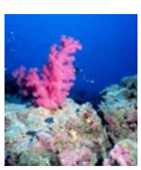
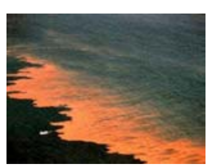
NOAA
Ship Recapitalization Plan

Office of Marine and Aviation Operations

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NOAA SHIP RECAPITALIZATION PLAN
FY 2010 to FY 2024

EXECUTIVE SUMMARY

The National Oceanic and Atmospheric Administration (NOAA) is a science-based federal agency within the Department of Commerce with regulatory, operational, and information service responsibilities. High quality data are the foundation of meeting NOAA's responsibilities to inform and advise the public and to manage national trust resources. Sea-going vessels have been, and will continue to be, a primary source of observation data, providing in-situ measurements of physical and biological oceanography and supporting both NOAA's information services and its ecosystem management services.

NOAA's ships face challenges similar to other observational infrastructure: expanding mission requirements, age and obsolescence, and finite resources for recapitalization. NOAA has developed "The FY 2010 to FY 2024 NOAA Ship Recapitalization Plan" using a systematic approach to link requirements drivers to at-sea data requirements to ship operating day requirements. This plan articulates the national benefit gained from the products and services that NOAA delivers and the management activities that it performs.

NOAA currently operates, manages and maintains a fleet of 18 research and survey ships with a capacity of nearly 4800 operating days when fully utilized. NOAA relies on private sector and university partnerships to help meet requirements for at-sea data collection – obtaining about 2000 days of chartered support annually from private and university ships. The scope of this plan is the replacement of this current capacity with new and rebuilt ships that will maintain NOAA's ability to meet current mission-critical functions. In preparing this assessment NOAA identified a potential additional 13,200 sea days worth of activities that would support NOAA's mission. NOAA uses this effective approach when ships with the capability and capacity to meet NOAA requirements are available and will continue to use these critical assets in the future to meet mission requirements.

NOAA has successfully developed, adapted, and/or fielded a number of technologies that have enhanced the capabilities of NOAA ships and is currently evaluating a number of technologies that have potential to contribute to more effective and efficient mission accomplishment. While technology is expected to allow NOAA to make incremental advances over its current capabilities in the near-term, there currently is no technology foreseen to have a dramatic impact on how NOAA collects data or operates its ships.

During the period FY 2010 to FY 2024, the service lives of ten active NOAA ships will end if additional capital funds are not invested for service life extensions and major repair periods. These requirements were combined into specific requirements groups based on current ship condition and regional requirements for at-sea data and ship operating days.

To determine the best alternative to address the requirements of the ten requirements groups, an analysis of alternatives (AoA) was conducted. The AoA was done in two parts: (1) a cost-effectiveness economic analysis based on guidance provided in the Office of Management and Budget (OMB) Circulars A-11 and A-94 and, (2) a program performance analysis that assessed how changes in ship capacity and capability would impact NOAA GPRA measure results. The AoA evaluated "New Build," "Service Life Extension," "Charter," and "Conversion" options for meeting the requirements of the ten requirements groups.

The results of the economic analysis indicate that constructing nine new ships and that conducting one service life extension for a ship that will be 21 years old in FY 2010 is the most cost effective solution. The program performance analysis indicated that the "New Build" alternative for eight of the ten requirements groups is the most programmatically beneficial in terms of percentage change of GPRA measure. The program performance analysis provides both quantitative and qualitative evidence that all NOAA programs that have at-sea data requirements will benefit from an increase in ship capacity and capability.

NOAA corporately and collectively considered the outcome of the requirements determination effort as well as the analysis of alternatives in the context of all its recapitalization and operational requirements. It is recommending a long term (FY 2010 to FY 2024) ship recapitalization plan that provides a steady state investment level that will construct nine ships and extend the service life of one ship. During the next 15 years, nine currently active NOAA ships, - DAVID STARR JORDAN, OREGON II, MILLER FREEMAN, RAINIER, HI'IALAKAI, MCARTHUR II, OSCAR ELTON SETTE, GORDON GUNTER and FAIRWEATHER will be replaced. A service life extension will be conducted on the KA'IMIMOANA.

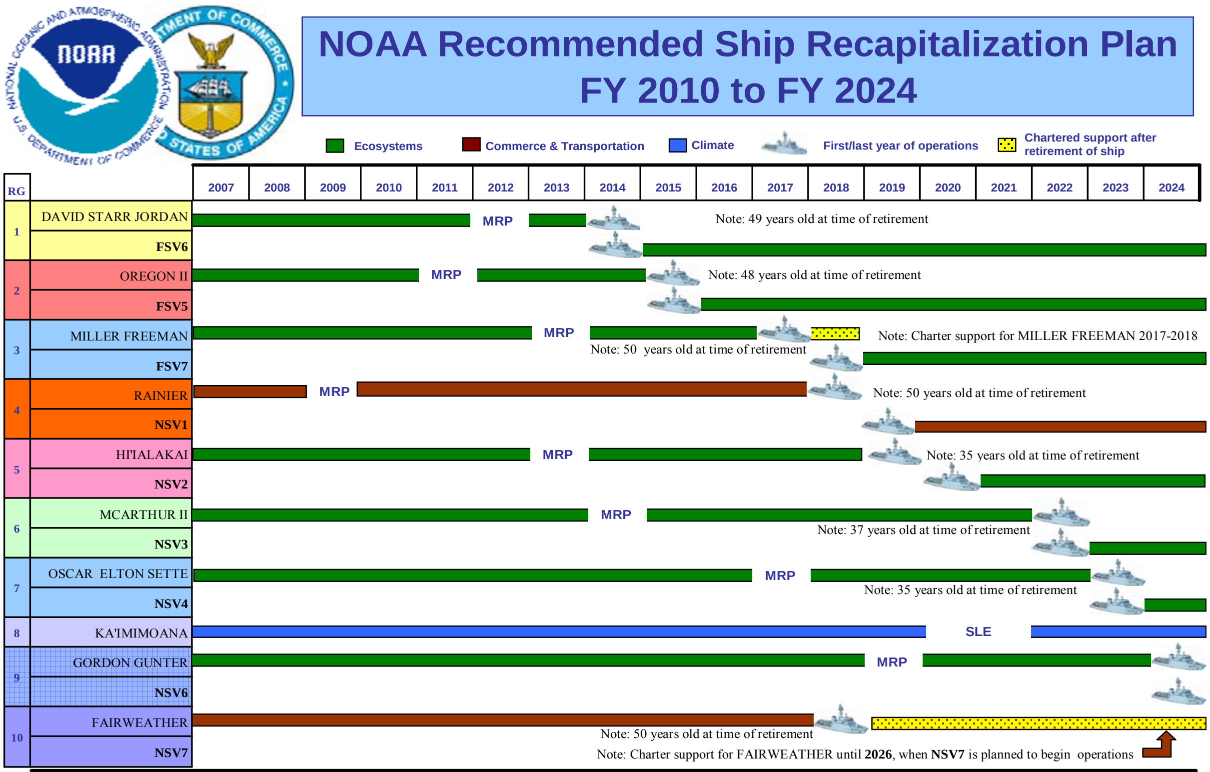
NOAA is dedicated to enhancing the Nation's economic security and safety through the prediction and research of weather and climate-related events, information service delivery for transportation, and by providing environmental stewardship of our nation's coastal and marine resources. NOAA relies on data collected at sea to achieve outcomes mandated by Congress, and the economic impact is significant. For example:

- The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act require sufficient data to establish annual catch limits for fisheries. If sufficient data are not available, catch limits must be reduced from current levels with an estimated negative impact on the commercial fishing industry of up to $7 billion annually.

- Alaska's economic contribution to the Nation relies heavily on NOAA's charts for safe navigation. Its commercial fishing industry contributes $6.5 billion to the gross national product and Alaska's oil and gas industry has produced more than 16 billion barrels of oil and 6 billion cubic feet of natural gas, accounting for 20 percent of U.S. domestic production, nearly all of which is transported via tankers to the U.S. West Coast.

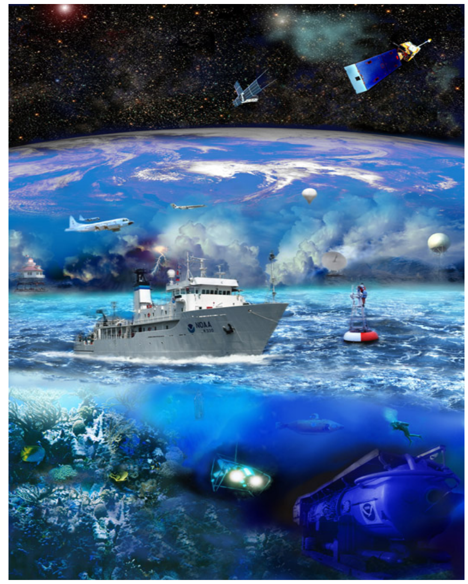
- Marine ecosystems provide employment opportunities in a wide range of sectors including the commercial fishing industry, marine recreation and tourism, shipbuilding, passenger and cargo transport, and oil and natural gas exploration. In 2004, these sectors supported over 2.3 million jobs with an annual payroll of $63 billion and contributed in excess of $138 billion to gross domestic product (GDP) across all coastal states.

The FY 2010 to FY 2024 NOAA Ship Recapitalization Plan ensures NOAA maintains a relevant and vital at-sea data collection capability. It allows NOAA to accomplish its mission of protecting life and property and conserving and protecting natural resources – a mission that has significant annual economic impact and benefit to the nation.



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Average Age of the Fleet	27.6	26.8	21.8	22.8	23.8	24.8	24.5	24.4	24.2	22.7	22.6	21.0	17.8	17.8	17.8	17.9	17.0	17.1
Number of Ships	19	21	20	20	20	20	21	22	21	19	20	20	19	18	19	20	20	19

Chapter 1
INTRODUCTION



The National Oceanic and Atmospheric Administration (NOAA) is a science-based federal agency within the Department of Commerce with regulatory, operational, and information service 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 our nation's economic, social, and environmental needs. Americans rely on NOAA to provide: marine, surface, aviation, space, and local weather forecasts; safe and vibrant coastal waters; a sustainable supply of quality seafood; and the safe transport of waterborne cargo. NOAA's vision is an informed society that uses a comprehensive understanding of the role of the oceans, coasts, and atmosphere in the global ecosystem to make the best social and economic decisions. Success in achieving this vision depends upon how well NOAA understands the Earth's dynamic natural systems and assesses the effects of human activities upon those systems. To achieve its mission, and to fulfill its vision, NOAA focuses on four service goals and one support goal:

- Protect, restore, and manage the use of coastal and ocean resources through an ecosystem approach to management
- Understand changes in climate, including the El Niño phenomenon, to ensure that we can plan and respond properly
- Monitor, enhance, and deliver environmental information, science, and services to save lives, protect property, and support environmental stewardship
- Provide weather and navigation information for safe, secure, efficient, and environmentally sound movement of goods and people in the U.S. transportation system
- Provide critical support for NOAA's mission

High quality data are the foundation of meeting NOAA's responsibilities to inform and advise the public and to manage national trust resources. NOAA is dedicated to enhancing economic security and national safety through the prediction and research of weather and climate-related events and information service delivery for transportation, and by providing environmental stewardship of our nation's coastal and marine resources. Through the emerging Global Earth Observation System of Systems (GEOSS), NOAA is working with its federal partners, more than 70 countries and the European Commission to develop a global monitoring network that is as integrated as the planet it observes, predicts and protects. Ships have been, and will continue to be, a primary source of observation data, providing *in situ* measurements of physical and biological oceanography and supporting both NOAA's information and ecosystem management services.

NOAA's ships face challenges similar to other observational infrastructure: expanding mission requirements, age and obsolescence, and finite resources for recapitalization. To address these issues, NOAA has developed the FY 2010 to FY 2024 "NOAA Ship Recapitalization Plan." This plan provides a comprehensive review of at-sea observation and operational requirements, assesses current capabilities and capacities, and provides a plan to ensure the sustainability of vital at-sea data collection capability. Implementing this plan promotes both economic and social benefits for the Nation.

Chapter 2
APPROACH

The FY 2010 to FY 2024 Ship Recapitalization Plan was developed using a systematic approach. It links requirements drivers to ship operating day requirements and identifies the national benefit of the resulting products, services, and management activities. The recapitalization plan was developed in four primary phases:

Phase 1: Assessment of Requirements

Phase 2: Analysis of Current NOAA Marine Operations

Phase 3: Definition of the Scope of Recapitalization and the Analysis of Alternatives

Phase 4: Development of a Recommended Ship Recapitalization Plan

Phase 1: Assessment of Requirements: The current mission and support goals that NOAA uses to describe its business functions served as the organizing structure for defining and assessing at-sea data requirements. The steps below outline the approach used to validate the need for operating days:

1. NOAA's legislated missions were used as the starting point. Major legal mandates and authorities, as well as the policies and priorities that underpin NOAA's mission and strategic goals, were identified.

2. Performance measures that are linked to NOAA's mandates, including the Government Performance and Results Act (GPRA) measures, were identified for each goal.

3. NOAA capabilities and activities needed to meet performance metrics were identified.

4. Types of at-sea data required to support NOAA capabilities and activities were determined.

5. At-sea data requirements were translated into operating days. Scenarios using historical and current data gathering methodologies illustrate how data requirements and operating days are linked.

6. Products and services that resulted from data collected during an operating day were identified.

7. Outcomes and benefits were linked to these products and services to demonstrate the value of at-sea data and NOAA ships.

Note: Chapters 4 – 7 and Appendices A and B provide additional detail on each of these steps.

Phase 2: Analysis of Current NOAA Marine Operations: The steps below outline the approach used to assess current marine operations:

1. Current ship conditions were assessed
2. Complement of personnel required to operate each ship was determined
3. Capacity, in terms of operating days of current ships, was identified
4. Capabilities and the major mission equipment of each ship were identified
5. Currently used and future technology options were evaluated

Note: Chapters 8 and 9 and Appendix C provide additional detail resulting from each of these steps.

Phase 3: Defining the Scope of Recapitalization and Analysis of Alternatives: The steps below outline the approach used to define the scope of the plan and to conduct the analysis of alternatives:

1. Definition of time period of the ship recapitalization plan
2. Development of requirements groups based on requirements, location, and current operations
3. Assessment of condition, capacity, and capability of the requirements groups at status quo
4. Identification of the alternatives available for each requirements group
5. Analysis of alternatives conducted for each requirements group

Note: Chapters 10 and 11 provide additional detail resulting from each of these steps.

Phase 4: Development of Recommended Ship Recapitalization Plan: The steps below outline the approach used to finalize the recommended ship recapitalization plan:

1. Important factors considered in the investment strategy identified
2. Alternatives within each requirements group based on factors ranked
3. Recommended ship recapitalization plan developed
4. Benefits to Nation calculated

Chapter 3
NOAA'S MISSION OVERVIEW

In a July 1970 statement to Congress, President Nixon proposed creating The National Oceanic and Atmospheric Administration (NOAA) to serve a national need "...for better protection of life and property from natural hazards...for a better understanding of the total environment...[and] for exploration and development leading to the intelligent use of our marine resources..." On October 3, 1970, NOAA was established under the Department of Commerce.

Today, NOAA's mission is: "to understand and predict changes in the earth's environment and conserve and manage coastal and Great Lakes resources to meet our nation's economic, social, and environmental needs," much like it was over 30 years ago. NOAA works for the Nation every day by providing timely and precise weather, water, and climate forecasts; monitoring the environment; managing fisheries and building healthy coastlines; making our nation more competitive through safe navigation; and tracking changes in the oceans.

Achieving NOAA's vision - an informed society that uses a comprehensive understanding of the role of the oceans, coasts and atmosphere in the global ecosystem to make the best social and economic decisions - depends upon how well NOAA understands the Earth's dynamic natural systems and assesses the effects of human activities upon those systems.

In its role as a federal agency focused on the condition of the oceans and the atmosphere, NOAA plays two distinct roles:

A Supplier of Environmental Information Products

One of the most important resources in our society is knowledge. NOAA supplies information to its customers about the state of the oceans and the atmosphere. In general the public is most familiar with NOAA's weather warnings and forecasts, but NOAA's information products extend to climate, ecosystems and commerce as well.

A Provider of Environmental Stewardship Services

NOAA also is the steward of national coastal and marine environments. In coordination with federal, state, local, tribal, and international authorities, NOAA manages the use of these environments, regulating fisheries and marine sanctuaries as well as protecting threatened and endangered marine species.

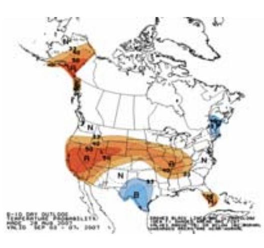
Based on stakeholder input and an internal assessment of NOAA's mandates and missions, NOAA has adopted a structure with four mission goals (Ecosystems, Climate, Weather and Water, and Commerce and Transportation) and a mission support goal; this structure defines how NOAA's work is planned and organized.

ECOSYSTEMS

Protect, restore, and manage the use of coastal and ocean resources through an ecosystem approach to management

Coastal areas are among the most developed in the Nation. More than half of our population lives on less than one-fifth of the land in the contiguous United States. Employment in near-shore areas, including the Great Lakes region, is growing three times faster than the population as a whole. Coastal and marine waters support over 28 million jobs and provide a tourism destination for nearly 90 million Americans a year. The value of the ocean economy to the United States is over $115 billion. The value added annually to the national economy by the commercial and recreational fishing industry alone is over $60 billion. U.S. aquaculture sales total almost $1 billion annually.[1] With an Exclusive Economic Zone of 3.4 million square miles, the United States manages the largest marine territory of any nation in the world.

NOAA has a specific mandate from Congress to be a lead federal agency in protecting, managing, and restoring coastal and marine resources. Unprecedented interest in the world's oceans, their health, and their economic value led to a comprehensive report by the U.S. Commission on Ocean Policy and the Administration's response to it, the U.S. Ocean Action Plan. In implementing this plan, NOAA is working closely with partners to address important regional, national, and international issues. NOAA scientists, specialists, and external partners contribute world-class expertise in oceanography, marine ecology, marine archeology, fisheries management, conservation biology, natural resource management, aquaculture, and environmental risk assessment. To achieve balance among ecological, environmental, and social interests, NOAA has adopted an ecosystem approach to management. Increased public knowledge of ecosystems and the principles of sustainable development, as well as the active involvement of the public as stewards for coastal and marine ecosystem issues in their communities, are critical components of this mission.



CLIMATE

Understand changes in climate, including the El Niño phenomenon, to ensure that we can plan and respond properly

Climate shapes the environment, natural resources, economies, and social systems that people depend upon worldwide. While humanity has learned to contend with some aspects of climate's natural variability, major climatic events, combined with the stresses of population growth, economic growth, public health concerns, and land-use practices, can impose serious

[1] New Priorities for the 21st Century – NOAA's Strategic Plan, Updated for FY 2006-FY 2011, April 2005

consequences on society. The 1997-98 El Nino, for example, had a $25 billion impact on the U.S. economy, including property losses of $2.6 billion and crop losses of nearly $2 billion[2]. Long-term droughts lead to increased and competing demands for fresh water, with related effects on terrestrial and marine ecosystems, agricultural productivity, and the spread of infectious diseases. Decisions about mitigating climate change can alter economic and social structures on a global scale.

Delivering climate information can help minimize risks and maximize opportunities for decisions in agriculture, public policy, natural resource management, water and energy use, and public health. By developing a seamless suite of weather and climate products, NOAA addresses predictions on time scales of up to a decade or longer. NOAA's climate information, products, and services enable society to understand and respond to changing climate conditions.

WEATHER AND WATER

Monitor, enhance, and deliver environmental information, science, and services to save lives, protect property, and support environmental stewardship

Floods, droughts, hurricanes, tornadoes, tsunamis, wildfires, and other severe weather events cause $11 billion in damages each year in the United States. Weather is directly linked to public health and safety, and nearly one-third of the U.S. economy (about $3 trillion) is sensitive to weather and climate.[3] With so much at stake, NOAA's role in understanding, observing, forecasting, and warning of environmental events is increasingly vital. NOAA provides decision makers with key observations, analyses, predictions, and warnings for a range of weather and water conditions, including those related to water supply, air quality, space weather, and wildfires. Businesses, governments, and non-governmental organizations are becoming more sophisticated in their use of weather and water information to improve operational efficiencies, manage environmental resources, and create a better quality of life. NOAA is strategically positioned to conduct sound scientific research and provide integrated observations, predictions, and advice for decision makers who manage environmental resources. Realizing that its information and services bridge both weather and climate time scales and local to global spatial scales, NOAA collects and analyzes environmental data and issues forecasts and warnings that protect health, life, and property and enhance the U.S. economy.

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[2] New Priorities for the 21st Century – NOAA's Strategic Plan, Updated for FY 2006-FY 2011, April 2005
[3] New Priorities for the 21st Century – NOAA's Strategic Plan, Updated for FY 2006-FY 2011, April 2005

COMMERCE AND TRANSPORTATION

Provide weather and navigation information for safe, secure, efficient, and environmentally sound movement of goods and people in the U.S. transportation system

Safe and efficient transportation systems are crucial to the growth of the U.S. economy. More than just a means to move from place to place, the U.S. intermodal transportation system carries more than 15 billion tons of freight annually, at a total value of over $9.1 trillion. The U.S. marine transportation system currently ships over 95 percent of this freight tonnage - more than 20 percent by value - of foreign trade through U.S. ports. This includes 48 percent of the oil needed to meet America's energy demands. The Department of Transportation now forecasts that total freight volumes will increase by more than 50 percent in the next 20 years. [4]

NOAA has specific mandates to provide information, services, and products for transportation safety and for increased commerce in the air and on roads, rails, and waterways. NOAA seeks to deliver consistent, accurate, and timely data to help transportation users make better decisions and exploit the existing capacity within intermodal infrastructure safely and efficiently. For example, up-to-date nautical charts, real-time and forecast water levels and accurate marine weather predictions help mariners avoid hazardous conditions, accidents, losses, delays, and use available port capacity for more efficient and economical operations. For example, by knowing current or future waterway conditions, commercial shippers can maximize cargo loads and thereby their economic gain. NOAA's ability to respond to hazardous material spills and search and rescue efforts saves lives and money, and protects the coastal environment. The data NOAA collects for transportation decision-making supports coastal zone managers, emergency planners, scientists, and others working in the coastal zone. NOAA's information services are critical to enhancing the resilience of air, sea, and surface transportation without compromising safety or economic, homeland, and environmental security.

MISSION SUPPORT

Provide critical support for NOAA's mission

Effective and efficient support activities are necessary for NOAA to achieve its mission goals. Facilities, ships, aircraft, environmental satellites, data-processing systems, computing and communication systems, integrated ocean observations, and data management provide the foundation of support for all of NOAA's activities. NOAA must also support U.S. homeland security by maintaining continuity of operations and by providing NOAA services, such as civil alert relays through NOAA Weather Radio and air dispersion forecasts, in response to national emergencies. NOAA ships, aircraft, and environmental satellites are the backbone of the global earth observing system and provide critical mission support services. To keep this capability strong and current NOAA will ensure adequate access to safe and efficient ships and aircraft through the use of both NOAA platforms and those of other agency, academic, and commercial partners.

[4] New Priorities for the 21st Century – NOAA's Strategic Plan, Updated for FY 2006-FY 2011, April 2005

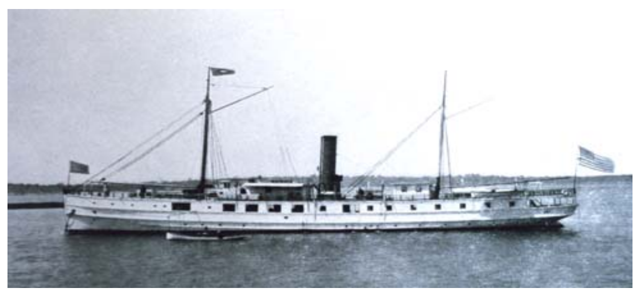
Chapter 4

LEGAL MANDATES, AUTHORITIES, POLICIES AND PRIORITIES

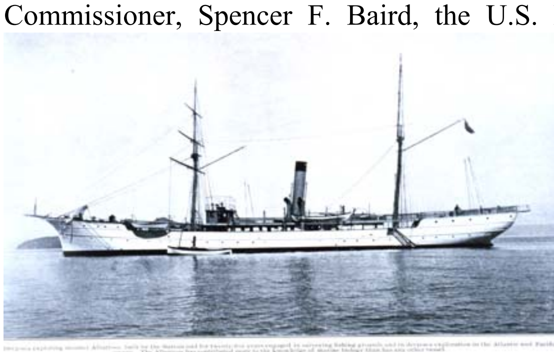
NOAA's roots are planted in America's oldest scientific agency: the Survey of the Coast. Created in 1807 by President Thomas Jefferson, it provided nautical charts to the U.S. maritime community for safe passage into United States (U.S.) ports and along our extensive coastline. This agency laid the groundwork for a legacy of products to enhance safe and efficient navigation on our Nation's waterways. From the original mandate to survey the U.S. coastline, today NOAA's Office of Coast Survey continually updates its collection of 1,000 current charts and the National Geodetic Survey maintains the nation's spatial reference system.

In 1870, the first government agency to provide weather observations and warnings was established within the U.S. Army. The Weather Bureau began in 1890, when Congress transferred these services to the Department of Agriculture. The Weather Bureau published its first Washington, DC weather map, established the first hurricane warning service, and began regular kite observations within its first thirty years of existence. From these "firsts," this service has evolved its scope and capacity, becoming the National Weather Service in 1970. Today, NOAA is the primary source of weather data, forecasts, and warnings. NOAA is also the official voice for issuing warnings during life-threatening weather events in the U.S.

The United States Commission of Fish and Fisheries (the U.S. Fish Commission) was established in 1871 as an independent commission mandated to investigate the causes for the decrease of commercial fish and aquatic animals in U.S. coastal and inland waters, recommend remedies to Congress and the states, and oversee restoration efforts. Under the leadership of its first Commissioner, Spencer F. Baird, the U.S. Fish Commission carried out extensive biological investigations, and designed, built and operated fish hatcheries and related laboratory facilities. Two ships were built for the Commission: the 157-foot schooner rig steamer *Fish Hawk*, and the 234 foot long brigantine-rig steamer USS *Albatross* (1882). The *Fish Hawk* and the *Albatross* facilitated extensive collection of scientific information, exploration expeditions in the Atlantic and Pacific, and collection of data to piece together how fisheries and ecosystems are related to a variety of human-induced and natural fluctuations in ocean conditions. The current ships used to support NOAA's fisheries and ecosystem missions carry on this lineage of purpose-built fishery science and biological oceanography ships.



Fish Hawk



Albatross I

The conservation and stewardship legislation of the 1970s steered NOAA into a significantly increased role of regulating resource management. NOAA needed to gather more scientific information to support regulatory and resource allocation decisions (fisheries); decide how to accommodate or manage multiple uses of marine resources and protected areas (sanctuaries); evaluate, issue, or deny requests for taking or using marine resources (marine mammals); protect endangered species; and assess coastal states' ability to enforce natural resource laws at the state level (coastal zone management).

The criticality of NOAA's products and services to national incident management was demonstrated during the events of September 11, 2001; Hurricanes Katrina, Rita and Wilma in 2005; and whenever the National Incident Management System (NIMS) calls for a staffed Incident Command Post whether the incident is on a local, state or regional level.

Recent Administration and Congressional actions show that ocean issues will continue to remain a high priority. Congress recently passed the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSRA), which is the primary fishery management authority for federal rules. In 2007, Congress passed the Marine Debris Research, Prevention, and Reduction Act, which directs NOAA to take action to protect ocean and coastal ecosystems from marine debris. Congressional interest is further highlighted by the introduction of numerous other statues that will require at-sea observations by NOAA.

Today, NOAA products support management of federal trust resources (living marine resources and essential habitat), 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 mandated by enabling legislation, executive orders, and administrative actions.

What follows is an overview of the major legal mandates, authorities, policies and priorities that underpin the work being done to achieve the strategic goals and outcomes established by NOAA.

NOTE: Relevant excerpts of each are provided in Appendix A.

ECOSYSTEMS

Coral Reef Conservation Act [5]

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 [6]

[5] 16 U.S.C. §6401; PL 106-562
[6] 16 U.S.C. §§ 1531-1544; PL 93-205, reauthorized in 1992

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. NOAA administers ESA's provisions for listed marine mammals, turtles, and other marine species. Species of plants and animals are listed as either "endangered" or "threatened" according to assessments of the extinction risk. 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 withstand 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."[7] Economic factors cannot be taken into account. When a species is listed, critical habitat must also be designated. The preparation of recovery plans for the conservation and survival of listed species is also required.[8] 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.

Executive Order 13158, Marine Protected Areas [9]

Executive Order 13158 establishes the Marine Protected Areas Center and a national system of marine protected areas. It 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 [10]

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 carry out federal and state annual monitoring and analysis activities.

Magnuson-Stevens Fishery Conservation and Management Reauthorization Act [11]

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

[7] 16 U.S.C. § 1533(a)(1).
[8] 16 U.S.C. § 1531(f)(1).
[9] Executive Order 13158 of May 26, 2000
[10] 16 U.S.C. § 1451; P.L. 105-383, reauthorized in 2004
[11] 16 U.S.C. §§ 1801-1882; PL 101-627, as amended in 1996 and reauthorized in 2006, PL 109-479

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.[12] FMPs and FMP implementing regulations must "prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery."[13] 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."[14]

The MSRA, reauthorized 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 collection is essential for providing conservation information necessary for management.

Marine Mammal Protection Act [15]

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 stocks and for stocks for which new information is available, and at least triennially for all other stocks. [16]

[12] 16 U.S.C. § 1853, 1852(h), 1851(a)(1)-(7)
[13] 16 U.S.C. § 1851(a)(1)
[14] 16 U.S.C. §1802(29)
[15] 16 U.S.C. §§ 1361-1421h, October 21, 1972, as amended 1973, 1976-1978, 1980-1982, 1984, 1986, 1988, 1990, 1992-1994 and 1996
[16] 16 U.S.C. §§ 1361-1421; PL 92-522, as amended in 2006

Marine Protection, Research, and Sanctuaries Act [17]

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 [18]

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.

Presidential Proclamation 8031 – Establishment of Papahānaumokuākea Marine National Monument [19]

This Presidential Proclamation establishes the Papahānaumokuākea 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 established the Monument, with conservation measures such as fishing prohibitions to take effect in the near future.

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[17] 16 U.S.C. 1431 et seq, as amended through P.L. 106-513
[18] 33 U.S.C. 1121 et seq, as amended through P.L. 107-299
[19] (71 FR 36443, June 26, 2006), as amended by P.P. 8112 (72 FR 10031, March 5, 2007)

CLIMATE

Global Change Research Act [20]

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 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 [21]

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.

National Climate Program Act [22]

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 [23]

The National Weather Service Organic Act 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.

[20] 15 U.S.C. 2921 et seq.,
[21] 16 U.S.C. §§ 1801-1882; PL 101-627, as amended in 1996 and reauthorized in 2006, PL 109-479.
[22] 15 U.S.C. 2901-2908, at 2904(d) (4), et,
[23] 15 U.S.C. § 313

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."

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).

WEATHER AND WATER

Coast and Geodetic Survey Act [24]

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.

National Weather Service Organic Act [25]

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.

Tsunami Warning and Education Act [26]

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.

[24] 33 U.S.C. § 883a – 883i
[25] 15 U.S.C. § 313
[26] Public Law 109-424

Navigation and Navigable Waters Act[27]

Section 883d authorizes the Secretary of Commerce 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.

COMMERCE AND TRANSPORTATION

Coast and Geodetic Survey Act[28]

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 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. 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.

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.

Coast Guard Navigation Safety Regulations[29]

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.

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[27] 33 U.S.C. § 883d
[28] 33 U.S.C. § 883a et seq
[29] 33 CFR 164.33

Hydrographic Services Improvement Acts (HSIA) [30]

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…"

National Response Plan [31]

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'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

MISSION SUPPORT

Homeland Security

Executive Order 12656, Assignment of Emergency Preparedness Responsibilities [32]

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.

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[30] Hydrographic Services Improvement Acts (HSIA) of 1998 and 2002 U.S.C. 851 note (Pub. L. 104-384, 112 Stat. 3451 and Pub. L. 107-372, 116 Stat. 3078

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

[32] Executive Order (E.O.) 12656, Assignment of Emergency Preparedness Responsibilities, November 18, 1988

Homeland Security Act of 2002 [33]

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 [34]

Homeland Security Presidential Directive (HSPD) #5, Management of Domestic Incidents, tasks the Secretary of Department of Homeland Security (DHS) 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 National Response Plan (NRP).

Homeland Security Presidential Directive #7*, *Critical Infrastructure Identification, Prioritization and Protection [35]

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 [36]

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.

National Response Plan [37]

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.

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[33] Homeland Security Act of 2002
[34] Homeland Security Presidential Directive (HSPD) #5, Management of Domestic Incidents, February 28, 2003
[35] Homeland Security Presidential Directive (HSPD) #7, Critical Infrastructure Identification, Prioritization and Protection, December 17, 2003
[36] Homeland Security Presidential Directive (HSPD) #8, National Preparedness
[37] The National Response Plan (NRP), December 2004

National Security Presidential Security Directive #51/Homeland Security Presidential Directive #20, National Continuity Policy [38]

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.

Satellite Services Support

Energy Bill Act of 2005 [39]

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.

Navigation and Navigable Waters Act [40]

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.

Integrated Ocean Observing

Executive Order 13366, Committee on Ocean Policy [41]

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.

United States Ocean Action Plan and United States Ocean Action Plan Implementation Update (January 2007) [42]

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 Observation." The United States is playing a lead role in bringing the international community

[38] National Security Presidential Directive (HSPD) #51, Homeland Security Presidential Directive (HSPD) #20, National Continuity Policy
[39] Energy Bill Act of 2005 PL 109-*58*
[40] 15 U.S.C. § 313
[41] Executive Order 13366 – Committee Ocean Policy
[42] U.S. Ocean Action Plan – The Bush Administration's Response to the U.S. Commission on Ocean Policy

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."

Fleet Services

Navigation and Navigable Water Act [43]

The Navigation and Navigable Water Act authorizes NOAA to acquire, construct, maintain and operate ships, to acquire and equip up to six Fisheries Survey Vessels and prescribes conditions for NOAA vessel construction and leasing. It also authorizes NOAA to "…procure…vessels, equipment and technologies…" to acquire hydrographic data.

[43] 33 U.S.C. Chapter 17, 883i and 892

Chapter 5

AT-SEA DATA REQUIREMENTS

NOAA performs a wide array of at-sea activities to meet legal mandates, exercise its legal authority, and respond to national priorities. Performing these activities requires a large amount of underlying data. Since NOAA's inception, much of its oceanographic, atmospheric, hydrographic, fishery, and coastal data have been collected on NOAA ships. Without these data, products and services like weather forecasts and warnings, nautical charts, fisheries management, harmful algal bloom warnings, climate outlook, and a host of other products, services, and management activities would not be possible.

ECOSYSTEMS

Best Scientific Information Available

A unique feature of NOAA's stewardship mission is the need for multiple comprehensive data streams to provide the *best available* scientific information in support of three major legislative drivers – the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSRA), the Marine Mammal Protection Act (MMPA), and the Endangered Species Act (ESA).

MSRA requires that Fishery Management Councils prepare fishery management plans that "specify objective and measurable criteria for identifying when a fishery is overfished….and where fisheries are determined to be approaching an overfished condition or are overfished, develop conservation and management measures to prevent overfishing, or end overfishing and rebuild the fishery." This is codified in MSRA's National Standard 2: Conservation and management measures shall be based upon the best scientific information available. Providing the best scientific information involves collecting and evaluating relevant data; analyzing these data by using a model of the stock and its fishery; subjecting the data, methods, and results to a peer-review process; and delivering the results to the Fishery Management Council and other stakeholders.

Fishery Management Councils generally interpret "best scientific information available" as the most recent and relevant information available to them, typically as it appears in stock assessments and other reports generated through NOAA Fisheries Science Centers. Congressional use of the term "best scientific information available" is one of several techniques used to facilitate the preparation and influence of scientific information in the regulatory process along with mandates for scientific studies and the strengthening of scientific advisory bodies. Because fish populations may fluctuate, often significantly between years, fishery assessments requiring population data are generally updated each year. Thus there is an ongoing need to collect annual fishery data.

Numerous lawsuits have challenged whether National Standard 2 and similar provisions have been met in Fishery Management Plans and other federal actions under legislation mandating the use of "best scientific information available." In rendering decisions, the federal courts have not precisely defined the term, but instead, have repeatedly ruled on NOAA's actions to protect, conserve, and rebuild living marine resources taking into account the amount and quality of information available at that time.

NOAA has consistently viewed "best scientific information available" as the underlying data streams systematically collected through established procedures and analytical products, based on commonly accepted statistical techniques or models developed specifically for living marine resource management.

Living Marine Resource Management

NOAA is responsible for assessing 530 stocks and stock complexes that are identified and referenced in federal fishery management plans. NOAA also produces stock assessment reports for 154 protected marine mammal stocks across three regions —Alaska (33 stocks); the Pacific Ocean, including Hawaii (61 stocks); and the Atlantic Ocean, including the Gulf of Mexico (60 stocks). NOAA conducts three activities for living marine resource management: fish stock assessment, protected species assessment for marine mammal and ESA-listed species, and ecosystem assessment (including essential fish habitat).

Fish Stock Assessment

Stock assessment is the scientific and statistical process whereby the status of living marine resource population or subpopulation (stock) is assessed in terms of population abundance, reproductive status, fishing mortality, and sustainability. A fully adequate stock assessment provides estimates of historical, current, and projected future abundance of the fish stock and mortality caused by fishing; thus, it provides the necessary information to determine if overfishing is occurring or if the stock has become depleted. The concept of an adequate assessment is closely linked to the quality and quantity of scientific information available when conducting the assessment. The collection of reliable data is essential to effective conservation, management, and scientific understanding of fishery resources. In the face of an ever-growing list of stocks shifting from virgin or underfished to fully utilized or overfished status and the overcapitalization of fisheries, information is even more important to end overfishing and to support the effective management of fisheries. These situations, as in the West Coast and Alaskan groundfish fisheries, highlight the need for more and better research. A solid scientific backing can reduce the unknown, refine the known, and provide a better analysis of the alternatives for management.

In the most recent annual report on the status of U.S. fisheries, NOAA scientists reviewed 530 individual stocks and stock complexes and made determinations of both overfishing and overfished status, and also noted which stocks were lacking adequate data. The overfishing status of approximately 60 percent of fish stocks is unknown. Research can reduce the number of unknown status stocks, and help establish research priorities for stocks of concern. Better assessments can provide more accurate abundance estimates and better forecasts of future abundance, reducing the uncertainty in allocating quotas and lowering the costs of following the precautionary approach to fisheries management. Better assessments also result in increased confidence from the fishing industry, encouraging better compliance with management measures. Better research on bycatch, essential fish habitats (EFH), life history, and ecosystems holds the promise for progressing from reactive management towards adaptive management, allowing maximum catches with reduced risks for over fishing.

Data sources and collection methodologies across the U.S. include both fishery-dependent and fishery-independent data. Fishery-dependent data are typically collected from fishermen and processors as catch are delivered ashore. The at-sea component of fishery-dependent data collection is accomplished by sea-going fishery observers. Fishery-independent data are obtained through at-sea resource surveys conducted by NOAA fisheries survey vessels (FSV) and program-chartered fishing vessels. A 1998

National Research Council review found that fishery-independent surveys are the most reliable source of information on trends in fish abundance.[44]

Fishery-independent surveys incorporate an unbiased statistical design for the collection of biological data, control over sampling location, timing and intensity, and quality assurance. These surveys can most reliably detect trends in fish abundance when conducted in a highly standardized manner over extended time periods (years to decades).

Marine Mammal and Endangered Species Management

The primary goal of the Marine Mammal Protection Act (MMPA) is to maintain the health and stability of marine mammals and their function in the marine ecosystem. Consistent with this objective, all stocks of marine mammals should be maintained within their optimum sustainable population levels. In meeting this goal, the MMPA requires NOAA to monitor the status of all seal, sea lion, and cetacean stocks that occur in waters under United States jurisdiction. Stock assessment reports must include a description of the geographical range of the stock, information on the population dynamics of the stock, estimates of the total human caused mortality by source, and estimates of the maximum level of direct human-caused mortality that the stock can sustain. The statutory guidance for the quality of information included in stock assessment reports and in management decisions is to use the best available scientific information. However, maintaining up-to-date, high quality information on all stocks of marine mammals is not feasible, and NOAA establishes priorities for data collection under the MMPA. The consequences of using information or estimates with high uncertainty vary. Where human-caused mortality approaches or exceeds sustainable levels for depleted marine mammals, imprecise information could have a dramatic effect on the recovery of these stocks, or could result in major disruption of economically important activities potentially affecting the stock, particularly commercial fishing.

One of the principal purposes of the Endangered Species Act (ESA) is to conserve the ecosystems upon which threatened and endangered species depend and to develop programs for the species' recovery. These programs, including scientific research and management actions, may be conducted by state or federal entities or through international agreements. Embedded in the details of the law are several provisions that require research or monitoring to assess the status and trends of listed species and to identify and understand the various factors within the ecosystem that affect listed species. Specifically, the listing process requires scientific and commercial data regarding the status of species, effects of destruction or modification of habitat, effects of utilization - particularly over utilization - for various purposes (including incidental use), and the effects of disease, predation, and other natural or anthropogenic factors affecting the species. Once a species has been listed, NOAA must reexamine its status periodically to evaluate the continuing need for protection under the ESA. The ESA also encourages international cooperation in species research and cooperation as a commitment of the United States to the worldwide protection of threatened and endangered species. From a fishery management perspective, the most consequential provision of the ESA is the requirement for federal agencies to consult with NOAA under Section 7 of the Act. These consultations are required to ensure that federal actions (such as the implementation of fishery management plans) do not jeopardize or adversely affect threatened or endangered species or modify their habitats in ways which contribute to their jeopardy. This requirement means that NOAA must have reliable information upon which to base a biological assessment of the effects of commercial fishing operations on listed species. The assessment of impacts upon listed species includes direct and indirect effects of fishing, and necessitates adequate status and

[44] Improving Fish Stock Assessments, 1998. National Research Council Committee on Fish Stock Assessment Methods. National Academy Press, Washington, DC, 177 pp.

trend information and an understanding of ecosystem processes. Endangered species in U.S. waters include some marine mammals, all turtle stocks, marine occurrences of some Pacific and Atlantic salmon, and a few other marine fish stocks.

Research and development of new technologies to mitigate or minimize the impacts of fishing operations require substantial scientific effort. The status of listed species is recognized as precarious; therefore, the need for reliable and timely information is critical. Where fishing operations overlap the distribution of threatened or endangered marine species, high quality information is essential to avoid management decisions that would be unnecessarily risky for the affected species or unnecessarily restrictive for the fishing fleet.

Because the stocks managed by NOAA under the ESA and MMPA are marine species, most of them are not accessible from shore for monitoring purposes. While fishery observers provide valuable data on interactions with listed species (i.e. as bycatch), they cannot conduct population counts, take tissue samples from animals in distress, monitor migrations that may be impacted by shipping or fishing activities, or map pelagic habitats that are essential to the survival of protected species. At-sea data collection is required to obtain data on numerous population and ecological parameters that are needed for management. From a fisheries management perspective, at-sea data collection translates into fisheries management plans that can be implemented with fewer restrictions, leading to greater economic return and a decreased litigation risk for NOAA. NOAA ships play a critical role in determining the adequacy of stock assessments, which in turn play a key role in management decisions.

Ecosystem Assessment

The MSRA contains EFH provisions and mandates a supporting program to describe and identify EFH, to identify and evaluate actual and potential adverse effects on EFH (including both fishing-related and non-fishing related impacts), and to develop methods and approaches to conserve and enhance EFH. The ultimate goal of EFH research is to link fish productivity to habitat. This not only provides information for the protection, restoration and maintenance of marine habitat, but also advances objectives to provide sustainable fisheries.

NOAA's ecosystem observations support essential fish habitat characterization and include multiple coastal and oceanic observing systems to support routine monitoring, assessment, and operational forecasts of living marine and coastal resources and their environment. These activities provide scientific information on the status of living coastal and marine resources and their habitat by conducting monitoring and observing activities, producing routine assessments and forecasts of the current and future states of these resources and the ecosystems as a whole, and distributing this information to NOAA's clients and resource users. These efforts compliment the scientific contribution of NOAA's ecosystem research, which supports the development of new products, technology and information. In particular, it is necessary to understand how variations in marine environmental conditions affect the recruitment variability of fish stocks.

Living marine resource management also includes data/information management and quality assurance activities, as well as the production of routine scientific and technical reports (e.g., living marine resource stock assessments). The data acquired for fish stock assessments and marine mammal and endangered species and ecosystem characterization also support collaborative linkages to coral reef conservation, coastal marine resource management, habitat restoration, and protected species and fisheries management, as well as to understanding and predicting the consequences of climate variability and change on marine ecosystems. NOAA's living marine resource management observation activities are an essential component of NOAA's contribution to the Integrated Ocean Observing System (IOOS) and represent the primary NOAA ecosystem observing activities in NOAA's Observing System Architecture.

LIVING MARINE RESOURCE MANAGEMENT ACTIVITIES AND DATA REQUIREMENTS

Major Requirement Drivers	Activities	Data Requirements
Endangered Species Act Magnuson-Stevens Fishery Conservation and Management Reauthorization Act Marine Mammal Protection Act	**Fish Stock Assessment** - periodic (annual) index of each managed fish stock's abundance to provide trend data for stock assessment model, in the: ▪ Pacific Islands Region ▪ Gulf of Mexico, South Atlantic, and Caribbean Region ▪ Alaska Region ▪ California Current, Pacific International and Antarctic Region ▪ Northeast Region	Numbers and weight of fish collected using acoustics, trawls, visual methods and other standardized samplers at statistically selected sample sites Body length and other biological characteristics; associated ecosystem and environmental data
	Marine Mammals and Endangered Species Act-listed Species Management - periodic index of each marine mammal or ESA-listed stock's abundance to track trends, in the: ▪ Pacific Islands Region ▪ Gulf of Mexico, South Atlantic, and Caribbean Region ▪ Alaska Region ▪ California Current, Pacific International and Antarctic Region ▪ Northeast Region	Numbers of marine mammal and ESA-listed species observed using acoustics, visual methods, mark-recapture, and other standardized samplers at statistically selected sampling sites; biological characteristics such as size and maturity; associated ecosystem and environmental data
	Ecosystem Assessment - coordinated, multi-disciplinary characterization of ecosystem and environmental conditions sufficient to describe essential fish habitat, develop ecosystem temporal indicators and develop functional dynamic models of the ecosystem, in the : ▪ Pacific Islands Region ▪ Gulf of Mexico, South Atlantic, and Caribbean Region ▪ Alaska Region ▪ California Current, Pacific International and Antarctic Region ▪ Northeast Region	Physical, chemical and biological oceanographic data and benthic data collected at selected sites throughout the regional ecosystem using diverse array of samplers: CTD (Conductivity-Temperature-Depth), plankton nets, ADCP (Acoustic Doppler Current Profiler), multibeam sonar, remotely operated vehicles (ROV) and AUVs (Autonomous Underwater Vehicles)

Ecosystem Research

NOAA's mission is supported by the application of scientific data, information, and new technology development. Ecosystem research enables NOAA to meet legislative and executive mandates to base policy decisions on sound science; aid coastal resource managers to supporting society's needs for information; protect marine mammals and endangered marine life; and provide credible, unbiased science to the public. By conducting state-of-the-art ecosystem research and by providing scientifically defensible approaches to support protection, restoration, and management of coastal, Great Lakes, and marine ecosystems, the agency strives to be an “honest broker” for the public. At-sea data collection, technology development, and exploration are necessary for ecosystem research to support NOAA’s mission. Broad-based ecosystem research relies on both internal and extramural programs to investigate the natural and human-related influences that affect coastal, Great Lakes, and marine ecosystems. Research priorities are determined by legislative and executive mandates directing NOAA to manage specific marine resources and ecosystems, to develop regional scientific infrastructure, and to support and conduct coastal, Great Lakes, and marine research to conserve marine resources for future generations. NOAA conducts ecosystem exploration and characterization to provide scientists and managers with baseline information about poorly-known and unknown areas of the world’s oceans. In addition, NOAA conducts applied research and technology development that provide both NOAA and NOAA stakeholders with scientific information and tools for implementing and evaluating ecosystem management.

Ecosystem research on anthropogenic stressors to ocean, coastal, and Great Lakes ecosystems have centered primarily on the effects from fishing, habitat degradation, and declining water quality. Less is known about the linkages among climate change, food webs, physical-biological coupling, and ecosystem production dynamics. Improved knowledge in these areas will allow NOAA to develop a new suite of ecosystem forecasts, addressing such conditions as harmful algal blooms, anoxia, beach closings, and water quality and quantity. In addition, NOAA will be able to develop multi-purpose, integrated forecasts. For example, forecasts of sea-level rise could be used to forecast shoreline location, which in turn could be used to forecast bathymetry, fish community structure, changes in human angler behavior, and thus changes in coastal economies. NOAA forecasts will provide the necessary decision-support tools for adaptive, ecosystem-based management of fisheries and marine resources, to predict human impacts on ecosystems, and to protect human health. Additionally, social and economic studies—critical components of any ecosystem approach to management—will be enhanced as part of NOAA’s ecosystem research.

Comprehensive, integrated observations are required to take the “pulse of the planet” by observing natural scales of variability, identifying perturbations and changes, putting current trends into an historical framework, providing a comprehensive and scientifically sound data to forecasting models, and providing a context for assessing the impact of management decisions. Ecosystem research depends on integrated ecological, at-sea observations that expand NOAA’s ability to characterize physical, chemical, and biological properties of aquatic ecosystems and to better understand ecosystem processes and their relationship to NOAA’s management responsibilities. Ecosystem research supports four general activities that support NOAA’s stewardship mission: advancing technology, ecosystem characterization, forecasting and modeling ecosystem events, and outreach and education. These activities support the production of Integrated Ecosystem Assessments that allow evaluation of the cumulative environmental impacts of the variety of human activities.

ECOSYSTEM RESEARCH ACTIVITIES AND DATA REQUIREMENTS

Major Requirement Drivers	Activities	Data Requirements
Coral Reef Conservation Act Endangered Species Act	**Advancing Technology** – develop, apply, and test new and existing technologies in a "natural laboratory" setting, which catalyzes rapid	Digital video imagery, hydroacoustic data, geological (rocks, carbonates, asphalt, and push cores), biological (both mobile

Major Requirement Drivers	Activities	Data Requirements
Harmful Algal Bloom and Hypoxia Research and Control Act Magnuson-Stevens Fishery Conservation and Management Reauthorization Act Marine Protection, Research and Sanctuaries Act National Sea Grant College Program Act	transfer of technology to the actual environments to be managed	and sessile fauna), and chemical sampling (CO_2 and SO_2), as well as navigational and bottom mapping Harmful algal bloom spatial and temporal distribution, water quality (oxygen, productivity), interactions between weather and coastal circulation patterns, basin configuration, and physiology and behavior of algal species
Coral Reef Conservation Act Endangered Species Act Harmful Algal Bloom and Hypoxia Research and Control Act Magnuson-Stevens Fishery Conservation and Management Reauthorization Act Marine Protection, Research and Sanctuaries Act National Sea Grant College Program Act	**Ecosystem Characterization** – develop baseline understanding of the biological, chemical, physical, and geological aspects of spatially delineated ecosystems Focus on open-ocean areas involving deep coral habitats, vents, cold seeps, maritime heritage sites, extended continental shelf mapping, polar areas, canyons, and seamounts	Digital video, and geological, biological, and chemical samples Bathymetric maps, bottom depths, digital video imagery, still imagery, hydroacoustic data, geological (rocks, carbonates, asphalt, and push cores), biological (both mobile and sessile fauna), and chemical sampling, as well as navigational and bottom mapping Fish, zooplankton, and benthic assemblages (numbers and weight), vertical profiles and surface water property fields of salinity, temperature, chlorophyll, plankton, ammonia, turbidity, light attenuation, and nutrient type and concentration Hydrodynamic, meteorological, bathymetric, benthic sediment, and digital video imagery
Coral Reef Conservation Act Endangered Species Act Harmful Algal Bloom and Hypoxia Research and Control Act Magnuson-Stevens Fishery Conservation and Management Reauthorization Act Marine Protection, Research and Sanctuaries Act National Sea Grant College Program Act	**Forecasting and Modeling Ecosystem Events** - using the information from ecosystem characterizations, narrow the range of variables to those that drive the ecosystem event to produce a model that can forecast future events, as well as the outcomes from a range of possible management strategies	Harmful algal bloom spatial and temporal distribution, water quality (oxygen, productivity), interactions between weather and coastal circulation patterns, basin configuration, and physiology and toxicity of algal species Fish, plankton, and microbial communities are sampled, as well as vertical profiles of temperature, oxygen, chlorophyll, and zooplankton

Major Requirement Drivers	Activities	Data Requirements
Harmful Algal Bloom and Hypoxia Research and Control Act Magnuson-Stevens Fishery Conservation and Management Reauthorization Act National Sea Grant College Program Act	**Outreach & Education** – provide research products (technology, assessments, and forecasting models) to the public, partners, and customers via outreach and education efforts Products are adapted to different ecosystems and issues, and improvements to technology, new areas and topics for research, and refinement and application of current forecasting models are developed For coastal and Great Lakes ecosystems, Sea Grant extension agents directly communicate research results to coastal communities, and commercial fishers, and provide training for teachers and students	Educational benefits result from a Science Class Remotely Operated Vehicle (ROV) and telepresence system, giving classroom students the sense of being present at a remote site and ability to accomplish a high degree of operational performance Students and teachers sample plankton, pH, dissolved oxygen, water clarity, hypoxic areas, sediment samples, fish, zooplankton, and benthic invertebrates. These activities often are directed by actual researchers

Coral Reef Conservation

Successful coral reef ecosystem conservation requires adaptive management that responds quickly to changing environmental conditions. This, in turn, depends on monitoring programs that track trends in coral reef ecosystem health and reveal patterns in their condition. Monitoring also plays a vital role in guiding and supporting management strategies such as no-take ecological reserves, fishing gear restrictions, or habitat restoration, by documenting the impacts of gaps in existing management schemes and illustrating the effectiveness of new measures over time. The United States Coral Reef Task Force, established by Executive Order, has called for the development of a nationally coordinated, long-term program to inventory, assess, and monitor United States coral reefs.

The Task Force, which includes 12 federal agencies and the seven states and territories with coral reef resources, passed a 2005 resolution endorsing NOAA's vessel-based coral reef monitoring and assessment efforts and requesting continuation of these efforts for each coral reef jurisdiction on a biennial basis. Activities supported by NOAA vessels include SCUBA surveys for fish, algae, invertebrates, coral bleaching, and coral disease. These efforts also include the deployment and collection of oceanographic monitoring stations that either transmit data via satellite or log data for future retrieval.

Coral reef benthic habitat maps and ecosystem monitoring provide the foundation for the science-based management decisions required to understand, sustain, and conserve these resources. These activities are required to monitor and report on the condition of coral reef ecosystems over time. Accurate, reliable coral reef ecosystem maps are essential tools for federal, state and local managers to assess reef condition, diagnose problems, prioritize and implement solutions, evaluate the results of management decisions, and forecast future conditions. To effectively manage these resources, a manager must know the extent and condition of the coral reefs in their jurisdictions as a baseline characterization. This baseline characterization is developed with bathymetric data gathered via ship-based or autonomous underwater vehicle (AUV)-based multi-beam sonar systems. From this baseline information, managers can overlay management actions, human activities and other threats to determine priority areas for conservation and protection. Federal partners such as the National Park Service have used the digital maps to define no anchoring zones and zones of anchoring to minimize impacts to coral reef habitats at Buck Island, St. Croix, USVI. Habitat maps depicting locations of deep coral communities allow management actions to be taken (e.g. bottom trawling bans) that protect these ecosystems. Habitat map products need to be updated at an interval of approximately seven to ten years to document significant changes (positive or negative) in coral reef extent and condition. Deep-sea coral communities are the most biologically diverse deep-water ecosystems on earth: they are storehouses of biological wealth, potential sources of new pharmaceuticals and have been identified as Essential Fish Habitat in the South Atlantic. Mapping and characterization of these habitats via vessel-based multibeam systems is required to initiate management actions for the protection and conservation of these ecosystems.

Derelict fishing gear in Hawaii's coastal and marine habitats presents a potentially lethal entanglement hazard to numerous marine species, most notably the critically endangered Hawaiian monk seal, the threatened green sea turtle, and the endangered humpback whale. Drifting derelict fishing gear also becomes ensnared in the coral reef ecosystems of the Papahānaumokuākea Marine National Monument and damages these pristine resources. The Hawaiian Archipelago is especially prone to accumulating debris due to its central location in the North Pacific gyre, a clockwise circular pattern of the prevailing ocean currents that circulates debris from around the North Pacific rim. The Coral Reef Conservation Act mandates NOAA to provide assistance to states in removing marine debris from coral reef ecosystems. Through a multi-agency partnership, NOAA has been removing marine debris using trained diver teams and NOAA ships to transport marine debris from the Northwestern Hawaiian Islands to Honolulu for disposal. A 2005 field study estimated derelict fishing gear accumulation in the Northwestern Hawaiian Islands to be 52 metric tons per year.

CORAL REEF CONSERVATION ACTIVITIES AND DATA REQUIREMENTS

Major Requirement Drivers	Activities	Data Requirements
Coral Reef Conservation Act Magnuson-Stevens Fishery Conservation and Management Reauthorization Act	**Deep Coral Reef Mapping** - develop comprehensive maps of all U.S. coral reef habitats: bathymetric coral reef maps; and benthic habitat maps ground truthed	Acoustic bathymetry data Acoustic backscatter data Georeferenced optical video or still imagery to ground truth acoustic data
	Coral Reef Condition Assessment – produce synthesized data products such as monitoring reports and the biennial *State of the Coral Reef of the United States* report which is required by the Coral Reef Conservation Act, and peer-reviewed papers that are published to highlight findings and trends in coral reef condition Data from this effort is used to populate ecological models to forecast the condition of coral reef ecosystems	Coral reef bleaching, disease, algae, coral cover, fish, invertebrates, apex predators, turtle/marine mammals Temperature, salinity; dissolved oxygen; chlorophyll; current direction and speed; wind direction and speed; conductivity; light transmission; submerged aquatic vegetation species, distribution and abundance; ocean pH; (water nutrients; and passive acoustics)

Major Requirement Drivers	Activities	Data Requirements
	Coral Reef Management - develop understanding of coral reef fishery stocks for informed management decisions including marine protected areas, gear restrictions and catch limits	Larval fish samples at 1m and 10m depths along 10 or more transects Larval collections from light traps and settlement traps Oceanographic (conductivity, temperature, light transmission, dissolved oxygen, currents, chlorophyll) and meteorological data from larval collection sites Geospatially referenced identification of spawning aggregation locations
	Marine Debris Removal - remove abandoned fishing gear, marine debris, and abandoned vessels from coral reefs to conserve living marine resources	Marine debris - every tenth load of marine debris is analyzed for net type, mesh size, material used and other parameters

Coastal and Marine Resource Management

The goal of coastal and marine resource management is to promote the health and productivity of coastal and marine ecosystems through a comprehensive approach balancing protection and use of the ecosystems, from coastal watersheds to the oceans. Management and conservation efforts are implemented at a range of geographic scales in partnership with state and local partners and through coordination with a range of domestic and international partners at all levels of government. NOAA has unique partnerships with states to manage the Nation's coastal and marine resources; states contribute resources and authorities to the comprehensive management of the nation's coastal areas, thereby leveraging NOAA investments and contributing to national objectives. Management actions on the use and protection of these areas are designed to improve the long-term resilience of communities and ecosystems, thereby addressing stresses caused by either specific hazards or from the cumulative impacts of long-term changes. Coastal and marine resource management provides the bridge for linking conservation planning and economic development with hazards mitigation. Decision-makers need sound science on which to base management decisions.

Developing effective ecosystem-based management strategies requires knowing what lives in coastal and ocean waters and their association to specific types of habitat. NOAA scientists are answering some of these questions with studies about the distribution of marine life and physical oceanography within National Marine Sanctuaries. Known as “biogeography,” these studies represent some of the most comprehensive efforts undertaken to understand how marine life and habitats are associated with one another. The information will support ecosystem approaches to management as well as supporting regional marine science and education efforts. Virtually all of this information must be gathered through research cruises.

A key mandate of the National Marine Sanctuary Program is to explore, characterize, and protect submerged historic resources and to share these discoveries with the public. To that end, multi-day reconnaissance expeditions occur in sanctuary waters to document submerged heritage sites. Expedition teams survey the remains of wrecks of varying ages, sizes and types. Shipwreck reconnaissance program partners include the National Park Service and various coastal states.

NOAA research cruises are used to answer questions about both short and long-term changes in the environment. For example, the significant absence of krill off Northern California for two years in a row caused reproductive failure in seabirds and forced blue whales to forage elsewhere. Scientists investigated the relationship between physical oceanographic features and the abundance of marine life in sanctuary waters by conducting around-the-clock surveys for top-level predators such as seabirds and marine mammals, and plankton tows to examine productivity beneath the surface. Their results confirmed that greatest productivity occurred where ocean features, such as submerged islands and the Continental Shelf edge, generate upwelling -- the stirring up of nutrient rich waters close to the ocean's surface. Research findings will be used to help managers understand the complex natural and human-caused factors that affect ocean health.

Data gathered for coral reef mapping and condition assessments will be used to provide baseline data for sanctuary emergency response, damage assessment, and scaling restoration activities, revised Sanctuary Management Plans and reports, scientific publications, and educational outreach modules. Data will assist sanctuaries in protecting endangered whale species. Shipping lanes could be shifted to assist in whale protection, which generates multi-million dollar tourist industry in the sanctuary. Delineating certain important habitats helps eliminate damage to pristine habitats and therefore enhances groundfish stock recovery. Data collected will improve the understanding of oceanic forcing of recruitment for target estuarine species. Researchers produce high-resolution, bathymetric maps to enhance future research, monitoring, and restoration efforts. Maps are also used to help sanctuary staff plan the removal of derelict fishing gear and to create three-dimensional video products for sanctuary education and outreach efforts.

COASTAL MARINE RESOURCE MANAGEMENT ACTIVITIES AND DATA REQUIREMENTS

Major Requirement Drivers	Activities	Data Requirements
Executive Order 13158, Marine Protected Areas Marine Protection, Research, and Sanctuaries Act Presidential Proclamation 8031, Papahānaumokuākea Marine National Monument	**Habitat Mapping and Characterization –** monitor changes in deep water habitats and biological communities	Bathymetry and side scan sonar providing data of bottom habitat Visual data collected from remotely operated vehicles (ROV) submersible provides monitoring capability of deep water habitats
	Inventory of Fishes, Marine Mammals, Coral and Benthic Invertebrates – determine local abundance and distribution data	Abundance and distribution of seabirds, marine mammals, and krill, and oceanographic sampling Acoustic marine mammal movement data Biopsy sampling and photo-identification studies of marine mammals Changes in fish species composition, size composition, and relative abundance, primary productivity, feeding aggregations of marine vertebrates such as

Major Requirement Drivers	Activities	Data Requirements
		seabirds, marine mammals, sea turtles, and oceanographic conditions CalCOFI (California Cooperative Oceanic Fisheries Investigations) protocols for standard oceanographic parameters, nutrients, phytoplankton biomass, diversity, and productivity, and distribution and abundance of fish eggs, larvae, marine birds, and mammals Coral samples for disease outbreaks and bleaching dynamics
	Education – introduce local leaders and students to NOAA's science objectives	Cruise utilized for education purposes and for learning about NOAA operations
	Cultural Heritage Characterization - inventory of historic properties	Video and sonar imagery of wrecks and archaeological sites
	Water Quality/ Physical Oceanographic Research - characterization of nearshore and offshore water column including documentation of the physical and biotic links between estuaries and the nearshore ocean waters	Physical oceanographic data and visual surveys of habitats. Coastal Ocean & Plume Dynamics Conductivity-Temperature-Depth (CTD) casts, nutrient measurements, and zooplankton sampling, measurements of dissolved nutrients, and zooplankton net sampling at a series of 15 to 20 reference ocean stations along the Oregon continental shelf

CLIMATE

The oceans cover about 71 percent of the earth's surface and contain 97 percent of the earth's water. Through their fluid motions, high heat capacity, and ecosystems, the oceans play a central role in shaping the earth's climate and its variability. Changes in sea level have major impacts on coastal regions. Accordingly, it is vital to monitor and understand changes in the oceans and their effects on climate and improve the quality of model ocean simulations.

NOAA maintains a consistent and uninterrupted monitoring of many components of the earth's oceans and atmosphere that can provide clues about both long-term and short-term changes in the global climate and conducts a wide range of research into complex climate systems and how they work. The data collected worldwide by NOAA researchers aid the understanding of, and ability to, forecast changes in complex climatic systems. Using ever more powerful and sophisticated computer systems, NOAA researchers are working on numeric modeling of climate systems that will help improve the accuracy of climate forecasts. NOAA relies on its federal, academic, private, and international partners to help understand and describe climate variability and change so that climate services can provide decision makers with a predictive understanding of the global climate system and translate this information so the public can incorporate the information and products into their everyday decisions.

Climate Observing and Analysis

Observations are the foundation for research and analysis leading to a better understanding of the Earth's climate system. That will in turn result in greater use of improved predictions and forecasts through integrated observations, analysis, and data stewardship. Access to quality observations and science-based analysis of these data has provided unique abilities to minimize climate-related risk and maximize climate-related opportunities. Delivering on this demand and achieving more comprehensive outcomes will be accomplished by improving NOAA's ability to meet stringent climate monitoring principles and by working with national and international partners through the Global Earth Observation System of Systems, which includes integrated data and information management systems linked to integrated NOAA observing systems.

Ocean surface and subsurface data are required to calibrate satellite observations, initialize and validate forecast models, and to detect climate change. A global climate ocean observing system that will respond to the long term observational requirements of the operational forecast centers, international research programs, and major scientific assessments is needed. Although the United States Climate Change Science Program (CCSP) has identified the critical need for the federal government to deliver regular reports documenting the state of the Earth's climate, an observing system does not presently exist that is capable of accurately documenting climate variability and change. Over the past decade NOAA has worked with national and international partners to begin building a sustained global ocean system for climate, focusing first on the tropical Pacific, and expanding to the Atlantic and the Indian Oceans. It is now well understood that documenting and forecasting climate will require continuous measurements from space along with the instrumenting of the entire global ocean. The present international effort is about 57 percent of what will ultimately be needed for the global system. NOAA presently maintains approximately 50 percent of the *in situ* networks and 30 percent of the space components and is committed to the goal of providing at least 50 percent of the composite system over the long term.

CLIMATE OBSERVING AND ANALYSIS ACTIVITIES AND DATA REQUIREMENTS

Major Requirement Drivers	Activities	Data Requirements
Global Change Research Act Implementation Plan for the Global Observing System for Climate National Climate Program Act	**Produce Key Observational Datasets** - data sets underpin operational El Nino Southern Oscillation forecasts, documenting tropical climate variability and change, and validating forecasts and projections	Moored buoy measurements of Meteorological (wind, T, rain, rH, radiation) and physical ocean (T, S, P, currents) conditions

Major Requirement Drivers	Activities	Data Requirements
National Weather Service Organic Act Strategic Plan for the United States Climate Change Science Program	**Monitor Deep Ocean Circulation** - including western boundary currents, and transport of heat and freshwater	Temperature, salinity, currents, and particulate matter
	Produce Decadal Inventories of Global Ocean Carbon and Estimates of Coastal Margin and Continental Shelf Carbon Cycling - to monitor changes in ocean carbon uptake from the atmosphere and constrain North American continental carbon cycle estimates	Measurements of ocean carbon, chemical tracers, and physical ocean data
	Produce Critical Subsurface (0 to 2000m) datasets - datasets needed to drive forecast models and contribute to near real-time monitoring of global ocean temperature, salinity, and currents	Ocean temperature, salinity, currents
Global Change Research Act Implementation Plan for the Global Observing System for Climate National Climate Program Act National Weather Service Organic Act Strategic Plan for the United States Climate Change Science Program	**Deploy and Maintain Moorings** – supports the Arctic ocean observing system	Ocean temperature, salinity, pressure, species surveys, nutrients, currents
	Conduct Climate Research - in targeted regions of climatic relevance	Ocean temperature, salinity, pressure, meteorological data

Characterization of Climate Change Forcings

Reducing uncertainty in the information on atmospheric composition and feedbacks that contribute to changes in the earth's climate will provide the understanding needed to link emissions to the radiative forcing of climate change for science-based decision support. This requires measurements of atmospheric and oceanic constituents to reduce uncertainties associated with interannual variability in the global carbon cycle and the radiative influence of other atmospheric and oceanic constituents in the forcing of climate change. These data specifically address information needs associated with atmospheric species whose human-caused changes in atmospheric and oceanic abundances force the climate system to change. A quantitative characterization of climate change forcings from greenhouse species is needed for input to global climate models to optimize predictions of what climate changes could result from policy choices among options for mitigating climate change. Key among these climate forcings are carbon dioxide and aerosol particles. These observations will provide the data needed to establish an understanding of the climate forcing properties of aerosols and ozone, as well as new information on the climate roles of the radiatively important trace atmospheric species. These data will broaden the suite of non-carbon options available for policy support regarding the climate change issue. In the case of aerosols and ozone, which are key contributors to poor air quality in many parts of the world, targeted research studies can provide win-win information for policymakers addressing both climate and air quality issues. NOAA's Climate Forcing and Air Quality programs work closely together to achieve this aim, with focused field studies in coastal regions targeted at addressing specific state/regional climate and air quality concerns, e.g. to help California Air Resources Board comply with the California Global Warming Solutions Act of 2006.

CHARACTERIZATION OF CLIMATE CHANGE FORCINGS ACTIVITIES AND DATA REQUIREMENTS

Requirement Drivers	Activities	Data Requirements
Global Change Research Act National Weather Service Organic Act Magnuson-Stevens Fishery Conservation and Management Reauthorization Act	**Air-sea Interactions Study** – examine climate relevant gases, e.g. carbon dioxide to document the mechanisms of ocean uptake of increasing atmospheric carbon dioxide	Meteorological data, temperature, salinity, currents, pCO2, wave height
	Air Quality Study - track plumes from Asia over the ocean into the United States to inform mitigation or adaptation policies and management practices	Measurements of atmospheric aerosols and trace gases off US coasts

Understanding Climate Effect on Ecosystems

A sound ecosystem approach to management requires the understanding of how climate fluctuations affect the ecosystem. The North Pacific Climate Regimes and Ecosystem Productivity (NPCREP) study is building this understanding for the eastern Bering Sea and Gulf of Alaska by investigating the physical and biological controls on the ecosystems and how these are affected by climate variability and change. A combination of retrospective, monitoring, process and modeling studies are advancing the understanding of the impacts of climate on the fisheries in the region. NPCREP maintains a monitoring network that utilizes preexisting ecosystem and climate observations and supplements these with measurements critical to the success of the project. For example, these data will provide base measurements of acidification that are necessary to understand and estimate the dissolution of shells of the food of young fish, thus impacting the Nation's most productive fishery.

UNDERSTANDING CLIMATE EFFECT ON ECOSYSTEMS ACTIVITIES AND DATA REQUIREMENTS

Requirement Drivers	Activities	Data Requirements
Global Change Research Act Magnuson-Stevens Fishery Conservation and Management Reauthorization Act National Weather Service Organic Act	**Time Series Data Monitoring** - observe physical ocean properties of the productive Bering Sea ecosystem **Living Marine Resource Assessments and Forecasts** - inform the North Pacific Fishery Management Council's recommendations for Total Allowable Catches of Alaskan marine fisheries	Ocean temperature Pressure Currents Nutrients Chlorophyll Zooplankton abundance Marine mammal and seabird counts; Stock assessments of

Requirement Drivers	Activities	Data Requirements
National Climate Program Act		abundance, distribution, size structure, and survival of larvae and spawning species
	Ocean Acidification Study - examine impacts of increased ocean carbon dioxide content on productive ocean ecosystems as part of an overall ecosystem approach to management of living marine resources	Temperature, salinity, pressure, ichthyoplankton, and meteorological data

WEATHER AND WATER

Tsunami Hazard Mitigation

Tsunami hazard mitigation is an internationally cooperative effort to save lives and protect property through hazard assessment, warning guidance, mitigation, and research capabilities. The hazard assessment process identifies tsunami sources, estimates tsunami frequency, develops models and maps of inundation, and provides input to vulnerability assessments to determine coastal risks. Warning guidance is accomplished by tsunami warning centers that acquire observational data from seismic and water-depth monitoring networks, process the data to assess the tsunami threat, and disseminate the data using a variety of communication systems to issue timely and accurate warning information bulletins to emergency management agencies and the public. Detailed maps of future tsunami flooding (inundation) are needed for delineation of evacuation routes and long-term planning in vulnerable coastal communities. Computer models using quality bathymetric and topographic data sets are used to develop the inundation maps for coastal community planning. Inundation maps require continual maintenance and upgrades as better data become available and coastal changes occur. Mitigation, advanced through collaborative initiatives such as *TsunamiReady*, is capacity building, education, and outreach using a multi-hazards approach to enhance awareness and preparedness for communities at risk. Research improves the understanding of tsunami processes and impacts, as well as development of more efficient and effective warning and mitigation measures.

NOAA operates two tsunami warning centers that continuously monitor data from seismological and tidal stations, evaluate earthquakes that have the potential to generate tsunamis, and disseminate tsunami information and warning bulletins to government authorities. Detecting a tsunami is done by checking tide gauges, seismic sensors and tsunami detectors, which are located in coastal areas and throughout the Pacific basin. To ensure early detection of tsunamis and to acquire data critical to real-time forecasts, NOAA has placed Deep-ocean Assessment and Reporting of Tsunami (DART™) stations at sites in regions with a history of generating destructive tsunamis. NOAA has 34 stations deployed to date and plans to expand to a full network of 39 stations by the end of 2008. DART™ systems consist of an anchored seafloor bottom pressure recorder (BPR) and a companion moored surface buoy for real-time communications. An acoustic link transmits data from the BPR on the seafloor to the surface buoy.

Data are required for the development of Digital Elevation and Tsunami Inundation Models which enable the warning centers to provide more accurate tsunami forecasts that reduce unnecessary evacuations and save lives. Ship time is also needed to maintain critical DART buoy operations to ensure warning centers receive critical operational data.

TSUNAMI HAZARD MITIGATION ACTIVITIES AND DATA REQUIREMENTS

<table>
<tr><th>Major Requirement Drivers</th><th>Activities</th><th>Data Requirements</th></tr>
<tr><td rowspan="3">Coast and Geodetic Survey Act

National Weather Service Organic Act

Tsunami Warning and Education Act</td><td>Deep-ocean Assessment and Reporting of Tsunamis (DART) Network Support – acquire data critical to real-time forecasts and provide ongoing operations and maintenance of the DART network</td><td rowspan="2">Tsunami Offshore: Post event and Realtime
Water Temperature – Regional
Seawater Conductivity with Depth
Seawater Pressure with Depth
Seawater Temperature with Depth
Water Level: Global
Water Level: Regional</td></tr>
<tr><td>DART Research and Development of Mooring Systems – conduct research in support of improved measurement technology and the design of optimal tsunami monitoring networks</td></tr>
<tr><td>Tsunami Inundation Grids - produce digital elevation models for tsunami inundation modeling and forecasting</td><td>Nautical Charting
Post Event survey
Hydrography: Coastal and shallow
Barometric Pressure - Regional
Bathymetry: Deep Water</td></tr>
</table>

Air Quality Research

Information and tools on the key processes contributing to poor air quality, the impacts of poor air quality, and potential solutions are needed to support the development of effective policies and emissions management programs by environmental policy-makers and resource managers. Timely and accurate air quality forecast guidance allows people to take appropriate action to limit adverse effects of poor air quality. NOAA scientists are conducting research crucial for improving the ability to predict and monitor changes in air quality, including air pollutant transport, air pollutant transformation processes, atmospheric deposition, particulate matter characterization, and tropospheric ozone reaction and transport processes. These activities specifically address the large public health risk caused by poor air quality. The data and analyses provided will help establish the basis for building next generation air quality forecasts even as the initial National Air Quality Forecasting capability is made available.

AIR QUALITY RESEARCH ACTIVITIES AND DATA REQUIREMENTS

Major Requirement Drivers	Activities	Data Requirements
National Weather Service Organic Act	**National Study** - conduct biannual field study , to understand climate forcing and air quality interactions and the sources and atmospheric processes responsible for the formation and distribution of ozone and aerosols in the atmosphere over the ocean and the influence that these species have on the radiative forcing of climate, human health, and regional haze **Regional Study** - support 2010 California air quality study	Ozone Surface and Vertical Profile Particulate matter Mass Surface Particulate matter Mass Vertical Profile Deposition Toxics Surface Toxics Vertical Profile Ozone Precursors Particulate Matter Precursors Particulate Matter Characteristics Meteorology Surface and Profile Radiation Vertical Fluxes Fire Properties

Science and Technology Infusion

Science and technology infusion enables weather and water service improvements into NOAA operational services. Balancing near-term responsibility to address the needs of its primary customers both inside and outside of NOAA, science and technology infusion provides a long term commitment to conduct visionary research critical for managing future environmental and societal threats. This dual responsibility requires knowledge of new technology to transfer research and development into operations, as well as exploring the unknown of important new concepts.

SCIENCE AND TECHNOLOGY INFUSION ACTIVITIES AND DATA REQUIREMENTS

Major Requirement Drivers	Activities	Data Requirements
Navigation and Navigable Waters Chapter 17 Section 883d, Improvement of methods, instruments, and equipments; Investigations and research	**Air-Sea Interaction Hurricane Intensity research** – supports improvement of early detection of cyclone formation and numerical methods to initialize vortex structure in operational forecast models. This activity provides data in the E. Atlantic genesis region	Air Temperature Surface Atmospheric Pressure Cloud Imagery Ocean Waves Precipitation Profile Sea Surface Winds Water Vapor, Direction and Speed Hydrometeor Size & Type Quantitative Precipitation Estimation Radar Reflectivity Cloud Cover Cloud Liquid Water/Ice Longwave and Shortwave Radiation/ Precipitation Amount

COMMERCE AND TRANSPORTATION

Hydrographic Surveying

The United States (U.S.) economy relies heavily upon the U.S. marine transportation system (MTS) as part of the intermodal network moving people, cargo, and commerce to, from, and across the nation. More than 95 percent of U.S. foreign trade by weight moves by sea, and two billion tons of cargo moves each year through U.S. ports. Since 1955, maritime trade has doubled and the nation's volume of international trade has nearly quadrupled. As dependence on the MTS grows with the anticipated doubling of container shipping trade by 2020, it is crucial for mariners to know where and when changes occur in ports, harbors, and waterways to help prevent accidents and groundings. Significantly, the Department of Transportation's *1999 Report to Congress: An Assessment of the U.S. Marine Transportation System* noted, "The greatest safety concern voiced at the Regional Listening Sessions and the November MTS National Conference related to the availability of timely, accurate, and reliable navigation information." This information is what NOAA provides to the MTS for safe and efficient navigation -- weather and ice forecasts, real-time and forecast water level conditions and obstruction surveys, nautical charts, accurate positioning tools, hazardous spill response, and satellite Search and Rescue. Mariners rely on NOAA's decision support tools to reduce risk and provide a complete picture of the marine environment in which they must operate.

