, or operate at high latitudes in the Arctic and the Southern Ocean (Figure 3).

- Survey ships acquire a wide range of oceanographic, charting, pollution, fisheries, and habitat data, often in support of resource management programs. Their laboratories have instruments to routinely calibrate and analyze data obtained by continuously operating acoustic and optical devices and other survey instruments. Selected survey cruises are repeated periodically (e.g., seasonally or annually) to provide data time series. Some survey ships are designed for specialized missions. For example, FSVs are very quiet over a wide range of speeds (in accordance with standards defined by the In-

Figure 3. Research ships are able to conduct multiple research activities during a single expedition, though some are specialized for specific research or support operations. Top to bottom. R/V *Atlantis* with Deep Submergence Vehicle *Alvin* hanging from the A-frame (Photo credit: Woods Hole Oceanographic Institution). The scientific drillship *JOIDES Resolution* (Photo credit: Integrated Ocean Drilling Program, U.S. Implementing Organization). R/V *Maurice Ewing* shooting multichannel seismic profiles (Photo credit: Lamont-Doherty Earth Observatory). USCG Icebreaker *Healy* in the Arctic, with cranes extended, conducting research (Photo credit: PA3 Jamie Bigelow, USCG).

ternational Council for Exploration of the Seas [ICES][9]) while others are capable of collecting high-resolution bathymetry, gravity, and magnetic data to enable construction of detailed seafloor maps.

All vessels in the Federal Oceanographic Fleet are capable of providing at-sea experiences to teach students, teachers, and the general public about the oceans. In addition to undergraduate and graduate class cruises, activities include grades K–12 teacher training and demonstration of new technologies and research results, often as part of targeted outreach programs. Increasingly, teachers and students in classrooms around the country participate in cruises through the Internet by following lesson plans developed by the agencies or funded through federal grants, viewing progress reports from expeditions, and joining audio-video conferences with scientists while they are working aboard ship or on the ocean floor in a submersible, such as DSV *Alvin*. Most IWG-Facilities agencies use or provide time on ships included in this Fleet status report to accomplish education and outreach goals (Appendix 2).

C. SHIPS BY CLASS

Research and survey ships can be categorized by class based primarily on size. Larger ships generally have greater range; carry more scientists and crew; have larger, more extensively equipped laboratories; and are more expensive to build and operate. This Fleet status report apportions the Fleet into four classes (Table 1); however, it addresses only the largest three of the four classes, specifically those ships with lengths greater than 40 m (130 ft), because of their significant renewal, maintenance, and operating costs.

Table 1. Ship Classes

Ship Performance/Class	Global Class	Ocean Class (Intermediate*)	Regional Class	Local Class
Endurance	50 days	40 days	30 days	20 days
Range	25,000 km	20,000 km	15,000 km	10,000 km
Length	> 70 m	55–70 m	40–55 m	< 40 m
Science berths	30–35	20–25	15–20	15 or less
New types of ship designs, such as twin hulls, may lead to vessels having capabilities similar to those of a larger class. Local Class ships are not addressed in this Fleet status report. *Intermediate refers to a class of older, less-capable ships that will be replaced by Ocean Class ships. Intermediate Class ships were not designed to these criteria.				

- Global Class ships (> 70 m or 230 ft) are highly capable vessels, able to work world wide, have an at-sea endurance of 50 or more days, are able to carry more than 30 scientists and technicians, and have a range of 25,000 km (13,500 NM). With their extensive deck space and equipment, and a broad and diverse complement of laboratory space and outfitting, they are equipped to handle a wide array of instruments and to deploy suites of moorings, autonomous vehicles, large and complex sampling tools, and sophisticated acoustical equipment. Some vessels in this class support specialized services, including the operation of deep-submergence vehicles or multichannel seismic reflection equipment. Some are ice-strengthened for operations in higher latitudes.

- Ocean Class (Intermediate) ships (55–70 m or 180–230 ft) are designed to support integrated, interdisciplinary research and surveys with many of the same capabilities of the modern Global Class ships on cruises of somewhat shorter duration (40 days) and with fewer (up to 25) participating scientists. They have a range of 20,000 km (10,200 NM) and generally operate from their home port, with only occasional cruises to other oceans. Intermediate Class ships (e.g., Figure 4), which are smaller than Ocean Class ships, are being phased out as they become less capable of meeting the support needs of the scientists. Their missions are being replaced by the newer and more technologically advanced Ocean Class and Regional Class ships.

Figure 4. Scientists and crew aboard the UNOLS Intermediate Class R/V *Oceanus* prepare a Conductivity-Temperature-Depth instrument for deployment off Cape Hatteras. (Photo credit: C. Linder, Woods Hole Oceanographic Institution)

- Regional Class ships (40–55 m or 130–180 ft) are the smallest vessels for which federal funding is anticipated to be the primary source for construction. With a range of 15,000 km (8,100 NM) and about 30-days endurance, these vessels typically operate on the continental shelf and in the open ocean with the capability to work in shallower areas such as estuaries and bays. They can carry up to 20 scientific staff and many of the same instrument systems as the larger ships, but are optimized for operation in shallower water and typically have shallow drafts.

- **Local Class** ships (< 40 m or 130 ft) typically have an endurance of 20 days, a range of 10,000 km (5,100 NM), and carry 15 or fewer scientific staff. They continue to be an important component of the Federal Oceanographic Fleet; however, they are not considered in this *Federal Oceanographic Fleet Status Report* because of their lower capital renewal costs and the majority are not federally owned. Science mission requirements and vessel design are largely driven by local and regional needs.

3. FLEET MISSIONS AND UTILIZATION

A. MISSIONS

This *Federal Oceanographic Fleet Status Report* highlights the current agency missions supported by the Fleet and gives a sense of future trends based on recent ocean science assessments[10,11,12]. The *Ocean Research Priorities Plan and Implementation Strategy*[5] provides additional insight into research areas to be considered important for the national interest. In the period 2007–2015, some agencies anticipate growth in ship use while other agencies project their usage rates will remain approximately the same as current levels.

NOAA missions in living marine resources, safe navigation, weather and climate services, and Marine Protected Areas call for access to a diverse mix of operational systems to conduct ocean/in situ/at-sea data collection. NOAA is playing a role in hazard detection and notification, especially in deploying and maintaining tsunami-warning systems for the Deep Ocean Assessment and Reporting of Tsunamis (DART) Program[13] (Figure 5). In addition, NOAA's goals in ocean exploration, coral reef ecosystems, fisheries habitat, climate research, and implementation of integrated ocean and coastal observing systems may result in expanding use of ship time to accomplish the mission goals.

The USCG currently supports research in the polar regions by operating the nation's icebreaking fleet for NSF on a reimbursable basis. In addition, the USCG supports NOAA with cutters, boats, and aircraft resource hours that help maintain their National Data Buoy System. If this network expands as part of the Integrated Ocean Observing System (IOOS)[14], the support provided from entities outside the USCG may need to be reviewed.

Looking to the future, basic and applied research are expected to be funded by NSF and ONR at the same level as in the recent past, and therefore infrastructure support is also anticipated to be needed at the same level. Increased focus on climate change, ocean circulation, and environmental and fisheries research in the seasonally ice-covered waters in the Alaskan region is driving the need for a more capable, ice-strengthened vessel to operate in this harsh environment. It is anticipated that the Alaska Region Research Vessel (ARRV), an Ocean Class vessel, included in the FY 2007 President's Budget Request to Congress for funding through the NSF Major Research Equipment and Facilities Construction (MREFC) account, will fill this critical infrastructure requirement. The NSF Office of Polar Programs (OPP) also supports basic research, including climate-change

Figure 5. NOAA Global Class ship *Ronald H. Brown* servicing a DART tsunami warning buoy. The DART system consists of a seafloor bottom pressure recording system capable of detecting tsunamis as small as 1 cm in the open ocean (the height of which can increase to many meters as the bottom shallows and they approach the shore), and a surface moored buoy for real-time communications. An acoustic link transmits data to the surface buoy.

studies in the Arctic Ocean and in the waters surrounding Antarctica. Platforms, including USCG icebreakers, internationally owned icebreakers, leased ice-capable vessels, fuel tankers, and cargo ships from the Military Sea Lift Command provide support for high-latitude research activities and the United States Antarctic Program (USAP).

The academic science community has demonstrated the value of an advanced-technology ocean drillship that can return the highest-quality seafloor sediment, fluid, and rock samples to conduct research on environmental change, processes, and effects; solid Earth cycles and geodynamics; and the deep biosphere[15]. Drilling activities by the Integrated Ocean Drilling Program (IODP)[16] are projected to be at a level similar to past operations, although improved ship capabilities should enable increased scientific activity.

Use of NAVOCEANO's fleet of seven survey vessels is based on Navy requirements in support of national security. Expanding programs and continued support of other federal agencies' survey missions may increase the use of NAVOCEANO ships in support of national priorities.

EPA operates two ships that monitor and assess impacts from ecological disturbances and land- and ocean-based human activities on the oceans, Great Lakes, and coastal waters. EPA's ships support its mission to monitor water quality and its statutory obligation to monitor the deposition of dredged materials under the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972.