Title 33 of the Code of Federal Regulations requires that NOAA charts be carried on all self-propelled vessels greater than 1600 gross tons, which includes NOAA's own research and survey fleet. Chart use is recommended for all vessels – commercial and recreational -- operating in U.S. waters. Hydrographic data are the primary data layer for electronic navigational and raster/paper nautical charts as well as the Coast Pilot and other products designed to support safe and efficient navigation. NOAA conducts hydrographic surveys to determine the depths and contours of the seafloor and locate natural and manmade obstructions to navigation. It is NOAA's full-bottom coverage surveys that alert mariners to the depths, rocks, wrecks, and other obstructions they must avoid reducing risk of accident and damage to life, property, and the environment. As noted in the Department of Homeland Security's National Response Plan, NOAA is also called upon to survey after hurricanes and other emergencies and incidents of national significance where updated hydrographic data are needed to reopen shipping lanes to traffic or for accident investigation. Examples of these situations include the massive amounts of debris left in waterways after Hurricanes Katrina and Rita; the TWA 800, JFK and EgyptAir airplane crashes in the 1990s; and incidents like the oil spill resulting from the 2004 ATHOS I strike of submerged objects in the Delaware River navigation channel.

Responsible for charting the 3.4 million square nautical miles (SNM) of the U.S. Exclusive Economic Zone (EEZ), NOAA undertook a realistic assessment of hydrographic surveying needs and capability in 1994 when faced with diminishing resources and survey platforms. Given its limited ability to address this huge responsibility, NOAA focuses on roughly 500,000 SNM of the EEZ - about 15 percent - determined to be navigationally significant due to the greatest threat of natural and manmade hazards to marine navigation. As detailed in the 2007 NOAA Hydrographic Survey Priorities plan (NHSP), this area constitutes the geographic bounds of the data requirement for hydrographic surveys from NOAA and contract platforms: waterways with high commercial traffic volumes, oil or hazardous material transport, compelling survey requests from users, and transiting vessels with low underkeel clearance over the seafloor. Much of the survey backlog is in Alaska, where large areas have never been surveyed, earthquakes can cause significant change, and high-occupancy cruise ships are venturing into the uncharted waters at the feet of receding glaciers. At least 50 percent of the existing data on NOAA nautical charts was collected pre-1940 with leadline soundings, and some depths date back to the 1800s.

The areas identified in the NHSP also need to be periodically resurveyed, as dynamic sea bottoms, navigation hazards caused by hurricane debris, accidents and currents, and shifts in shipping lanes and transit patterns cause frequent change in navigable waterways. Arctic ice melt is also creating new survey requirements, as more favorable sea routes for commercial shipping open up with global warming. Over the past 30 years, Arctic sea ice extent has decreased on average approximately 10 percent, with model simulations projecting acceleration in this sea ice retreat. Extensive melting in spring seasons allows a longer navigation season in the Northern Sea from the Atlantic to the Bering Straits. Current models suggest that the current navigation season of 20 to 30 days per year will increase to 90 to100 days by 2080. The extension of the navigation season and the introduction of new possible navigation routes will have very important economic and environmental implications. These routes will increase the ability to navigate shorter distances between the Asian and American continents and access the region's resources, but significant safety and environmental protection issues will arise. Surveying these uncharted areas will require vessels with greater endurance than NOAA presently has.

NOAA currently has the capacity to survey roughly 3000 SNM a year with its own platforms, supplemented by contract assets. NOAA's stated goal is to achieve the capacity to survey and process 10,000 SNM annually, which would put the navigationally significant areas on a 50-year resurvey cycle and ensure that nautical charts accurately portray navigation depths and obstructions. Although the Hydrographic Services Review Panel Federal Advisory Committee noted in its 2007 assessment of NOAA that this is an inadequate schedule from the commercial shipping perspective, it is an objective NOAA believes achievable if resourced adequately, and certainly an improvement over the 166 years it will take to survey the navigationally significant areas once at the agency's current rate.

A key element of meeting mission requirements is maintaining hydrographic expertise to survey U.S. waters for navigation safety, national security, and maritime commerce. NOAA must maintain sufficient competence in survey technology and hydrographic knowledge of the diverse U.S. waterways (Alaska, East Coast, West Coast, Great Lakes, Pacific Islands, Virgin Islands/Puerto Rico, and the Gulf of Mexico) to exercise adequate quality control over hydrographic data acquired by contractors and assume liability for these data to be later incorporated into official NOAA charts and related products. NOAA currently relies on four NOAA hydrographic surveying ships that can generally survey only four of the seven main geographic areas in the U.S.: Alaska, the West Coast, the East Coast, and Virgin Islands/Puerto Rico. The NOAA survey ships serve both a production and training role in meeting the hydrographic survey mission. These are the primary platforms from which NOAA collects full-bottom coverage data for the nautical charting program, trains personnel to maintain hydrographic expertise, and conducts operational tests and evaluations of new hydrographic surveying technologies and systems. These activities not only enable NOAA to support navigation safety and manage and quality assure its contracts for additional hydrographic data, but also benefit other NOAA programs and agencies in need of core expertise for such activities as Integrated Ocean and Coastal Mapping, baseline security assessments, and essential fish habitat mapping.

Hydrographic expertise is defined in terms of a sufficient cadre of trained physical scientists, crew, and NOAA Corps officers capable of using the latest hydrographic technology to collect and process depth and obstruction data in order to:

- Provide effective oversight of private sector surveying and mapping contracts;
- Meet NOAA's annual square nautical mile survey targets, with the ultimate objective to survey and process 10,000 square nautical miles each year;
- Support NOAA's Integrated Ocean and Coastal Mapping effort by assisting other programs and agencies with their mapping needs to ensure multi-use data;

- Improve data acquisition and processing efficiency to increase data collected and reduce marginal survey costs per project by testing and developing new survey technologies with academia and the private sector;
- Support Homeland Security and Maritime Domain Awareness survey requirements for change analysis, countermine warfare, and emergency response; and
- Support the understanding, development, and advancement of international hydrographic standards

NOAA is the only agency mandated to acquire and disseminate hydrographic data to ensure safe navigation of commerce in the Nation's waters (except for dredged waterways). Although there are other agencies which acquire hydrographic data including the U.S. Army Corps of Engineers and the Naval Oceanographic Office, NOAA is recognized internationally as the national authority for hydrographic surveying and nautical charting. NOAA's operation of dedicated hydrographic vessels is a direct contributor of this expertise, which must continue as the nation's reliance on the Marine Transportation System for movement of goods and people continues to grow. Hydrographic and other oceanographic data collected not only support navigation products but are also a fundamental part of an Integrated Ocean Observing System, providing the basis for activities such as tsunami and flood modeling, coastal and marine resource management, engineering projects, long-term sea-level trends, and homeland security needs.

HYDROGRAPHIC SURVEYING ACTIVITIES AND DATA REQUIREMENTS

Major Requirement Drivers	Activity	Data Requirements
Coast and Geodetic Survey Act Coast Guard Navigation Safety Regulations Hydrographic Services Improvement Acts National Response Plan	**Hydrographic Surveying** - measure water depth and physical oceanographic traits of the waterways to correct those measurements for water levels (tides) and speed of sound and establish chart datum, and detect and obtain least depths on all features and hazards to navigation for nautical charts and safety notices to mariners Products from field units are individual Dangers to Navigation and gridded surfaces representing the surveyed ocean bottom	Depth soundings for the 3.4M SNM of the US exclusive economic zone (EEZ) and full bottom coverage to detect and obtain least depths on all features and/or hazards to navigation Priority subset is the 500K SNM of navigationally significant areas, with a goal of achieving 10,000 SNM a year for a minimum 50-year resurvey cycle

Geodetic Gravity Modeling

Geodetic gravity modeling – geodesy - is the science of measuring and monitoring the size and shape of the Earth and its gravity field, or geoid. Geodesy is used to understand physical processes on, above, and within the Earth. NOAA is responsible for the development and maintenance of a national geodetic data system that is used for navigation, communication systems, mapping and charting, construction, and many other purposes. All of the elements of geodesy are joined together in the National Spatial Reference System (NSRS). For over 200 years, the National Geodetic Survey (NGS) and its predecessors have been using geodesy to map the U.S. shoreline, determine land boundaries, and improve transportation and navigation safety.

Scientists can determine exactly how much the earth's surface has changed over time by obtaining highly accurate horizontal and vertical positions based on NOAA's NSRS and the geoid model. Using the Global Positioning System (GPS), everyone now has the ability to determine location within meters on or above the surface of the earth. With additional augmentations and/or observing times from NOAA's Online Positioning User Service (OPUS), accuracies of less than one centimeter horizontally are achievable. NOAA's capability to accurately position an object or person has proven to be essential for the transportation industry to support the safety of people, goods, and services, while reducing costs.

GPS alone (even with the additional augmentations and observing times) is currently incapable of providing accurate elevations relative to sea-level. Making this possible would require a more accurate geoid model, to allow conversion of GPS heights to heights relative to sea-level. The existing geoid model has meter-level errors due to a poor gravity dataset. Improving the data will eliminate these errors, and allow efficient, centimeter-level measurement of heights using GPS. There are many other applications that would benefit from an improved geoid model. Heights are especially critical in coastal areas for sea-level rise monitoring, flood plain mapping, inundation models, evacuation route planning, VDatum, and digital elevation models. A significantly improved geoid model would also reduce costly local physical infrastructure currently required to achieve accurate elevations.

To maintain and improve the geoid model, NOAA collects airborne gravity data, but these data must be validated by surface gravity measurements. Shipborne gravity data collection with gravimeters - a type of accelerometer designed to measure the local gravitational field and very tiny changes within the earth's gravity - perpendicular to aircraft flight lines is particularly key to resolving the present inconsistent gravity field from onshore to offshore in coastal regions.

GEODETIC GRAVITY MODELING ACTIVITIES AND DATA REQUIREMENTS

Requirement Drivers	Activities	Data Requirements
Coast and Geodetic Act Hydrographic Services Improvement Acts	**Gravity Data Collection** – an absolute gravimeter is installed onboard ship and calibrated. The gravimeter operates by letting a mass free-fall in vacuum and measuring its rate of acceleration. By counting and timing the interference fringes, the velocity of the mass can be measured. Gravity field readings are taken along pre-designated ship track lines ▪ Alaska ▪ Gulf of Mexico ▪ Eastern Florida Gulf Stream This work can occur concurrently with other NOAA science missions	Observations nadir to flight profiles to be used to validate the aerogravity collected in accordance with Geodesy's National Gravity Survey Plan

MISSION SUPPORT

Homeland Security

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. NOAA has direct or supporting responsibilities in 10 of the 15 Emergency Support Functions. The specific support and utilization of ship time varies given the nature of the incident supported. NOAA incident response engages multiple capabilities simultaneously due to the interdependencies of NOAA's operations.

HOMELAND SECURITY ACTIVITIES AND DATA REQUIREMENTS

Major Requirement Drivers	Activities	Data Requirements
Homeland Security Act of 2002 National Response Plan (NRP) National Weather Service Organic Act Various Presidential Directives related to homeland security	**National Incident Response Support -** provides NOAA and contract ship response for hydrographic surveys hostelry and emergency operations center support for NOAA and other federal, state and local agencies **National Exercise Program Support** – provides support of annual exercises in the maritime, such as the NOAA sponsored SAFE SEAS	Hydrographic, debris, fisheries, and water-quality surveys for the reopening of ports, reestablishment of fisheries and habitat, and verification of water and seafood quality, as well as hostelry and emergency operations center support in an impacted area that has lost normal infrastructure

Satellite Service Support

NOAA operates sixteen environmental satellites and calibrates and distributes the operational and preoperational data necessary to accurately monitor and observe the land, sea, atmosphere, and space. Within NOAA, satellite command and control, product processing, and distribution and applied research activities are integrated to allow end-to-end utilization of NOAA’s satellite observation and research capabilities. Satellite support activities include vicarious calibration support of all ocean color sensor data, and production of ocean color environmental and climate data records to provide the science support required to prepare for future ocean color satellite sensors and to develop improvements to more efficiently acquire vicarious satellite ocean color data with advanced hyperspectral autonomous buoy (AHAB) technology. Operating day requirements for Marine Optical BuoY Operations and the Marine Optical Characterization Experiment directly support *in situ* data collection from NOAA ships to maintain quality control and assessment of the 10-year vicarious ocean color calibration data stream for satellite ocean color observations and buoy and mooring swap outs to refurbish platform equipment, instruments, and power supplies.

SATELLITE SERVICE SUPPORT ACTIVITIES AND DATA REQUIREMENTS

Major Requirement Drivers	Activities	Data Requirements
Energy Bill Act National Weather Service Organic Act Navigation and Navigable Waters (Ocean Satellite Data)	**Marine Optical Buoy (MOBY) Operations** (Advanced Hyperspectral Autonomous Buoy) - provide acceptance criteria, initialization and product verification for NPP/NPOESS VIRS **Marine Optical Characterization Experiment (MOCE)** - maintain the primary reference standard for all ocean color satellites	Ocean water-leaving radiance values with a threshold precision of 5 percent and a goal of 2 percent and reprocessed science quality data with a threshold of 2 percent and a goal of 1 percent

Major Requirement Drivers	Activities	Data Requirements
	Coastal Optical Characterization Experiment (COCE) - routine sampling and event sampling to measure a range of quantities of a desired variable necessary to develop a new algorithm for coastal applications	

Integrated Ocean Observing

NOAA routinely and continuously provides quality controlled data and information on current and future states of the oceans and Great Lakes from the global scale of ocean basins to local scales of coastal ecosystems through the Integrated Ocean Observing System (IOOS). IOOS is a multidisciplinary system of systems designed to provide data in forms and at rates required by decision makers to address relevant societal goals. Achieving the goals of integrated ocean observing depends on establishing a system that provides required data and information in forms and at rates specified by the users. Integrated ocean observing links observations and data telemetry, data management and communications (DMAC), and data analysis and modeling subsystems.

NOAA's ecosystem observing activities require habitat characterization and include the need for multiple coastal and oceanic observing systems to support routine monitoring, assessment, and operational forecasts of the environment containing our living marine and coastal resources. Real-time IOOS observations, made from multi-purpose observing platforms, provide one of NOAA's most complete characterizations of the environment and support integrated ecosystem assessments. Characterization of the environment involves as many as 65 simultaneously measured environmental parameters, which serve needs across multiple NOAA activities.

The integrated ocean observing subsystem consists of a global component and a coastal component. The latter is composed of a "national backbone" with regional coastal ocean observing systems (RCOOSs) embedded within it. This observing subsystem employs both remote and *in situ* sensing. Remote sensing includes satellite, aircraft and land-based sensors, power sources and transmitters. *In situ* sensing includes platforms (ships, buoys, gliders, etc.), *in situ* sensors, power sources, sampling devices, laboratory-based measurements, and transmitters.

Delivering a quality controlled, real-time ocean observation data stream is a continuous investment that fulfills the U.S. coastal component of the international GOOS effort, addresses the mandate of the U.S. Commission on Ocean Policy (USCOP), and serves the National Oceanographic Partnership Program to bring together government, industry, and academia. These measurements provide definitive information on the effects of the changing climate on coastal communities; improve forecasts of ocean conditions that adversely affect coastline erosion and the fishing, tourism, and oil and gas industries; allow biological and chemical water sampling; provide information on locations of marine endangered or protected species; and monitor coral reef health. Through a distributed implementation model that utilizes existing NOAA capabilities, NOAA makes buoy and coastal station technology available throughout NOAA, other federal agencies, academia, industry, and the public to assist them in meeting their mission requirements.

INTEGRATED OCEAN OBSERVING DATA REQUIREMENTS AND ACTIVITIES

Major Requirement Drivers	Activities	Data Requirements
Interagency Working Group on Ocean Observation Magnuson-Stevens Fishery Conservation and Management Reauthorization Act National Response Plan National Weather Service Organic Act U.S. Ocean Action Plan	**Operation and Maintenance of Integrated Ocean Observing System (IOOS) Moored Buoys -** maintain the primary reference standard for all meteorological and oceanographic sensors (observing system ground truth), as well as testing the equipment	Ocean temperature profiles Wave direction Period, power spectral density Wave height Swell height, period, and power Spectral density Precipitation Salinity Sea surface height Humidity Wind direction, max 1-second wind gusts Wind speed Current direction and speed Incoming surface long wave radiation Ocean marine visibility
	Expand IOOS Moored Buoy systems – increase temporal and spatial density by deploying more fully instrumented, faster reporting observing stations that deliver required coastal and ocean measurements	

Chapter 6

TRANSLATING AT-SEA DATA REQUIREMENTS INTO OPERATING DAYS

To determine the entire suite of mission-critical and mission-related activities, the data needed to conduct these activities was identified and is detailed in Chapter 5. The following scenarios describe how these **data requirements** are translated into **operating days**. Operating days for FY 2010 to FY 2014 are discussed in this chapter by activity.

ECOSYSTEMS

At-sea data needs for NOAA's ecosystem-related missions are diverse. Missions range from fish and protected resources stock assessments, to ecosystem research, to coral mapping, to marine cultural and heritage resource characterization. Ecosystem requirements are not as direct as other NOAA at-sea data requirements. Research missions may change annually in response to previous research results. Because of the uncertainty associated with ecosystems management, scenarios that considered historical, current, and projected situations for each required NOAA capability were developed to provide an estimate of operating day needs. These scenarios are unlikely to exactly play out but they do allow for consideration of qualitative differences in social, environmental, and technical conditions in the development of operating day requirements. Specific examples demonstrating how these needs were developed are provided here.

Living Marine Resource Management

To manage the United States' living marine resources (LMR), NOAA monitors and evaluates marine ecosystems through physical, chemical and biological observations. One of the ways in which NOAA accomplishes this task is by utilizing capabilities that focus on annual monitoring and assessment of managed fisheries stocks, protected species, and coastal and ocean ecosystems. A unique requirement of this stewardship mission is reliance on comprehensive data streams for LMR and ecosystem assessments. The assessment programs are vitally dependent on at-sea data collection to provide a continuing suite of observations supporting data collection on resource abundance, distribution, habitat requirements, and related ecosystem components. At-sea data also supports the management of fishery stocks and protected resources (e.g., marine mammals and turtles) through surveys directed at understanding the interrelationships of climate variability, habitat characteristics, and lower trophic level productivity on ecosystems supporting managed species. In 1998, NOAA provided a comprehensive data acquisition plan that provided the basis for acquiring the first six new fisheries survey vessels (FSV). The 1998 plan provides a comprehensive overview of requirements for living marine resource management. This document updates and expands on the 1998 data acquisition plan emphasizing new requirements from updated fisheries legislation.[45]

[45] NOAA National Marine Fisheries Service Data Acquisition Plan September, 1998. NOAA National Marine Fisheries Service Office of Science and Technology, Silver Spring, MD. 28 pp and appendices.

Fish Stock Assessment

NOAA continues to place a major focus on improving the scope and accuracy of assessments of exploited and protected species. This is essential for documenting the relationship between population changes and exploitation rates as they represent a critical part of the data needed for achieving conservation and management objectives. Fishery stock assessment is a complex process that draws information from a number of sources on the fishery itself (e.g. commercial and recreational catches) and scientific investigations to interpret the impact of fisheries on populations and ecosystems.

Figure 1. provides a generalized information flow diagram that illustrates how various pieces of fishery-dependent data and fishery-independent data contribute to an overall stock assessment. Stock assessments provide the scientific baselines for management actions, and are concerned with determining three basic quantities: (1) the harvest rate that a population of fish is experiencing (e.g., the percent of the population killed by fishing annually), (2) the current population size, and (3) the number of small, young animals that will enter the fishery in future years (recruitment). With these three quantities, fishery scientists can determine if overfishing is occurring (the rate of harvest exceeds the maximum permissible rate defined in the management plan). Second, scientists can determine if the stock is overfished (the population size is less than the minimum biomass[46] threshold determined for the stock). Last, by knowing the recruitment level, combined with current population size and assumptions about harvest rate, scientists can make year-ahead forecasts about how the stock may respond to various management options.

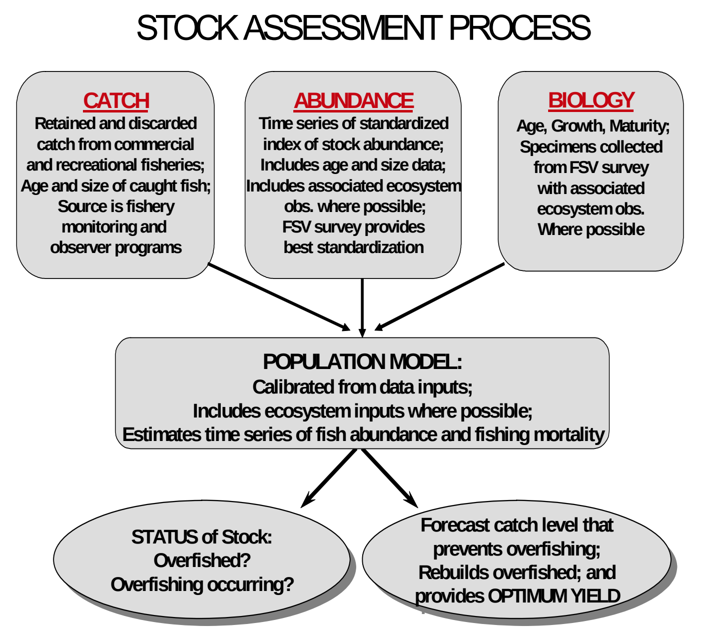


Figure 1. A flow diagram illustrating the stock assessment process.

Overall, 169 specific surveys aboard NOAA fisheries survey vessels (FSV) are currently being undertaken or are proposed to meet Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSRA), Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) mandates. Most fishery surveys are conducted annually and marine mammal surveys biannually. These are ongoing operational requirements to monitor the status of populations and inform management authorities. All mandates are met using specific surveys directed at target species (or multiples) and are conducted with quantifiable objectives related to the precision and accuracy of data supporting resource management activities. Overall, individual activities require from a few operating days up to about 400

[46] Biomass is the amount of living matter in a given habitat, expressed either as the weight of organisms per unit area or as the volume of organisms per unit volume of habitat.

operating days depending on the scope and complexity of the tasks.

Specific surveys have been developed for individual species or, in many cases, are intended to sample multiple species that inhabit the same region. These surveys provide the basic abundance data from which models can be used to calculate the three quantities of interest (harvest rate, population size, and recruitment levels). There are two types of survey information that can be used for stock assessments: absolute abundance and relative population indices from time series data. In absolute abundance surveys, the technology used is intended to provide a direct estimate of all the fish in the path of the vessel as it surveys (see Example 2). By extrapolating the proportion of the area covered to the area occupied by the stock this provides a direct estimate of total population size. However, in many cases it is not technically feasible to conduct this absolute calibration. The second approach uses relative population indices from a time series of surveys along with time series data on fishery catch to estimate harvest rate, population size and recruitment in a population model. This indirect methodology is the basis for most fishery stock assessment in the world.

Examples 1 and 2 are specific examples of the application of each approach to fishery stock assessment missions supporting MSRA requirements and demonstrate how operating day requirements are developed from data requirements: the Northeast Bottom Trawl Survey (BTS) conducted each autumn by the Northeast Fisheries Science Center in Woods Hole, Massachusetts; and the Spring Spawning Grounds Survey for Walleye Pollock in the Shelikof Straits by the Alaska Fisheries Science Center, in Kodiak Alaska. Example 3 is an example of how conducting periodic indices of marine mammals and ESA-listed species and ecosystem assessments drive an operating day requirement.

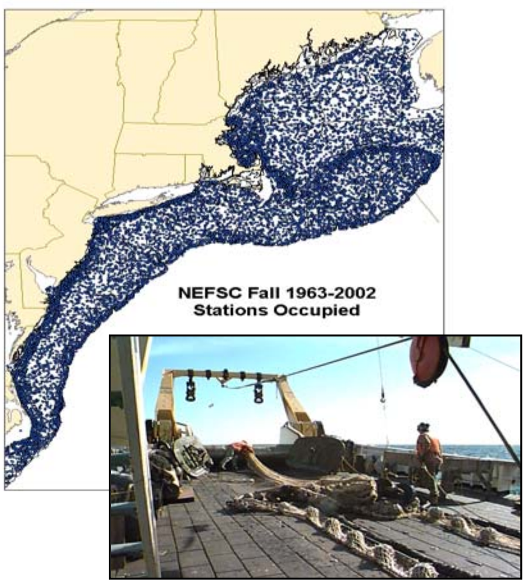
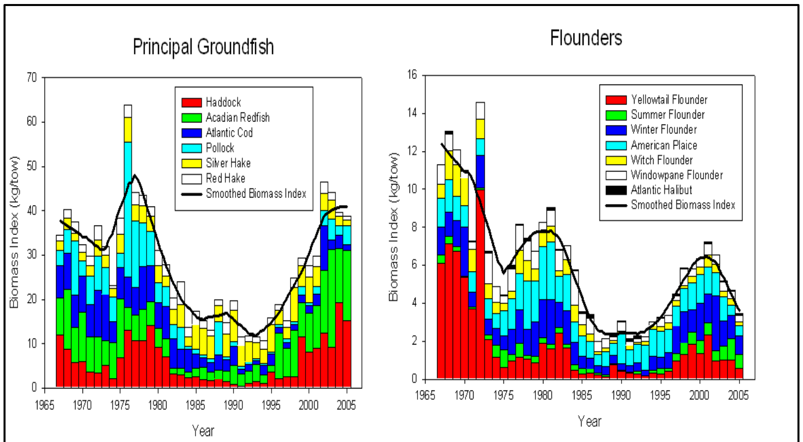


Figure 2. Northeast Fisheries Science Center stations occupied from 1963 to 2002

Figure 3. Sampling frame for the Northeast bottom trawl survey

Example 1: Fishery Stock Assessment: Northeast Bottom Trawl Survey (BTS)

The Northeast Bottom Trawl Survey is a standardized, (same procedures and gear), science based (statistically designed) sampling survey used to index the abundance of about four dozen of the region's most important fishery species. These include New England groundfishes (cod, haddock, flounders, etc.), Middle Atlantic States groundfish (summer flounder, scup, and black sea bass) squids, herring, mackerel and monkfish. Designed from the outset to index all the species that are encountered, this survey provides a wealth of information about how the ecosystem has responded to human activities (e.g., fishing) and climate variability (e.g., water temperature change). Since its inception in 1963, the survey has used the same gear (a "Yankee #36" bottom trawl net) configured in the same way. During this 44 year period, the survey has used a random, stratified, or layered, survey design (Figure 2) that assigns locations for net tows randomly within small regions of similar depth and habitat type. About 360 pre-determined trawling locations are fished during each survey, extending from North Carolina to Nova Scotia encompassing an area of approximately 93,000 square nautical miles. The use of about 360 stations per survey is considered optimal from a precision standpoint. Studies of the survey indicate that even if the number of stations (trawl tows) was doubled, there would not be a corresponding halving of the variance (precision measurement) of the abundance measure. However, if the number of stations were halved (to less than 100) the variance would increase exponentially.



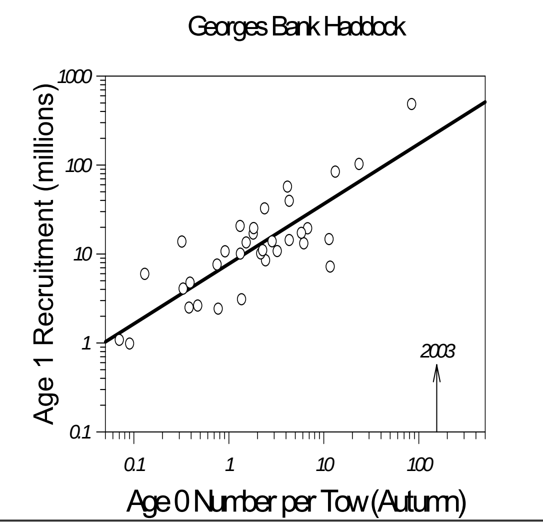
Relative biomass index of principal groundfish (Atlantic cod, haddock, pollock, silver hake, red hake, and Acadian redfish) in the NEFSC autumn survey, 1967-2005. The solid line represents a smoothed index.

Relative biomass index of flounders (yellowtail flounder, summer flounder, winter flounder, American plaice, witch flounder, windowpane flounder, and Atlantic halibut) in the NEFSC autumn survey, 1967-2005. The solid line represents a smoothed index.

Figure 4. Abundance measures for some Northeast species

At each location a 30 minute net tow is made, with the contents of the catch sorted to species, weighed, and counted (Figures 2 and 3). A Fisheries Scientific Computing System (FSCS) manages all these measurements (As a long-term biological record of species change in a large marine ecosystem, the survey is the longest running record of its type in the world. The multispecies nature of the survey is indicated in Figure 4. Figure 4 provides population trends for two groups of species that contribute greatly to the nation's fisheries. As can be seen, trends for the principal groundfishes are generally up, while flounders struggle due to the effects of persistent overfishing. These data are key to the design of fishing regulations to achieve sustainability by eliminating overfishing and rebuilding stocks. As shown in Figure 5, the index of abundance of baby haddock (average number per trawl tow) is highly correlated with the model-based estimate of how many fish in absolute terms enter the population each year. Thus, the third element of stock – population forecasting – is possible.

Fig. 5. Recruitment projections for Georges Bank haddock come from surveys



The long time series of measurements allows the ability to set long term targets for rebuilding. This survey has also been a bellwether of climate change. It is a highly reactive area in terms of water temperature variability. The 1960s were very cold, and more recently the average water temperatures have set record highs. Changes in the distribution patterns of fishes in this region document and allow prediction of how some species will react to elevated temperatures (pole-ward movements of the geographic ranges).

Each Northeast BTS survey takes about 45 operating days to complete. This is because of the large geographic area being surveyed, and the logistics of ship movements and trawling activities. On average, the vessel can complete about 11 trawl stations per day. The vessel works 24 hours per day, with double scientific crews standing 12 hour watches. The survey is based from Woods Hole, Massachusetts, which is at the approximate mid-point of the survey area. Four 12 day "legs" are accomplished, with the vessel starting the survey in Woods Hole, and sailing south to survey south to north. Two week legs are made because of the fuel capacity of the ship and other logistical issues. The survey schedule allows a certain number of "weather days" when the conditions are too rough to fish the gear safely or doing so would provide biased information.

Because of the multispecies nature of the survey it is not "optimized" for any one species. For example, if one were designing just a haddock survey or a squid survey, the geographic area would be much smaller. However, it would be prohibitive in costs and manpower to conduct four dozen individual surveys for the important species, and the ecosystem observations would not be as synoptic. The data obtained from these surveys is an indispensable component of stock assessments for 48 of the region's species, including many of the country's species currently determined to be subject to overfishing. The relative stock indices are used as population trends in models that combine with fishery dependent data to provide size, harvest rate and recruitment estimates for management purposes.

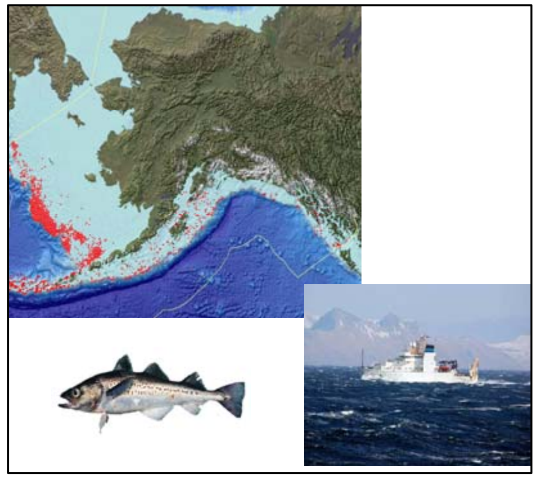


Figure 6. Hydroacoustic survey of Walleye Pollock in the Shelikof Strait

Example 2: Fishery Stock Assessment: Shelikof Straits Hydroacoustic Survey

Fishery independent surveys can also provide direct estimates of stock sizes. We illustrate the use of direct estimates of population size with the annual survey of walleye pollock in the Shelikof Straits area of the Gulf of Alaska. Walleye pollock provide the most fishery landings of any species in the world, providing over three billion pounds of landings each year. The Bering Sea and Gulf of Alaska are the areas occupied by stocks of pollock. Each winter and spring the pollock stocks aggregate in dense spawning concentrations. In the early 1980s, one such concentration was located in the Shelikof Straits between Kodiak Island and the mainland of Alaska (Figure 6). There are a number of such spawning concentrations which allow for a relatively rapid, precise and repeatable estimate of this species in areas where they essentially are the only species encountered. Spawning grounds surveys for pollock provide direct estimates by using hydroacoustic estimates of the abundance of the population. Hydroacoustic measurements are illustrated in Figure 7. This is an "echogram" of about five miles of a transect showing dense pollock schools near the bottom and in mid water depths. Trawling activities (which can target fish in different layers) have determined that fish close to the bottom are the adults, while those in the mid-waters are juveniles (recruits). This separation is due to the biology of the species (e.g., they are cannibals) and the fact that juveniles eat small crustaceans that occur mostly in mid water.

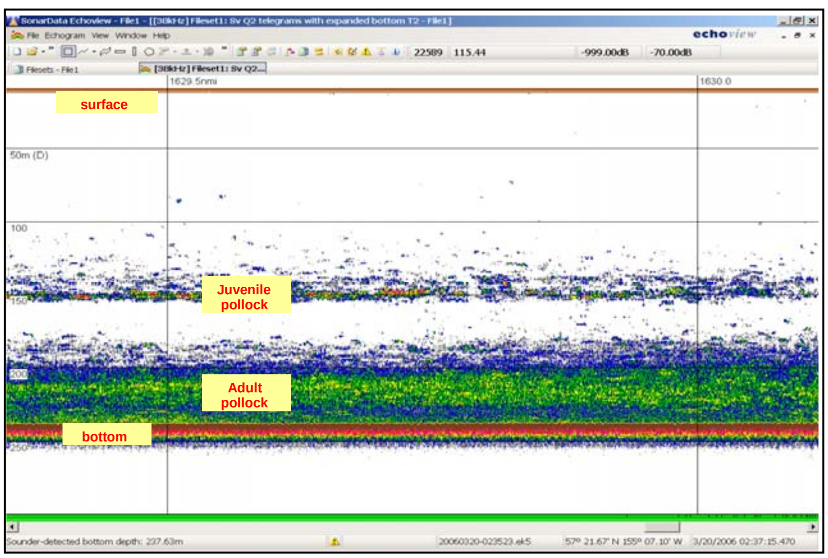


Figure 7. Echogram of Pollock on one transect

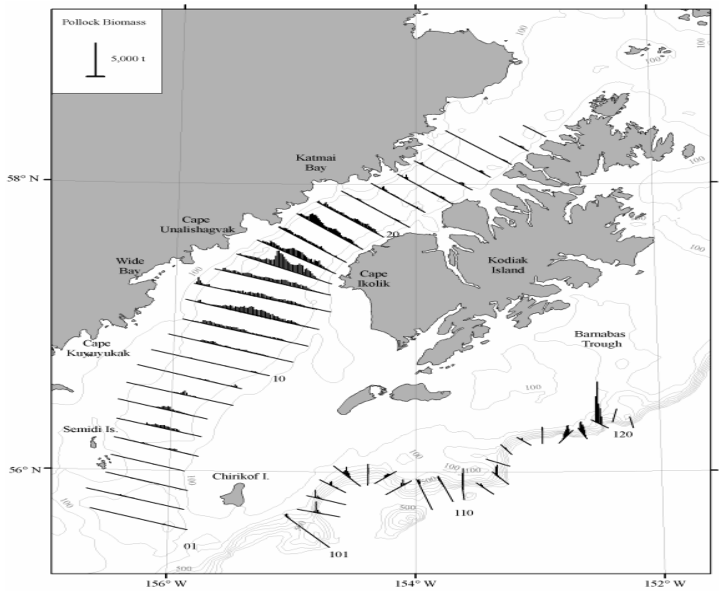


Figure 8. Shelikof Strait near-bottom adult pollock biomass and Chirikof Island shelf break pollock

Hydroacoustic estimates of population size involve several extrapolations. First, along any particular transect line the echo from the sonar is "integrated" into an overall signal strength reflecting the abundance of targets encountered. The higher the biomass in the path of the vessel results in a larger (louder) integrated echo. Controlled experiments with individual fish have provided how much echo strength occurs when that fish is "pinged". Dividing the total echo along the transect by the per fish signal strength gives an estimate of the number of fish along the transect. The echo applies to a narrow swath under the ship so the biomass encountered in all the transect strips is multiplied by the potential number of such strips to give an overall population estimate. The survey plan for adult pollock in the Shelikof area is provided in Figure 8. A total of 50 hydroacoustic transects are conducted in the area around Kodiak Island, and the distribution of biomass on each transect clearly shows that in 2006 the adults are concentrated near Cape Ikolik (Figure 8). This may change from year to year, so the survey area has to encompass all possible locations where the stock is likely to be. The time series of pollock survey biomass estimates in this area is given in Figure 9. Clearly the population has tended downward over time, which means that managers must be increasingly careful that fishing does not threaten the continued viability of this stock. Similar surveys are done in various spawning locations along the Gulf of Alaska and in the Bering Sea and during non-spawning times in summer in both areas.

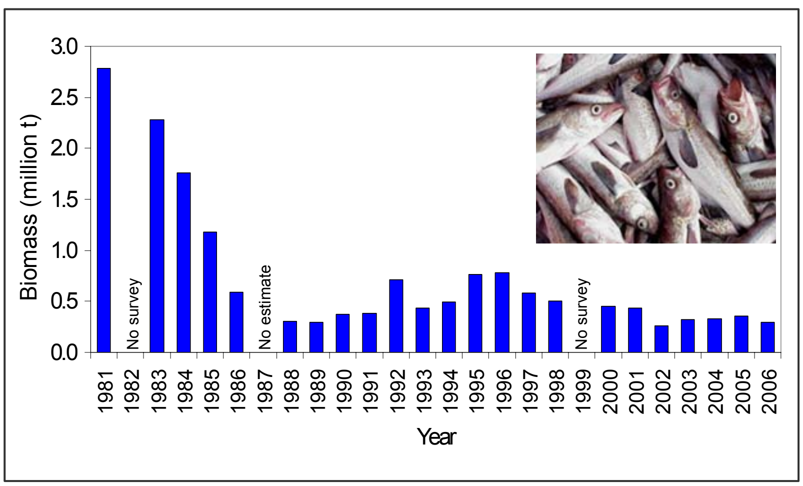


Figure 9. Annual acoustic-trawl pollock biomass estimates for the Shelikof Strait area

The Shelikof Straits survey takes about 18 operating days to complete. The number of operating days is determined by the need to do 50 survey transects spaced ten miles apart in this region in order to provide an accurate and precise population estimate. In this case, steaming time to and from home port is relatively short, and adds relatively few days to the survey, but those days in combination with the length of each individual transect line and the ten mile transect spacing determine the total number of days required to complete the survey. Experiments conducted in this region show that by using transects spaced 20 miles apart (e.g., 25 transects for a survey) it would provide a survey estimate of biomass with much greater statistical variance. Likewise, there are marginal gains to be had by spacing them at 5 mile intervals. These two specific examples show how the requirements for accurate and precise estimates of harvest rate, population biomass and recruitment for managed species are translated into specific operating day requirements. Similar justifications support all stock assessment activities supporting MSRA, ESA, and MMPA.

Example 3: Mammals and ESA-listed Species Management and Ecosystem Assessments: Stenella Abundance Research Project (STAR) in the eastern tropical Pacific

The eastern tropical Pacific Ocean (ETP) is an area of some 21 million square kilometers, ranging from the U.S.-Mexico border to northern Peru and seaward to Hawaii. This area supports one of the world's largest fisheries for yellow fin tuna landing 100,000 to 300,000 metric tons each year. The success of this fishery is due in large part to an unexplained association between yellow fin and two species of cetaceans, pantropical spotted and spinner dolphins. These dolphins and tuna regularly associate in mixed-species schools which, when feeding, also attract large flocks of seabirds. The high visibility of these assemblages, and the fact that the tuna and dolphin remain together even during fishing operations, has made it possible to catch tunas by visually detecting dolphins and seabirds, and then chasing and setting purse seine nets on the associated tunas and dolphins.

During the half century that fishermen in the ETP purse-seine fishery have been capturing yellow fin tuna by exploiting this tuna-dolphin association, initially high fishery-related mortality of the dolphins was observed and at least three dolphin stocks (northeastern offshore spotted dolphins, eastern spinner dolphins, and at least one stock of coastal spotted dolphins) were designated as "depleted" under the Marine Mammal Protection Act (MMPA).

Due to regulatory measures implemented under the MMPA, the ingenuity of ETP tuna fishermen, and international conservation efforts, observed dolphin mortality in this fishery has decreased by about 99 percent, from approximately 100,000 dolphins per year in the mid-1980's to less than 900 animals during 2006. The especially dramatic reduction in direct mortality that occurred in the mid-1990's led to expectation that the depleted stocks would begin to recover at about four percent per year. However, abundance estimates through 2000 show no evidence of the expected increase in population levels.

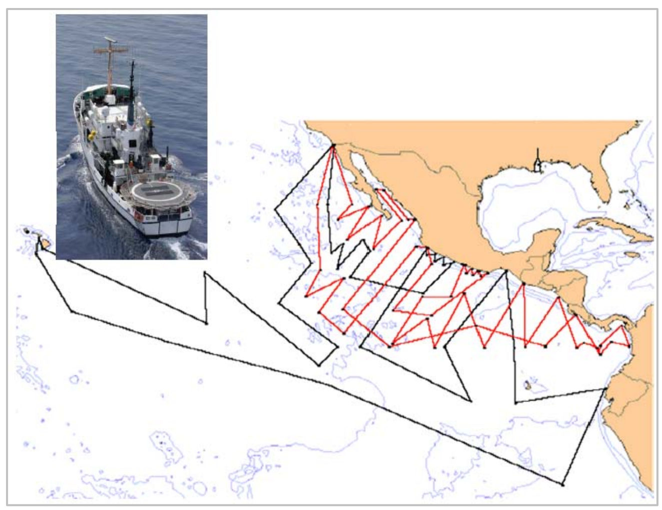


Figure 10. Survey effort in the eastern tropical Pacific, 2006.

The *Stenella* Abundance Research Project (STAR) is a multi-year cetacean and ecosystem assessment study designed to assess the status of dolphin stocks affected by this fishery. The project consists of a series of research vessel cruises which began in the 1970's and are repeated periodically. A five year series was conducted between 1986 and 1990 (known as MOPS - Monitoring of Porpoise Stocks), a three year series was completed from 1998 through 2000, two cruises were conducted in 2003 and 2006; future monitoring cruises are planned at three year intervals. STAR surveys utilize two vessels, departing from San Diego, California. Each survey covers approximately 100,000 linear kilometer of trackline, both ships combined (Figure 10). The size of the study area translates into a minimum requirement of 240 operating days per survey (120 operating days per vessel) in order to obtain adequate coverage for an abundance estimate. Because the McARTHUR II is home ported in Seattle but the survey begins in San Diego, an additional 12 operating days are required of the McARTHUR II for the transit between the two ports (six days of transit each way). The total survey requirement is therefore 252 operating days.

Data used to support estimates of stock abundance are collected using state of the art line-transect methods and wide-format photographs of dolphin schools taken from a helicopter or fixed-wing aircraft. Research on cetacean biology provides additional critical information for stock assessment. This includes analysis of skin biopsy samples collected with biopsy darts, acoustic recordings, and lateral photographs to provide information on population structure, use of biopsy samples and aerial photographs to investigate pregnancy rates and demographic composition of schools, and studies to determine how dolphin behavior influences ship-based detection. Ecosystem assessments provide a context in which to place abundance and assessment results and are a critical means of separating fishery from non-fishery effects on dolphin abundance. Cetacean habitat is characterized through collection of physical and biological oceanographic data, cetacean prey through collection of low and mid trophic-level fishes and invertebrates, and cetacean predators, competitors, and commensals through studies of other apex predators in the system.

Because of the multidisciplinary nature of the survey, ship time is allocated to each sampling component with a view toward optimizing the whole. Between 180 and 200 nautical miles must be covered each 24 hour period (each ship) in order to complete the survey. The majority of daylight hours are spent conducting visual surveys for cetaceans, seabirds, marine turtles, and flyingfishes, and an acoustic survey for cetaceans (using a towed array) at an ideal speed of 10 knots. A rigid-hull inflatable boat is often used to collect skin biopsy samples and lateral photographs, and to sample marine turtles. These deployments require between 1 and 4 hours, depending upon the circumstances. The bulk of ecosystem sampling is conducted while underway. Expendable Bathythermographs (XBTs) are deployed every 30 nautical miles to obtain data on thermal structure of the water column and an associated surface water sample is collected for chlorophyll concentration. Surface temperature and salinity are recorded continuously, as is acoustic backscatter data (to obtain estimates of density of mid-trophic fishes and invertebrates). One hour before sunrise on each day, a Conductivity-Temperature-Depth (CTD) cast is made while the ship sits on station. A second one hour CTD cast is made one hour after sunset. A one hour dipnet station occurs concurrently with the evening CTD cast to sample for nektonic fishes and squids. Post evening CTD, two additional net tows are conducted. The stationary portion of sampling therefore occupies approximately 3 hours per 24 hour period.

The data collected during these cruises have made it possible to assess the status of dolphin stocks affected by the purse seine fishery. These assessments include hind- and fore-casting of population abundance and estimation of uncertainty (Figure 11).

Biological and ecosystem data from the cruises also make it possible to investigate competing hypotheses to explain the lack of recovery of these stocks. These hypotheses include a) the purse seine fishery may be reducing dolphin reproduction and survival in cryptic ways; b) our understanding of demographic parameters for these stocks is incomplete; c) an oceanic regime shift has changed the ecosystem so that recovery cannot occur.

Ecosystem Research

Ecosystem research provides scientific information and tools for coastal, Great Lakes and marine management through applied research, ocean exploration, and mapping and documenting living and non-living resources and processes. This broad-based research relies on both internal and extramural programs to focus on the natural and anthropogenic factors that affect coastal, Great Lakes, and marine ecosystems. The information generated plays a crucial role in developing a ‘baseline’ understanding of the marine environment (e.g., biological, geological, physical, and chemical characteristics), protected species conservation, the understanding of human health issues relating to the ocean, and habitat conservation and restoration. Ecosystem research is needed to develop a fundamental understanding, as well as to track and report on changes to the condition of ecosystems. This includes information about endangered fish and corals, in addition to potential natural products (e.g., pharmaceuticals) and mineral resources. Ecosystem research also supports the development of forecasting models to predict events, such as harmful algal blooms in coastal areas. Through outreach and education, the resulting NOAA data and products allow federal, regional, and local municipalities to apply ecosystem technologies and models to specific issues, assess ecosystem condition, diagnose problems, prioritize and implement solutions, evaluate potential management options, and forecast future conditions.

NOAA's ecosystem research focuses on four general activities: advancing technology; conducting ecosystem characterizations; forecasting and modeling ecosystem events; and providing tools for education and outreach. At-sea data acquisition is essential to meet the requirements of an extraordinarily varied set of data and information, ranging from the use of small vessels for education and outreach purposes, to the use of large, world-class vessels, surface operation instruments, sophisticated shipboard computing systems, and underwater vehicles used to collect data for monitoring, exploration, and applied research. Other data collection techniques (e.g., satellite imagery, buoys), although useful, cannot provide the range or detail of data necessary to meet our requirements.

The majority of NOAA's ecosystem research is selected by a proposal-driven process. Operating day requirements for the outyears are relatively easy to calculate for specific projects that continue every year; however, estimating requests in outyears for new projects, particularly those that occur far from shore, can be particularly difficult. As demonstrated in the examples below, lessons learned during operations on previous cruises were used to extrapolate the time needed to conduct similar operations (e.g., net tows, CTD casts, remotely operated vehicle dives, autonomous underwater vehicle surveys) in different geographic locations or at different depths. Research cruise plans are developed on a cruise-by-cruise basis and factor in transit time, data requirements, and other cruise operations, while also factoring in a reasonable buffer for "inclement weather" days. This buffer can be quite substantial, depending on start and end ports, operating areas, and season. Many shiptime requests are submitted with an eye toward appropriately balancing the number of 'science' days with the number of transit days. A minimal number of transit days are ideal. Unfortunately many places in our world's ocean are quite far from adequate port facilities.

The three examples provided demonstrate how ecosystem research operating day requirements link to data collections, onboard activities, and research outcomes. The first is a detailed example encapsulating an ecosystem characterization that applies advanced technology. This exploratory deepwater cruise uses a remotely operated vehicle (ROV) and an autonomous underwater vehicle (AUV) to collect data at depths greater than 1000 meters. In this example, a peer-review proposal process identifies specific projects, which guide the cruise plans to explore the bottom habitats of the Papahānaumokuākea Marine National Monument. The second example describes the research required to forecast and model ecosystem events. The goal of this research is to predict the occurrence and magnitude of harmful algal blooms, which can produce toxins that affect aquatic organisms and humans, as well as negatively impact natural marine resources (e.g., beach closures or fishing restrictions). The third example is research and education in Sea Grant, a nationwide network (administered through NOAA) of 30 university-based programs that work with coastal communities. Sea Grant has an extramural research program with a peer-reviewed process that selects projects to address strategic research themes. By combining research, education, and outreach, Sea Grant communicates research findings and ecosystem research products directly to the public, including scientists, resource managers, teachers and students. As a result, these efforts enable NOAA to make productive contributions to a variety of important products including

NOAA National Marine Sanctuary management plans and condition reports, joint interagency National Coastal Condition reports, peer-reviewed scientific journal publications, new technology, and educational outreach modules.

Example 1: Ecosystem Characterization Using Advanced Technology: Exploration and characterization of Marine Sanctuaries: A Foundation for Future Ecosystem Assessment and Monitoring

This example describes an ecosystem characterization that applies advanced technology. This example demonstrates potential outcomes from a 20-day project exploring deepwater (>1000 meters) benthic habitats at the Papahānaumokuākea Marine National Monument based on the accomplishments of past projects using similar technologies. Ocean Exploration (OE) uses a peer-review proposal process to ensure quality science relevant to NOAA's mission. Specific details concerning outputs are captured in the proposals and refined in the cruise plans. Due to the discovery potential inherent in exploring unknown areas, many important and unanticipated outcomes and results are quantified after field operations are completed.

This example of a hypothetical 20 day expedition focuses on outputs anticipated when using a regional or global class vessel equipped with standard shipboard sensors, an AUV with multibeam capabilities and a science-class ROV. The project focuses on locating and mapping unknown and poorly known benthic habitats (e.g., deep-sea corals) at depths greater than 1000m using 1) hull-mounted multibeam bathymetric mapping, 2) fine scale multibeam bathymetric mapping using AUV, and 3) targeted ROV dives for collection of digital video, still imagery, and geological, biological, chemical, and other samples. All ship and platform data would be archived at the most appropriate NOAA data center. Standard oceanographic and atmospheric data sets are not covered in this example.

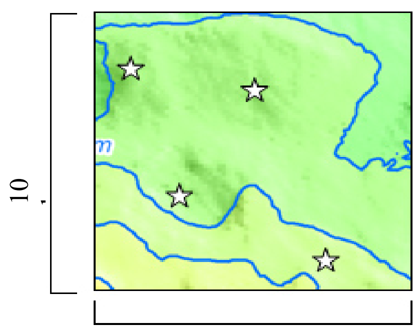
In the past, this type of project was a collaborative effort within NOAA and with other government agencies. This particular example is envisioned to be a joint effort with the National Marine Sanctuary Program, coral reef conservation, and the Pacific Islands Fisheries Science Center. With the expectation that other NOAA capabilities will provide additional ship days, the OE request is limited to 20 operating days. These 20 operating days in this example do not include mobilization, demobilization, transit from port, or transit to port days. Contingencies such as ship mechanical problems, equipment malfunctions, poor weather or water conditions, and illness can affect output.

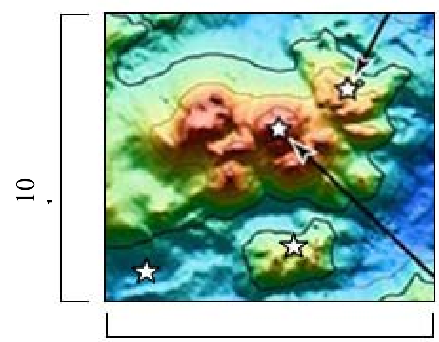
ACTIVITIES, DATA COLLECTED, AND OPERATING DAY NEEDS TO EXPLORE AND CHARACTERIZE MARINE SANCTUARIES

Activity	Data Collected	Operating Days
Transit between sites		1.5
Ship Multibeam survey	▪ Hull-mounted multibeam data ▪ Fathometer ▪ ADCP digital recordings ▪ Marine weather observation logs ▪ Navigational data ▪ Bottom depths	2.0
AUV multibeam survey	▪ Multibeam data ▪ CTD and other water column data ▪ Navigational data	2.0
ROV dives	▪ Digital video imagery ▪ Digital still imagery ▪ CTD data	6.0

Activity	Data Collected	Operating Days
	▪ Water chemistry samples ▪ Geological samples (e.g. rocks, carbonates, asphalt, push cores) ▪ Biological samples (e.g. mobile fauna, sessile fauna) ▪ Navigational data	
Combined AUV Survey/ROV dives	▪ Multibeam data ▪ CTD and other water column data ▪ Digital video imagery ▪ Digital still imagery ▪ Water chemistry samples ▪ Geological samples (e.g. rocks, carbonates, asphalt, push cores) ▪ Biological samples (e.g. mobile fauna, sessile fauna) ▪ Navigational data	6.0
Transit between sites	N/A	1.5
Weather days	N/A	0.5
Total operating days	N/A	19.5

Figure 12. Demonstrating Implications of Topography





The time and operational requirements to adequately characterize a site are greatly affected by the topographical complexity of the area. Both of the images above are produced from multibeam bathymetry surveys on previous OE projects. The left image in Figure 12 represents a large area with relatively simple topography. The four starred sites within the above left image likely have similar biological, chemical, physical, and geological characteristics due to the similar topography. Due to the similarity among starred sites, characterization of those sites may take advantage of 'economies of scale' and therefore may require less time than a topographically complex area. The above right image represents an area with increased topographic complexity. Due to this increased complexity, it could be inferred that each of the four starred sites on the above right image have distinct biological, geological, physical, and chemical characteristics. The uniqueness of these sites will result in a longer period of time per site for the characterization than the sites on the above left image. Since the general topography of the sites will be unknown until multibeam bathymetry is collected during the cruise, times listed in this project summary represent an estimate of the total time required to characterize a number of sites.

DAY-BY-DAY CRUISE PLAN FOR A 20-DAY EXPEDITION
(DOES NOT INCLUDE TRANSIT TO AND FROM PORT)

Day	Hours	Activity
1	12	Arrive on site A Hull-mounted multibeam survey of broad area at site A to identify potential target areas/anomalies for AUV multibeam survey
	12	AUV multibeam survey to perform fine-scale bathymetric mapping of target areas/anomalies found at site A
2	24	AUV multibeam survey continued ROV Dive 1A to investigate high priority target areas/anomalies and perform video and sample collections
3	12	AUV multibeam survey continued ROV Dive 1A continued
	12	Surface time between ROV Dives 1A and 2A Sample processing from ROV Dive 1A
4	24	ROV Dive 2A to continue investigating high priority target areas/anomalies and performing video and sample collections
5	12	ROV Dive 2A continued
	12	Transit to site B Sample processing from ROV Dive 2A
6	12	Arrive on site B Hull-mounted multibeam survey of broad area at site B to identify potential target areas/anomalies for AUV multibeam survey
	12	AUV multibeam survey to perform fine-scale bathymetric mapping of target areas/anomalies found at site B
7	24	AUV multibeam survey continued ROV Dive 1B to investigate high priority target areas/anomalies and perform video and sample collections
8	12	AUV multibeam survey continued ROV Dive 1B continued
	12	Surface Time between ROV Dives 1B and 2B Sample Processing from ROV Dive 1B
9	24	ROV Dive 2B to continue investigating high priority target areas/anomalies and performing video and sample collections
10	12	ROV Dive 2B continued
	12	Weather Day
11	12	Transit to Site C Sample Processing from ROV Dive 2B
	12	Arrive on Site C Hull-mounted multibeam survey of broad area at site C to identify potential target areas/anomalies for AUV multibeam survey

Day	Hours	Activity
12	12	AUV multibeam survey to perform fine-scale bathymetric mapping of target areas/anomalies found at site C
	12	AUV multibeam survey continued ROV Dive 1C to investigate high priority target areas/anomalies and perform video and sample collections
13	24	AUV multibeam survey continued ROV Dive 1C continued
14	12	Surface Time between ROV Dives 1C and 2C Sample Processing from ROV Dive 1C
	12	ROV Dive 2C to continue investigating high priority target areas/anomalies and performing video and sample collections
15	24	ROV Dive 2C continued
16	12	Transit to Site D Sample Processing from ROV Dive 2C
	12	Arrive on Site D Hull-mounted multibeam survey of broad area at site D to identify potential target areas/anomalies for AUV multibeam survey
17	12	AUV multibeam survey to perform fine-scale bathymetric mapping of target areas/anomalies found at site D
	12	AUV multibeam survey continued ROV Dive 1D to investigate high priority target areas/anomalies and perform video and sample collections
18	24	AUV multibeam survey continued ROV Dive 1D continued
19	12	Surface Time between ROV Dives 1D and 2D Sample Processing from ROV Dive 1D
	12	ROV Dive 2D to continue investigating high priority target areas/anomalies and performing video and sample collections
20	24	ROV Dive 2D continued

Example 2: Forecasting and Modeling Ecosystem Events: Data and Operational Requirements for Ecology and Oceanography of Harmful Algal Blooms (ECOHAB) Extramural Projects within the Center for Sponsored Coastal Ocean Research (CSCOR)

This example describes how operating days are determined for research required to support forecasting and modeling ecosystem events. Within NOAA, the CSCOR Coastal Ocean Program, National Sea Grant Program, and the Office of Protected Resources are sponsoring research on harmful algal bloom ecology and oceanography. This research program includes process-related, oceanographic field studies, laboratory experiments, and physical and ecological models to develop predictive capabilities and address gaps in knowledge related to mechanisms that regulate harmful algal species. ECOHAB also supports research assessing impacts of harmful algal blooms and hypoxia on coastal resources and protected species. The distribution and bloom conditions and hypoxia conditions are influenced by coastal circulation and weather, basin configuration, and the physiology and behavior of algal species. ECOHAB projects require ocean-going and regional research vessels that operate in coastal and offshore systems, using oceanographic ships to collect chemical, biological, and environmental samples. Project requirements include collection of data to locate/track/monitor harmful algal bloom conditions, understand causation and persistence, predict environmental and health consequences, and produce the environmental samples for subsequent project laboratory-components.

Extramural ECOHAB related projects are the result of peer-reviewed competitions. The specific cruise requirements are determined after the selection and awarding of grants resulting from those competitions. The requested cruise operating days at sea are based on past and current projects in those programs. The specifics of the projects vary, but they generally occur in stressed HAB/hypoxia-vulnerable coastal areas and typically combine large-scale survey cruises, remotely operated vehicles, autonomous underwater vehicles, autonomous gliders, moored instruments and traps, drifters, satellite imagery, and numerical models development.

Projects, at their completion, will have produced a comprehensive understanding of the formation, growth, dynamics, and forcing mechanisms for algal blooms and hypoxia events and the associated toxicity, and other effects, on coastal organisms across large coastal areas of the U.S. Conceptual and sophisticated numerical models will be developed and tested to explain and forecast HAB/hypoxia events that will markedly improve management intervention to mitigate ecosystem and human heath effects.

Example 3: Outreach and Education: Sea Grant Education: Michigan Sea Grant Summer Discovery Cruises 2006

This example demonstrates how the operating day requirement for Sea Grant is determined. The 2006 Summer Discovery Cruise (SDC) season included 30 operating days for outreach and education. The onboard activities were meant to excite and engage both students and teachers alike as they collected and observed plankton, and learned about water quality via temperature, pH, dissolved oxygen, and depth measurements. They gained an understanding of light penetration in the water column using Secchi disks and learned about the relationship between light and biological factors. One of the highlights of the research cruise is a trawl where participants not only see the process of bringing up fish and other organisms from the sea, but get to examine them under the guidance of an onboard marine biologist. The cruises also included mud grabs and biological dredges in order to familiarize students and teachers with the smaller and yet integrally important invertebrates in the coastal system. Sea Grant activities operate under the National Sea Grant College Program Act. Designed to provide vessel-based Great Lakes educational opportunities to free choice learners, the cruises were conducted involving 1156 learners, 75 percent of whom were adults (18 and older). Michigan Sea Grant Extension provided overall program development and implementation leadership, and website development (www.discoverycruises.org). Seven cruise types were offered: Nature, History, Science for Teachers, Fisheries, Great Lakes Art, as well as our first “Exploring with ROVs” and “First Nations” cruises (both new for 2006). Nature and History cruises dominated the schedule, as in previous years. Sea Grant Extension personnel and appropriate state agency staff participated in the cruises.

Coral Reef Conservation

Coral reefs are some of the most biologically rich and economically valuable ecosystems on earth. They are also in serious jeopardy, threatened by an array of impacts from over-exploitation, pollution, habitat loss, invasive species, disease and climate change. To conduct the mapping, monitoring, assessment and research of coral reef ecosystems necessary to make informed management decisions, biological, physical and chemical oceanography data from often remote coral reef locations under U.S. jurisdiction is needed. The following scenarios provide a sample of how operating day requirements are calculated.

Example 1: Shallow and Moderate Depth Coral Reef Mapping

NOAA develops two primary types of coral reef ecosystem mapping products: (1) bathymetric coral reef maps; and (2) benthic habitat maps. Both types of maps require vessel time to collect the necessary data to develop the product. For depths less than 30 meters, visual interpretation of habitat features seen in satellite imagery is used to create a coral reef ecosystem habitat map and is ground truthed through optical imagery or diver surveys conducted from vessels. To achieve the needed accuracy (~90 percent) to effectively inform management agencies, approximately 1500 points of ground truthing data are needed for a single jurisdiction's coral reef map.

For depths between 30 to 200 meters, acoustic multibeam data are used to develop bathymetry maps and habitat maps for coral reef ecosystems. Multibeam data are collected via 24/7 operations and requires use of a ship-based multibeam system and via 12 hour operations utilizing a smaller survey launch-based multibeam system. ROV or towed camera systems are used to collect geospatially referenced optical habitat data in order to ground truth multibeam data. Multibeam data requires an extensive data processing phase that begins while still on board the ship and continues on land in development of map products. Assuming acceptable weather conditions and the maximum ship speed is used during multibeam surveys, approximately 35 square kilometers can be surveyed per day. The goal of characterizing high priority moderate-depth (30 to 200 meters) areas has been achieved in most of the Pacific, except in the Papahānaumokuākea Marine National Monument, where only approximately 28 per cent of the extensive bank areas between 20 and 200 m have been completed. At the current rate of effort, ten more years would be needed to complete this work in the Monument. In the Main Hawaiian Islands limited multibeam surveying was undertaken in mid-depth areas to augment extensive university-collected data already available. In the remainder of the Pacific Islands, including American Samoa, Guam, Commonwealth of the Northern Mariana Islands Commonwealth of the Northern Mariana Islands, and the equatorial Pacific, approximately 90 per cent of the moderate depth habitat has been mapped using multibeam sonar, and the data have been processed and made available to regional management agencies. In the Caribbean and Atlantic targeted moderate depth mapping has been done in Navassa, Puerto Rico, the United States Virgin Islands, Florida, and the Gulf of Mexico, but significant effort is still required.

Example 2: Deep Sea Coral Mapping

Deep-sea corals, also known as deep-water or cold-water corals, provide habitat for rich animal communities that may rival shallow tropical coral reefs in diversity, but are only beginning to be understood by the scientific community. These habitats, ranging from 50 m to over 3000 m in depth and appear to be much more extensive and important to ecosystem function than previously known. Deep coral ecosystems are often associated with a large number of other invertebrates and appear to form biodiversity "hotspots" in deeper waters. Deep coral structures may also provide habitat for commercially important fishes. Locating, mapping, and characterizing deep coral and sponge habitats are central to conservation efforts. In conjunction with maps of human activities (e.g., mapping VMS access and bycatch, assessing fishing pressure through data analysis, and mapping non-fishing activities), this will provide managers with improved assessments of potential fisheries and other human induced impacts. Such information is needed (and requested) to identify essential fish habitat (EFH), habitat areas of particular concern (HAPCs) and deep coral zones. This initiative will inform sound management decisions to reduce impacts of fishing on deep coral communities and support ecosystem-based planning.

Locating and mapping unknown and poorly known deep sea coral habitats requires use of a regional or global class vessel equipped with standard shipboard sensors, AUV with multibeam capabilities, and a science-class ROV. This equipment will be used to locate and map deep sea coral communities by 1) hull-mounted multibeam bathymetric mapping, 2) fine scale multibeam bathymetric mapping using AUV, and 3) targeted ROV dives for collection of digital video, still imagery and geological, biological, chemical and other samples. All ship and platform data would be archived at the most appropriate NOAA data center.

Requirements for operating days are developed considering the needs for each phase of the cruise including 1) mobilization (2 days), 2) transit to site (4 days), 3) ship multibeam surveys (3 days), 4) ROV dives (9 days), 5) sampling and surface time between ROV dives (6 days), 6) demobilization (2 days), and 7) accommodation for weather days (4 days). This example represents a 30 day expedition to locate and map deep sea coral communities in one area. Two cruises of this magnitude would be needed per year for three years in order to meet the goal of mapping and characterizing the deep sea coral communities of each U.S. region.

Example 3: Marine Debris Removal

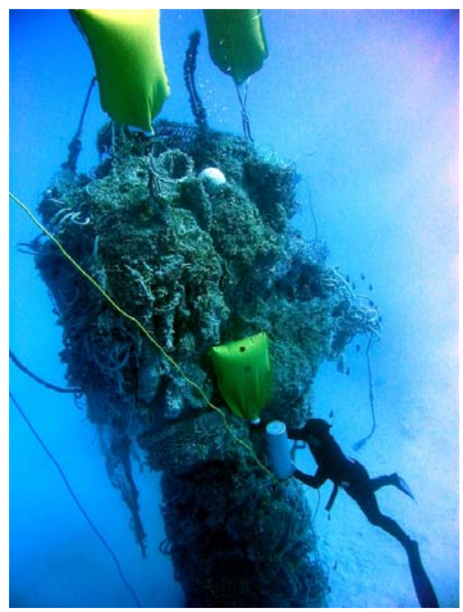


Figure 13: Diver Using Lift Bags to Remove Marine Debris

Trawl nets, gill nets, and other fishing gear lost or discarded by North Pacific fishing fleets are damaging the coral reefs of the Northwestern Hawaiian Islands (NWHI). The debris is transported in ocean currents and becomes ensnared on the pristine reefs of this chain of atolls and islets. Once the debris is snagged on the reef, wave action can cause it to break off coral heads and abrade the surrounding reef. Such damage can continue until the debris is removed or sinks, weighted down by the broken coral. To remove the destructive debris, 16 highly trained marine debris specialists spend up to four months at sea during each field season (Figure 13.) Operations require a charter or NOAA vessel to transport equipment and personnel and serves as a support platform for debris removal and research activities throughout the duration of the project. Transit from the Main Hawaiian Islands to the Northwestern Hawaiian Islands requires 2 to 5 days each way depending on the location of the targeted island/atoll.

The Marine Debris Team uses four small NOAA boats (5.3 meter Avons) launched from the support vessel to conduct field operations. Targeted shallow-water (less than ten meters) areas are systematically surveyed for the presence of buoyant or submerged marine debris. Two types of in-water surveys are employed: tow surveys (two snorkelers will be towed approximately ten meters behind the lead boat) and snorkel surveys (in areas where bathymetry makes tow surveys inappropriate). Designated accumulation rate zones are revisited to gather continuing data.

Upon sighting a derelict net and/or net fragment, a hand signal is given to halt the boats and a Global Positioning System (GPS) waypoint is taken. Debris type, size, fouling level, water depth, and substrate type are recorded. Debris that can be physically recovered or towed by small boats is carefully removed by divers. Workers cut debris free from the substrate, using care to avoid additional coral damage. To the maximum extent possible, detached coral heads and fragments entangled in the nets will be extracted on-site and returned to the bottom. Derelict nets in which more than 75 percent of surface area has been incorporated into the reef structure and are no longer an entanglement hazard will be left in place to avoid additional coral damage. Survey efforts then resume, with the small boats returning to their support vessel to offload collected debris when they reach their maximum capacity. The amount of derelict fishing gear collected varies depending on the location, weather conditions, type of habitat, and number of small boats in the field. A recent accumulation rate study now predicts 52 metric tons of derelict fishing gear to be recruiting annually in the NWHI. With this rate of accumulation each year, 147 days at sea will be needed to protect and restore the valuable coral reef ecosystems of the Papahānaumokuākea Marine National Monument.

Example 4: Coral Reef Ecosystem Condition Assessment: Guam and Mariana Islands Reef Assessment and Monitoring (MARAMP)

Figure 14. Algae Survey

A detailed discussion of the Pacific coral reef monitoring and assessment requirements, including the specific capabilities provided by NOAA ships is provided to demonstrate the vessel-based activities required to obtain the necessary data for coral reef condition assessments.

Coral reef ecosystem monitoring includes both biological and physical monitoring. Biological monitoring activities include direct, periodic field observations of the health of critical reef ecosystems. Physical monitoring activities include automated, continuous daily monitoring of key environmental factors that are known to affect the health of reef ecosystems. The MARAMP effort is part of a comprehensive, integrated, ecosystem-based approach to understanding coral reef condition and dynamics in the Pacific basin. This biennial cruise requires 72 operating days to accommodate the variety of activities required. The ship requires a total of 30 days to transit to and from Guam/Mariana Islands. To conduct the biological reef assessment surveys at these jurisdictions, a total of 960 scuba dives at 90 monitoring sites are conducted. All aspects of the coral reef ecosystem are observed and/or sampled at each monitoring site, including coral habitat, fish, invertebrates, algae, marine mammals, turtles, coral bleaching, and coral disease. Several complementary techniques are used to enumerate the diverse reef fish. Rapid ecological assessments monitor reef habitats and organisms to specific taxonomic levels. Specialists in coral, algae and macroinvertebrate communities use complementary survey methods including video transects, photoquadrats, on-site observations of taxonomy, and organism collection. Towed-diver surveys record benthic composition and distribution patterns using video and still cameras, as well as observational notes. A team of 18 trained divers conduct these activities daily for the maximum time permitted by NOAA dive safety regulations (Figure 14). Specialized capabilities for these activities include: (1) ability to launch and recover small boats to transport diving teams; (2) dive recompression chamber and medical officer; (3) scuba tank refilling equipment; and (4) locker space for dive equipment for 18 people. The biological observations are then coupled with the oceanographic observations (via existing data stations) to better understand the influence of ocean temperature, wave energy, and current on ecosystem health and dynamics.

To record physical data, six satellite-telemetered surface buoys and 51 subsurface data recorders have been installed at Wake, Guam and the Mariana Islands. Instrumentation on the surface buoys provides a high-resolution time series of sea surface temperature, salinity, photosynthetically available radiation, ultraviolet radiation-B, air temperature, barometric pressure, and wind velocity. The surface telemetered observations are augmented by a cost-effective network of subsurface instruments recording water temperature, salinity, current profiles, wave, tide, and acoustic data. This equipment has an operational lifespan of two years and must be maintained or replaced on each biennial MARAMP cruise or the data recorded will be lost and it will be another two years before NOAA is able to return to those monitoring sites.

In addition to permanent data stations, conductivity-temperature-depth profiles, and acoustic Doppler current profiler transects are conducted to provide a more detailed spatial description of ocean conditions. *In situ* water samples measure concentrations of chlorophyll a, nutrients, dissolved inorganic carbon and other constituents. Integration of the data from moorings and *in situ* observations provides an improved understanding of the influences of environmental processes on the surrounding coral reef ecosystems.

Figure 15: R/V AHI Survey Launch

The MARAMP cruise also conducts simultaneous acoustic and optical mapping data collection through use of the ship-based multibeam system (24 hour operations) and the survey launch (12 hour operations) (Figure 15). A total of 13,627 square kilometers of coral reef area were mapped during the cruise including the Saipan Harbor area in partnership with the NOAA Office of Coast Survey. This partnership is an example of NOAA's Integrated Ocean and Coastal Mapping (IOCM) initiative and encourages the piggybacking of other IOCM efforts on coral reef assessment and monitoring cruises in the future.

This multidisciplinary ecosystem assessment cruise is required at each of the U.S. coral reef jurisdictions to accurately track coral reef condition and provide the data and products managers and decision-makers need for effective management of these vital resources. Transit time and the number of monitoring stations vary by jurisdiction, but the type and level of activities conducted at each location are consistent so that results can be compared among jurisdictions. The monitoring and assessment of coral reef ecosystems enables comparisons of heavily impacted and degraded reef systems with remote, relatively pristine reef systems. Through this direct comparison, researchers are able to better assess the effects of nutrient loading, sedimentation, fishing, tourism, and other human related pressures on sustaining healthy coral reef systems.

Coastal Marine Resource Management

To effectively manage coastal marine resources within a sanctuary system, scientists must understand a sanctuary's natural and cultural resources and the threats they face. Site characterizations providing an account of biodiversity, habitats, resources, and ecological processes controlling environmental character, including links with physical processes (e.g. weather, climate, physical conditions) are a key component to gaining this understanding. When combined with research, site characterizations provide the means for objective and informed management and policy decisions.

Figure 16. Launch/recovery of the ROPOS ROV off the NOAA Ship McARTHUR II

A national plan for site characterization has been developed to ensure system-wide consistency in the basic approach for this effort, but it is recognized that considerable flexibility may be required to meet the needs of individual sites. NOAA's National Centers for Coastal Ocean Science is partnering with the National Marine Sanctuary Program to provide scientific support for environmental characterization within the sanctuaries. The following examples are extracts from reports of cruises that directly supported habitat characterization, inventory of living resources, and maritime heritage within the sanctuary system.

Example 1: Habitat Mapping and Characterization

From May 22 to June 4, 2006, NOAA scientists led a research cruise using the Remotely Operated Platform for Ocean Science (ROPOS) (Figure 16) to conduct a series of dives at targeted sites in the Olympic Coast National Marine Sanctuary (OCNMS) with the goal of documenting deep coral and sponge communities. Dive sites were selected from areas for which OCNMS had side scan sonar data indicating the presence of hard or complex substrate. The team completed 11 dives in sanctuary waters ranging from six to 52 hours in length, at depths ranging from 100 to 650 meters. Transect surveys were completed at 15 pre-selected sites, with additional observations made at five other sites. The survey locations included sites both inside and outside the Essential Fish Habitat (EFH) Conservation Area, known as Olympic 2. Bottom trawling is prohibited in the Olympic 2 Conservation Area for non-tribal fishermen. The Conservation Area covers 159.4 square nautical miles or about 15 percent of the sanctuary. Several species of corals and sponges were documented at 14 of the 15 sites surveyed, at sites both inside and outside the Conservation Area, including numerous gorgonians and the stony corals *Lophelia pertusa* and *Desmophyllum dianthus,* as well as small patches of the reef building sponge *Farrea occa*. The team also documented *Lophelia* sp. and *Desmophyllum* sp. coral rubble, dead gorgonians, lost fishing gear, and other anthropogenic debris, supporting concerns over potential risks of environmental disturbances to coral health.

In addition to the McARTHUR II crew and officers, 14 scientists and ROV staff participated. Operations were conducted around the clock to maximize ROV dive time, with the scientists and ROV crew working

12 hour shifts. Although rough weather was forecasted, the vessel only had to reposition twice due to weather — these were the two dives in the relatively calmer waters of the Strait of Juan de Fuca. The remaining nine dives were conducted along the outer coast up to 20 miles offshore, one of which was at the head of the Juan de Fuca Canyon. Dive plans were developed to take advantage of nearest neighbor dive sites to minimize launch and recovery operations, particularly during night operations when fewer ship crew were on active duty.

To aid in conducting transects, the navigation screen for the ROV pilot included the polygons and evenly spaced transect lines of the proposed survey areas developed in project planning. The obstacle avoidance sonar on the ROV was used throughout the dives to aid in locating hard substrates and trawl tracks. When trawl tracks were evident, the sonar was recorded to document the tracks.

The sites selected were surveyed by video transect and digital photography. Both a vertical and forward facing video camera were used along with a vertical digital camera. The video transects will be randomly or systematically sampled during post-cruise processing to address various research questions and the digital photographs are being reviewed as well to determine if they can be used for similar purposes. The sample units obtained during post-processing include parameters such as the following: densities of megafauna, living/dead, broken/whole, size (area and height), and evidence of fishing activity (gear, tracks, etc.). The survey design provides a basis for addressing non-statistical objectives (e.g., locating coral and sponge assemblages in the sanctuary and looking for any evidence of environmental disturbances that may pose risks to coral health) as well as those of a more quantitative nature (e.g., is the species diversity/abundance/richness of non-coral species significantly different in coral areas than in adjacent areas without corals?).

More than 100 invertebrate samples were collected. Photos were taken of each organism *in situ* prior to collection and again once on deck. In some cases, higher-magnification images were obtained using a stereomicroscope. Tentative identifications were made on board whenever possible and the organisms were preserved.

The ROV was equipped with a Conductivity-Temperature-Depth (CTD) recorder with a dissolved oxygen (DO) sensor that recorded data during each dive from about 1m off the seafloor. Because the instrument was time-code linked to the navigation file, scientists were able to isolate the portion of the profile related to the bottom time at each site surveyed. The mean values for salinity, temperature, DO and depth were calculated. Current speeds encountered at the dive sites were estimated by the ROV pilot by turning the ROV into the current and applying forward speed and by observing the direction and speed of movement of marine snow while sitting stationary.

Only a minor portion of this sanctuary has been photographically surveyed to date. Reliable information to help locate potential coral sites (e.g., using data derived from side scan sonar or multibeam bathymetry surveys) is currently only available for approximately 26 percent of the sanctuary (primarily at depths < 400 m) because of the cost and logistical challenges associated with conducting acoustic surveys in deeper waters by towed array. However, some corals (e.g., bamboo corals (family Isididae) and bubblegum corals (family Paragorgiidae) are found only in deeper areas. Within the mapped area, hard substrates existing within a specific depth criterion that may provide coral habitat have been identified at 48 sites. Quantitative ROV dive transects have been completed at 15 of these 48 sites. NOAA intends to sample the remainder of the polygons in future years in order to meet overall project goals.

Example 2: Inventory of Fishes, Marine Mammals, Corals and Benthic Invertebrates

NOAA and partner scientists from Hawaii led a research cruise in the Northwestern Hawaiian Islands: Nihoa Island, French Frigate Shoals, and Gardner Pinnacles and Johnston Atoll to collect specimen and tissue information on reef fish, corals, and other invertebrates; conduct surveys of coral bleaching and disease; and conduct apex predator inventory through tagging and recovery with acoustic and satellite transmitters. In addition to the officers and crew of the HI'IALAKAI, twenty-two scientists participated in the cruise. Researchers participated in over 539 dives registering over 26,500 minutes of bottom time. Over 3000 digital video and photo files were recorded. Researchers collected over 2,500 coral, fish and invertebrate specimens.

Genetic surveys of fish species across the NWHI and Johnston Atoll were conducted to assess the level of connectivity among isolated reef habitats in the two National Wildlife Sanctuaries, the state NWHI Sanctuary, and the NWHI Coral Reef Ecosystem Reserve. During this research cruise, our team logged 27 scuba dives and approximately the same number of snorkel dives. Scientists collected a total of 861 fin clips from 21 species of fish.

Scientists collected a total of 1364 specimens of 26 species from Nihoa Island, French Frigate Shoals, Gardner Pinnacles and Johnston Atoll. The target species inhabited shallow reefs and are accessible via snorkeling, or scuba dives. Tissue biopsy samples were typically obtained as small fragments for corals (1 cm2), arm clips for sea stars, brittle stars and sea cucumbers, and whole animals for smaller invertebrates. In addition, coral samples of two species were shared with other researchers on the cruise. By documenting the pattern and magnitude of connectivity in a diverse set of invertebrate taxa, researchers can determine if there are general patterns that can guide management decisions for understudied species. The genetic surveys of connectivity among reef habitats will substantially augment the scientific foundation for conservation measures. Specifically, this research will establish whether reef ecosystems of the NW Hawaiian Islands are isolated management units (as preliminary data indicate) or components of an interactive metapopulation.