NASA will continue to use ship time in support of calibration activities for satellite-based sensors, ocean biology and biogeochemistry research, research in ocean physics, and validation of data products from space-based and aircraft-borne sensors. NASA investigators work collaboratively with other agencies and investigators to conduct oceanic research for approximately six months each year.

The USGS foresees an increasing use of ships for seafloor and geophysical characterization related to habitat identification, establishment of continental shelf limits, and hazard assessment, particularly with respect to potential tsunami hazards. USGS technical capabilities will continue to be applied largely in collaboration with other federal agencies in support of comprehensive environmental characterization. Not having its own ships, application of USGS expertise in data collection, analysis, and interpretation will be based on continued access to vessels of the Federal Oceanographic Fleet.

MMS anticipates increased deepwater research over the next 5–10 years in the Gulf of Mexico Outer Continental Shelf (OCS) waters from 300–3000 m (984–9,840 ft) depth to monitor and understand the effects of increasing exploration and development of oil and gas resources on deep-sea benthic ecology and physical processes. In addition, MMS anticipates acquiring a new set of offshore environmental data to support the OCS renewable energy and alternative use program.

Several agencies have large initiatives currently in the planning stages. Should those become funded programs, adjustments in Fleet size and composition may need to be considered. For example, the NSF-led Ocean Observatories Initiative (OOI)[17] is expected to be implemented over the next ten years. Ships will be used to install, service, and remove oceanographic buoys, moorings, and deep seafloor infrastructure and instrumentation. The IWG-Facilities will continue to assess the fleet capacity needed as new programs are funded.

B. UTILIZATION

As defined for this *Federal Oceanographic Fleet Status Report*, capacity is the ability of the Fleet to support federally funded projects in a timely and cost-effective manner. It is determined by considering a number of factors in combination: the total operating budget, the total number of ships in the Fleet (or in a particular class of ships in the Fleet), the ships' design/size/range/endurance, the total number of available science berths, the ships' mission configuration, and the Fleet's geographic distribution. Fleet capacity impacts the number of operating days available, science-party size, maximum cruise lengths, and the ability to operate in certain areas.

Over the past decade, NAVOCEANO, NOAA, and UNOLS Global Class ships, as well as the NOAA Ocean Class ships have been operating at or near their optimum usage (Figure 6a and 6b). The R/V *Kilo Moana* is currently the only UNOLS Ocean Class ship in the Fleet. It entered service in 2002 and started the transition of the UNOLS fleet from the outdated Intermediate Class ships to the modern, highly advanced Ocean Class ships. Insufficient bunk and laboratory space to accommodate large interdisciplinary projects, lack of certain ship capabilities (e.g., dynamic positioning), and the smaller size of the Intermediate Class ships has had a negative impact on their utilization (Figure 6c). With the increased complexity of the present-day science experiments and the inability to operate effectively in high latitudes during the fall and winter seasons, Intermediate Class ships have become much less capable of meeting the needs of science teams. NOAA Regional Class ships have been utilized very effectively over the past decade (Figure 6d). The lower usage of the four UNOLS Regional Class ships in the past several years is due to the reduced capabilities of the 40-year-old R/V *Alpha Helix,* which was retired in 2006. Although the use of UNOLS ships by ONR and NSF has remained fairly steady in the recent past, the mix of type of ships used by each agency has shifted, with NSF using a greater portion of the available Global Class ship days. EPA's two ships are fully utilized, with statutory MPRSA monitoring requirements filling most of the OSV *Bold*'s yearly working capacity.

During the last decade, NASA has used approximately six months of ship time per year to support ocean research activities. The USGS has recently used about 50 days at sea per year. MMS has used UNOLS and NOAA vessels and chartered commercial ships to address its oceanographic information needs.

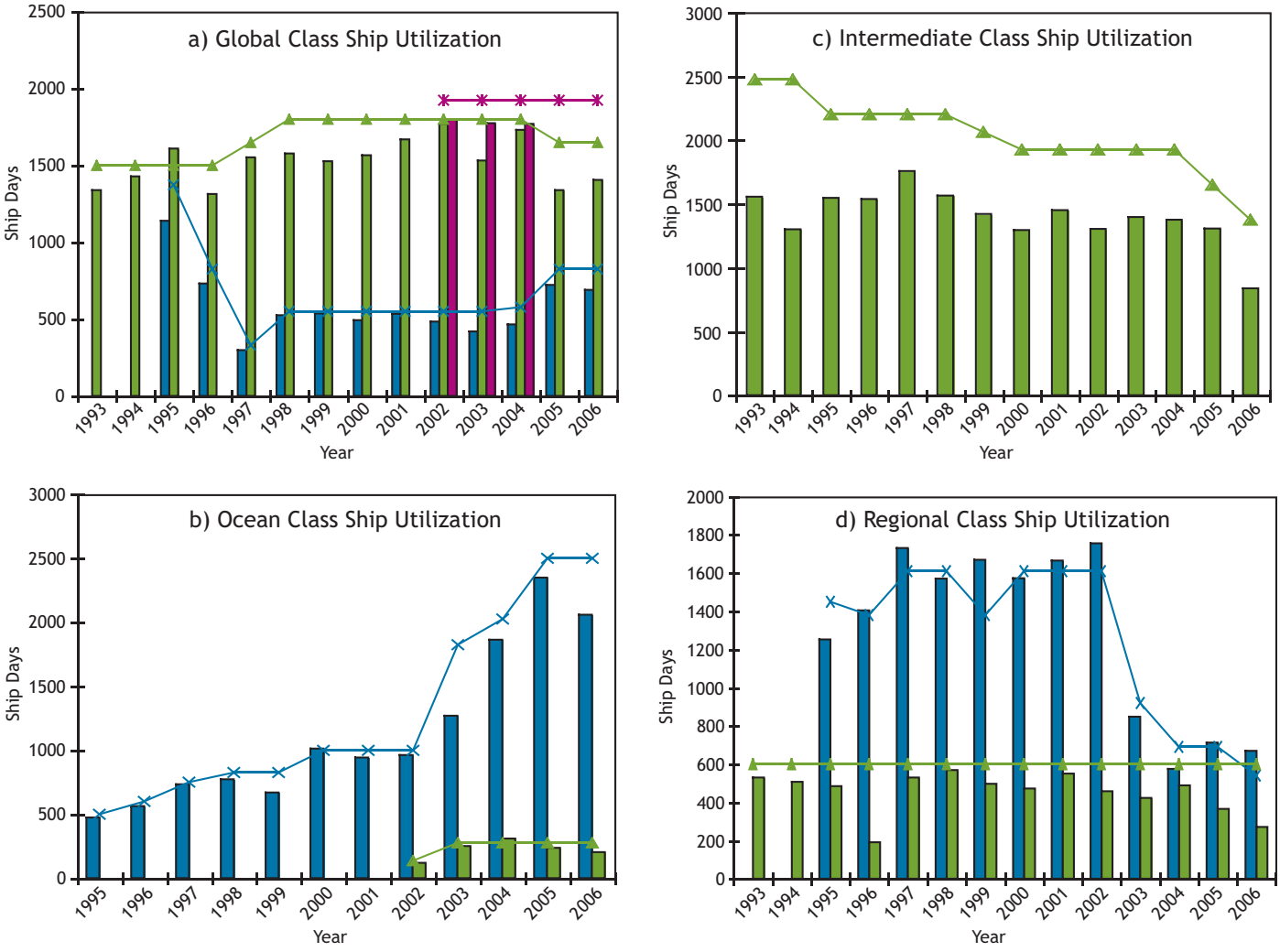


Figure 6.Fleet utilization by class for NOAA, NAVOCEANO, and UNOLS ships. Ship days include those used by all federal agencies. (a) Global Class ships have been operating near optimum usage. Data includes five UNOLS, three NOAA ships (polar not included) and only three years of data were available for the six NAVOCEANO ships. (b) The ten NOAA Ocean Class ships have been operating near optimum usage. R/V *Kilo Moana* is the only UNOLS Ocean Class Research ship currently in the Fleet. (c) Utilization of the five UNOLS Intermediate Class ships reflects their reduced capacity to meet the requirements of present-day science experiments due to size and technological obsolescence. (d) The three NOAA Regional Class ships have been effectively utilized. Utilization of the four UNOLS ships reflects reduced usage of the 40-year-old R/V *Alpha Helix*, which was retired in 2006.

C. CHALLENGES AND IMPACTS

The federal agencies are managing numerous challenges associated with cost-effectively operating and maintaining the Fleet, while at the same time assessing the need and planning for renewal of ships as they reach their projected End of Service Life dates. These challenges include matching Fleet capabilities to missions across agencies, addressing rising operational costs, and meeting crew and training requirements.