Researchers reached their sampling goals for most species, especially at Johnston Atoll. Coral reef invertebrates were collected by hand using pliers, forceps or hammer and chisel depending on the species. On board HI'IALAKAI, fishes were kept in an open-system cooler with flow-through ambient temperature seawater. To prevent agonistic interactions, individuals were placed in plastic kitchen containers with holes drilled for water circulation. Open-system circulation was shut down upon entering State of Hawaii waters, and air bubblers were used to maintain circulation and aeration. Researchers stored tissue samples in 70 percent Ethanol at room temperature in two milliliter vials during fieldwork.

Researchers captured sharks by using a bottom-set, ten hook shark line. Captured sharks were brought alongside the skiff, tail-roped, inverted to initiate tonic immobility and measured. Sharks remained docile in tonic immobility while acoustic transmitters were surgically implanted. Several sharks were equipped with s satellite transmitters (in addition to surgically implanted acoustic transmitters). Two types of satellite transmitters were used; (1) fin mounted fixed transmitters and (2) pop-up archiving tags. Fin mounted fixed transmitters transmit the shark's location to the Argos satellite array whenever the dorsal fin breaks the surface of the water. Pop-up *arcKving* tags collect and store temperature, depth and light intensity data as the shark swims, and then detach from the animal on a preprogrammed date and time. The released tags float to the surface where they transmit archived data to the Argos satellite array.

Example 3: Cultural Heritage Characterization

NOAA and partner scientists from Hawaii led a research cruise in the Northwestern Hawaiian Islands: French Frigate Shoals, Maro Reef, Pearl and Hermes Atoll, Midway Atoll, and Kure Atoll, with the goal of conducting assessments of living and cultural heritage resources in the surrounding waters. Maritime heritage objectives for the cruise included: 1) locate new submerged resources using magnetometer remote sensing; 2) document previously located submerged resources; 3) establish permanent transects at selected wreck sites, 4) begin site plan trilateration at selected wreck sites; 5) collect diagnostic samples at selected wreck sites; and 6) collect high definition video footage of heritage resources and sites above and below the water. Scientists utilized a number of methods, approved by the Hawaii State Historic Preservation Division and USFWS, for gathering information on the cultural resources including: remote sensing magnetometer and diving surveys, permanent transect establishment, digital photo and video documentation, baseline trilateration measurements, and diagnostic artifact collection.

In addition to the officers and crew of the HI'IALAKAI, five NOAA scientists in collaboration with director/film makers John Brooks and John Lindsay of the NOAA Ocean Media Center participated in the maritime heritage portion of the cruise.

Magnetometer operations began at French Frigate Shoals, and six lanes were completed under rough sea conditions outside the eastern reef. The team did discover two shipwrecks, a landing craft or barge at French Frigate Shoals and a modern vessel (likely the *Mimi*) lost at Pearl and Hermes Atoll in 1989. In addition, partner researchers on board the HI'IALAKAI found coal in the western passage at Kure Atoll, the area where the iron sailing bark *Dunnottar Castle* (carrying a cargo of coal from Sydney to California) ran aground in 1886.

Eight previously located wreck sites were documented: two whaling ship wrecks at Pearl and Hermes Atoll, USS *Macaw* and *Carrollton* at Midway Atoll, and at Kure Atoll, a 19th century wooden sailing ship wreck, a steel hulled motor vessel, back reef artifacts from the USS *Saginaw* wreck site, and the deteriorating fishing trawler *Houei Maru*. Documentation consisted of measured drawings of major features where needed, digital still photography, and photomosaic production where needed. In addition, lat/long GPS positions were taken on additional features discovered outside the initial surveys. Transect pins were established at three sites. At each site 8 to 12 stainless steel pins were hammered and fixed with epoxy into the coral substrate along a 50 to 70 meter line. These pins make it possible to repeatedly set a fixed reference or baseline for accurate measurement of all artifacts, and for long term monitoring of the site. The technique is similar to state and United States Fish and Wildlife Service coral biology transect placement, and was carried out with full NHPA sec106 review and approval by the State Historic Preservation Division.

Diagnostic samples were collected from three different sites. A total of 30 individual small diagnostic artifacts were collected, including: glass bottle fragments, wood samples, copper nails, spikes and drift pins, lead musket balls, brick and ceramic samples, copper sheathing, and wire rope sections. These samples will assist in confirming identification of sites by making stylistic and constituent component analysis possible.

ECOSYSTEM OPERATING DAYS

Ecosystems Operating Days	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Currently supported by NOAA ships or charter activity*	5386	5386	5386	5386	5641
Other activities that support NOAA's mission	3388	3592	3670	3374	3005

* Current allocation is based on historical allocation at full operating tempo and FY09 projected charter support. Allocation levels are set annually based on execution year priorities; therefore this table may not accurately reflect actual allocation in the outyears.

CLIMATE

Climate Observing and Analysis

Vessel time requirements and objectives for climate observing and analysis are derived from legislative mandates, national and international science plans, and NOAA's overarching mission to **"**to understand and predict changes in the Earth's environment and conserve and manage coastal and Great Lakes resources to meet our nation's economic, social and environmental needs." These overarching requirements are broken down into scientific objectives, which NOAA scientists then use to guide their science planning. Cruises fall into three sometimes-overlapping categories: deploy and maintain buoys, monitor ocean conditions, and deploy ARGO floats and drifting arrays. Calculations of operating day requirements are project dependent (e.g. not all cruises are alike), taking into consideration the scientific objectives for a given project, the number of stations, the amount of time at each station, the region being sampled, the capabilities of the ship being used, and the transit time. For cruises designed around recovering and deploying buoys, the ship time requested typically factors in the time needed for: transit, sensor intercomparison periods (both old and new buoys systems are compared against on-site water column profiles documenting temperature, pressure (depth), and salinity), recovery and deployment of the buoys, and transit time between stations, if multiple buoys are involved. In addition, cruises often accommodate multiple projects in a region (so-called piggyback projects). Sampling needs are specified to meet the stated scientific objectives, and the ship time is optimized to take into account the various projects being serviced. Priority is given to the main project's sampling needs. The following examples of cruise descriptions exemplify many of the factors taken into account when planning a scientific cruise and the required operating days.

Example 1: Woods Hole Hawaii Ocean Time Series Program (WHOTS)

The primary intent of the WHOTS mooring is to provide long-term, high-quality air-sea fluxes and upper ocean temperature, salinity and velocity as a coordinated part of the Hawaii Ocean Timeseries (HOT) program, and contribute to the goals of observing heat, fresh water and chemical fluxes at a site representative of the oligotrophic North Pacific Ocean. The first WHOTS mooring was deployed in August 2004, and the site has been continuously occupied since that time by means of annual mooring service cruises.

A given maintenance cruise involves five principal operations. These operations are expected to require approximately eight operating days:

1. **Existing Buoy Sensor intercomparison period**. This involves the ship holding position for a 24 hour intercomparison period between the buoy being replaced and the new buoy. Conductivity, temperature, depth (CTD) casts will be done at four hour intervals and the acoustic releases are tested using the trawl winch and the A-frame.

2. **Recovery of the existing mooring**. This involves releasing the buoy (sending an acoustic signal); using a small boat to grapple the buoy, connect, a leader, and bring the mooring to the stern of the ship; recover the mooring buoy-first through the A-frame using the mooring winch, capstan, air tuggers, and crane.

3. **Preparation of the new mooring and instrumentation.** A 36 hour period between recovery of the old mooring and deployment of the new mooring is used to stow the deck from the recovery operation, clean and stow recovered instruments, and prepare the deck gear, mooring materials and instruments for deployment operations. Because of the proximity to port (Honolulu) and

concerns about fantail deck space and the ability to transfer equipment from the upper decks to the fantail at sea, the ship may opt to return to Honolulu for these operations.

4. **Deployment of the new mooring**. The new buoy will be deployed through the A-frame, after which the ship will proceed slowly ahead. The remainder of the mooring is deployed over the stern using the mooring winch, capstan, air tuggers, and crane as necessary. Following the anchor drop, the ship holds station approximately 0.25 nautical miles away from the drop point. It is expected to take about 30 min for the anchor to reach the bottom. Once the anchor has settled, the ship occupies three stations approximately 2.5 nautical miles from the anchor drop point in a triangular pattern. Acoustic ranging from three stations allows the mooring anchor position, to be determined by triangulation.

5. **Replacement buoy sensor intercomparison period**. This operation is analogous to the initial intercomparison period, except that ship stands off from the just-deployed buoy instead of the old buoy.

After the operations above are completed, a conductivity, temperature, depth survey will be conducted in the vicinity of the WHOTS mooring. The survey pattern is determined by the science party and refined in consultation with the bridge.

SAMPLE TIMELINE FOR WOODS HOLE HAWAII OCEAN TIME SERIES CRUISE OPERATIONS

Day	Activity
1	Depart UH Marine Center for WHOTS operations area (approx 120 nmi at 10 kt = 12 hr transit)
2	0500 – 0600 (following day) Ship/Buoy intercomparison 0430 Approach buoy (0.25 nmi), confirm Argos reception 0500 Begin intercomparison 0600 Shallow CTD (200 m) near buoy (0.5 mi) 1200 Mid-depth CTD (1000 m) near buoy (1.0 mi) 1800 Shallow CTD (200 m) near buoy (0.5 mi)AUV multibeam survey to perform fine-scale bathymetric mapping of target areas/anomalies found at site A
3	0000 Mid-depth CTD (1000 m) near buoy (1.0 mi) 0600 Shallow CTD (200 m) near buoy (0.5 mi) 0700 - 1600 WHOTS-3 Mooring Recovery 0700 Maneuver to recovery start position, begin deck prep 0800 Confirm Acoustic Comm's, fire release 0830 Maneuver to buoy, launch small boat, connect to buoy 0900 - 1700 Recovery operations; deck, buoy and instrument clean up 1700 Shallow (500 m) CTD for microCAT "postcal" 1800 Release tests 2000 Depart WHOTS site for Sand Island
4	0800 Arrive UH Marine Center 0800 - 1800 Destage WHOTS-3, stage WHOTS-4 1800 Depart Sand Island for WHOTS site

Day	Activity
5	0600 WHOTS-4 mooring deployment 0600 Set and drift, determine start position and course 0700 Maneuver to deployment start position 0800 - 1600 WHOTS-4 mooring deployment 1600 - 2000 Clean up deck, stow gear 2000 - 2200 Anchor tracking and survey
6	0100 WHOTS-4 Ship/Buoy intercomparison and CTDs 0030 Approach buoy (0.25 nmi), confirm Argos reception 0100 Begin intercomparison 0600 Shallow CTD (200 m) near buoy (0.5 mi) 0900 WHOTS-1 buoy visual inspection (circumnav. with ship) 1200 Mid-depth CTD (1000 m) near buoy (1.0 mi) 1800 Shallow CTD (200 m) near buoy (0.5 mi)
7	0000 Mid-depth CTD (1000 m) near buoy (1.0 mi) 0600 Shallow CTD (200 m) near buoy (0.5 mi) 0700 - 0300 (following day) Regional CTD Survey mid-depth (1000 m) casts in pattern surrounding WHOTS site
8	0300 Depart WHOTS site for Sand Island 1530 Arrive UH Marine Facility, begin destage WHOTS-4

Example 2: Tropical Atmosphere Ocean (TAO) Moorings

The TAO array in the tropical Pacific Ocean is a critical, operational observing system for predicting the onset of El Nino and La Nina, major climate phenomena with global weather event implications. Planning the days at sea requirement for TAO mooring recovery/deployment does utilize a basic formula: 5 days (~120 hours) of on-station time for each meridian of longitude containing seven standard TAO buoy sites, for the combined time needed to replace/repair buoys and conduct intermediate CTDs at all sites along the meridian. The rest of the time is the pure transit requirements based on the meridian distance between 8N and 8S (960 miles), the distances between meridians (usually ~900 miles) and the distances to/from the starting/ending meridian to a port. What follows is a timeline of a sample cruise; it also demonstrates the piggyback work that occurs on TAO cruises. This cruise includes maintenance of a hydrophone array. Recorded data from the hydrophone array are analyzed to detect and characterize vocalizations from threatened and endangered marine mammals, providing information on distribution and species found in the region.

SAMPLE TIMELINE FOR TAO ARRAY CRUISE OPERATIONS

Day	Hours	Activity
1 - 5	60	Transit from Panama to TAO/Hydrophone site at 08S095W
6	8	Recover/deploy 08S095W Hydrophone
6	16	Service 08S095W TAO site, deep CTD, resume transit for continued ops
7-9	72	Service TAO sites at 05S095W, 02S095W, intermediate CTDs and transits
10	8	Recover/deploy EQ-095W Hydrophone
10	16	Service EQ-095W TAO site, deep CTD, resume transit for continued ops

Day	Hours	Activity
11-13	72	Service TAO sites at 02N095W, 05N095W, intermediate CTDs and transits
14	8	Recover/deploy 08N095W Hydrophone
14	16	Service 08N095W TAO site, deep CTD, resume transit for continued ops
15-17	72	Transit between 095W and 110W
18	8	Recover/deploy 08N110W Hydrophone
18	16	Service 08N110W TAO site, deep CTD, resume transit for continued ops
19-21	72	Service TAO sites at 05N110W, 02N110W, intermediate CTDs and transits
22	8	Recover/deploy EQ-110W Hydrophone
22	16	Service EQ-1105W TAO site, deep CTD, resume transit for continued ops
23-25	72	Service TAO sites at 02S110W, 05S110W, intermediate CTDs and transits
26	8	Recover/deploy 08S110W Hydrophone
26	16	Service 08S1105W TAO site, deep CTD, resume transit for port.
27-32	144	Transit from 08S110W to Panama, end of cruise.
Subtotal	720	30 OD for standard TAO maintenance cruise on 095W, 110W
Subtotal	48	2 OD for EPR Hydrophone mooring array recovery/deployment
TOTAL	768	32 OD COMBINED CRUISE

Characterizing Climate Change Forcing

Ship time requirements and objectives for characterizing climate change forcings are broken down into scientific objectives, which NOAA scientists then use to guide their science planning. The cruises fall into three categories: air-sea interaction, ocean acidification, and climate/air quality studies. Like climate observing, calculations of operating day requirements are project dependent (e.g. not all cruises are alike), taking into consideration the scientific objectives for a given project, the number of stations, the amount of time at each station, the region being sampled, the capabilities of the ship being used, and the transit time.

The following example of a project cruise description exemplifies many of the factors taken into account when planning a scientific cruise and the required days at sea.

Example: Air Quality Study (This study is a collaborative effort between the Climate and Weather and Water Goals)

NOAA conducts an intensive field study biannually, aimed at providing a better understanding of the sources and atmospheric processes responsible for the formation and distribution of ozone and aerosols in the atmosphere and the influence that these have on the radiative forcing of climate, human health, and regional haze. The shipboard measurements are generally coordinated with aircraft and ground-based measurements. The regional studies need to capture the seasonal weather patterns and atmospheric transport of gases and aerosols. This requires approximately 6 weeks of nearly continuous measurements to produce a useful data set to pair with diagnostic chemical, meteorological, and radiative models to assess and improve the forecasting and prediction tools. In mid to high latitudes, with frontal passages every three to five days, six weeks of sampling provides us with ten transport events. These need to be spread over the spatial domain of the experiment reducing the number of events to only two to three in any one area. At lower latitudes the flow is less predictable. In 2006, for example, the flow over the Gulf of Mexico was from the south for the first four weeks of the experiment. Off-shore flow occurred only during the last two weeks of the experiment. In addition to characterizing the regional atmospheric composition, the 2006 project had a number of specific objectives:

Emissions verification – Determine how well current inventories represent actual emissions for: cities, point sources, ships, and vegetation.

Transport and mixing - Determine the roles of local, regional, and long-range transport processes in the accumulation and spatial distribution of pollution in the boundary layer over Eastern Texas, and in the export to the free troposphere.

Chemical transformation – Determine how gaseous and aerosol emissions evolve chemically and physically as they are transported away from the source regions.

Aerosol properties and radiative effects – Determine what the chemical, physical, and optical properties of the regional aerosol and how do these properties affect regional haze and aerosol direct and indirect radiative forcing of climate.

While some of these objectives can be accomplished simultaneously, some require positioning the ship in a particular location (e.g. under a satellite overpass, downwind of a shipping channel) to await the target. An example of ship positioning to accomplish the objectives of the Texas Air Quality Study 2006 is shown in Figure 17.

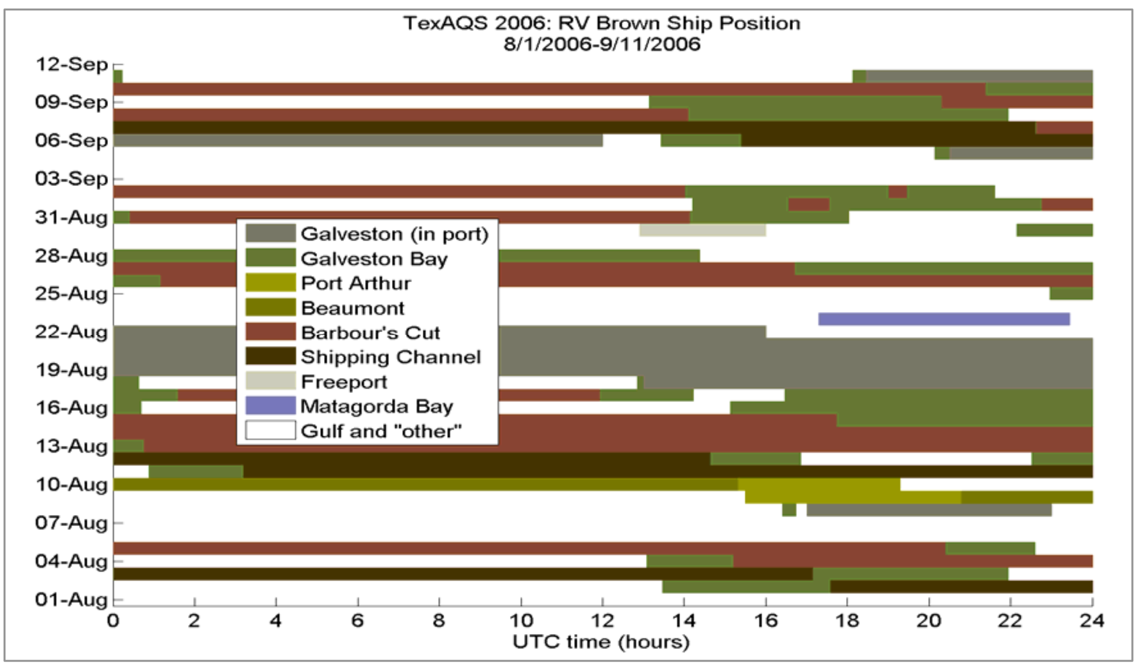


Figure 17: Ship Position Locations

Allocation of Ship Time during Texas Air Quality Study	
Objective	Days
Emissions verification	12
Transport and mixing	9
Chemical transformation	11
Aerosol radiative effects	10

Four additional days are typically requested for transit to the study area. In addition, the programs require approximately one week before the ship leaves port to install, test, and calibrate instrumentation. Our intent is to conduct each of the regional experiments in the same manner. Therefore, past experience with similar experiments is used to project future needs. Since the Climate Forcing and Air Quality Programs share this ship time, each program requests 23 operating days (six weeks of continuous sampling in the working area and 4 days of transit) biannually (odd numbered years).

Understanding Climate Effect on Ecosystems

Efforts to understand the climate effect on ecosystems and the interactions between climate and marine ecosystems, enhances NOAA's ecosystem approaches to management of living marine resources, a key requirement in the Magnuson-Stevens Fisheries Conservation and Management Reauthorization Act (MSRA). The focus of the work is on ecosystems in the Gulf of Alaska and the Bering Sea. Finfish and shellfish from these waters constitute over half of the US harvest, generating over two billion dollars each year in revenue. Hence, projects in these waters focus on elucidating how climate variability influences ecosystems, and the recruitment of economically valuable marine resources and protected species. In addition to the large economic value of the US harvest in these waters, these Arctic ecosystems are particularly sensitive to climate variability and change. These waters are a suitable starting point to evaluate climate and ecosystem linkage, which can be expanded to other regions.

Example: Mooring Cruise in the Bering Sea

The following cruise plan highlights what goes into planning the ship time for a mooring cruise in the Bering Sea; the cruise also includes a piggyback project with the University of Washington (a NOAA Cooperative Institute). This cruise is a mooring cruise, recovering and redeploying biophysical moorings in the Bering Sea. Some of the sites have been occupied since 1995. Planning for ship time is time sensitive in this region, because of the seasonal occurrence of sea-ice and dangerous winter storms. Moorings are recovered and deployed at 10 to 15 sites. In addition to transit time, the principal investigator must build in time for CTD casts (water profiles of conductivity (salinity), temperature, and depth with concurrent water bottle sampling), zooplankton tows, and bio-optical instrument deployments at the moorings and on selected transects. The number of stations and transects selected are determined based on the scientific objectives of the cruise and the desired spatial resolution needed to meet those goals.

MOORING CRUISE IN THE BERING SEA

Cruise Phase	Description of Activity
3.4 Cruise Plan	The ship will depart Kodiak, Alaska with DeWitt, Floering, Proctor and Smith aboard, on Thursday, April 12, 2006, and steam directly to the Amukta Pass mooring site. See Section 9.2 Cruise MF-06-05 Chartlet for an overall view of the proposed cruise.

Cruise Phase	Description of Activity
3.4.1 Shelikof Strait	Mooring operations will consist of recovering two subsurface moorings. No CTDs will be completed. Dragging operations will be conducted at 05SSP-1A – which was located during MF06-02 but did not surface.
3.4.2 Amukta Pass	Mooring operations will consist of deploying four subsurface moorings across the pass. No CTDs will be required.
3.4.3 Dutch Harbor touch-and-go	Load equipment and personnel (Jenkins, Righi, Wilson, De Robertis, Thornton, Munger).
3.4.4 Kodiak Crab moorings	Prior to each of the mooring operations, a calibration CTD will be completed. At each of two sites, mooring operations will consist of recovering one subsurface mooring and deploying one subsurface mooring. No CTD will be required after the deployment of either of the moorings.
3.4.5 FOCI Bering Sea Site 2	Prior to mooring operations, a calibration CTD with nutrient and chlorophyll samples will be completed. Mooring operations will consist of recovering two subsurface moorings and deploying one surface and three subsurface moorings. After the completion of all mooring operations, a calibration CTD with nutrient and chlorophyll samples will be completed. At four sites surrounding Site 2, a CTD with nutrient and chlorophyll samples will be completed. Note: no CalVETs or bongo tows at this site.
3.4.6 FOCI Bering Sea Site 4	The ship will transit along the 70m isobath from FOCI Bering Sea Site 2 to FOCI Bering Sea Site 4. At each of the twenty stations along this transit, a CTD with nutrient and chlorophyll samples will be completed. Prior to mooring operations, a calibration CTD with nutrient and chlorophyll samples will be completed. Mooring operations will consist of recovering two subsurface mooring and deploying one surface and one subsurface mooring. After the completion of all mooring operations, a calibration CTD with nutrient and chlorophyll samples will be completed. At four sites surrounding Site 4, a CTD will be completed. Note: no CalVETs or bongo tows at this site.
3.4.7 FOCI Bering Sea Site 5	The ship will resume the CTD transect along the 70m isobath from FOCI Bering Sea Site 4 to FOCI Bering Sea Site 5. At each of the eighteen stations along this transect, a CTD with nutrient and chlorophyll samples will be completed. Prior to mooring operations, a calibration CTD will be completed. Mooring operations will consist of recovering two subsurface moorings and deploying three subsurface moorings. After the completion of all mooring operations, a calibration CTD with nutrient and chlorophyll samples will be completed. At four sites surrounding Site 5, a CTD with nutrient and chlorophyll samples will be completed. The ship will resume the CTD transect along the 70m isobath from FOCI Bering Sea Site 5 to FOCI Bering Sea Site 8. At each of the eighteen stations along this transect, a CTD with nutrient and chlorophyll samples will be completed. At some point after discussions with FOCI scientists aboard the University of Washington R/V THOMAS G. THOMPSON, we will break off operations and meet up with R/V *THOMAS G. THOMPSON* to conduct joint operations. Note: no CalVETs or bongo tows at this site.

Cruise Phase	Description of Activity
3.4.8 Joint operations with the University of Washington R/V THOMAS G. THOMPSON:	In conjunction with FOCI scientists aboard THOMPSON, we will spend six days conducting various operations including diving, CTDs, Methot tows, trawling, collecting acoustics data and towing an underwater vehicle. The stern platform will be removed to enable trawling operations. Dive operations are tentatively scheduled for the morning hours. No more than eight short, low-intensity dives are anticipated. Weather permitting; we will dive once or twice on each of the first two days, no dives on the third day, one or two dives on each of the next two days, and no dives on the last day. Two divers will be required in the water at any given time. Divers will photograph the underside of ice floes, will scrape samples of the underside of ice, and use a slurp gun to collect plankton under the ice. CTD nutrient samples will be transferred to THOMPSON for analysis; preserved samples will remain on FREEMAN. Midwater trawling and hydroacoustic transects will generally occur in the morning/afternoon/evening and will follow dive operations. The trawls will be conducted using a poly Noreastern bottom net with a AWT 0.5 inch liner. We anticipate that each towing operation should last 2 to 3 hours – start to finish – and occur once or twice per day. Generally, four hydroacoustic transects per day will be placed at random distances along a line perpendicular to the general direction of the ice edge. Portions of these transects will enter the marginal ice zone. Also during this time frame, Methot tows and towed vehicle operations will be conducted.

CLIMATE OPERATING DAYS

Climate Operating Days	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Currently supported by NOAA ships or charter activity*	742	767	742	767	742
Other activities that support NOAA's mission	260	319	348	379	362

* Current allocation is based on historical allocation at full operating tempo and FY09 projected charter support. Allocation levels are set annually based on execution year priorities; therefore this table may not accurately reflect actual allocation in the outyears.

WEATHER AND WATER

Tsunami Hazard Mitigation

Example 1: Inundation Mapping

A quantitative analysis of the ship time required to survey 29 U.S. coastal regions was prepared by the NOAA's National Geophysical Data Center Tsunami Inundation Gridding Project (TIGP). The need for operating days in each region was independently evaluated by approximating the area in square nautical miles of required survey data coverage using integrated geographic information system (GIS) tools (Figure 18). The approximate value of two square nautical miles surveyed per operating day was used to calculate the number of sea days needed to satisfy the 100 percent requirement. Much of the current data available within the TIGP areas were collected prior to 1970 and is sparse in coverage. The TIGP requires reliable, high resolution data to accurately model coastal bathymetric relief for tsunami inundation modeling. Therefore, the total area covered by surveys collected prior to 1970 plus areas without any data were identified by defining the bounding polygons. Table 5 provides the estimated square nautical miles and required operating days for each of the 29 geographic areas which were analyzed for data requirements.

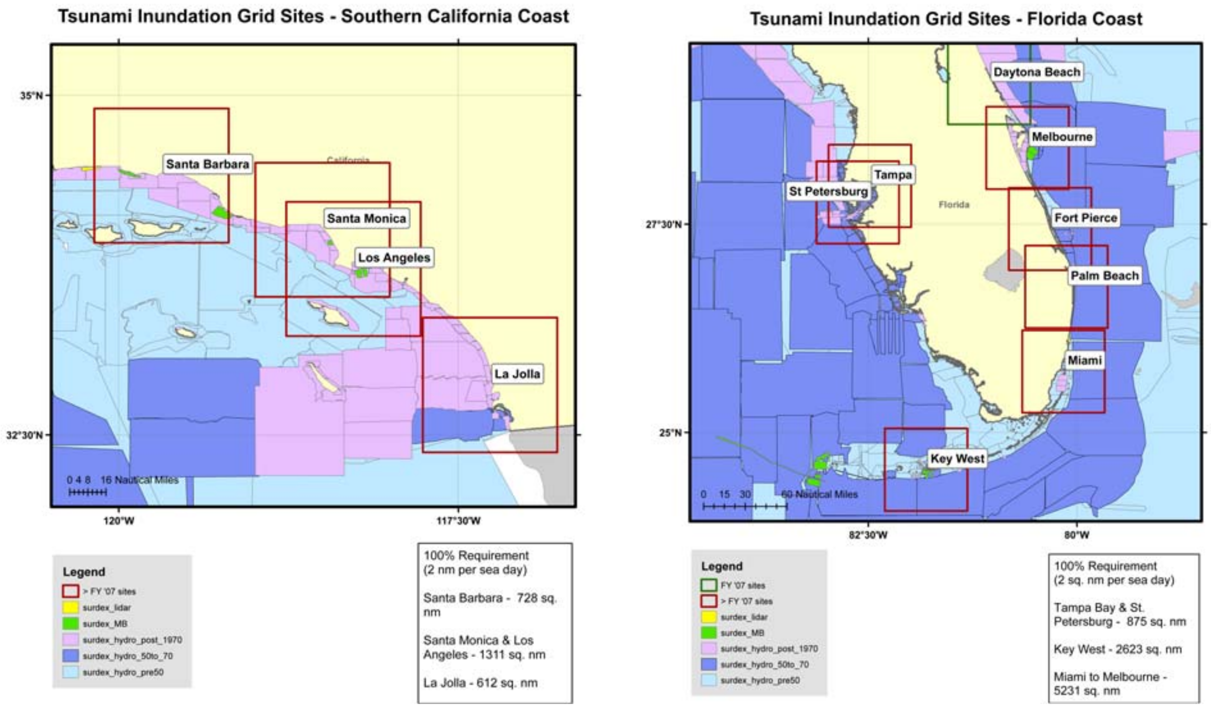


Figure 18: Examples of Inundation Grid Sites

U.S. COASTAL REGIONS REQUIRING INUNDATION MAPPING

City or Area	State/US Territory	Est. Square Nautical Miles	Est. Total Operating Days
Shemya	Alaska	2,100	1,050
Old Harbor	Alaska	760	380
Craig	Alaska	494	247
Cordova	Alaska	641	321
Adak	Alaska	1,865	933
Atka	Alaska	1,836	918
Santa Barbara	California	728	364
La Jolla	California	612	306
Santa Monica / Los Angeles	California	1,311	656
Arena	California	1,691	846
Point Reyes and Alameda	California	2,011	1,006
North Spit and Eureka	California	1,311	656
Tampa Bay and St. Petersburg	Florida	875	438
Key West	Florida	2,623	1,312
Miami to Melbourne	Florida	5,231	2,616
Oahu	Hawaii	1,749	875
Portland	Maine	758	379
Nantucket	Massachusetts	1,953	977
Cape Cod and Boston	Massachusetts	1,749	875
Wilmington	North Carolina	437	219
Morehead	North Carolina	787	394
Charleston and Port Orford	Oregon	2,332	1,166
Newport	Rhode Island	641	321
Charleston	South Carolina	875	438
Virgin Islands	Virgin Islands	1,486	743
Cherry Point	Washington	350	175
Friday Harbor	Washington	728	364
Southern Puget Sound	Washington	696	348
Columbia River and Southern Washington	Washington	2,340	1,170
TOTAL		**40,970**	

Example 2: DART Network Support

The NOAA National Data Buoy Center has the ongoing operational requirement to properly maintain the Deep Ocean Assessment and Reporting of Tsunamis (DART) network (Figure 19). Using the present life cycle maintenance requirement for the DART technology, the geographical spacing of 39 stations in the U.S. DART network, established logistical hubs, regional operational constraints and known vessel limitations the annual need has been estimated at 300 operating days to support the operations and maintenance of the present configuration of the DART Network.

Annual Network Transit Distance = 235 Days
- 45,000 Nautical Miles per year
- Vessel Speed 7 to 10 knots

Annual Time on Station = 45 Days
- 39 DART stations throughout Pacific and Atlantic Oceans
- 1.15 days per DART station

Annual Port Time = 20 Days
- 5 logistical hubs
- 4 days staging per hub port

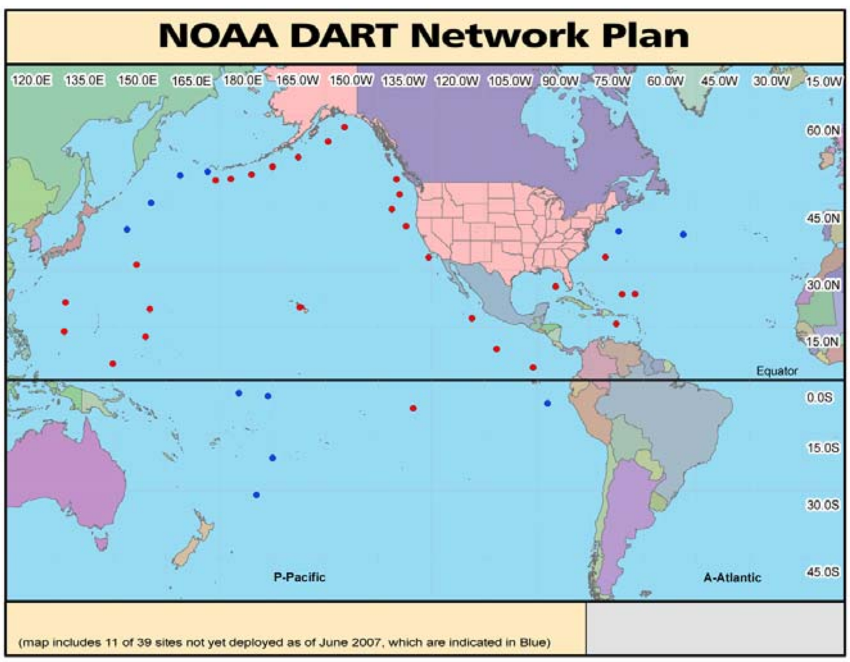


Figure 19: NOAA DART Network Plan

Example 3: DART Research

Historical and forecast annual need of at-sea support of developmental DART technology prototypes has set the need for ship time to support this activity at 5 days.

Air Quality Research

Example 1: Air Quality Study (This study is a collaborative effort between Climate and Weather and Water – see Climate section for detail)

Science and Technology Infusion

Air-sea interaction hurricane intensity research done to support improvement of early detection of cyclone formation and numerical methods to initialize vortex structure in operational forecast models requires data from the east Atlantic genesis region.

WEATHER AND WATER OPERATING DAYS

Weather and Water Operating Days	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Currently supported by NOAA ships or charter activity*	85	60	85	60	85
Other activities that support NOAA's mission	4340	4387	4370	4357	4340

* Current allocation is based on historical allocation at full operating tempo and FY09 projected charter support. Allocation levels are set annually based on execution year priorities; therefore this table may not accurately reflect actual allocation in the outyears.

COMMERCE AND TRANSPORTATION

Hydrographic Surveying

Data collection and compilation for nautical charts are the principle objectives of a hydrographic survey. Hydrographic survey data support a variety of maritime functions including safe and efficient navigation, port and harbor maintenance (dredging), coastal engineering (beach erosion and replenishment studies), coastal zone management, and offshore resource development. The primary data associated with hydrographic surveys are water depth (bathymetry) and object detection. However, there is also considerable interest in sea-floor texture and composition (i.e., sand, mud, rocks) due to their implications for anchoring, dredging, marine construction, pipeline and cable routing, tsunamis, and storm surge modeling. An operating day in support of hydrographic surveying directly benefits Integrated Ocean and Coastal Mapping, as many programs have requirements for hydrographic data, such as tsunami modeling, storm surge prediction and sanctuary management. The bathymetric, backscatter and side scan sonar data can also be used to support other NOAA missions such as essential fish habitat mapping and characterization, bottom type classification and submerged cultural resources management.

NOAA's operational requirement for hydrographic surveys derives from its survey area of responsibility -- the 3.4 million square nautical miles (SNM) of U.S. Exclusive Economic Zone -- with 500,000 SNM of navigationally significant areas prioritized as detailed in the NOAA Hydrographic Surveys Priorities (NHSP) plan.[47] NOAA follows the NHSP in developing its annual survey schedules. NOAA currently

[47] *NOAA Hydrographic Survey Priorities, 2007 Edition*, U. S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Ocean Service, Office of Coast Survey, 2007

has the capacity to survey only 3000 SNM annually, although the established goal is to achieve 10,000 SNM each year for navigation safety (placing the nation's critical waterways on a 50 year resurvey cycle). Although actual survey coverage rates vary dramatically with the depth and complexity of the survey area, analysis of annual performance has shown that NOAA and its contractors average two SNM of hydrographic data acquisition per operating day, so that meeting the 10,000 SNM goal equals approximately 5000 operating days.

Data acquisition for nautical chart updates begins with the selection of a survey area and deployment of resources to accurately and efficiently conduct the survey. Following extensive planning, NOAA or contractor field units conduct hydrographic survey operations. Survey teams calibrate all sonar and vessel orientation and positioning systems prior to data acquisition to assure proper equipment operation. Data accuracy must comply with predetermined specifications, and each individual depth measurement corrected for velocity of sound through the water column, vessel heave, pitch, and roll, vessel configuration offsets, water level, and other factors in effect at the time each measurement was acquired.[48,49] Field units conduct frequent conductivity, temperature, and depth measurements to ensure proper sound velocity corrections are applied to sounding data. Water level stations are installed to monitor water level variations in the survey area to provide corrections to reduce data to the proper tidal datum. While not directly required for hydrographic survey operations, tidal current surveys are sometimes concurrently performed for cost efficiency to ensure tidal current predictions, another NOAA navigation product, are accurate. All oceanographic data collected help to provide the mariner with a more complete picture of the operating environment.

Global Positioning System (GPS) satellite systems provide precise positioning for survey data and additional accuracy is determined using the U.S. Coast Guard Differential GPS (DGPS) network. Fixed land stations monitor variations in GPS satellite signals and transmit correctors to survey platforms during data acquisition. DGPS broadcast sites provide correctors for most survey areas, but remote areas, such as some areas in Alaska, require the placement and maintenance of independent DGPS ground reference stations.

Primary depth measurements are acquired with multibeam sonar, or with a single beam echosounder if multibeam is not available. Multibeam technology obtains hundreds more soundings per unit time than single beam systems and covers a wide swath of the ocean floor. Some field units employ side scan sonar systems, which use a towed instrument to assist in detecting objects (wrecks, rocks, or other obstructions) that project from the sea floor. As potential hazards to navigation, these objects must be fully investigated and verified by multibeam sonar or divers. Side scan and multibeam sonar are modern systems which provide near 100 percent bottom coverage of the sea floor, greatly enhancing the ability to detect hazards undiscovered by earlier, less modern surveys.

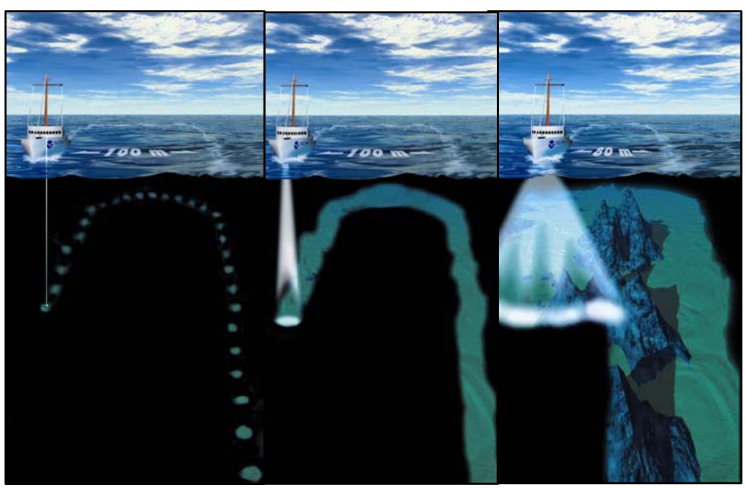
NOAA also uses other new technologies to expand the capacity of its ships to acquire hydrographic data. In near shore areas where water clarity permits, Light Detection and Ranging (LIDAR) technology is sometimes used to collect hydrographic data. This makes launch operations in these areas safer because launches spend less time in shallow, hazardous regions and more efficient, because the sonar swath widths are shorter and less efficient in shallow water. LIDAR, however, does not provide the object detection capabilities of multibeam, therefore some follow-up multibeam work is generally required in

[48] *NOS Hydrographic Surveys Specifications and Deliverables,* U. S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Ocean Service, Office of Coast Survey, April 2007
[49] *IHO Standards for Hydrographic Survey, 4th Edition, Special Publication No 44*, International Hydrographic Organization, International Hydrographic Bureau, Monaco, April 1998.

irregular sea-floor areas initially surveyed with LIDAR to resolve ambiguities in the LIDAR data and to perform least depth measurements on significant obstructions. NOAA is also beginning to integrate Autonomous Underwater Vehicles (AUV) into hydrographic survey operations to increase the rate of survey coverage and reduce the marginal cost of the overall survey effort with more effective deployment of personnel and fleet resources. Because AUVs operate while submerged, they are able to acquire more data under a wider range of weather conditions than surface vessels, therefore leading to less surveying "down-time."

Once the data are collected, whether by multibeam or side scan sonar, LIDAR or AUV, the millions of measurements taken need to be verified and compiled to produce an accurate, understandable graphic depiction of the survey area. Much of this happens aboard ship to weed out deficiencies in the data just collected and determine whether areas need to be resurveyed for quality control before the ship departs. A digital version of the survey and/or a hard copy Smooth Sheet are produced for final quality assurance, nautical chart compilation, and archiving. A descriptive report accompanies each survey and provides detailed descriptions of items that cannot be explained in graphic form.

A hydrographic survey also incorporates other measurements or observations. These include precise positioning of aids to navigation, conspicuous landmarks, and offshore drilling structures, and sampling of the sea floor bottom material to determine adequate anchorage areas. Also documented are the variations in the shoreline location or features along the shore (new piers, pilings, bulkheads). Hazards to navigation are reported immediately upon verification to alert ship operators via the Coast Guard's Notice to Mariners.



Leadline **Single Beam** **Multi Beam**

Figure 20: Bottom Coverage Comparison by Survey Method

NAVIGATIONALLY SIGNIFICANT SURVEY DAY NEEDS

Regional Area	SNM	Frequency (years)	Yearly Survey (SNM)
East Coast - Areas within 90 ft depth	38,019	50	760
Caribbean Islands - Areas within 90 ft depth	1,477	50	30
Great Lakes - Areas within 120 ft depth	24,950	50	499
Gulf of Mexico coast - Areas within 90 ft depth in eastern and 200 ft in western	53,858	50	1,077
West Coast - Areas within 90 ft depth	4,738	50	95
Pacific Islands - Areas within 400 ft depth	6,599	50	132
Southern Alaska (Gulf of Alaska and Aleutian Is) - Areas within 400 ft depth	76,573	50	1,531
Western Alaska - Areas within 200 ft depth	140,300	50	2,806
Northern Alaska - Areas within 90 ft depth	28,330	50	567
Resurvey areas - Port approaches that frequently experience bottom changes	9,237	5	1,847
Remaining Navigationally Significant Area	126,864	200	634
TOTAL	510,945		9978

Geodetic Gravity Modeling

A more accurate geoid model requires surface validation of the airborne gravity data NOAA collects. Shipborne gravity data collection with gravimeters perpendicular to aircraft flight lines is particularly key to resolving the present inconsistent gravity field from onshore to offshore in coastal regions. The operating day requirement of 20 days per shipboard gravity data collection area is based on capturing a total of 5,000 nautical miles (NM) of gravity data per region per year assuming a 10 to 11 knot speed of advance. These data would be collected in tracks starting 100 NM offshore underneath gravity collection air profiles for each region and heading inshore at 5 NM spacing to form a grid and overlaps underneath the air profiles. Because of the smaller area of the Eastern Florida Gulf Stream, only ten operating days (2500 NM of gravity data) would be needed in FY 2013 to FY 2014 and for all regions, collection in the FY 2015 to FY 2024 would be much smaller (average of five operating days or 1250 NM of gravity data) per region as nationwide aerial gravity data would be largely complete and gravity collection would be for checking, updating and improving gravity data. This work can occur concurrently with other NOAA science missions or may be aggregated over time in the gravity collection regions.

COMMERCE AND TRANSPORTATION OPERATING DAYS

Commerce and Transportation Operating Days	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Currently supported by NOAA ships and contracts for hydrographic data *	1800	1800	1800	1800	1800
Other activities that support NOAA's mission	3255	3295	3295	3285	3285

* Current allocation is based on historical allocation at full operating tempo. Allocation levels are set annually based on execution year priorities; therefore this table may not accurately reflect actual allocation in the outyears. NOAA contracts for hydrographic data are written in terms of quantity of data rather than number of days of data collection. In the period FY 2010 – FY 2014, the assumption is that NOAA will contract for $31.2M of hydrographic data; this is based on the FY09 President's Request for Address Survey Backlog hydrographic survey data contracts. $31.2M in contracts equates *very* roughly to 780 days at sea.

MISSION SUPPORT

Homeland Security

Incident requirements are difficult to predict with specificity, however historical trends indicate the need for approximately 21 days of support during any given year. Previous incidents of national significance requiring NOAA and contract ship response - such as 2005 responses to hurricanes Katrina and Rita - resulted in the diversion of NOAA's ships equipped to support hydrographic, debris, fisheries, and water-quality studies surveys; and hostelry and base of operations support. In response to Hurricane Katrina in 2005, NOAA ships THOMAS JEFFERSON and NANCY FOSTER each performed approximately 21 days on surveys. NOAA ships GORDON GUNTER and OREGON II each performed 30 days hostelry and emergency operations center support for NOAA and other federal, state and local agencies. Contracted survey ships performed a total 14 operating days on hydrographic surveys. The maturation of the National Exercise Program which includes annual exercises in the maritime, such as the NOAA sponsored SAFE SEAS, will continue to call for engagement of NOAA shipboard assets. While response activities are situation-specific, NOAA ships typically provide hydrographic, debris, fisheries, and water-quality surveys for the reopening of ports, reestablishment of fisheries and habitat, and verification of water and seafood quality, as well as hostelry and emergency operations center support in an impacted area that has lost normal infrastructure.

Satellite Service Support

With the advent of new operational satellite instruments, in particular the National Polar-orbiting Operational Environmental Satellite System (NPOESS), Prepatory Project (NPP)/ NPOESS Visible/Infrared Imager/Radiometer Suite (VIIRS), the operational requirement for ship time to routinely service satellite ocean color vicarious calibration and validation routine operations through the Marine Optical BuoY (MOBY) Project remains. MOBY directly supports the operational calibration plans of Sea-viewing Wide Field-of-view Sensor (SeaWiFs), Moderate Resolution Imaging Spectroradiometer (MODIS), Medium Resolution Imaging Spectrometer, NPP/NPOESS, and Geostationary Operational Environmental Satellite-Series R (GOES-R). MOBY data ensure the quality of the satellite ocean color data integral to the NOAA Operational Harmful Algal Bloom Forecast System's detection and assessment activities. Without ship support, the MOBY ocean color vicarious calibration facility will not be available for the fundamental and crucial initial certification, calibration, and validation of future satellite ocean color sensors including the NPP/NPOESS VIIRS and the GOES-R Hyperspectral Environmental Suite - Coastal Waters Imager. To date, the MOBY effort has been a National Aeronautics and Space Administration-supported research and development project; however, NASA has discontinued its support in conjunction with the transition of MOBY from research to operations. To maintain quality ocean color satellite data, it is imperative that NOAA support operating days via NOAA ship or charter for maintenance transits of 32 operating days per year (distributed one 8-day cruise per quarter). The transition to new technology will cause variable day requirements between FY 2011 and 2013.

Integrated Ocean Observing

Factors that contribute to the calculation of required number of operating days include the servicing vessel home port, economical speed over ground, as well as the time required to accomplish the mission objective once at the observing platform. As an example, the requirement for moored buoy operational days is largely derived from the 6 to 12 hour operations, maintenance or service evolution required during each visit, transit time required at 10 knots, and the number and locations of the moored.

The requirements for operating days support observations from Integrated Ocean Observing System (IOOS) moored buoys and Coastal-Marine Automated Network (C-MAN) stations. The IOOS moored buoys require operating days for deployment and retrieval activities, operations and maintenance activities, site and system calibration/validation, unscheduled maintenance visits, and operational data delivery validation and quality assurance.

MISSION SUPPORT OPERATING DAYS

Mission Support Operating Days	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Currently supported by NOAA ships or charter activity*	22	22	22	22	22
Other activities that support NOAA's mission	680	792	896	1022	1134

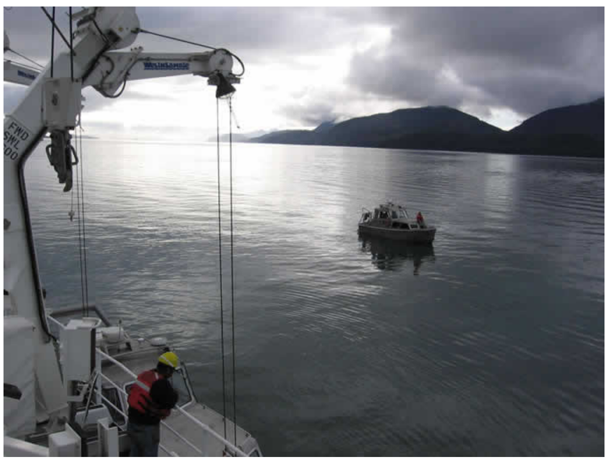
* Current allocation is based on historical allocation at full operating tempo and FY09 projected charter support. Allocation levels are set annually based on execution year priorities; therefore this table may not accurately reflect actual allocation in the outyears.

Chapter 7

OUTCOMES AND BENEFITS

NOAA enriches life through science. NOAA's reach extends from the surface of the sun to the depths of the ocean floor as it works to keep citizens informed of the changing environment around them. Americans depend on NOAA for a wide variety of services and support, including the local weather forecast, a sustainable supply of quality seafood, the safe transport of people and millions of tons of waterborne cargo, a safe and vibrant coastline, and detailed research on the climate from the frozen arctic to the depths of the oceans. NOAA's products and services support economic vitality and affect more than one-third of America's gross domestic product.[50]

ECOSYSTEMS



Ecosystems are highly valued for their biological, ecological, cultural, and economic resources, as well as their aesthetic qualities. The economic value of the ocean, coastal areas, and Great Lakes economies to the United States is estimated to be over $115 billion. NOAA has a significant role in conserving, sustaining, and managing these highly valued resources with management responsibilities in the U.S. EEZ, the largest marine territory of any nation in the world, and for the coastal areas of the U.S., including a shoreline of 17,500 statute miles. Not only is NOAA's area of responsibility considerable, but America's coastal areas are among the most developed in the Nation. Coastal counties, home to 53 percent of the U.S. population, are the most densely populated, averaging 300 people per square mile - compared with 98 people per square mile in non-coastal counties. Coastal population density is increasing rapidly. From 1980 to 2000, population density in coastal areas increased 28 percent and is expected to increase another 4 percent by 2008.

The examples below provide illustrations of the national benefits produced from NOAA's role.

- U.S. consumers spent an estimated $69.5 billion for all fishery products in 2006. NOAA has a regulatory mandate to manage U.S. marine fisheries. Commercial landings (edible and industrial) by U.S. fishermen at ports in the United States totaled 9.5 billion pounds and were valued at $4.0 billion in 2006. By producing and marketing a variety of fishery products for domestic and foreign markets, the commercial marine fishing industry contributed $35.1 billion (in value added) to the U.S. GNP.[51] NOAA provides the science data that inform fishery management decisions that ensure the sustainability of fishery resources.

- Within the United States, the economic contribution of coral reef ecosystems has been calculated for Hawaii, southeast Florida, American Samoa, Guam, and the Commonwealth of the Northern

[50] All economic statistics used in this chapter are found in New Priorities for the 21st Century – NOAA's Strategic Plan, Updated for FY 2006-FY 2011, April 2005 or "Economic Statistics for NOAA" version 6 unless otherwise cited.

[51] Fisheries of the United States 2006, NMFS

Marianas Islands. In the Main Hawaiian Islands, coral reefs were estimated to provide annual economic benefits of over $360 million, 85 percent of which was directly attributed to recreation and tourism. NOAA assists state governments with a variety to tools to manage and conserve coral reef ecosystems, including the development of protocols to prevent the introduction and spread of coral diseases and alien species, mapping, and the use of NOAA data to help determine the effectiveness of local management regulations and to track changes in managed and unmanaged areas through time.

- In the four-county area of southeast Florida (Palm Beach, Broward, Miami-Dade, and Monroe Counties), artificial and natural reefs supported over 28 million person-days of recreational diving, fishing, and viewing activities, generated approximately $4.4 billion in local sales, almost $2 billion in local income, and 71,300 full and part-time jobs. The data collection efforts aboard NOAA ships support a better understanding of whether key coral reef fishery species' life cycles in the south Florida and Caribbean ecosystems are solely contained within the region or whether they are seeded from outside areas. With this knowledge, NOAA can work with the appropriate Fishery Management Councils and state/local agencies to develop the most effective management measures to rebuild dwindling fishery stocks. Resulting management measures may include implementation of new marine protected areas or increased enforcement of existing protected areas to protect larval fish during their most vulnerable times.

- NOAA has the responsibility to characterize new ecosystems and identify places of high biological or cultural value, both within the U.S. EEZ and the global ocean. Nearly 95 percent of the global oceans have yet to be visited or studied, including major features such as: 50,000 km of mid-ocean ridge crest, 10,000 km of deep-sea trenches, more than 60,000 seamounts, and the water-column of the ocean which is home to 99 percent of the earth's living organisms. Within the U.S. EEZ, approximately 9,800 seamounts are known to exist, but only a few of which have been mapped or studied. There are currently more than 100 ship-years of surveying required to map the 3.4 million square nautical miles of the U.S. EEZ at high resolution alone, much less determine habitat and the diversity, distribution, and abundance of living and non-living resources. The vast majority of the US EEZ is in the "deep" ocean, at depths greater than 200 meters. NOAA's baseline characterization and assessment of the biological, physical, chemical, and geological environments in these regions (global and U.S. EEZ) is critical to understanding the ocean's relationships with life on land and is needed to develop a management plan for these presently unknown "deep" resources.

- NOAA has over 15 congressional mandates to maintain the integrity of the Great Lakes ecosystem, which is the largest freshwater ecosystem on the planet. This mission requires constant monitoring—particularly, shipboard. As an early indicator of degradation in the Great Lakes, Lake Erie's ecosystem faces wide and varied threats to its health and integrity, including harmful algal blooms in the west basin, recurring low oxygen episodes ("dead zones") in the central basin, and invasive species. NOAA provides ecosystem forecasting through multidisciplinary research and monitoring.

Capabilities	Products & Services Management Activities	Outcomes and Benefits
Living Marine Resource Management	Monitoring, assessment and applied forecasts of living marine and coastal resources and their habitats; including surveys, monitoring and assessment of the economic and	Healthy and sustainable commercial and recreational fisheries. U.S. consumers spent an estimated $69.5 billion on commercial and recreational fishery products in 2006

Capabilities	Products & Services Management Activities	Outcomes and Benefits
	sociocultural aspects of healthy and productive coastal and marine ecosystems	Healthy and recovering protected species populations Protected and restored essential [fish] habitats Healthy and sustainable marine and coastal ecosystems. The economic value of the ocean, coast and Great Lakes economy to the United States is estimated to be over $115 billion
Ecosystems Research	Baseline understanding of the biological, chemical, physical, and geological aspects of spatially delineated ecosystems; focusing on areas such as deep coral habitats, vents, cold seeps, maritime heritage sites, extended continental shelf mapping, polar areas, canyons, and seamounts Forecasts for a suite of ecological conditions including fisheries, anoxia, harmful algal blooms, beach closings, and water quality Capability to apply advanced technology (e.g. sensors, autonomous underwater vehicles, remotely operated vehicles, models, etc.) to complex ecosystem issues	Decreased human health risks through the improved condition of coastal, marine and Great Lakes resources Evidence to support potential claim to extend the US EEZ Discovery of new habitats, ocean features, natural products (e.g. pharmaceuticals), and potential living and non-living resources Sustainability of coastal and marine resources with respect to harvesting pressure and climate change A well informed public able to make decisions that best respect the ecosystem while allowing for economic benefits and enjoyment
Coral Reef Conservation	Regional maps of deep sea coral locations Characterizations of identified deep coral communities Removal of 50-60 tons of marine debris from NWHI coral reefs which is incinerated to generate electrical power for the residents of Honolulu	Reduced direct physical impacts from maritime industry and natural/non-natural hazard, improving navigation safety and preserving productive coral reef ecosystems Productive deep-sea coral ecosystems support commercially important fishery species and are potential sources of new pharmaceuticals
Coastal Marine Resources Management	Provides decision-makers with sound science and other information on which to base day-to-day decisions about the use and protection of coastal and marine ecosystems	Habitat data are utilized to identify areas for additional protection, allowing for increased long-term recovery and productivity of fish stocks and endangered species

Capabilities	Products & Services Management Activities	Outcomes and Benefits
	Delivers tools, technology, and training to resource managers to facilitate effective decision-making	Data are utilized to protect maritime heritage resources allowing for increased recreational opportunities Healthy coral ecosystems help sustain local tourism and recreation businesses Public awareness leads to increased public support for NOAA and improved marine and coastal stewardship

CLIMATE

Weather and climate sensitive industries account for one-third of the Nation's Gross Domestic Product, equivalent to nearly $3 trillion. NOAA has a long-standing commitment to provide climate products and services to users, including governments, the private sector, and the American public. Virtually every sector of the Nation's economy benefits from the weather and climate data and analyses produced by NOAA. For example, the engineering (and insuring) of structures and the provision of critical resources such as energy, food, and water, are impacted by climate variations and extremes. NOAA's services and resources include historical information, climate outlooks, prognostic resources, diagnostic tools, educational resources, and a wide variety of assessment products. This enables NOAA to provide its customers with assessments of current and future impacts of regional to global climate events, including major droughts, floods, rapid climate change and long-term climate trends.

The fruits of NOAA's vigorous climate research program have not only raised public awareness of variability in climate, but have also established a clear and strong demand for further information, guidance, and tools that can be used to cope with climate changes. Concerns over the impact of varying climate on the environment were initially spurred by the public's awareness of the influence of the El Niño Southern Oscillation (ENSO) on seasonal climate norms in and around most of the world, including parts of the United States. The role of greenhouse gases in raising the observed global mean temperature and altering other important aspects of our climate (e.g., sea level rise, changes in extreme weather, altered quality and availability of water, and quality of air, etc.) has also captured the public's attention and concern.

Climate impacts on marine ecosystems are being observed at all spatial scales. In local and coastal regions, climatic variations in river runoff impact both fresh water spawning species and nutrient loads in coastal and watershed areas. In the major boundary currents, large-scale climatic variations, such as El Niño and the Pacific Decadal Oscillation, strongly influence regional ecosystems. At a global level, increased absorption of carbon dioxide in the ocean is modifying its chemistry and leading to a reduction in the pH of the upper ocean sufficient to affect organisms.

The world is facing a warming trend in temperature that, along with the associated changes in precipitation and sea-level rise, will have a significant impact on the U.S. environment and economy. For example, the Federal Emergency Management Agency estimated the annual direct losses to the U.S. due to drought were at $6 to $8 billion. Demand for climate information services is emerging in *all* of

NOAA's missions. As the globe warms, there is increasing demand for sea level rise forecasts at the local and regional levels, while the receding Arctic sea ice provides opportunities and challenges related to both potentially new navigable waterways through the Arctic Ocean and increased storm surge intensity and inundation.

Reducing climate-related uncertainties in policy and decision-making can be valued at more than $100 billion for the U.S. alone, and relatively small increases in accuracy can yield substantial benefits. Climate variability and change present risks to people, property, and resources and challenge our ability to design and implement adaptive and mitigation strategies. The information products and services that NOAA generates will improve the Nation's ability to cope and adapt to climate variability and change.

Capabilities	Products & Services Management Activities	Outcomes and Benefits
Climate Observations and Analysis	Comprehensive documentation of the state of the climate system through integrated climate observations	Improved descriptions of past and present climate for better predictions, projections, and decision support (e.g. infrastructure (construction, engineering), natural resource management, water resource management, validation of carbon management strategies and policies minimizing human contributions to climate change)
Characterizing Climate Change Forcing	Science-based information on gases and aerosols that is needed to characterize options for altering radiative forcing, in both the near term (short-lived species like aerosols) and the longer term (carbon dioxide) in effective and efficient ways	Verification of the recovery of the ozone layer and the decline of ozone-depleting chemicals in the atmosphere Climate services and information for improved public health, safety and environmental, economic, and community planning
Understanding Climate Effects on Ecosystems	Predict the probable effects of climate change on marine systems and the living resources contained therein Provide marine resource managers the knowledge and tools needed to incorporate climate variability into the management of living marine resources	Improved management and stewardship of the nation's largest fisheries (including pollock, cod, halibut, salmon, and crab)

WEATHER AND WATER

NOAA's weather and water services make a tremendous contribution to the Nation's health and economy. Weather warnings protect the public from the hazards of extreme environmental events, while forecasts are essential to weather and climate sensitive industries, which account for one-third of the Nation's GDP. For example, during a typical hurricane season NOAA's efforts save the Nation $3 billion. Floods cost $5 billion and cause more than 80 deaths each year. Trends such as just-in-time production, globalization, and increased travel amplify the impact weather and water information and services have on the economy. Substantial population and business growth in coastal and arid regions increases the population's sensitivity to weather and water conditions as well. Weather and water events in one geographic area can have national economic impact.

Air quality has improved significantly in recent decades following passage of the Clean Air Act in 1970. There are still many areas of the country, however, where the public is exposed to unhealthy levels of air pollutants. Sensitive ecosystems are also damaged by air pollution. The cost of poor air quality to the U.S. from air pollution-related illness alone has been estimated at $150 billion per year. Forecasting poor air quality can provide early notice and warning to individuals and communities to limit exposure and thereby reduce or avoid asthma attacks; eye, nose, and throat irritation; respiratory and cardiovascular problems; and even save lives. For each 1 percent reduction in adverse health impacts that air quality forecasting could provide, over $1 billion would be saved every year. To help the nation realize these benefits, Congress has directed NOAA to provide national air quality guidance.

Capabilities	Products & Services Management Activities	Outcomes and Benefits
Air Quality Research	Provides key information about the atmospheric processes responsible for poor air quality and related tools	Limit adverse effects of poor air quality Local, regional, and national air quality decision-makers can make effective policies and plans to protect public health, reducing mortality and morbidity, and sensitive ecosystems while also maintaining a vital economy through improved national air quality policies and local and regional air quality management strategies
Tsunami Hazard Mitigation	Operation of two tsunami warning centers Production of inundation maps Assisting States extend hazard assessments and inundation modeling to previously unmapped coastal regions Operational network of deep ocean sensors used in for the advanced warning and validation of tsunami events	Reduced loss of life, injury, and damage to the economy through: • improved tsunami detection, and detailed forecast and warning information to emergency and coastal zone managers • increased tsunami awareness and knowledge for persons in tsunami vulnerable areas • improved tsunami detection, forecast and warning, and hazard mitigation activities • increased number of persons educated about tsunami preparedness

Capabilities	Products & Services Management Activities	Outcomes and Benefits
Science and Technology Infusion	Information on the early stages of tropical cyclone formation and growth	Improved predictions of the onset, duration, and impact of high-impact weather and water events Scientific understanding of the key physical processes responsible for the weather and water conditions it predicts Public benefits indirectly through advances in science and technology which lead to better environmental information and data products and services

COMMERCE AND TRANSPORTATION

Safe and efficient transportation systems are crucial to the U.S. economy. The U.S. economy relies upon an intermodal transportation network of ship, rail, highway, and air transport to move people, cargo, and commerce to, from, and across the Nation. The U.S. marine transportation system ships over 95 percent of the tonnage of foreign trade through U.S. ports, including 48 percent of the oil needed to meet America's energy demands. From 1990 to 2003, the value of U.S. international merchandise trade increased an average 6 percent annually, from $889 billion to about $2 trillion (in current dollars). The Nation loses $4 billion annually to economic inefficiencies resulting from weather-related air-traffic delays. Surface weather-related accidents cost an average of $42 billion annually in lives and property. The safe and effective movement of commerce and transportation is heavily dependent upon NOAA weather and ice forecasts, real-time and forecast water level conditions, obstruction surveys, nautical charts for safe navigation, hazardous spill response, and satellite Search and Rescue.

NOAA has clear mandates to support water, air and surface transportation with navigational information and accurate and timely weather forecasts that protect lives, economic investment and environmental integrity by providing critical tools for the Nation's intermodal transportation network. Navigational tools such as Electronic Navigational Charts and accurate tides and currents data support the safe, efficient, and environmentally sound transport of goods. NOAA's standards, data, and processes protect the taxpayer in tort litigation related to marine accidents. Knowing exact water depths can allow a ship to load valuable extra cargo - just one inch of additional draft can increase revenues up to $50,000 or more.

Up-to-date charts, real-time and forecast water levels and accurate marine weather predictions help travelers to avoid hazardous conditions, accidents, losses, and delays. NOAA products also promote the use of available port capacity for more efficient and economical operations. By knowing current or future water conditions, commercial shippers can safely maximize cargo loads and thereby economic gain. NOAA hydrographic surveys determine the depths and contours of the seafloor in navigationally significant U.S. waters. Hydrographic data provide electronic navigational and raster charts as well as the Coast Pilot and other navigational products with up-to-date accurate information that supports safe and efficient navigation. Hydrographic data and services also provide the basis for tsunami and flood modeling, marine habitat mapping, coastal resource management, engineering projects, long-term sea-level trends, and homeland security needs. The hydrographic science expertise developed within NOAA maintains NOAA's leadership in the development of standards and practices. The experience gained aboard NOAA field units (ships and small boats) maintains a supply of professionals who can respond to national and regional emergencies that require ocean mapping expertise. NOAA's hydrographic data are also being used to support the U.S. claim to extended Continental Shelf rights under Article 76 of the United Nations Convention on the Law of the Sea.

Geodesy is the science of measuring and monitoring the size and shape of the earth. In basic terms, geodesists assign addresses to points all over the earth. As positioning and navigation have become fundamental to society, geodesy has become increasingly important. Geodesy helps the transportation industry ensure safety and reliability, while reducing costs. Geodesy also helps shipping companies save time and money by shortening their ships' and airplanes' routes, reducing fuel consumption. Building roads and bridges, conducting land surveys, and making maps are some of the important activities that depend on a spatial reference system. Geologists, oceanographers, meteorologists, and even paleontologists use geodesy to understand physical processes on, above, and within the earth. Because geodesy makes extremely accurate measurements (to the centimeter level), scientists can use its results to determine exactly how much the earth's surface has changed over very short and very long periods of time.

Capabilities	Products & Services Management Activities	Outcomes and Benefits
Hydrographic Surveying	Provides critical decision support information, tools and services to: • State and local governments, shippers, pilots, port authorities, fishermen and others who rely on safe and efficient marine navigation for maritime commerce/ economic security/ environmental protection • US Navy, US Coast Guard, Military Sealift Command to safely and efficiently navigate US waters to provide national security • Federal weather and modeling efforts for tsunami, storm surge, oceanographic conditions and federal/state/local mapping efforts for coastal features	Safe, efficient, and environmentally sound navigation and reduced risk of avoidable accidents due to undetected obstructions and shoals which could result in loss of life, property, and damage to the environment, and for which the government can be held liable Efficient, safe transits bring consumer goods at lower prices, supports recreational/tourist enjoyment of coasts free of oil/other accident impacts Hydrographic data and charts facilitate the 60,000 calls a year to U.S. ports by vessels required to carry NOAA charts (over 1600 gross tons); supporting annual movement of 2.5 billion short tons of cargo valued at over $1 trillion

Capabilities	Products & Services Management Activities	Outcomes and Benefits
	benthic habitat, Outer Continental Shelf claims and other purposes. • Emergency managers for hazardous materials response, natural hazard (storms, hurricanes, tsunamis), and other Incidents of National Significance • Significantly improve federal, state, and local coastal resource managers' ability to conduct coastal zone planning, restoration projects, vulnerability assessments and other resource management issues • Recreational users of the coastal environment • State and local port infrastructure planners to facilitate (re)development of port infrastructure in an environmentally sound manner	and 9.6 million pounds of commercial fish landings (catch) in U.S. waters Aid 70 million recreational boaters in navigating/enjoying U.S. waters
Geodetic Gravity Modeling	Improved Geoid model, the fundamental model for all vertical positioning activities	Provides infrastructure, models and tools, and capacity building products and services to allow accurate positioning to the centimeter level for commercial, scientific, and government users Accurate geographic data, allowing a wide segment of the population to benefit from the many spin-offs of GPS technology, including a wide range of recreational activities such as hiking, biking, boating, fishing, hunting and sports

MISSION SUPPORT

Effective and efficient support activities are necessary for NOAA to achieve its mission goals. Facilities, ships, aircraft, integrated ocean observations, environmental satellites, homeland security, data-processing systems, computing and communication systems, and environmental modeling provide the foundation of support for all NOAA programs. Without the infrastructure needed to support the science and data collection behind NOAA's products and services, NOAA would be severely challenged to accomplish its mission.

Capabilities	Products & Services Management Activities	Outcomes and Benefits
Homeland Security	Support for incidents of national significant requiring NOAA and contract ship response - for hydrographic surveys hostelry and emergency operations center support for NOAA and other federal, state and local agencies Support for the National Exercise Program which includes annual exercises in the maritime, such as the NOAA sponsored SAFE SEAS, will continue to call for engagement of NOAA shipboard assets	Surveys to open ports, determine affects on fisheries and habitat, and measure seafood and water quality. Hostelry and emergency operations center support directly assists federal/state/local authorities involved in on scene incident management in affected areas that have suffered significant or total loss of infrastructure required for adequate response
Satellite Services	Accurate ocean color data used in monitoring ecosystem health and changes over time	Ability to generate environmental data records for ecosystem management and applications (e.g. harmful algal blooms)
Integrated Ocean Observing	Operational El Niño Southern Oscillation Observing System (ENSO) forecasts for decision making across a variety of economic sectors: fisheries, agriculture, hydropower, water resource management, weather forecasts Quality controlled data and information on current and future states of the oceans and Great Lakes from the global scale of ocean basins to local scales of coastal ecosystems	Integrated ocean observing will save lives and property by providing more precise model output guidance to the forecast process, and increasing warning lead-times and forecast accuracy. Longer warning lead times will reduce life and property loss by enabling more timely and effective response actions. Interoperable ocean data sets also have the potential to stimulate private sector investments in the development of new commercial products and services

Chapter 8

THE CURRENT STATUS OF NOAA'S MARINE OPERATIONS

NOAA operates, manages, and maintains a fleet of research and survey ships whose mission is to collect environmental data in the oceans and atmosphere. NOAA is responsible for operating the largest dedicated fleet of federal research ships. This fleet of 19 ships provides a wide range of capabilities for ocean exploration and scientific support, including: oceanographic research ships, capable of reaching the furthest reaches of the world's oceans and collecting benthic and atmospheric data; hydrographic survey ships, responsible for charting the nation's coastal waters; and fisheries survey ships, equipped to perform living marine resource and ecosystem assessment surveys. NOAA's ships have been specifically designed and equipped to support the agency's activities. As technology advances, ships are modified to acquire the quality and quantity of data needed to make NOAA's science missions successful. Many ships are capable of meeting multiple data requirements, even when specialists are not sailing aboard the vessels. Multimission operations provide the data that allow scientists to compile a complete picture of the health of an ecosystem.

VISION

To be the best in class for at-sea data acquisition for NOAA and the Nation

MISSION

To safely and efficiently operate NOAA ships, incorporate emerging data acquisition technologies, and provide a specialized professional team responsive to NOAA programs

One of NOAA's objectives is to fulfill NOAA's at-sea data collection requirements with safe, efficient platforms, supported by a highly skilled workforce and the continuous integration of appropriate technology. NOAA's marine operations are supported by a combination of personnel systems including: general schedule civilians, wage mariners, and officers of the NOAA Commissioned Corps, the Nation's smallest uniformed service. The officers also support the mission and goals of NOAA's diverse programs through rotational assignments, which being sea duty expertise to programs and programmatic expertise to sea duty.

NOAA marine operations seek to:

- Focus resources to deliver best value in ship and technical services
- Renew and retain a highly adaptable, technically competent, and diverse workforce
- Expand public and private partnerships to best meet customer needs and NOAA business objectives

The current status of NOAA's marine operations is described in four parts: (1) Ship Material Condition, (2) Ship Staffing Model, (3) Ship Capacity, and (4) Ship Capability.

Origins of NOAA's Ship Fleet

To understand NOAA's ships today, it is important to understand the history and origin of NOAA's ship fleet. NOAA's fleet of ships traces its origins to a variety of sources. Some ships were built and delivered for specific NOAA missions, while others were acquired through inter-governmental transfers, making good use of a government ships no longer needed for their original purpose. These latter ships still had remaining useful service life[52] and were capable of being adapted for new missions. Though not always ideal for their science mission, these adaptations provided a good value for the government dollar.

Many of NOAA's oldest ships built in the 1960s came from two organizational sources: the National Ocean Service and the National Marine Fisheries Service. The National Ocean Service (formerly the Coast & Geodetic Survey) had 16 ships constructed during the 1960s. Only three ships remain active today: RAINIER, FAIRWEATHER, and RUDE. The National Marine Fisheries Service (formerly the Bureau of Commercial Fisheries) constructed six major research ships during the same period. Five ships from that era remain active: MILLER FREEMAN, ALBATROSS IV, DAVID STARR JORDAN, OREGON II, and DELAWARE II. These ships were transferred to a central marine operations office when NOAA was formed in 1970.

NOAA's projected FY 2010 inventory of ships is shown in Figure 1. These ships support NOAA's priority at-sea data collection requirements.

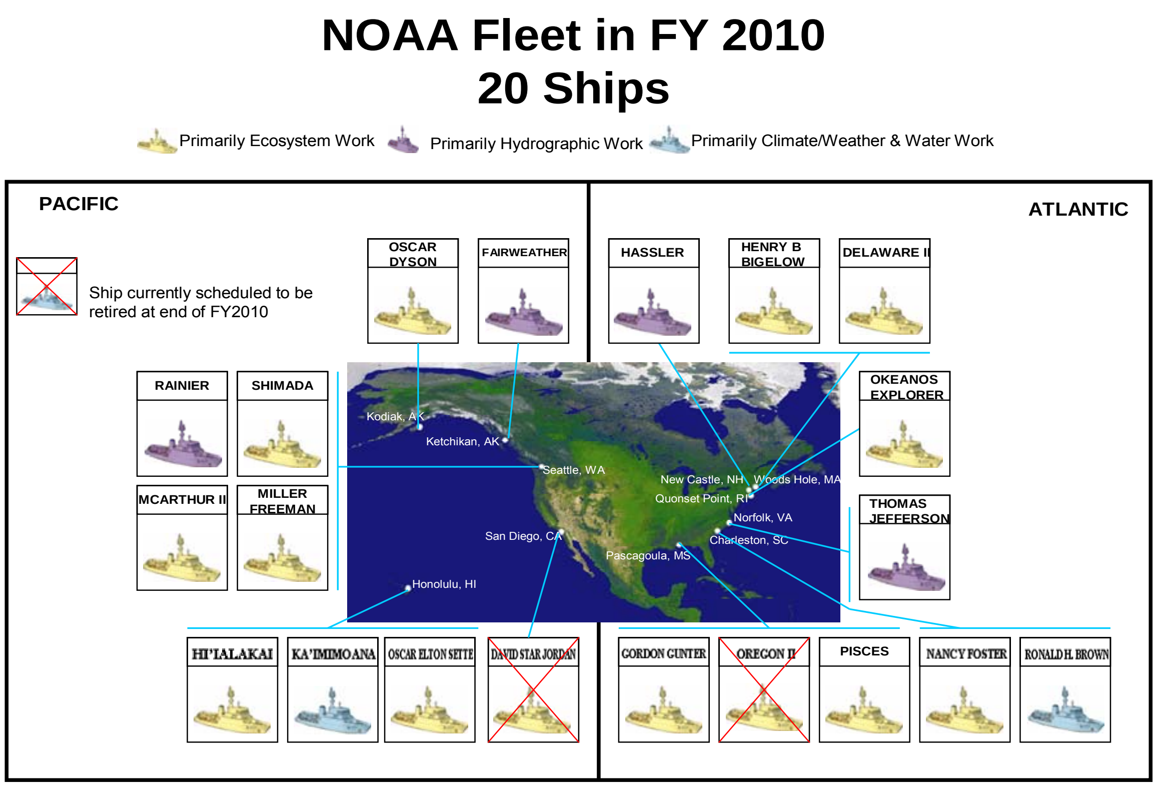


Figure 1. NOAA Ship Inventory in FY 2010

[52] Useful Service Life is constantly evaluated based on the condition, repair history and utility of the ship. OMAO's operational experience provides most NOAA ships with a useful service life of 30 years.

The largest segment of the fleet is represented by a group of ships whose origins originated in service to the United States Navy (USN). The Tactical Auxiliary General Ocean Surveillance (T-AGOS) ships gathered acoustical data in support of anti-submarine warfare. Over a period of several years, seven ships of this class were transferred to NOAA. The USN ship CAPABLE was renamed the OKEANOS EXPLORER and will join the fleet in 2008 to perform ocean research. Other active T-AGOS ships adapted for NOAA service include: GORDON GUNTER, HI'IALAKAI, KA'IMIMOANA, MCARTHUR II, and OSCAR ELTON SETTE (ASSERTIVE, the only inactive ship in NOAA custody, has not been converted to perform agency missions). Two additional ships transferred from the USN, THOMAS JEFFERSON and NANCY FOSTER, were also adapted to NOAA service and address a variety of fisheries and ocean survey missions. These ships are all approaching 20 years of useful service life and are due for a mid-life restoration and modernization or replacement.

Age of the Fleet and Notional Service Life

NOAA ships's ages range from the DAVID STARR JORDAN, which will be 45 years old in FY 2010, to BELL M. SHIMADA, which will begin operations in FY 2009 (Figure 2). NOAA's projected fleet of ships in FY 2010 is composed of 20 ships, with an overall average age of 21.8 years. The age of a ship serves as a good proxy for its condition for two reasons: 1) age is easily measured - ship age is measured from the date the vessel is delivered until the current year - and 2) it is part of the design criteria when building a structure that the ship must withstand the rigors of a dynamic and hostile ocean environment over time.

Current Status of NOAA Fleet Age Profile FY 2008 - FY 2024

NOAA Ship Name	Fiscal Year Delivered	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
ALBATROSS IV	1962	46	Offline															
BELL M. SHIMADA (FSV4)	2009		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DAVID STARR JORDAN	1965	43	44	45	Offline													
DELAWARE II	1968	40	41	42	43	44	45	46	47	Offline								
FAIRWEATHER	1968	40	41	42	43	44	45	46	47	48	49	50	Offline					
GORDON GUNTER	1990	18	19	20	21	22	23	24	25	26	27	28	29	30	Offline			
HENRY B. BIGELOW	2006	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
HI'IALAKAI	1984	24	25	26	27	28	29	30	Offline									
JOHN N. COBB	1950	58	Offline															
KA'IMIMOANA	1989	19	20	21	22	23	24	25	26	27	28	29	30	Offline				
MCARTHUR II	1985	23	24	25	26	27	28	29	30	Offline								
MILLER FREEMAN	1967	41	42	43	44	45	46	47	48	49	50	Offline						
NANCY FOSTER	1991	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
OKEANOS EXPLORER	1989	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
OREGON II	1967	41	42	43	Offline													
OSCAR DYSON	2005	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
OSCAR ELTON SETTE	1988	20	21	22	23	24	25	26	27	28	29	30	Offline					
PISCES (FSV3)	2008	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
RAINIER	1968	40	41	42	43	44	45	46	47	Offline								
RONALD H. BROWN	1997	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
RUDE	1966	42	Offline															
FERDINAND R HASSLER (SWATH)	Late 2008		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
THOMAS JEFFERSON	1992	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
ASSERTIVE (Not Operational)	1986	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
	Fiscal Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Average Age (does not include AS)		26.8	21.8	22.8	21.4	22.4	23.4	24.4	25.1	22.6	23.6	22.5	20.4	20.4	20.3	21.3	22.3	23.3
# of Ships Taken Offline		0	3	0	2	0	0	0	1	3	0	1	2	1	1	0	0	0
# of Operational Ships		21	20	20	18	18	18	18	17	14	14	13	11	10	9	9	9	9
Ships > 30 years		9	6	6	4	4	4	5	5	2	2	2	2	2	2	3	3	3
Ships > 40 years		9	6	6	4	4	4	4	4	2	2	1	0	0	0	0	0	0
Ships > 50 years		1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
TAGOS Ships ID by color																		

Figure 2. NOAA Ships by Age and Overall Average Age of Ships

NOAA, University-National Oceanographic Laboratory System (UNOLS) and other federal ships are designed to American Bureau of Shipping (ABS) standards.[53] ABS is an internationally recognized body that sets standards for the design, construction, and operational maintenance of ships and other marine structures and certifies ships that comply with those standards. ABS standards represent the best knowledge and experience of naval engineers and naval architects. While NOAA ships were constructed to ABS standards existing at the time of their design and construction, they may not meet today's evolved standards.