The current Federal Oceanographic Fleet capacity, while strongly supportive of the federal agency missions, has the potential to improve in certain areas. There are times when ships with specific technical capabilities desired for a selected cruise by an agency are not available. For example, ships that are available may not have the ability to conduct operations in winter months or in high latitudes (UNOLS Intermediate Class ships are not used as frequently due to their smaller size and reduced sea-keeping ability); may not be sufficiently quiet for fisheries assessments (as a result, NOAA is transitioning to the new FSV design); may not have the ability to handle HOV, autonomous underwater vehicles (AUV), or remotely operated vehicles (ROV) and their associated equipment; or may not have precise station-keeping abilities (UNOLS Intermediate Class ships have a limited ability to handle AUV/ROV equipment and do not have dynamic positioning systems). Ships may be laid up for unplanned repairs during high-demand periods and older ships may be out of service for extended periods because replacement parts are not readily available. Additional coordination of operations and maintenance plans for ships in the Fleet by the owning agencies is being pursued and may increase availability to support specific missions.

Some of the actions taken by the federal agencies in response to Fleet capacity and capability challenges include canceling, deferring, or conducting at-sea science programs under less-than-optimum circumstances. For example, science missions that cannot be supported by the smaller and less-capable UNOLS Intermediate Class ships or cannot be cost-effectively contracted to the private sector are being deferred until the larger Global Class ships are available.

In addition to the challenges associated with Fleet capacity and capabilities, the federal agencies have been addressing the issues of operating and maintaining the Fleet as costs continue to rise. Figure 7 illustrates the rising costs experienced by the UNOLS Global Class vessels. In addition to significantly higher fuel costs, the introduction of new security requirements (such as secure dock facilities and surveillance systems); new international safety standards; new pollution control measures on ballast water, garbage disposal, and shipyard work; and the rising cost of health care coverage have all contributed to the

increased operating costs. As the Fleet has aged, maintenance costs have also risen because older ships require more frequent and extensive repairs. When federal managers of oceanographic facilities are faced with budget shortfalls as a result of rising costs, the options available to them for overall program management are to take funds from core science programs (if available); switch to new modes of operation, including additional sharing of ships between agencies; seek increased funding from non-federal sources; reduce research and operations plans; defer research and maintenance; and schedule non-operational periods and/or retire ships. Although these actions may resolve short-term funding problems, they perpetuate funding and scheduling issues in the out-years and limit the ability of scientists to conduct valuable research, education, and survey activities.

Ship operators are being challenged in hiring qualified crew, especially engineers, due to increased training requirements. Entry-level crew cannot afford to train or gain experience for higher-level licenses and fully experienced and licensed crew command higher wages and are nearing retirement age. The requirements for obtaining necessary certifi-

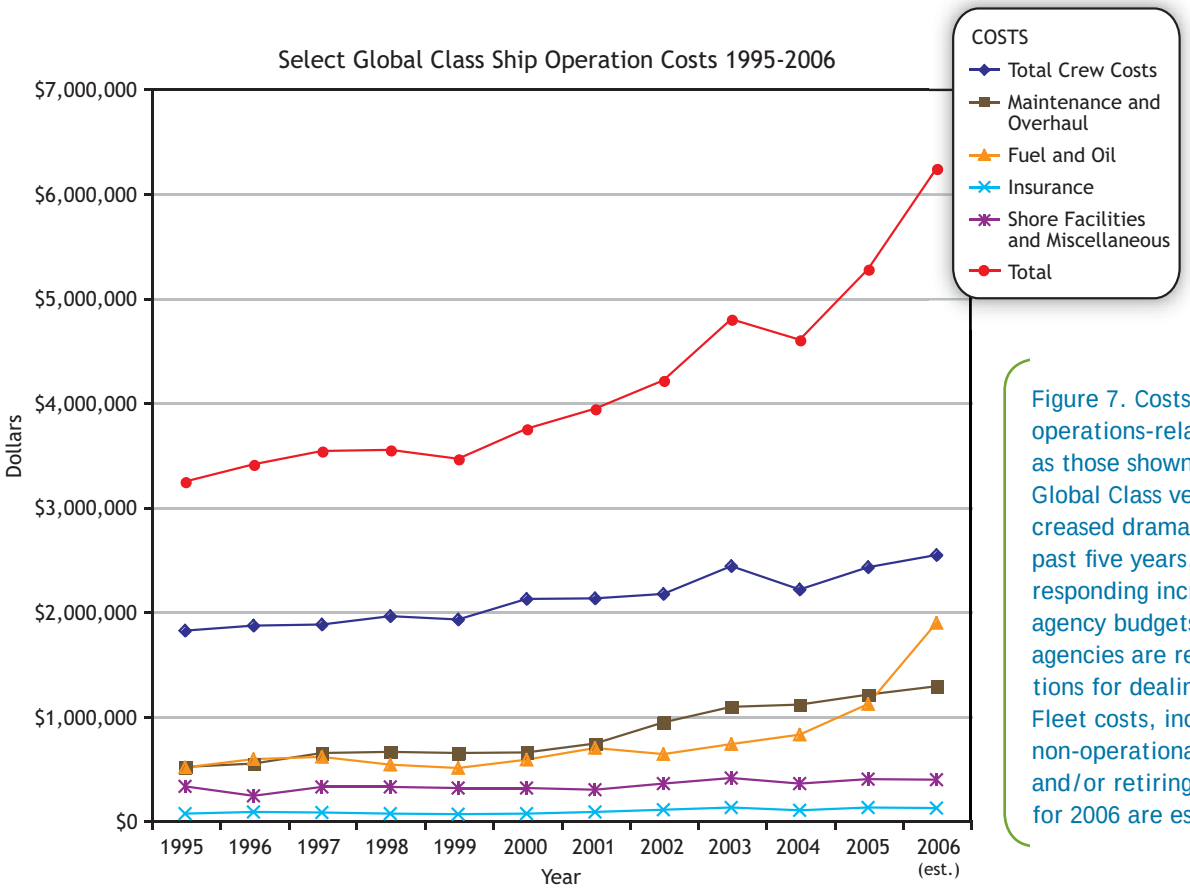


Figure 7. Costs of several ship-operations-related items, such as those shown here for UNOLS Global Class vessels, have increased dramatically over the past five years, without corresponding increases in federal agency budgets. The federal agencies are reviewing all options for dealing with increased Fleet costs, including scheduling non-operational periods and/or retiring ships. (Costs for 2006 are estimates.)

cations, compounded by the obvious challenges of going to sea, being away from home port for extended periods of time, and competition from the commercial shipping industry, are also affecting the ship operators' ability to retain and recruit qualified marine technicians and crew.

The IWG-Facilities and ship operators are working together to address the challenges of operating and maintaining the Fleet in the face of rising costs, while also assessing and planning for renewal, as needed, to ensure the appropriate level of fleet capacity will be available in the future.

4. RENEWAL AND TRANSITION PLANS

A. 2007–2015: RESEARCH SHIPS

Currently, there are 11 Global Class, 11 Ocean Class (five of which are the older Intermediate Class ships), and three Regional Class research ships. Seven of these research ships are expected to remain in service beyond 2025 (Figure 8). As of this writing, three funded (appropriated/partially appropriated) ships (*Langseth*, Scientific Ocean Drilling Vessel [SODV], *Okeanos Explorer*), should enter the Fleet in the period 2007–2008 (Figure 9). By 2015, an additional three ships are programmed for which funding will be provided from within agency budgets (RCRV 1–3), and one is programmed through the NSF MREFC account when funding is appropriated (ARRV). The two Ocean Class ships programmed by Navy (OCRV 1–2) will support the transition of the Fleet from the technologically obsolete Intermediate Class.

Global Class

Of the 11 Global Class ships (Figure 8), six are multi-purpose oceanographic vessels. The NOAA ship *Ronald H. Brown* and three Navy-owned UNOLS vessels, *Atlantis*, *Roger Revelle*, and *Thomas G. Thompson,* are between 10 and 15 years old. The R/V *Melville* is planned for retirement in 2014 and *Knorr* in 2015. The NSF-owned UNOLS ship R/V *Maurice Ewing* went out of service in 2005 and will be replaced in 2007 with the R/V *Marcus Langseth*, a newer and more capable seismic ship.

Five of the 11 Global Class ships are specialized for high-latitude work. Having entered the Fleet in 2001, the USCGC *Healy* is the newest icebreaker and is primarily assigned to support science mission requirements in the Arctic. Two USCG cutters, *Polar Star* and *Polar Sea*, commissioned in the late 1970s, have provided the annual heavy icebreaking services needed to break open a channel into McMurdo Station in support of NSF's USAP. NSF manages the USAP on behalf of the U.S. government and provides support for scientific research, environmental stewardship, and a geopolitical presence in Antarctica, as mandated by Presidential Memorandum 6646 and Presidential Decision Directive NSC-26.

Status Definitions

Federal agencies go through several steps to refurbish, replace, and add ships. For purposes of this Fleet status report, two stages are applicable:

- Programmed applies to those ships that have been included in an agency budget request to Congress
- Appropriated applies to those ships for which funds have been provided by Congress

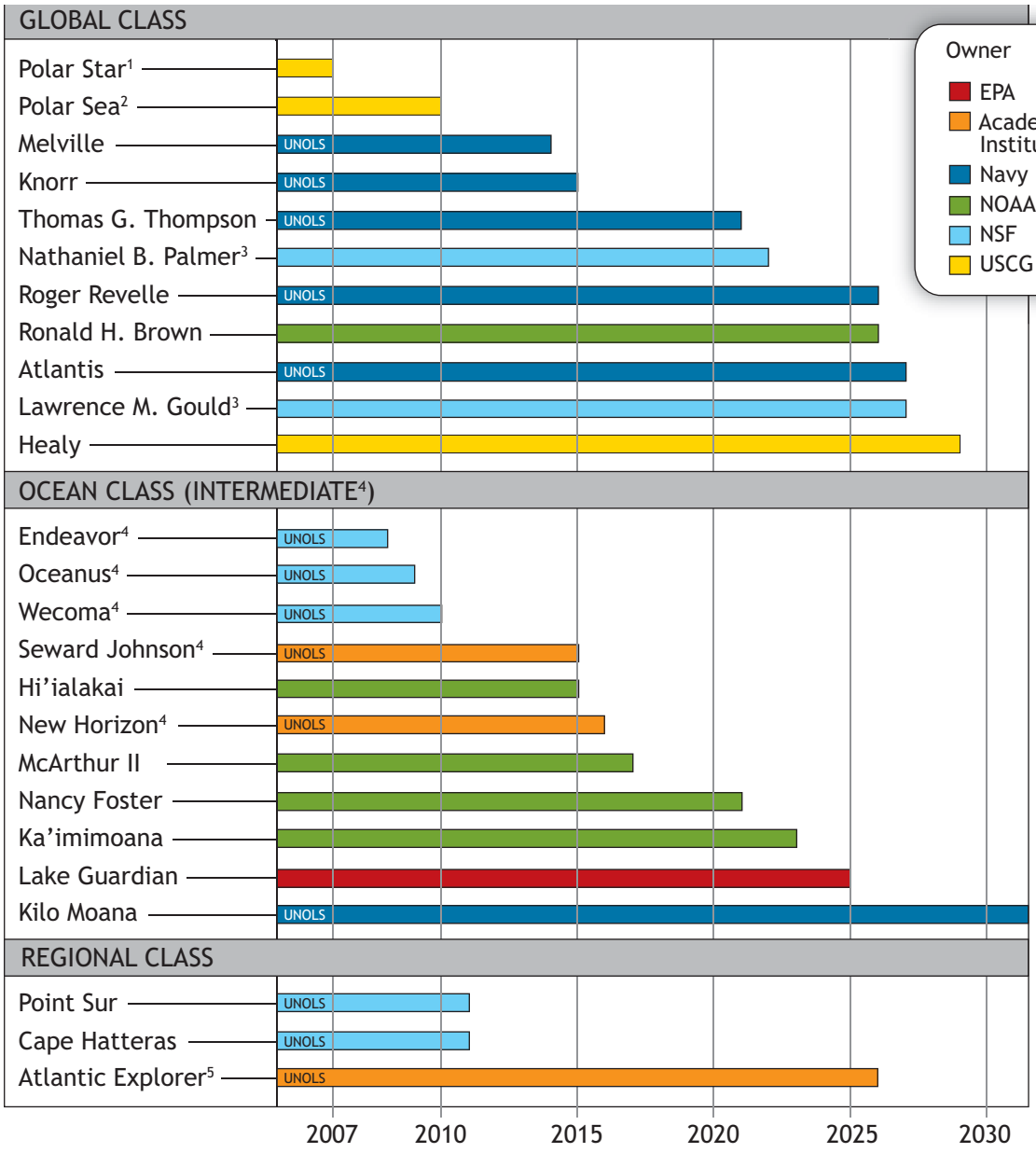


Figure 8. Projected End of Service Life dates by Class for research ships currently in the Fleet.

[1] *Polar Star* was placed in caretaker status on July 1, 2006 for a period of at least 18 months. During caretaker status, the crew will be reduced from 134 to 34. The vessel's future will depend on a national policy decision on polar icebreakers.

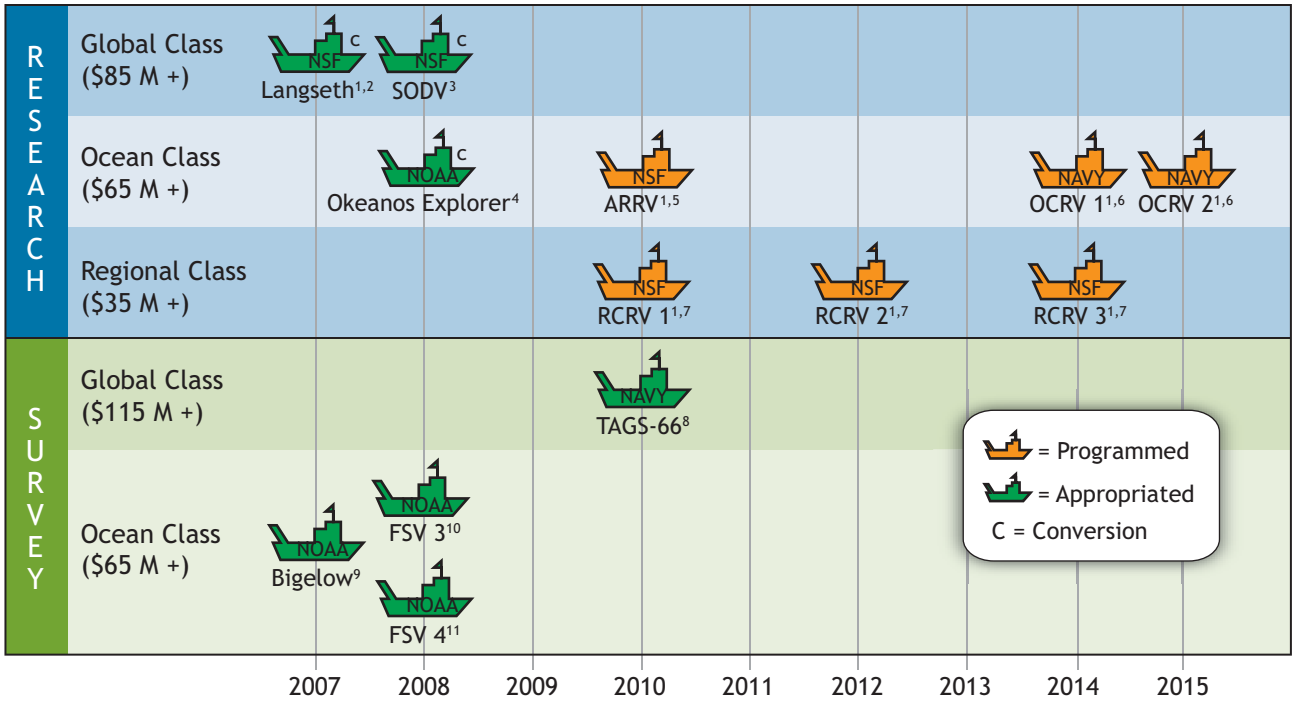
[2] *Polar Sea* completed maintenance work to sustain it operationally for the next 4-8 years, depending on ice conditions and usage. The vessel's future will depend on a national policy decision on polar icebreakers.

[3] Leases for the *Laurence M. Gould* and the *Nathaniel B. Palmer* expire in 2008 and 2012, respectively. Open competitions for subsequent lease contracts are anticipated on a 10-year cycle.

[4] In previous documents, these ships have also been called UNOLS Intermediate Class vessels as they are significantly smaller and less capable than Ocean Class ships. It is intended that UNOLS Intermediate Class ships will be phased out of the Fleet and replaced by more capable Ocean Class vessels.

[5] The R/V *Atlantic Explorer* (formerly the R/V *Seward Johnson II* and operated as an Intermediate Class vessel) was purchased by BIOS from HBOI and re-entered the UNOLS fleet as a Regional Class vessel in 2006.

Federal Oceanographic Fleet Renewal (2007-2015)



[1] It is anticipated that the operator will apply for status as a UNOLS vessel
[2] FY 2004-2006 appropriations for acquisition/conversion
[3] FY 2005 and FY 2006 appropriation for conversion; FY 2007 President's Budget Request for conversion funds
[4] FY 2005 appropriations for vessel conversion, operating funds in FY 2008 President's Budget Request
[5] FY 2007 President's Budget Request for construction funds through NSF MREFC account (2007-2008)
[6] FY 2008 President's Budget Request forShip Construction, Navy
[7] FY 2004-2006 appropriations for vessel design; FY 2007 President's Budget Request for vessel design and construction (2007-2012)
[8] FY 2007 appropriations for vessel construction
[9] FY 2007 President's Budget Request for operating funds
[10] FY 2005 appropriations for vessel construction
[11] FY 2006 appropriations for vessel construction

Figure 9. Fleet renewal and transition by agency, class, and function, as described in this Fleet status report. Ship icons are located on the year in which they are anticipated to enter the Fleet.

With the *Polar Star* and *Polar Sea* reaching the end of their design lives, and with rapidly escalating repair costs, the USCG and NSF are studying how best to meet these icebreaker needs in the future. The recommendations of a recent external NSF Advisory Committee report on the USAP Re-Supply Mission[18], in addition to calling attention to the need for reliable icebreaking services in the Antarctic, provide options for meeting the USAP re-supply requirement in the event that icebreaking services become unavailable for a year. Pending a national policy decision on polar icebreakers, USCGC *Polar Star* was placed in caretaker status with a reduced crew on July 1, 2006 for a period of at least 18 months and the USCGC *Polar Sea* completed maintenance work to sustain it operationally for the next four to eight years, depending upon ice conditions and usage. In addition to these three federally owned polar ships, two ships, R/V *Nathaniel B. Palmer* (icebreaker) and R/V *Laurence M. Gould* (ice-strengthened), are managed for the USAP by their support contractor, Raytheon Polar Services Company, through a lease with Edison Chouest Offshore, Inc.