Ship age is referenced to both notional and useful service life. The notional, or theoretical, service life is the initial age assumption made during the first stages of ship design. This notional service life drives a number of parameters for the ship such as strength and design life fatigue and takes into account the corrosive effects of the saltwater environment on construction materials. Useful Service Life is based on the actual condition of the ship. It is constantly evaluated based on condition, repair history, inspections, and utility of the ship.

Though a 20 year notional service life is the design standard of many of NOAA's ships, their actual useful service life is re-evaluated constantly through maintenance and inspections. NOAA has made routine repair periods for all its ships a high priority. NOAA ships have historically lasted longer then their notional service life estimates due to this investment and care. NOAA projects the T-AGOS class useful service life is 30 years, ten years longer than their notional service life.

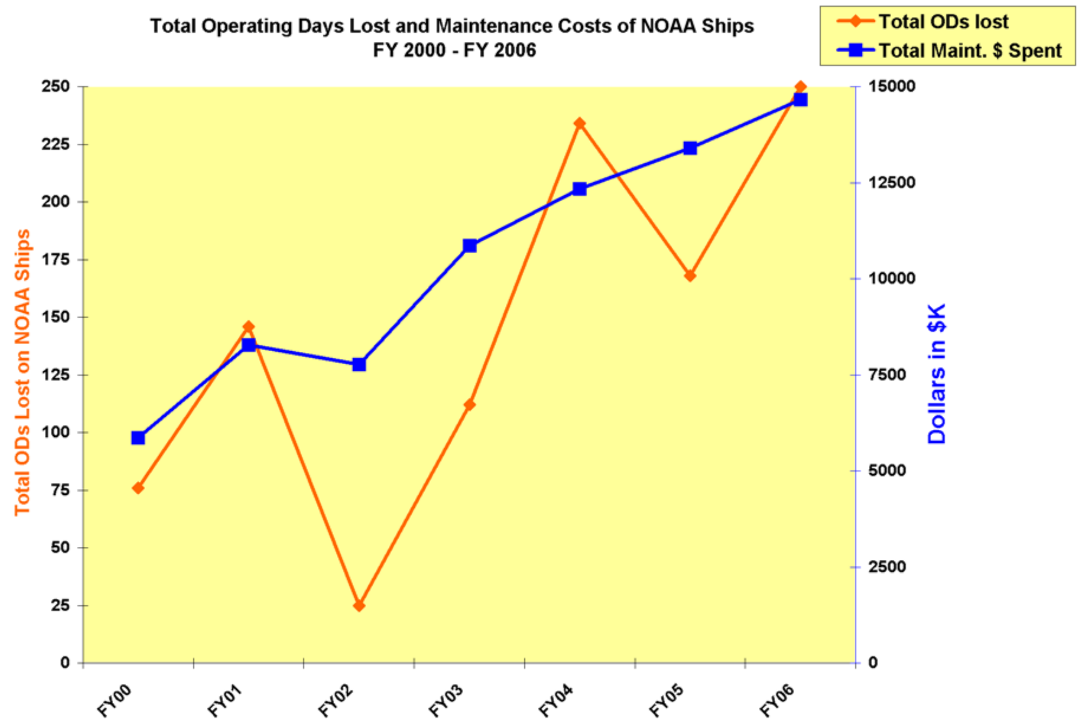
In some cases, a ship's life can extend far beyond the notional life with an extensive capital investment called a Service Life Extension (SLE). ABS publishes a guide to rebuilding ships at 20 to 25 years for extended service. If ships are rebuilt according to the guide, their notional service life can be extended to a total service life of 40 to 50 years. This estimate is consistent with what other agencies are using for their maximum service life (US Coast Guard, USN, UNOLS). Assuming ships undergo a SLE, refurbishment, or major repairs at the 20 to 25 year mark, NOAA projects ships can operate safely and efficiently up to fifty years of age and will do so as long as it is cost effective. Without capital investment at the 20 to 25 year mark, NOAA recommends ships be decommissioned at 30 years.

Assessing the Condition of NOAA Ships

NOAA's ship assessments looked at several dimensions of ship operations and maintenance. Maintenance cost information, operating days lost due to maintenance, and records of ship casualty reports (CASREPS) were collected from the past ten years. This assessment provided an unpredictable maintenance trend for NOAA's aging fleet. Figure 3 provides a graphic of the assessment.

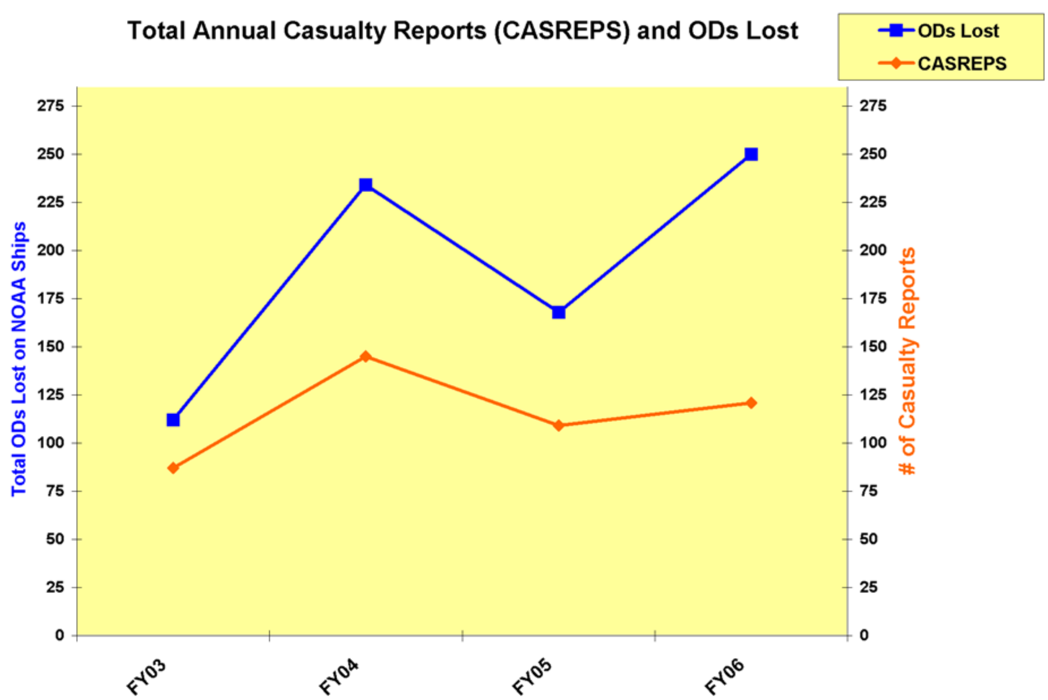
[53] ABS standards assume a 20 year service life based on a ship operating in the North Atlantic and estimating the number of bending cycles it would experience over a twenty year period. Theses bending cycles are factored into the analysis as a means to anticipate and prevent fatigue failure of the ship structure during its lifetime.

Figure 3. Total Operating Days Lost and Maintenance Dollars Spent on all NOAA Ships



The synthesized results did *not* demonstrate that fleet age correlated with increased maintenance costs, operating days lost on a ship or the number of CASREPS on a ship by ship basis. Figure 3 does, however, illustrate increasing fleet maintenance costs overall from FY 2000 to FY 2006.

Figure 4. Total Number of Casualty Reports and Operating Days Lost for all NOAA Ships



As shown in Figure 4, Casualty Reports provide no definitive increasing trend either. Casualty reports are normally used to alert management if some part of the ship's hull, machinery, electrical, or personnel prevents the ship from performing its mission.

This lack of logical trends in the data is not unique to NOAA. The USN looked at maintenance and casualty reports for two classes of ships; the DD-963 class with 31 ships and the CG-47 class with 27 ships. Both classes of ships provide a solid comparison to NOAA ships. USN results for DD-963 class looked at maintenance costs and concluded "No apparent correlation between ships aging and maintenance expenditures for corrective maintenance." They also found it difficult to track maintenance backlogs and the existing databases were highly subjective.

Adherence to local, regional and national standards for environmental pollution and safety design standards issued by the American Bureau of Shipping (ABS) presents additional challenges for the condition assessment and operation of NOAA's ships. Environmental standards are rapidly changing; 30 years ago, overboard discharge rules were very different. NOAA's ships comply with the legal mandates through changes in operating policy that reduce the effectiveness of the ships. For example, holding tanks for grey water were sized for the operating profile and the geographic locations the ships were originally expected to operate within. Today's restrictions require the ships to move further away from sanctuaries or shallow, coastal areas before discharging the effluent. Therefore some ships must conduct data collection during the day, then drive offshore during the night to appropriately discharge effluents. This disruption could be substantially reduced with larger holding tanks and the new equipment designed to reduce the effects of the effluent; however, the current ship configuration does not have the space to allow the adaptation of these older ships to the new rules.

As noted in Appendix C, many ships adhere to ABS standards for ship construction, maintenance and operations. In some cases, however, these ships have been allowed to "fall" out of class because the expense to upgrade or alter the ships was not considered as high priority as other repairs. In no case did any decision affect the safe operation of a ship or endanger the crew, but it did in some cases affect NOAA's compliance with ABS standards.

A recent independent operational assessment of NOAA ships noted "….irrespective of age, [the condition] was very good."[54] Details of each ship "site" visit recorded the details of their condition. These reports noted issues with maintenance, age, and status (whether or not it was in class by ABS standard) of the ship.

Ships should be equipped with the best available technology, sufficiently robust to operate reliably and safely in the remote field locations and under severe conditions, and in compliance with increasingly restrictive regulations for overboard discharge, emissions, and other environmental guidance. Systems must have built-in redundancies and self-protection mechanisms to withstand open ocean conditions and operate reliably and safely. Ideally, ships and technology should be easy to maintain. Ships are subject to moist salt air, violent motion at sea, and occasional human error.

Current Staffing of NOAA Ships

One of NOAA's biggest priorities is its workforce. For marine operations this workforce includes NOAA Corps Officers, civilian wage mariners (including licensed engineers), Public Health Service (PHS)

[54] NOAA Operational Assessment Report, Prepared in joint cooperation by GMATS and SMS, LLC, October 17, 2007.

Officers, and rotating civilian electronic technicians. The three primary and distinctive personnel systems supporting NOAA's marine operations and NOAA's goal to recruit and retain a highly adaptable, technically competent and diverse workforce are described below.

The NOAA Corps

The NOAA Corps provides operational leadership and experience to assist NOAA in the completion of environmental and scientific missions. It is the smallest of the seven uniformed services of the United States and is a direct descendant of the commissioned service of the United States Coast and Geodetic Survey (C&GS). It provides a cadre of professionals educated in engineering, earth sciences, oceanography, meteorology, fisheries science, and other related disciplines who begin their careers on NOAA's ships in operational assignments. Junior officers develop programmatic expertise in alignment with the officer's educational or occupational background. Officers typically have two to three year sea tours followed by three to four years ashore, resulting in a twenty to thirty year career with approximately nine to twelve years of sea duty. NOAA Corps officers are trained for positions of leadership and command in the operation of ships and aircraft; in the conduct of remote projects on land, at sea, and in the air; in the management of NOAA equipment and facilities; as members or leaders of research efforts; and in the management of various organizational elements of NOAA. Officers also provide an operational capability for effective response to national or regional emergencies.

Civilian Employees

Wage mariner positions are the backbone of the fleet. Licensed engineers, who are fully-licensed by the United States Coast Guard (USCG) in accordance with commercial requirements, maintain and operate the mechanical and electrical equipment that provide "household" services to the ship's crew and scientists. The Chief Engineer is responsible for a wide variety of ship's operations, from fueling the ship and small boats to heat for hot showers. When compared to private industry, the engineers' leave and benefits put NOAA at a competitive disadvantage for the best employees. The biggest discrepancy is in leave, since industry generally has a one-for-one sea-to-shore periodic rotation, and NOAA full-time staffing does not have the same business model. Often a NOAA-trained engineer can find a position in private industry that pays roughly the equivalent salary, but offers as much as six months of time in a non-deployed, and sometimes non-work, status.

As ship operating plants become more technologically advanced, highly-trained engineers are in even greater demand. A prime example of the new set of skills required aboard NOAA ships is the electronic engineering technician, or EET, who is responsible for the automated systems present in modern engineering plants. Retention of these critical knowledge positions is challenging when NOAA employees compare their earnings and benefits with their peers working in factory control mechanisms or other similar work.

Civilian rotating electronic technicians are responsible for administration of operation and maintenance of the shipboard computer network, and for many ship safety and communication systems, including radars, radios, satellite receivers, multibeam echosounders, and global positioning systems (GPS). These personnel develop highly- marketable skills that lead them to opportunities that do not require several months' at-sea duty each year. The elder generation of electronics technicians has been retiring rapidly, and it is a challenge to engage and retain replacements with satisfying work, good working conditions, and sufficient support for the challenges they face in the field.

Mission-related personnel in deck and survey departments are vital to the quality and safety of data acquisition, especially aboard hydrographic survey ships. Small boat safety begins with the coxswain, or boat driver, who is often responsible for operating a small skiff or survey launch an hour or more distance from the ship. Survey technicians operate a myriad of electronic equipment, and ensure that data meet quality standards and fall within calibration bounds. NOAA faces challenges staffing augmentation pools for sailing personnel for regular mid-season or emergency shore leave, implementing best-qualified hiring practices, and creating continuous opportunities for advancement through cross-fleet promotion and recognition.

Public Health Service Officers

The United States Public Health Service (USPHS) is a cadre of approximately 6,000 health or health-related professionals headed by the Surgeon General, Department of Health and Human Services. There are approximately 14 USPHS officers assigned to NOAA, 11 of whom support Health Services for marine operations. USPHS officers include nurse practitioners and physician assistants who provide occupational health services to NOAA employees through the two Marine Operations Centers and the Aviations Operations Center and provide primary/urgent/emergent care aboard NOAA ships while underway.

Current Status of Ship Capacity

NOAA strives for full utilization of available ship time. Capacity is defined as the amount of time available for acquiring data in support of NOAA's at-sea data collection requirements, and is typically shown as ship operating days. Full utilization is defined in this plan as 255 operating days.[55] Although funding available for most ships has been below full utilization levels, Figure 5 provides a summary of the current capacity of NOAA ships if funded at full operating tempo (assuming no additional capital investment is required to fulfill this requirement).[56] The total number of NOAA ships operating will decrease from 20 in FY 2008 to nine in FY 2024 without additional investment in infrastructure, decreasing operating day capacity by roughly 50 percent.

[55] 255 Operating Days is defined as fully utilized because of the necessity of ship husbandry, replenishment of supplies, staging of successive operations, and personnel arrival and departure tasks which together add up to the remaining 110 days in a year.
[56] In reality, fully funding an annual operating schedule of 255 days would require substantial augmentation to ensure retention of personnel and accomplish requisite ship husbandry during the inport periods.

NOAA Ship Capacity FY2008 - FY2024																	
	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24
ALBATROSS IV	Calibration	Offline															
BIGELOW	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
DELAWARE	255	255	255	255	255	255	255	255	Offline								
OKEANOS EXPLORER	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
RUDE	255	Offline															
HASSLER		255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
THOMAS	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
FOSTER	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
RON BROWN	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
GUNTER	255	255	255	255	255	255	255	255	255	255	255	255	255	Offline			
OREGON II	255	255	Calibration	Offline													
PISCES		255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
JORDAN	255	255	Calibration	Offline													
SHIMADA			255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
SETTE	255	255	255	255	255	255	255	255	255	255	255	Offline					
HI'IALIKAI	255	255	255	255	255	255	255	Offline									
KA'IMIMOANA	255	255	255	255	255	255	255	255	255	255	255	255	Offline				
FREEMAN	255	255	255	255	255	255	255	255	255	255	Offline						
COBB	255	Offline															
RAINIER	255	255	255	255	255	255	255	255	Offline								
MACARTHUR II	255	255	255	255	255	255	255	255	Offline								
DYSON	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
FAIRWEATHER	255	255	255	255	255	255	255	255	255	255	255	Offline					
Total ODs	**4845**	**4845**	**4590**	**4590**	**4590**	**4590**	**4590**	**4335**	**3570**	**3570**	**3315**	**2805**	**2550**	**2295**	**2295**	**2295**	**2295**
# of Ships	**20**	**19**	**20**	**18**	**18**	**18**	**18**	**17**	**14**	**14**	**13**	**11**	**10**	**9**	**9**	**9**	**9**

Figure 5. NOAA Ship Capacity FY 2008-FY 2024 at full operational funding [Full Utilization]

Current Capability

Ship capability is determined by a number of components, including staff, ship instrumentation, ancillary equipment, mission-specific equipment, and ship design and configuration. Figure 6 provides a summary of the capabilities of current NOAA ships, including ships presently being constructed or converted as of FY 2008. Capabilities are listed in order of data acquisition systems, mission-specific systems and emerging technology.

The ships' capability scores are assigned as:

- Zero: the capability is absent
- One: the capability is present
- Two: extensive capability is present as defined under its parameters

Capability	A4	M2	DE	DJ	FA	GU	HB	PISCES	HA	JC	KA	MF	NF	DY	R2	SE	RA	RB	RU	TJ	EX
Trawl	1	1	1	1	0	1	1	1	0	1	0	1	1	1	1	1	0	0	0	0	0
Multibeam - Biomass	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	
Multibeam - Bottom Mapping	0	0	0	0	1	0	1	1	1	0	0	0	1	0	0	0	1	1	1	1	1
Single Beam	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Side Scan Sonar	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0
Moving Vessel Profiler	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Instrumented Work Boats	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	2	0	0	1	0
Dopplar Radar System	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Longline	1	0	1	1	0	1	1	1	1	0	0	1	0	1	1	1	0	0	0	0	0
Extensive Dive Capability	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	1	1	0	0	0	0
A Frame	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	0	0	1
J Frame	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	0	1	0	0	1
Mooring Handling Capability	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0
Lab Space	1	1	1	1	1	2	2	2	1	0	1	2	1	2	1	2	0	2	0	0	1
Scientific Berthing Space	1	1	1	1	2	1	2	2	2	0	1	1	1	2	1	2	0	2	0	0	2
Survey Space	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	1	1	1	1
Hydro/Oceanographic Winch	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Dynamic Position System	0	0	0	0	0	0	1	1	0	0	1	0	1	1	0	0	0	1	0	0	1
POS/MV	0	1	0	0	1	1	1	1	1	0	0	1	0	1	0	0	1	1	0	1	1
Endurance	0	1	0	0	0	1	1	1	1	0	0	1	0	1	1	0	0	1	0	1	1
UAS Configuration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AUV Configuration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ROV Configuration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Telepresence	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
ICES Acoustic Quieting	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
Zero Discharge Capability	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Ice Strengthening	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
Total	**8**	**10**	**8**	**8**	**14**	**11**	**17**	**17**	**14**	**3**	**8**	**11**	**10**	**17**	**8**	**11**	**10**	**15**	**5**	**9**	**13**

Defining Parameters		
Lab Space		0 = No capability in this area
Under 500 sqt	0	1 = Capability exists
Over 500	1	2 = Extensive capability
Over 1000	2	
Endurance		
Above 30 days	1	
30 days and below	0	
Scientific Berthing		
Under 5	0	
6 to 15 spaces	1	
Above 15	2	
Instrumented Work Boats		
Over 4	2	
1 to 4	1	
None	0	
ROV Configuration		
Ship cannot Support ROV Ops	0	
Ship can support 1 operational ROV	1	
Ship supports tandem ROV operations	2	

Figure 6. NOAA Ship Capability FY 2008 to FY 2024 at full operational utilization

NOAA has new ships, old ships, large multi-purpose ships and smaller single-purpose vessels. NOAA's ships are dedicated to NOAA's missions; from climate research, to ocean exploration, and hydrographic surveying to fisheries data collection. NOAA ships support scientific data collection that is at the heart of NOAA's products and services.

Chapter 9

TECHNOLOGY EVALUATION

Any discussion of the current and future NOAA ship fleet must consider the potential advantages of integrating advanced and emerging technology. As demonstrated in Chapter Six, data collection requirements are driven by both NOAA's legislated mandates and programmatic requirements to collect better data for their products and services. Operating ships to support acquisition of data to meet these mandates requires investments in many aspects of agency infrastructure. Planned procurement of capital and non-capitalized assets, strategic and tactical maintenance of expertise in mission accomplishment, and optimizing operational efficiencies through strategic implementation of technology all have significant impacts in supporting NOAA's efforts to meet national goals. Supporting and maximizing data acquisition goes hand-in-hand with the value of the products and services stemming from these data, and one cannot exist without the other.

An oft-proposed suggestion to reduce capital costs while maintaining data collection capacity is through the incorporation of technology. It is a short-sighted, however, to believe that technology can replace ships. Just as improvements in the technology of various sensors that collect data from space will never replace the need for the satellite that transports them through their orbit, ships are needed to transport data collection sensors to wherever they are needed at sea. Moreover, increasingly sophisticated instruments often require highly-skilled labor support for operation, maintenance, and repair. Technology does have a significant role to play in the future NOAA ship fleet by making operations and data collection more cost efficient. Through improving ship performance and/or by increasing the quality and quantity of data collected during an operating day, the goal of technology integration is to maximize the data collection potential of NOAA's ships during a day at sea, getting the most "bang" out of the proverbial buck.

This section provides a broad overview of two different categories of technology, **data collection** and **ship infrastructure**, describing their possible applications and potential benefits for NOAA as currently envisioned. Within each category, technology is categorized into one of three stages of development:

> **State of the art technology:** This represents the lowest risk in terms of cost and benefit certainty. It includes technology that is aboard some, but not all NOAA ships, is anticipated to be incorporated into future builds, and is considered to be in the "application" stage as defined in NOAA Research to Application transition documents.
>
> **Developing technology:** This category represents medium risks in terms of cost and benefit certainty. It includes technology that is currently being used aboard few NOAA ships, may be incorporated into future builds, and is considered to be in the "pre-operations" stage of the "research to application" cycle.
>
> **Conceptual technology:** This category represents the highest risk in terms of cost and benefit certainty. This technology is at the absolute cutting edge of implementation.

NOAA has successfully developed, adapted, and/or fielded a number of technologies that have enhanced the capabilities of NOAA ships by allowing scientists to conduct their research more effectively and efficiently. Further, NOAA is currently evaluating a number of technologies that have potential to contribute to more effective and efficient research. In the near-term, technology is expected to enable NOAA to make incremental advances over its current capabilities. There currently is no technology foreseen in the next 15 years that will replace the need for NOAA to have ships.

Decisions on which technologies to incorporate and when to adopt them need to be based on analyses determining the economic benefit of a candidate technology relative to alternative approaches in the context of a specific mission need. While the qualitative benefits of a technology may be relatively easy to discern, it is often much more difficult to quantify those benefits in terms suitable for fiscal decisions.

NOAA has successfully implemented new technologies on older ships to maintain efficient operations and improve effectiveness of the vessels, and has sought to use state-of-the-art equipment on new vessels as budgets have allowed. Testing and evaluation of program-supplied technology has also occurred. In general, the technologies discussed in this chapter are representative of efforts within NOAA to optimize *in situ* data acquisition operations in the NOAA fleet.

Collaboration with NOAA scientists on technology implementation on NOAA fleet units will ensure that the questions below are addressed:

- What current or future NOAA mission requirements will the technology support?
- What types of data will the technology collect?
- What capabilities does the technology provide?
- What benefits are derived from these capabilities?
- Can the capabilities be gained in a cost effective manner relative to alternative technologies?
- When will the technology be ready for fleet implementation?
- What impact will the technology have on ships in terms of workforce needs, training, configuration (e.g., ship arrangement/space requirements), infrastructure (e.g., hotel services, power requirements, communications requirements, and handling equipment), data processing, and ship operations including conflicts with other mission systems or requirements?

More focused technology implementation will: (1) help NOAA scientists develop suitable and defendable requirements to demonstrate a need for the technology, (2) ensure suitable analyses are conducted, when appropriate, to demonstrate an acceptable business case supporting technology implementation, and (3) identify a suitable platform and implementation opportunity that minimizes impact on available ship capacity.

This approach will significantly increase collaboration and coordination between the NOAA scientific research community and NOAA ship designers/maintainers/operators and should help ensure technological advances are incorporated into the fleet in an appropriate, logical, and cost effective manner.

STATE OF THE ART DATA COLLECTION TECHNOLOGY

Remotely Operated Underwater Vehicles

Remotely operated underwater vehicles (ROVs) are unoccupied, highly maneuverable, underwater vehicles linked to a ship by a cabling that carries electrical signals between the shipboard operator and the vehicle. Most are equipped with at least a video camera and lights. Additional equipment (e.g, still cameras, manipulator or cutting arms, water samplers, and instruments that measure water clarity, light penetration, and temperature) may be added to expand the vehicle’s capabilities. First developed for private industry purposes, such as internal and external inspections of pipelines and the structural testing of offshore platforms, ROVs are now used for many applications, many of which are scientific in nature. They have proven extremely valuable in NOAA for ocean exploration, seafloor characterization, and fisheries research efforts.

ROVs range in size from that of a bread box to a small truck (see Figure 1, for example). Deployment and recovery operations range from simply dropping the ROV over the side of a small boat to complex deck operations involving large winches and A-frames to manage the conducting wire and recover the ROV back onto the deck. ROV operations are simpler and safer to conduct than any type of occupied-submersibles (which require substantially larger cranes to comply with weight hauling requirements) or diving operations.

Figure 1. ROV *Innovator* Launch from NOAA Ship RONALD H BROWN

Currently Utilizes ROVs		
Goal & Capability	**Mission**	**Data Collected**
Ecosystems/Living Marine Resource Management	Resource assessment surveys; habitat surveys; slow moving or immobile object collection in areas not suitable for trawls	Visual imagery of fish and shellfish biomass and behavior and habitat topography and structure; biomass and habitat samples
Commerce & Transportation/Hydrographic Surveying	Hydrographic surveying in support of nautical charting: characterization of submerged objects that may pose hazards to safe navigation, and search and recovery operations.	Video imagery used for identification or correlation of sonar contacts and short range scanning sonar for object detection.
Ecosystems/Ecosystems Research	Exploration and research use a variety of ROVs for all aspects of their missions	Physical samples, imagery of seafloor and sealife, high precision mapping (e.g. Titanic photomosaic)
Could Benefit from ROV Use		
Goal & Capability	**Mission**	**Data Collected**
Commerce & Transportation/Hydrographic Surveying	Hydrographic Surveying in support of nautical charting: Least depth measurements and characterization of submerged objects that may pose hazards to safe navigation or be of special cultural significance.	Characterization of sonar targets and investigation of benthic features when diving is unsafe; video imagery.

Mission Capabilities

ROVs provide the capability to non-destructively survey underwater resources, habitats, and objects and collect samples in areas not available through other means (e.g., deep water abalones and rockfish in high relief habitats; submerged hazards to navigation, underwater geographic features). In some cases, ROVs can be used in lieu of divers, limiting risk to personnel and increasing time available for observations.

Experience has shown that ROVs are less expensive than manned submersibles for conducting visual surveys beyond diver depth. From a lease-buy perspective, the limited availability and associated costs (equipment and personnel) of self-contained (containerized) ROV control systems, although not documented, were considered in NOAA's decision to include ROV capability in the conversion work package for the NOAA Ship OKEANOS EXPLORER. The anticipated high duty cycle of ROV operations on the OKEANOS EXPLORER indicated that the increased operational efficiency of a dedicated system was desirable. Also, there are limited numbers of 6,000 meter depth capable ROVs in existence, also precluding leasing. The National Academy of Sciences has explored the comparative value of ROVs vs. other submersible systems in its report, "Future Needs in Deep Submergence Science."

Integration Requirements

ROV operations require: (1) a means to launch and recover the vehicle (typically a deck crane), (2) a means to store, payout, and retrieve the umbilical cable connecting the ship and the vehicle (typically a traction winch via an A-frame), (3) equipment and space to control ROV operations and collect and analyze data, (4) vehicle maintenance and storage space, (5) and sufficient berthing and habitability services to support ROV scientists, pilots, data technicians, and maintenance personnel. ROV operations require dynamic positioning capability and generally preclude all other concurrent research efforts.

NOAA has embarked self-contained (containerized) ROV control systems on several research missions. This requires sufficient, suitable deck space and nearby clean power as well as berthing and boarding services for the ROV crew. While ROV operations to significant depth require substantial ship infrastructure, there are many small ROV systems that can be used for coastal operations up to 300 meters in depth. These systems can be deployed from smaller vessels with reduced ship infrastructure requirements.

Multibeam Sonar Systems

Multibeam sonar systems measure bathymetry and acoustic backscatter across a swath of seabed. They are typically used for ocean mapping, bottom type classification, and biomass assessments. Often they are mounted on the hull of a research ship or instrumented work boat, but the advances in multibeam power and computer technology increasingly allow them to be installed on towed platforms or mounted to autonomous underwater vehicles (AUV) or ROVs.

Hull-mounted multibeam sonar systems can have more than 100 precisely-located and optimally-tuned transducers that compute accurate depths by forming acoustic beams through interference-based physics. These beams travel through the water and reflect off of features to either side of the ship (see Figure 2). The multibeam system measures and records the time it takes for the acoustic signal to travel from the transducers to the features and back to the transducer. The systems commonly record the amplitude and phase characteristics of the arriving signal as well, which is referred to as acoustic backscatter. Multibeam sonar systems produce a "swath" of soundings across the ship's track as well as a line of soundings typically available from single beam sonar systems along the ship's path. These systems are usually designed to meet standards set by the International Hydrographic Office. NOAA (as the National Hydrographic Office) develops and promulgates standards for the data acquisition processes as well as the products required. Development of these standards has traditionally been based upon NOAA expertise created and maintained on the NOAA ships through implementation of new technologies and improved algorithmic applications. Data processing software in common use around the world is based on NOAA's approach to bathymetric mapping.

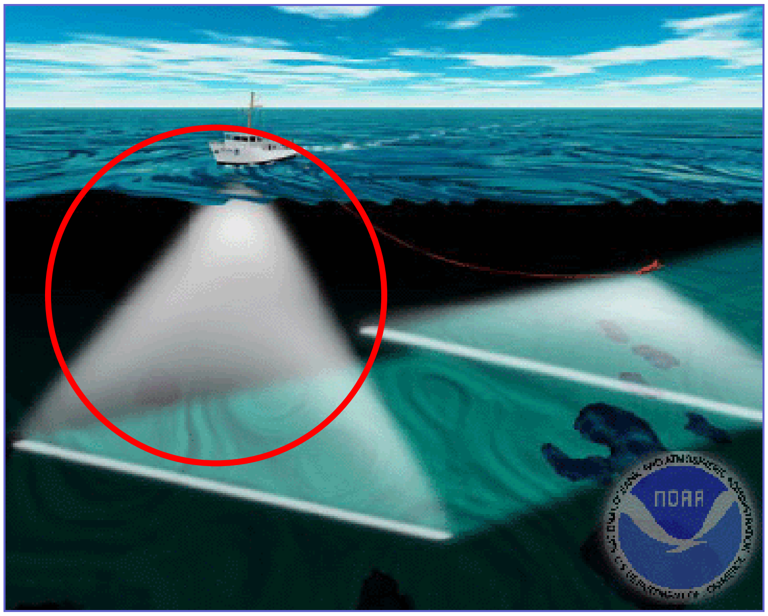


Figure 2. Hull-Mounted Multi-Beam Sonar Coverage

Currently Utilizes Multi-Beam Sonar Systems		
Goal & Capability	**Mission**	**Data Collected**
Commerce & Transportation/Hydrographic Surveying	Hydrographic Surveying in support of nautical charting	Full bottom coverage bathymetry and seabed imagery used for nautical charting and other ocean mapping products.
Ecosystems/Living Marine Resource Management	Fisheries resource assessments	Fish biomass estimates and behavior; krill and other micro-zooplankton estimates
Ecosystems/Living Marine Resource Management	Marine mammal assessments	Marine mammal distribution and behavior
Ecosystems/Living Marine Resource Management	Habitat mapping	Data that produce highly accurate maps of benthic features
Ecosystems/Ecosystems Research	Exploration and research routinely use multi-beam mapping to characterize unknown regions	All aspects described in entries above
Could Benefit from Multi-Beam Sonar Systems		
Goal & Capability	**Mission**	**Data Collected**
Ecosystems/Living Marine Resource Management	Additional fish and marine mammal species surveys	Predator/prey dynamics – four dimensional observations of animal aggregations in relation to predator foraging tactics.

Mission Capabilities

Multi-beam sonar systems produce high resolution bathymetry and acoustic backscatter data over a wide area in a single pass, enhancing data quality and reducing data collection time. For bottom type classification efforts, multi-beam sonar systems provide data that can augment ground-truth sampling to extend classification maps across wider areas.

Integration requirements

Multi-beam sonar transducers can be mounted in a fairing on the hull of the ship or mounted on a pole alongside the hull near the stern or working deck. Mounting the transducers in a fairing on the hull is the most stable installation but is also the most expensive and complex and must be accomplished in a dry dock. The fairing must be designed to minimize flow noise over the transducers and the transducers must be placed to minimize flow noise from other appendages and hull discontinuities. The exact physical location of each system component and the distances between them must be surveyed with great accuracy and precision. This information is used to correct for vessel motion and assure that the spatial accuracy of the bathymetry or backscatter information meets applicable requirements[57]. Pole-mounted transducers are much less invasive to install but are substantially more limited in capability, generally experiencing a loss of signal due to turbulence and a reduction in speed along track because of drag and turbulence.

System transceivers must be located within a certain distance of the transducers and a suitable operations space must be provided to house other system components and operate the system. Additional berthing space and habitability services may be required to support trained system operators.

Side Scan Sonar

Side scan sonar is a specialized sonar system for submerged feature detection and bottom type classification. Side scan sonar systems are typically towed but can be operated from AUVs or hull-mounted in shallow water. This section addresses side scan sonar systems towed from research ships.

Towed side scan sonar systems include three components—a towfish that sends and receives acoustic pulses, a transmission cable and winch attached to the towfish that sends data to the ship, and the ship's processing computer. In a side scan, the transmitted energy is formed into the shape of a fan (see Figure 3) that sweeps the seafloor from directly under the towfish to either side. The side-scan beam is oriented to the side of the ship, and usually slightly downward. As the ship moves along its path, the towfish, which is towed approximately 10 to 30 meters above the bottom of the sea, illuminates features to the ship's side. Side scans allow a ship to search at constant speeds and along straight lines, so that objects may be identified by their sonar return.

The strength of the return echo is continuously measured, and by applying various algorithms to the data, an image of the seafloor features can be created. Hard objects protruding from the bottom send a strong echo and create a dark image. Shadows and soft areas, such as mud and sand, send weaker echoes, thus creating a light image. Analysis of these dark and light images, called segmentation, allows scientists to locate and describe seafloor features and possible obstructions to navigators. Due to the sonar's height above bottom, the detection ability of the sidescan is enhanced, but depth information is not available from the side-looking sonar beam.

[57] For example see NOS Specifications and Deliverables for Hydrographic Surveys, or International Hydrographic Organization Special Publication 44.

Fully digital multi-beam side scan sonar systems are the state of the art and represent a significant improvement over the previous generation of digital single beam systems, which require relatively slow towing speeds so that the towfish does not "outrun" the returning echo. The end result of excessive tow speeds is regular gaps in the seabed coverage. In addition, high-resolution high-speed side scan sonar, such as the Klein 5500 deployed by NOAA survey vessels, uses multiple beams to maximize resolution at high speeds, and is the preferred system for object detection by hull mounting it for use in shallow waters.

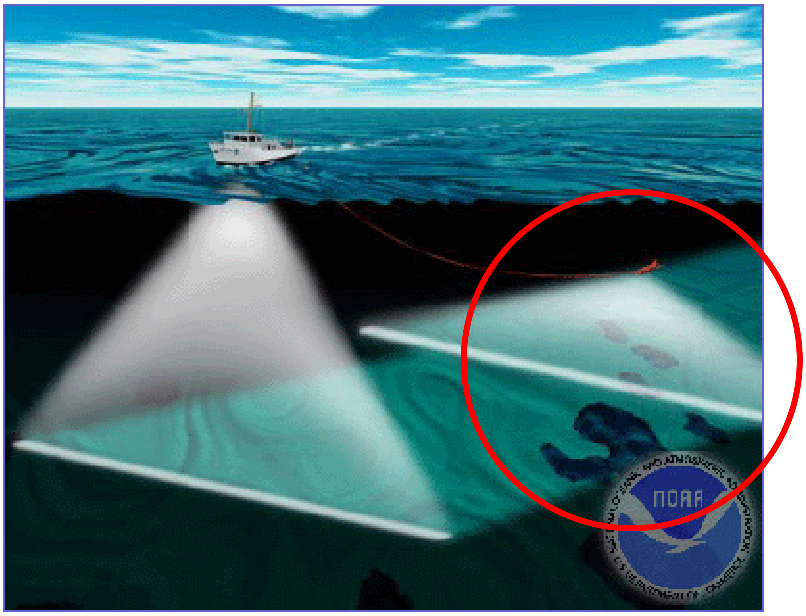


Figure 3. Side Scan Sonar Coverage

Currently Utilizes Side Scan Sonar Systems		
Goal & Capability	**Mission**	**Data Collected**
Commerce & Transportation/Hydrographic Surveying	Hydrographic Surveying in support of nautical charting	Detection and characterization of submerged objects that may pose hazards to safe navigation; High-resolution, geo-referenced acoustic imagery.
Commerce & Transportation/Hydrographic Surveying	Exploration and research use side scan sonar to characterize unknown areas in the ocean and to locate features such as shipwrecks	Seabed imagery, backscatter/shadows and bottom type characterization
Ecosystems/Living Marine Resource Management	Fisheries resource assessments for upper water column fish species	Epipelagic fish biomass estimates and behavior
Could Benefit from Side Scan Sonar Systems		
Goal & Capability	**Mission**	**Data Collected**
Ecosystems/Living Marine Resource Management	Deep water reef fish surveys	Fish habitat data

Mission Capabilities

Side scan sonar systems increase the efficiency of acoustic search efforts by expanding the area that can be searched in a single pass. Areas of interest, identified in the imagery produced by side scan sonar systems, can be further investigated using other acoustic detection or visual techniques.

Integration Requirements

From ship arrangement/space and infrastructure capability perspectives, side scan sonar operations require suitable launch and recovery systems, specifically a slip-ring winch with sufficient cable capacity, an instrumented sheave for measuring the amount of cable deployed to confirm towfish position, towfish tracking systems for longer tows, data acquisition and system maintenance laboratories, and data processing and management support systems.

Survey-Grade Positioning and Attitude Measurement

The survey-grade positioning and attitude measurement system is a GPS aided Inertial Navigation System that delivers full six degree freedom position and orientation solutions for research ships and enables continuous survey in areas where Global Positioning System (GPS) U.S. Coast Guard Differential GPS (DGPS) reception is problematic. It replaces conventional gyro compasses, motion sensors, and positioning systems.

Currently Utilizes Survey-Grade Positioning and Attitude Measurement Systems		
Goal & Capability	**Mission**	**Data Collected**
Commerce & Transportation/Hydrographic Surveying	Hydrographic surveying in support of nautical charting	Precise and accurate position and motion data to maintain the accuracy of bathymetric sonar measurements.
Commerce & Transportation/Hydrographic Surveying	Ocean mapping	Precise and accurate position and motion data to maintain the accuracy of bathymetric sonar measurements
Could Benefit from Survey-Grade Positioning and Attitude Measurement Systems		
Goal & Capability	**Mission**	**Data Collected**
Climate, Ecosystems	Physical and biological oceanography	Precise pointing of Acoustic Doppler Current Profiler, split beam echosounders, and other equipment

Mission Capabilities

Survey-grade positioning and attitude measurement is significantly more accurate than that typically installed aboard research ships for navigational purposes. Improved position and attitude measurement improves data quality from many ship-mounted remote sensing systems and is essential for multi-beam sonar operations.

Integration Requirements

From ship arrangement/space and infrastructure capability perspectives, survey-grade positioning and attitude measurement systems must be surveyed into place, ideally along the major vessel axis fore and aft, near the vessel's center of rotation. Data output is generally integrated into data acquisition systems in the laboratory, and raw data output is sometimes used as well.

Instrumented Buoys and Landers

Instrumented autonomous buoys and landers are used to extend the spatial coverage of measurements from a research ship to near shore environments and temporal coverage from days to months or even years. The lightweight instrumented buoy can be deployed for many weeks or months with remote control and data collection via satellite, radio, or other link. After the research vessel deploys the buoys, it is free to concurrently conduct other research.

Similarly, landers are autonomous instrumented platforms that sit on the seafloor and record sensor data over a period from days to years. Data can be recovered by acoustic modem or a cable to a surface receiver, or transmitted directly by radio to land or ship, or via commercial or data satellite. Acoustic Doppler Current Profilers (ADCP) are deployed from ships and charter vessels to acquire speed and direction of currents in bays, passes, and open water in this manner.

For NOAA modeling, hydrographic survey, and tsunami warning communities, accurate water level measurements offshore is a growing requirement. Currently, most water level measurements are acquired from shore-side water level gauges which are time consuming to install for short periods of observation and whose data may not be representative of the offshore environment.

Currently Utilizes Instrumented Buoys/Landers		
Goal & Capability	**Mission**	**Improved Support**
Commerce & Transportation/Hydrographic Surveying	Safe Navigation	Current measurement from seafloor using ADCP
Ecosystems/Living Marine Resource Management	Remote observations of animal abundances and movement patterns; oceanographic conditions (e.g., physical properties, phytoplankton, current structure, and meteorological conditions at the sea surface)	Active acoustic data (volume backscattering and target strength) at multiple frequencies; small nets; video and still camera images; temperature, salinity, and oxygen content; wind speed and direction; air temperature, pressure, and humidity; fluorometry; and more
Could Benefit from Instrumented Buoys/Landers		
Goal & Capability	**Mission**	**Improved Support**
Ecosystems/Living Marine Resource Management	Any mission requiring a long-term monitoring presence and, for which, the instrumentation can be mounted on the buoy or lander	Would depend upon available platform-mountable instrumentation
Commerce & Transportation/Hydrographic Surveying	Hydrographic surveying in support of nautical charting	Post-Processed Kinematic (PPK) GPS elevation data from buoys for water level measurement

Mission Capabilities

Low-cost, modular instrumented buoys allow multidisciplinary studies of nearshore ecosystems to be economically conducted on the most appropriate time- and space-scales, allowing research ship sea days to be used for offshore investigations on shorter time-scales. Similarly, landers permit observations over long time-scales while permitting more efficient use of research ships.

Although no specific analyses have been identified that quantify the economic benefit of instrumented buoys and landers in relation to other available options, the long-term autonomous operations capability coupled with relatively low equipment and support costs, suggests these technologies are cost effective methods to augment research ship capacity.

NOAA will deploy the GPS buoys in advance of or during hydrographic survey operations with ships and launches. The GPS buoys will be placed in open water areas to collect tide data for post-processing of hydrographic data acquired.

Presently, NOAA collects this critical water level information (tides) only along the shore because the tide gauge mechanisms and recording devices reside on shore. Measuring tides from shore can introduce inaccuracies for data gathered in open water. Educated assumptions have to be made as to what the water level is doing in the middle of, or at the entrance to, a bay or estuary. The GPS tide buoys accurately measure what the water level is doing offshore in these unknown areas. As a result of having GPS buoy data, depth inconsistencies due to incorrect tides will be greatly reduced, and potentially eliminated.

Integration Requirements

Buoys and landers have little long-term impact on ship operations but do require the capability to launch and recover the devices and store them during transit to and from their launch and recovery area. On deck storage of these devices may conflict with other research operations competing for the same space.

DEVELOPING DATA COLLECTION TECHNOLOGY

Autonomous Underwater Vehicles

Autonomous Underwater Vehicles (AUVs) are unmanned, untethered, self-powered, submersible robots with diverse payload capability that can operate without physical connection to an operator or ship. Sensors on board the AUV can sample ocean parameters (spatial, depth, and time series data) and provide acoustic bathymetry and imagery of the seafloor as the AUV moves through the water.

Currently Evaluating AUVs			
Goal & Capability	**Mission**	**Data Collected**	**Est. Availability for Fleet Implementation**
Ecosystems/Living Marine Resource Management	Resource assessment surveys (e.g., krill in the near shore areas of the Antarctic Peninsula, Rockfish near the seafloor in the Southern California Bight, and anchovy and sardine near the sea surface off the West Coast of the US); habitat assessment surveys	Fish biomass estimates and fish behavior; bathymetry and acoustic backscatter data characterizing benthic habitats	Currently not available
Commerce &	Hydrographic surveying in support of nautical	High-resolution, geo-referenced acoustic imagery; current-	FY 2009

Currently Evaluating AUVs			
Transportation/Hydrographic Surveying	charting, incident response, port security.	temperature-depth (CTD) data, bathymetric measurements	
Ecosystems/Ecosystems Research	Ocean mapping, shipwreck imaging, habitat characterization	Bathymetry, sonar and optical imagery, physical/chemical/biological oceanographic parameters	Currently not available
Could Benefit from AUV Use			
Goal & Capability	**Mission**	**Data Collected**	
Ecosystems/Living Marine Resource Management	Nearly any chemical or physical oceanographic mission not requiring visual data.	Acoustic bathymetry, hydrographic data (salinity, temperature, dissolved O^2), small biological collections (e.g., plankton)	
Ecosystems/Living Marine Resource Management	Untrawlable habitat surveys	Benthic topography and community structure	

Mission Capabilities

AUVs are expected to act as force multipliers; optimizing existing NOAA vessels by adding AUVs that increase at-sea data collection capacity. AUVs can deploy a wide range of sensors under a wide range of conditions and for longer mission durations. AUVs cannot replace launches or ships, but can increase their effectiveness and efficiency.

In 2006, NOAA developed an internal economic analysis[58] to assess how AUV could satisfy unmet hydrographic survey requirements. Because of the enormity of the area, NOAA has prioritized 500,000 square nautical miles as being navigationally significant and in need of modern surveys. NOAA collects hydrographic data with various sonar systems mounted on NOAA ships and hydrographic launches and via contract survey vessels. Current capacity surveys about 2500 to3000 square nautical miles annually. To fully serve the Nation's need for updated, accurate navigation data, 10,000 square nautical miles would need to be surveyed each year.

The report used the secondary economic analysis approach that determines which of several planning alternatives (for example, new construction versus commercial lease) would most economically satisfy an unmet need. Alternatives considered by the analysis included:

1. Incorporate AUVs on NOAA ships THOMAS JEFFERSON and FERDINAND HASSLER (SWATH)
2. Convert the USNS *John McDonnell*, sister ship of USNS *Littlehales* (now the NOAA ship THOMAS JEFFERSON)
3. Build an additional ship to support hydrographic services on the East and Gulf coast
4. Outsource the additional SNM (3550 SNM) using commercial contracts to meet target

[58] *Economic Analysis of NOAA's Autonomous Underwater Vehicle*, July 2006

The report concluded that incorporating AUVs provides a 54 percent net present value cost avoidance over building an additional ship, which ranked second. Converting a ship ranked third and is 57 percent less cost efficient than the AUV alternative. Outsourcing ranked last and is 57.2 percent less cost efficient than the incorporating AUVs.

The report acknowledged that additional analyses will be required "as technology and capability of AUVs develop within NOAA" and that "CONOPS [Concept of Operation] for AUVs may vary from mission to mission or with the vessels intended usage." The report further acknowledged that "[a]long with CONOPS, possible changes in management processes that are required with the integration of AUVs must be considered. Data processing management issues, shipboard staffing changes, design of launch and recovery systems, and AUV configuration management are some areas where adjustments will have to be made to accommodate the new technology."

Integration Requirements

From ship arrangement/space and infrastructure capability perspectives, the challenges that AUV operations entail include suitable launch and recovery systems, vehicle communications and tracking systems, laboratory, maintenance, and stowage facilities, and possibly increased habitability and habitability support systems.

Marine Unmanned Aerial Systems

Unmanned Aerial Systems (UAS) are a developing segment of the aviation industry. A UAS can be remotely controlled or fly autonomously based on pre-programmed flight plans or more complex dynamic automation systems. UASs are currently used in a number of military roles, including reconnaissance and attack. They are also used in a small but growing number of civil applications, where a human observer would be at risk, such as firefighting, police observation of civil disturbances and scenes of crimes, and reconnaissance support in natural disasters as well as for research.

There are a wide variety of UAS shapes, sizes, configurations, and characteristics. In the context of this chapter, a UAS is characterized as being capable of controlled, sustained level flight and powered by a jet or reciprocating engine. This chapter is focused on marine unmanned aerial systems (MUAS), which are further characterized as being designed for over water operations and shipboard launch and recovery.

NOAA's UAS Project has conducted or participated in a number of UAS demonstrations and is establishing regional test beds to evaluate the research and operational potential of the aircraft; three test beds currently exist.

The Arctic is a unique place on Earth with special challenges. Changes in the Arctic can impact the rest of the globe. Satellite measurements are often the most uncertain in the Arctic, with clouds, snow and sea-ice often giving similar signals. Surface measurements collected through international collaboration combine data from a variety of different instruments sponsored by the eight Arctic countries. Often, these measurements are only available from cities or villages where inhabitants can assist in data collection. The measurements over the Arctic Ocean are sporadic, often from buoys. There are no direct upper air measurements across the Arctic Ocean presenting a great challenge for weather forecasters, particularly in predicting the severity of storms that are developing. Despite the need for further measurements, the cost and risk to human life has been too great to systematically gather the needed data. The Arctic test bed is investigating UAS flights for conducting routine measurements over the Arctic Ocean, using dropsondes, which would allow for improved weather and climate predictions.

The Pacific test bed is focusing on early detection and monitoring of Pacific storms for forecasting flash floods, water resources management, fisheries assessments and enforcement, habitat mapping, environmental monitoring, climate, and protection of marine sanctuaries and endangered species. The Pacific region is well suited for the application of a UAS because of the large oceanic extent and remote land areas with limited continuous environmental observations.
The hurricane test bed is focused on using UASs to conduct observations to develop improved tropical cyclone analysis and prediction capabilities.

The following table summarizes the goal and capability and specific research missions that are considering the use of MUASs as well as other existing or future capabilities and research missions where MUASs could be effectively utilized.

Currently Evaluating MUASs			
Goal & Capability	**Mission**	**Data Collected**	**Est. Availability for Fleet Implementation**
Ecosystems/Living Marine Resource Management	MPA enforcement, fishing effort monitoring, and ecosystem abundance studies	Counts of dolphins in schools; high resolution video imagery of ship activity	2009
Could Benefit from MUAS Use			
Goal & Capability	**Mission**	**Data Collected**	
Ecosystems/Living Marine Resource Management	Sea bird studies	Counts of nesting birds	
Commerce & Transportation/Hydrographic Surveying	Hydrographic surveying in support of nautical charting	Reconnaissance data to augment mission efficiency and safety; Light Detection and Ranging (LIDAR) data	

Mission Capabilities

The primary benefit offered by UASs are in the conduct of missions that are *dirty*, *dangerous*, or *dull* - *dirty* because they can be sent to contaminated areas; *dangerous* because they can go into hazardous areas with no threat to human life; and *dull* because they allow for long transit times, opening new dimensions of persistent surveillance and tracking.

Integration Requirements

From ship arrangement/space and infrastructure capability perspectives, the challenges that UAS operations entail include suitable launch and recovery systems, vehicle communications and tracking systems, laboratory, maintenance, and stowage facilities, and possibly increased habitability and habitability support systems.

Phase Differencing Bathymetric Sonar

Phase differencing bathymetric sonar (often referred to as interferometric sonar) is described [59] as being able to provide co-located bathymetry and imagery by accurately measuring depths at precise locations on the seafloor via the use of exactly spaced phase differencing transducer elements which measure the phase offsets of acoustic returns. The phase offset is used to calculate the angle (θ) from which the return was received. The angle, in combination with range based on two way travel time, is used to calculate the position of the seafloor and objects upon it relative to the instrument.

Currently Evaluating Interferometric Sonar			
Goal & Capability	**Mission**	**Data Collected**	**Est. Availability for Fleet Implementation**
Commerce & Transportation/Hydrographic Surveying	Hydrographic surveying in support of nautical charting	High resolution wide swath bathymetry and backscatter imagery in shallow water	3rd Qtr FY 2008
Could Benefit from Interferometric Sonar Use			
Goal & Capability	**Mission**	**Data Collected**	
Ecosystem/Ecosystem Research	Exploration and research could benefit from this technology for mapping and imaging of seafloor features	High resolution wide swath bathymetry and backscatter imagery in shallow water	

Mission Capabilities

Interferometric sonar will allow for targeted bathymetric investigations in shallow water without the need for full area coverage by multi-beam sonar systems. A 2006 report entitled *NOAA Test and Evaluation of Interferometric Sonar Technology*[60] states:

> NOAA currently spends a large portion of its overall hydrographic survey effort obtaining bathymetric data in waters shoaler than 20 meters. Interferometric sonar systems are one tool that may be capable of significantly improving the safety and efficiency of hydrographic survey operations in shoal waters. Interferometers provide high-resolution wide-swath bathymetry in shallow water with swaths of 10 to 15 times instrument altitude; a significant improvement over the typical 3 to 5 times water depth capability of shallow water multibeam.

Integration Requirements

High-frequency high-resolution systems may be mounted on work boats, autonomous vehicles, and vessels of opportunity so that work in shoal waters can be safely and efficiently performed. Larger, low-frequency systems could be mounted on ships' hulls to achieve long-range measurements, but the transmitted power may be injurious to marine creatures. Thus, the primary use of the technology for NOAA's missions is likely limited to high-frequency, smaller systems.

[59] *Efficacy of an Interferometric Sonar for Hydrographic Surveying: Do interferometers warrant an in-depth examination?*

[60] Gostnell, C., Yoos, J., & Brodet, S.

Laser Line Scan

Seafloor habitat research within NOAA typically has concentrated on estuarine and relatively shallow marine waters. Part of the reason this has not been extended to deeper areas is the fundamental difficulty and expense of making detailed, deep-water observations over an area large enough to be relevant to the dynamics of fish populations. Below SCUBA depth (i.e., greater than 30 meters), visual observations must be made either from human-occupied submersibles or from cameras on an ROV. This approach can be time-consuming and expensive, and usually is limited to "representative" small areas. Acoustic surveys by sidescan or multibeam sonar can cover much broader areas and are useful in a number of fishery habitat applications, but they have much lower resolution than direct observations. They can define the distribution of different types of seafloor, i.e., mud, smooth sand, rippled sand, rock outcrops, canyons, etc., but they cannot show the relationship of fish and invertebrates to these habitats. Also, interpretations of the acoustic images must be checked by visual observations, usually from a submersible or ROV.

The challenge is to find a more efficient technique -- one that provides high-resolution information on both the variety of seafloor habitats and the associated marine life, and can cover a large enough area to be statistically useful. Laser line scan technology, an electro-optic imaging technique, may be able to bridge the gap. It provides the efficiency and spatial coverage of a remote survey system at an image resolution approaching that of visual observations.

Currently Evaluating Laser Line Scan Technology			
Goal & Capability	**Mission**	**Data Collected**	**Est. Availability for Fleet Implementation**
Commerce & Transportation/Hydrographic Surveying	Hydrographic Surveying in support of nautical charting	High resolution imagery and bathymetry data	FY 2009
Could Benefit from Laser Line Scan Technology			
Goal & Capability	**Mission**	**Data Collected**	
Ecosystems/Ecosystems Research	Exploration and research could benefit from this technology for mapping and imaging of seafloor features	High resolution imagery and bathymetry data in deep waters	

Mission Capabilities

Laser line scan technology produces high contrast underwater light field images at millimeter to centimeter scale resolution and at two to five times the range of conventional video and photographic systems. Resolution and area covered by the images vary with water quality and tow height above the bottom.

Integration Requirements

Laser line scan technology is more appropriately embarked on towed bodies or AUVs rather than the ship itself. There must be high-power conductive cabling connecting the laser line scan to the vessel, so AUV usage is a conceptual technology. Data management is also an issue for large areas due to the resolution acquired.

CONCEPTUAL DATA COLLECTION TECHNOLOGY

Improvements in Active and Passive Acoustic Detection Systems

NOAA recognizes that acoustic detection systems have played a major role in our ability to conduct more effective and efficient research and, therefore, is continuously monitoring developments in both active and passive acoustics. Examples include:

- The next generation multi-beam sonar system is expected to provide increased data acquisition speeds by allowing for multiple simultaneous sonar pings in the water column.

- Advances in "split-beam" sonars, when combined with those in multibeam echosounders, will create opportunities for advanced detection and classification of sonar targets. This will lead to improvements in algorithms as well as in basic measurements.

- Synthetic aperture sonar is expected to provide long range, wide swath bathymetry data and images, which should improve mapping operation efficiency particularly in the open ocean.

Ship-Mounted LIDAR and Videogrammetry Systems

Side-looking ship-mounted Light Detection and Ranging (LIDAR) and stereographic video systems are expected to provide geo-referenced elevation data and backscatter strength with the potential for automated feature detection and categorization. These systems should enhance current near shore hydrographic techniques by providing more accurate results than visual observations and potentially seamless elevation coverage across the air-water interface.

STATE OF THE ART SHIP INFRASTRUCTURE TECHNOLOGY

Dynamic Positioning System

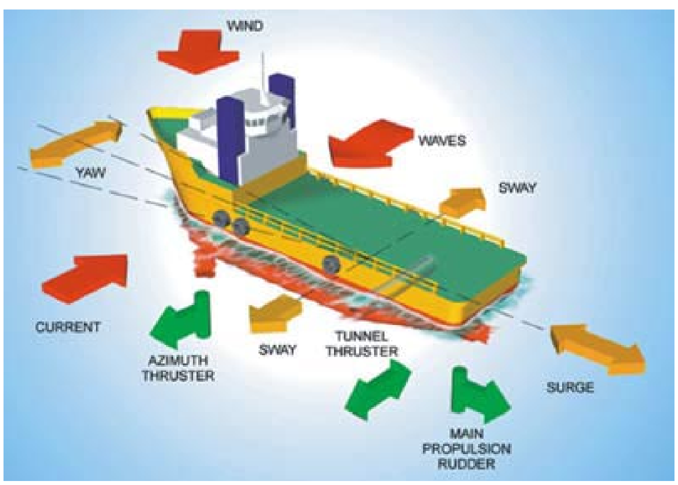


Figure 4. Yaw, Sway, and Surge

Any object has six freedoms of movement. For a ship, movement is described as roll, pitch, yaw, surge, sway and heave. The primary function of a dynamic positioning (DP) system is to automatically control yaw, sway, and surge by integrating the actions of propulsion, rudder control, and bow/stern thruster systems. This allows the ship to maintain position relative to a fixed location or to maintain speed and minimize across track distance without manual analysis and effort (see Figure 4). DP systems are currently installed on fisheries survey vessel (FSV)-class ships and NOAA ships RONALD H BROWN, NANCY FOSTER and OKEANOS EXPLORER.

Mission Capabilities

The ability to accurately maintain position relative to a fixed location or specified track allows researchers to acquire more accurate and precise data in specific areas of interest. Operational DP requirements also include precise control of heading and speed for safe recovery and deployment of current equipment and are expected to be a significant safety-driven threshold for future operations that include autonomous vehicles. To support ROV operations it is a requirement.

Currently Utilizes Dynamic Positioning Systems		
Goal & Capability	**Mission**	**Improved Support**
Ecosystems/Living Marine Resource Management	Missions that require precise movement along transect lines, e.g., fisheries resource assessment surveys; marine mammal surveys	Fish biomass estimates and behavior; marine mammal distribution and behavior
Ecosystems/Ecosystems Research	OKEANOS EXPLORER ROV operations	High Definition video and samples collected by the ROV; safe recovery of equipment in higher sea states
Could Benefit from Dynamic Positioning Systems		
Ecosystems/Living Marine Resource Management	Buoy and boat deployment and recovery operations	Minimize personnel and equipment risk at sea
Commerce & Transportation/Hydrographic Surveying	ROV & AUV deployment and recovery operations	Increased working sea state and safety factor at sea

Infrastructure Requirements

Although a DP system can be installed on an existing ship, the scope of the effort is highly dependent on: (1) power and control assets such as maximum available power, number and size of rudders, number and power of thrusters; (2) expected operating conditions and environmental forces to include expected sea state, wind, and current conditions; and (3) position and track accuracy and precision requirements. The NOAA ship OKEANOS EXPLORER is a good example as the existing tunnel bow thruster was replaced with an azimuthing bow thruster and two stern thrusters were installed. Both installations required substantial work on the hull structure and hydraulic systems and significantly affected the ship's available space and equipment arrangement. For a retrofit installation, maximum available power often limits the performance of the system in some combinations of ship heading and speed and sea state, wind, and current conditions.

Moving Vessel Profiler

The Moving Vessel Profiler (MVP) can automatically deploy instruments into the water column while the vessel is underway. Instruments which can be deployed with a MVP include Conductivity-Temperature-Depth (CTD) sensors, sound velocimeters, fluorometers, transmitometers, and penetrometers. MVPs are available in a range of sizes and configurations, depending on the size of the vessel and deployment depth required. These systems are typically integrated to data acquisition systems using a computer-controlled winch to deploy the sensor to the desired depth at the required periodicity while the vessel is underway. This produces a spatially and temporally denser dataset, and improves efficiency by eliminating the need to stop the vessel to take traditional oceanographic casts. Systems are available in several different sizes and configurations depending upon speed, sensor, and sampling depth requirements. MVPs are typically autonomous using a computer-controlled smart winch and deployment system to deploy the sensor while the ship is underway (see Figure 5 for an example). MVPs are currently installed on NOAA ships THOMAS JEFFERSON and FAIRWEATHER.

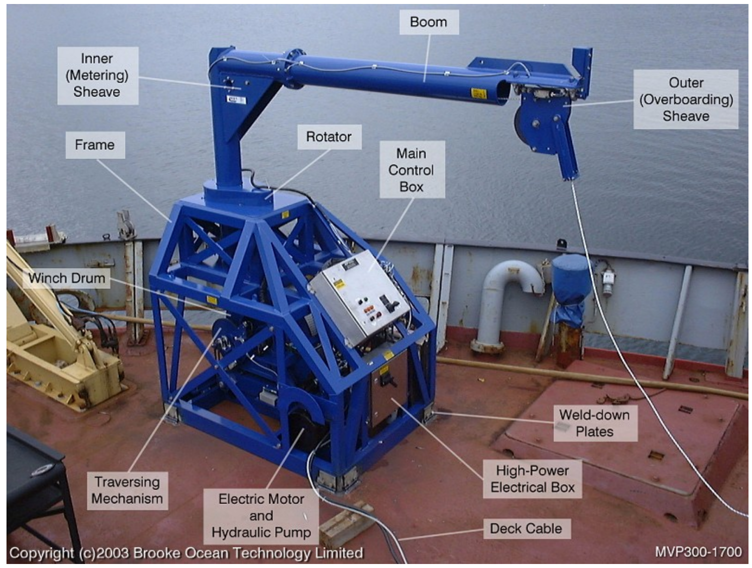


Figure 5. Moving Vessel Profiler

Mission Capabilities

The technology improves mission efficiency by providing near real time deployment without stopping for casts. This reduces or eliminates the need to interrupt research activities for time-consuming traditional casts. If functioning autonomously, the technology serves to extend operations after normal working hours and in expanded environmental conditions with limited crew involvement.

For the Ocean Mapping mission, the use of moving vessel profilers for sound speed casts have been estimated to result in a 12 to 25 percent increase in data acquisition efficiency when utilized on ships engaged in 24 hour operations, and 6 to 19 percent when utilized aboard instrumented work boats (survey launches) conducting survey operations for an eight hour work day[61]. No specific analyses have been identified that quantify the economic benefit of the increased spatial and temporal density of datasets acquired with moving vessel profiler systems, though professional papers indicate that data from high-frequency casts do improve data accuracy[62]. In addition, the integration of MVPs into the multibeam echosounder data systems improves data quality control processes and can thus reduce the overall bathymetric data delivery time.

[61] This estimate assumes that a ship engaged in hydrographic survey operations will stop for a CTD cast every 4 hours (the standard interval for NOAA surveying), and that each CTD cast will result in total time lost from sonar surveying of 30 minutes to 1 hour. For survey launches, the estimate assumes that the launch is working an 8 hour day (typical), will stop for 2 or 3 CTD casts during that time, and that each cast will result in 15 to 30 minutes of lost production.

[62] For example, refer to Hughes-Clarke, J.E, Lamplugh, M, and Kammerer, E. "Integration of near-continuous sound speed profile information" *Proceedings of Canadian Hydrographic Conference*, May 2000.

Currently Utilizes Moving Vessel Profilers		
Goal & Capability	**Mission**	**Improved Support**
Commerce & Transportation/Hydrographic Surveying	Ocean mapping	High temporal and spatial resolution sound velocity profiles for accurate sonar measurements
Ecosystems/Ecosystems Research	Ocean biology, chemistry and physics	Any data which can be collected by *in situ* instrumentation and possibly water samples
Ecosystems/Living Marine Resource Management	Bottom Type Classification / Habitat Characterization	Seabed composition data acquired with free falling cone penetrometer deployed from an MVP[63].
Could Benefit from Moving Vessel Profilers		
Ecosystems/Ecosystems Research Biological or Physical Oceanography		Not-to-interfere data acquisition during other projects, possibly direct off-loaded using satellite transmission capability

Infrastructure requirements

MVPs occupy deck space on the stern of the vessel that can impact other towed equipment, but have been shown to work with side scan sonar and similar sensors. Direct integration with data acquisition systems is required for automated operation, and may allow for off-site control of the system. Integration to multibeam echosounder systems can be difficult, but improves accuracy of data and strengthens quality control processes.

Automated Controls

Every NOAA ship has some sort of control automation, but the implementation of these controls has been inconsistently based on available funding and design era. The systems have improved in concert with computer technology, and as sensor technology has miniaturized, programmable logic controllers (PLCs) are found in every system, from fire detection to fuel manifolds. This has enabled full integration of bridge and engine controls, and a commensurate complication in maintenance even as requisite manning has been reduced per industrial standards and legal requirements for automated systems. Standardization is a key component of staff training, and this is the biggest challenge for fleet operations as additional automated control systems are introduced.

Mission Capabilities

Integrated bridge and engine controls enable a reduced staffing model per American Bureau of Shipping (ABS) and international standards. Full integration of these controls is usually performed by value added resellers for various manufacturers and is common in the commercial sector where an on-the-job training mission is not part of the traditional operation. However, the additional complication of PLC-based

[63] Refers to use of MVP for penetrometer deployment from NOAA ship FAIRWEATHER during 2006 "FishPAC" cruise in the Bering Sea.

controls requires significant training, integration of shipboard staff into the installation process, and attention to retention of staff to ensure complete success. As an example, the NOAA ship RAINIER has successfully updated the original "automated" engine control system from 1967 to a PLC-based monitoring and control system through careful attention of the chief engineer and his staff to the requirements for user interface and failure recovery modes.

Currently Utilizes Automated Control Systems		
Goal & Capability	**Mission**	**Improved Support**
Ecosystems/Ecosystems Research	High-berth requirement scientific missions that require reduced ship staffing	Reduced manning and risk of mechanical failure modes
Commerce & Transportation/Hydrographic Surveying	Hydrographic surveying in support of nautical charting	Reduced manning and risk of mechanical failure modes
Could Benefit from Automated Control Systems		
All	High-berth requirement scientific missions that require reduced ship staffing	PLC-based controls are more efficient and highly reliable with proper staffing

Infrastructure Requirements

Hiring and retaining expert staff for older ships and older mechanical plants is difficult for several reasons, including the major reason of lack of career progress when using antiquated equipment. These staffs have significant impact on the efficiency with which the ship is operated. Migration to modern PLC-based automated control systems not only improves the equipment's efficient monitoring and control by reducing staff, but also encourages those staff to stay with NOAA and build additional expertise that benefits all mission accomplishment.

Ice Strengthening

Ice strengthening allows operations in high latitude areas where multi-year or first-year ice is expected, as shown in Table W. ABS has established ice classes which determine the extent of strengthening required and the ice conditions and times of year suitable for operations. Modern NOAA research ships (e.g., FSV 40 class) are strengthened to ABS ice class C0 which requires structural strengthening of the bow, amidships, and stern and limits year around operations to water with first-year ice within specific mean area ice density ratios. NOAA ships RAINIER and FAIRWEATHER are not ice classed under ABS, but were built with some ice strengthening by reducing the frame spacing in the bow. This permits bathymetric data acquisition in Alaskan waters where ice calved from retreating glaciers is too thick for survey launch operations. Glaciers have seasonal increases in calving rate due to temperature and rain rate, and strengthened hulls allow for improved operational efficiency by not limiting data acquisition to the winter stormy season.

Mission Capabilities

Ice strengthening extends the range of a ship's research capabilities into areas that may not be accessible due to storm conditions at other times of the year, allowing examination of unique species, habitats, geographic features, and other items or issues of interest. No analyses have been identified that quantify the economic benefit of ice strengthening.

Currently Requires Ice Strengthening		
Goal & Capability	**Mission**	**Improved Support**
Commerce & Transportation/Hydrographic Surveying	Bathymetric mapping in ice-laden Alaskan waters	Reduced risk to vessel and increased data acquisition
May Require Ice Strengthening		
Commerce & Transportation/Hydrographic Surveying	Western Alaska, Arctic and Bering Seas	Mapping the areas free from summer sea ice as arctic condition warm

Infrastructure Requirements

Depending upon ice thickness expected and ABS class requirements, the ship's hull structure and plating must be increased. In addition, increased protection for the rudder, propeller, and other appendages may have to be provided. The commensurate increase in ship's mass drag may also impact propulsion requirements. For these reasons, ice strengthening is rarely retrofit and NOAA will limit this capability to new construction ships.

Tele-Presence

More than 20 years ago, Dr. Robert Ballard envisioned a new way of conducting oceanographic exploration where the scientists no longer needed to leave their institutions. Using high-bandwidth satellite communications, video and sensor data can be transmitted in real-time from oceanographic research vessels at sea to specially designed Remote Science Consoles (RSC) installed at institutions around the country. Scientists participate from shore as they would if they were on the research ship - a concept called "tele-presence".

"Tele-presence," as envisioned by Dr. Ballard, is at the high end, customized solution that combines Very Small Aperture (VSAT – a two way satellite mobile earth station with a dish antenna that is typically smaller than 3 meters) satellite communication technology with high- definition video broadcasting technology to transmit real-time video and data from ship to shore for trouble shooting, quality control or analysis. NOAA ships currently utilize commercially available mobile VSAT satellite communication systems to transmit scientific data for quality checking, replicate shipboard maintenance data to shore, exchange real-time weather observation information and access land-based network shares and internet services.

Mission Capabilities

In collaboration with the Institute for Exploration (IFE), NOAA has embarked a portable "tele-presence" system onboard NOAA ships to transmit images from ROV operations to shore. The first dedicated NOAA "tele-presence" system will be installed on the NOAA ship OKEANOS EXPLORER and is expected to be operational in late spring/early summer of 2008. This "tele-presence" system will be used in two different operating modes: Exploration Mode and Intensive Investigation Mode. The intent during Exploration Mode is to use the ship's multibeam echosounder system, oceanographic sensors, ROV and camera sled to efficiently and effectively scan the ocean floor searching for features of interest. After a feature of interest has been identified and deemed worthy of further investigation, the vessel switches to the Intensive Investigation operating mode. The primary difference between the two operating modes is the use of the ship's Very Small Aperture Terminal communication system and how that system facilitates shore-based participation. During Exploration Mode the shipboard VSAT will operate with reduced bandwidth (typically less than 1.5 Mbps data rates), however during the Intensive Investigation Mode, the shipboard VSAT will operate at much higher data rates (typically up to 45 Mpbs) in order to transmit data, high-definition images and video from the ship's multibeam echosounder system, employed ROV and the other shipboard sensors and cameras are transmitted in real-time to shore for scientific analysis at the RSCs for scientific analysis.

Currently Utilizes "Tele-Presence"or VSAT Data Transmission		
Goal & Capability	**Mission**	**Improved Support**
Ecosystems/Ecosystems Research	Public Outreach and reduced staffing complement at sea	High-definition video, raw data from sensors, and improved communications sent to shore
Ecosystems/Living Marine Resource Management	Fisheries abundance surveys	Catch information provided real-time to the commercial fishing industry
Could Benefit from "Tele-Presence" or VSAT Data Transmission		
Commerce & Transportation/Hydrographic Surveying	Marine weather observations	Automated real-time weather for improved marine forecasts
Commerce & Transportation/Hydrographic Surveying	Bathymetric mapping for nautical charting.	Bathymetric data and sonar imagery transmitted for data review and product compilation

Infrastructure Requirements

The "tele-presence" system itself is comprised primarily of computers and other electronic components and displays that are typically mounted in racks or on bulkheads in an operations area. For the OKEANOS EXPLORER, the "tele-presence" system components will be installed in the ROV/Mapping Control Room and the adjacent Rack Room. The system is integrated with ship sensors (e.g., ROV and mapping computers) and a VSAT antenna sized to transmit sufficient bandwidth to support system requirements. The fact that scientists can participate and contribute in real time without being embarked on the ship suggests some obvious economic benefits. First, fewer at-sea berths may be required, depending upon other mission requirements. Second, and possibly more important, is the value of additional research opportunities; the research that can be conducted by scientists on-shore when not engaged in "tele-presence" activities, and the availability of scientists for research that does not require weeks away from the office. Finally, this may provide future opportunities to streamline operational mapping by allowing hydrographic scientists ashore to review data and compile products in near real time.

To enable vessels to efficiently and effectively perform scientific missions, all new ships should be outfitted with VSAT systems. In addition, "tele-presence,' as envisioned for the OKEANOS EXPLOXER, is a candidate for installation on new construction ships and could be a candidate for retrofit on existing ships assuming the ship has suitable space and can accommodate the VSAT antenna.

Instrumented Work Boats

Almost every NOAA ship has at least one work boat, and some ships have several. These boats are used for a variety of purposes from basic transportation to diver support to data acquisition. As computer technology and sensor technology have miniaturized, work boats have been outfit with a variety of sensors similar to those found on the ships, such as multibeam and split-beam echosounders, passive acoustic arrays, and meteorological sensors. Data can be transmitted back to the primary research ship for real-time data integration, analysis, and adaptive sampling.

Mission Capabilities

Instrumented work boats allow extension of research by adding sensor capacity, and can effectively improve access to nearshore and shoal areas. Depending upon the staffing and number of boats available, each vessel increases the cost effectiveness of a ship by a significant fraction by acting as a force multiplier[64] to increase data acquisition capacity once a ship has reached its working area.

Currently Utilizes Instrumented Work Boats		
Goal & Capability	**Mission**	**Improved Support**
Ecosystems/Living Marine Resource Management	Remote observations of animal abundances and movement patterns; physical and biological oceanographic conditions; active sensors (video, still, acoustic)	Small nets for added physical sampling over time and space; acoustic samples over a wide area; highly maneuverable vessel
Commerce & Transportation/Hydrographic Surveying	Hydrographic surveying in support of nautical charting	Added capacity on project, and in areas that would be unsafe for the ship to navigate due to proximity to hazards and unknown bathymetry areas
Could Benefit from Instrumented Work Boats		
ALL	High-resolution *in situ* sampling in areas that ships cannot navigate	Spatially diverse data acquisition aboard small boats is less expensive than ships

Infrastructure Requirements

Although a conceptually simple installation, work boats have a significant impact on ship staffing, space, stability, distributed mechanical (typically hydraulic), and electrical systems. Fuel and human waste systems must be compatible with the ship's, and other support services, from galley operations to bridge and aft-deck working arrangements, are likely to be affected. The concept of operations must be tuned to the mission to be accomplished, the environmental conditions, and the staffing model.

[64] "Force Multiplier" is defined as an additional asset or platform used to optimize an existing platform by adding additional sensor deployment capacity.

DEVELOPING SHIP INFRASTRUCTURE TECHNOLOGY

ICES Acoustic Quieting

The International Council for the Exploration of the Seas (ICES), the oldest intergovernmental organization in the world concerned with marine and fisheries science, has developed acoustic quieting standards for survey ships aimed at reducing both flow noise over acoustic transducers and ship noise transmitted into the water. ICES contends *fish show an avoidance reaction to vessels when the radiated noise levels exceed their threshold of hearing by 30 dB or more* and *scientific echo-sounders … need to work in a low noise field if full benefit is to be gained* [65]. Although not all researchers agree that acoustically quiet research ships are effective in reducing fish avoidance for all species. The Ona et al study in 2007 only considered one species (herring) in one area.[66] More thorough analysis is required to better understand these effects.

Although some NOAA research ships were originally built with some level of sound quieting (specifically, former Navy T-AGOS ships) and other NOAA ships have been modified to improve some aspect of sound quieting (e.g., low cavitation propeller on the MILLER FREEMAN), fisheries survey vessel (FSV)-1 class ships are the only NOAA research ships that meet ICES standards for acoustic quieting above three knots (GUNTER meets the ICES curve at three knots and below). The following table identifies capabilities and specific research missions currently supported or planned to be supported by these acoustically quiet ships as well as other existing or future goal and capability and research missions that could benefit from acoustically quiet ships.

Currently Supported by ICES Acoustically Quiet Ships		
Goal & Capability	**Mission**	**Improved Support**
Ecosystems/Living Marine Resource Management	Fisheries resource assessments	Better fish biomass estimates and behavior; krill and other micro-zooplankton estimates due to increase in signal-to-noise of acoustics
Ecosystems/Living Marine Resource Management	Marine mammal assessments	Marine mammal distribution and behavior is less disturbed
Could Benefit from ICES Acoustically Quiet Ships		
Ecosystems/Living Marine Resource Management	Individual marine mammal identification, tissue sampling, behavior studies, and tagging	Marine mammal pregnancy status, vital statistics, foraging tactics, and movement patterns less disturbed by vessel presence
Ecosystems/Living Marine Resource Management	Additional fish and marine mammal and bird species surveys	Predator/prey dynamics not disturbed by vessel presence
Commerce & Transportation/Hydrographic Surveying	Hydrographic surveying in support of nautical charting	Improved sonar measurements through increase in signal-to-noise of acoustics

[65] 1995 ICES Cooperative Research Report on Underwater Noise of Research Vessels (CRR 209)

[66] Ona, E., Godø, O, Handegard, N., Hjellvik, V.,Patel, R, & Pedersen, G. (2007). Silent research vessels are not quiet. *Journal of the Acoustical Society of America*, 121(4).

Mission Capabilities

A major source of uncertainty in collecting data on pelagic and semi-demersal species is the potential for a behavioral reaction by the organisms to the vessel. Stimuli that may initiate a behavioral response may be acoustic (radiated ship noise), visual or changes in water pressure, and particle motion. An acoustically quiet ship reduces noise at frequencies known to disturb surveyed fish (less than about 1 kHz), thereby reducing avoidance reactions of fish or marine mammals, and has the potential to benefit fishery-independent fish surveys, gear research, and habitat assessments. Benefits in limiting avoidance reactions may be species-specific.

Equally as important, an acoustically quiet ship enhances the capability of both active and passive acoustic detection systems through an increase in the signal-to-noise ratio which increases detection ranges and improves robustness of the detection solution. Active acoustic detection systems are increasingly used throughout NOAA for seafloor and habitat mapping, underwater object detection and evaluation, and marine mammal and fish biomass assessments.