One Global Class research ship specialized for deep-ocean drilling, *JOIDES Resolution*, began operations in 1978 as an oil exploration vessel, but was converted for scientific research in 1985 when the ship was leased from Overseas Drilling Limited to support the Ocean Drilling Program (ODP). The rig can drill to an ocean depth of 8,235 m (27,018 ft). In 2003, the Ocean Drilling Program concluded and the lease for the *JOIDES Resolution* ended when scientific activities were finished. NSF has entered into a lease agreement again with Overseas Drilling Limited in support of the Integrated Ocean Drilling Program (IODP) that was initiated in 2004. It is anticipated that the *JOIDES Resolution* (referred to as SODV in Figure 9) will undergo a conversion through NSF MREFC funding, will be renamed, and will re-enter service to support IODP in 2008.

Ocean Class

There are 11 Ocean Class research ships, five of which will be at or beyond their projected End of Service Life dates by 2015 (Figure 8). It is important to note that although categorized here as Ocean Class vessels, five of the older UNOLS ships were designated as Intermediate Class in the 2001 FOFC fleet renewal plan[19] and are significantly smaller and less capable than the Ocean Class ships being considered as replacements. Of these, the UNOLS R/Vs *Endeavor*, *Oceanus*, and *Wecoma* are approaching 30 years old and are projected to retire by 2010. R/V *Seward Johnson* will reach its projected retirement date in 2015 and R/V *New Horizon* by 2016. R/V *Kilo Moana* entered the Fleet in 2002 and is currently the only UNOLS Ocean Class research ship. The Navy has programmed the construction of two Ocean Class ships (referred to as OCRV 1 and 2 in Figure 9). These new ships represent an important transition of the UNOLS fleet to modern, technologically

advanced ships capable of meeting the scientific research missions of the nation for the next 30 years.

Design development for the new Ocean Class ice-capable ship (ARRV) is complete. The National Science Board approved the ARRV for funding through the NSF MREFC account. Funding for the ARRV was included in the FY 2007 President's Budget Request to Congress.

NOAA's Ocean Class research vessel *Hi'ialakai* will reach its expected retirement date by 2015, *McArthur II* before 2020, and *Nancy Foster* and *Ka'imimoana* before 2025. Funding for a fifth NOAA Ocean Class research vessel has been appropriated and will enable conversion of USNS *Capable* (to be renamed *Okeanos Explorer* [Figure 9]), an ex-Navy T-AGOS class ship, to provide additional capability for ocean exploration mission support.

The EPA's *Lake Guardian* is expected to remain in service until at least 2025.

Regional Class

By 2011, the R/Vs *Point Sur* and *Cape Hatteras* will have reached their expected retirement dates (Figure 8). NSF intends to fund construction of three new Regional Class research ships starting in FY 2007 within the base budget of the Division of Ocean Sciences (Figure 9). NSF has signed a Memorandum of Agreement with the Navy Program Executive Officer, Ships (PEO Ships) for program management support and contract authority for Regional Class ship acquisition. The main operating areas covered by these new ships will be the East Coast, West Coast, and Gulf of Mexico. There will be an open competition for the operator of each of these new ships. The need for a fourth Regional Class ship in 2015, identified by the UNOLS community in the 2001 FOFC fleet renewal plan[19], will be reviewed as the actual ship requirements to support science and new research programs on the horizon, such as the OOI, become more defined. The R/V *Atlantic Explorer*, formerly the R/V *Seward Johnson II* and operated by Harbor Branch Oceanographic Institution (HBOI) as an Intermediate Class vessel, was purchased by the Bermuda Institute of Ocean Sciences (BIOS) and reentered the UNOLS fleet as a Regional Class ship in 2006.

B. 2007–2015: SURVEY SHIPS

Currently, there are eight Global Class, eight Ocean Class, and three Regional Class survey ships (Figure 10). Although many of the survey ships are less than 15 years old, a few are 40 or more years old. The majority of the Ocean and Regional Class survey ships are specialized to support the fisheries survey mission.

Global Class

Of the eight Global Class survey ships, the six Navy-owned ships (USNS *Bowditch*, *Bruce C. Heezen*, *Henson*, *Pathfinder*, *Mary Sears*, and *Sumner*) are all less than 15 years old. NOAA's two Global Class survey ships, *Fairweather* and *Rainier*, are both 39 years old. *Fairweather* underwent a service life extension in 2003 and is expected to operate until 2019.

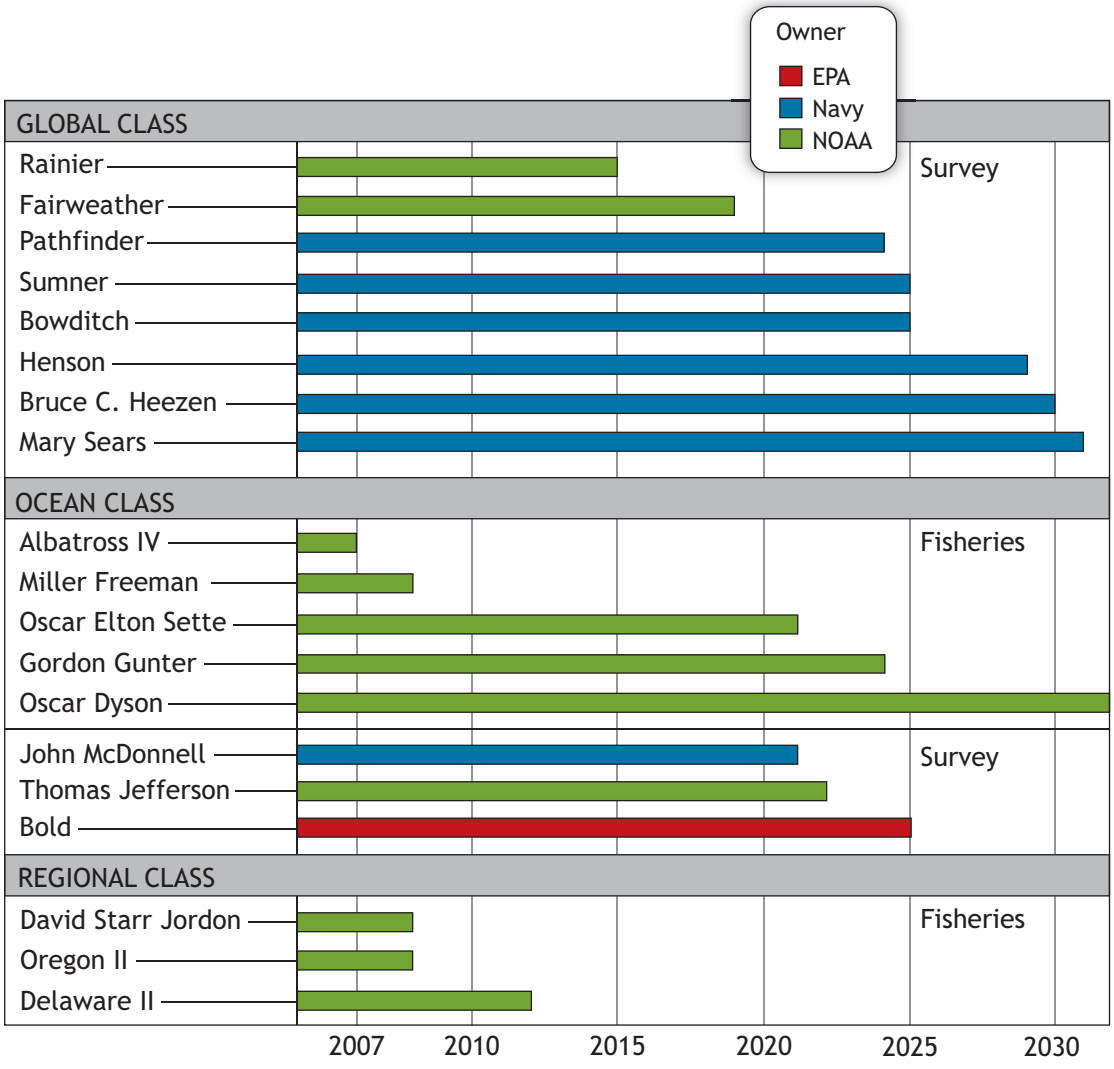


Figure 10. Projected End of Service Life dates by Class for survey ships.

Figure 11. Launch of the Ocean Class FSV *Oscar Dyson* at VT Halter Marine, Moss Point, Mississippi. The *Oscar Dyson* is the first of four new, acoustically quiet FSVs that have been appropriated. Initial reports on this ship indicate it has significantly improved NOAA's ability to collect accurate stock assessment data critical to the ecosystem management approach of the nation's fishery resources. (Photo credit: NOAA)

Ocean Class

Of the eight Ocean Class survey ships, five are specialized for fisheries surveys: NOAA's *Albatross IV*, *Miller Freeman*, *Gordon Gunter*, *Oscar Dyson*, and *Oscar Elton Sette* (Figure 10). NOAA's 1998 Data Acquisition Plan[20], which assessed the type and number of FSVs needed, whether they should be government-owned and managed or chartered, and how they fit in with changing assessment technologies (including ship, air, and satellite-borne instruments), concluded NOAA should use federally owned and operated acoustically quiet fisheries ships. In response, the NOAA ship *Oscar Dyson* entered service in 2005 as the first of the new FSVs (Figure 11). *Henry B. Bigelow* (FSV 2) has been delivered and is planned as the replacement for *Albatross IV* in 2007. In addition, FSVs 3 and 4 have been appropriated and are scheduled for delivery in 2008 (Figure 9).

There are three non-fisheries Ocean Class survey ships. The Navy's USNS *John McDonnell* was delivered in 1991 and will remain in service through 2021. The EPA ship *Bold* is expected to remain in service until 2025. NOAA's *Thomas Jefferson* is expected to remain in service through 2022.

Regional Class

NOAA has three Regional Class FSVs (*David Starr Jordan*, *Delaware II*, and *Oregon II*), all of which will reach their expected retirement age before 2015. The Regional Class is being phased out and replaced by the new Ocean Class FSVs.

5. PLANNING CONSIDERATIONS

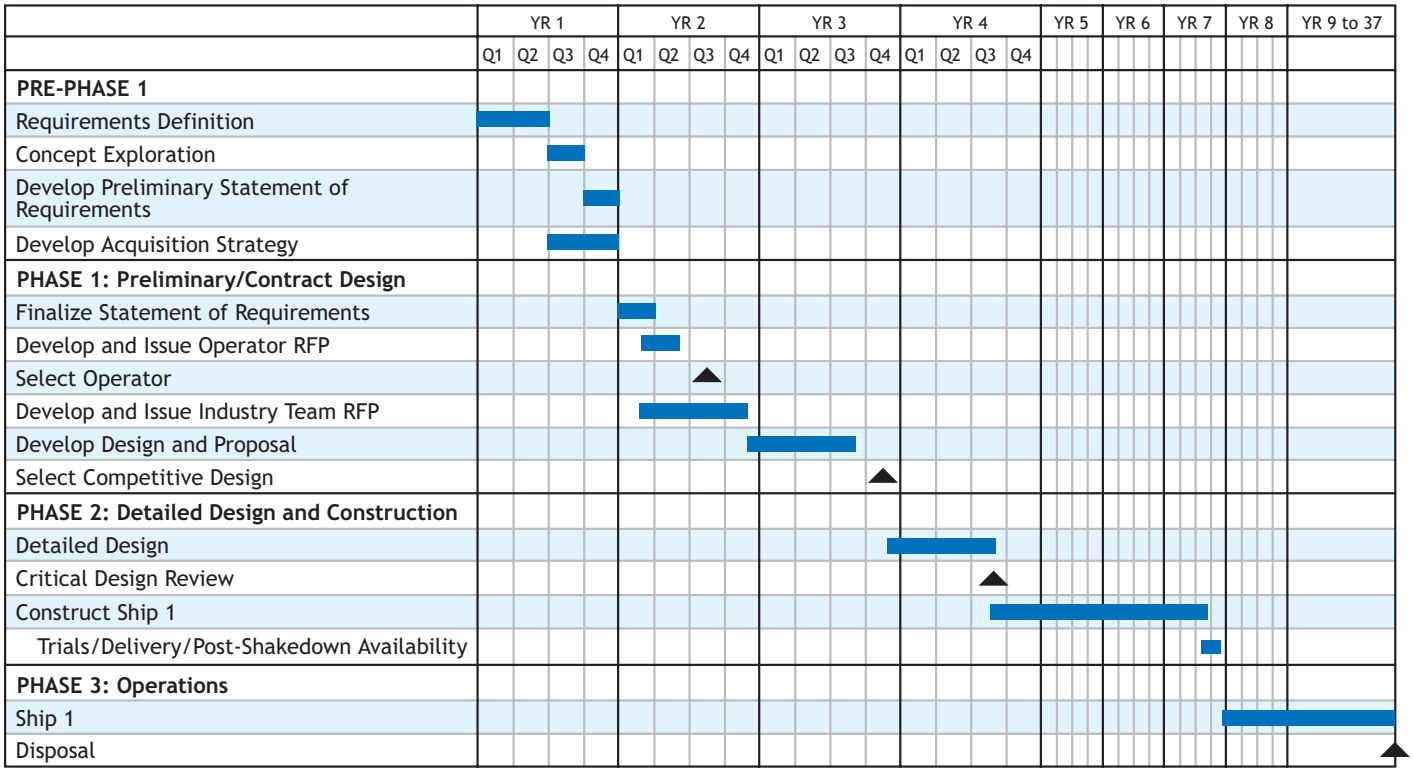
A. LIFE CYCLE COSTS

DESIGN, ACQUISITION, MAINTENANCE, AND DISPOSAL

Federal agencies have taken a total life-cycle approach to the Federal Oceanographic Fleet from design through disposal (Figure 12). Of particular note is the long design and acquisition lead time required in planning for any ship renewals. Global, Ocean, and Regional Class oceanographic research and survey vessels are expected to complete a 30-year service life for the ship hull, with regularly scheduled maintenance and upgrades of onboard electronics, hotel services, and quality-of-life systems. Although design and acquisition planning is based on the service-life expectancy, technology advancements have provided opportunities to extend the service life of many of the larger ships beyond 30 years. These decisions require careful evaluation of the impact on total ownership costs.

Figure 12. Conceptual Ocean Class service life time line. Procurement of large research vessels requires many years to develop a design, acquire funding, negotiate and award the contract, and build and deliver the ship.

Nominal Ship Acquisition and Life-Cycle Timeline



As with all forms of capital equipment, the final stage of a ship's life-cycle management is associated with disposal options and costs. Unlike less-complex systems, ship disposal may have long-term berthing, salvaging, scuttling, and environmental implications. Although each ship is different, there are many common disposal considerations. Depending on the condition of the vessel and included equipment, there is the possibility of transfer to another agency, academic institution, or foreign nation. Lessons learned on the various options have been shared by the federal agencies through FOFC, and will continue through the IWG-Facilities to ensure disposal is done safely and with the greatest possible return or the least possible cost.

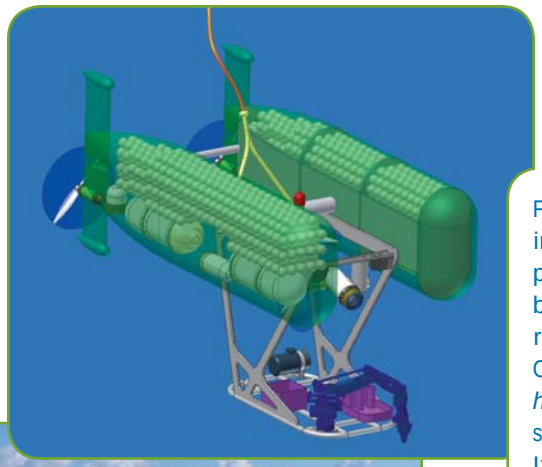
B. TECHNOLOGY INFUSION

As the frontiers of science and technology continue to expand, there will be increasing opportunities for incorporating new ship concept designs and technology trends in mechanical engineering, information technology, acoustic quieting, and sea keeping into new construction, conversions, and upgrade projects. In addition, new technology sensors and advanced data-collection platforms such as ROVs and gliders will make it possible to extend the capabilities of the ships, and will allow reassessment of the most efficient and effective infrastructure needed to support a given mission.

Capitalizing on the studies done cooperatively by IWG-Facilities agencies on common hull configurations, acoustically quiet ship designs, and advanced over-the-side handling systems, NSF is proceeding with design plans and intends to fund construction of three new highly capable, technologically advanced Regional Class ships. Navy and NSF are conducting a pilot project of a new design motion-compensating package handling crane and winch system on one Global and one Ocean Class ship. This promising new technology has the potential to significantly improve the safety and efficiency of over-the-side handling operations, specifically in adverse weather conditions. In coordination with ONR, UNOLS and the oceanographic community evaluated several hull form design options for the new Ocean Class vessels being planned. Within the context of the science mission requirements, construction cost estimates, and life-cycle costs, they determined that the next Ocean Class ships should be an advanced technology monohull design.

The NOAA FSVs were a completely new ship design, using the very latest acoustic quieting technology to ensure successful mission accomplishment. Initial reports on the FSV *Oscar Dyson*, which was commissioned in 2005, indicate it has significantly improved NOAA's ability to collect accurate stock assessment data critical to the ecosystem management approach of the nation's fishery resources. NOAA's recent conversion of several ex-Navy ships to fisheries survey and oceanographic research missions included state-of-the-art science mission equipment support infrastructure. NOAA is also exploring the use of Synthetic Aperture Sonar to collect very-high-resolution imagery for fish habitat mapping and coral research. This new technology also has the potential to significantly increase the area covered during a standard survey period.