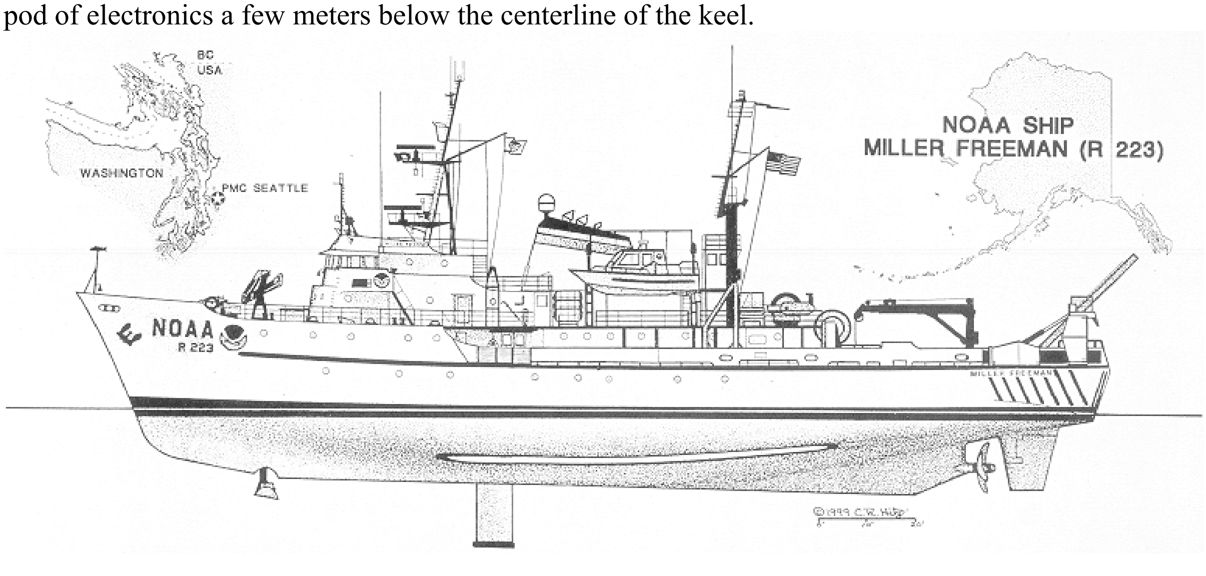
NOAA has assessed the economic benefits accruing from acoustically quiet ships. This assessment estimates the reduced value of data stemming from the use of non-quiet ships to quantify the incremental benefits of new construction ships with acoustic quieting. The reduced value of data is calculated as a fractional decrease in the value of benefits derived from selected marine protected species, commercial fisheries, and saltwater angling due to lower quality data available to manage the fish and mammals. The analysis is described in more detail in Chapter 12 of this plan.

Infrastructure Requirements

This technology is suitable for only new construction ships since it involves many aspects of the ship. Primary factors include the design of the hull form, rudder(s) and other appendages, propellers(s), propulsion motors, and connections to sea. In addition, the application of acoustic insulation to the interior of the ship and sound-proof mounting of ship systems and equipment increases the maintenance workload for the crew and requisite repair time in port.

Extensible Centerboards

The NOAA ship MILLER FREEMAN and the new FSV have extensible centerboards that place a large pod of electronics a few meters below the centerline of the keel.



Currently Supported Extensible Centerboards		
Goal & Capability	**Mission**	**Improved Support**
Ecosystems/Living Marine Resource Management	Fisheries resource assessments	Better fish biomass estimates and behavior; krill and other micro-zooplankton estimates due to increase in signal-to-noise of acoustics
Ecosystems/Living Marine Resource Management	Marine mammal assessments	Marine mammal detection is improved by increased signal-to-noise in the passive array on a centerboard
Could Benefit from Extensible Centerboards		
Commerce & Transportation/Hydrographic Surveying	Hydrographic surveying in support of nautical charting	Improved sonar measurements through increase in signal-to-noise of acoustics

Mission Capabilities

These have been shown to improve acoustic performance of the embedded sensors, thus increasing data quality and refining the scientific goals. Installation of multibeam echosounders and other sensors on large centerboards would reduce the data measurement errors associated with sound velocity near the surface warming layer and improve lateral trackline stability of the survey vessel.

Infrastructure Requirements

These are large systems that cannot be retrofit to an existing ship, but a similar pod-based fairing has been used for multibeam echosounders in both NOAA and the commercial fleet. Centerboards can require shortened maintenance intervals.

BioFuel/Lubricant Conversion

Great Lakes Environmental Laboratory (GLERL) successfully transitioned its small fleet to biologically-based fuel and lubrication[67], which is uncommon in the marine industry. In addition, extensive operational investigation was done in 2006 for use on the NOAA ship NANCY FOSTER. The RAINIER switched to biodegradable lubricant in major systems in 2007. As noted in the GLERL case, diesel-powered vessels emit heavy pollutants visible in high-profile areas, especially sanctuaries. Older propulsion systems operating in warmer waters can accept partial biodiesel without extensive conversion costs. Current cost for biodiesel is slightly more than standard diesel, (approximate increase of $50,000 per year for the NANCY FOSTER), but the advantages are clear---less emissions and exposure to scientists and crew, and less adverse publicity risk when working near high-density population centers or zero discharge zones. Biodiesel is most applicable to fueling in warmer climates and infrastructure is available in the US Virgin Islands, southeastern coast and Gulf of Mexico.

Currently Supported by BioFuel/Lubricant Conversion		
Goal & Capability	**Mission**	**Improved Support**
Ecosystems/Living Marine Resource Management	Great Lakes water quality	Reduced particulate emissions
Commerce & Transportation/Hydrographic Surveying	Hydrographic surveying in support of nautical charting	Reduced risk of lost sea days due to controllable pitch propeller seal loss

[67] EPA BioFuel discussion of GLERL effort is found at http://www.epa.gov/cleandiesel/ports/casestudies.htm#glerlb

Could Benefit from BioFuel/Lubricant Conversion		
ALL	Climate & Water studies	Especially useful when reduced particulate emissions are warranted

Mission Capabilities

The NOAA ship RAINIER lost several weeks of production in 2004 when an emergency dry dock was scheduled to address a severe leak in the controllable pitch propeller hydraulic control system. This leak caused a small slick each time the system was operated, and had to be mitigated as quickly as possible. This caused significant loss of production in the middle of the summer high-production survey season. At the next normal dry-dock repair availability, the RAINIER migrated to a biodegradable lubricant to remove the recurring risk of a controllable pitch propeller hub leak.

GLERL's first trial of biodiesel was in June of 2000 onboard the R/V Shenehon, a 67-foot ex-Army T-boat built in 1952. The ship's configuration included a new (1999) Caterpillar 3406 main diesel, and two Cummins generators (1970 vintage). All engines are dry exhaust, allowing for easy emission testing. The initial load of 700 gallons was a 20 percent blend (B20). Immediate reductions in visible stack emissions, smoke and a less offensive odor, with unchanged performance of the main engine or generators, warranted an increase to a pure biodiesel (B100) trial. A load of B100 was taken the next month and extensive system evaluations were conducted. Over the next five years the ship operated on more than 8,000 gallons of B100 with the exception of the last fuel delivery each fall and two instances when bio-product was not readily available. This addressed the cold flow and storage limitations during the winter months but also proved that intermittent use of petroleum diesel was invisible to operation or equipment. However, scientists onboard were quick to complain of the return to the noxious diesel odor.

Infrastructure Requirements

Significant fueling capacity for the fleet in a variety of locations, especially in Alaska and the Pacific, is the primary limitation to widespread use of this technology. As biofuels become more available, transition to partial biofuel and eventual 100 percent biofuel usage is possible. Some of the technical limitations are maintenance-based, with different requisite oil-change intervals, oil sump heating requirements, and training for personnel at the forefront.

Zero Discharge Marine Sewage Systems

The Environmental Protection Agency and state departments that regulate environmental quality are creating No Discharge Zones (NDZ) that requires holding tanks for most marine vessel operators. Black water (sewage) and grey water (galley, shower, sinks) are generally handled separately in practice, but are combined in this legislation. Grandfather clauses are increasingly stricken, and all vessels built since 1980's Clean Water Act must meet the more stringent international and domestic regulations. Type III Marine Sewage Devices (MSD) for marine use are typically holding tanks due to low cost, but new systems similar to municipal wastewater treatment systems will be required for many NOAA vessel operations.

Possible Requirement for Zero Discharge Systems		
Goal & Capability	**Mission**	**Improved Support**
Ecosystems/Living Marine Resource Management	Resource assessments in marine sanctuaries	NDZ prevent efficient fleet access

Possible Requirement for Zero Discharge Systems		
Ecosystems/Living Marine Resource Management	Marine mammal assessments	Marine mammal distribution and behavior is less disturbed

Mission Capabilities

Zero discharge of black and grey water is a significant limiting factor in deployment of vessels. The NOAA ship RUDE can no longer work in Long Island Sound, New York, due to the lack of approved MSD aboard the vessel and no space for a holding tank. The NOAA ship HI'IALAKAI is similarly restricted from long-term operations within the Northwest Hawaiian Island area, and must transit outside the boundaries of the National Monument periodically to evacuate the Type II MSD. If the existing Type II systems were replaced with Fixed Activated Sludge Treatment (FAST), similar to the new construction FSV-class, then the ship could operate in this area.

Infrastructure Requirements

Fixed Activated Sludge Treatment (FAST) are polymer based panels that make it practically no-maintenance[68] according to marketing, but NOAA experience has not yet shown this to be true. MSD systems in general require regular and systemic maintenance to ensure reliable operation within environmental regulations.

CONCEPTUAL SHIP INFRASTRUCTURE TECHNOLOGY

Unmanned Aerial, Surface, and Underwater Systems

Unmanned sensors in the air and sea hold great promise for extending observations to a greater footprint around a deployed vessel. These systems can either hold data for download upon return to the mother craft, or transmit data in real-time for continuous adaptation to operational requirements. As untethered sensors, these systems provide a force multiplier of data per ship.

Could Benefit from Unmanned Systems		
Goal & Capability	**Mission**	**Improved Support**
Commerce & Transportation/Hydrographic Surveying	Ocean mapping	Wide temporal and spatial resolution sound velocity profiles for accurate sonar measurements
Ecosystems/Living Marine Resource Management	Tracking biological and oceanographic properties	Marine mammal pregnancy status, vital statistics, foraging tactics, and movement patterns less disturbed by large vessel presence
Ecosystems/Living Marine Resource Management	Additional fish and marine mammal and bird species surveys	Predator/prey dynamics not disturbed by vessel presence; force multiplier
Commerce & Transportation/Hydrographic Surveying	Hydrographic surveying in support of nautical charting	Improved sonar measurements through increase in signal-to-noise of acoustics

[68] FAST system description in marketing literature http://www.biomicrobics.com/downloads/FAST_Brochure.pdf

Mission Capabilities

Joint research with academic and military users of these technologies indicates that a wide variety of geospatially-reference data observations are possible. Video, audio, air sampling, active and passive acoustics, active and passive light (LIDAR and hyperspectral) and other missions have already been performed across government in research settings.

Infrastructure Requirements

Operational usage requires sustainability of the vehicles, sensors, staff, and data. Thus, vehicles must be recoverable, maintainable, and repairable in the real environmental conditions found days or further from shore support. Sensors, including spare sensors, must be available and field-serviceable. Field staff, including ships' crews, must be trained appropriately for the missions and operational deployment and recovery of the systems. Finally, data must be managed in standards-based systems that allow for full scientific usage and, in combination with other systems, such as tele-presence, be archived as soon as possible off-site.

Conclusion

In order to build the most capable NOAA fleet of the future, ships must be able to not only accommodate existing and developing technologies but also *unimagined* technologies for data acquisition and dissemination. The ships of the future need to be adaptable and extensible to provide the infrastructure and capabilities to evolve with future changes in technology and mission requirements. NOAA ships constructed 40 years ago are today carrying sensors and performing missions unforeseen when the vessels were designed, and experience has shown that the vessel lifecycle is significantly longer than the scientific technology lifecycle. NOAA Ships RAINER and FAIRWEATHER, for example, constructed to carry launches capable of sextant-based positioning of acquired soundings using single-beam echosounders and lead lines, now carry shallow-water multi-beam systems and large data storage and processing systems (with attendant power and cooling capacity) which had to be retro-fitted to the ships ten years ago. Furthermore, the cost and complexity of adapting vessels to new scientific technology in the future will increase with the degree to which they were originally specialized for specific instrumentation systems. While it is impossible to predict all future advances in technology, new ships should provide the infrastructure, i.e. mission and berthing space, power and endurance, to maintain expertise that supports efficient operations. It is also important to provide the "hooks" to accommodate evolving requirements and increasingly sophisticated and sensitive technology consistent with NOAA's fundamental sea-going missions while not limiting the potential use of the ships due to environmental or regulatory requirements.

Chapter 10

DEFINING THE SCOPE OF RECAPITALIZATION

NOAA took the following four steps in determining the scope for the NOAA Ship Recapitalization Plan:

1. Definition of time period for ship recapitalization planning
2. Development of requirements groups based on current ship condition and regional requirements
3. Assessment of ship condition, capacity and capability of the ships within these requirements groups at "status quo"
4. Identification of the alternatives for each requirements group

1. Defining the time period of the ship recapitalization plan

Ship recapitalization planning considers assets and requirements beginning in FY 2010 and extends to FY 2024. FY 2010 is the earliest year capital investment funds could be available in the federal government budget process. The scope of the plan ends in FY 2024, consistent with a 15 year scope for planning, budgeting and capital asset life cycle considerations. Ship acquisition - from identification of investment need to delivery of the new ship - could take up to10 years. Fifteen years shows new ship acquisition decisions reflected in the plan and how those assets would affect agency performance.

2. Determining Requirements Groups

During the period FY 2010 to FY 2024, the service lives of ten active NOAA ships will end if additional capital funds are not invested for service life extensions and major repair periods. The requirements currently met by those NOAA ships were identified. These requirements were organized into specific requirements groups based on the current ship's condition and regional requirements for at-sea data and ship operating days. These ten ships collect data to support fish stock management, coral reef monitoring, marine mammal protection, climate and weather forecasting, and hydrographic products and services.

The operating day requirements presently met by the ten active ships were organized into ten requirements groups. The ten requirements groups included in the scope of the FY 2010 to FY 2024 Ship Recapitalization Plan are identified as follows:

DEFINITION OF TEN REQUIREMENTS GROUPS

Requirements Group	Current Ship	Capability	Operational Area
Group 1	DAVID STARR JORDAN	Living Marine Resource Management	Pacific West Coast Eastern Tropical Pacific
Group 2	OREGON II	Living Marine Resource Management	Gulf of Mexico and Atlantic
Group 3	MILLER FREEMAN	Living Marine Resource Management	Alaska & High Arctic
Group 4	RAINIER	Hydrographic Surveying	Alaska & Pacific Northwest
Group 5	HI'IAKAKAI	Coral Reef Conservation & Living Marine Resource Management	Pacific Islands
Group 6	MCARTHUR II	Living Marine Resource Management	Pacific Northwest, West Coast, Tropical Pacific
Group 7	OSCAR ELTON SETTE	Living Marine Resource Management	Pacific Islands
Group 8	KA'IMIMOANA	Climate Observing and Analysis	El Niño & Southern Oscillation/Equatorial Pacific
Group 9	GORDON GUNTER	Living Marine Resource Management	Gulf of Mexico, Atlantic, Caribbean
Group 10	FAIRWEATHER	Hydrographic Surveying	Alaska & Pacific Northwest

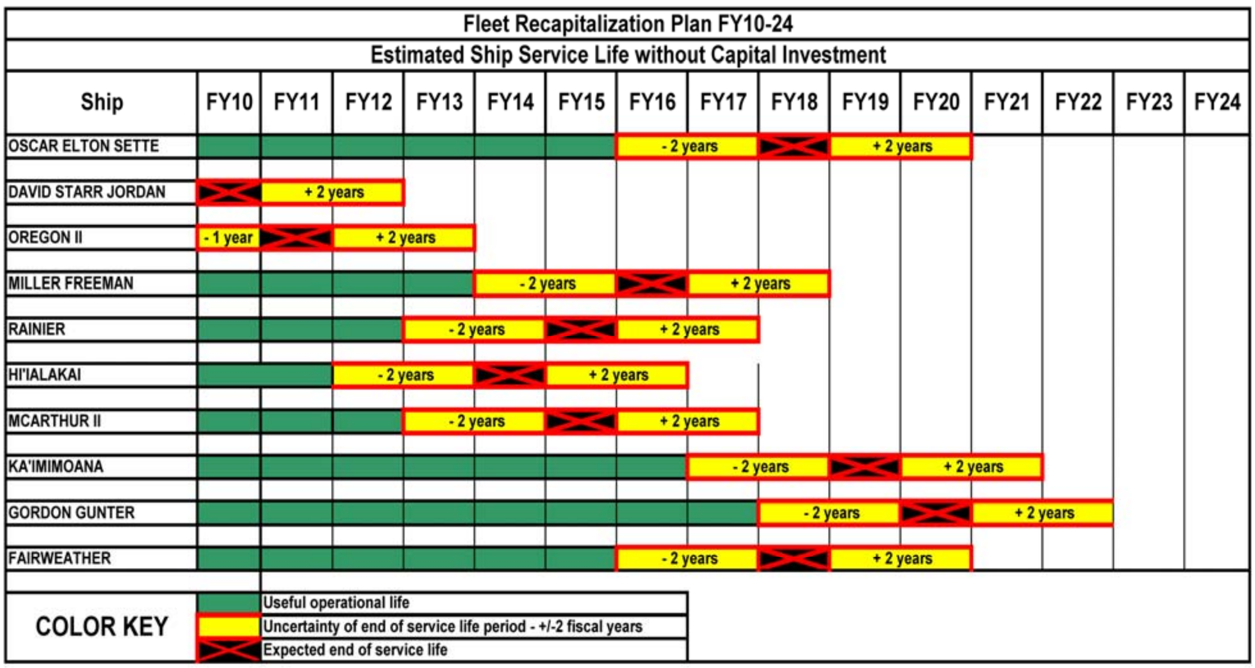
3. Assessing ship condition, capacity and capability of the ships in the requirements groups at Status Quo

"Status Quo" describes the current state of material condition, capacity and capability for the ten requirements groups. The current state assumes static operational funding and no capital investment in NOAA ships from FY 2010 through FY 2024 except for hydrographic launches, technology refreshment and ship equipment already supported through NOAA's budget planning process.

Current Ship Condition

As discussed in Chapter 8, most ships in the NOAA ship fleet were designed with notional service lives of 20 to 25 years, but NOAA ships' useful services lives have historically been 30 years or longer due to regular scheduled maintenance and capital investments. When the ships reach 50 years of service life; however, NOAA recommends they be retired, consistent with the American Bureau of Shipping (ABS), University-National Oceanographic Laboratory System (UNOLS), Coast Guard and Navy ship condition standards.

As shown below, ten NOAA ships presently supporting the ten requirements groups will reach or exceed their 30 year useful service life during the period form FY 2010 to FY 2024.



Ship age serves as a good proxy for ship condition and risk associated with the operation of a ship. Other Indicators of increased risk and deteriorating condition include rising maintenance costs or increased interruptions to ship operations, measured in lost operating days, due to equipment or machinery problems. The operating days lost due to maintenance and repairs for each of the NOAA ships in the ten requirements groups are shown in Appendix C.

NOAA ships as a whole show a trend of increasing maintenance costs (illustrated in Chapter 8); however, nine out of the ten ships analyzed in this plan show no definitive trend of increasing costs or increasing number of interruptions to ship operations. Ignoring the dry dock extensive routine maintenance done every few years, KA'IMIMOANA is the only ship that shows a trend of increased maintenance funding on a year to year basis. There appears to be no correlation between rising maintenance costs and operating days lost on an annual basis. The results of the condition assessment of all ships indicate no consistent relationship between operating days lost and maintenance funding, even for the oldest ships, and therefore does not provide reliable indicators for measures of risk.

NOAA completes regular ships inspections and records those results in Material Condition Assessments (MCA). From the condition assessments for the ships in the ten requirements groups, several patterns of age-related condition effects materialize. There are four issues that relate to ship material condition assessment: (1) ship structure (scantling) and hull plating wastage, (2) electrolysis[69], (3) aged machinery, and (4) presence of hazardous materials. Figure 10.3 provides a summary of which ships represented in the ten Requirements Groups show a history of age-related issues that represent either a substantial risk or liability to continued safe operation.

SUMMARY OF SHIP CONDITION ASSESSMENT OF TEN REQUIREMENTS GROUPS

Requirements Group	Current Ship	Ship age in FY 2010	Plate & Scantling or Piping Corrosion	Electrical Systems / Electrolosis	Machinery & Equipment	Hazardous Materials
Group 1	DAVID STARR JORDAN	45	X	X	X	X
Group 2	OREGON II	43	X	X	X	X
Group 3	MILLER FREEMAN	43	X	X	X	X
Group 4	RAINIER	42	X	X	X	X
Group 5	HI'IALAKAI	26	X		X	X
Group 6	MCARTHUR II	25	X		X	X
Group 7	OSCAR ELTON SETTE	22			X	X
Group 8	KA'IMIMOANA	21	X		X	X
Group 9	GORDON GUNTER	20			X	X
Group 10	FAIRWEATHER	42	X	X		X

Ship Capacity

Current capacity from FY 2010 through FY 2024, as summarized in Figure 1, details the operating days these ships could accomplish at the current budget level.[70] The assumption behind this is that at the end of the service life of each ship, the operating and maintenance funds saved by taking the ship out of service would then be used to charter for a ship of equal capability. Previous charter vessel costs have often been higher then the cost of ship operating days. The result is ship capacity decreases from 1,858 operating days in FY 2010 to 1048 operating days in FY 2024 as depicted in Figure 1.

[69] Electrolysis occurs in areas of the propeller and along the waterline and is of particular concern on aging ships. Stray current from ship's electrical equipment causes corrosion to occur over extended periods or when equipment malfunctions.
[70] The methodology and rationale behind the projected capacity is included in Appendix D

NOAA OPERATING DAY CAPACITY STATUS QUO - No Additional Capital Invesment															
	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Ship															
JORDAN	196	offline													
OREGON II/PISCES	196	193	193	193	193	193	193	193	193	193	193	193	193	193	193
FREEMAN	196	193	193	193	193	193	193	70	110	110	110	70	110	110	110
RAINIER	94	193	193	193	193	193	87	87	87	87	87	87	87	87	87
HI'IALAKAI	196	193	193	73	117	117	117	58	117	117	117	58	117	117	117
MCARTHUR II	196	193	193	193	73	117	117	117	59	117	117	117	59	117	117
SETTE	196	193	193	193	193	193	193	70	110	110	110	70	110	110	110
KA'IMIMOANA	196	193	193	193	193	193	193	193	193	120	120	120	120	120	120
GUNTER	196	193	193	193	193	193	193	193	193	69	107	107	107	96	107
FAIRWEATHER	196	193	193	193	193	193	193	193	193	87	87	87	87	87	87
Total	**1858**	**1737**	**1737**	**1617**	**1541**	**1585**	**1479**	**1174**	**1255**	**1010**	**1048**	**909**	**990**	**1037**	**1048**

Figure 1. Summary of Ship Capacity at Status Quo

Ship capacity is defined as the amount of time available for collecting data in support of NOAA's requirements. Capacity in this plan is defined in terms of ship operating days. Status quo performance, described by the capacity for the ten requirements groups at their current state in FY 2010, FY 2017 and FY 2024 (without additional investment), is summarized in the table below. In FY 2010 all ships in the assessed requirements groups are operating. In FY 2017, NOAA ships supporting six out of ten requirements groups continue operating. In FY 2024 none of the requirements groups in this plan will be supported by NOAA ships. The planned operating days for FY 2024 will be accomplished by using the operations and maintenance funds currently used to operate NOAA ships to pay for operating days provided by chartered ships. Without additional investment, by FY 2024 ship operating days will decrease by 44 percent and NOAA's Government Performance and Results Act (GPRA) results will be negatively impacted due to the inability to adequately collect at-sea data.

Ship Capacity Summary at Status Quo within the Ten Requirements Groups			
Performance Indicators	**FY 2010**	**FY 2017**	**FY 2024**
Operating Days	1858	1255	1048 (all chartered)
# of NOAA Ships Operating	10	6	0
Ecosystem/Living Marine Resource Management GPRA Impact	43 Adequate Stocks Assessed, 72 Adequate PRs Assessed	Less than 43 Adequate Stocks Assessed, Less than 43 Adequate PRs Assessed	Less than 43 Adequate Stocks Assessed, Less than 43 Adequate PRs Assessed
Ecosystem/Coral Reef Conservation GPRA Impact	Ability to Transit to Coral Reef Jurisdictions	Ability To Transit to Coral Reef Jurisdictions	Inability to Transit to Coral Reef Jurisdictions
Commerce & Transportation GPRA Impact	Adequate Number of SNMs Accomplished	Adequate Number of SNMs Accomplished	Inadequate Number of SNMs Accomplished
Climate GPRA Impact	Ability to Deploy/ Maintain Drifters, Moorings	Ability to Deploy/ Maintain Drifters, Moorings	Inability to Deploy/ Maintain Drifters, Moorings

Ship Capability

Ship capability includes instrumentation, mission support equipment and some design and configuration factors that provide the ability for ships to meet at sea data requirements. Figure 2 provides a summary of the capabilities of the NOAA ships included in the ten requirement groups. The twenty six capabilities were defined by ship support staff and their current customers.[71] Capabilities are listed in order of data acquisition systems, mission support systems and emerging technology. Capabilities are assumed to degrade over time due to technology obsolescence and/or antiquated ship support systems. The true impact of age and obsolescence on current capability could not be quantified due to the high level of uncertainty over the next 15 years.

The ships' capability scores (as of FY 2008) are assigned as:

- Zero: the capability is absent
- One: the capability is present
- Two: extensive capability is present as defined under its parameters

[71] Definitions of all capabilities are provided in Appendix E

Ship Capability Matrix - Current Fleet										
Assessing Current Ship Capability to Meet Mission Requirements where additional capital investment may/maynot be needed										
Capability	**M2**	**DJ**	**FA**	**GU**	**HA**	**KA**	**R2**	**SE**	**RA**	**MF**
Trawl	1	1	0	1	0	0	1	1	0	1
Multibeam - Biomass	0	0	0	0	0	0	0	0	0	0
Multibeam - Bottom Mapping	0	0	1	0	1	0	0	0	1	0
Single Beam	1	1	0	1	1	1	1	1	1	1
Side Scan Sonar	0	0	1	0	0	0	0	0	1	0
Moving Vessel Profiler	0	0	1	0	0	0	0	0	0	0
Instrumented Work Boats	0	0	1	0	1	0	0	0	2	0
Dopplar Radar System	0	0	0	0	0	0	0	0	0	0
Longline	0	1	0	1	0	0	1	1	0	1
Extensive Dive Capability	0	0	0	0	1	0	0	1	0	0
A Frame	1	1	1	1	1	1	0	1	1	1
J Frame	1	1	1	1	1	1	1	1	0	0
Mooring Handling Capability	1	0	0	0	1	1	0	1	0	0
Lab Space	2	1	1	2	1	2	1	2	0	2
Scientific Berthing Space	1	1	2	1	2	1	1	2	0	1
Survey Space	1	0	1	0	1	0	0	0	1	0
Hydro/Oceanographic Winch	1	1	1	1	1	1	1	1	1	1
Dynamic Position System	0	0	0	0	0	0	0	0	0	0
POS/MV	1	0	1	1	1	1	0	0	1	1
Endurance	1	0	0	1	1	1	1	1	0	1
UAS Configuration	0	0	0	0	0	0	0	0	0	0
AUV Configuration	0	0	0	0	0	0	0	0	0	0
ROV Configuration	0	0	0	0	0	0	0	0	0	0
Telepresence	0	0	0	0	0	0	0	0	0	0
ICES Acoustic Quieting	0	0	0	0	0	0	0	0	0	0
Zero Discharge Capability	0	0	0	0	0	0	0	0	0	0
Ice Strengthening	0	0	0	0	0	0	0	0	0	0

Ship Acronym List		**Scoring:**	**Parameters**	
MCARTHUR II	**M2**	0 = No capability in this area	**Lab Space**	
DAVID STARR JORDAN	**DJ**	1 = Capability exists	Under 500 sqt	0
FAIRWEATHER	**FA**	2 = Extensive capability	Over 500	1
GORDON GUNTER	**GU**		Over 1000	2
HI'IALAKAI	**HA**			
KA'IMIMOANA	**KA**		**Endurance**	
OREGON II	**R2**		Above 30 days	1
OSCAR ELTON SETTE	**SE**		30 days and below	0
RAINIER	**RA**			
MILLER FREEMAN	**MF**		**Scientific Berthing**	
ASSERTIVE	**AS**		Under 5	0
Ship aconymns consistent w/ NOAA circular 06-03 dated 8/12/2006 (except ASSERTIVE who has not been designated yet)			6 to 15 spaces	1
			Above 15	2
			Instrumented Work Boats	
			Over 4	2
			1 to 4	1
			None	0
			ROV Configuration	
			Ship cannot Support ROV Ops	0
			Ship can support 1 operational ROV	1
			Ship supports tandem ROV operations	2

Figure 2. Ship Capability Matrix within Ten Requirements Groups

4. Alternatives for each requirement group

The operating day requirements for each of the ten requirements groups could be met with an alternative that provides at least the current capability and capacity of the current ship. The analysis considered the following alternatives within each group:

Alternative 1. Status Quo (as defined previously)
Alternative 2. Non-Ship Approaches and New Technology
Alternative 3. Extend Service Life of NOAA Ships
Alternative 4. Charter
Alternative 5. Convert a Ship (considered for only Requirements Group 1)
Alternative 6. Construct a New Ship

Non-Ship Approaches and New Technology

Ships are needed for carrying data collecting technology to wherever *in situ* ocean and atmosphere measurements are required. While current technological advances can improve the quality and quantity of data collected, currently all known approaches for meeting the at-sea data requirements identified in previous chapters will require ship support.

Incorporating advances in ship infrastructure and data collection technology into ships maximizes the potential of available ships. Autonomous underwater vehicle technology increases the potential annual number of square nautical miles surveyed by NOAA ships, and therefore the number of updates to nautical charts provided to mariners. Moving vessel profiler technology allows a NOAA ship to continue steaming to a target destination rather than stopping periodically to collect oceanographic profile data, shortening the amount of time spent in total transit.

The main benefit from incorporating advanced technology into ships will be the increased quality and quantity of products and services that the agency can provide. New technology will play a critical role in shaping the capability and capacity of the future NOAA fleet, but regardless of the technology, the end result, requires continued support from NOAA's ships.

Note: See Chapter 9, Technology Evaluation for a more detailed perspective on the future and impact of technology.

Extend Service Life of NOAA Ships

Extending the service life of a NOAA ship (called a service life extension (SLE) in this plan) is an alternative for each of the ships currently supporting the ten requirements groups. With an SLE, the service life of some NOAA ships in the requirements groups can be extended, with some, but not all, desired capability upgrades incorporated**.**

The *American Bureau of Shipping (ABS) Guide for Rebuilding Vessels Less Than 90 Meters (295 feet) in Length (2003 Edition, November)* served as the basis used to define the extent of the SLE alternative for NOAA ships. "Rebuilding" in this guide includes "the necessary survey, analysis and repair to enable a vessel to continue actively working past its notional life." To be considered as a candidate for "Rebuilding," the condition of the existing hull and structure of the ship must be determined to be within acceptable standards via an ultrasonic thickness measurement.

The projected scope of work needed for each ship is based on the best estimates provided by port engineers and crews. The required repairs may be underestimated depending on the level of age-related deterioration hidden by insulation, cosmetic bulkheads, inside tanks and voids, or otherwise inaccessible areas. The actual extent of the repairs required is determined after the vessel is properly cleaned and prepared to facilitate a detailed examination of the hull and structure. Therefore there is risk associated with the "SLE" alternative, primarily because the true scope of work associated with SLE can only be partially defined until actual dry-dock-based SLE work begins.

Convert an Existing Ship

Conversion of an existing ship is an alternative for one of the 10 requirements groups. During the period from 1999 to 2004, NOAA acquired seven tactical auxiliary general ocean surveillance (T-AGOS) ships and one yard torpedo test (YTT) ship from the United States Navy. All except two of those ships, have been converted to provide capability to meet NOAA at-sea data collection needs. One T-AGOS is in the conversion process at this time, as the OKEANOS EXPLORER. The remaining T-AGOS ASSERTIVE is a candidate for conversion as an alternative for requirements group 2. ASSERTIVE will be 24 years old in FY 2010.

Converting or retro-fitting a ship to support work different from the original mission presents unique challenges and added risks in addition to the unknown structural status (as noted in SLE discussion). Adding equipment to the deck may require significant supporting structural changes. If the structure is substantially modified to accommodate a very different mission, the risk of substantial changes to the ship's stability increases from moderate to high. Converting T-AGOS ships for ecosystem mission support is characterized as a moderate risk, because the original mission design of the T-AGOS was primarily towing heavy objects at slow speeds (similar in character to the fisheries trawls used for ecosystem missions).

Although NOAA has had success with its previous conversions, an example of the risks inherent in structural modifications is the Coast Guard's 110 foot patrol boat. These were recently converted to extend the length of the hull and add a stern ramp to launch and retrieve a small boat. Despite the best engineering, the main structural element – the keel – was compromised after a short period of service in the open ocean.

Use Charter to Meet Requirements

NOAA uses charter ship arrangements for ship support from the private sector and the university community to meet some at-sea data collection requirements. In FY 2006, NOAA acquired more than 1900 ship operating days of ship support from over 40 private sector and 25 university ships. These ships provided support for fisheries research, oceanographic research, and ecosystem assessment projects.[72]

NOAA also uses contracts to acquire hydrographic surveying services. Several task orders are awarded annually to obtain hydrographic survey data similar to the data collected by the NOAA hydrographic survey vessels. Funding for the hydrographic contracting program has averaged $25 million per year. NOAA is able to effectively manage and provide quality assurance of the data from these contracts because it maintains surveying expertise using NOAA ships and boats.

In June, 2007, NOAA issued a Sources Sought Notice survey the market for available charter vessels that could provide capability similar to present NOAA ships that support fishery and marine mammal program data collection requirements.[73] The market survey solicited vendors to identify ships available for time charter or bareboat charter with the capability to meet NOAA at-sea data collection requirements. The market survey asked for responses from vendors that could either provide a ship to meet the identified requirements or modify or convert a ship to meet the majority of the critical requirements. NOAA received no responses to that market survey.

The Military Sealift Command (MSC) charters ships to support Navy research. One of the MSC charters is for a ship of similar size as present NOAA ships and the MSC charter ship includes laboratory space and berthing for mission personnel. The MSC charter is an offshore supply ship that was converted to meet Navy requirements. The MSC charter does not currently include the fishing capability (e.g. trawl capability), buoy handling capability or the dive support capability of present NOAA ships.

[72] A table of the Charter Breakdown in FY 2006 is provided in Appendix F
[73] A copy of the Sources Sought Notice is included in Appendix G

There is risk associated with the "Charter" alternative. Ships with the capability and capacity required to meet NOAA's data collection needs may not be available. This could be particularly critical during emergency situations like Hurricane Katrina or other Homeland Security/Maritime Domain Awareness events, where surveys are immediately required to reopen ports for critical services or establish safe routes for military mobilization. If all hydrographic data were collected by charter, the overall effectiveness of the hydrographic mission would be impacted by the lost expertise required to assure the quality of the contract data. In-house expertise enables NOAA to discover and prove new methodologies and technologies, confidently accept data from outside sources, assume liability for contractor data it accepts for charting, and provide competent oversight of all aspects of private surveying practices for multi-million dollar contracts to collect hydrographic data.

Construct a New Ship

In 2001, NOAA awarded a contract for the design and construction of a fisheries survey vessel (FSV), with options for three additional FSVs. The contract required ships with the capability to meet NOAA's fish stock management and marine mammal data collection needs, including acoustic quieting to international standards. All options were awarded and two of the FSV's have been delivered to NOAA and brought into operation. NOAA has also awarded a contract for construction of a Small Waterplane Area Twin Hull (SWATH) ship that will test new technologies in ocean mapping and collect hydrographic data for nautical charting. An advantage of new construction is that the ship can be purpose designed and constructed with the capability needed to optimally collect data required to meet NOAA's needs.

There are risks with new construction. Ideally, a ship will meet all the operational requirements of NOAA, be constructed on-budget and on-time. and commence operations when planned. The time gap between specifications for building the ship and the actual construction, whether due to funding limitations, legal challenges to the contract award, or changes in shipyard capacity, can allow for many changes to the design based on the evolution of technology requirements. New sensors, changes in regulations, or even changes in expected staffing may impact the final constructed ship, and thus the funding and operational expectations. Growing cost estimates can also force changes to the ship design based on available funding.

Relative Risk of Each Alternative

As described in the sections on each alternative, there is risk associated with each alternative which is summarized below in terms of relative risk of each alternative compared to the lowest risk alternative.

The lowest risk alternative is to construct a new ship. NOAA has recent experience with new ship construction (OSCAR DYSON and HENRY B BIGELOW). The new ships were delivered within budget, met specified design criteria, startup problems (common when introducing a new class of ships) were corrected, and the ships are successfully operating and collecting data in support of NOAA programs.

The "SLE" alternative has varying risks depending on the age of the ship. The risks are associated with the fatigue life, structural integrity, and other ship and ship systems that are inaccessible without major rip-out of spaces and teardown of machinery. Based on the assumption of greater risk with greater ship age, the "SLE" relative risk assigned is shown in the table below.

SLE RELATIVE RISK

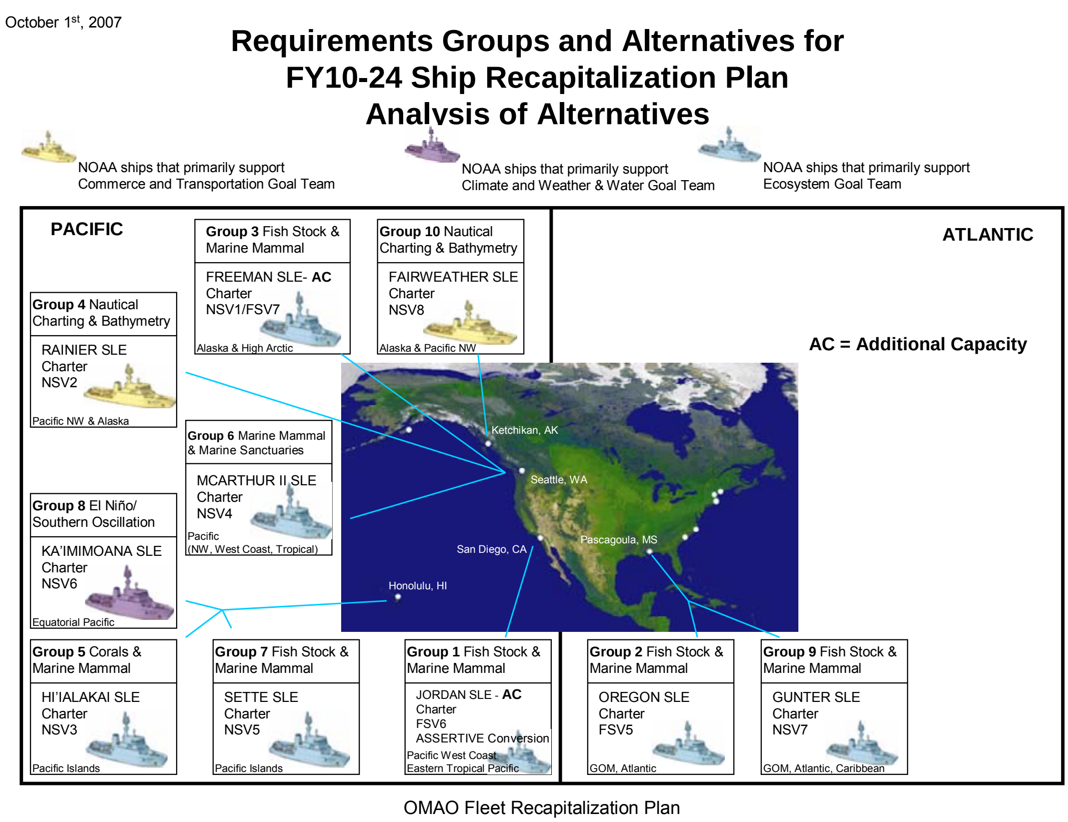
Ship Age at time of SLE	Relative Risk
0 to 20 years	Low
20 to 30 years	Medium
30 to 50 years	High

The "Conversion" alternative risk is related to both the ship condition at the time of conversion and changes in structural loading due to the conversion. NOAA has experience converting the same ship class as the one considered for the "Conversion" alternative and also has some information on the condition of the ship considered for conversion. Based on previous experience, the relative risk of this conversion is considered moderate.

The risk associated with the "Charter" alternative risk is related to availability (or rather lack thereof) of charter ships with the capability to meet NOAA requirements at the time and location where data collection is needed. Due to the lack of response from a Sources Sought Notice market survey and NOAA's knowledge of the charter market, the relative risk of charter is high.

Requirements Groups and Alternatives

The ten requirements groups and alternatives to meet the highest priority program requirements requiring data collection at sea are shown in table below. The remainder of this Ship Recapitalization Plan focuses on these 10 requirements groups and on determining the best alternative to meet the requirements in each group.



Chapter 11
ANALYSIS OF ALTERNATIVES

An analysis of alternatives (AoA) was conducted to provide the analytical foundation for the FY 2010 to FY 2024 Ship Recapitalization Plan. The AoA compares the cost and operational effectiveness of the proposed alternatives for each of the ten requirements groups identified by this plan. As an important component of NOAA's acquisition process, AoAs not only identify the most cost effective alternative, they make a compelling statement about the benefit of acquiring the system and provide a structured assessment of a system's desirability and affordability in the context of all organizational requirements. Both an economic analysis of alternatives and a program performance analysis of alternatives were conducted. The analyses were conducted using the best available programmatic and operational information.

ECONOMIC ANALYSIS

The EAoA was developed in six steps:

Step 1: Determined which type of analysis to perform

Step 2: Defined the time period in order to capture life cycle costs

Step 3: Formulated cost inputs for each alternative

Step 4: Normalized alternatives within each requirements group to provide equal annual affects

Step 5: Calculated Net Present Value (NPV) of the net costs for each alternative

Step 6: Conducted sensitivity analysis

Step 1: Analysis Assessment

The economic analysis used in the AoA follows the guidance provided in the Office of Management and Budget (OMB) Circular A-11, Part 7, including appropriate Appendices and Supplements, and OMB Circular A-94. Those documents provide guidance on planning and budgeting for federal capital assets and on economic analyses of alternatives.

The following documents were referenced for the economic analysis of alternatives:

- OMB Circular A-11, Part 7, Planning, Budgeting, Acquisition, and Management of Capital Assets
- OMB Circular A-11, Appendix I, Principles of Budgeting for Capital Asset Acquisitions
- OMB Circular A-11, Appendix J, Selected OMB Guidance and Other References Regarding Capital Assets
- OMB Circular A-11, Supplement, Capital Programming Guide
- OMB Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs including Appendices and latest Memorandum from OMB on Discount rates for OMB Circular A-94

OMB A-94 prescribes the process for *cost-benefit analysis* which includes determining societal benefits and costs. OMB A-94 also indicates that *cost-effectiveness economic analysis* is appropriate: (1) for internal planning decisions of the Federal Government; (2) when each alternative provides equal annual affects; and (3) when it is impractical to determine net societal benefits of each alternative.

The difficulty of estimating the net societal benefits of NOAA ships to meet OMB Circular A-94 standards was a factor behind the decision to perform a *cost-effectiveness* analysis versus a *cost-benefit* analysis. Planning for ship recapitalization is consistent with the criteria for using cost-effectiveness economic analysis and therefore this technique was used to determine the net present value of each alternative considered for each requirements group.

The Economic Analysis of Alternatives (EAoA) is a cost-effectiveness analysis that demonstrates the cost of each alternative within each requirements group. Costs were estimated on a yearly basis throughout the entire time period and discounted back to FY 2010 using constant dollars. This approach was used to evaluate the fiscal impact of capital investment decisions for NOAA ships.

Step 2: Time Period of Economic Analysis Determination

The service life of the new construction alternative is 30 years. In order to capture full life cycle costs, the period of the economic analysis extends from FY 2010 to 30 years after the new construction ship would become operational for each requirements group.

Step 3: Cost Input Formulation

For each requirements group, the following costs were included in the analysis:

- Implementation costs
- Full life cycle costs for capital investment
- Capital investment costs such as design and construction
- Operation and maintenance costs
- Asset disposal costs, including credits for any expected income to the federal government from the sale of a ship
- Cost adjustments needed to normalize the alternatives considered for each requirements group at the end of the time period covered by the economic analysis, such as remaining value of an asset to NOAA.

Costs were included for the entire time period covered by the economic analysis, including the full service life of any new ships that would be constructed and ships that would be converted. Constant FY 2010 dollars and the real discount rate (3 percent) specified by OMB were used in the cost-effectiveness analysis. Because the analysis includes some costs that are funded within the current NOAA budget, the costs used in the analysis can not be used to identify incremental budget increases that would be required to implement each alternative. Required Procurement, Acquisition and Construction (PAC) and Operations, Research and Facilities (ORF) funding above the current services budget are provided in Chapter 12.

Ship Service Life Extension (SLE) Cost Estimates

Costs estimates of the capital investment required to conduct a service life extension (SLE) on existing ships to extend their service lives were estimated by NOAA marine and electronic engineers that are routinely involved in the maintenance and repair of those ships.

Ship Conversion Cost Estimates

The cost to convert the tactical auxiliary general ocean surveillance ship (T-AGOS) ASSERTIVE was estimated by marine and electronic engineers that have been involved in the conversion of other T-AGOS ships for NOAA use.

Charter Cost Estimates

The economic analysis includes charter estimates for each requirements group. The estimates are from 3 sources:

1. Charter estimates for replacing the FAIRWEATHER and RAINIER are based on an Office of Coast Survey (OCS) contract presently being executed.

2. Charter costs for collecting multibeam data to support fishery needs were estimated by OCS using information from the contract presently being executed.

3. Charter estimates for providing capability equivalent to present NOAA ships that collect data for living marine resource management proved more difficult. In June, 2007, NOAA issued a Sources Sought Notice market survey of available charter vessels that could provide capability similar to current NOAA ships that support living marine resource management data collection requirements. NOAA received no responses to that market survey. Lacking specific cost estimates from the market, another approach was used to estimate costs for living marine resource management charters. The Military Sealift Command (MSC) charters ships to support Navy research. Charter estimates for providing a charter ship with capability equal to other NOAA ships used in the economic analysis were developed from a charter ship that the Military Sealift Command (MSC) charters for Navy research.

New Ship Construction Cost Estimates

New ship construction costs were estimated using the commonly accepted parametric estimating method used by the Office of the Secretary of Defense (OSD) Cost Analysis Improvement Group (CAIG) and is consistent with the approach of the Society of Cost Estimating and Analysis. It estimates future costs based on actual costs of ships that are approximately the same size with similar missions, adding cost estimates for design, project risk, post delivery activities, contract incentives, project management and adjusting for the unique acoustic quieting requirements. Using similar ships provides an acceptable approximation regardless of mission specific requirements. If a unique, expensive requirement is known, (e.g. acoustic quieting), an adjustment is made to the parametric curve. The estimate will be further refined using accepted cost estimating methods as the requirements become better defined, trade-offs are made, and actual ship parameters are established.

Successive NOAA Survey Vessels (NSV) are projected to have a common baseline configuration, with some minor variation to support a specific primary mission (e.g. hydrographic vs. fisheries research). The requirements for all NSVs have not yet been sufficiently defined to distinguish between specific mission configurations. For example, the multibeam echosounder sonar installed on OSCAR DYSON-class ships has not had enough operational use to know whether it might able to replace the trawl survey on later ship builds. If multibeam sonar analysis changes stock assessment requirements, the trawl system might be removed or replaced with a different configuration for a similar or slightly different mission requirement. The estimate for successive NSVs is therefore kept constant; specific mission needs will be addressed for each ship as construction approaches and will be consistent with available technology and changes to data collection requirements.

Hydrographic survey ships, in addition to their data production expectations, have also traditionally fulfilled a significant role in the creation of hydrographic scientific knowledge and expertise. These ships are operated in a fundamentally different paradigm than the fisheries or oceanographic ships because the scientific personnel are assigned to the ship permanently, rather than cruise-by-cruise. Any changes to ship staffing for these ships that would improve operational efficiency while maintaining scientific expertise have not been factored into these calculations.

Ship Calibration Cost Estimates

Data collected for living marine resource management and research can be skewed by the platform collecting the data. Long term data series are best collected by the same platform in order to reduce the uncertainty in the data that can be caused by changing platforms. When the platform used to annually collect similar fishery and marine mammal data is changed, the two platforms should be calibrated (run side by side collecting similar data) to reduce data uncertainty. Ship calibration costs are included in the analysis of alternatives.

Ship Operation and Maintenance Cost Estimates

Operation and maintenance cost estimates for current NOAA ships were based on FY 2007 actual costs and adjusted to 255 operating days, which is the operating day level used for all alternatives. These costs were then inflated to FY 2010 dollars. Operation and maintenance cost estimates for the ASSERTIVE were based on historic costs of similar T-AGOS ships that were converted and are operated by NOAA. Operation and maintenance cost estimates for new construction ships were based on costs of similar ships that have recently begun operating for NOAA.

Ship Sale and Disposal Cost Estimates

If the ”New Build” or “Charter” alternative was implemented for a requirements group, the existing NOAA ship could be sold and that income used to offset some of the new construction or charter costs. An estimate of the market value of the appropriate existing NOAA ship was included as a cost offset for the new construction and charter alternatives. Prior NOAA experience with disposal of NOAA ships indicates that there is little market-demand for these ships. An average of the prior amounts from NOAA ship disposal sales, inflated to FY 2010 dollars, were used in the economic analysis for the ship sale and disposal costs.

Step 4. Cost Normalization of Alternative to Provide Equal Annual Effect

Within the ten requirements groups, alternatives were developed to provide equal capability, capacity and equal annual affect to the extent possible. The “New Build” alternative allows a ship to be specifically designed and constructed to take advantage of presently available technology and to provide the capability to best meet NOAA data collection requirements. For six requirements groups, existing single-purpose NOAA ships and available charter ships do not have the capability to collect all the required data that can be collected by the ”New Build” ships.

One example is a new ship constructed to collect data for living marine resource management (fish stock assessments and marine mammal and endangered species management). The “New Build” alternative can provide a ship that can trawl for fish, observe marine mammals, berth scientists, provide laboratory space, collect environmental data such as salinity and temperature versus depth, collect biomass information through acoustic techniques, and map the ocean floor for habitat studies, all during one cruise. Existing individual NOAA ships and available individual charter ships do not have that broad capability. In the six requirements groups that have a living marine resource management primary mission, an estimate of the additional cost to collect data equivalent to the data collected by ”New Build” ships was added to the existing ship and charter ship alternatives.

The multibeam sonar capability of newly constructed ships will result in economies of scope; each research cruise on a newly constructed ship can collect data that will support multiple types of assessments, as opposed to the more limited (single-dimensional) capabilities of the present NOAA and charter ships. The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSRA) requires assessment of essential fish habitats and the delineation of habitats of particular concerns. The multibeam sonar capability will be available on newly constructed ships and allow those mapping missions to occur either simultaneously with other resource assessments (e.g., a stock assessment) or sequentially aboard a single vessel. The other alternatives (“Charter” and “SLE” options) for each requirements group cannot provide this capability. The cost of acquiring this multibeam data was added to the other alternatives so that each alternative would provide equal affect.

Any remaining value to NOAA of any ships that would have remaining service life at the end of the time period covered by this economic analysis was accounted for in the analysis by including that value as an income at the end of the analysis period. The value was determined by estimating the book value of the ship at the end of the analysis period.

The new construction ships, particularly the NSVs, will be designed with the capability needed to collect data for multiple NOAA programs. For example, an NSV would have the capability to collect hydrographic data to nautical charting standards and to collect the data needed for living marine resource management. That multiple program capability has value for NOAA, but that value cannot currently be quantified and was therefore not included in the quantitative analysis.

Value of acoustic quieting for ships that support fishery and marine mammal requirements

NOAA is currently constructing new ships to meet acoustic quieting standards that allow observation and data collection of fish and marine mammals without noise altering the behavior of the animals under observation. The value of the higher quality data can be expressed as the cost of not collecting that higher quality data or the cost of reduced value data. The “SLE” and “Charter” alternatives for each requirements group that includes living marine resource management data collection requirements includes an estimated cost of reduced value data to provide equal effect.

Acoustic quieting is necessary for pelagic species assessments. The acoustic quieting capability of the ”New Build” alternative allows better measurement of abundance and distribution of marine organisms and result in more precise stock assessment estimates than are currently available. Stock assessment precision directly affects living marine resource management. Because the precautionary approach to management operates “on the lower bound” of the stock estimate, improved precision can result in increased harvest allowances in some fisheries than would otherwise be allowed. NOAA is required under MSRA to establish annual catch limits that preclude overfishing for all federally managed fisheries by 2011. Where stock assessment precision is low, these annual catch limits will need to be set conservatively to confidently avoid overfishing. Setting annual catch limits targets at 75 percent of the overfishing limit has already been implemented in some fishery management plans.

Only the “New Build” alternative can provide acoustic quietness. It is impractical to modify an existing or charter ship to provide acoustic quietness that meets living marine resource management data collection requirements. To account for the difference in acoustic quietness for those requirements groups that include an acoustic quietness requirement, NOAA estimated the value of acoustic quieting. That value was added, where applicable, as a cost to the alternatives that can not provide acoustic quieting. An explanation of the method used to develop the value of acoustic quieting is provided in Appendix H.

Value of increased hydrographic surveying that support nautical charting

The “New Build” alternatives for the requirements groups that support NOAA’s hydrographic surveying capability provide an additional annual benefit when compared to the “SLE” and “Charter” alternatives. Only the new ship can provide an increase in hydrographic productivity due to increased capability. Both the FAIRWEATHER and the RAINIER are nearing their 50^{th} year of service; investing multi-million dollar technology refreshment packages will not provide a return on investment for the taxpayer when both ships will be offline after FY 2018 due to risk associated with age.

FAIRWEATHER presently has two hydrographic launches used to conduct near-shore surveying (although davits and infrastructure exist to support four launches). RAINIER currently has a 1990’s-vintage shipboard multibeam sonar system (MBES) that is technologically obsolete and can not provide the required hydrographic depth accuracies. FAIRWEATHER has a moving vessel profiler (MVP – see Chapter Nine for a description) but the RAINIER does not. Both ships have an endurance of only 22 days, which means that the ship needs to come into port at least twice a month. Neither ship is configured to handle formal autonomous underwater vehicle (AUV) operations.

Replacing the current ships primarily dedicated to hydrographic surveying and bathymetric mapping with the assumed capability of the new NSV class will increase hydrographic surveying capacity and capability to meet Government Performance Review Act (GPRA) targets. A production increase in square nautical miles (SNM) surveyed from RAINIER over a new NSV is attributed to four capability improvements: (1) addition of a new state-of-the-art MBES, (2) configured ship that supports a hydrographic AUV suite, (3) MVP, and (4) increased ship endurance.

Based on experience with the similar MBES on the FAIRWEATHER, the RAINIER-model NSV productivity is estimated to increase by 250 SNM per year with this new capability. Hydrographic AUV operations are expected to increase productivity by at least 50 SNMs per year per AUV based on the current pilot program estimates. A full configuration of AUV systems is assumed to include four operating vehicles per shipboard suite for a total productivity increase of 200 SNM per year. Recently installed on FAIRWEATHER, the MVP has been shown to increase shipboard multibeam data collection from approximately 19 hours per day to 23 hours per day. This productivity increase of four hours per day is only realized if accompanied by the new shipboard multibeam system that can be integrated with the MVP; the MVP is then estimated to add 42 SNM per year. Additionally, increased ship endurance is estimated to reduce the frequency of port calls from two per month (using six operating days) to one per month (using four operating days). This effectively adds 17 additional operating days dedicated to data collection within the allocated 255 operating days for an estimated productivity increase of 43 SNM per year. Together, the capabilities of the “New Build” alternative will provide 535 more SNM than the current ship.

It is worth noting that the assumed annual SNM per operating day production rates for RAINIER and FAIRWEATHER do vary from year to year; and NOAA priorities and requirements dictate where hydrographic operations must be conducted. It is likely the 2.6 SNM per operating day rate used in this analysis is lower than expected for RAINIER.

A production increase in SNM surveyed from FAIRWEATHER to a new NSV is attributed to three capability improvements: (1) configured ship that supports a hydrographic AUV suite, (2) addition of two hydrographic survey launches, and (3) increased ship endurance. As in the RAINIER scenario, hydrographic AUV operations are expected to increase productivity by at least 50 SNM per year per AUV and are assumed to include four operating vehicles per shipboard suite for a total productivity increase of 200 SNM per year. The addition of two launches is estimated to increase production by 200 SNM per year, and also enables hydrographic surveying in complex near-shore areas. This productivity increase is based on historic productivity rates of the launches on the RAINIER. Finally, increasing ship endurance can effectively add 17 additional operating days within the allocated 255 operating days for an estimated productivity increase of 60 SNM per year. Together, the capabilities of the "New Build" alternative will provide 460 more SNM than the current ship.

Based on the charter estimates from the Office of Coast Survey (OCS), contracts presently being executed provide a cost per SNM of $25,000. This unit cost is multiplied by the additional SNM produced by the new ship and added to both the "SLE" and "Charter" alternatives to provide equal benefit or effect within the requirements group at the delivery year of the new ship. With this additional cost, the requirements groups that support NOAA's hydrographic surveying were normalized and are consistent with all other groups.

Step 5: Net Present Value (NPV) Calculation of the Net Costs for Each Alternative

The net present value (NPV) calculation takes into account the time value of money; recognizing that a dollar has more value today than a dollar ten years from now. In a cost-effectiveness analysis, NPV calculation is a method used to compare alternatives with different annual funding requirements and equal annual benefit (even though the value of the benefits cannot be quantified). This method focuses on the NPV of the cost of each alternative for comparison.

All cost inputs to provide equal benefits, to the extent possible, were included in each year of each alternative within the requirements groups. To include the entire useful life of the "New Build" alternative, these costs were calculated beginning in FY 2010 and extended to 30 years after the delivery of the new ship. All annual costs were discounted back to FY 2010 dollars using OMB approved discount rate of 3 percent. The alternative that demonstrates the smallest NPV cost within each requirements group is the best alternative

NPV can be calculated using either constant future dollars, in which future cost estimates include no inflation, or inflated future dollars, in which future cost estimates include inflation. Different discount rates are used for constant dollar NPV calculations (called the real discount rate) and inflated dollar NPV calculations (called the nominal discount rate). Constant FY 2010 dollars were used for the cost inputs this analysis, therefore the real discount rate was used.

Step 6: Sensitivity Analysis

Sensitivity analysis is an examination of how sensitive conclusions are to various assumptions made in the analysis. Sensitivity analysis has at least two primary goals: to make sure the right conclusion was reached by challenging its basis and to reach deeper insights about why that answer was the result. A sensitivity analysis was performed on the dominant cost elements of the NPV analysis that include uncertainty including ship construction, ship conversion, and SLE estimates.

The sensitivity analysis was performed using a single variant approach. This approach tests one variable at a time and assesses the results as the variable is changed. There were insufficient data to support a multi-variant sensitivity analysis; therefore a single-variant analysis was performed.

Figure 1 shows each cost estimate that was varied in the sensitivity analysis and the amount of variance. The rationale for the variance range of each cost element is described in Appendix I.

Cost Estimates Varied for Sensitivity Analysis		
	Variance	
	Lower	Higher
New ship construction	-10%	10%
New ship construction (FSV 6)	-4%	4%
Other charter (all requirements group but Group 5 and 10)	-25%	25%
Group 5 and Group 10 (RA/FA) charter	-10%	10%
Value of Acoustic Quieting	0%	25%
Value of Hydrographic Data	-5%	10%
Charter for Multibeam Data	-25%	25%
Current Ship O&M	-5%	5%
New Ship O&M	-10%	10%
Existing ship SLE	0	15%
Conversion	0	15%

Figure 1. Sensitivity Analysis Variables

Varying each cost estimate as per the table above resulted in no change of outcome in the NPV results. Figure 2 summarizes the results of the sensitivity analysis.

Summarized Results of Sensitivity Analysis

	Baseline NPV Analysis Results	10% Increase in New Ship Build Estimates	10% Decrease in New Ship Build Estimates	10% Increase in Hydro Charter	10% Decrease in Hydro Charter	25% Increase in Other Charter	25% Decrease in Other Charter	25% Increase in Value of Acoustic Quieting	5% Increase in Value of Hydro Data	10% Decrease in Value of Hydro Data
1 DAVID STARR JORDAN	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build
2 OREGON II	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build
3 MILLER FREEMAN	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build
4 RAINIER	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build
5 HI'IALAKAI	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build
6 MCARTHUR II	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build
7 OSCAR ELTON SETTE	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build
8 KA'IMIMOANA	SLE	SLE	SLE	SLE	SLE	SLE	SLE	SLE	SLE	SLE
9 GORDON GUNTER	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build
10 FAIRWEATHER	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build
Continued....	*Other Charter is defined by all charter except hydro charter (no RA/FA); this includes KA, plus all EGT req'ts groups									

	25% Increase in Fisheries Multibeam Data	25% Decrease in Fisheries Multibeam Data	5% Increase in Current O&M	5% Decrease in Current O&M	10% Increase in New Ship O&M	10% Decrease in New Ship O&M	50% Increase in Ship Disposal	50% Decrease in Ship Disposal	SLE/ Conversion Increase of 15%	
1 DAVID STARR JORDAN	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	
2 OREGON II	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	
3 MILLER FREEMAN	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	
4 RAINIER	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	
5 HI'IALAKAI	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	
6 MCARTHUR II	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	
7 OSCAR ELTON SETTE	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	
8 KA'IMIMOANA	SLE	SLE	SLE	SLE	SLE	SLE	SLE	SLE	SLE	
9 GORDON GUNTER	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	
10 FAIRWEATHER	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	New Build	

Figure 2. Sensitivity Analysis Variables

Results of Economic Analysis

The NPV of net incremental costs for each alternative is provided by requirements group. NPV at status quo is not included because status quo affects are not comparable to the other alternatives. Figure 3 provides the results of the NPV Analysis with bold numbers signifying the least cost alternative.

Requirements Group Number and Existing Ship	Net Present Value in $M			
	Lowest NPV Alternative is in bold			
	"SLE" of Present Ship	"Charter"	"New Build"	"Conversion"
1 DAVID STARR JORDAN	$431	$542	**$225**	$464
2 OREGON II	$308	$436	**$207**	N/A
3 MILLER FREEMAN	$515	$597	**$279**	N/A
4 RAINIER	$315	$459	**$232**	N/A
5 HI'IALAKAI	$247	$259	**$214**	N/A
6 MCARTHUR II	$403	$456	**$223**	N/A
7 OSCAR SETTE	$284	$405	**$228**	n/a
8 KA'IMIMOANA	**$157**	$178	$210	N/A
9 GUNTER	$326	$453	**$222**	N/A
10 FAIRWEATHER	$377	$463	**$274**	N/A

Figure 3. Results Summary of Economic Analysis

Considering only fiscal impacts, the "New Build" alternative is the best choice to meet NOAA's requirements for 9 of the 10 requirements groups. For requirements group 8, the "SLE" alternative is the best choice to meet NOAA's requirements based on cost. A single variant sensitivity analysis of cost elements does not change this outcome.

PROGRAM PERFORMANCE ANALYSIS

Program Performance Analysis (PPA) provides information independent of the economic analysis for use in the fleet recapitalization decision process. This analysis shows how changes in ship capacity and capability would change expected NOAA Government Performance and Results Act (GPRA) measure results. This method shows the link between NOAA capabilities and the operational abilities of ships.

The PPA was developed in steps:

Step 1: Defined the capacity and capability of current NOAA ships within the ten requirement groups

Step 2: Projected the capacity and capability of the alternatives including Status Quo within the ten requirement groups

Step 3: Linked NOAA performance measures to ship operating days and ship capability

Step 4: Assessed the impact on program performance

The PPA assesses the impact that data acquisition platforms have on NOAA's performance targets.

Program Impact of Changes in Ship Capacity			
Requirement	Projected FY07 Capacity (OD)	FY10 Capacity (OD)	FY 10 Δ in Capacity (OD) from FY07
DJ - Status Quo	228	196	-32
DJ SLE	NA	255	27
DJ Charter	NA	255	27
ASSERTIVE	NA	255	27
FSV6	NA	255	27
R2 - Status Quo	194	196	2
R2 SLE	NA	255	61
R2 Charter	NA	255	61
FSV5	NA	255	61
MF - Status Quo	236	196	-40
MF SLE	NA	255	19
MF Charter	NA	255	19
FSV7	NA	255	19
RA - Status Quo	191	94	-97
RA SLE	NA	255	64
RA Charter	NA	255	64
NSV1	NA	255	64
HA - Status Quo	215	196	-19
HA SLE	NA	255	40
HA Charter	NA	255	40
NSV2	NA	255	40
M2 - Status Quo	210	196	-14
M2 SLE	NA	255	45
M2 Charter	NA	255	45
NSV3	NA	255	45
SE - Status Quo	215	196	-19
SE SLE	NA	255	40
SE Charter	NA	255	40
NSV4	NA	255	40
KA - Status Quo	227	196	-31
KA SLE	NA	255	28
KA Charter	NA	255	28
NSV5	NA	255	28
GU - Status Quo	199	196	-3
GU SLE	NA	255	56
GU Charter	NA	255	56
NSV6	NA	255	56
FA - Status Quo	207	196	-11
FA SLE	NA	255	48
FA Charter	NA	255	48
NSV7	NA	255	48

Figure 4. Ship Capacity for PPA

Step 1: Defining the Capacity and Capability of the Current NOAA Fleet ships within the ten requirement groups

Current Capacity and Capability of the Ten Requirements Groups

Ship capacity is defined as the amount of time available for collecting data in support of NOAA's requirements and is described as "operating days." Ship capability refers to the instrumentation, mission support equipment, and some design and configuration factors that provide the ability for ships to meet at sea data collection requirements. Specific detail on the current capacity and capability of the ten requirements groups reflects what is described in Chapter 10.

Step 2: Projecting the Capacity and Capability of the Alternatives in the Ten Requirements Groups

The capacity reference point used in this analysis is the projected FY 2007 performance of the ships in the ten requirements groups in terms of operating days and with respect to current ship capability. The efficiency and effectiveness of the ship recapitalization alternatives for the time period between FY 2010 and FY 2024 were projected from this baseline.

Future Ship Capacity

In order to provide efficient asset (ship) utilization, the capacity goal for all alternatives ("Service Life Extension," "Charter," "Conversion," and "New Build") is 255 operating days per year. This is the full operating tempo assumed for the time period FY 2010 to FY 2024 for all ten requirements groups. Figure 4 illustrates the change in capacity from the current services operations, based on FY 2007 projected operating days accomplished, from FY 2010 through the FY 2024 time period[74] for all ten requirements groups.

Future Ship Capability[75]

NOAA has begun implementing the capability to support more than one mission, beginning with fisheries survey vessels (FSV). New ships, particularly the NOAA survey vessels (NSV), will be designed with the capability needed to collect data for multiple NOAA programs. For instance, an NSV will have the capability to collect hydrographic data to nautical charting standards, as well as oceanographic and living

[74] A detailed explanation of how capacity was projected is in Appendix D.
[75] Projecting the future capability of new ships at this stage is challenging. When acquisition funds for new ships are programmed, NOAA will work directly with its customers to define requirements, develop a concept of operations (CONOPs) and begin ship design.

marine resource management data. Although the "multi-mission" capability cannot be quantified currently, it provides NOAA with more effective and efficient platforms to collect at-sea data requirements and maximize the data collected per operating day.

Ship Capability Matrix - Future Fleet within the ten requirement groups

Capability	FSV5	FSV6	FSV7	NSV1	NSV2	NSV3	NSV4	NSV5	NSV6	NSV7	AS*
Trawl	1	1	1	1	1	1	1	1	1	1	1
Multibeam - Biomass	1	1	1	1	1	1	1	1	1	1	0
Multibeam - Bottom Mapping	1	1	1	1	1	1	1	1	1	1	0
Single Beam	1	1	1	1	1	1	1	1	1	1	1
Side Scan Sonar	0	0	0	1	1	1	1	1	1	1	0
Moving Vessel Profiler	0	0	0	1	1	1	1	1	1	1	0
Instrumented Work Boats	0	0	0	1	1	1	1	1	1	1	0
Dopplar Radar System	0	0	0	0	0	0	0	0	0	0	0
Longline	1	1	1	1	1	1	1	1	1	1	1
Extensive Dive Capability	0	0	0	1	1	1	1	1	1	1	1
A Frame	1	1	1	1	1	1	1	1	1	1	1
J Frame	1	1	1	1	1	1	1	1	1	1	1
Mooring Handling Capability	1	1	1	1	1	1	1	1	1	1	1
Lab Space	2	2	2	1	1	1	1	1	1	1	2
Scientific Berthing Space	2	2	2	1	1	1	1	1	1	1	2
Survey Space	0	0	0	1	1	1	1	1	1	1	0
Hydro/Oceanographic Winch	1	1	1	1	1	1	1	1	1	1	1
Dynamic Position System	1	1	1	1	1	1	1	1	1	1	0
POS/MV	1	1	1	1	1	1	1	1	1	1	0
Endurance	1	1	1	1	1	1	1	1	1	1	1
UAS Configuration	0	0	0	0	0	0	0	0	0	0	0
AUV Configuration	0	0	0	1	1	1	1	1	1	1	0
ROV Configuration	0	0	0	0	0	0	0	0	0	0	0
Telepresence	0	0	0	0	0	0	0	0	0	0	0
ICES Acoustic Quieting	1	1	1	1	1	1	1	1	1	1	0
Zero Discharge Capability	0	0	0	1	1	1	1	1	1	1	0
Ice Strengthening	0	1	0	1	1	1	1	1	1	1	0

Defining Parameters	
Lab Space	
Under 500 sqt	0
Over 500	1
Over 1000	2
Endurance	
Above 30 days	1
30 days and below	0
Scientific Berthing	
Under 5	0
6 to 15 spaces	1
Above 15	2
Instrumented Work Boats	
Over 4	2
1 to 4	1
None	0
ROV Configuration	
Ship cannot Support ROV Ops	0
Ship can support 1 operational ROV	1
Ship supports tandem ROV operations	2

Future Capability Assumptions:
NSV capability was determined based on a CONOPS that the ship would be multi-mission capable while focusing on a primary mission. This assumption may change after CONOPS and feasibility design is performed. Therefore all NSVs are equal in capability for this exercise.
FSV capability was to be equal to that of the DYSON and BIGELOW
ASSERTIVE capability is assumed to be similar to existing and current T-AGOS ships (M2, SE, etc.)

Scoring:
0 = No capability in this area
1 = Capability exists
2 = Extensive capability (as defined)
*AS is ASSERTIVE

Figure 5. Ship Capability for Ten Requirements Groups

In the Program Performance Analysis, the "New Build" alternative for Requirements Groups 1, 2 and 3 are assumed to have similar capability as the existing DYSON class FSV. The "New Build" alternative for Requirements Groups 4 through 10 is assumed to have equal multi-mission capability but will focus on the primary mission of its replacement ship. Figure 5 provides a summary of the projected capability of each of the "New Build" alternatives within the ten requirements groups being assessed in this plan.

Step 3: Linking GPRA measures to Operating Days and Ship Capability

The NOAA ships provide an array of data to meet specific needs of each NOAA Mission Goal. Figure 6 summarizes the primary NOAA Mission Goal supported by each requirement group included in this recapitalization plan.

To assess the capability and capacity impact of alternatives for each requirements group at the goal level, impact was defined in terms of percentage change in NOAA GPRA measure target. The change in capacity and capability (depending on which alternative) was assessed each year from FY 2010 through FY 2024 based on the FY 2007 performance projections. Programs provided the methodology for linking their program performance with operational needs. The data that are

Figure 6: Requirements Group and Existing Ship	Goal
1. JORDAN	Ecosystems
2. OREGON II	Ecosystems
3. FREEMAN	Ecosystems
4. RAINIER	Commerce and Transportation
5. HI'IALAKAI	Ecosystems
6. MCARTHUR II	Ecosystems
7. SETTE	Ecosystems
8. KA'IMIMOANA	Climate
9. GUNTER	Ecosystems
10.FAIRWEATHER	Commerce and Transportation

collected for specific programs that can also support other NOAA GPRA targets are not quantified in this analysis.

Step 4: Calculating the Percentage Change in NOAA GPRA Performance Measures

Ecosystem Performance Measure Impact: Living Marine Resource Management

NOAA's Ecosystem performance is captured by the FY 2007 GPRA performance measure: *Percentage of Living Marine Resources (LMRs) with Adequate Population Assessments and Forecasts*. This new GPRA measure combines in one reporting metric two measures previously tracked in FY 2004 through FY 2006; 1) status of 230 "major" fish stocks in the Fish Stock Sustainability Index (FSSI) and the degree to which fishing mortality is controlled and whether FSSI stocks are managed near optimum abundance targets, and 2) status of 234 "protected species" stocks of marine mammals, sea turtles, Atlantic and Pacific salmon, and others listed under Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA). These adequate assessments depend upon inclusion of ecosystem data regarding the abundance of the fish and protected resource stock, generally as a trend but some as absolute measures of abundance. This analysis focuses on the living marine resource management GPRA improvement. Thus, the great benefits of ecosystem data collected by FSV-based surveys while they are also collecting the needed living marine resource management assessment data are not included in these calculations and overall performance impacts.

Figure 7. The number of Adequately Assessed Fish and Protected Resources from each region that are dependant on NOAA ships to gather the required data. For calculation purposes each ship is considered critical for the assigned adequate assessment number for that region (e.g. FREEMAN and DYSON each have two adequately assessed fish stocks.)

Adequate	# Fish stocks	# PR
Gulf of Alaska (AK) (FREEMAN, DYSON)	2	5
California Current (CC) (MACARTHUR II, FREEMAN, JORDAN)	3	25
Northeast (NE) (BIGELOW)	19	13
Southeast (SE) (GUNTER, OREGON II)	19	2
Pacific Islands (PI) (SETTE)	0	27
Total	**43**	**72**

Data Sources for Fisheries Stock Assessments:

The possible sources of abundance information are:

- FSV
- Aircraft
- Chartered vessel
- Industry cooperative project
- Non-NOAA survey (usually conducted by a coastal State agency)
- Catch rate from commercial fishery
- Catch rate from recreational fishery

For each stock, Fisheries Science Centers determine whether the possible sources of abundance information provided data that were used in the assessment as the:

- Primary trend or abundance indicator in an adequate assessment
- Secondary - included in assessment model, but less influential
- Auxiliary - data exist, but not useful for assessment due to limited temporal, spatial coverage on marginally effective sampling gear. (Due to limited time to complete this data call, this category was not exhaustively included.)

- Potential - potentially useful data exist, but not yet evaluated in assessment; possibly a new data series

Of the 230 fish stocks on the FSSI list, 126 are considered to currently have adequate assessments (as of September 2007). Of these 126 adequately assessed FSSI fish stocks; there are 43 (approximately 1/3) that base this adequate assessment primarily on surveys conducted from a NOAA ship.

Similarly, there are currently 234 stocks of Protected Resources (PR) accounted for by the living marine resource management performance measure, out of an available universe of 237. Of the 234 PRs, 72 are considered to currently have adequate assessments. Figure 7 summarizes both Fish Stocks and Protected Resources assessed using NOAA ships as well as the basic region and current ships that provide the assessments.[76]

Calculating Percentage Change in the Living Marine Resource Management GPRA Measure

The calculation for the percentage change in the LMR GPRA measure incorporates both capacity and capability change depending on the alternative (including status quo) in each requirements group. The living marine resource management GPRA measure was calculated using a filtering approach. First, the increase and/or decrease of operating days based on FY 2007 operating days were calculated for each alternative including status quo. Second, a tiered formula[77] was calculated by multiplying the percent change in operating days (%Δ OD) for a specific NOAA ship against the number of Adequately Assessed LMRs associated with that ship. These changes and filters were used to obtain a "new" percentage. Lastly, the original percentage was subtracted from the "new" calculated percentage to show the change in the number of LMRs with adequate assessments.

An additional component to this analysis determined the impact of increases in ships' capability to the living marine resource management GPRA measure. Capability only affects the "New Build" alternative. Weighting factors were assigned by the Fisheries Science Center associated with requirements group to each capability of the new ship with respect to its relevance/importance to living marine resource management surveys, which were then multiplied by values for each capability as determined by the NOAA's Marine Operation Centers. The calculated percentage change was then multiplied by the associated number of LMRs for that vessel and used to calculate the change to the GPRA. Figure 8 summarizes this effort showing the effect of increased capability on the living marine resource management GPRA measure broken down by Fish and PR Assessments per ship and then the total effect to the GPRA measure that includes all adequately assessment Fish and PR stocks.

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[76] Appendix J provides additional information on NOAA's LMR performance measure, including definitions of tiered levels of FSSI index and PR thresholds.

[77] A "Tiered" formula was used due to the multi-faceted manner of how LMR stocks are assessed. Specific stocks are assessed using ship data as well as other sources; these data are then incorporated into the entire GPRA measure.

Current Ship	New Ship	New Ship Capability Increase Fish Assessments	New Ship Capability Increase PR Assessments	Capability Effect on total GPRA Measure
JORDAN	ASSERTIVE	28%	150%	8.0%
JORDAN	FSV6	84%	255%	14.3%
OREGON	FSV5	133%	129%	6.0%
FREEMAN	FSV7	63%	95%	1.2%
MCARTHUR II	NSV3	121%	150%	8.9%
SETTE	NSV4	68%	67%	4.0%
GUNTER	NSV6	90%	125%	4.2%

Figure 8. Capability results summary of living marine resource management GPRA measure impact to NOAA ship

Combining both capacity and capability effects, Figure 9 summarizes the overall impact on the GPRA measure by alternative in each requirements group that contributes to the LMR performance measure. OREGON II (R2) requirements group shows the biggest impact with the "New Build" alternative positively increasing the performance measure by 31 percent. This is mostly due to the capability difference between the new and current ship. The requirements group with the least impact is the SETTE, largely due to the fact that it does not assess fish stocks and is one of the younger ships with more capability than other ships that impact the living marine resource management measure.

Annual % Change in EGT/EOP GPRA Measure from FY07 Projected Performance															
	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24
DJ - Status Quo	-0.9%	offline													
DJ SLE	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Charter	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
FSV6					0.7%	19.8%	19.8%	19.8%	19.8%	19.8%	19.8%	19.8%	19.8%	19.8%	19.8%
ASSERTIVE		0.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%
R2 - Status Quo	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%
R2 SLE	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
Charter	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
FSV5						7.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%
MF - Status Quo	-6.3%	-6.3%	-6.3%	-6.3%	-6.3%	-6.3%	-6.3%	-7.1%	-6.8%	-6.8%	-6.8%	-7.1%	-6.8%	-6.8%	-6.8%
MF SLE	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
Charter	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
FSV7									1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%
M2 - Status Quo	-0.4%	-0.5%	-0.5%	-0.5%	-4.0%	-2.7%	-2.7%	-2.7%	-4.4%	-2.7%	-2.7%	-2.7%	-4.4%	-2.7%	-2.7%
M2 SLE	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
Charter	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
NSV3													10.2%	10.2%	10.2%
SE - Status Quo	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	-3.5%	-3.0%	-3.0%	-3.0%	-3.5%	-3.0%	-3.0%	-3.0%
SE SLE	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
Charter	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
NSV4														5.6%	5.6%
GU - Status Quo	-0.1%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-3.0%	-2.1%	-2.1%	-2.1%	-3.0%	-2.1%
GU SLE	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
Charter	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
NSV6															5.5%

Figure 9. Results Summary of Living Marine Resource Management GPRA Measure Impact

Other Impacts not reflected by a change in GPRA measure

While 43 of the current 126 adequate assessments use NOAA ships as a primary source of assessment data, there are 58 additional assessments that reported a potential for an expanded role of FSV-based surveys in the future. These would not increase the GPRA score as currently calculated, but they would increase the precision of the assessments and they would provide more frequent assessment updates. Importantly, the criteria for evaluating an "adequate" assessment may become for stringent as Regional Fishery Management Councils revise management plans to fully implement annual catch limits as required by the Magnuson-Stevens Fisheries Conservation and Management Reauthorization Act

(MSRA), so increases in assessment precision and timeliness may be needed in the future. In addition to the current adequate assessed stocks, 104 stocks do not have adequate assessments. There are 39 inadequately assessed stocks that currently receive NOAA ship data and 30 additional stocks for which NOAA ships could potentially collect relevant assessment data.