Various new or improved undersea vehicles are increasing the capabilities of the Federal Oceanographic Fleet (Figure 13). The National Deep Submergence Facility is currently overseeing the design of a more capable deep-diving HOV to replace the 40-year-old DSV *Alvin*. The vehicle design elements include compatibility with the UNOLS dedicated tender ship R/V *Atlantis*, greater depth capability (6,500 m vs 4,500 m), larger interior volume, increased rate of descent and ascent, and variable ballast and trim systems.



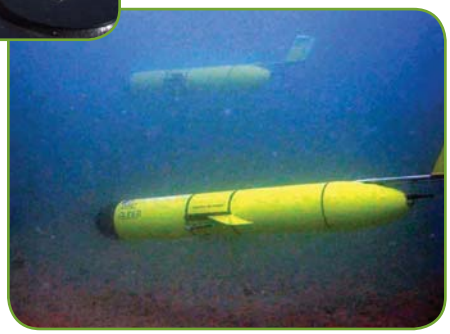


Figure 13. Top. The HROV, scheduled for sea trials in 2007, will provide routine access to the deepest parts of the world's oceans and under ice, and will be able to be rapidly deployed for immediate event response investigations (© Jack Cook, Woods Hole Oceanographic Institution). Middle. The AUV *Seahorse* can sustain four knots for 72 hours collecting such data as conductivity, temperature, and depth. It has an Acoustic Doppler Current Profiler, and side-scan sonar. Use of AUVs such as these extend ship's capabilities (Photo credit: Navy). Bottom. The Webb Slocum glider is one of several AUVs that enable oceanographers to measure hydrographic, chemical, and biological fields on long sections of the oceans. In the coming years, the hope is that gliders such as these will become a routine tool for monitoring red tides in U.S. coastal waters (Photo credit: Oscar Schofield, Rutgers University).

ROV and AUV technology continues to develop and act as a force multiplier in support of federal agency missions. The number and variety of vehicles and their uses in ocean research and operations is increasing. As additional breakthroughs are made in the areas of power management, communications, and vehicle interactions, ROV and AUV development will further expand and the ability of these tools to conduct science will further increase. Several examples of current ROV and AUV projects demonstrate the importance of these scientific tools. The *Jason II* ROV with 6,500 m (21,325 ft) depth capability will provide greater access to the mid ocean in support of scientific research missions. The Hybrid Remotely Operated Vehicle (HROV), a multi-agency funded project (NSF, Navy, NOAA) expected to be completed in FY2008, will provide full ocean depth capability (11,000 m). An ONR-supported buoyancy-driven ocean glider with a wing span of 6.5 m (20 ft) currently under development will significantly increase the suite of potential ocean data collection sensor packages capable of being deployed on gliders. Navy and NOAA are planning to transition AUVs from research and development into their data collection platform suites to significantly increase the ability to complete bathymetric mapping, ocean data collection, habitat characterization and ecosystem monitoring mission requirements. AUVs will allow the agencies to optimize a day-at-sea by improved survey efficiency.

C. OTHER OPPORTUNITIES

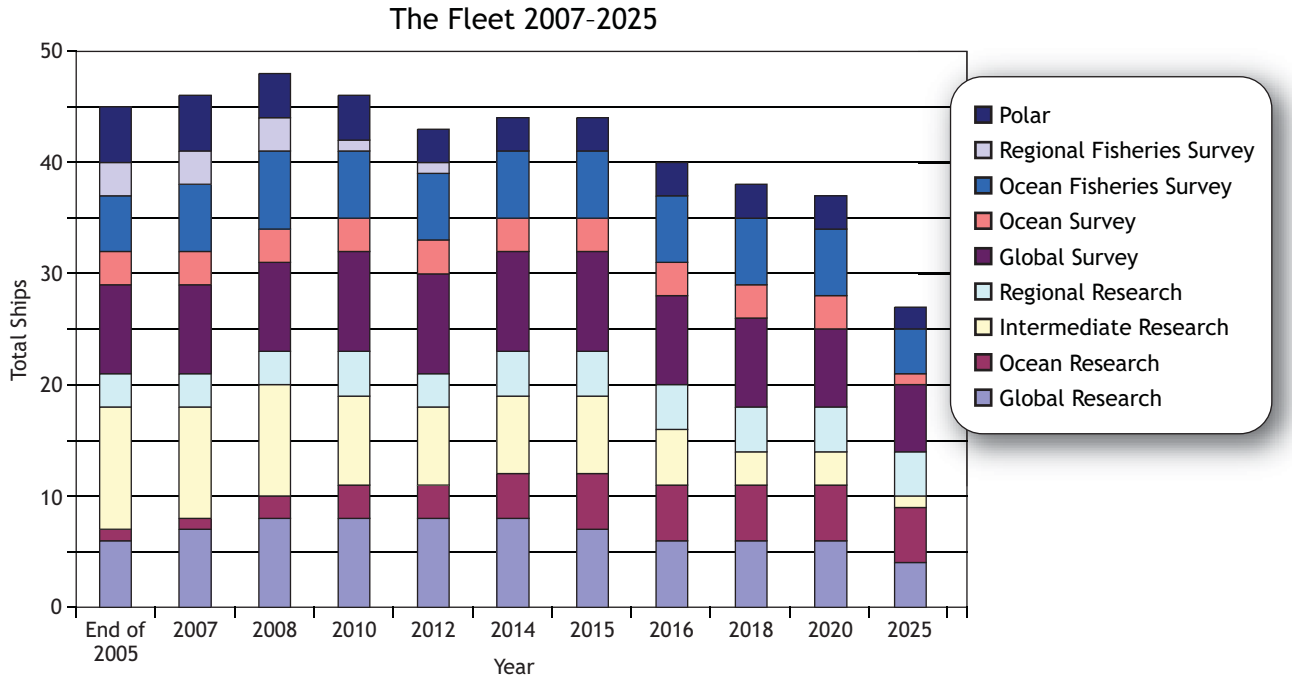
Ships of the Federal Oceanographic Fleet are designed for the specific needs of each agency (Appendix 2); however, most ships are capable of supporting work outside their primary mission area. Opportunities for cross-agency use of the ships are coordinated and scheduled through UNOLS. Federal agencies also have the opportunity to evaluate charter and commercial vessels as possible options and use private sector ship support, when appropriate, to cost-effectively accomplish missions such as environmental monitoring, buoy servicing, and bathymetric mapping. NOAA utilizes contracting of commercial vessels to supplement its core capabilities, recognizing that the more capacity brought to bear on hydrographic surveying, the better the agency can support safe navigation in U.S. waters. Since 1994, NOAA's funding for survey contracts has risen from $0 to $30 million per year, roughly half of its budget for hydrographic data collection. NOAA's strong partnerships with the private sector and academia have fostered technology improvements as well as process improvements for hydrographic surveying.

6. CONCLUSIONS

Ships are fundamental tools to advancing our knowledge of the oceans. They make it possible to acquire the data necessary to understand the mysteries of complex Earth systems, more carefully manage ocean resources for the benefit of society, and respond to catastrophic events around the globe.

This *Federal Oceanographic Fleet Status Report* describes the current capacity and capabilities to support the nation's vital interests in understanding the world's ocean. The currently programmed and appropriated Global, Ocean, and Regional Class ships will maintain overall Fleet capacity through 2015 (Figure 14). Future Fleet capacity needed to support national ocean priorities for the period 2015 through 2025 will be determined through an interagency infrastructure assessment process under the auspices of the JSOST and led by the IWG-Facilities.

Figure 14. The existing ships along with those renewal efforts identified in Figure 9 will enable Fleet capacity to remain stable through 2015. The introduction of new Ocean Class Research vessels and Fisheries Survey vessels transition the Fleet from older and less-capable Intermediate Class Research and Regional Class Fisheries Survey ships.



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*All Web sites references have been properly accessed as of March 29, 2007.

APPENDIX 1. SHIPS IN THE FEDERAL OCEANOGRAPHIC FLEET (> 40 METERS)

KEY

FSV = Fisheries Survey Vessel
MPR = Multi-Purpose Research
MPS = Multi-Purpose Survey
* Leased

Owner	Class	Purpose	Name	Length (ft)	Delivery Date	Projected End of Service[1]
EPA	Ocean	MPS	*Bold*	224	1989	2025
EPA	Ocean	MPR	*Lake Guardian*	180	1981	2025
Institution (UNOLS[2])	Intermediate	MPR	*Seward Johnson*	204	1985	2015
Institution (UNOLS[2])	Intermediate	MPR	*New Horizon*	170	1978	2016
Institution (UNOLS[2])	Regional	MPR	*Atlantic Explorer*[3]	161	1982	2026
Navy	Global	MPS	*Pathfinder*	328	1994	2024
Navy	Global	MPS	*Sumner*	328	1995	2025
Navy	Global	MPS	*Bowditch*	328	1995	2025
Navy	Global	MPS	*Henson*	328	1998	2029
Navy	Global	MPS	*Bruce C. Heezen*	328	2000	2030
Navy	Global	MPS	*Mary Sears*	328	2001	2031
Navy	Ocean	MPS	*John McDonnell*	208	1991	2021
Navy (UNOLS[2])	Global	MPR	*Melville*	279	1969	2014
Navy (UNOLS[2])	Global	MPR	*Knorr*	279	1970	2015
Navy (UNOLS[2])	Global	MPR	*Thomas G. Thompson*	274	1991	2021
Navy (UNOLS[2])	Global	MPR	*Roger Revelle*	274	1996	2026
Navy (UNOLS[2])	Global	MPR	*Atlantis*	274	1997	2027
Navy (UNOLS[2])	Ocean	MPR	*Kilo Moana*	185	2002	2032
NOAA	Global	MPS	*Rainier*	231	1968	2015
NOAA	Global	MPS	*Fairweather*	231	1968	2019
NOAA	Global	MPR	*Ronald H. Brown*	274	1997	2026
NOAA	Ocean	FSV	*Albatross IV*	187	1963	2007
NOAA	Ocean	FSV	*Miller Freeman*	215	1967	2008
NOAA	Ocean	FSV	*Oscar Elton Sette*	224	1988	2021
NOAA	Ocean	FSV	*Gordon Gunter*	224	1989	2024
NOAA	Ocean	FSV	*Oscar Dyson*	209	2004	2033

table continues on next page...