There are currently 234 stocks of protected species accounted for by the LMR performance measure, out of an available universe of 237. The stocks cover the complete universe of species currently protected under the Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA). Unlike the MSRA managed fish stocks, assessments for PR mammals and turtle stocks are principally linked to the NOAA ship-based surveys. There are exceptions from other species groups – pacific salmon, corals, Johnson seagrass, sturgeon – but the bulk of the survey work for marine mammals and sea turtles requires operating days on some type of platform from which survey tracks can be run. This is particularly important for understanding pelagic marine mammals, which may never be accessible through shore-based monitoring networks or through small boat surveys. In addition, acoustic quieting of newer ships allows NOAA to develop acoustic survey technologies that can augment traditional trackline surveys. The multi-beam sonar mapping capabilities of some NOAA ships will also generate refined mapping products for habitats that protected resources inhabit - a necessity for coral conservation, for example. Consequently, it is reasonable to directly link percentage change in the total NOAA ship operating days dedicated to marine mammal observations to a percentage change in the total number of adequate PR assessments.

What these impacts mean for the Nation

Increases in the LMR GPRA measures results, as well as those impacts not reflected by a change in GPRA measure result, have a substantial impact on the economic and social well-being of the Nation. MSRA mandates that federally-managed stocks that are either assessed with low precision or are currently being overfished must have Annual Catch Limits (ACLs) established such that overfishing does not occur. If data on a fishery are absent or of low quality, overly conservative ACLs may have an economic impact on the economy of up to $9.1B total. The regions addressed by the ships in this plan could suffer an economic impact of nearly $7B from overly conservative ACLs. Increasing the number of stocks adequately assessed allows more precise ACLs to be set, affording the opportunity for an optimal economic use of the resource. NOAA’s stewardship responsibility compels its managers to seek information on unknown and little known stocks to ensure that overfishing is not occurring and allow potentially overfished stocks the opportunity to recover for future economic exploitation.

While the economic value of marine protected species has been estimated at $21.5B, it can be said that their perceived value to the public is unquantifiable. The public has demonstrated their commitment to preserving these species with the success of such campaigns as the Dolphin-Safe tuna label and the more recent public outpouring of support (not to mention the resources committed by local, state and government officials) when two humpback whales were stranded in the Sacramento River in May 2007. Collecting increased data that drive management and conservation activities for these threatened species impacts NOAA’s ability to fulfill its mandates under the ESA and MMPA and preserve these charismatic ambassadors of the oceans for future generations.

Ecosystem Performance Measure Impact: Coral Reef Conservation

Coral reef conservation long-term performance is tracked using several high-level performance measures. One measure used by the NOAA’s National Marine Sanctuary Program (which includes the Papahānaumokuākea Marine National Monument in the Northwestern Hawaiian Islands (NWHI)) is:

Annual number of Coastal, Marine and Great Lakes Ecological Characterizations that Meet Management Needs (GPRA). This GPRA measure only includes NWHI activities. The remainder of coral reef ecosystem monitoring and assessment activity aboard the HI'IALAKAI is tracked by other performance measures. Because the GPRA measure tracks 1 ecological characterization of the NWHI that would be conducted annually, this measure does not provide a useful illustration of program performance with regard to operational needs. Given the high priority of the NWHI, monitoring this location is anticipated to occur on an annual basis regardless of the new capacity and capability scenarios, thus GPRA performance will not change.

Coral Reef Jurisdictions
Hawaiian Islands (HI)
American Samoa (AS)
Guam (GU)
Commonwealth of the Northern Mariana Islands (CNMI)
U.S. Virgin Islands (USVI)
Florida (FL)
Puerto Rico (PR)

Figure 10. Coral Reef Jurisdictions

A more appropriate method to link program performance and operational capability is the NOAA Corporate Measure: *Percent of Shallow Coral Reef Regions with Improved Condition*. This is the only coral reef conservation corporate performance measure and it is used to track the outcomes of all of the coral reef conservation activities including ship-based mapping, monitoring, assessment and research of coral reef ecosystems in the seven coral reef jurisdictions, four in the Pacific and three in the Atlantic/Caribbean (see Figure 10).

The goal of NOAA's extensive work with local coral reef managers to improve the effectiveness of coral reef conservation and management and reduce the key threats to coral reefs, is to improve coral reef condition in three primary areas: (1) habitat condition; (2) water quality; and (3) living marine resources.
Calculating Percentage Change in the Coral Reef Conservation GPRA Measure

All three of these characteristics are tracked through ship-based monitoring and assessment. The HI'IALAKAI is the only NOAA ship that is dedicated to coral reef monitoring. NOAA's ability to know whether or not its actions are working is dependent upon the ability to travel to the U.S. coral reef jurisdictions and conduct these multidisciplinary assessment cruises. With this corporate measure, NOAA has implemented performance targets with a phased approach: 14 percent of coral reef regions (one of seven) to have improved condition by 2010; 43 percent (three of seven) of coral reef regions by 2012, and 100 percent of coral reef regions by 2015. The program intends to develop follow-on performance measures closer to 2015 to track continuing progress in coral reef condition beyond 2015.

This corporate measure consists of two activities: (1) the ability of the ship to get to the specific coral reef jurisdiction (based on the amount of operating days per year), and (2) actually observing an improved condition of the reefs in the jurisdiction. Improved condition would be measured by collecting data from the three areas mentioned above (habitat, water quality and living marine resources). Improved condition would be the result of the many activities that the NOAA is coordinating as well as other external factors. Some external activities include capacity-building at the local level for improved coral reef management and outreach and education to highlight coral reef ecosystem threats and significance to the community. Because it is very difficult to forecast whether the acquired data on the ship will observe an improved condition in this time period, Figure 11 illustrates the impact of this program even though the overall percentage change in the corporate measure cannot be quantified at status quo operating day capacity. Figure 12 illustrates the impact of an increase in operating days as defined within the three alternatives of each requirements group.

FY07 Projected Capacity Point of Reference	% Δ in Capacity from 215	Assumed Capacity	Ability to get to Coral Reef Jurisdiction by Ship (dependent on transit times)	Observed improved condition of reefs in region	Corporate Measure Target associated with Coral Reef Jurisdictions (numbered 1-7)	Impact to Corporate Measure
FY10	-19	196	HI, AS visited	?	1 of 7 w/ improved condition	?
FY11	-22	193	HI, GU, CNMI - visited	?	1 of 7 w/ improved condition	?
FY12	-22	193	HI, AS visited	?	2 of 7 w/ improved condition	?
FY13	-22	193	HI, GU, CNMI - visited	?	3 of 7 w/ improved condition	?
FY14	-98	117	HI visited	?	5 of 7 w/ improved condition	?
FY15	-98	117	HI visited	?	7 of 7 w/ improved condition	?
FY16	-98	117	HI visited	?	7 of 7 w/ improved condition	?
FY17	-98	117	HI visited	?	7 of 7 w/ improved condition	?
FY18	-98	117	HI visited	?	7 of 7 w/ improved condition	?
FY19	-98	117	HI visited	?	7 of 7 w/ improved condition	?
FY20	-98	117	HI visited	?	7 of 7 w/ improved condition	?
FY21	-98	117	HI visited	?	7 of 7 w/ improved condition	?
FY22	-98	117	HI visited	?	7 of 7 w/ improved condition	?
FY23	-98	117	HI visited	?	7 of 7 w/ improved condition	?
FY24	-98	117	HI visited	?	7 of 7 w/ improved condition	?

Figure 11. Ship Activities in Coral Reef Areas at Status Quo Capacity

The capability component of this analysis is also challenging to illustrate if all NSVs provide equal capability. Replacing the current ship primarily dedicated to coral reef monitoring, assessment and research with the assumed capability of the new NSV class will not provide an increase capability in for the program. This is because coral reef ecosystem monitoring and assessment in the remote U.S. Pacific jurisdictions are a multidisciplinary effort in order to make the most of limited time on site in the jurisdiction. These efforts include a three person mapping team, 18 scuba divers, and a dive chamber operator. If the projected NSV capabilities remain constant, the program will lose berthing space for at least 6 people. Assuming the reduction of staff are members of the diving team, less monitoring and assessment work will be done per day. NOAA dive safety regulations limit the amount of bottom time per diver, so additional days will be needed to visit all of the required monitoring stations at each coral reef jurisdiction. The additional time required can be recovered by the additional 40 days of operating time per year that the NSV provides compared to the HI'IALAKAI's current schedule. Therefore, no change to the performance measures is anticipated with the replacement of the ship. NOAA understands the importance of working with specific programs as Requirements Definitions are provided at the Ship Design stage of ship construction. There will be a balancing of capabilities depending on the missions that each ship will perform closer to the execution stage

FY07 Projected Capacity Point of Reference	% Δ in Capacity from 215	Assumed Capacity	Ability to get to Coral Reef Jurisdiction by Ship (dependent on transit times)	Observed improved condition of reefs in region	Corporate Measure Target associated with Coral Reef Jurisdictions (numbered 1-7)	Impact to Corporate Measure
FY10	40	255	HI, AS visited	?	1 of 7 w/ improved condition	?
FY11	40	255	HI, GU, CNMI - visited	?	1 of 7 w/ improved condition	?
FY12	40	255	HI, AS visited	?	2 of 7 w/ improved condition	?
FY13	40	255	HI, GU, CNMI - visited	?	3 of 7 w/ improved condition	?
FY14	40	255	HI, AS visited	?	5 of 7 w/ improved condition	?
FY15	40	255	HI, GU, CNMI - visited	?	7 of 7 w/ improved condition	?
FY16	40	255	HI, AS visited	?	7 of 7 w/ improved condition	?
FY17	40	255	HI, GU, CNMI - visited	?	7 of 7 w/ improved condition	?
FY18	40	255	HI, AS visited	?	7 of 7 w/ improved condition	?
FY19	40	255	HI, GU, CNMI - visited	?	7 of 7 w/ improved condition	?
FY20	40	255	HI, AS visited	?	7 of 7 w/ improved condition	?
FY21	40	255	HI, GU, CNMI - visited	?	7 of 7 w/ improved condition	?
FY22	40	255	HI, AS visited	?	7 of 7 w/ improved condition	?
FY23	40	255	HI, GU, CNMI - visited	?	7 of 7 w/ improved condition	?
FY24	40	255	HI, AS visited	?	7 of 7 w/ improved condition	?

Figure 12. Ship Activity in Coral Reef Areas at Capacity as Depicted in all Alternatives

What the impacts mean for the Nation

NOAA is mandated to preserve, sustain, manage, and restore coral reefs for the benefit of local communities and the nation by the Coral Reef Conservation Act. These reef communities have a substantial economic impact; estimates of the annual economic value of coral reefs in the Pacific Islands range from $5.1 milion (for American Samoa, a figure equal to 1.2 percent of their GDP) to $385 million for the reefs of the Main Hawaiian Islands. Monitoring the health of coral reefs is also an important indicator for the health of the ocean's ecosystems overall. NOAA, as a steward of the oceans resources, must protect the biodiversity of coral reefs and inform local officials on best management practices to ensure that the reefs remain healthy and productive for economic, recreational, and cultural use for present and future generations. Those practices must be grounded in sound science from the data collected on the extent, health, and vitality of coral reefs.

Climate Performance Measure Impact

Two overarching GPRA measures for tracking Climate outcomes include: (1) *Reduce the Error in Global Measurement of Sea Surface Temperature* and (2) *U.S. Temperature Forecasts (Cumulative Skill Score Computed over the Regions Where Predictions are made).* Both measures are highly dependent upon retrieving ocean and surface meteorological observations from the tropical Pacific, where NOAA's Tropical Atmosphere and Ocean moorings (TAO) are located. TAO provides direct, real-time observations of ocean conditions that monitor the El Nino-Southern Oscillation, a climate phenomenon that drives regional weather patterns over much of the globe. Observations and predictions of El Niño-Southern Oscillation are essential for NOAA's seasonal climate forecasts.

The KA'IMIMOANA is the only NOAA ship that is dedicated to servicing the TAO array in the tropical Pacific: Reducing the error in the measurement of sea surface temperature encompasses data acquisition for the Climate Program in three primary areas: (1) data from moorings; (2) data from surface drifters; and (3) data from direct ship-based observations. Hence, reducing sea days on the KA'IMIMOANA will not only negatively impact the servicing of the TAO array, it will also negatively impact NOAA's ability to routinely deploy drifting buoys in targeted divergent zones (e.g. the equator) where measurements are sparse, and thus negatively impact NOAA's GPRA performance goals.

Calculating Percentage Change in the Climate GPRA Measure

If operating days are lost on the KA'IMIMOANA, the data return from the moorings and the drifting buoys will decline proportionally. Reduced ship time will result in fewer moorings recovered and redeployed. For example, for each cruise that is not conducted, seven recoveries/deployments and three repairs will not be completed, which is estimated to reduce the data return for the entire array by two percent (1/55 moorings not recovered) and 0.13 percent (assuming 1/13 sensors per mooring not repaired). In the status quo scenario, when the KA'IMIMOANA's useful service life has ended and the operations and maintenance funding is used to contract this mission, the reduction to the data return on the entire array will decrease by 43 percent. Similarly, reduced ship time will mean correspondingly fewer drifting buoys deployed. In 2006, the KA'IMIMOANA deployed 55 drifting buoys; a decrease in sea days is assumed to result in a proportionate loss of buoys deployed, and data lost.

The data return is only part of what goes into the GPRA measure *Reduce the Error in Global Measurement of Sea Surface Temperature.* The sea surface temperature performance measure aims to document NOAA's progress in deploying a global ocean observing system that will effectively minimize the bias errors associated with global satellite measurements of sea surface temperature. NOAA's target is to reduce the error to less than 0.3 degrees Celsius by FY 2009. In FY 2007, the error was 0.53 degrees Celsius. The sea surface temperature performance measure is dependent upon global data streams from the moored buoys, drifting buoys, and direct ship-based observations. At status quo, beginning in FY 2010 the KA'IMIMOANA will have a 31 to 34 day reduction in operating days. This results in a 2 percent decrease in the Climate GPRA measure. For the year 2006, NOAA was able to calculate the impact of reduced measurements in a hindcast mode[78], and compare these results with the actual performance using all available observations. The simulation concluded that if the TAO array in the tropical Pacific is unable to be maintained and/or serviced, NOAA would be unable to sustain the current capability to observe and predict the El Nino-Southern Oscillation. Without these data in 2006, current performance targets would be negatively impacted by 13% over the course of the year. This decrease in GPRA measure is directly correlated with the reduced amount of operating days (-107 operating days) that the KA'IMIMOANA will experience in FY 2019 when it reaches the end of its useful service life at Status Quo and is taken offline due to lack of capital investment.

Assessing the impact of specific increased operating days on the KA'IMIMOANA on the GPRA is more difficult to quantify. Several articles in the peer-reviewed literature highlight the importance of El Nino-Southern Oscillation observations in predicting seasonal to interannual climate variability. However, predictive skill is dependent not only on the data but also on the models used to make the predictions. Resources are not currently available to run the forecasts in a hindcast mode with different scenarios of data loss or gain to accurately quantify the impact of operating days on the seasonal forecast measure. Presently, climate experts at NOAA cannot make a direct correlation that increased operating days equals increased data and a resulting reduction in global error of sea surface temperature.

The capability component impact for Climate performance is also challenging to determine based on the nature of the GPRA measure. Replacing the current ship primarily dedicated to buoy/drifter deployment and maintenance with the assumed capability of the new NSV class will not provide an increase in capability for the program. Assuming the NSV will have mooring recovery/deployment and water column sampling capabilities, the capability will remain constant. However, this will not impact the GPRA measure, which is dependent upon the data collected once the moorings are deployed. Increased vessel speed may decrease the transit times, but will not have a discernible impact on the cruise operations.

Combining both capacity and capability effects, Figure 13 summarizes the overall impact on GPRA measure by alternative in the requirements group that contributes to the *Reduce the Error in Global Measurement of Sea Surface Temperature* performance measure. KA'IMIMOANA requirements group cannot show an impact in increased capability and/or capacity due to the nature of the performance measure. The program can, however, prove a negative impact on the GPRA at status quo at -2 percent beginning in FY 2010 and then -13 percent beginning in FY 2019. This is generally due to the lack of continuous data being collected due to decreased operating days.

Annual % Change in Climate GPRA Measure from FY07 Projected Performance															
	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24
KA - Status Quo	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-13.0%	-13.0%	-13.0%	-13.0%	-13.0%	-13.0%
KA SLE	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Charter	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NSV5														0.0%	0.0%

Figure 13. Annual Percent Change in Climate GPRA Measures

What the impacts mean for the Nation

NOAA's at-sea data collection for its climate mission differs in character from managing living marine resources and ecosystems, but it has no less importance for the economic well-being of the Nation. Indeed, NOAA's climate mission, with it's responsibility for forecasting El Niño and La Niña events in

[78] A hindcast is a way of testing a model. Known or closely estimated inputs for past events are entered into the model to see how well the output matches the known results.

the tropical Pacific Ocean, is often said to be the answer to the Kansas farmer's question "what do ocean observations mean to me?" Agricultural planting decisions are informed with NOAA's forecasts, driven by climate models that are fed data from the TAO array and "drifter' buoys. These forecasts are estimated to provide an annual economic benefit of $265 to $300 million. These climate forecasts have wide-ranging impact on other forecasts, from levels of expected Atlantic hurricane activity to productivity of fishing grounds off of South America's Pacific Coast. NOAA must maintain the capability not only to deploy these "drifter" buoys in the remote Equatorial Pacific region to provide data critical to these climate forecast models.

In addition to the direct economic benefit the data fed into climate forecast models provide to the Nation, maintaining and servicing the TAO array 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 drifters and TAO buoys – ensuring that the satellites are providing accurate data and any errors are accounted for in climate models.

Commerce and Transportation Performance Measure Impact: Hydrographic Surveying

NOAA tracks long-term hydrographic surveying performance using the GPRA goal*: Reduce the Hydrographic Survey Backlog within Navigationally Significant Areas by 2,700 square nautical miles (SNM).* This goal measures NOAA's ability to provide navigation information for safe, secure, efficient, and environmentally sound movement of goods and people in the U.S. marine transportation system (MTS), crucial to the growth of the U.S. economy.

FAIRWEATHER SUMMARY OF AVERAGE SNM PER YEAR

FAIRWEATHER			
Field Season	ODs Accomplished	SNM Accomplished	Average SNM/OD
2005	238	939	3.9
2006	198	575	2.9
2007	207	750	3.6
Total	**643**	**2264**	**3.5**

For 2007, the GPRA goal is 3000 SNM of hydrographic surveying in navigationally significant areas. The average production for 2005, 2006, and 2007 (estimated) is 3.5 SNM per operating day for the FAIRWEATHER and 2.6 SNM per operating days for the RAINIER. The different productivity rates for each vessel are due to special vessel capabilities that are leveraged depending on the type of bathymetry needed.

RAINIER SUMMARY OF AVERAGE SNM PER YEAR

RAINIER			
Field Season	ODs Accomplished	SNM Accomplished	Average SNM/OD
2005	209	621	3.0
2006	216	490	2.3
2007	191	465	2.4
Total	**616**	**1576**	**2.6**

Under the "New Build" alternative, replacing the current ships primarily dedicated to hydrographic surveying and bathymetric mapping with the assumed capability of the new NSV class will increase capacity and capability to meet increased GPRA targets.

Calculating Percentage Change in the Hydrographic Surveying GPRA Measure

A 17.8 percent total GPRA measures increase from current operations to the "New Build" alternative is attributed to four capability improvements: (1) addition of a new state-of-the-art multibeam system (MBES), (2) outfit with a hydrographic AUV suite, (3) addition of a Moving Vessel Profiler (MVP), and (4) increased ship endurance. If compared on a ship by ship basis, the NSV will increase productivity over the current ship by 87 percent. This significant improvement will help survey the navigationally significant backlog in Alaska and the Pacific Northwest.

A 15.3 percent total GPRA increase from current operations to the "New Build" alternative is attributed to three capability improvements: (1) outfit with a hydrographic AUV suite, (2) addition of two hydrographic survey launches, and (3) increased ship endurance. If compared on a ship by ship basis, the NSV will increase productivity over the current ship by 72 percent. This significant improvement will help survey the navigationally significant backlog in Alaska and the Pacific Northwest. Figure 14 provides a summary of the capability increase that NOAA realizes with the "New Build" Alternative on two levels: (1) A ship to ship comparison and (2) Total Effect on the GPRA measure.

Current Ship Dedicated to Nautical Charting and Bathymetry	New Ship	New Ship Capability Increase In SNM	Capability Effect on Total GPRA Measure
RAINIER	NSV 1	87%	17.8%
FAIRWEATHER	NSV 7	72%	15.3%

Figure 14. Summary of Capability Impact to Ship and to Total GPRA Measure

Combining both capacity and capability effects, Figure 15 summarizes the overall impact on GPRA measure by alternative in the two requirements groups that contribute to the hydrographic surveying performance measure. RAINIER requirements group shows the biggest impact with the "New Build" alternative positively increasing the performance measure by 23 percent. This is mostly due to the capability difference between the new and current ship. This increase will not be realized until the delivery of the ship in FY 2019. The FAIRWEATHER requirements group also shows a positive impact in the "New Build" alternative with a 21 percent GPRA measure increase annually. This increase will not be realized until the ship is delivered in FY 2026. If each requirements group was compared to the current status or status quo, the RAINIER and FAIRWEATHER requirements groups would experience a 35 percent and 37 percent increase in GPRA productivity, respectively.

Annual % Change in C&T/MTS GPRA Measure from FY07 Projected Performance															
	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24
RA - Status Quo	-8.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-12.0%	-12.0%	-12.0%	-12.0%	-12.0%	-12.0%	-12.0%	-12.0%	-12.0%
RA SLE	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Charter	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
NSV1										23.0%	23.0%	23.0%	23.0%	23.0%	23.0%
FA - Status Quo	-1.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-16.0%	-16.0%	-16.0%	-16.0%	-16.0%	-16.0%
FA SLE	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Charter	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
NSV7															

Figure 15. Annual Percent Change in Commerce and Transportation GPRA Measures

What the impacts mean for the Nation

The collection of hydrographic data to update nautical charts is a public good provided by NOAA that facilitates safe and efficient navigation. Nautical charts are the road maps of the Nation's water "highways." They enable commercial traffic to travel in and out of US ports; supporting commerce that equals nearly 95 percent of the $3.639 trillion overall US export / import operations.[79] They guide the more than 70 million recreational boaters in the Nation's waterways as well. Accurate and current nautical charts can help prevent environmental damage from groundings (by identifying shoal areas and hazards to navigation),

For Alaska in particular, the capability of new ships will extend NOAA's reach far beyond what is currently feasible. The increased endurance of the replacement ships will enable NOAA hydrographers and littoral scientists to reach areas in the upper Bering Sea and Arctic Slope; areas for which full bottom coverage bathymetric data for nautical charts is nonexistent. This area is home to some of the most productive commercial fisheries in the Nation. With decreasing Arctic ice coverage, this region will likely experience a significant growth in commercial traffic, increasing the risk of environmental damage and economic loss because this area is known to be relatively shallow and hazards to navigation have not been identified. Better data from this region can significantly reduce the risks to the surrounding economy and ecosystems.

Requirements Group Number and Existing Ship	Program Performance of Each Alternative				
	Status Quo	SLE	Charter	New Build	Conversion
1 DAVID STARR JORDAN	Low	Medium	Medium	**High**	Medium
2 OREGON II	Low	Medium	Medium	**High**	NA
3 MILLER FREEMAN	Low	Medium	Medium	**High**	NA
4 RAINIER	Low	Medium	Medium	**High**	NA
5 HI'IALAKAI	Low	NA	NA	NA	NA
6 MCARTHUR II	Low	Medium	Medium	**High**	NA
7 OSCAR SETTE	Low	Medium	Medium	**High**	NA
8 KA'IMIMOANA	Low	NA	NA	NA	NA
9 GUNTER	Low	Medium	Medium	**High**	NA
10 FAIRWEATHER	Low	Medium	Medium	**High**	NA

Figure 16. Summary of Program Performance Impact

Results of Program Performance Analysis

Taking into account the mentioned changes in capability and capacity for different scenarios defined in this report, Figure 17 summarizes the program performance impact based on percentage change in performance measure. It is evident that there is a large gap between "Status Quo," "SLE," "Charter" and "New Build." The PPA found that the "New Build" alternative for eight of the ten requirements groups was most beneficial on a programmatic level in terms of percentage change of GPRA measure. The HI'IALAKAI requirements group could not be linked to a performance measure based on external factors that were beyond ship operations and at-sea data collection. The KA'IMIMOANA requirements group

[79] Source: U.S. Census Bureau, Foreign Trade Statistics, 2006.

showed a negative impact due to loss in capacity but could not illustrate positive impact with increased operating days and ship capability due to the nature of the performance measure and non-direct link to operational requirements. The PPA provides both quantitative and qualitative evidence that all NOAA programs that have at-sea data requirements will benefit from an increase in ship capacity and capability. This impact was taken into account when an investment strategy and recommended recapitalization plan was developed.

Requirements Group Summary of Annual % Change in GPRA Measure from FY07 Projected Performance

	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24
DJ - Status Quo	-0.9%	offline													
DJ SLE	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
Charter	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%
FSV6					19.8%	19.8%	19.8%	19.8%	19.8%	19.8%	19.8%	19.8%	19.8%	19.8%	19.8%
ASSERTIVE		8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%
R2 - Status Quo	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%	-0.4%
R2 SLE	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
Charter	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
FSV5						7.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%	7.4%
MF - Status Quo	-6.3%	-6.3%	-6.3%	-6.3%	-6.3%	-6.3%	-6.3%	-7.1%	-6.8%	-6.8%	-6.8%	-7.1%	-6.8%	-6.8%	-6.8%
MF SLE	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
Charter	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%
FSV7									1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%
RA - Status Quo	-8.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-12.0%	-12.0%	-12.0%	-12.0%	-12.0%	-12.0%	-12.0%	-12.0%	-12.0%
RA SLE	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Charter	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
NSV1										23.0%	23.0%	23.0%	23.0%	23.0%	23.0%
HA - Status Quo	Not possible to quantify impact based on GPRA or Corporate Performance measure at this point; see qualitative impact in this section for Corals Program														
HA SLE															
Charter															
NSV2															
M2 - Status Quo	-0.4%	-0.5%	-0.5%	-0.5%	-4.0%	-2.7%	-2.7%	-2.7%	-4.4%	-2.7%	-2.7%	-2.7%	-4.4%	-2.7%	-2.7%
M2 SLE	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
Charter	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
NSV3													10.2%	10.2%	10.2%
SE - Status Quo	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%	-3.5%	-3.0%	-3.0%	-3.0%	-3.5%	-3.0%	-3.0%	-3.0%
SE SLE	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
Charter	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
NSV4														5.6%	5.6%
KA - Status Quo	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-13.0%	-13.0%	-13.0%	-13.0%	-13.0%	-13.0%
KA SLE	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Charter	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
NSV5														0.0%	0.0%
GU - Status Quo	-0.1%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-0.6%	-3.0%	-2.1%	-2.1%	-2.1%	-3.0%	-2.1%
GU SLE	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
Charter	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
NSV6															5.5%
FA - Status Quo	-1.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-2.0%	-16.0%	-16.0%	-16.0%	-16.0%	-16.0%	-16.0%
FA SLE	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Charter	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
NSV7															

Figure 17. Results of Percentage Impact of all Requirements Groups by Alternative; FY 2010 to FY 2024

Chapter 12

INVESTMENT STRATEGY AND RECOMMENDED PLAN

NOAA's Ship Recapitalization Plan provides an end-to-end process identifying (1) data collection requirements and the operational needs to support them, (2) current status of ship condition, capability and capacity, (3) alternative methods to meet requirements, (4) high priority requirements that are currently unmet, and (5) the cost to sustain NOAA's at-sea data collection requirements. While total cost is a significant factor that drives capital decision making; it is not the only factor considered. NOAA also takes into account other variables such as mission effectiveness, risk, and benefit to the Nation. Sustainability of operations and performance is a high priority within NOAA. This plan not only provides an in-depth view of the benefits of recapitalizing NOAA's fleet of ships, but the challenges NOAA will face if capital investment is not made and the impact on the Nation if the at-sea data collection that drives critical science and stewardship degrades.

The approach taken to develop the recommended NOAA Ship Recapitalization Plan was:

***Step 1*:** Defined important factors considered in the investment strategy

***Step 2*:** Ranked alternatives within each Requirements Group based on factors

***Step 3*:** Developed recommended plan

Step 4: Calculated benefit to Nation

***Step 1*. Definition of Factors for Investment Strategy Approach**

The following factors were considered as the investment strategy for the plan was developed:

- Cost to the Nation
- Risk to NOAA people and the Nation
- Mission effectiveness and program performance within NOAA
- Benefit to the Nation

Cost to the Nation is defined as the total cost of investment to recapitalize NOAA's fleet of ships. NOAA conducted an economic analysis to identify the least cost alternative to meet the portion of requirements currently being met as well as other high priority requirements that are currently not being met. The alternative with the lowest cost provides the most cost-effective alternative for NOAA to meet critical requirements and the alternative with the highest cost provides the least cost-effective option. Nine of ten requirements groups show that the "New Build" alternative provides the lowest cost option while one requirements group (KA'IMIMOANA) shows that the "SLE" alternative is the lowest cost option.

Risk is defined in this document as the relative likelihood that each alternative will be able to provide the intended capacity and capability to collect data required by NOAA programs. The probability data required for a quantitative risk analysis are not available, therefore, a qualitative assessment of relative risk by alternative was developed. The alternative with low risk has the highest likelihood of providing the intended capacity and capability and the alternative with high risk has the lowest likelihood of providing the intended capacity and capability. The "New Build" alternative provides the lowest risk option.

Mission Effectiveness is defined by three variables: (1) Impact to NOAA GPRA measure, (2) Total number of operating days to support NOAA programs, and (3) Ship suitability defined by the quantity and quality of data collected. In the Program Performance Analysis, GPRA measure impacts were quantified by alternative within each requirements group. The "New Build" alternative demonstrates the largest impact on GPRA results overall due to the increased capability to meet mission requirements. The total number of operating days is consistent throughout all alternatives in the Requirements Groups providing 255 operating days per year. Ship suitability encompasses how well the ship meets NOAA missions. Technology and cost efficiency and effectiveness maximize the data per dollar collected on the ship and enhance the overall ability of NOAA ships to collect at-sea data.

These three factors were defined, individually ranked and incorporated into NOAA's approach for ship recapitalization. The alternative with high performance has the highest likelihood of providing the most value-added service to NOAA and the Nation and the alternative with low performance has the lowest likelihood of providing value-added service. The "New Build" alternative provides the highest performance option.

***Step 2.* Ranking Alternatives based on Investment Strategy Factors**

Cost Ranking

Requirements group number and existing ship	Cost Ranking of Each Alternative			
	SLE	Charter	New Build	Conversion
1 DAVID STARR JORDAN	Medium	High	**Low**	High
2 OREGON II	Medium	High	**Low**	NA
3 MILLER FREEMAN	Medium	High	**Low**	NA
4 RAINIER	Medium	High	**Low**	NA
5 HI'IALAKAI	Medium	High	**Low**	NA
6 MCARTHUR II	Medium	High	**Low**	NA
7 OSCAR SETTE	Medium	High	**Low**	NA
8 KA'IMIMOANA	**Low**	Medium	High	NA
9 GUNTER	Medium	High	**Low**	NA
10 FAIRWEATHER	Medium	High	**Low**	NA

Risk Ranking

Requirements group number and existing ship	Relative Risk of Each Alternative			
	SLE	Charter	New Build	Conversion
1 DAVID STARR JORDAN	High	High	**Low**	Medium
2 OREGON II	High	High	**Low**	NA
3 MILLER FREEMAN	High	High	**Low**	NA
4 RAINIER	High	High	**Low**	NA
5 HI'IALAKAI	Medium	High	**Low**	NA
6 MCARTHUR II	Medium	High	**Low**	NA
7 OSCAR SETTE	Medium	High	**Low**	NA
8 KA'IMIMOANA	Medium	High	**Low**	NA
9 GUNTER	Medium	High	**Low**	NA
10 FAIRWEATHER	High	High	**Low**	NA

Mission Effectiveness Ranking based on Program Performance Analysis

Requirements Group Number and Existing Ship	GPRA Measure Impact to NOAA				
	Status Quo	SLE	Charter	New Build	Conversion
1 DAVID STARR JORDAN	Low	Medium	Medium	**High**	Medium
2 OREGON II	Low	Medium	Medium	**High**	NA
3 MILLER FREEMAN	Low	Medium	Medium	**High**	NA
4 RAINIER	Low	Medium	Medium	**High**	NA
5 HI'IALAKAI	Low	NA	NA	NA	NA
6 MCARTHUR II	Low	Medium	Medium	**High**	NA
7 OSCAR SETTE	Low	Medium	Medium	**High**	NA
8 KA'IMIMOANA	Low	NA	NA	NA	NA
9 GUNTER	Low	Medium	Medium	**High**	NA
10 FAIRWEATHER	Low	Medium	Medium	**High**	NA

Step 3. Recommended Plan

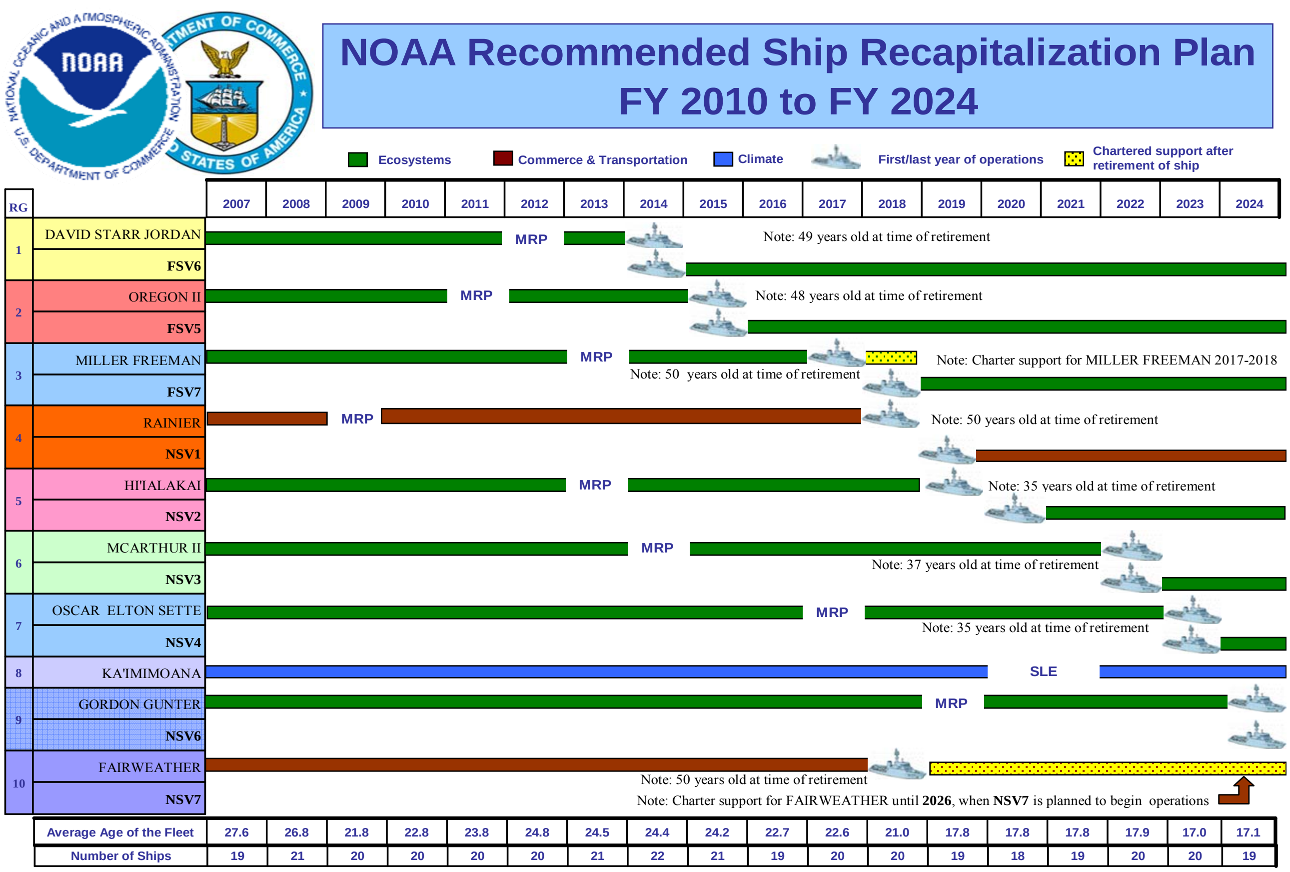


Figure 1. NOAA Recommended Ship Recapitalization Plan FY 2010 to FY 2024

Step 4. Benefit to Nation

While economic, risk and performance analyses have determined the appropriate plan for ship recapitalization, calculating the resulting benefit to the Nation is integral to justifying the large capital investment needed to sustain and augment NOAA's ability to collect at-sea data.

Ocean and coastal ecosystems are crucial to sustainable economic development and societal well-being. Marine ecosystems provide employment opportunities in a wide range of sectors including the commercial fishing industry, marine recreation and tourism, shipbuilding, passenger and cargo transport, and oil and natural gas exploration. In 2004, these sectors supported over 2.3 million jobs with an annual payroll of $63 billion and contributed in excess of $138 billion to gross domestic product (GDP) across all coastal states. In addition, healthy ocean and coastal ecosystems provide other services to the public, e.g., seafood safety, food security, and recreational opportunities and are home to unique, publicly-valued national trust resources such as marine protected species and corals. The value of the goods and services derived from the marine sector and their contribution to vital, sustainable coastal economies and societal well-being, depends in no small part to the science information and management activities undertaken by NOAA.

There is a strong economic basis for ensuring sustainable fishing opportunities and maintaining and recovering stocks of marine protected species. Marine protected species are valued at over $21 billion (see Figure 2; shaded rows are regions not covered by ships in this plan), and in 2006 the commercial fishing industry contributed over $35 billion to gross national product (GNP) and the recreational fishing industry contributed $16.7 billion to GNP (see Table 2; regions in bold are covered by ships in this plan).[80]

	Marine Protected Species *(values in billions of dollars)*
Alaska	**4.7**
West Coast	**8.9**
Gulf of Mexico	**1.8**
South Atlantic	**2.4**
North Atlantic	2.4
Pacific Islands	**1.4**

Figure 2. Value of Marine Protected Species by Ecosystem

While the economic importance of fishing activities varies by region, the contribution of fishing to all regions is sizable. The Magnuson-Stevens Conservation and Management Reauthorization Act (MSRA) requires the establishment of Annual Catch Limits (ACLs) on all Federally-managed stocks by 2011. Where stock assessment precision is low, ACLs must be set conservatively to avoid the potential of overfishing any stock. The potential annual economic consequences of the new ACL requirement are shown in the final column of Figure 3. The large platform capacity provided by FSVs and NSVs and, in particular, their special capabilities (diver/remote underwater vehicle support, dynamic positioning, and,

[80] Note that of the $35 billion in GNP generated by the commercial fishing industry, approximately $20 billion is directly attributable to domestic harvests, which is the estimate used in Table 1 below for total contribution of commercial fishing to the U.S. economy. In addition, note that the protected species value were obtained for only a limited set of marine protected species (7 species) and then aggregated. Thus, the estimate cited does not represent a true National valuation of all marine protected species.

especially, noise-quieted machinery and advanced acoustic systems, the latter of which is not available on charter vessels) are critical if NOAA is going to successfully provide the scientific information required to comply with MSRA.

	Estimated Contribution of Commercial Fishing to GNP	Estimated Contribution of Recreational Fishing to GNP	Total Contribution of Fishing to GNP	Potential Decrease in GNP due to overly restrictive ACLs
Alaska[81]	**$6.5B**	**0**	**$6.5B**	**$1.6B**
West Coast	**$2.2B**	**$1.5B**	**$3.7B**	**$928M**
Gulf of Mexico	**$3.3B**	**$6.0B**	**$9.4B**	**$2.3B**
South Atlantic	**$1.7B**	**$6.0B**	**$7.8B**	**$1.9B**
North Atlantic	$5.7B	$2.4B	$8.1B	$2.0B
Hawaii	**$326M**	**$669.2M**	**$1B**	**$248.7M**
Total			**$36.5B**	**$9B**

Figure 3. Contribution of Commercial & Recreational Fishing to GNP by Ecosystem

In addition to living marine resource management, NOAA's hydrographic surveying effort is a critical component of the Federal infrastructure underlying the ports, waterways and shipping lanes of the U.S. Marine Transportation System (MTS). International trade of goods moving through US ports has a tremendous impact on the national economy. Over $2.8 trillion worth of merchandise moves through US ports.[82] In 2004, the marine transportation and cargo transport sector supported over 300,000 jobs with an annual payroll of $19 billion and contributed $28 billion to gross domestic product (GDP) across all coastal states. NOAA's hydrographic surveys and nautical charts enable 8000 foreign and U.S. flag ships (and 70 million recreational boaters) to travel safely and efficiently on our "water highways." In particular, the $15 billion increase in merchandise trade through Alaska and the west coast from 2005 to 2006 may be attributed at least in part to the 1,560 square nautical miles of waters mapped in these regions during 2005.

NOAA's responsibilities for managing coral reef ecosystems and the National Marine Sanctuaries are dependent also upon data collected with NOAA ships. Maintaining and restoring healthy coral reefs and sanctuaries improve the health and vitality of the local ecosystems, and an important part of management is mapping to fully understand ecosystem extent and composition. The National Marine Sanctuaries are estimated to provide an economic benefit to the Nation of an estimated $12.6 million annually, while the coral reefs of the Pacific Islands are estimated to be provide an annual economic benefit valued anywhere from to $5.1 million (for American Samoa, a figure equal to 1.2 percent of their GDP) to $385 million annually (reefs around the Main Hawaiian Islands).[83]

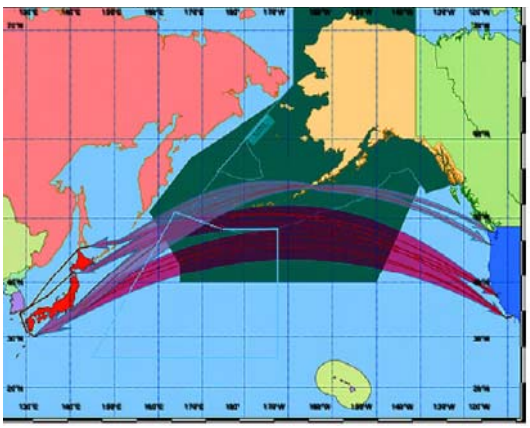
NOAA's climate prediction mission also has a significant economic impact on the Nation's economy. The servicing of moored TAO array buoys in the Pacific Ocean, as well as the deployment of data-collecting "drifter" buoys, feed oceanographic data and provide in situ validation of satellite data that drive El Niño/La Niña forecasting models. One example of the economic impact of these forecasts is

[81] No information currently available on recreational fishing effort or angler expenditures.
[82] Source: U.S. Census Bureau, Foreign Trade Statistics, 2006.
[83] Results from the Coral Reef Task Force Workshop "Economic Valuation of Coastal Resources – Applying Research and Results into Action." August 2007.
http://www.coralreef.gov/taskforce/pdf/evagenda_samoa_2007.pdf

their contribution to the planting decisions of the US agricultural sector, providing an estimated $265 to $300 million annual economic benefit. Without regular deployment of “drifters” in the equatorial region, the quality and quantity of data collected from drifters diminishes within months.

To illustrate the importance of the NOAA research vessels to the coastal economies of the Nation, consider how the scientific information obtained by the research cruises support industries critical to the Alaska economy. The commercial fishing industry is the largest private employer in Alaska causing fishery management decisions to have broad economic implications for the state. Further, while the Alaskan fisheries are among the highest value in the Nation, the lack of economic diversity in fishing communities coupled with high unemployment rates and poverty rates (100 percent and 30 percent higher than the national average, respectively) further bolsters the need for ensuring fishery management decisions are made with the best available scientific information. That is, management decisions based on poor scientific information can have far reaching adverse economic consequences for an acutely vulnerable population

Figure 4. Map showing the “Great Circle Route” traversing through or near Alaska. Source: USCG Maritime Domain Awareness Center



In addition, more than 3000 ships per year pass through Alaska's Aleutian Islands while traveling between North America and Asia via the "Great Circle Route."[84] Safe and efficient travel through these remote and environmentally sensitive areas is dependent upon critical hydrographic survey data and NOAA charts of these waters. NOAA has identified 10,000 square nautical miles in Alaskan waters that are in critical need of survey or resurvey due to changes from earthquakes, glacial melt, transit patterns and age of prior surveys

Beyond protecting and promoting the economic value of the resources for which NOAA has management responsibilities, NOAA provides services that have a value beyond dollars and cents. The flexibility to rapidly deploy assets and expertise in response to an emergency situation, such as after Hurricane Katrina when NOAA sent ships THOMAS JEFFERSON and NANCY FOSTER to reopen waterways and ensure the safety of local seafood, minimizes the disruption and impact to the national economy, but also helps local communities recover more quickly.

NOAA’s stewardship responsibility ensures that the cultural, recreational, and historical significance of the oceans’ resources endures for future generations to enjoy. Investing in NOAA assets whose dedicated mission promotes both economic and social values is an investment worth making.

[84] Vessel Traffic in the Aleutians Subarea” Updated Report to the Alaska Department of Environmental Conservation. Prepared by Nuka Research Group LLC and Cape InterNational, Inc. http://www.dec.state.ak.us/spar/perp/docs/060920vesselreport_s.pdf

APPENDICES

Appendix A – Requirements Drivers

MAJOR LEGAL MANDATES, AUTHORITIES AND POLICIES

ECOSYSTEMS

CORAL REEF CONSERVATION ACT of 2000 16 U.S.C§6401 (Pub .L.106-562)

Charges the Administrator of NOAA to preserve, sustain, and restore the condition of coral reef ecosystems; promote the wise management and sustainable use of coral reefs; develop sound scientific information on the condition and threats to coral reefs; support conservation programs, and provide financial resources for coral reef conservation and management projects

Relevant excerpts:

SEC. 202. FINDINGS AND PURPOSES.

(b) The purposes of this title are—
(1) to preserve, sustain, and restore the condition of coral reef ecosystems;
(2) to promote the wise management and sustainable use of coral reef ecosystems to benefit local communities, the Nation, and the world;
(3) to develop sound scientific information on the condition of coral reef ecosystems and the threats to such ecosystems;

SEC. 208. NATIONAL PROGRAM.

(a) IN GENERAL.— Subject to the availability of appropriations, the Secretary may conduct activities, including with local, regional, or international programs and partners, as appropriate, to conserve coral reef ecosystems, that are consistent with this title, the National Marine Sanctuaries Act, the Coastal Zone Management Act of 1972, the Magnuson-Stevens Fishery Conservation and Management Act, the Endangered Species Act of 1973, and the Marine Mammal Protection Act of 1972.
(b) AUTHORIZED ACTIVITIES.— Activities authorized under subsection (a) include—
(1) mapping, monitoring, assessment, restoration, socioeconomic and scientific research that benefit the understanding, sustainable use, biodiversity, and long-term conservation of coral reef ecosystems;
(2) enhancing public awareness, education, understanding, and appreciation of coral reef ecosystems;
(3) removing, and providing assistance to States in removing, abandoned fishing gear, marine debris, and abandoned vessels from coral reefs ecosystems to conserve living marine resources;
(4) responding to incidents and events that threaten and damage coral reef ecosystems, including disease and bleaching;
(5) cooperative conservation and management of coral reef ecosystems; and
(6) centrally archiving, managing, and distributing data sets and providing coral reef ecosystem assessments and services to the general public. with local, regional, or international programs and partners.

ENDANGERED SPECIES ACT 16 U.S.C. §§ 1531-1544 (Pub. L. 93-205, reauthorized in 1992)

Requires NOAA to evaluate the status of species (or lower taxons) and determine whether or not the species is threatened or endangered; to designate critical habitat; and to evaluate Federal actions and ensure that these actions do not jeopardize the continued existence of threatened or endangered species or adversely modify critical habitat. The information standard for the ESA is the best available scientific information.

Relevant excerpts:

SEC. 1533. Determination of endangered species and threatened species

(a) Generally

(1) The Secretary shall by regulation promulgated in accordance with subsection (b) of this section determine whether any species is an endangered species or a threatened species because of any of the following factors:

(A) The present or threatened destruction, modification, or curtailment of its habitat or range;

(B) Overutilization for commercial, recreational, scientific, or educational purposes;

SEC. 1533. Determination of endangered species and threatened species

(b) Basis for determinations

(2) The Secretary shall designate critical habitat, and make revisions thereto, under subsection (a)(3) of this section on the basis of the best scientific data available and after taking into consideration the economic impact, the impact on national security, and any other relevant impact, of specifying any particular area as critical habitat. The Secretary may exclude any area from critical habitat if he determines that the benefits of such exclusion outweigh the benefits of specifying such area as part of the critical habitat, unless he determines, based on the best scientific and commercial data available, that the failure to designate such area as critical habitat will result in the extinction of the species concerned.

SEC. 1533. Determination of endangered species and threatened species

(f) Recovery plans

(1) The Secretary shall develop and implement plans (hereinafter in this subsection referred to as "recovery plans") for the conservation and survival of endangered species and threatened species listed pursuant to this section, unless he finds that such a plan will not promote the conservation of the species. The Secretary, in developing and implementing recovery plans, shall, to the maximum extent practicable

(A) Give priority to those endangered species or threatened species, without regard to taxonomic classification, that are most likely to benefit from such plans, particularly those species that are, or may be, in conflict with construction or other development projects or other forms of economic activity;

(B) Incorporate in each plan -

(i) A description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species;

(ii) Objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list; and

(iii) Estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal.

EXECUTIVE ORDER 13158 of May 26, 2000 Marine Protected Areas

Relevant excerpt:

"The purpose of this order is to, consistent with domestic and international law: (a) strengthen the management, protection, and conservation of existing marine protected areas and establish new or expanded MPAs; (b) develop a scientifically based, comprehensive national system of MPAs representing diverse U.S. marine ecosystems, and the Nation's natural and cultural resources; and (c) avoid causing harm to MPAs through federally conducted, approved, or funded activities....Each Federal agency whose authorities provide for the establishment or management of MPAs shall take appropriate actions to enhance or expand protection of existing MPAs and establish or recommend, as appropriate, new MPAs. Agencies implementing this section shall consult with the agencies identified in subsection 4(a) of this order, consistent with existing requirements."

HARMFUL ALGAL BLOOM AND HYPOXIA RESEARCH AND CONTROL ACT OF 1998 16 U.S.C. §1451; P.L. 105-383, reauthorized in 2004

Charges NOAA to advance the scientific understanding and ability to detect, monitor, assess, and predict Harmful Algal Blooms and to develop programs for research into methods of prevention, control, and mitigation of harmful algal blooms.

Relevant excerpts:

SEC. 104. LOCAL AND REGIONAL SCIENTIFIC ASSESSMENTS. Section 603 of such Act, as amended by Section 103, is further amended by adding at the end the following: ''(e) LOCAL AND REGIONAL SCIENTIFIC ASSESSMENTS.—
(1) IN GENERAL.—The Secretary of Commerce, in coordination with the Task Force and appropriate State, Indian tribe, and local governments, to the extent of funds available, shall provide for local and regional scientific assessments of hypoxia and harmful algal blooms, as requested by States, Indian tribes, and local governments, or for affected areas as identified by the Secretary. If the Secretary receives multiple requests, the Secretary shall ensure, to the extent practicable, that assessments under this subsection cover geographically and ecologically diverse locations with significant ecological and economic impacts from hypoxia or harmful algal blooms. The Secretary shall establish a procedure for reviewing requests for local and regional assessments. The Secretary shall ensure, through consultation with Sea Grant Programs, that the

findings of the assessments are communicated to the appropriate State, Indian tribe, and local governments, and to the general public.

(2) PURPOSE.—Local and regional assessments shall examine—
(A) the causes and ecological consequences, and the economic cost, of hypoxia or harmful algal blooms in that area;
(B) potential methods to prevent, control, and mitigate hypoxia or harmful algal blooms in that area and the potential ecological and economic costs and benefits of such methods

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT REAUTHORIZATION ACT 16 U.S.C. §§ 1801-1882 (Pub. L. 101-627, reauthorized by Pub. L. 109-479 in 2006)

Amends the Magnuson-Stevens Fishery Conservation and Management Act to authorize activities to promote improved monitoring and compliance for high seas fisheries, or fisheries governed by international fishery management agreements, and for other purposes.

Relevant excerpts:

SEC. 1802. Definitions

(29) The terms "overfishing" and "overfished" mean a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the maximum sustainable yield on a continuing basis.

SEC. 1851. National standards for fishery conservation and management

(a) In general

Any fishery management plan prepared, and any regulation promulgated to implement any such plan, pursuant to this subchapter shall be consistent with the following national standards for fishery conservation and management:

(1) Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.

(2) Conservation and management measures shall be based upon the best scientific information available.

(3) To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

(4) Conservation and management measures shall not discriminate between residents of different States. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocation shall be (A) fair and equitable to all such fishermen; (B) reasonably calculated to promote conservation; and (C) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

(5) Conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.

(6) Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

(7) Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

SEC. 1852. Regional fishery management councils

(h) Functions:

Each Council shall, in accordance with the provisions of this chapter -

(1) for each fishery under its authority that requires conservation and management, prepare and submit to the Secretary

(A) a fishery management plan, and (B) amendments to each such plan that are necessary from time to time (and promptly whenever changes in conservation and management measures in another fishery substantially affect the fishery for which such plan was developed);

SEC. 1853. Contents of fishery management plans

Any fishery management plan which is prepared by any Council, or by the Secretary, with respect to any fishery, shall -

(A) necessary and appropriate for the conservation and management of the fishery, to prevent overfishing and rebuild overfished stocks, and to protect, restore, and promote the long-term health and stability of the fishery;

MARINE MAMMAL PROTECTION ACT 16 U.S.C. §§ 1361-1421 (Pub. L. 92-522, as amended in 2006)

The Marine Mammal Protection Act addresses species management.

Relevant excerpts:

SEC. 1362. Definitions

For the purposes of this chapter—

(1) The term “depletion” or “depleted” means any case in which—

(A) The Secretary, after consultation with the Marine Mammal Commission and the Committee of Scientific Advisors on Marine Mammals established under subchapter III of this chapter determines that a species or population stock is below its optimum sustainable population;

(B) A State, to which authority for the conservation and management of a species or population stock is transferred under section 1379 of this title, determines that such species or stock is below its optimum sustainable population; or

(C) a species or population stock is listed as an endangered species or a threatened species under the Endangered Species Act of 1973 [16 U.S.C. 1531 et seq.].

MARINE PROTECTION, RESEARCH AND SANCTUARIES ACT of 1972 – 16 U.S.C. § 1431 et seq, as amended through P.L.106-513

Directs NOAA to support, promote and coordinate scientific research on, and long-term monitoring of the resources of these marine areas, and evaluate the implementation of each sanctuary's management plan and goals.

Relevant excerpts:

16 U.S.C. § 1433. Sanctuary designation standards

(a) Standards
The Secretary may designate any discrete area of the marine environment as a national marine sanctuary and promulgate regulations implementing the designation if the Secretary determines that—
(1) the designation will fulfill the purposes and policies of this chapter;
(2) the area is of special national significance due to—
(A) its conservation, recreational, ecological, historical, scientific, cultural, archaeological, educational, or esthetic qualities;
(B) the communities of living marine resources it harbors; or
(C) its resource or human-use values;

(b) Factors and consultations required in making determinations and findings
(1) Factors
For purposes of determining if an area of the marine environment meets the standards set forth in subsection (a) of this section, the Secretary shall consider—
(A) the area's natural resource and ecological qualities, including its contribution to biological productivity, maintenance of ecosystem structure, maintenance of ecologically or commercially important or threatened species or species assemblages, maintenance of critical habitat of endangered species, and the biogeographic representation of the site;
(J) the area's scientific value and value for monitoring the resources and natural processes that occur there;

16 U.S.C. § 1437. Enforcement

(a) In general
The Secretary shall conduct such enforcement activities as are necessary and reasonable to carry out this chapter.
(b) Powers of authorized officers
Any person who is authorized to enforce this chapter may—

(1) board, search, inspect, and seize any vessel suspected of being used to violate this chapter or any regulation or permit issued under this chapter and any equipment, stores, and cargo of such vessel;

16 U.S.C. § 1440. Research, monitoring, and education

(a) In general
The Secretary shall conduct, support, or coordinate research, monitoring, evaluation, and education programs consistent with subsections (b) and (c) of this section and the purposes and policies of this chapter.

(b) Research and monitoring
(1) In general
The Secretary may—
(A) support, promote, and coordinate research on, and long-term monitoring of, sanctuary resources and natural processes that occur in national marine sanctuaries, including exploration, mapping, and environmental and socioeconomic assessment;
(B) develop and test methods to enhance degraded habitats or restore damaged, injured, or lost sanctuary resources;
(C) support, promote, and coordinate research on, and the conservation, curation, and public display of, the cultural, archeological, and historical resources of national marine sanctuaries.
.
(c) Education
(1) In general
The Secretary may support, promote, and coordinate efforts to enhance public awareness, understanding, and appreciation of national marine sanctuaries and the System. Efforts supported, promoted, or coordinated under this subsection must emphasize the conservation goals and sustainable public uses of national marine sanctuaries and the System.
(2) Educational activities
Activities under this subsection may include education of the general public, teachers, students, national marine sanctuary users, and ocean and coastal resource managers.

NATIONAL SEA GRANT COLLEGE PROGRAM ACT 33 U.S.C. § 1121 et seq, as amended through P.L. 107-299

Relevant excerpts:

SEC. 1123. National Sea Grant College Program

b) Program elements

The national sea grant college program shall consist of the financial assistance and other activities authorized in this subchapter, and shall provide support for the following elements--
(1) sea grant programs which comprise a national sea grant college program network, including international projects conducted within such programs;
(2) administration of the national sea grant college program and this subchapter by the national sea grant office, the Administration, and the panel
(3) the fellowship program under Section 1127 of this title; and

(4) any national strategic investments in fields relating to ocean, coastal, and Great Lakes resources developed with the approval of the panel, the sea grant colleges, and the sea grant institutes.

SEC. 1126. Sea grant colleges and sea grant institutes

(a) Designation

(1) A sea grant college or sea grant institute shall meet the following qualifications—
(A) have an existing broad base of competence in fields related to ocean, coastal, and Great Lakes research
(B) make a long-term commitment to the objective in Section 1121(b) of this title, as determined by the Secretary
(C) cooperate with other sea grant colleges and institutes and other persons to solve problems or meet needs relating to ocean, coastal, and Great Lakes resources;
(D) have received financial assistance under Section 1124 of this title;
(E) be recognized for excellence in fields related to ocean, coastal, and Great Lakes resources (including marine resources management and science), as determined by the Secretary; and
(F) meet such other qualifications as the Secretary, in consultation with the panel, considers necessary or appropriate.

(2) The Secretary may designate an institution, or an association or alliance of two or more such institutions, as a sea grant college if the institution, association, or alliance-
(A) meets the qualifications in paragraph (1); and
(B) maintains a program of research, advisory services, training, and education in fields related to ocean, coastal, and Great Lakes resources.

PRESIDENTIAL PROCLAMATION 8031 - Papahanaumokuakea Marine National Monument (formerly Northwestern Hawaiian Islands Marine National Monument) (71 FR 36443, June 26, 2006), as amended by P.P. 8112 (72 FR 10031, March 5, 2007).

In the Pacific Ocean northwest of the principal islands of Hawaii lies an approximately 1,200 nautical mile stretch of coral islands, seamounts, banks, and shoals. This diverse ecosystem is home to many species of coral, fish, birds, marine mammals, and other flora and fauna including the endangered Hawaiian monk seal, the threatened green sea turtle, and the endangered leatherback and hawksbill sea turtles. In addition, this area has great cultural significance to Native Hawaiians and a connection to early Polynesian culture worthy of protection and understanding. I, President of the United States of America, by the authority vested in me by Section 2 of the Act of June 8, 1906 (34 Stat. 225, 16 U.S.C. 431), do proclaim that there are hereby set apart and reserved as the Northwestern Hawaiian Islands Marine National Monument for the purpose of protecting the objects described above. The Federal land and interests in land reserved includes approximately 139,793 square miles of emergent and submerged lands and waters of the Northwestern Hawaiian Islands, which is the smallest area compatible with the proper care and management of the objects to be protected.

Relevant excerpts:

The Secretary of Commerce, through the National Oceanic and Atmospheric Administration (NOAA), will have primary responsibility regarding management of the marine areas, in consultation with the Secretary of the Interior.

The Secretary of Commerce and the Secretary of the Interior (collectively, the ''Secretaries'') shall review and, as appropriate, modify the interagency agreement developed for coordinated management of the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, signed on May 19, 2006. To manage the monument, the Secretary of Commerce, in consultation with the Secretary of the Interior and the State of Hawaii, shall modify, as appropriate, the plan developed by NOAA's National Marine Sanctuary Program through the public sanctuary designation process, and will provide for public review of that plan. To the extent authorized by law, the Secretaries, acting through the FWS and NOAA, shall promulgate any additional regulations needed for the proper care and management of the objects identified above.

CLIMATE

GLOBAL CHANGE RESEARCH ACT OF 1990

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.

Relevant excerpts:

SEC. 101. FINDINGS AND PURPOSE.

(a) FINDINGS- The Congress makes the following findings:

(4) Development of effective policies to abate, mitigate, and cope with global change will rely on greatly improved scientific understanding of global environmental processes and on our ability to distinguish human-induced from natural global change

(b) PURPOSE- The purpose of this title is to provide for development and coordination of a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change.

(c) RESEARCH ELEMENTS- The Plan shall provide for, but not be limited to, the following research elements:

(1) Global measurements, establishing worldwide observations necessary to understand the physical, chemical, and biological processes responsible for changes in the Earth system on all relevant spatial and time scales.

IMPLEMENTATION PLAN FOR THE GLOBAL OBSERVING SYSTEM FOR CLIMATE IN SUPPORT OF THE UNFCCC (GCOS-92, October 2004)

The plan lays out specific recommendations for an effective ocean observing system for climate. It 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 sustained operations....Without urgent action to address these finding, the Parties will lack the information necessary to effectively plan for and manage their response to climate change."

Relevant excerpts:

Section 5. Oceanic Climate Observing System**.** There is a pressing need to obtain global coverage [of the oceans] using proven observing technologies, to establish telecommunications and data management infrastructure, and to enhance ocean analysis and reanalysis capacity . . . Attaining and sustaining global coverage is the most significant challenge for the oceanic climate observing system. This challenge will only be met through national commitments to the global implementation and maintenance effort and with international coordination . . .

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT REAUTHORIZATION ACT 16 U.S.C. §§ 1801-1882 (Pub. L. 101-627, reauthorized by Pub. L. 109-479 in 2006)

Mandates that NOAA manage commercial and recreational fishery stocks in the U.S. EEZ and encourages an ecosystem approach to fisheries management

Relevant excerpts:

16 U.S.C. 1881c 104-297 SEC. 404 Fisheries Research
(a) IN GENERAL.—The Secretary shall initiate and maintain, in cooperation with the Councils, a comprehensive program of fishery research to carry out and further the purposes, policy, and provisions of this Act. Such program shall be designed to acquire knowledge and information, including statistics, on fishery conservation and management and on the economics and social characteristics of the fisheries.

(c) AREAS OF RESEARCH**.**--Areas of research are as follows:
(1) Research to support fishery conservation and management, including but not limited to, biological research concerning the abundance and life history parameters of stocks of fish, the interdependence of fisheries or stocks of fish, the identification of essential fish habitat, the impact of pollution on fish populations, the impact of wetland and estuarine degradation, and other factors affecting the abundance and availability of fish.

NATIONAL CLIMATE PROGRAM ACT (As enacted by Public Law 95–367 (Sept. 17, 1978) [As Amended Through P.L. 106–580, Dec. 29, 2000]

Authorizes global data collection, and monitoring and analysis activities to provide reliable, useful and readily available information on a continuing basis.

Relevant excerpts:

SEC. 3. 15 U.S.C. 2902 PURPOSE. It is the purpose of the Congress in this Act to establish a national climate program that will assist the Nation and the world to understand and respond to natural and man-induced climate processes and their implications.

SEC. 5. NATIONAL CLIMATE PROGRAM
(1) assessments of the effect of climate on the natural environment, agricultural production, energy supply and demand, land and water resources, transportation, human health and national security. Such assessments shall be conducted to the maximum extent possible by those Federal agencies having national
programs in food, fiber, raw materials, energy, transportation, land and water management, and other such responsibilities, in accordance with existing laws and regulations. Where appropriate such assessments may include recommendations for action;
(2) basic and applied research to improve the understanding of climate processes, natural and man-induced, and the social, economic, and political implications of climate change;
(3) methods for improving climate forecasts on a monthly, seasonal, yearly, and longer basis;
(4) global data collection, and monitoring and analysis activities to provide reliable, useful and readily available information on a continuing basis

NATIONAL WEATHER SERVICE ORGANIC ACT

Ensures there are atmospheric, oceanic, and terrestrial measurements suitable for establishing and recording U.S. climate conditions.

Relevant excerpt:

§ 313. Duties of Secretary of Commerce

The Secretary of Commerce shall have charge of the forecasting of weather, the issue of storm warnings, the display of weather and flood signals for the benefit of agriculture, commerce, and navigation, the gauging and reporting of rivers, the maintenance and operation of seacoast telegraph lines and the collection and transmission of marine intelligence for the benefit of commerce and navigation, the reporting of temperature and rain-fall conditions for the cotton interests, the display of frost and cold-wave signals, the distribution of meteorological information in the interests of agriculture and commerce, and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States…

STRATEGIC PLAN FOR THE CLIMATE CHANGE SCIENCE PROGRAM (July 2003)

Describes a national strategy for developing knowledge of variability and change in climate and related environmental and human systems, and for encouraging the application of this knowledge.

Relevant excerpts:

Chapter 1: Introduction, CCSP Mission. Facilitate the creation and application of knowledge of the Earth's global environment through research, observations, decision support, and communication.

Chapter 1: CCSP Goal 1. Improve knowledge of the Earth's past and present climate and environment, including its natural variability, and improve understanding of the causes of observed variability and change.

Chapter 1: Approach 2. Enhance observations and data management systems to generate a comprehensive set of variables needed for climate-related research.

Chapter 12: Observing and Monitoring the Climate System. Goal 1: Design, develop, deploy, integrate, and sustain observation components into a comprehensive system.

Chapter 16: Program Management and Review, Box 16-1: Principal Areas of Focus for the CCSP Agencies. Specifically, NOAA's research program includes ongoing efforts in operational *in situ* and satellite observations with an emphasis on oceanic and atmospheric dynamics, circulation, and chemistry; understanding and predicting ocean-land-atmosphere interactions, the global water cycle, and the role of global transfers of carbon dioxide among the atmosphere, ocean, and terrestrial biosphere in climate change.

WEATHER AND WATER

COAST AND GEODETIC SURVEY ACT

Authorizes the Secretary of Commerce to conduct hydrographic and topographic surveys, geomagnetic, seismological, gravity, and related geophysical measurements to provide charts and other information for safe marine and air navigation.

Relevant excerpt:

To improve the efficiency of the Coast and Geodetic Survey and to increase engineering and scientific knowledge the Director is authorized to conduct developmental work for the improvement of surveying and cartographic methods, instruments, :and equipment and to conduct investigations and research in geophysical sciences, including geodesy, oceanography, seismology and geomagnetism.

NATIONAL WEATHER SERVICE ORGANIC ACT

Sets forth the primary duties of the National Weather Service (NWS) that include but are not limited to gauging and reporting the flow of rivers, maintain and operating the seacoast telegraph lines and collecting and transmitting marine intelligence for the benefit of commerce and navigation

Relevant excerpt:

§ 313. Duties of Secretary of Commerce

The Secretary of Commerce shall have charge of the forecasting of weather, the issue of storm warnings, the display of weather and flood signals for the benefit of agriculture, commerce, and navigation, the gauging and reporting of rivers, the maintenance and operation of seacoast telegraph lines and the collection and transmission of marine intelligence for the benefit of commerce and navigation, the reporting of temperature and rain-fall conditions for the cotton interests, the display of frost and cold-wave signals, the distribution of meteorological information in the interests of agriculture and commerce, and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States…

TSUNAMI WARNING AND EDUCTION ACT

The Tsunami Warning and Education Act authorizes and strengthens the tsunami detection, forecast, warning, and mitigation program of the National Oceanic and Atmospheric Administration, to be carried out by the National Weather Service.

Relevant excerpts:

SEC. 3. PURPOSES.

The purposes of this Act are—

(1) to improve tsunami detection, forecasting, warnings, notification, outreach, and mitigation to protect life and property in the United States;

(2) to enhance and modernize the existing Pacific Tsunami Warning System to increase coverage, reduce false alarms, and increase the accuracy of forecasts and warnings, and to expand detection and warning systems to include other vulnerable States and United States territories, including the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico areas;

(3) to improve mapping, modeling, research, and assessment efforts to improve tsunami detection, forecasting, warnings, notification, outreach, mitigation, response, and recovery;

(4) to improve and increase education and outreach activities and ensure that those receiving tsunami warnings and the at-risk public know what to do when a tsunami is approaching;

(5) to provide technical and other assistance to speed international efforts to establish regional tsunami warning systems in vulnerable areas worldwide, including the Indian Ocean; and

(6) to improve Federal, State, and international coordination for detection, warnings, and outreach for tsunami and other coastal impacts.

NAVIGATION AND NAVIGABLE WATERS CHAPTER 17 - NATIONAL OCEAN SURVEY SUBCHAPTER II – SURVEYS 33 USC Chapter 17

Relevant excerpt:

SEC. 883d. Improvement of methods, instruments, and equipments; investigations and research

To improve the efficiency of the National Ocean Survey and to increase engineering and scientific knowledge, the Secretary of Commerce is authorized to conduct developmental work for the improvement of surveying and cartographic methods, instruments, and equipments; and to conduct investigations and research in geophysical sciences (including geodesy, oceanography, seismology, and geomagnetism).

COMMERCE AND TRANSPORTATION

COAST AND GEODETIC SURVEY ACT

The Act provides NOAA a permanent authorization of appropriations to acquire hydrographic and other oceanographic data for the safe navigation of marine commerce; test and develop new technologies in pursuit of operational efficiencies, engineering gains and scientific knowledge; conduct geodetic control surveys and research in geophysical sciences; and acquire, construct, maintain, and operate ships, stations, equipment, and facilities as needed to meet the mission.

Relevant excerpts:

33 U.S.C.

SEC. 883a. Surveys and other activities

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 Secretary of Commerce, is authorized to conduct the following activities:

(1) Hydrographic and topographic surveys;
(2) Tide and current observations;
(3) Geodetic-control surveys;
(4) Field surveys for aeronautical charts;
(5) Geomagnetic, seismological, gravity, and related geophysical measurements and investigations, and observations for the determination of variation in latitude and longitude.

SEC. 883d. Improvement of methods, instruments, and equipments; investigations and research

To improve the efficiency of the National Ocean Survey and to increase engineering and scientific knowledge, the Secretary of Commerce is authorized to conduct developmental work for the improvement of surveying and cartographic methods, instruments, and equipments; and to conduct investigations and research in geophysical sciences (including geodesy, oceanography, seismology, and geomagnetism).

SEC. 883h. Employment of public vessels

The President is authorized to cause to be employed such of the public vessels as he deems it expedient to employ, and to give such instructions for regulating their conduct as he deems proper in order to
carry out the provisions of this subchapter.

SEC. 883i. Authorization of appropriations

There are authorized to be appropriated such funds as may be necessary to acquire, construct, maintain, and operate ships, stations, equipment, and facilities and for such other expenditures, including personal services at the seat of government and elsewhere and including the erection of temporary observatory buildings and lease of sites therefore, as may be necessary for the conduct of the activities herein authorized.

COAST GUARD NAVIGATION SAFETY REGULATIONS

Coast Guard regulations require that vessels 1600 gross tons or larger carry official nautical charts.

Relevant excerpts:

SEC. 164.33 Charts and publications.
(a) Each vessel must have the following:
(1) Marine charts of the area to be transited, published by the National Ocean Service, U.S. Army Corps of Engineers, or a river authority that--
(i) Are of a large enough scale and have enough detail to make safe navigation of the area possible; and
(ii) Are currently corrected.

HYDROGRAPHIC SERVICE IMPROVEMENT ACT OF 1998 and 2002 Amendments

This Act restates NOAA's responsibilities under 33 USC 883a et seq for collecting and disseminating hydrographic data, products and services, and authorizes NOAA to maintain expertise by operating vessels and testing and evaluating technology; promulgate hydrographic services standards nationally and internationally; ensure adequate coverage of services; support ocean and coastal resource management, and enhance Homeland Security.

Relevant excerpts:

33 U.S.C.

SEC. 892a. Functions of the Administrator

(a) Responsibilities

To fulfill the data gathering and dissemination duties of the Administration under the Act of 1947, the Administrator shall--
(1) acquire and disseminate hydrographic data;
(2) promulgate standards for hydrographic data used by the Administration in providing hydrographic services;
(3) promulgate standards for hydrographic services provided by the Administration;

(4) ensure comprehensive geographic coverage of hydrographic services, in cooperation with other appropriate Federal agencies;
(5) maintain a national database of hydrographic data, in cooperation with other appropriate Federal agencies;
(6) provide hydrographic services in uniform, easily accessible formats;
(7) participate in the development of, and implement for the United States in cooperation with other appropriate Federal agencies, international standards for hydrographic data and hydrographic services; and
(8) to the greatest extent practicable and cost-effective, fulfill the requirements of paragraphs (1) and (6) through contracts or other agreements with private sector entities.

(b) Authorities

To fulfill the data gathering and dissemination duties of the Administration under the Act of 1947, and subject to the availability of appropriations, the Administrator--
(1) may procure, lease, evaluate, test, develop, and operate vessels, equipment, and technologies necessary to ensure safe navigation and maintain operational expertise in hydrographic data acquisition and hydrographic services;
(2) may enter into contracts and other agreements with qualified entities, consistent with subsection (a)(8) of this section, for the acquisition of hydrographic data and the provision of hydrographic services;

(c) Conservation and management of coastal and ocean resources
Where appropriate and to the extent that it does not detract from the promotion of safe and efficient navigation, the Secretary may use hydrographic data and services to support the conservation and
management of coastal and ocean resources.

SEC. 892d. Authorization of appropriations

There are authorized to be appropriated to the Administrator the following:

(6) To carry out activities authorized under this subchapter that enhance homeland security, including electronic navigation charts, hydrographic surveys, real time tide and current measurements, and geodetic functions, in addition to other amounts authorized by this section, $20,000,000.

NATIONAL RESPONSE PLAN

The Department of Homeland Security's December 2004 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 NRP Emergency Support Functions (ESF). NOAA's Commerce and Transportation 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.

Hydrographic and geodetic data are a critical component of NOAA's trajectory and dispersion models, and NOAA's hydrographic survey capability is directly called out as a response function.

Relevant excerpts:

Emergency Support Function #1 – Transportation Annex (page 125)

ESF #1 is designed to provide transportation support to assist in domestic incident management.

Department of Commerce/National Oceanic and Atmospheric Administration

- Provides weather and dispersion forecasts in support of response measures following transportation events that release materials into the atmosphere.
- Provides dispersion forecasts for materials spilled into the ocean following a transportation event.

Emergency Support Function #9 – Urban Search and Rescue Annex (page 191)

ESF #9 is designed to rapidly deploy components of the National Urban Search and Rescue Response System to provide specialized life-saving assistance to State, local, and tribal authorities during an Incident of National Significance.

Department of Commerce/National Oceanic and Atmospheric Administration

- Acquires and disseminates weather data, forecasts, and emergency information.
- Provides weather information essential for efficient US&R.
- Predicts pollutant movement and dispersion over time (marine and atmospheric).
- Assesses areas of greatest hazard following a marine or atmospheric release.

Emergency Support Function #10 – Oil and Hazardous Materials Response Annex (page 199)

ESF #10 provides Federal support in response to an actual or potential discharge and/or uncontrolled release of oil or hazardous materials during Incidents of National Significance when activated.

Department of Commerce/National Oceanic and Atmospheric Administration

- Provides operational weather data and prepares forecasts tailored to support the response, through the Interagency Modeling and Atmospheric Assessment Center (IMAAC) when activated.
- Provides expertise on natural resources and coastal habitat, the environmental effects of oil and hazardous materials, and appropriate cleanup and restoration alternatives.

- Coordinates NOAA scientific support for responses in coastal and marine areas, including assessments of the hazards that may be involved.
- Predicts pollutant movement, dispersion, and characteristics (marine) over time.
- Provides information on meteorological, hydrological, ice, and oceanographic conditions for marine, coastal, and inland waters.
- Provides charts and maps for coastal and territorial waters and the Great Lakes.
- Conducts emergency hydrographic surveys, search and recovery, and obstruction location to assist safe vessel movement.

Emergency Support Function #11 – Agriculture and Natural Resources Annex (page 215)

ESF #11 supports (1) provision of nutrition assistance; (2) control and eradication of an outbreak of a highly contagious or economically devastating animal/zoonotic disease, highly infective exotic plant disease, or economically devastating plant pest infestation; (3) assurance of food safety and food security and (4) protection of natural and cultural resources and historic properties resources prior to, during, and/or after an Incident of National Significance.

Department of Commerce/National Oceanic and Atmospheric Administration

- Makes available an environmental data archive for determining baseline conditions.
- Provides contaminant analysis expertise and facilities.
- Provides aerial mapping and satellite remote sensing for damage assessment.
- Provides detailed site-specific weather forecasts and forecasts of travel time for river contaminants.
- Provides expertise and assistance on coral reefs and coral reef ecosystems.
- Provides expertise and consultation on marine mammals and essential fish habitat issues.
- Provides seafood inspection capabilities to assess safety, wholesomeness, proper labeling, and quality of fish and fishery products through process and product verifications, product evaluations and certifications, and laboratory analysis.

Emergency Support Function #13 – Public Safety and Security Annex (page 231)

ESF #13 integrates Federal public safety and security capabilities and resources to support the full range of incident management activities associated with potential or actual Incidents of National Significance.

Department of Commerce/National Oceanic and Atmospheric Administration

Provides overall support regarding weather services during disasters and airborne plume prediction.
In addition provides:

- Law enforcement and security capabilities
- Nautical and aeronautical charting, surveys, tidal and geodetic services, and geo-referenced coastal imagery
- Support through the Satellite Vessel Surveillance System tracking infrastructure; and

- Public dissemination of critical pre-event and post-event information over the all-hazards NOAA Weather Radio (NWR) system, the NOAA Weather Wire Service, and the Emergency Managers' Weather Information Network (EMWIN).

MISSION SUPPORT

Homeland Security

EXECUTIVE ORDER 12656, ASSIGNMENT OF EMERGENCY PREPAREDNESS RESPONSIBILITIES

Relevant excerpts:

PART 4-Department of Commerce

SEC. 401. *Lead Responsibilities.* In addition to the applicable responsibilities covered in Parts 1 and 2, the Secretary of Commerce shall:

8) Develop overall plans and programs to ensure that the fishing industry continues to produce and process essential protein in national security emergencies;

(9) Develop plans to provide meteorological, hydrologic, marine weather, geodetic, hydrographic, climatic, seismic, and oceanographic data and services to Federal, State, and local agencies, as appropriate;

HOMELAND SECURITY ACT OF 2002

Established the Department of Homeland Security (DHS). HSP supports DHS in its functions through information sharing, complying with Continuity of Operations guidance, and providing response and recovery assistance.