FOOTNOTES

[1] Projected End of Service dates are based on Operator estimates; typically these are a 30-year service life or 15 years after a mid life refit.

[2] University National Oceanographic Laboratory System (UNOLS) is a coordinating body for the national academic research fleet.

[3] The R/V *Atlantic Explorer* (formerly the R/V *Seward Johnson II* and operated as an Intermediate Class vessel) was purchased by BIOS from HBOI and reentered the UNOLS fleet as a Regional Class vessel in 2006.

KEY

FSV = Fisheries Survey Vessel
MPR = Multi-Purpose Research
MPS = Multi-Purpose Survey
* Leased

Owner	Class	Purpose	Name	Length (ft)	Delivery Date	Projected End of Service[1]
NOAA	Ocean	MPS	*Thomas Jefferson*	208	1992	2022
NOAA	Ocean	MPR	*Hi'ialakai*	224	1984	2015
NOAA	Ocean	MPR	*McArthur II*	224	1985	2017
NOAA	Ocean	MPR	*Ka'imimoana*	224	1989	2023
NOAA	Ocean	MPR	*Nancy Foster*	187	1991	2021
NOAA	Regional	FSV	*David Starr Jordan*	155	1966	2008
NOAA	Regional	FSV	*Delaware II*	171	1968	2012
NOAA	Regional	FSV	*Oregon II*	170	1967	2008
NSF*	Global	Polar	*Nathaniel B. Palmer*[4]	308	1992	2022
NSF*	Global	Polar	*Lawrence M. Gould*[4]	230	1997	2027
NSF (UNOLS[2])	Intermediate	MPR	*Endeavor*	184	1976	2008
NSF (UNOLS[2])	Intermediate	MPR	*Oceanus*	177	1976	2009
NSF (UNOLS[2])	Intermediate	MPR	*Wecoma*	184	1976	2010
NSF (UNOLS[2])	Regional	MPR	*Cape Hatteras*	135	1981	2011
NSF (UNOLS[2])	Regional	MPR	*Point Sur*	135	1981	2011
USCG	Global	Polar	*Polar Sea*[5]	399	1978	2010
USCG	Global	Polar	*Polar Star*[6]	399	1976	2007
USCG	Global	Polar	*Healy*	420	2000	2029

FOOTNOTES

[2] University National Oceanographic Laboratory System (UNOLS) is a coordinating body for the national academic research fleet.

[4] Leases for the *Laurence M. Gould* and the *Nathaniel B. Palmer* expire in 2008 and 2012, respectively. Open competitions for subsequent lease contracts are anticipated on a 10-year cycle.

[5] *Polar Sea* has completed maintenance work to sustain it operationally for the next 4-8 years, depending on ice conditions and usage. The vessel's future will depend on a national policy decision on polar icebreakers.

[6] *Polar Star* was placed in caretaker status on July 1, 2006 for a period of at least 18 months. During caretaker status the crew will be reduced from 134 to 34. The vessel's future will depend on a national policy decision on polar icebreakers.

APPENDIX 2.

RESEARCH AND SURVEY ACTIVITIES BY AGENCY

KEY
U = Uses Ship Time
P = Provides Ship Time

	NAVY	NOAA	NSF	EPA	MMS	NASA	USCG	USGS
Science and Technology								
Earth System Science *(atmospheric, chemical, geological, physical, space, acoustics, Earth structure, Earth history, earthquakes, climate change, optics, calibration and validation of remotely sensed measurements from satellites)*	U/P	U/P	U/P	U/P	U	U	P	U
Exploration *(historic sites/vessels, new environments, mapping, natural resources)*		U/P	U/P	U/P	U	U	P	
Living Marine Resources *(biological sciences/processes, ecosystems, marine protected areas/sanctuaries, coral reefs)*	U/P	U/P	U/P	U/P	U	U	P	U
Polar *(environmental, biological, and social sciences; climate change, physical science [including astrophysics])*	U	U	U/P	U		U	P	
Observation Systems Development *(human-occupied, remotely operated, and autonomous underwater vehicles, engineering, sensor testing)*	U/P		U/P			U	P	U
Resource Management								
Hydrographic Surveys *(chemical, physical, optical)*	U/P	U/P		U/P	U	U	P	U
Bathymetric Surveys *(charting, safe navigation, natural resources)*	U/P	U/P		U/P	U		P	U
Living Marine Resources Surveys *(diversity, distribution, abundance, habitat, marine protected areas/sanctuaries, coral reefs)*		U/P		U/P	U			U
Geophysical Surveys *(gravity, magnetics, seismic, sediment, seabed geo-acoustic properties)*					U			U
Polar *(science and environmental stewardship at both poles, and geopolitical presence in the Antarctic)*		U	U/P			U	P	
Observation Systems Support *(tsunami warning, El Niño, global climate change, weather, dumping activity, ecosystems, marine protected areas/sanctuaries, assessment of environmental impacts of human activity)*	U/P	U/P			U	U	P	
Education and Outreach	P	P	U/P	P	U	U	P	

APPENDIX 3.
ACRONYMS AND ABBREVIATIONS

ADCP .....Acoustic Doppler Current Profiler

ARRV.....Alaska Region Research Vessel

AUV .....Autonomous Underwater Vehicle

BIOS.....Bermuda Institute of Ocean Sciences

DARPA .....Defense Advanced Research Projects Agency

DART.....Deep Ocean Assessment and Reporting of Tsunamis

DoE .....Department of Energy

DSV .....Deep Submergence Vehicle

EPA.....Environmental Protection Agency

FOFC .....Federal Oceanographic Facilities Committee

FSV.....Fisheries Survey Vessel

FY .....Fiscal Year

HBOI .....Harbor Branch Oceanographic Institution

HOV.....Human Occupied Vehicle

HROV.....Hybrid Remotely Operated Vehicle

ICES .....International Council for the Exploration of the Seas

ICOSRMI.....Interagency Committee on Ocean Science and Resource Management Integration

IODP.....Integrated Ocean Drilling Program

IOOS.....Integrated Ocean Observing System

ISM.....International Safety Management

IWG-Facilities.....Interagency Working Group on Facilities

JOIDES .....Joint Oceanographic Institutions for Deep Earth Sampling

MMS .....Minerals Management Service

MPR .....Multi-Purpose Research

MPRSA.....Marine Protection, Research and Sanctuaries Act of 1972

MPS.....Multi-Purpose Survey

MREFC.....NSF Major Research Equipment and Facilities Construction account

NAS.....National Academy of Sciences

NASA.....National Aeronautics and Space Administration

NAVOCEANO.....Naval Oceanographic Office

NM.....Nautical Miles

NOAA.....National Oceanic and Atmospheric Administration

NOPP.....National Oceanographic Partnership Program

NSC.....National Security Council

NSF.....National Science Foundation

OCRV.....Ocean Class Research Vessel

ODP.....Ocean Drilling Program

ONR.....Office of Naval Research

OOI.....Ocean Observatories Initiative

OPP.....NSF's Office of Polar Programs

OSTP.....White House Office of Science Technology Policy

OSV.....Ocean Survey Vessel

RCRV.....Regional Class Research Vessel

REVEL.....Research and Education: Volcanoes, Exploration and Life

R/V.....Research Vessel

ROV.....Remotely Operated Vehicle

SODV.....Scientific Ocean Drilling Vessel

SWATH.....Small Waterplane Area Twin Hull

T-AGOS.....Tactical Auxiliary General Ocean Surveillance

UNOLS.....University National Oceanographic Laboratory System

NOPP

The National Oceanographic Partnership Program (NOPP) was established in FY1997 to promote the national goals of assuring national security, advancing economic development, protecting quality of life, and strengthening science education and communication through improved knowledge of the ocean.

Editing and design services provided by Geosciences Professional Services, Inc.

Editing services also provided by Ocean Associates, Inc.

Special thanks to the NOPP Office for providing significant report support and to the UNOLS community which provided scientific and technical input.

NOPP