Relevant excerpt:

SEC. 501. UNDER SECRETARY FOR EMERGENCY PREPAREDNESS AND RESPONSE.

In assisting the Secretary with the responsibilities specified in Section 101(b)(2)(D), the primary responsibilities of the Under Secretary for Emergency Preparedness and Response shall include-

(1) helping to ensure the preparedness of emergency response providers for terrorist attacks, major disasters, and other emergencies;

HOMELAND SECURITY PRESIDENTIAL DIRECTIVE #5, MANAGEMENT OF DOMESTIC INCIDENTS

Relevant excerpst:

Tasking

(14) The heads of all Federal departments and agencies are directed to provide their full and prompt cooperation, resources, and support, as appropriate and consistent with their own responsibilities for protecting our national security,

19) The head of each Federal department and agency shall:

(a) By June 1, 2003, make initial revisions to existing plans in accordance with the initial version of the NRP.

(b) By August 1, 2003, submit a plan to adopt and implement the NIMS to the Secretary and the Assistant to the President for Homeland Security. The Assistant to the President for Homeland Security shall advise the President on whether such plans effectively implement the NIMS.

HOMELAND SECURITY PRESIDENTIAL DIRECTIVE #7, CRITICAL INFRASTRUCTURE IDENTIFICATION, PRIORITIZATION AND PROTECTION

Relevant excerpts:

23) The heads of all Federal departments and agencies will coordinate and cooperate with the Secretary as appropriate and consistent with their own responsibilities for protecting critical infrastructure and key resources.
(24) All Federal department and agency heads are responsible for the identification, prioritization, assessment, remediation, and protection of their respective internal critical infrastructure and key resources. Consistent with the Federal Information Security Management Act of 2002, agencies will identify and provide information security protections commensurate with the risk and magnitude of the harm resulting from the unauthorized access, use, disclosure, disruption, modification, or destruction of information

HOMELAND SECURITY PRESIDENTIAL DIRECTIVE #8, NATIONAL PREPAREDNESS

Relevant excerpts:

Federal Department and Agency Preparedness

(20) The head of each Federal department or agency shall undertake actions to support the national preparedness goal, including adoption of quantifiable performance measurements in the areas of training, planning, equipment, and exercises for Federal incident management and asset preparedness, to the extent permitted by law.

5) To help ensure the preparedness of the Nation to prevent, respond to, and recover from threatened and actual domestic terrorist attacks, major disasters, and other emergencies, the Secretary, in coordination with the heads of other appropriate Federal departments and agencies and in consultation with State and local governments, shall develop a national domestic all-hazards preparedness goal. Federal departments and agencies will work to achieve this goal by:

(a) providing for effective, efficient, and timely delivery of Federal preparedness assistance to State and local governments; and
(b) supporting efforts to ensure first responders are prepared to respond to major events, especially prevention of and response to threatened terrorist attacks

NATIONAL RESPONSE PLAN (NRP)

Aligns Federal coordination structures, capabilities, and resources into a unified, all-discipline, and all-hazards approach to domestic incident management. NOAA has a direct or support role in all of the NRP Essential Support Functions.

Relevant excerpt:

The purpose of the NRP is to establish a comprehensive, national, all-hazards approach to domestic incident management across a spectrum of activities including prevention, preparedness, response, and recovery. The NRP incorporates best practices and procedures from various incident management disciplines—homeland security, emergency management, law enforcement, firefighting, hazardous materials response, public works, public health, emergency medical services, and responder and recovery worker health and safety—and integrates them into a unified coordinating structure. The NRP provides the framework for Federal interaction with State, local, and tribal governments; the private sector; and NGOs in the context of domestic incident prevention, preparedness, response, and recovery activities. It describes capabilities and resources and establishes responsibilities, operational processes, and protocols to help protect the Nation from terrorist attacks and other natural and manmade hazards; save lives; protect public health, safety, property, and the environment; and reduce adverse psychological consequences and disruptions.

Satellite Services Support

ENERGY BILL ACT OF 2005 PUBLIC LAW 109-58

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.

Relevant excerpt:

(2) Membership.--The Committee shall be composed of at least 7 members, including--
(B) the Secretary of Commerce;
` (c) National NOTE: Research and development. Deadline. Climate
Change Technology Policy.--
(1) In general.--Not later than 18 months after the date applicable Federal climate reports, submit to the Secretary and the President a national strategy to promote the deployment and

commercialization of greenhouse gas intensity reducing technologies and practices developed through research and development programs conducted by the National Laboratories, other Federal research facilities, institutions of higher education, and the private sector.

NATIONAL WEATHER SERVICE ORGANIC ACT

Provides the authority to forecast the weather, issue storm warnings and collect/transmit marine data.

Relevant excerpt:

§ 313. Duties of Secretary of Commerce. The Secretary of Commerce shall have charge of the forecasting of weather, the issue of storm warnings, the display of weather and flood signals for the benefit of agriculture, commerce, and navigation, the gauging and reporting of rivers, the maintenance and operation of seacoast telegraph lines and the collection and transmission of marine intelligence for the benefit of commerce and navigation, the reporting of temperature and rain-fall conditions for the cotton interests, the display of frost and cold-wave signals, the distribution of meteorological information in the interests of agriculture and commerce, and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States…

NAVIGATION AND NAVIGABLE WATERS CHAPTER 17 - NATIONAL OCEAN SURVEY SUBCHAPTER II - SURVEYS

Relevant excerpt:

33 USC Chapter 17 Section 883j (Ocean Satellite Data)….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.

Integrated Ocean Observing

EXECUTIVE ORDER 13366, COMMITTEE ON OCEAN POLICY

SEC. 3. Establishment of Committee on Ocean Policy.

SEC. 4. Functions of the Committee. To implement the policy set forth in section 1 of this order, the Committee shall:

(e) ensure coordinated government development and implementation of the ocean component of the Global Earth Observation System of Systems

U.S. OCEAN ACTION PLAN and UNITED STATES OCEAN ACTION PLAN IMPLEMENTATION UPDATE (January 2007)

Relevant excerpt:

Build a Global Earth Observation Network, Including Integrated Oceans Observation Integrate U.S. ocean Observing Efforts into the Global Earth Observing System of Systems: In April 2006, the Joint Subcommittee on Ocean Science and Technology (JSOST) established the Interagency Working Group on Ocean Observations (IWGOO) to advise and assist the JSOST on matters related to ocean observations. A function of the IWGOO is to integrate U.S. ocean observing efforts, including the Integrated Ocean Observing System IOOS), into the Global Earth Observing System of Systems (GEOSS) and to other international programs. The First Annual IOOS development plan was approved by the National Ocean Research Leadership Council (NORLC)/ Interagency Committee on Ocean Science and Resource Management Integration (ICOSRMI) in January 2006. 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)

Relevant excerpt:

Critical Elements
Deployment of a robust ocean-observing system that can describe the actual state of the ocean, coupled with a process to synthesize observational data, will fundamentally alter society's view of the ocean environment. Observations underpin fundamental knowledge of the open ocean, coasts, coastal watersheds, and Great Lakes. Although much work remains, communities interested in ocean research and management have developed mature plans for many components of an integrated, global ocean-observing system. Deploying the priority elements of that observing system will increase society's access
to the ocean and allow researchers to enable the promise of ocean forecasting and ecosystem-based management during the next decade.

INTERAGENCY WORKING GROUP ON OCEAN OBSERVATION (IWGOO) CHARTER

Relevant excerpt:

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."

Fleet Replacement

FISHERY SURVEY VESSEL ACQUISITION P.L. 106-450, title III, Nov. 7, 2000, 114 Stat. 1945

Authorizes NOAA to 1) acquire, construct, maintain, and operate ships, and 2) acquire and equip six Fishery Survey Vessels and prescribes conditions for NOAA vessel and leasing

Relevant excerpts:

SEC. 302. ACQUISITION OF FISHERY SURVEY VESSELS.
(a) In General. - The Secretary, subject to the availability of appropriations, may in accordance with this section acquire, by purchase, lease, lease-purchase, or charter, and equip up to six fishery survey vessels in accordance with this section.
(b) Vessel Requirements. - Any vessel acquired and equipped under this section must -
(1) be capable of -
(A) staying at sea continuously for at least 30 days;
(B) conducting fishery population surveys using hydroacoustic, longlining, deep water, and pelagic trawls, and other necessary survey techniques; and
(C) conducting other work necessary to provide fishery managers with the accurate and timely data needed to prepare and implement fishery management plans; and
(2) have a hull that meets the International Council for Exploration of the Sea standard regarding acoustic quietness

HYDROGRAPHIC SERVICES IMPROVEMENT ACT OF 1998 (amended 2002)

Authorizes the NOAA Administrator to procure, lease, evaluate, test, develop, and operate vessels, equipment, and technologies necessary to ensure safe navigation and maintain operational expertise in hydrographic data acquisition and hydrographic services.

Relevant excerpts:

SEC. 303. FUNCTIONS OF THE ADMINISTRATOR. NOTE: 33 USC 892a.
(b) Authorities.--To fulfill the data gathering and dissemination duties of the Administration under the Act of 1947, and subject to the availability of appropriations, the Administrator--
(1) may procure, lease, evaluate, test, develop, and operate vessels, equipment, and technologies necessary to ensure safe navigation and maintain operational expertise in hydrographic data acquisition and hydrographic services

Appendix B - Program Mission Overviews

PROGRAM MISSION OVERVIEWS

Today NOAA's mission: **"**to understand and predict changes in the Earth's environment and conserve and manage coastal and Great Lakes resources to meet our nation's economic, social and environmental needs" is much like it was over 30 years ago. NOAA still works for America every day. From providing timely and precise weather, water and climate forecasts, to monitoring the environment, to managing fisheries and building healthy coastlines, to making our nation more competitive through safe navigation and examining changes in the oceans.

And NOAA's vision for an informed society that uses a comprehensive understanding of the role of the oceans, coasts and atmosphere in the global ecosystem to make the best social and economic decisions, depends up on how well NOAA understands the Earth's dynamic, natural systems and how well we assess the affects of human activities upon those systems.

Based on stakeholder input and an internal assessment of NOAA's mandates and mission, NOAA has adopted a structure of four mission goals and a mission support goal around which all of its work is planned and organized:

- **Ecosystems:** Protect, restore and manage the coastal and ocean resources through an ecosystem approach to management.
- **Climate:** Understand changes in climate, including the El Niño phenomenon, to ensure that we can plan and respond properly.
- **Weather & Water:** Monitor, enhance and deliver environmental information, science and services to save lives, protect property and support environmental stewardship.
- **Commerce & Transportation:** Provide weather and navigation information for safe, secure, efficient and environmentally sound movement of goods and people in the U.S transportation system.
- **Mission Support:** Provide critical support for NOAA's mission.

An overview of each goal and program that requires or benefits from at-sea data collections is presented below.

ECOSYSTEMS

NOAA works to conserve and manage marine and coastal resources through a holistic, ecosystem approach to management in partnership with other federal agencies, states, local governments, councils, the private sector, non-governmental organizations, tribal groups, foreign nations, international bodies and the general public. Specifically, NOAA provides end-to-end capabilities and services for conservation and management of coastal and marine ecosystems, including: monitoring and observation systems to assess the health of ecosystems and living marine resources (LMR); ecosystem mapping; scientific analysis and models of ecosystem function and LMRs; predictions and forecasts of LMR status and trends; regulation and issuance of permits; habitat consultations and restorations; stock and species rebuilding and recovery plans; guidance, approval, and implementation of management plans; technical and financial assistance; prevention and control of invasive species; and environmentally sound marine aquaculture.

Mission: Protect, restore, and manage the use of coastal and ocean resources through an ecosystem approach to management

Outcomes:

- Healthy and productive coastal and marine ecosystems that benefit society
- A well informed public that acts as a steward of coastal and marine ecosystems

Coastal and Marine Resources Program

The Coastal and Marine Resources Program (CMRP) helps federal, state, local, and international managers protect, restore, and use coastal ecosystem services. CMRP promotes a comprehensive approach to balancing competing interests from coastal watersheds to marine waters. The CMRP includes place-based management and conservation programs implemented in partnership with state and local partners or through coordination with key international, federal, state and local partners. Through CMRP NOAA has unique partnerships with states to manage the Nation's coastal and marine resources: states contribute resources and authorities to the comprehensive management of the Nation’s coastal areas, thereby leveraging NOAA investments and contributing to national objectives. CMRP supports management actions designed to improve the long-term resilience of communities and ecosystems, thereby addressing stresses caused by either specific hazards or from the cumulative impacts of long-term changes.

Primary program capabilities are: applied research and technology development; place-based management of coastal and marine resources; capacity building; stewardship; and coordination and integration. In collaboration with other stewardship programs, and building upon the research, modeling, and assessment competencies in the Ecosystem Goal, CMRP provides the critical building blocks for protecting, restoring and managing the use of coastal and ocean resources through an ecosystem approach to management.

Operating days are needed for researchers to complete integrated assessments of estuarine research reserves and to develop habitat mapping data and identify high-risk/vulnerable coastal habitats for restoration and protection.

Coastal and Marine Resources Program Outcomes:

- Priority land and water habitats are protected, restored or enhanced as habitat for fish and wildlife
- Coastal and marine managed areas operate effectively as demonstrated by performance measures tracking progress toward management objectives
- Coastal economic, ecological and cultural priorities are balanced through coordination of NOAA, state and local management tools and practices
- Enhanced place-based management in US and international coastal and ocean areas through improved coordination, integration and cooperation
- Integrated observing systems throughout the United States Exclusive Economic Zone are providing comprehensive data and information that improves effective management
- Important ocean, coastal and Great Lakes areas are fully characterized
- Ocean, coastal and Great Lakes resource decision-makers increasingly apply innovative scientific and technology tools
- Increased ocean, coastal and Great Lakes literacy demonstrated by public, students and educators that participate in site education programs
- Public is using monitoring information, data and tools generated in ocean and coastal areas to effectively participate in place-based management initiatives

- Gaps in a scientifically-based comprehensive national and international system of MPAs are identified and filled

Coral Reef Conservation Program

NOAA has significant responsibilities to conserve and manage coral reef resources as outlined in legal and administrative mandates and international treaties. The Coral Reef Conservation Program supports effective management and sound science to preserve, sustain, and restore coral reef ecosystems through coral reef mapping, monitoring, research, outreach and education, and management activities. The Coral Reef Conservation Program mandates require the collection of comprehensive coral reef ecosystem data using equipment-based and human observations, high quality acoustic data, and optical (video or camera) data in order to develop the mapping and ecosystem assessment products necessary to effectively and comprehensively manage the Nation's vital coral reef ecosystems. These data are required across a large geographic area including the Atlantic/Caribbean and the remote Pacific. The Coral Reef Ecosystem Integrated Observing System collects and analyzes environmental and ecological data on common platforms to ensure data quality, manage data efficiently for the long-term, and develop and implement mechanisms to guarantee that data are accessible to all users. Because of their remote locations, deep-sea corals are a challenge to comprehensively characterize and study. It is the critical understanding of complex connections and interactions of coral reef ecosystems that allow prediction of the consequences of specific threats and management actions.

NOAA works closely with other Federal agencies, state and territory governments, and non governmental organization (NGO) partners to reduce the impacts of key threats to coral reef ecosystems. NOAA serves as co-chair of the U.S. Coral Reef Task Force, established by Executive Order 13089 to lead and coordinate U.S. efforts, and helps implement coral reef conservation actions in response to threats identified as high priority, including over fishing, land-based sources of pollution, climate change and coral bleaching, disease, recreational overuse and misuse, and lack of public awareness. As part of its national program, NOAA also provides direct assistance to states and territories to aid their efforts in critical initiatives, such as coral reef management, monitoring and research.

Coral Reef Conservation Program Outcomes:

- Understand the impacts of climate change and coral disease on coral reef ecosystems and develop approaches to enhance resilience of corals
- Reduce direct physical impacts from maritime industry and natural/non-natural hazards
- Reduce impacts from coastal uses and land-based activities
- Reduce over fishing and other adverse impacts from commercial and recreational fishing
- Deep-sea coral and sponge communities located, understood and adverse impacts from fishing and other causes of decline reduced
- Educate decision-makers and stakeholders on coral reef condition, issues, and needed actions
- Increase local technical expertise and management capacity
- Observe Coral reef ecosystems and their stressors
- Expand monitoring parameters to fill critical gaps

- Conduct targeted outreach and education

Ecosystem Observations Program

NOAA's Ecosystem Observation Program (EOP) is designed to be a coastal and oceanic ecological observing system. Mission requirements of the Protected Species, Habitat, and Fisheries Management Programs drive the data collection activities of EOP. As the primary user of NOAA's at-sea data-acquisition capacity, EOP is responsible for collecting and analyzing the data and provides these programs with the data and scientific information they require to support their missions. EOP's capabilities encompass routine observations (e.g., resource surveys), assessments and forecasts, and product development to improve the technical capability of the observation system. EOP also includes data management and quality assurance activities, the production of routine technical reports, and supports appropriate collaborative linkages to other NOAA programs. EOP's capabilities are directed at providing the necessary information for management decisions. EOP collects the data and observations to support fish population estimates and health assessments for fisheries management, to identify marine mammal migratory routes for protected species, and to characterize the physical attributes of the seafloor environment in fish spawning grounds. This contrasts EOP with the Ecosystem Research Program ERP that conducts research that leads to the development of new products, technology and information.

Ecosystem Observations Program Outcomes:

Short Term

- Updated fish and protected resources stock assessments
- Routine use of new scientific developments and state-of-the-art technologies, integrating them into NOAA's observing capabilities
- Increased understanding of biology, ecology and life history of protected resources and commercially and recreationally important fish stocks
- Increased ability to assess the short-run costs and benefits and cost- effectiveness of alternative management measures
- Dissemination of scientific information data and tools to the science and management communities, policy makers, conservation groups and resource users world-wide
- Collaboration with academic, industry, citizen groups, NGOs and International community partners
- Integration of the National Observer Program and physical observations for Living Marine Resources and Protected Resources
- Development of indicators of ecosystem productivity, health and stress (in conjunction with ERP)
- Identification and integration of NOAA's ecosystem observing capabilities into the Integrated Ocean Observation Program (IOOS)

Mid-Term

- Increased understanding and monitoring of species listed under the Endangered Species Act and Marine Mammal Protection Act
- Increased accuracy of sustainable harvest estimates for commercially important fisheries

- Increased ability to assess the longer term impacts of proposed management measures as well as the cumulative effects of regulations on fishermen, shore side firms and fishing-dependent communities
- Transition of monitoring and assessment results, products, and procedures into operational application
- Increased development of the National Ecological Observing "backbone" for IOOS
- Routine integration of existing physical observations into fish and protected species forecasts
- Provide integrated routine indicators to show "status of the ecosystem"
- Increased habitat characterization associated with living marine resources under NOAA's jurisdiction
- Increased number of ecosystem variables and parameters that describe the status and trends of coastal ecosystems and living marine resources and are amenable for use in ecological forecasting

Long-Term

- Integrated "End to End " coastal and oceanic observing system to collect and analyze data and provide forecasts required to meet management and societal needs for ecosystem management
- High quality, routine ecosystem assessment and forecasts to meet NOAA's and the American public's management needs and expectations
- Implementation of new procedures, data systems, and techniques to manage and archive ecosystem information for NOAA's clients in the government and private sectors
- Routine production and delivery of NOAA Ecosystem Observations Program's findings and products to its constituents
- Increased public awareness of ecosystem conservation and management issues and improved sense of stewardship for ecosystems and their component resources by the public

Ecosystem Research Program

The Ecosystem Research Program (ERP) provides scientific information and tools necessary for ocean, coastal and Great Lakes management. ERP's ecosystem assessments and research focus on natural and anthropogenic factors that affect coastal, Great Lakes, and ocean ecosystems. Through applied research, ocean exploration, and mapping and documenting living and non-living resources and processes, ERP plays a crucial role in protected species conservation, the understanding of human health issues relating to the ocean, and habitat conservation and restoration. ERP's research enables NOAA to base policy decisions on sound science, aid coastal resource managers in supporting society's needs for information, protect marine mammals and endangered marine life, and provide credible, unbiased science to the public. NOAA has the responsibility to assess new areas and identify places of high biological or cultural value. About 95 percent of the oceans have not been visited or studied, including major features such as the 50,000 kilometers of mid-ocean ridge crest, 10,000 kilometers of deep-sea trenches, more than 30,000 seamounts, and the water-column of the ocean – which is home to 99 percent of the earth's living organisms.

ERP is developing integrated ecosystem models and forecasts that, when coupled with ERP's socioeconomic research, will enable resource managers to make scientifically based, better informed decisions that balance the costs and benefits for both the ecosystem and society. ERP is responsible for the exploration of the oceans and the development and enhancement of ocean and coastal resources. ERP develops and transfers technology and tools to resource managers (including other NOAA Ecosystem Programs), and works with coastal stakeholders through engagement, capacity building, and education. ERP is educating our next generation to become environmental stewards.

Ecosystem Research Program Outcomes:

- Resource managers have the best available science to make ecosystem-based decisions
- A well-informed public acts as an effective steward of coastal, marine, and Great Lakes resources
- Human health risks decrease as a result of improvements in the condition of coastal, marine, and Great Lakes resources
- Resource managers benefit from the transfer of technology that ensures sustainable use of marine resources
- New resources are discovered or developed
- Sufficient knowledge available to develop ecosystem-based models
- Analyses of regional ecosystems and the component parts of ecosystems are available
- New or improved environmental technologies are demonstrated
- Operational ecological forecast models are transferred
- Tools and information are transferred to the appropriate NOAA programs and/or local states and regional agencies to enhance decision making
- Resources allocation and ecosystem function are optimized
- The ability to balance social, economic, and environmental goals in ecosystem management is achieved
- Life-long environmental literacy programs are expanded
- NOAA trains the next generation of diverse, multi-disciplinary marine, coastal, and Great Lakes scientists
- Understanding, acceptance and support of resource management decisions is increased
- Research findings are integrated into education programs
- Baseline characterizations of ecosystems including integrated ocean mapping products are available
- Social and economic impacts are determined
- Indicators of ecosystem condition are identified
- Technologies that increase understanding and responsible use of ecosystems are developed or improved
- Stressors affecting ecosystem condition are identified
- Research priorities for ecosystems and their component parts are established

Fisheries Management Program

Management of federal fishery resources in the United States is entrusted to NOAA. Within NOAA, the Fisheries Management Program (FMP) ensures that fisheries are maintained at productive levels for supporting sustainable fisheries and the ecosystems to which they contribute. FMP achieves this objective by eliminating over-fishing and rebuilding over-fished stocks. FMP applies ecosystem-based principles in conserving and managing fisheries within the broad ecosystem structure defined by the jurisdictions of the Regional Fishery Management Councils, the Atlantic Highly Migratory Species program, state, and international fisheries. FMP translates the status of key fisheries and conveys these indices through various NOAA processes for advancing a conservation ethic in the public including stewardship of marine fisheries. FMP also includes trade, financial, and inspection services to fishery dependent communities and industry sectors.

FMP works under the authority of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSRA) which contains a key provision aimed at ending overfishing; the new law mandates the use of annual catch limits and accountability measures in all federal fishery management plans. Working within this structure of legislation, collaboration, and international agreements, the FMP maintains and restores productive stocks important to commercial, recreational, tribal, and subsistence fisheries.

At-sea data collection is critical to support fisheries management that is conducted in the context of changing environmental conditions. It is impossible to set fishing targets while having an acceptably low chance of over-fishing without fully understanding how fisheries fluctuate due to environmental factors. The FMP requires the at-sea data/information provided by the Ecosystems Observation Program (EOP) to conduct surveys to monitor fish stocks, to accurately assess the status (overfishing and overfished) of fish stocks and to develop annual catch limits.

Fisheries Management Program Outcomes:

- Fish stocks are maintained at productive levels to support sustainable fisheries and ecosystems
- Ecosystem-based principles are applied in conservation and management of Federal, state, and international fisheries
- An environmentally literate public has adopted a conservation ethic and promotes stewardship of marine fisheries
- Regulatory quality improvements are fully implemented
- Guidance is applied to develop/revise plans to incorporate ecosystem-based management principles
- Over-fished stocks are managed under rebuilding plans
- Improved economic performance of fishing industry
- Federal/state/international fishery managers become increasingly knowledgeable on ecosystem-based principles
- Outreach/Education messages are effectively communicated to foster a conservation ethic
- Regulatory quality improvement training and quality assurance (QA)/quality control (QC) protocols are operational
- Increased opportunities for industry to improve economic performance
- Coordination of marine fisheries management and conservation between state and federal levels is strengthened
- Efforts are continued to secure appropriate management measures in regional fishery management organizations
- Guidance for ecosystem-based management principles is developed among headquarters, regional offices, and Councils
- Credible understanding of public's acceptance of its stewardship role is obtained

Habitat Program

Coastal, marine, and Great Lakes habitats, including rivers and estuaries, are an indispensable part of our Nation's natural resources and sustain a significant portion of the U.S. economy. These habitats are components of complex ecosystems beginning inland at the headwaters of streams and extending seaward. The health of these habitats depends on the quality of the ecosystems' physical and chemical processes and associated biological communities. Their degradation and loss affect the viability and productivity of invaluable natural resources.

The NOAA Habitat Program seeks to protect and restore habitats that support NOAA trust resources (resources associated with coastal, marine, and Great Lakes habitats, including rivers and estuaries) that are essential to the long-term health and sustainability of coastal, marine, and Great Lakes ecosystems. The Habitat Program applies the latest science, technology, and management tools to ensure that ecosystem productivity, function, and services are protected and restored using a variety of strategies and measures authorized by dozens of legislative and executive mandates. The Habitat Program promotes sound stewardship by engaging partners (i.e., federal, state, and local agencies, as well as tribes and stakeholders) to leverage additional capabilities to ensure long-term habitat integrity and sustainability.

Data/collection/synthesis/analysis, including 1) assessment and characterization of invasive species impacts on coastal and marine resources and 2) assessment and characterization of coastal habitat condition and function, is essential for providing the most effective protection and restoration of habitat for NOAA trust resources. Data needed to meet mandates on the identification and protection of essential fish habitat include 1) nationwide seafloor mapping and interpretation of benthic habitats of sufficient resolution and spatial scales relevant to fishery management and habitat protection; 2) development of efficient and effective visual and acoustic methods to survey benthic habitats and fishes, particularly in complex, deep-water habitats; 3) identification and protection of core nursery and spawning areas, relative to anthropogenic and natural impacts; 4) enhanced oceanographic monitoring systems to understand species/climate/ocean interactions and effects on production; 5) distribution and function of deep coral communities as components of essential fish habitat; and 6) functional impacts of fishing on benthic habitats and fish productivity, including rates of impacts and recovery, estimates of fishing efforts, and evaluating the role of marine protected areas.

Habitat Program Outcomes:

- Habitat protection
- Habitat assessment and characterization
- Habitat restoration
- Invasive species control
- Habitat research
- Stewardship

Protected Species Program

NOAA has responsibility to protect and recover marine and anadromous species listed as threatened and endangered under the Endangered Species Act, and for conservation of most marine mammals protected by the Marine Mammal Protection Act to ensure that these species are fully functioning elements of their ecosystems. The first priority of the Protected Species Program (PSP) is to stop the decline of protected species populations to reduce the risk of extinction. Next, efforts are made to stabilize populations, and to recover populations to levels that make them functional members of marine and coastal ecosystems. PSP achieves protection and recovery of species through planning, regulation, partnerships, direct action, and outreach and education in both domestic and International arenas. PSP implements policies intended to proactively pursue conservation efforts, identify species in need of protection, and promote the recovery and conservation of already threatened and endangered species. PSP reviews permits for Department of Defense readiness exercises, for commercial oil and gas exploration activities, and for international commerce in shipping lanes shared by endangered whales.

In order to successfully carry out its mission, PSP relies on at-sea data and observations collected by the Ecosystems Observation Program. These data include observations of population numbers along migratory routes and within breeding grounds and foraging and nursery areas; biological and physical health data collected from specimens; and observations on important biological, physical, and chemical environmental variables which influence the species of interest.

Protected Species Program Outcomes:

- Recovery and maintenance of all protected species to fully functioning elements of their ecosystems
- Improved or maintained Protected Species status, including abundance, distribution, productivity, and diversity
- A reduction of risk to species through alleviation of threats (i.e., those factors limiting the survival and recovery of species)
- Increased public awareness of protected species issues
- Effective direct action taken by program partners as a result of management strategies developed by the program

CLIMATE

The U.S. Global Change Research Act of 1990 (PL 101-606) requires the establishment of a United States Global Change Research Program (USGCRP) aimed at understanding and responding to global change, including the cumulative effects of human activities and natural processes on the environment, to promote discussions toward international protocols in global change research, and for other purposes. Within this act, NOAA is identified as a major contributor to the development of a plan and the implementation of the program. NOAA is established as the lead agency for the successor program to USGCRP, the Climate Change Science Program. As the stress on this global system increases, it is essential for NOAA to continue to provide reliable observations, forecasts, and assessments of climate, water, and ecosystems to enhance decision makers' ability to minimize the risks associated with climate variability and change.

Mission: Understand changes in climate, including the El Niño phenomenon, to ensure that we can plan and respond properly.

Outcomes:

- A predictive understanding of the global climate system on time scales of weeks to decades with quantified uncertainties sufficient for making informed and reasoned decisions
- Climate-sensitive sectors and the climate-literate public effectively incorporating NOAA's climate products into their plans and decisions

Climate Observations and Analysis Program

The NOAA Climate Observation and Analysis Program serves every sector of the Nation's economy and delivers the data and information to enable effective environmental stewardship for the benefit of the nation, both domestically and internationally. The goal of this program is to describe and understand the state of the climate system through integrated observations, analysis, and data stewardship. Access to quality observations and science-based analysis of these data has provided our Nation with unique abilities to minimize climate related risk and maximize climate-related opportunities. Delivering on this demand and achieving more comprehensive outcomes will be achieved by improving our ability to meet stringent climate monitoring principles, working with our national and international partners through the Global Earth Observation System of Systems which includes integrated data and information management systems linked to integrated NOAA observing systems. The Department of Commerce has taken a lead role in implementing the Climate Change Science Program (CCSP) Strategic Plan, which integrates the U.S. Global Change Research Program (USGCRP) and the President's Climate Change Research Initiative. Lastly, the data and information must be monitored and analyzed to ensure high-quality data and information is available to our users.

At sea-data acquisition for critical atmospheric and oceanographic data, such as Sea Level, Ocean Carbon, Sea Surface Temperature and Surface Currents, Sea Surface Pressure and Air-Sea Exchanges of Heat, Momentum, and Fresh Water Ocean Heat and Fresh Water Content and Transports Sea Ice Thickness and Concentrations, is essential to describe and understand the state of the climate system. Both the U.S. CCSP and the Global Climate Observation System (GCOS) plans identify over 50 Essential Climate Variables that should be monitored. Adequate monitoring capability for these variables is necessary to ensure that NOAA does not falsely attribute a given cause (and subsequent solution) due to errors and biases in records used to monitor climate variability and change.

Climate Observations and Analysis Program Outcomes:

- Enable policy makers and resource managers to make informed national and global policy decisions using integrated climate observations and analysis
- Easy and convenient access by NOAA and it’s customers to new and historical national and global observations and climate analyses that meet rigorous scientific standards for quality
- Comprehensive documentation of the state of the climate system through a network of integrated climate observing systems

Climate Forcing Program

The objective of the Climate Forcing Program is to reduce uncertainty in the information on atmospheric composition and feedbacks that contribute to changes in Earth's climate. Specifically, the program seeks to provide the understanding needed to link emissions to the radiative forcing of climate change for science-based decision support to address the Climate Mission Goal outcome, "a predictive understanding of the global climate system on time scales of weeks to decades with quantified uncertainties sufficient for making informed and reasoned decisions."

The Climate Forcing Program is NOAA's research activity to:

- Understand atmospheric and oceanic processes, both natural and human-related, that affect carbon dioxide and other greenhouse gas trends that may be directly applied to climate projection and to policy decisions regarding carbon management that are related to limiting unwanted effects of future climate change

- Provide new information on the climate roles of the radiatively important trace atmospheric species (e.g., fine-particle aerosols and ozone, as well as other chemically reactive forcing agents that is needed to broaden the suite of non-carbon options available for policy support regarding the climate change issue

The Climate Forcing Program focuses on measurements (both within the program and with the Climate Observations and Analysis Program) of atmospheric constituents to reduce uncertainties associated with interannual variability in the global carbon cycle and the radiative influence of other atmospheric constituents in the forcing of climate change. A reduction of these climate-forcing uncertainties by the Climate Forcing Program is input needed for the improvement of the global climate models being developed with the Climate Predictions and Projections Program. Climate Forcing activities occur around the globe, through extensive observing networks maintained by NOAA, in field campaigns led by or involving NOAA, and by studies in the laboratory.

There is a need for fuller observations and analyses of the complex aerosols and aerosol-cloud interactions. An understanding of formation, transformation, and removal of aerosols is needed to calculate their abundances and properties. Aerosols have short atmospheric residence times, are highly non-uniform, and their physical and radiative properties vary considerably; hence, they need to be measured more frequently and in more places. The effects of cloud-aerosol interactions on climate are the most uncertain of all climate-forcing factors. Observations and analyses are needed to understand these processes and the nature of their feedbacks in climate change. Additionally, measurements and understanding of the oceanic uptake of CO_2 are essential for not only the carbon cycle but also for assessing ecosystem impacts, such as acidification. At sea-data acquisition, observations and monitoring are essential to the program and its objective to better quantify natural versus man-made processes that contribute to changes in earth’s climate.

Climate Forcing Program Outcomes:

- Improved understanding of atmospheric carbon dioxide trends for policy support and quantified carbon emission and uptake processes to form the needed input to climate model improvements
- New information on the climate roles of the radiatively important fine-particle aerosols, with an emphasis on aerosol-cloud interaction (the most uncertain of the climate forcing agents), and non-carbon dioxide greenhouse gases to provide decision support associated with options for potential near-term changes in radiative forcing of climate change
- Verification of the recovery of the ozone layer and the decline of ozone-depleting chemicals in the atmosphere, thereby facilitating compliance with the Montreal Protocol and its safeguarding the Earth’s ultraviolet shield

Climate and Ecosystems Program

The objective of the Climate and Ecosystems Program is to understand and predict the consequences of climate variability and change on marine ecosystems. The program accomplishes this by coupling observations with information from retrospective and process studies in order to detect the impacts of climate on marine ecosystems and build an understanding of climate-ecosystem relationships. The goal of the program is to develop forecasts of changes in fishery, coastal, and coral-reef resources in response to climatic changes. The forecasts provide users and managers of ocean and coastal resources information they require to adapt to changing climate regimes.

Changing climate is among the most significant long-term influences on the structure and functioning of marine ecosystems and must therefore be accounted for to insure healthy and productive ocean environments. NOAA must understand the effects of climate on marine ecosystems in order to meet its responsibilities under numerous mandates regarding the management of living marine and coastal resources. The program addresses this issue by monitoring changes in coastal and marine ecosystems through a network of *in situ* and remote observing systems and by developing biophysical indicators and models that meet the needs of marine resource managers to adapt to predicted climate-induced changes in fishery, coastal, and coral reef resources. This approach is characterized by the North Pacific Climate Regimes and Ecosystem Productivity project being conducted in the Eastern Bering Sea and the Gulf of Alaska. This geographic region was selected for initial climate and ecosystems studies due to its importance for living marine resources (Alaskan fisheries account for approximately 50% of the US commercial fishery landings), climate model predictions that climate change will be most severe at high latitudes, and many indications that environmental conditions are already changing in these regions.

At-sea data acquisition is essential to understanding and predicting the consequences of climate variability and change on marine ecosystems. Monitoring changes in coastal and marine ecosystems using a combination of *in situ* and remote observing systems involves at-sea data acquisition.

Climate and Ecosystems Program Outcomes:

- Improved ability to predict the consequences of climate variability and change on ecological systems in order to improve the management of living marine resources

WEATHER AND WATER

NOAA's Weather and Water programs touch the lives of every American. Every day, decisions are made based on NOAA weather information – from the mundane "should I pack an umbrella today?" to the most critical and potentially life-saving. With the mission to protect life and property, and enhance the United States' economy, NOAA is the sole official voice of the U.S. Government for issuing warnings during life-threatening weather situations. Covering the sun to the seas, NOAA provides local and regional forecasts, and emergency alerts for severe storms, tornadoes, hurricanes, floods, extreme heat, winter storms, fire threats, tsunamis and solar flares. Weather and climate sensitive industries in the United States account for about one-third of the Nation's Gross Domestic Product. Marine, aviation and space interests rely on NOAA's weather information, alerts and warnings. In addition, NOAA has a responsibility to support the growth of an environmental information enterprise, a partnership between government, academia and the private sector.

NOAA responds to the Nation's need for weather and water information services by sustaining high quality generation and delivery of information and services. Society receives a return on investment through critical improvements to weather and water science and technology by making the most of systematic development of services and products in conjunction with user communities, including climate, commerce and ecosystem management. In addition, society also benefits from the efficient transfer of knowledge through integrated and coordinated science and technology research. The integration of core competencies, facilities, and methods for process improvement enable a weather and water information enterprise.

Mission: Monitor, enhance and deliver environmental information, science and services to save lives, protect property and support environmental stewardship.

Outcomes:

- Reduced loss of life, injury, and damage to the economy
- Better, quicker, and more valuable weather and water information to support improved decisions
- Increased customer satisfaction with weather and water information and services

Air Quality Program

The NOAA Air Quality Program is a major and unique resource in the national effort to ensure that the public has clean air to breathe. In the often contentious field of air quality, NOAA acts as an 'honest broker", providing unbiased scientific information and tools to air quality decision-makers. The Air Quality Program provides environmental policy-makers at all levels of government and resource managers with information and tools to support the development of effective policies and emissions management programs. This includes information on the key processes contributing to poor air quality, the impacts of poor air quality, and potential solutions. The Air Quality Program also produces timely and accurate air quality forecast guidance for state and local air quality forecasters and the public so people can take appropriate action to limit adverse effects of poor air quality.

The Air Quality Program conducts a series of biennial regional assessments designed to determine the causes of, and potential solutions for, the poor air quality that plagues many of our cities. Most of the US cities that have serious air quality problems are located on the coast (e.g. Los Angeles, Houston, New York, Boston, etc.). In these cities transport and recirculation of pollution to and from the marine environment is believed to play an important role in determining regional air quality. The physical and chemical processes that control the distribution of air pollution in the coastal environment are poorly understood as is the role of emissions from commercial and recreational vessels operating in the coastal zone. The uncertainties attendant to these processes are a major impediment to the development of effective environmental policies and efficient emission management plans. Reducing these uncertainties is a major goal of the Air Quality Program.

In order to meet its mission needs, the Air Quality Program requires at-sea data collection. Studies conducted at sea in New England (2002 and 2004) and the Texas Gulf coast (2006) have yielded important new insights into emission sources, transport and chemical transformation in the coastal zone and near-coastal regions and have contributed significantly to the assessment goals for those regions. The Air Quality Program must conduct intensive sampling of the chemical and physical characteristics of the marine atmosphere in the coastal zone in order to meet its programmatic goals. The only practical and effective way to acquire this data is by deploying an extensive array of sensors (*in-situ* and remote) from sea-going platforms. Data acquired at sea provide a continuous record that is critical to improving our understanding of regional and global air quality and climate, as well as aiding or verifying international management strategies.

Air Quality Program Outcomes:

- Local, regional, and national air quality decision-makers can make effective policies and plans to protect public health, reducing mortality and morbidity, and sensitive ecosystems while also helping to maintain a vital economy
- The Nation can more effectively limit adverse effects of poor air quality, reducing mortality and morbidity while also helping to maintain a vital economy

Tsunami Hazard Mitigation Program

The mission of the Tsunami Hazard Mitigation Program is to coordinate and integrate the scientific and operational expertise, resources, and capacity across NOAA required to monitor, understand, and provide early warning of tsunami and related natural marine hazards. Addressing the physical and temporal scale of the "tsunami" phenomenon requires multiple functional capabilities to be harnessed efficiently and effectively including real-time ocean and coastal observation, tsunami forecast models that optimally interpret these observations, hazards and economic assessment and prediction, data management and communications, and outreach and education.

The Tsunami Hazard Mitigation Program is part of an international cooperative effort to save lives and protect property. NOAA currently operates two Tsunami Warning Centers in the Pacific Ocean Basin: The Alaska Tsunami Warning Center (ATWC) in Palmer, Alaska and the Pacific Tsunami Warning Center (PTWC) in Ewa Beach, Hawaii. The ATWC serves as the regional TWC for the U.S. States of Alaska, Washington, Oregon, and California and British Columbia, Canada. The PTWC is regional TWC for tsunamis that pose a Pacific-wide threat and assumes the responsibility for the Pacific Tsunami Warning System (PTWS). The PTWS is comprised of 26 International Member States that are organized as the International Coordination Group for the Tsunami Warning System in the Pacific Ocean.

As a result of the devastating Tsunami that occurred on December 26, 2004 in South Asia, NOAA is responsible for the expansion of the U.S. Tsunami Warning System. Started in mid-2005, the expansion will upgrade the current Pacific Ocean network of 6 DART Buoys to 39 in the Pacific and Atlantic Oceans and the Caribbean Sea, establish an Atlantic Tsunami Warning Center, deploy second generation buoys, and expand the Tsunami Hazard Mitigation Program including outreach and education. Additionally, NOAA will have a role in establishing an International Tsunami Detection System and is actively involved in Global Environmental Observing System of Systems (GEOSS).

Additionally, the Tsunami Hazard Mitigation Program supports the NOAA Center for Tsunami Research at the Pacific Marine Environmental Laboratory by developing high-resolution Digital

Elevation Models for select U.S. coastal regions. These combined bathymetric-topographic Digital Elevation Models are part of the tsunami forecast system SIFT (Short-term Inundation Forecasting for Tsunamis) currently being developed by the Pacific Marine Environmental Laboratory for the NOAA Tsunami Warning Centers. The coastal inundations Digital Elevation Models are used in the Method of Splitting Tsunami model developed by the Pacific Marine Environmental Laboratory to simulate tsunami generation, propagation, and inundation. At-sea data acquisition provides critical hydrographic sounding data for offshore Digital Elevation Model development.

At-sea data acquisition is required to monitor, understand, and provide early warning of tsunami and related natural marine hazards. The program utilizes a system of DART (Deep-Ocean Assessment and Reporting of Tsunami) Buoys and relies on ship support to deploy and maintain its buoys.

Tsunami Hazard Mitigation Program Outcomes:

- Reduce loss of life, injury, and damage to the economy through improved tsunami detection, and detailed forecast and warning information to emergency and coastal zone managers
- Reduce loss of life, injury, and damage to the economy by increasing tsunami awareness and knowledge for persons in tsunami vulnerable areas
- Reduce the loss of human lives and property through improved tsunami detection, forecast and warning, and hazard mitigation activities
- Increase the number of persons educated about tsunami preparedness
- Provide emergency managers with enough detail to appropriately scale their tsunami mitigation activities (evacuations are based on tsunami size, run-up maps, etc.)

Science, Technology and Infusion Program

NOAA's Science, Technology and Infusion (ST&I) Program is an enabling program for improvement of NOAA's Weather and Water services by meeting short-term needs of NOAA and its customers, while conducting long-term research that leads to breakthrough advances in services. ST&I provides NOAA operational units, with new science applications and technology tools to enable more skillful and timely forecasts and. ST&I performs state-of-the-art research and works with NOAA's service programs to infuse new science and technology via prototyping, evaluation, acquisition, and training. ST&I's capabilities are:

- Science
  - Expertise in physics of weather and water phenomena
  - Ability to evaluate and improve forecast models and tools
  - Equipment and staff for field studies
  - Societal and economic impact analysis

- Technology
  - Development of new sensors and observing strategies
  - Evauation of integrated observing systems
  - Engineering information technologies

- Infusion

- Testbeds for science and technology infusion
- Acquisition of new technologies
- Forecaster training
- Education and outreach to excite future scientists

Science, Technology and Infusion Program Outcomes:

- Improve predictions of the onset, duration, and impact of high-impact weather and water events
- Increase the application and accessibility of all types of environmental information and make this the foundation for creating and leveraging public, private, and academic partnerships
- Improve scientific understanding of the key physical processes responsible for the weather and water conditions it predicts
- Enable local, regional, and national resource and public safety managers to make effective policy and plans to optimize resource management and public safety
- Increase the coordination of weather and water services by integrating local, regional, and global observation and information systems
- Enhance its environmental literacy programs to enable society's understanding, value, and use of weather and water information services

COMMERCE AND TRANSPORTATION

NOAA supports the Nation's commerce with information for safe, efficient, and environmentally sound transportation. NOAA provides transportation-related products and services to benefit the American economy, public safety, national security, and the environment. From the Organic Act of 1807, which created the Survey of the Coast, through today's Homeland Security Presidential Directive, NOAA and its predecessor organizations have worked in partnership with other federal, state and local agencies, academia and the private sector to develop, maintain, and improve a safe, efficient U.S. transportation system. Several mandates from the U.S. Congress, the Executive Branch and international treaties provide the requirements for the Commerce and Transportation mission goal. The mandates span the breadth of the mission goal and require NOAA to: enhance national economic performance through an efficient U.S. transportation system; reduce risks to life, health, and property through development and use of the U.S. transportation system; protect the security of the U.S. transportation system; and ensure environmentally sound development and use of U.S. transportation.

Mission: Provide weather and navigation information for safe, secure, efficient and environmentally sound movement of goods and people in the U.S transportation system.

Outcomes:

- Safe, secure, efficient, and seamless movement of goods and people in the U.S. transportation system
- Environmentally sound development and use of the U.S. transportation system

Marine Transportation Systems Program

The United States Marine Transportation System is a network of navigable waterways, ports, harbors and intermodal hubs that link to rail, air, road, and pipeline systems. The Marine Transportation System (MTS) Program provides the navigation services needed for safe, efficient, and environmentally sound navigation. It acquires hydrographic, oceanographic, meteorological, and shoreline data so that mariners and other Marine Transportation System users can assess their operational surroundings, thereby reducing the risk of accidents and ensuring the just-in-time delivery of goods to market. It is NOAA's hydrographic surveys that form the basis for the official nautical charts required on vessels greater than 1600 gross tons. It is NOAA's full-bottom coverage surveys that alert mariners to the depths, rocks, wrecks and other obstructions they must avoid in order to reduce the risk of accident and damage to life, property, and the environment. MTS hydrographic, shoreline and physical oceanographic observation systems are also considered a fundamental part of the national backbone for the Integrated Ocean Observing System.

MTS relies on ships and launches to conduct hydrographic surveys to measure the depth and bottom configuration of water bodies, to produce the nation's nautical charts and ensure safe navigation in the US Exclusive Economic Zone (EEZ). The EEZ comprises 3.4 million square nautical miles (SNM) and extends 200 nautical miles offshore. Hydrographic surveys also identify sea floor composition (important for anchoring, dredging, cable or pipeline routing, and habitat protection), wrecks and obstructions, and other features on the seafloor including cables, pipelines, and fish habitat. These surveys support a variety of activities including port and harbor maintenance (dredging), beach erosion and replenishment studies, coastal zone management, habitat studies, and offshore resource development. These surveys contribute to the nation's ocean observing system by providing the data that are the foundation for so many ocean-related products and services.

Marine Transportation Systems Program Outcomes:

- Marine transportation systems users experience a reduction in navigation-related accidents, which protects lives, property and the environment.
- Marine transportation systems users save time and money through more efficient operations.
- Marine transportation systems users conduct port infrastructure (re)development activities in an environmentally sound manner.

Geodesy Program

Geodesy is the science of measuring and monitoring the size and shape of the earth and its gravity field, or geoid. Geodesy is used to understand physical processes on, above, and within the earth. NOAA is responsible for the development and maintenance of a national geodetic data system that is used for navigation, communication systems, mapping and charting, construction and many other purposes. All of the elements of geodesy are joined together in the National Spatial Reference System (NSRS). For over 200 years, the National Geodetic Survey (NGS) and its predecessors have been using geodesy to map the U.S. shoreline, determine land boundaries, and improve transportation and navigation safety.

Scientists can determine exactly how much the earth's surface has changed over time by obtaining highly accurate horizontal and vertical positions based on NOAA's NSRS and the geoid model.

Additionally, using the Global Positioning System (GPS), everyone now has the ability to determine location within meters on or above the surface of the earth. With additional augmentations and/or observing times from NOAA's Online Positioning User Service (OPUS), accuracies of less than 1 centimeter horizontally are achievable. This capability to accurately position an object or person has proven to be essential for the transportation industry to support the safety of people, goods, and services, while reducing costs.

To maintain and improve the geoid model, NOAA collects airborne gravity data, but these data must be validated by surface gravity measurements. Shipborne gravity data collection with gravimeters - a type of accelerometer designed to measure the local gravitational field and very tiny changes within the earth's gravity - perpendicular to aircraft flight lines is particularly key to resolving the present inconsistent gravity field from onshore to offshore in coastal regions.

Geodesy Program Outcomes:

- Ensure all geographic objects can be consistently and accurately located.
- Support the integration of accurate geospatial data into the full range of societal needs.

MISSION SUPPORT

Mission: Provide critical support for NOAA’s mission

Outcomes:

- One NOAA working together, guided by a clear strategic vision for planning, programming, and execution, to achieve NOAA’s goals
- A safe operating environment with efficient and effective financial, administrative, and support services
- Ship, aircraft, and satellite programs that ensure continuous observation of critical environmental conditions
- NOAA Homeland Security related capabilities that are fully integrated into national planning and available at all times
- A sustainable and strategic facilities master planning process with a 5- to 10-year planning horizon
- Secure, reliable, and robust information flows within NOAA and out to the public
- A dynamic workforce with competencies that support NOAA’s mission today and in the future

Satellite Services Program

The Satellite Services Program provides a bridge between NOAA’s Geostationary and Polar Acquisition programs and NOAA’s Mission programs by integrating NOAA’s satellite command and control, product processing and distribution, and applied research activities. Operating sixteen environmental satellites, the program collects, navigates, calibrates and distributes the operational and preoperational data necessary to accurately monitor and observe the land, sea, atmosphere, and space around us. Within NOAA, satellite command and control, product processing and distribution and applied research activities are integrated to allow end-to-end utilization of NOAA’s satellite observation and research capabilities. Satellite support activities include vicarious calibration support of all ocean color sensor data, and production of ocean color environmental and climate data records to provide the science support required to prepare for future ocean color satellite sensors and to develop improvements to more efficiently acquire vicarious satellite ocean color data with advanced hyperspectral autonomous buoy (AHAB) technology. Operating day requirements for Marine Optical BuoY Operations and the Marine Optical Characterization Experiment directly support and *in situ* data collection to maintain quality control and assessment of the 10-year vicarious ocean color calibration data stream for satellite ocean color observations and buoy and mooring swap outs to refurbish platform equipment, instruments, and power supplies.

With the advent of new operational satellite instruments, in particular the NPP/NPOESS VIIRS (Visible Infrared Imager/Radiometer Suite), the operational requirement for ships to routinely service routine satellite ocean color vicarious calibration/validation operations of the Marine Optical BuoY (MOBY) Project, the world's primary vicarious calibration facility for satellite ocean color observations, takes on increased significance. This requirement includes periodic extraction and replacement of the operational buoy system. MOBY directly supports the operational calibration plans of SeaWiFs, MODIS, MERIS, NPP/NPOESS and GOES-R. MOBY data ensures the quality of the satellite ocean color data integral to the NOAA Operational Harmful Algal Bloom (HAB) Forecast System's detection and assessment activities as well as all other programs requiring ocean color data. Without ship support, the MOBY ocean color vicarious calibration facility will not be available for the fundamental and crucial initial certification, calibration, and validation of future satellite ocean color sensors including the NPP/NPOESS VIIRS and the GOES-R HES-Coastal Waters Imager. This calibration and validation is critical in providing data links between these future sensors and current sensors. To date, the MOBY effort has been a joint NASA/NOAA-supported research and development project; however, NASA is transitioning its support to NOAA in conjunction with the transition of MOBY from research to operations.

As MOBY evolves and is upgraded in the future, there is a continuing need to test and validate measurements and instrument designs. The Marine Optical Characterization Experiment (MOCE) and the Coastal Optical Buoy (COBY) projects are integral components of an operational MOBY plan. MOCE is an ongoing bio-optical experiment that is necessary to characterize environmental and instrument uncertainties so as to constrain the errors in the vicarious calibration measurements. The next generation plans for MOBY include adaptations that will enable MOBY measurements in coastal waters. It is envisioned that a second separate next generation MOBY will be developed exclusively for coastal ocean color validation experiments (COBY).

Satellite Services Program Outcomes:

- Provide a continuous collection of Satellite environmental data products to support the Nation's economy and public wellbeing

Marine Operations and Maintenance and Fleet Replacement Programs

The Marine Operations and Maintenance Program, operates, maintains and charters ships to satisfy NOAA's data-acquisition requirements of NOAA's Mission Goals using safe, economical and productive government and commercial ships with the required range, capabilities, berthing space, mission equipment, seakeeping ability and adequate shoreside support. Additionally, the Marine Operations and Maintenance Program 1) provides educated and trained uniformed commissioned officers to NOAA Programs, 2) manages the NOAA Dive Program, 3) administers the Small Boat Safety Program and 4) administers the Teacher at Sea Program.

The Fleet Replacement Program develops the requirements, business case acquisition strategies, funding profiles, contractual instruments and preliminary arrangements necessary to design, construct/modernize, equip, and deliver the ships and ship systems required to safely meet NOAA's at-sea data-acquisition requirements.

Marine Operations and Maintenance and Fleet Services Program Outcomes:

- A mission-ready fleet of ships and support services that safely meet NOAA's at-sea functional and operational data collection requirements

Homeland Security Program

The Homeland Security Program (HSP) is responsible for coordinating the development of all plans, programs, and policies regarding NOAA's homeland security activities, and for providing a unity of effort and point of contact for NOAA leadership, Department of Commerce, and Department of Homeland Security. The program strengthens NOAA's ability to prepare for, respond to, and recover from terrorist attacks, natural and man-made disasters and other emergencies.

Due to the unpredictability of homeland security-related events, HSP has no specific and recurring requirements for at-sea or in-air platform support. Previous NOAA-related homeland security responses requiring platform support to acquire data - such as NOAA's 2004 responses to hurricanes Katrina and Rita – resulted in the diversion of NOAA ships equipped to support hydrographic surveys, water-quality studies, and aircraft equipped to support shoreline imagery.

Homeland Security Program Outcomes:

- Ensure a NOAA standard for preparedness and response that provides a seamless continuity of operations and a single, comprehensive organizational structure for management of NOAA capabilities supporting an incident response when natural or terrorist-related activities occur

Integrated Ocean Observing System (IOOS) Program

The Integrated Ocean Observing System (IOOS) is a system of systems that routinely and continuously provides quality controlled data and information on current and future states of the oceans and Great Lakes from the global scale of ocean basins to local scales of coastal ecosystems. It is a multidisciplinary system designed to provide data in forms and at rates required by decision makers to address seven societal goals.

Federal agencies of the Interagency Committee on Oceanic Science and Resource Management Integration (ICOSRMI), including NOAA, have several important roles in the design, implementation, operation, and improvement of the Integrated Ocean Observing System (IOOS) over time.

Many federal programs and activities that contribute to IOOS development were established by each agency to achieve their particular missions and goals. The IOOS supports new and improved products and services for user groups by integrating the data streams and information provided by these programs. This is the value added nature of the IOOS. Providing the data and information needed to address the seven societal goals requires an "integrated" observing system that:

- Efficiently links observations, data communications and management, and data analysis and modeling (to form an "end-to-end" system)
- Provides rapid access to multi-disciplinary data from many sources
- Serves data and information required to achieve multiple goals that historically have been the domain of separate agencies, offices or programs
- Efficiently links advances in science and technology to the development of operational capabilities
- Involves cross-cutting partnerships among federal and state agencies, the private sector, and academic institutions

Integrated Ocean Observing System (IOOS) Program Outcomes:

Through its participation in IOOS, the Integrated Ocean Observing System Program supports the following societal goals:

- Improve the safety & efficiency of marine operations
- Improve national/homeland security
- Improve forecasts of natural hazards and mitigate their effects more effectively
- Improve predictions of climate change & their effects
- Minimize public health risks
- Protect & restore healthy coastal marine & estuarine ecosystems more effectively
- Sustain living marine resources

Appendix C – Current Ship Overview

CURRENT SHIP OVERVIEW

ALBATROSS IV

ALBATROSS IV conducts fishery and living marine resource research. The ship's normal operating area is the Gulf of Maine, Georges Bank, and the continental shelf and slope from Southern New England to Cape Hatteras, North Carolina. Typical assessment work includes groundfish surveys and Ecosystem Monitoring surveys. Research conducted on the ship provides an understanding of the physical and biological processes that control year class strength of key economical fish, shellfish and zooplankton species.

General Specifications:

Launched: 1962
Commissioned: 1963
Length (LOA): 57.0 m (187 ft)
Beam: 10.1 m (33 ft)
Draft, Maximum: 4.9 m (16.2 ft)
Speed: 11.0 knots
Range: 3,933 nm
Endurance: 18 days
Laboratory Spaces: 800 sq. ft.

Complement:

Commissioned Officers: 4
Licensed Officers: 4
Crew: 13
Scientists: 14 (max)

Major Mission Equipment/Capability:

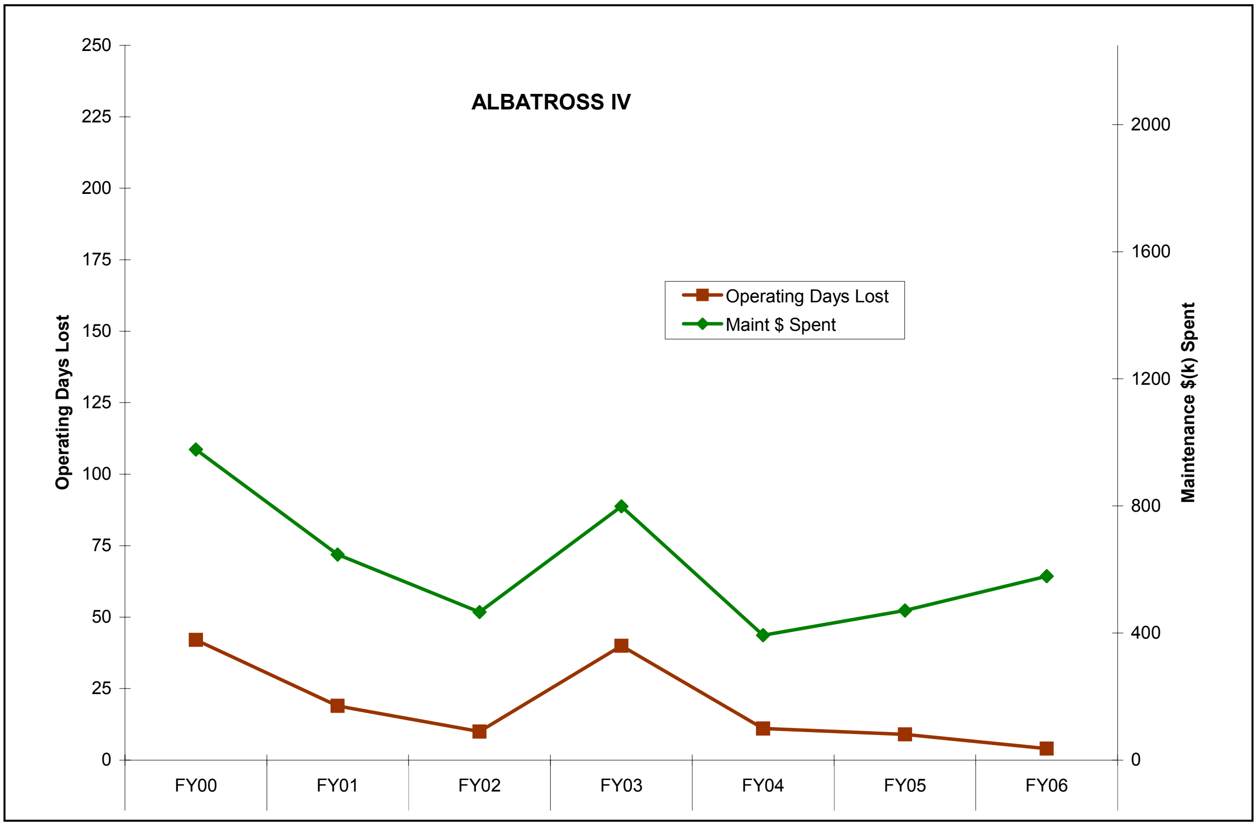
Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc.)	No
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	Shipboard Environmental Data Acquisition System

Hull Structure/Major Machinery Condition Assessment:

This ship does not meet ABS Class standards. It has maintained its Load Line for maximum load permissible. The ship cannot experience any increase in its center of gravity (KG) and does not meet criteria for damage stability.

This ship will be retired at the age of 46 years old in FY 2008 after completing calibration cruises alongside HENRY B BIGELOW. A major repair period was completed in the 2002-2003 timeframe to ensure the ship could last for another 6 to 8 years. This work included a thorough survey of the hull condition, preservation of bilge areas, overhaul of the steering system, and repair and overhauls to the refrigeration and HVAC systems. The Controllable Pitch Propeller (CPP) is original and worn beyond recommended specifications and unreliable. Both ship service generators are not configured for marine service. Neither generator engine can drive the power generators to full power. The electrical distribution system is not segregated. Wire ways are packed to capacity and too many circuits have been added to a system struggling to deliver electrical load. Electrical wiring is cracked and brittle. Plate deterioration and pinhole leaks in various piping are common repair/replacement items during regular repair periods. This metal deterioration is due to the corrosive environment and liquids in constant contact with metal. Electrical grounds can accelerate this deterioration if not kept in check.

Maintenance costs and operating days lost due to engineering related problems are tracked in the graph below.



DAVID STARR JORDAN

DAVID STARR JORDAN is a western-rigged stern trawler that conducts fisheries and oceanographic research, including mid-water and bottom trawling, longline sets, plankton tows, oceanographic casts, bottom sample grabs, SCUBA diving operations, and visual surveys of marine mammals and seabirds. The ship normally operates in California and Central American waters.

General Specifications:

Launched: 1964
Commissioned: 1966
Length (LOA): 52.1 m (171 ft)
Beam: 11.2 m (36.6 ft)
Draft, Maximum: 3.8 m (12.5 ft)
Speed: 10.0 knots
Range: 7,500 nm
Endurance: 30 days
Laboratory Spaces: 1,058 sq. ft.

Complement:

Commissioned Officers: 4
Licensed Officers: 3
Crew: 11
Scientists: 15 (max)

Major Mission Equipment/Capability:

Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc)	No
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes

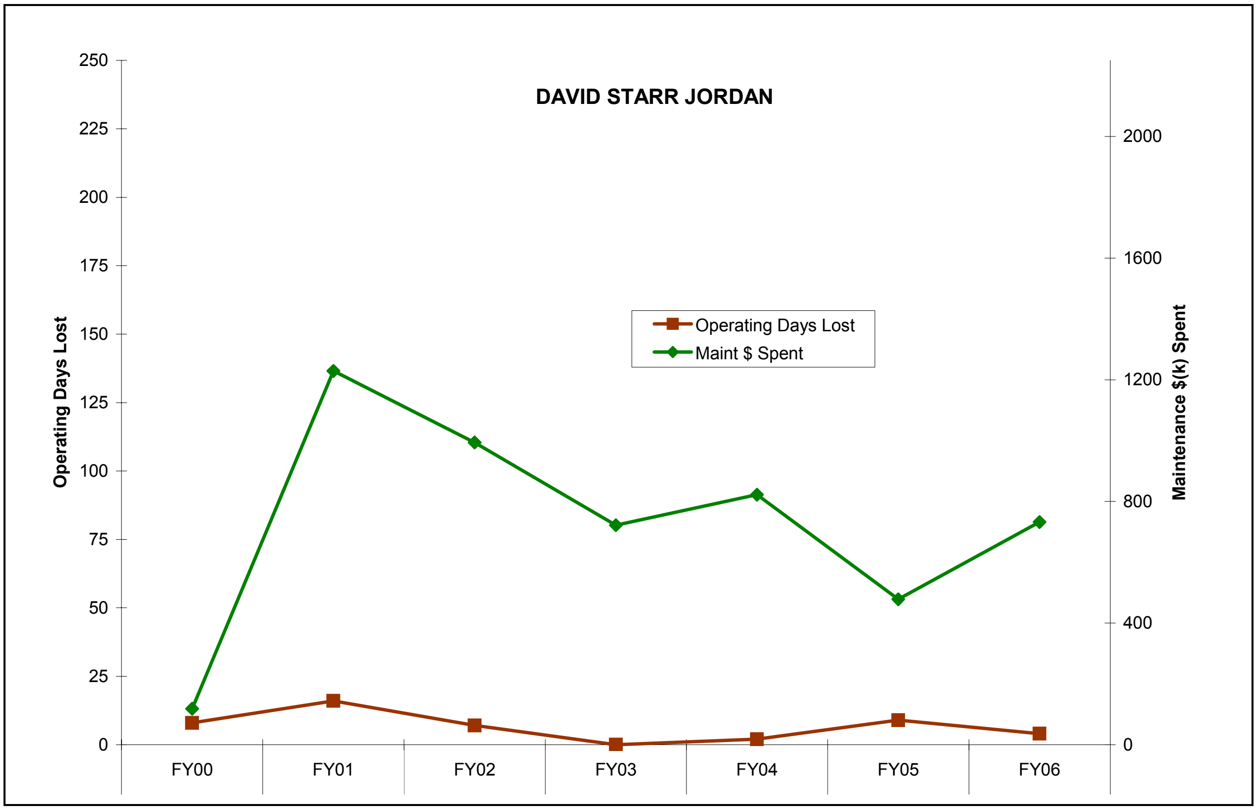
Hull Structure/Major Machinery Condition Assessment:

This ship does not meet ABS Class standards. It has maintained its Load Line for maximum load permissible. Ship cannot experience any increase in its center of gravity (KG) and does not meet criteria for damage stability.

The latest Machinery Condition Assessment (2006) indicates: signs of localized underwater body plate thinning that has required plate renewals, main deck thinning and wasted plate under the wet lab that required renewal of large deck areas, and a history of extensive superstructure plate renewals at the base of exterior bulkheads where interior sheathing has prevented maintenance. Similar corrosion has been identified and repaired at an increasing frequency due to pinhole leaks in numerous piping systems. The electrical distribution system is in poor condition. Power panels are obsolete and contactors are in poor condition. Wiring is deteriorated; many wires are no longer clearly identified. The corrosive environment, along with electrical grounds, contributes to an accelerated deterioration in metal plate and piping systems. The main propulsion engines made by Superior are no longer manufactured; the company no longer exists in name.

Known dangerous materials have been removed when appropriate and practical. Asbestos and lead paint are located throughout the ship.

Maintenance costs and operating days lost due to engineering related problems are tracked in the graph below.



DELAWARE II

DELAWARE II conducts fishery and living marine resource research. The ship's normal operating area is the Gulf of Maine, Georges Bank, and the continental shelf and slope from Southern New England to Cape Hatteras, NC. Typical assessment work includes groundfish assessment surveys and Marine Resources Monitoring, Assessment and Prediction (MARMAP) surveys. Research conducted from the DELAWARE II provides an understanding of the physical and biological processes that control year-class strength of key economical fish species.

General Specifications:

Launched: 1967
Commissioned: 1975
Length (LOA): 47.2 m (155 ft)
Beam: 9.1 m (30 ft)
Draft, Maximum: 5.1 m (16.6 ft)
Speed: 10.0 knots
Range: 4,546 nm
Endurance: 19 days
Laboratory Spaces: 494 sq. ft.

Complement:

Commissioned Officers: 2
Licensed Officers: 5
Crew: 10
Scientists: 14 (max)

Major Mission Equipment/Capability:

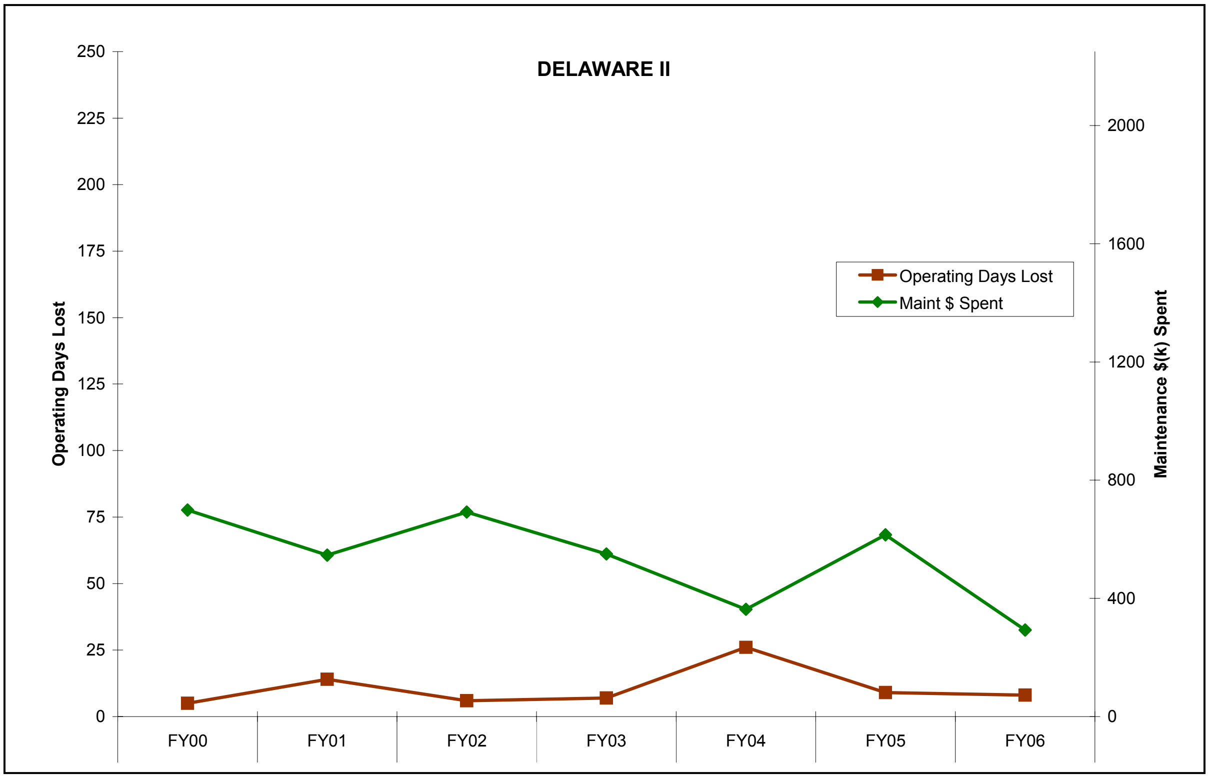
Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc.)	No
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	Shipboard Environmental Data Acquisition System

Hull Structure/Major Machinery Condition Assessment:

This ship is fully classed to ABS Class standards. It has maintained its Load Line for maximum load permissible. Ship cannot experience any increase in its center of gravity (KG). Ship meets 46 CFR Subchapter U for intact stability and 46 CFR 171.080 (e) for damage stability.

The most recent machinery condition assessment (2006) indicated replacement of hull plating and weather deck plating as an ongoing replacement project. This ship also maintains a very limited holding capacity for sewage requiring it adapt missions to comply with no discharge zones. The ship underwent a “Repair-to-Extend” (RTE) major repair period in 1999, giving it an additional expected service life of 10 to 15 years.

Maintenance costs and operating days lost due to engineering related problems are tracked in the graph below.



FAIRWEATHER

FAIRWEATHER is designed and outfitted primarily for conducting hydrographic surveys in support of nautical charting, but is capable of many other missions in support of NOAA programs. The ship is equipped with the latest in hydrographic survey technology – multi-beam sonar survey systems; high-speed, high-resolution side-scan sonar; position and orientation systems, hydrographic survey launches, and an on-board data-processing server. Increased mission space and deck machinery enable FAIRWEATHER to be tasked with anything from buoy operations to fisheries research cruises. FAIRWEATHER was originally commissioned with NOAA in 1968 and deactivated in 1989. The ship was reactivated in 2004 due to a critical backlog of surveys for nautical charts in Alaska.

General Specifications:

Launched: 1967
Commissioned: 1968
Length (LOA): 70.4 m (231 ft)
Beam: 12.8 m (42 ft)
Draft, Maximum: 4.7 m (15.5 ft)
Speed: 12.0 knots
Range: 6,000 nm
Endurance: 22 days

Complement:

Commissioned Officers: 8
Licensed Engineers: 4
Crew: 23
Scientists: 23 (max)

Major Mission Equipment/Capability:

Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc.)	Yes
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	

Hull Structure/Major Machinery Condition Assessment:

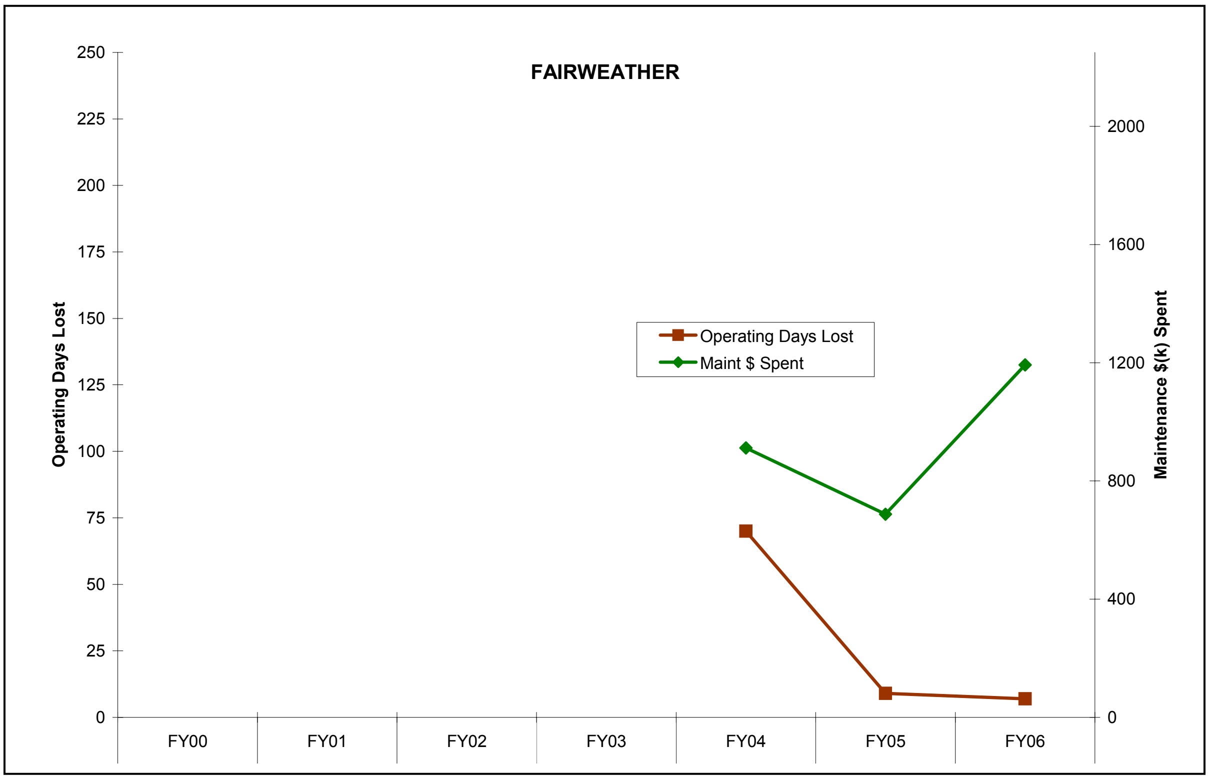
This ship meets selected ABS Class standards. It has maintained its Load Line for maximum load permissible. Ship meets 46 CFR Subchapter U for intact stability and 46 CFR 171.080 (e) for damage stability. Any increase is displacement or center of gravity is unacceptable.

The latest Machinery Condition Assessment (2007) indicates no history of underwater body, weather deck, or superstructure plate thinning or renewals in recent years. The assessment also indicates no significant issues with major machinery.

This ship was reactivated in 2004 after an extensive reactivation and conversion repair period modernized the machinery plant, upgraded habitability arrangements, and significantly revised and improved mission capability. Even after these repairs were completed, it has continues to experience problems with deteriorated piping and leaks in piping systems. This ship needs additional sewage holding capacity to meet new state discharge regulations in Alaska. The new survey launch davits have proven problematic and have caused many of the ship's lost sea days.

Known hazardous materials are contained and managed appropriately. These materials include asbestos, lead paint, and possibly PCBs in vent gasket materials not replaced during reactivation.

Maintenance costs and operating days lost due to engineering related problems are tracked in the graph below.



GORDON GUNTER

GORDON GUNTER is a converted U.S. Navy T-AGOS ship supporting fishery and living marine research. GORDON GUNTER was built in 1989 for the U.S. Navy and transferred to NOAA in 1993. The ship was converted to her present configuration through two intense repair periods beginning in March 1998. GORDON GUNTER has with modern navigation electronics and oceanographic winches, sensors, and sampling equipment. A custom designed marine mammal observation station was installed. Significant modifications were also made to the laboratory spaces with the installation of wet, dry, chemistry, and electronic lab equipment. Modifications were made to provide the capability to collect fisheries data by stern trawling, longlining, and deployment of plankton nets and other gear types.

General Specifications:

Launched: 1989
Transferred to NOAA: 1993
Commissioned: 1998
Length (LOA): 68.3 m (224 ft)
Beam: 13.1 m (43 ft)
Draft, Maximum: 4.9 m (16.0 ft)
Speed: 10.5 knots
Range: 8,000 nm
Endurance: 30 days
Laboratory Spaces: 1,232 sq. ft.

Complement:

Commissioned Officers: 4
Licensed Engineers: 4
Crew: 10
Scientists: 15 (max)

Major Mission Equipment/Capability:

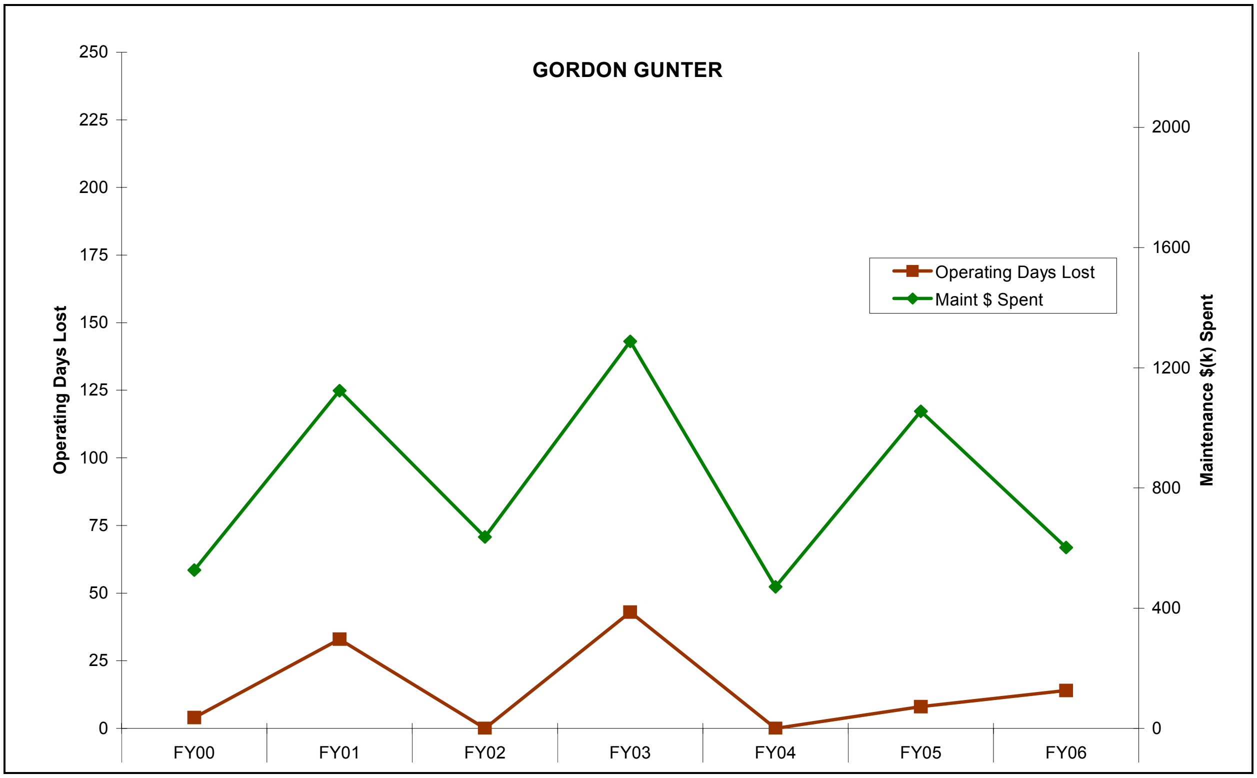
Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc.)	No
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	

Hull Structure/Major Machinery Condition Assessment:

This ship is fully classed to ABS standards. Ship meets 46 CFR Subchapter U for intact stability and 46 CFR 171.080 (e) for damage stability. An increase in displacement or center of gravity is unacceptable.

The most recent Machinery Condition Assessment (2000) indicates no history of underwater body plate thinning or renewals or weather deck or superstructure plate renewals. The assessment also indicates no significant issues with major systems.

Maintenance costs and operating days lost due to engineering related problems are tracked in the graph below.



HENRY B BIGELOW

HENRY B BIGELOW is the second of a class of four ultra-quiet modern fisheries research ships being built to support NOAA's mission to protect, restore, and manage the use of living marine, coastal, and ocean resources through ecosystem-based management. Its primary objective is to study and monitor northeast Atlantic marine fisheries. The ship also observes weather, sea state, and other environmental conditions; conducts habitat assessments; and surveys marine mammal and marine bird populations.

General Specifications:

Launched: 2005
Commissioned: 2007
Length (LOA): 63.8 m (209 ft)
Beam: 15.0 m (49 ft)
Draft, CB Housed: 6.0 m (19.4 ft)
Draft, CB Extended: 9.05 m (29.7 ft)
Speed: 12.0 knots
Range: 12,000 nm
Endurance: 40 days
Laboratory Spaces: 2,341 sq. ft.

Complement:

Commissioned Officers: 5
Licensed Officers: 4
Crew: 15
Scientists: 16 (max)

Major Mission Equipment/Capability:

Acoustic Quieting	Yes
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc.)	Yes
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	

Hull Structure/Major Machinery Condition Assessment:

This ship is new.

HI'IALAKAI

HI'IALAKAI is a former U.S. Navy T-AGOS ship built in 1984 and transferred to NOAA in 2001. The ship was converted to conduct research activities in support of coral reef ecosystem and habitat mapping efforts. The ship is equipped with multi-beam sonar equipment and a backscatter echosounder for coral reef mapping activities.

The ship is equipped to support both deep and shallow water dive projects. HI'IALAKAI carries two to five small workboats that transfer divers to the working grounds, a 15-person dive locker to store diving gear and equipment, an air compressor to fill tanks, and can be equipped with a three-person, double-lock decompression chamber in the event of a diving accident occurring in remote operating areas.

General Specifications:

Launched: 1984
Transferred to NOAA: 2001
Commissioned: 2004
Length (LOA): 68.3 m (224 ft)
Beam: 13.1 m (43 ft)
Draft, Maximum: 4.5 m (15.0 ft)
Speed: 11.0 knots
Range: 8,000 nm
Endurance: 30 days
Laboratory Spaces: 1,232 sq. ft.

Complement:

Commissioned Officers: 6
Licensed Engineers: 3
Crew: 15
Scientists: 23 (max)

Major Mission Equipment/Capability:

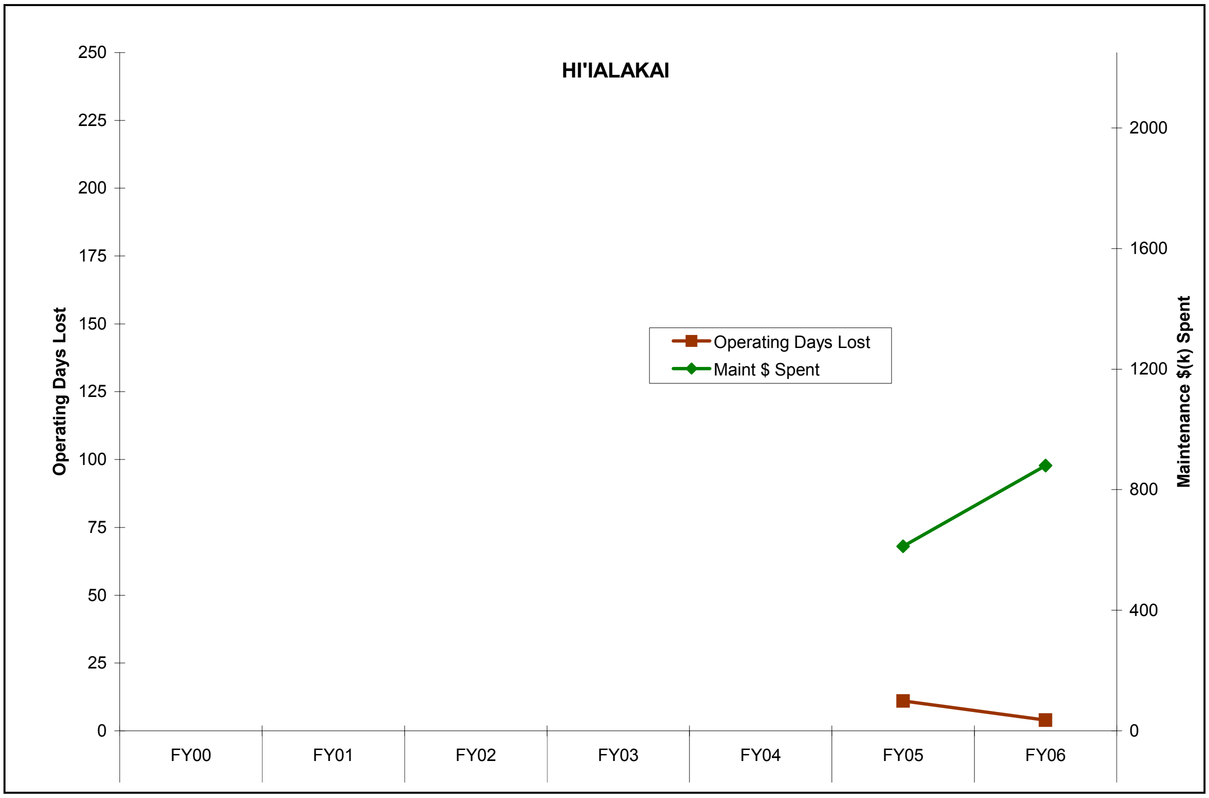
Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc.)	Yes
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	

Hull Structure/Major Machinery Condition Assessment:

This ship is fully classed to ABS standards.

Conversion for NOAA service occurred in two phases. In 2003 hull, mechanical, and electrical work was completed; in 2004 spaces were reconfigured for scientific use. Ship operates in a humid saltwater environment that accelerates the problems of corrosion in ventilation systems, and topside areas. The main ventilation plenums are suffering from corrosion and have numerous holes through to the insulation. Ship does not have sufficient holding capacity for sewage, affecting ship operations in no discharge zones of the northwest Hawaiian Islands. Salt water piping systems, particularly engine cooling and sewage systems, are known to have serious internal corrosion problems with frequent leaks.

Maintenance costs and operating days lost due to engineering related problems are tracked in the graph below.



JOHN N COBB

JOHN N COBB, NOAA's oldest and only wooden hull research ship, conducted fishery and living marine resource research in Southeast Alaska and in U.S. Pacific coastal waters. The ship collected fish and crustacean specimens using trawls and benthic longlines; plankton using plankton nets; and fish larvae and eggs, with surface and midwater larval nets. The ship was capable of conducting bottom trawls down to depths of over 300 fathoms (1,800 ft.) and marine mammal surveys of whales, porpoise, and seals.

General Specifications:

Launched: 1950
Commissioned: 1950
Transferred to NOAA: 1972
Length (LOA): 28.3 m (93 ft)
Beam: 7.9 m (26 ft)
Draft, Maximum: 3.4 m (11.0 ft)
Speed: 10.0 knots
Range: 2,850 nm
Endurance: 13 days
Laboratory Spaces: 150 sq. ft.

Complement:

Commissioned Officers: 2
Licensed Officers: 2
Crew: 4
Scientists: 4 (max)

Major Mission Equipment/Capability:

Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc)	No
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	No
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	No
Other	

Hull Structure/Major Machinery Condition Assessment:

JOHN N COBB was decommissioned on August 13, 2008.

KA'IMIMOANA

KA'IMIMOANA is a converted U.S. Navy T-AGOS ship that primarily supports the research programs of NOAA's Tropical Atmosphere-Ocean (TAO) Project. These programs are designed to improve our understanding of the role of the tropical ocean in modifying the world's climate. The ship deploys, recovers, and services deep sea moorings that measure ocean currents, ocean temperatures, and atmospheric variables, throughout the equatorial Pacific Ocean. In addition to buoy measurements, the ship measures upper ocean currents, surface salinity, carbon dioxide content, and takes upper air atmospheric soundings while underway. A census of barnacles and marine life that inhabit the recovered moorings and the periodic replacement of undersea hydrophone moorings used to locate undersea spreading centers and hydrothermal vents on the East Pacific Rise are also conducted on an ongoing basis.

General Specifications:

Launched: 1988
Transferred to NOAA: 1993
Commissioned: 1996
Length (LOA): 68.3 m (224 ft)
Beam: 13.1 m (43 ft)
Draft, Maximum: 4.6 m (15.0 ft)
Speed: 10.5 knots
Range: 8,000 nm
Endurance: 30 days
Laboratory Spaces: 950 sq. ft.

Complement:

Commissioned Officers: 4
Licensed Officers: 3
Crew: 13
Scientists: 12 (max)

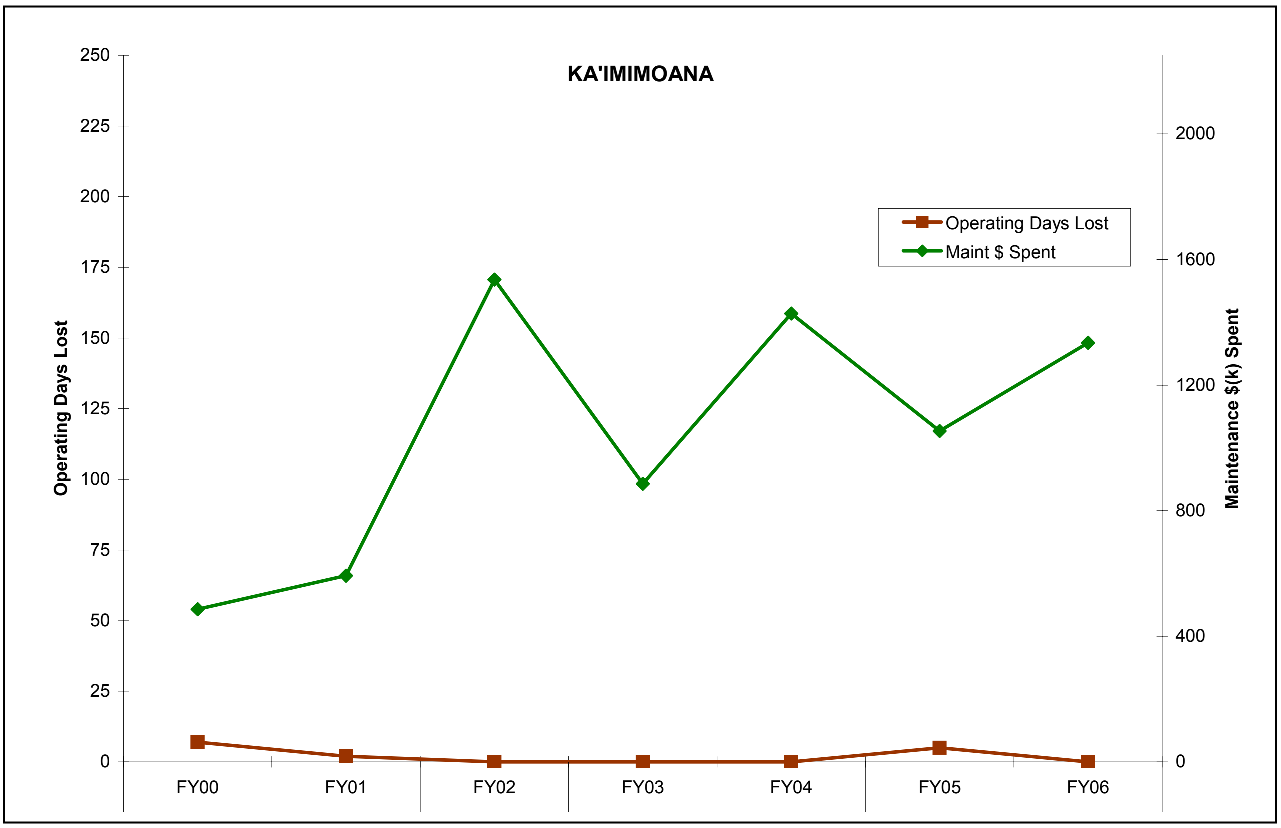
Major Mission Equipment/Capability:

Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc)	No
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	Shipboard Environmental Data Acquisition System

Hull Structure/Major Machinery Condition Assessment:

The ship was converted to NOAA service in 1995. This ship is fully classed to ABS standards. The most recent Machinery Condition Assessment (2000) indicates no significant issues with mission critical machinery. Ship meets 46 CFR Subchapter U for intact stability. An increase in center of gravity is unacceptable. The latest machinery Condition Assessment (2005) indicates no significant issues with major machinery. The sewage system needs to be upgraded, including holding capacity, due to increased no discharge zones in sanctuaries. Lead paint has been found in some areas of the ship that must be managed appropriately until it can be safely removed. Limited maintenance funds and an arduous annual operational schedule has resulted in an overall deterioration of the ship's condition, particularly in areas of structural preservation, interior habitability, and internal conditions of salt water tanks.

Maintenance costs and operating days lost due to engineering related problems are tracked in the graph below.



MCARTHUR II

MCARTHUR II is a former U.S. Navy T-AGOS ship converted to perform multipurpose oceanographic research missions ranging from manned submersible deployments to whale observations. The ship conducts coastal oceanographic research, marine mammal population studies and environmental assessments throughout much of the eastern Pacific, including the U.S. West Coast, and Central and South America.

General Specifications:

Launched: 1985
Transferred to NOAA: 2002
Commissioned: 2003
Length (LOA): 68.3 m (224 ft)
Beam: 13.1 m (43 ft)
Draft, Maximum: 4.6 m (15.0 ft)
Speed: 11.5 knots
Range: 8,000 nm
Endurance: 45 days

Complement:

Commissioned Officers: 5
Licensed Officers: 4
Crew: 13
Scientists: 15 (max)

Major Mission Equipment/Capability:

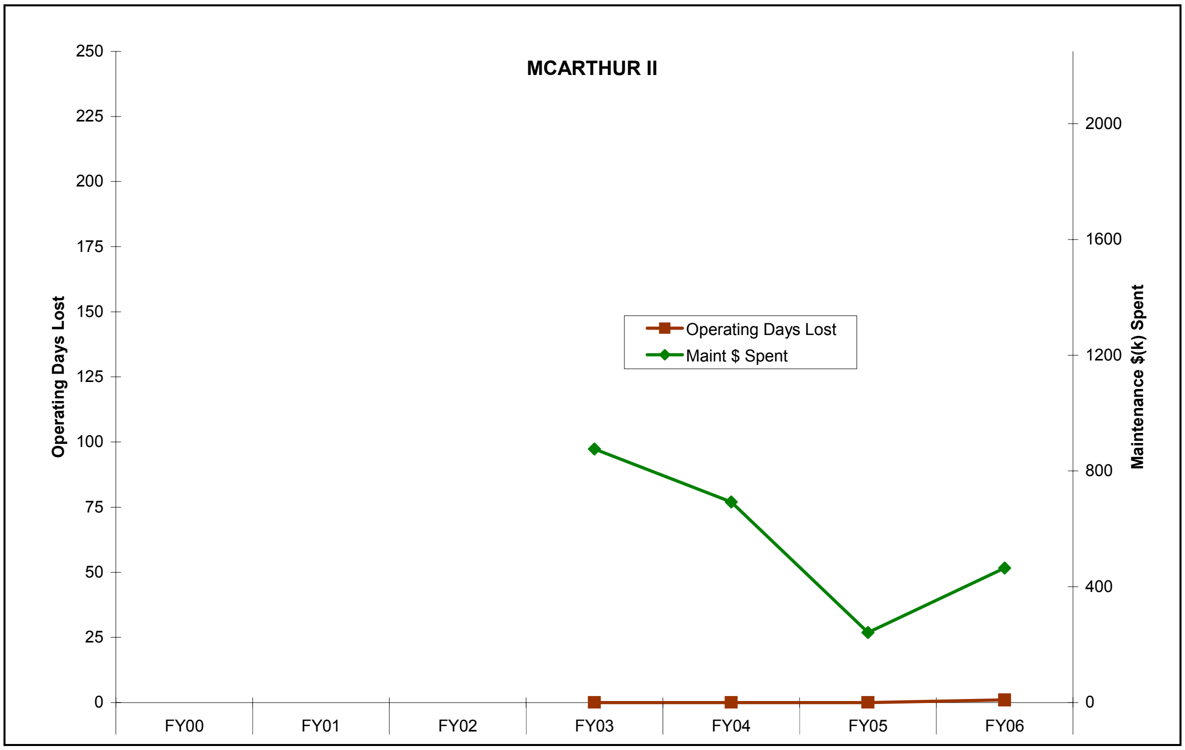
Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc)	No
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	Shipboard Environmental Data Acquisition System

Hull Structure/Major Machinery Condition Assessment:

This ship is fully classed to ABS standards. The latest machinery Condition Assessment (2006) indicates no significant issues with major machinery. Ship does not comply 46 CFR 171.080 (e) for damage stability.

Lead paint primer, a known hazardous material, has been identified on interior portions of the ship structure. Complete removal is only practical by gutting the entire ship first, then taking appropriate safeguards before sandblasting paint from metal and safely disposing. A total refurbishment and modernization of the laboratory and mission spaces was completed in 2007.

Maintenance costs and operating days lost due to engineering related problems are tracked in the graph below.



MILLER FREEMAN

MILLER PREEMAN is a Pacific stern trawler that conducts a wide variety of operations, including fisheries and oceanographic research and trawl gear testing. MILLER FREEMAN conducts bottom trawling operations in water depths up to 1,250 meters, midwater up to 1,100 meters, and over-the-side sampling. Projects include hydro-acoustic fish estimation and groundfish stock surveys in the Bering Sea, Alaskan waters and off the Pacific West Coast; weather and seas monitoring; and deploying surface and subsurface moorings.

General Specifications:

Launched: 1967 (laid up)
Commissioned: 1974
Length (LOA): 65.5 m (215 ft)
Beam: 12.8 m (42 ft)
Draft, CB Housed: 6.4 m (20.0 ft)
Draft, CB Extended: 9.8 m (32.0 ft)
Speed: 11.0 knots
Range: 12,582 nm
Endurance: 31 days
Laboratory Spaces: 1,280 sq. ft.

Complement:

Commissioned Officers: 7
Licensed Officers: 4
Crew: 23
Scientists: 11 (max)

Major Mission Equipment/Capability:

Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc)	No
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	Shipboard Environmental Data Acquisition System

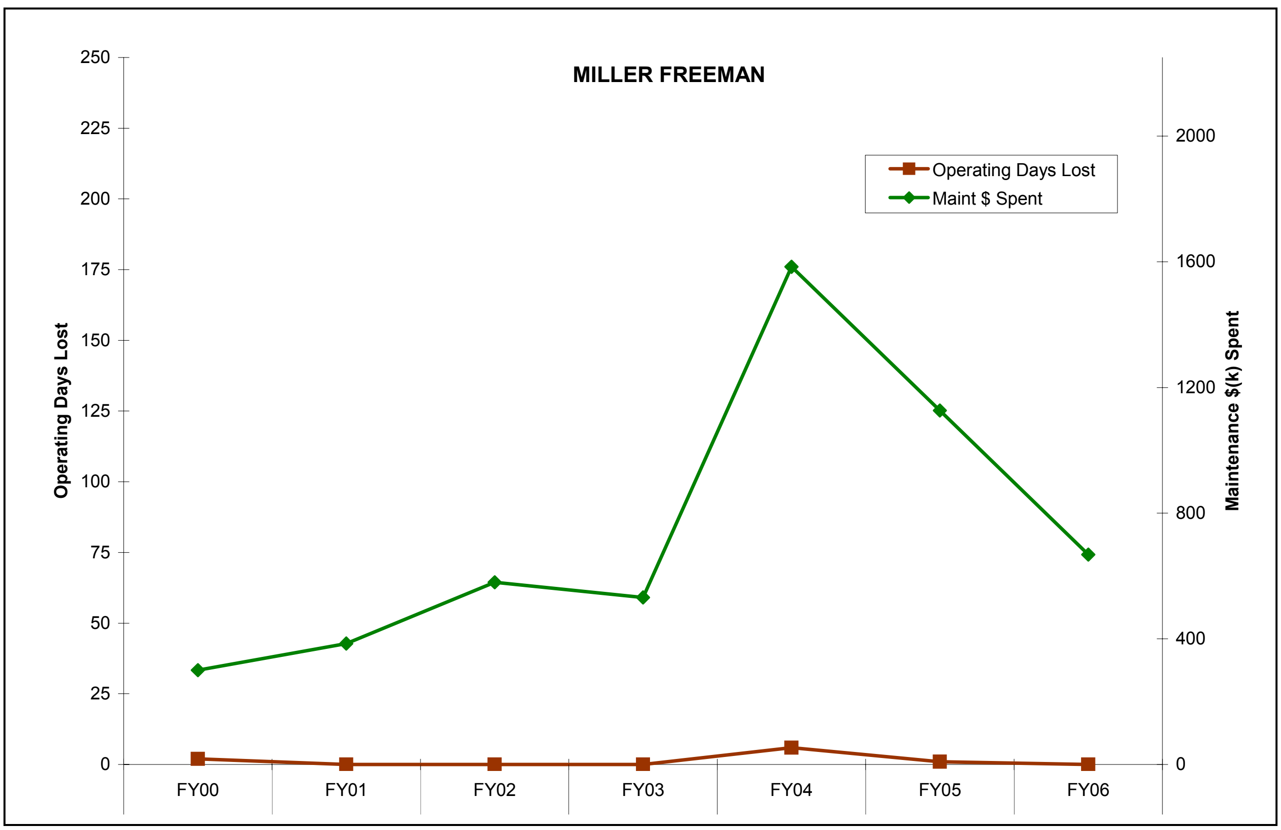
Hull Structure/Major Machinery Condition Assessment:

This ship currently meets ABS class standards. The load line assignment from the time it entered service remains. The ship completed a “Repair-to-Extend” (RTE) in 1998 with the intent of extending the ship’s service life by 10 years. This repair period only addressed mission equipment; major mechanical, habitability, and infrastructure system issues were not part of the scope of work. It also improved the ship condition to meet ABS class standards, which had lapsed over the years. The shipboard space arrangements are not particularly well suited for modern field assessment work. Ship continues to experience hull and deck plate deterioration. Piping systems and valves are also showing signs of corrosion in the bilge system, seawater cooling systems, fuel transfer system, and steel drain systems. Habitability is not consistent with today’s standards. Original design and machinery arrangements were built to standards of the time (1967). This configuration and manual operating requirements are not consistent with current “minimally-manned” staffing strategy, overtaxing crews’ ability to operating and maintain the ship.

The centerboard and related operating systems served as a prototype installation. This centerboard carries a limited number of sensors that need to be replaced. The design and configuration could use substantial improvement. The centerboard does not seat completely when retracted and can, at times, slip back down, increasing the draft unexpectedly. A significant investment in a new design and installation is required if this ship’s service is extended beyond 2008.

Many interior bulkheads contain asbestos materials. Hazardous materials are contained and do not pose an imminent hazard as long as they are properly maintained.

Maintenance costs and operating days lost due to engineering related problems are tracked in the graph below.



NANCY FOSTER

NANCY FOSTER is a former Navy yard torpedo test (YTT) craft converted to conduct coastal research along the U.S. Atlantic/Gulf coasts, and the Caribbean. FOSTER supports applied research and operations include the characterization of various habitats in National Marine Sanctuaries, pollution assessments, and studies to improve understanding of the connection between marine habitats and estuaries. FOSTER'S mission supports scientific data collection through bottom fish trawling, sediment sampling, side-scan and multi-beam sonar surveying, sub-bottom profiling, core sampling, diving with air and NITROX, ROV operations, and servicing oceanographic/atmospheric surface and subsurface buoys.

General Specifications:

Launched: 1991
Transferred to NOAA: 2001
Commissioned: 2004
Length (LOA): 56.7 m (187 ft)
Beam: 12.1 m (40 ft)
Draft, Maximum: 3.4 m (11.0 ft)
Speed: 10.5 knots
Range: 6,500 nm
Endurance: 14 days
Laboratory Spaces: 688 sq. ft.

Complement:

Commissioned Officers: 5
Licensed Officers: 3
Crew: 10
Scientists: 15 (max)

Major Mission Equipment/Capability:

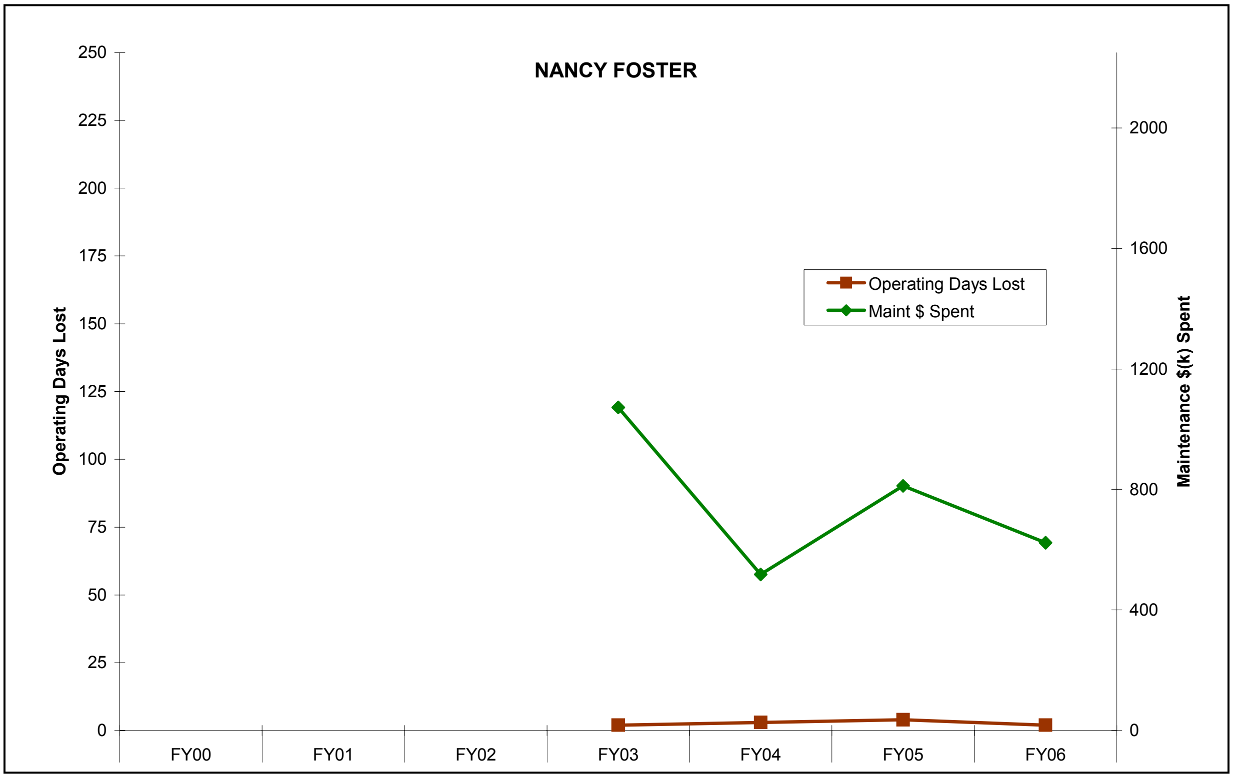
Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc)	Yes
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	

Hull Structure/Major Machinery Condition Assessment:

This ship is fully classed to ABS standards. Converted for NOAA service in 2002, it also under went a "Major Repair Period" (MRP) in 2005. Additional staterooms, an A-frame, bilge keel and multi-beam sonar were installed during the MRP. The latest Machinery Condition Assessment (2007) indicates no history of underwater body, weather deck, or superstructure plate thinning or renewals. The assessment also indicates no significant issues with major machinery, but the "Z-drives" and the generator engines are no longer supported by the original manufacturer. The "Z-drives" do not perform well in an open sea. Rudders were added as appendages to the hull for better control, but the new rudders continue to experience an unusual amount of wobble and vibration. Parts for both are difficult to locate and often expensive to buy with long lead times before delivery.

Potable water tanks have two design flaws inconsistent with current standards: 1) both tanks are interconnected without a valve to segregate them and 2) the skin of the tank is also the skin of the hull. The first issue can be corrected, but the second issue would require the installation of a cofferdam and subsequently reduce the amount of potable water that can be stored, further restricting the ship's ability to perform extended missions.

Maintenance costs and operating days lost due to engineering related problems are tracked in the graph below.



OKEANOS EXPLORER

OKEANOS EXPLORER is a former Navy T-AGOS class ship converted to conduct ocean research. It is the first ship dedicated to exploration of the oceans. Missions on this ship will have most of the scientists remaining ashore. Via telepresence, live images from the seafloor and other science data will flow over satellite and high-speed Internet pathways to scientists standing watches in any of five Exploration Command Centers ashore. Those scientists, and others on call if a discovery is made at sea, will add their expertise to missions no matter where in the world the ship is located.

General Specifications:

Launched: 1988
Transferred to NOAA: 2004
Commissioned: 2008
Length (LOA): 68.3 m (224 ft)
Beam: 13.1 m (43 ft)
Draft, Maximum: 4.6 m (15 ft)
Speed: 10 knots
Range: 9,600 nm
Endurance: 40 days

Complement:

Commissioned Officers: 6
Licensed Officers: 3
Crew: 18
Scientists: 19 (max)

Major Mission Equipment/Capability:

Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc)	Yes
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	Telepresence, dedicated ROV

Hull Structure/Major Machinery Condition Assessment:

OKEANOS EXPLORER was commissioned on August 13, 2008, after a three-year conversion period. This ship is fully classed to ABS standards.

OREGON II

OREGON II is an aging fisheries research ship supporting fishery and living marine research. OREGON II was built in 1967 for the Department of Interior's Bureau of Commercial Fisheries. OREGON II was constructed as a fisheries research ship patterned after North Atlantic distant-water trawlers, and designed for extended cruising range, versatility of operations, habitability, and seaworthiness. Upon transfer to NOAA in 1970, the ship received several mission system upgrades including electronic fish detection equipment, environmental sensors, deck-handling equipment, and limited laboratory spaces. In addition, ship electronics equipment was upgraded, living spaces were refurbished, and a bow thruster added to improve both station-keeping and ship handling capability.

OREGON II is the only fisheries research ship with a draft suitable to routinely support critical fisheries research from the five fathom curve seaward in the Gulf of Mexico needed to maintain the Southeast Area Monitoring and Assessment Program (SEAMAP) long time-series of annual surveys monitoring trends in fishery population abundance indices.

General Specifications:

Launched: 1967
Transferred to NOAA: 1970
Commissioned: 1977
Length (LOA): 51.8 m (170 ft)
Beam: 10.4 m (34 ft)
Draft, Maximum: 4.3 m (14.0 ft)
Speed: 10 knots
Range: 7,810 nm
Endurance: 33 days
Laboratory Spaces: 660 sq. ft.

Complement:

Commissioned Officers: 4
Licensed Engineers: 4
Crew: 10
Scientists: 13 (max)

Major Mission Equipment/Capability:

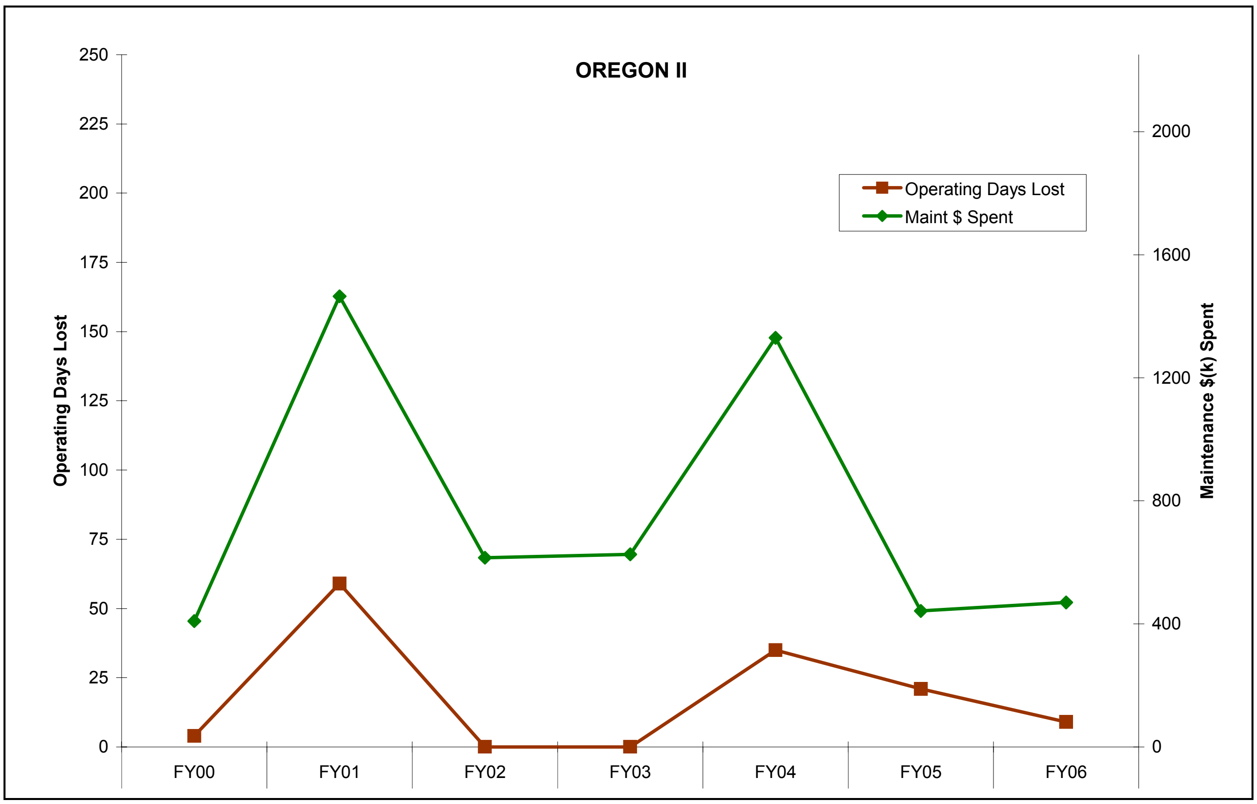
Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc.)	No
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	Shipboard Environmental Data Acquisition System

Hull Structure/Major Machinery Condition Assessment:

This ship does not meet ABS class standards. It has maintained its Load Line for maximum load permissible. Ship does not meet 46 CFR Subchapter U for intact stability and 46 CFR 171.080 (e) for damage stability. An increase in displacement or center of gravity is unacceptable.

The latest Machinery Condition Assessment (2007) indicates a history of underwater body plate thinning requiring periodic renewals, weather deck bulkhead plate renewals, and superstructure plate renewals. More recent inspections have also noted deterioration and wastage in watertight bulkheads. Bulkhead 13 is a patchwork of repairs, continuing to suffer deterioration; an appropriate repair would require gutting the ship in the area of the bulkhead. The 2007 assessment also indicates growing issues with the availability of repair parts for major machinery items (e.g., reduction gears and bow thruster). Lost operating days due to a variety of machinery problems is a recurring challenge.

Maintenance costs and operating days lost due to engineering related problems are tracked in the graph below.



OSCAR DYSON

OSCAR DYSON is the first of a class of four ultra-quiet modern fisheries research ships being built to support NOAA's mission to protect, restore, and manage the use of living marine, coastal, and ocean resources through ecosystem-based management. OSCAR DYSON's primary objective is to study and monitor Alaskan pollock and other fisheries in the Bering Sea and Gulf of Alaska. The ship also observes weather, sea state, and other environmental conditions, conducts habitat assessments, and surveys marine mammal and marine bird populations.

General Specifications:

Launched: 2003
Commissioned: 2005
Length (LOA): 63.8 m (209 ft)
Beam: 15.0 m (49 ft)
Draft, CB Housed: 6.0 m (19.4 ft)
Draft, CB Extended: 9.05 m (29.7 ft)
Speed: 12.0 knots
Range: 12,000 nm
Endurance: 40 days
Laboratory Spaces: 2,032 sq. ft.

Complement:

Commissioned Officers: 5
Licensed Officers: 4
Crew: 15
Scientists: 15 (max)

Major Mission Equipment/Capability:

Acoustic Quieting	Yes
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc.)	Yes
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	

Hull Structure/Major Machinery Condition Assessment:

The ship is new.

OSCAR ELTON SETTE

OSCAR ELTON SETTE is a converted U.S. Navy T-AGOS ship supporting fishery and living marine research. SETTE was built in 1989 for the U.S. Navy and transferred to NOAA in 1993. The ship normally operates throughout the central and western Pacific, and conducts fisheries assessment surveys, physical and chemical oceanography, marine mammal projects, and coral reef research. It collects fish and crustacean specimens using bottom trawls, longlines, and fish traps. Plankton, fish larvae and eggs are also collected with plankton nets and surface and mid-water larval nets.

The ship routinely conducts SCUBA diving missions for the Honolulu Laboratory and can carry a portable recompression chamber as an added safety margin for dive-intensive missions in remote regions. The ship is actively involved in Honolulu Coral Reef Restoration cruises, which concentrate scientific efforts on the removal, classification, and density of marine debris and discarded commercial fishing gear from fragile coral reefs.

General Specifications:

Launched: 1988
Transferred to NOAA: 1992
Commissioned: 2003
Length (LOA): 68.3 m (224 ft)
Beam: 13.1 m (43 ft)
Draft, Maximum: 4.5 m (15.0 ft)
Speed: 10.5 knots
Range: 5,500 nm
Endurance: 30 days
Laboratory Spaces: 1,530 sq. ft.

Complement:

Commissioned Officers: 4
Licensed Engineers: 4
Crew: 13
Scientists: 12 (max)

Major Mission Equipment/Capability:

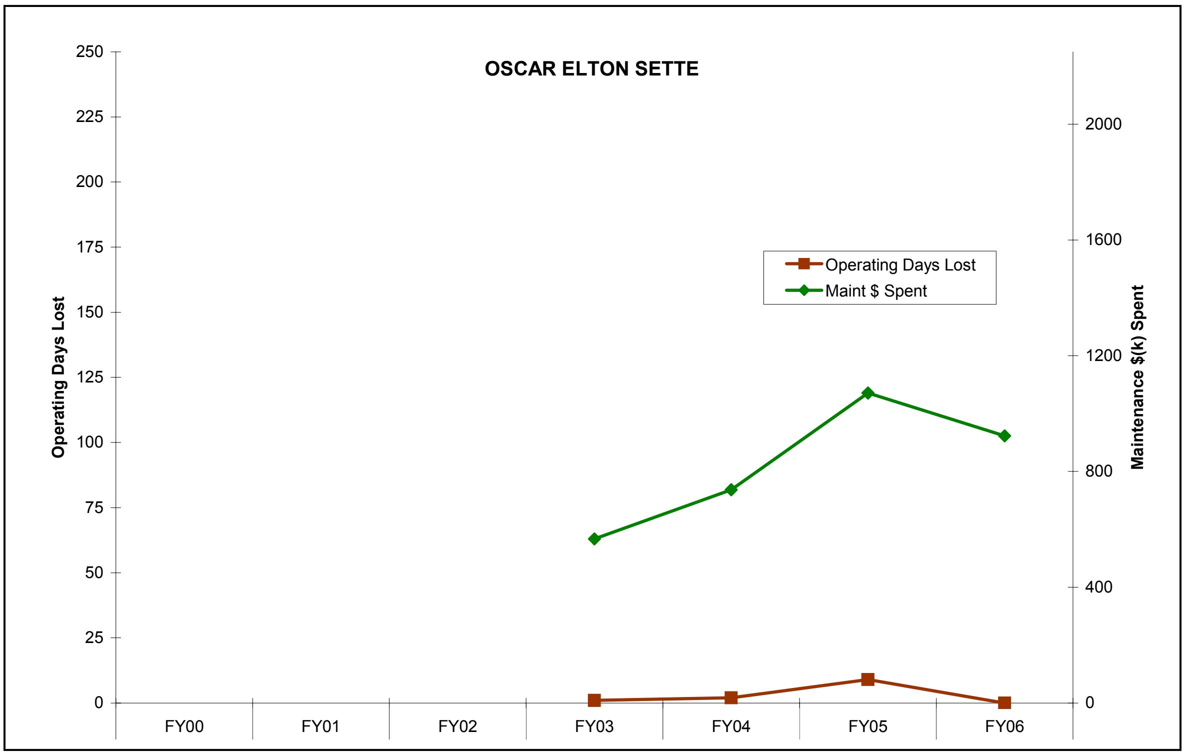
Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc.)	No
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	

Hull Structure/Major Machinery Condition Assessment:

This ship is fully classed to ABS standards. Ship meets 46 CFR Subchapter U for intact stability and 46 CFR 171.080 (e) for damage stability. An increase in displacement or center of gravity is unacceptable. The ship was converted to NOAA service in 2002, entering service in 2003.

The latest Machinery Condition Assessment (2007) indicates no history of underwater body plate thinning or renewals or weather deck or superstructure plate renewals. The assessment also indicates no significant issues with major systems. Some equipment is beginning to experience supplier problems; repair part lead times are increasing. Sewage holding tank is barely adequate with capacity to hold only one day's collection. This becomes an issue as no discharge regulations are tightened, particularly for science missions in the Northwest Hawaiian Island sanctuary.

Maintenance costs and operating days lost due to engineering related problems are tracked in the graph below.



RAINIER

RAINIER is designed and outfitted primarily for conducting hydrographic surveys in support of nautical charting. Scientific equipment aboard is normally limited to equipment that supports these survey operations. The ship operates off the U.S. Pacific Coast and in Alaskan coastal waters.

General Specifications:

Launched: 1967
Commissioned: 1968
Length (LOA): 70.4 m (231 ft)
Beam: 12.8 m (42 ft)
Draft, Maximum: 4.4 m (14.3 ft)
Speed: 12.0 knots
Range: 5,898 nm
Endurance: 22 days
Laboratory Spaces: 240 sq. ft.

Complement:

Commissioned Officers: 10
Licensed Engineers: 4
Crew: 52
Scientists: 4 (max)

Major Mission Equipment/Capability:

Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc.)	Yes
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	Shipboard Environmental Data Acquisition System

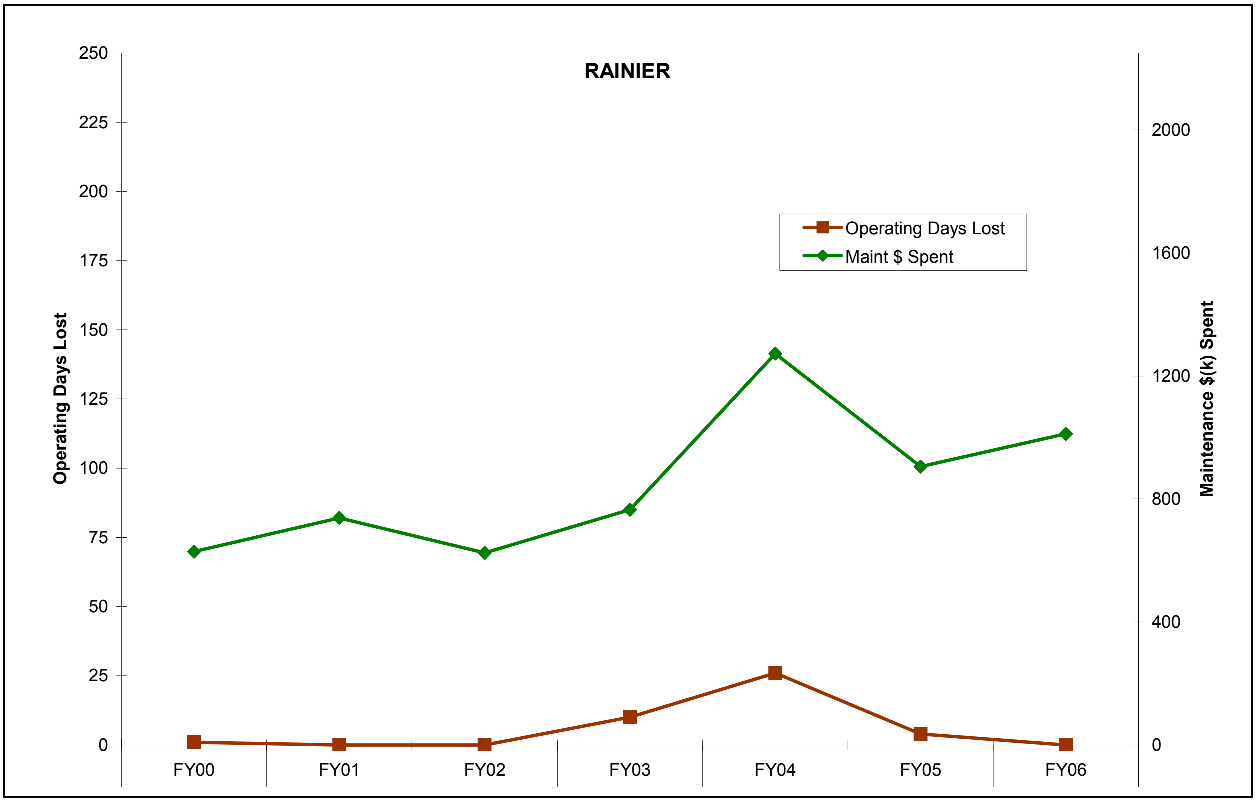
Hull Structure/Major Machinery Condition Assessment:

This ship does not meet ABS class standards. It has maintained its Load Line for maximum load permissible. Ship meets 46 CFR Subchapter U for intact stability only. An increase in displacement or center of gravity is unacceptable.

The latest Machinery Condition Assessment (2007) indicates ship is in generally good condition. Saltwater flushing and cooling piping systems are showing corrosion and does suffer from occasional pinhole leaks. Ship is showing its age. Most equipment is original equipment installed when the ship was first constructed. Recent unexpected separation of the boat davit foundation from the weather deck structure illustrates the effects of corrosion and fatigue stress that does go unnoticed.

This 42 year old ship (in FY 2010) continues to operate without having completed significant repairs to upgrade mission equipment or complete repairs intended to extend the service life of the ship. A request is moving forward in the budget process to take care of safety and critical system repairs only in FY 2009, but that does not address requirements for mission equipment and other major machinery.

Maintenance costs and operating days lost due to engineering related problems are tracked in the graph below.



RONALD H BROWN

RONALD H BROWN is a state-of-the-art oceanographic and atmospheric research platform and is the largest ship in the NOAA fleet. With its highly advanced instruments and sensors, BROWN travels worldwide supporting scientific studies to increase our understanding of the world's oceans and climate.

General Specifications:

Launched: 1996
Commissioned: 1997
Length (LOA): 83.5 m (274 ft)
Beam: 16.0 m (52.5 ft)
Draft, Maximum: 5.2 m (17.0 ft)
Speed: 15.0 knots
Range: 11,300 nm
Endurance: 60 days
Laboratory Spaces: 4,100 sq. ft.

Complement:

Commissioned Officers: 5
Licensed Officers: 4
Crew: 16
Scientists: 32 (max)

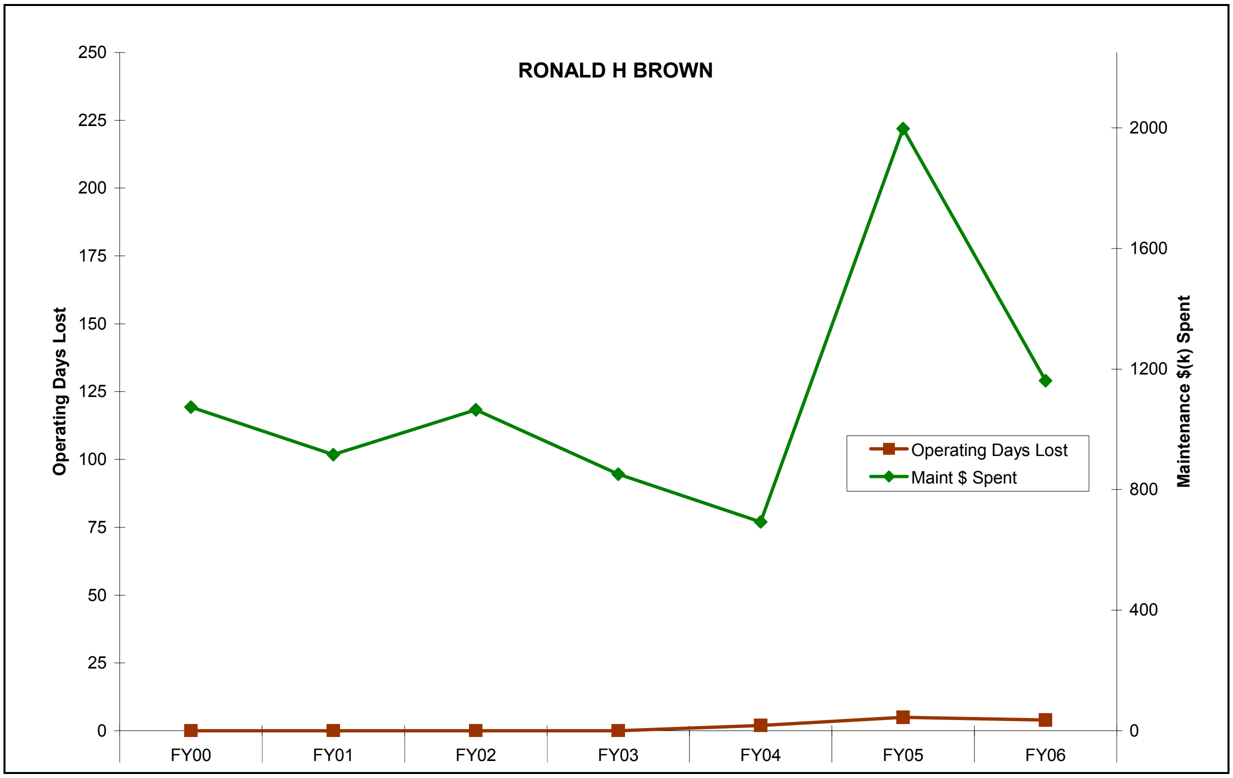
Major Mission Equipment/Capability:

Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc)	Yes
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	

Hull Structure/Major Machinery Condition Assessment:

This ship is fully classed to ABS standards. Ship meets 46 CFR Subchapter U for intact stability and 46 CFR 171.080 (e) for damage stability. This ship will be 13 years old in FY 2010. It was last inclined in 1997 to verify its condition of stability. The latest Machinery Condition Assessment (2007) did not highlight any issues.

Maintenance costs and operating days lost due to engineering related problems are tracked in the graph on the next page.


RONALD H BROWN
Operating Days Lost
Maintenance $(k) Spent
250
225
200
175
150
125
100
75
50
25
0
2000
1600
1200
800
400
0
FY00
FY01
FY02
FY03
FY04
FY05
FY06
Operating Days Lost
Maint $ Spent

RUDE

RUDE performed inshore hydrographic surveys along the east coast in support of NOAA's nautical charting mission, specializing in the location and accurate positioning of submerged hazards to navigation and was equipped for diving operations to allow determination of the precise nature of submerged obstructions. In addition, RUDE was often called upon to assist the U.S. Coast Guard and Navy in search, rescue, and recovery operations.

General Specifications:

Launched: 1966
Commissioned: 1967
Length (LOA): 27.4 m (90 ft)
Beam: 6.7 m (22 ft)
Draft, Maximum: 2.2 m (7.2 ft)
Speed: 10.0 knots
Range: 1,000 nm
Endurance: 5 days
Laboratory Spaces: 0

Complement:

Commissioned Officers: 4
Licensed Officers: 1
Crew: 6
Scientists: 0

Major Mission Equipment/Capability:

Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc)	Yes
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	

Hull Structure/Major Machinery Condition Assessment:

RUDE was decommissioned March 25, 2008.

THOMAS JEFFERSON

THOMAS JEFFERSON conducts hydrographic surveys to update NOAA's nautical charts. Hydrographic surveys used for nautical charting include thousands of systematic depth measurements, as well as positions of wrecks or obstructions in navigable waters. The ship operates primarily along the Atlantic and Gulf coasts, including Puerto Rico and the U.S. Virgin Islands.

General Specifications:

Launched: 1992
Transferred to NOAA: 2003
Commissioned: 2003
Length (LOA): 63.4 m (208 ft)
Beam: 13.7 m (45 ft)
Draft, Maximum: 4.3 m (14.0 ft)
Speed: 12.0 knots
Range: 19,200 nm
Endurance: 45 days
Laboratory Spaces: 700 sq. ft.

Complement:

Commissioned Officers: 8
Licensed Officers: 4
Crew: 21
Scientists: 3 (max)

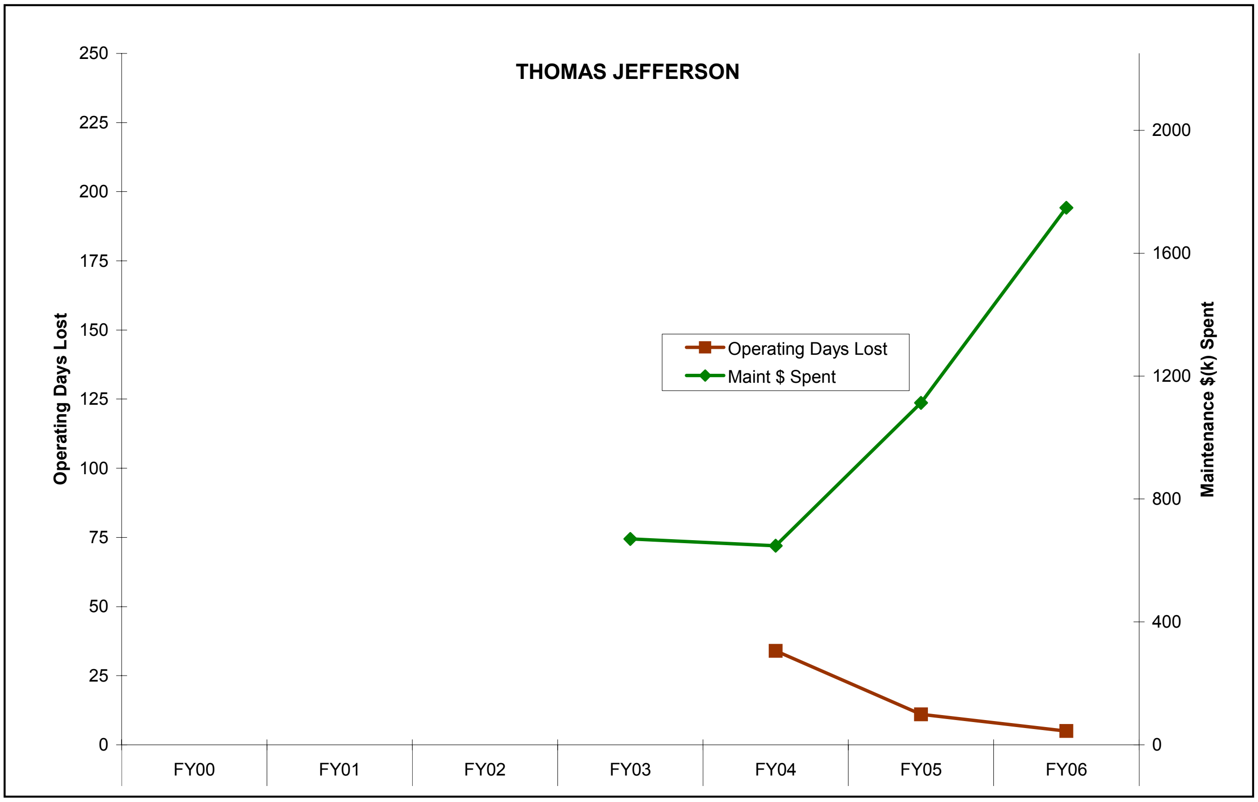
Major Mission Equipment/Capability:

Acoustic Quieting	No
Advanced Acoustic Detection (e.g, multi-beam sonar, side scan sonar, etc)	Yes
Other Acoustic Detection	Yes
Water Column Measurement (e.g., ADCP, XBT, CTD, etc.)	Yes
Meteorological Measurement (e.g., barometer, wind speed indicator, etc.)	Yes
Computing Systems (e.g., SCS, FSCS)	Yes
Other	Shipboard Environmental Data Acquisition System

Hull Structure/Major Machinery Condition Assessment:

This ship is fully classed to ABS standards. This THOMAS JEFFERSON was transferred to NOAA service in 2003.

Maintenance costs and operating days lost due to engineering related problems are tracked in the graph on the next page.



Appendix D – "Full Operating Tempo" at 255 Operating Days Rationale

255 Operating Days/Year/Ship Explanation

Given NOAA's current ship operating concept (one crew, one ship), all the factors that weigh into and affect the operation of a ship can be readily identified by categories. These categories capture, at the high level, an anticipated operating capacity based on programmatic needs both from the ship operator's perspective and the mission perspective. For reliable and safe ship operations, a Commanding Officer must ensure certain requirements are met before he considers the ship and its crew ready for sea. Those things that must be done are to stage mission equipment, fuel and re-provision, and train the crew for normal and emergency ship evolutions, as well as prepare to conduct data collection missions.

Several assumptions were made to develop this number. While these assumptions are not necessarily based on current reality, NOAA feels this operating tempo is feasible with appropriate policies to facilitate it. Those assumptions are:

- Ship retains the official full crew complement
- Crew attrition is low
- Pool of qualified crew are available to back fill for emergencies or regular leave
- Training is effective over the short period
- Ship is relatively new, equipment is modern and the ship system operates reliably
- Dry-dock periods and dockside repair periods are completed on time. No substantial discovery work is found during an open & inspect ship repair line item.
- Dry-dock years will reduce operating days from 255 to 240, or about two weeks for the additional needed to complete dry-dock repairs. Current requirement is to dry-dock ship twice every 5 years to remain within ABS Class.
- Weather is almost no factor in sailing.
- Mission equipment staging is complete and ready to load when ship returns from previous data collection effort and completes limited in port turnaround requirements.

Based on those assumptions, ships should be able to accomplish 255 days per year.

Operating Days per Year	
Operating Days	
Mission Days	235
Transit to Shipyard	3
Shakedown Post Availability	12
Training	5
Subtotal	255
Inport Requirements	
Pre-Bid Inspection	2
Contract Maintenance	42
Routine Ship Maintenance	28
Provisioning	5
Fueling	4
Weather	2
Crew Rest	12
Mission Staging	10
Ship Checks & Fleet Inspection	5
Subtotal	110
Total Days	365

Appendix E – Ship Capability Definitions

Ship Capability Definitions

CAPABILITY DEFINITIONS	
Capability	**Definition**
Trawl	Commercial size bottom and pelagic trawl nets, gear and sampling systems to meet fisheries survey requirements
Multibeam - Biomass	Multibeam Sensor of adequate model/make is currently mounted on hull and functioning on ship to collect biomass information
Multibeam - Bottom Mapping	Multibeam Sensor of adequate model/make is currently mounted on hull and functioning on ship to meet bottom mapping requirements
Single Beam	Single Beam Echosounder is mounted and functioning on ship to meet mission needs
Side Scan Sonar	Side Scan Sonar is mounted and functioning on ship
Moving Vessel Profiler	Deployment system for oceanographic systems that allow for continuous water column profiling (e.g CTDdata) while underway
Instrumented Work Boats	Instrumented small craft, outfitted with a variety of sensors and deployed froma ship, to allow extension of research to inaccessible near-shore or shoal areas
Doppler Radar System	A functioning radar that produces a velocity measurement as one of its outputs currently on ship
Longline	Current capability to implement fishing technique 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 FSV, and (3) there is more than 2 repetitive dives per day, and (4) there are more than 4 consecutive days of diving
A Frame	A frame is on ship and meets safety specs
J Frame	J frame is on ship and meets safety specs
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	Space on ship for scientists to perform science, analyze results, prepare mission equipment, etc...
Scientific Berthing Space	Adequate habilitability space for visiting scientists who are working on projects that meet requirements in area
Survey Space	Ship has space, equipment, crew w/ expertise and software to process data on ship
Hydro/Oceanographic Winch	A mechanical device that has a cable capable of holding the weight to perform the scientific mission needed to meet requirements
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; installed and functioning on ship
Survey-Grade Positioning and Attitude Measurement (POS/MV)	High accuracy navigation systems that blend GPS and inertial measurements to produce position and attitude solutions
Endurance	The ship currently has the ability to sustain at-sea operations (including food, fuel, etc..) for 30 days or more
Marine UAS Configuration	Ship is presently configured to support UAS operations including appropriate launch and retrieval system, communication support, deck space and crew expertise
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
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
Telepresence	System to transfer real-time video and sensor data from ship to shore using satellite communications
ICES Acoustic Quieting	The ship currently meets or exceeds ICES Acoustic Quieting standards
Zero Discharge Capability	Based on current holding tank capacitites, crew size; Capability of over 8,000 gal 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 F – NOAA Use of Private Sector Charter

NOAA Use of Private Sector Charter

NOAA routinely uses private sector and university ships to help meet program requirements for data collection at sea. NOAA uses this effective approach when ships with the capability and capacity to meet NOAA requirements are available. In FY06, NOAA acquired more than 1900 ship operating days of ship support from over 40 private sector and 25 university ships. The charters ranged from 65 foot fishing trawlers to 400ft icebreaking research ships and played an important role in helping NOAA meet at-sea data collection requirements.

Line Office	Program	NOAA Mission Goal	FY06 Reported Charter Days[1]
NOS	COP	Ecosystem	98
NOS	FGNMS	Ecosystem	43
NOS	Corals	Ecosystem	26
OAR	AOML	Climate	42
OAR	PMEL	Climate / Ecosystem	106
OAR	GLERL	Ecosystem	91
OAR	Sea Grant	Ecosystem	25
OAR	OE / NURP	Ecosystem	195
NMFS	AFSC	Ecosystem	552
NMFS	NWFSC	Ecosystem	338
NMFS	SWFSC	Ecosystem	86
NMFS	PIFSC	Ecosystem	106
NMFS	SEFSC	Ecosystem	124
NMFS	NEFSC	Ecosystem	53
NWS	NDBC	Weather & Water	76
NESDIS	MOBY	Mission Support	13

NOAA also uses contracts to acquire hydrographic surveying services. These contracts involve the use of private sector ships to acquire data. Several task orders are awarded every year to obtain hydrographic survey data that are used to update nautical charts. Funding for the hydrographic contracting program has recently averaged about $25 million per year.

[1] NOAA programs reported charter activity for vessels greater than 65 feet in length.

Appendix G – Sources Sought Market Survey Notice

Sources Sought Market Survey Notice

General Information

Document Type:	Sources Sought/Market Survey Notice
Solicitation Number:	Reference Number-
Posted Date:	XX May 2007
Original Response Date:	Posted Date + 1 Month
Current Response Date:	
Original Archive Date:	
Current Archive Date:	
Classification Code:	19 - Ships, Small Craft, Pontoons and Floating Pontoons
NAICS Code:	

Contracting Office Address

Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), Western Region Acquisition Division, 7600 Sand Point Way NE, Seattle, WA, 98115-6349, UNITED STATES.

Description

The Western Region Acquisition Division announces a market survey to obtain information about the cost, capability and availability of up to 4 vessels to provide continuous support to NOAA's fisheries data acquisition programs as multipurpose fisheries survey vessels (FSV). Submissions are invited for existing vessels and vessel modifications or conversions. All work performed to meet the proposed requirements specified in this market survey would have to meet all applicable U.S. laws and regulations.

Vessels will conduct marine fisheries and oceanographic research including stock assessments, physical and biological oceanography, life history, marine mammal assessment and biological research, weather and sea state observation, gear development, and habitat studies including coral reefs ecosystems and marine debris mitigation. Vessels must possess specialized capabilities as noted below.

THIS SOURCES SOUGHT NOTICE IS NOT A REQUEST FOR PROPOSAL. It is a market research tool being used to determine potential and eligible business firms capable of providing a suitable vessel or vessels for time charters and/or bareboat charters. Therefore, all qualified parties are encouraged to respond including: (a) existing vessels that are deficient in areas not identified as critical are invited under this survey, and (b) vessels that can be modified or converted to meet all or a majority of the critical element requirements are invited under this survey.

Where additional clarifying guidelines are believed to be beneficial, respondents are referred to sections of the "Statement of Requirements for Design and Construction of a 40 Day Endurance NOAA Fisheries Research Vessel, Revision C, June 13, 2005" (SOR FSV40-2).

This document can be accessed at http://www.omao.noaa.gov/fsv/contract.html, Section J-1 FSV2 SOR Rev C.

The Government is not obligated to and will not pay any costs incurred in the preparation of any submission to this market survey. This Sources Sought Notice does not commit the Government to awarding a contract and your response is not an offer.

REQUIREMENTS: Respondents to this Sources Sought Notice should describe their ability to provide a vessel or vessels that meet or exceed the following performance requirements:

1. Vessels Required:

A. Flag/Country of Registry: This market survey is open to vessels registered in any IMO-member State.

B. Age: Vessel should not be more than15 years old upon delivery.

C. Mission Gear: Vessel must be capable of supporting the following operations:

(1) Fishing: Commercial size bottom and pelagic trawl nets, bottom and pelagic longlines, plankton nets, scallop dredges, hydraulic jet clam dredges, naturalist dredge, towed sleds, small scientific samplers, traps and pots, and Grudley operated handlines.

(2) Diving support for: SCUBA, surface-supplied, remotely operated vehicles, and autonomous underwater vehicles, small boat launches, and hyperbaric chamber (modular) capacity.

(3) Oceanography: Multiple Opening and Closing Net Environmental Sampling System (MOCNESS) samplers in one square meter, two square meter, and ten square meter sizes; CTD and 6-ft diameter rosette sampler; bongo net tows; bottom grabs and trawls; corers; buoy and mooring deployment and retrieval; and continuous underway water sampling with acoustic Doppler current profilers and in-line phyto- and zoo-plankton samplers.

(4) Marine mammal survey observations: marine mammal observation stations that provide unobstructed viewing capability and towed passive acoustic arrays.

D. Design Standards: Vessel must be constructed to 46 CFR Subchapter U (Oceanographic Research Vessels) with ABS loadline, ABS classification, SOLAS and MARPOL. Additionally, ABS ACCU and ABS Ice Class C0 are desirable.

E. Design Features: Single or twin screw with additional take-home capability provided by an azimuthing jet-type bow thruster. All labs and fore and aft access must be on or above the bulkhead deck.

F. Operating Temperatures: Vessel must be capable of operating in seawater temperatures from 28 degrees F to 90 degrees F (minus 3 degrees C to 32 degrees C) and air temperatures from 0 degrees F to 99 degrees F (minus 18 degrees C to 37 degrees C).

G. Dimensions: Vessel must be no longer than 295 ft (90 M). Two classes of vessels are sought – two vessels each with a navigation draft of not greater than 20.0 ft (6.1M) and two vessels each with a navigation draft not greater than 15.0 ft (4.6 M).

H. Accommodations: Vessel must be capable of berthing and messing up to 20 sponsor personnel in two single staterooms and nine double staterooms and be equipped with a cafeteria style galley.
I. Speed:

(1) Trial Speed: 14 knots is desired.

(2) Midwater Trawl Speed **(Critical Element**): Five knots in 13.1 ft (4.0 M) waves with a 36,000 lb (160 kN) trawl drag at best heading at 600 fathoms trawl depth.

(3) Bottom Trawl Speed (**Critical Element**): Four knots in 13.1 ft (4.0 M) waves with a 36,000 lb (160 kN) trawl drag at all headings at 1000 fathoms trawl depth.

(4) Minimum Speed: One knot in calm water using main thrust.

(5) Continuous Speed Range: From 0.1 knot to service speed, with transition from auxiliary to main thrust as appropriate.

J. Maneuverability (**Critical Element**): Vessel must be capable of:

(1) Tactical Diameter: No more than three ship lengths in calm water.

(2) Low-speed Maneuverability: 180 degrees to either direction within one ship length at low speed (0-3 knots) during calm water sampling and retrieving operations using only rudder(s). 180 degrees to either direction within one ship length at low speed in conditions of 2.5 M significant wave height, 2.5 knot current and 30 knot wind, using both rudder(s) and bow thruster.

(3) Zero-speed Maneuverability: Capability to rotate about midships in conditions of 2.5 M significant wave height, 2.5 knot current and 30 knot wind.

(4) Contour Tracking: Capability to tow a net along a depth contour within one ship length at 4 knot speed with a 36,000 lb (160 kN) towing force.

(5) Station Keeping: Maintain a watch circle of one ship length diameter on best heading in conditions of 2.5 M significant wave height, 3 knot current and 35 knot wind with no trawl deployed.

(6) Dynamic Positioning.

(7) Precision Tracking.

(8) Towing Condition.

(9) Free Route Condition.

K. Fuel Capacity: Vessel must be equipped with fuel capacity to meet any mission scenario (refer to Table 070-1, SOR FSV40-2) plus 15 percent reserve.

L. Ship Motions (**Critical Element**): Vessel must meet certain roll, pitch, lateral and vertical accelerations at service speed, six knot trawl speed, and zero knot speed in specific conditions (refer to sec. 070e, SOR FSV40-2).

M. Stability and Trim (**Critical Element**): Vessel must meet certain standards for general conditions as well as icing and towing. Stern ramp height relative to the waterline must be maintained in all load conditions without excess trim (refer to sec. 079, SOR FSV40-2).

N. Visibility: (**Critical Element**): Vessel must be equipped with an aft-facing ship and winch control console(s) with visibility of gantry and trawl gallows and working deck. Vessel must be equipped with adequate visibility ahead and astern, of the side sampling/longlining station, and abeam down to the ship's waterline. From atop the bridge, vessel must have an unobstructed view of the horizon, no less than from dead ahead to 120 degrees aft.

O. Acoustic Requirements (**Critical Element**): Vessel must meet SNAME T&R Bulletin 2-25 and SNAME Code C-5 for vibration. Airborne noise requirements in shipboard spaces and at manned deck spaces must not exceed specified airborne noise limits (refer to Table 073-1, SOR FSV40-2). Vessel must also meet the following noise standards:

(1) Self Noise: Vessel shall be capable of performing effective mission acoustic operations through sea state three at the sustained speed.

(2) Radiated Noise: Maximum underwater radiated noise at speeds up to the sustained speed shall be in accordance with International Council for the Exploration of the Sea (ICES) proposed standard for hydroacoustic surveys (ICES Cooperative Research Report No. 209, Underwater Noise of Research Vessels) at 11 knots. In calm water with no bottom reflection, a minus 60 dB target shall be identifiable in 1640 ft (500 M) of water.

P. Working Deck Requirements **(Critical Element)**:

(1) Minimum Area: 1775 square feet (165 square meters) of clear and unobstructed area.

(2) Minimum Length: 47 ft (14.3 M)

(3) Stern trawl ramp with trawlway forward (refer to sec. 591c, SOR FSV40-2).

(4) Longlining Station: Working deck forward of bridge for conducting longline and trap/pot operations.

(5) Side sampling station located on starboard side, as close to amidships as possible for the retrieval of longlines, traps, and the deployment and retrieval of CTDs, ROVs, and plankton gear.

Q. Deck Equipment (**Critical Element**):

(1) Winches: Two trawl winches capable of towing to 1000 fathoms using 5/8 to 1-1/8 inch diameter wire rope, one third-wire winch, one oceanographic winch (positioned to serve either the side sampling station or stern gantry) capable of 6500 meter casts, two hydrographic winches (both located to service side sampling station) capable of 6500 meter casts, one net reel (at forward end of trawlway), and two gallows frames (port and starboard of stern gantry to support trawl blocks). (refer to sec. 591c-k, SOR FSV40-2)

(2) Cranes (**Critical Element**): One large crane and one knuckle crane sufficient to provide complete coverage of aft working deck. 1000 lb (455 KG) lift capacity at 5 ft (1.5 M) over stern at each quarter, 10,000 lb (4550 KG) lift capacity 20 ft (6.0 M) over starboard side, 7500 lb (3400 KG) lift capacity at 20 ft (6.0 M) over port side (refer to sec. 591b, SOR FSV40-2).

(3) Stores crane with 15 ft (4.5 M) outboard maximum beam to port or starboard.

(4) Stern Gantry: Pivoting U-frame located aft, bridging stern ramp with 11,000 lb (5000 KG) lift capability and 22 ft (6.8 M) clear vertical opening (refer to sec. 591c, SOR FSV40-2).

(5) Side Sampling Equipment: A starboard-side A-frame rated to handle an instrument with a water weight of 910 KG plus 3500 M of the heaviest wire and must have a towing capacity of 13.25 kN at angles of up to 45 degrees from vertical (refer to sec. 591m, SOR FSV40-2).

(6) Outriggers port and starboard.

(7) Three vans with ISO hold-downs (one 20-ft and two 10-ft vans).

(8) SOLAS-certified rescue boat and handling system and up to five work boats on a single deployment.

R. Mission Spaces: Vessel to be equipped with general spaces, scientific office, conference room, labs and freezer/refrigerator spaces, hyperbaric chamber, and storage and locker facilities, including dive locker for supporting up to 16 divers. Labs to be located in one complex, adjacent to the working deck, all on the same level (refer to sec. 070f, SOR FSV40-2).

S. Centerboard: A retractable centerboard capable of placing transducers below the aerated flow is desired. However, if transducers can be effectively placed below the aerated flow by other means, the alternative arrangement will be considered.

T. Mission Instrumentation Requirements (refer to sec. 400, SOR FSV40-2).

U. Communications Requirements (refer to sec. 400, SOR FSV40-2).

V. Vessel must be equipped with lounge/recreation, exercise, laundry, and hospital spaces (refer to sec. 645, 652 and 655, SOR FSV40-2).

W. Vessel must have the capacity for 40-days endurance with full ship's complement.
2. Charter Period: Vessel(s) must be available for the exclusive support of NOAA missions for at least ten years with additional years at government's option.
3. Delivery Period: First vessel must be available within the next three years, but not later than 2010.
4. Delivery Range: U.S. East Coast or U.S. West Coast.

RESPONSE: Interested businesses shall submit the following information for each vessel proposed:

1. Vessel name, flag/country of registry, current age and owner.
2. Detailed vessel characteristics (including draft), speeds, fuel consumption, etc.
3. Vessel general arrangement drawings and plans.
4. Statement indicating which, if any, critical elements cannot be satisfied under this proposal.
5. Estimated daily time-charter hire rate in U.S. dollars for full and reduced operating status. Time-charter hire rate shall include:
    (a) vessel
    (b) crew
    (c) maintenance
    (d) insurance
    (e) overhead costs

Government pays for fuel, lubes, port charges, communications, meals for Government employees, and other mission-related expenses.

6. Estimated daily bareboat hire rate in U.S. dollars (Government is responsible for crew, maintenance, insurance, fuel, lubes, port charges, communications, and other mission-related expenses).
7. Availability dates.
8. Vessel and owner experience in fisheries and oceanographic research operations.
9. Number and type of crew positions proposed to meet both USCG safe manning levels and fishery data collection needs.
10. Any pertinent questions, comments and/or alternative proposals.
11. Statement indicating business size and if company is small, small disadvantaged, minority, woman owned, or 8(a) business.

QUESTIONS: All questions regarding this Sources Sought Notice shall be submitted via e-mail to Joe.Hubbard@noaa.gov.
RESPOND TO: The requested information shall be sent by one of the following methods:

(a) e-mail to Joe.Hubbard@noaa.gov
(b) fax to (301) 713-1541, or
(c) mail to the following address:

National Oceanic and Atmospheric Administration
Office of Marine and Aviation Operations
8403 Colesville Road
Suite 500
Silver Spring, MD 20910-1541
ATTN: Joe Hubbard

Point of contact at NOAA/NMAO is Joe Hubbard, (301) 713-7639.

Proprietary data must be marked as such, on a page by page basis, and will be kept confidential and protected where so designated.

RESPONSE DUE DATE: The requested information shall be submitted by close of business (EDT) on **XX** June 2007.

Appendix H – Explanation of Value of Acoustic Quieting

Explanation of Value of Acoustic Quieting for Ships that Support Fishery and Marine Mammal Requirements

The acoustic quieting capability of the new construction ships will enable surveys of pelagic (mid-water) fish, which could not be done with the other alternatives. The improved capability of the new construction ships to measure abundance and distribution of marine organisms will produce more precise stock assessment estimates than are currently available.

An estimate of the value of this improved data is provided below. Since the precautionary approach to management suggests operating “on the lower bound” of the stock estimate, this may result in increased harvest allowances in some fisheries than would otherwise be allowed. NMFS is required under MSRA to establish annual catch limits for all federally managed fisheries by 2011 such that over fishing does not occur. Where stock assessment precision is low, these annual catch limits will need to be set conservatively to confidently avoid over fishing, and setting targets at 75% of the over fishing limit has already been implemented in some fishery management plans.

The nation receives a wide range of economic benefits from marine resources. Participants in the $70 billion seafood industry include marine suppliers, commercial harvesters, seafood processors, wholesalers and retailers, all of whom earn some portion or their entire income from U.S. harvested seafood. Likewise, saltwater anglers also support a thriving industry of bait and tackle shops, charter boat operations, marinas, coastal tourism, etc.

A “Lower Bound Approach” for Determining Benefits of acoustic quieting: In this economic assessment of the incremental benefits of the new construction ships that will collect data for fish stock management and marine mammals, the estimated contribution of the improved capability of the new ships is narrowly calculated as the stream of benefits derived from selected marine protected species, commercial fisheries, and saltwater angling over the planning horizon. The assessed value from commercial fishing value only captures the direct impact on the harvest sector in the relevant marine ecosystem, e.g., Gulf of Mexico, California Current, etc., and ignores the linkages to other industries clearly dependent upon commercial fishing activity, e.g., seafood processors, wholesalers, marine suppliers, boatyards, etc. Likewise, benefits from recreational fishing are calculated as total angler expenditures in the relevant ecosystem and ignores linkages to firms dependent upon angler purchases, e.g., marinas, bait and tackle shops. Finally, the value of marine protected species is limited to studies that a) have been published in scholarly journals and b) national estimates of annual value were published or can be derived from the published results. Combined, these criteria limit the scope of marine protected species included in this study to only seven species.

Calculation of benefits using this “minimalist” approach, i.e., only considering benefits to the core sectors and ignoring related sectors and being highly circumspect in selecting marine protected species values to include in this analysis, was done to ensure transparency in the calculation of benefits and to limit concerns that benefits are overestimated. Rather than including the size and scope of economic linkages across sectors or the suitability of including a particular marine protected species value, only a very limited set of information is used, which can then reasonably be considered a lower bound on benefits.

More specifically, benefits from the commercial harvest sector is calculated as ex-vessel value generated in the relevant ecosystem (e.g., Gulf of Mexico (GOM), California Current, etc.) and the value of recreational fishing is calculated as total angler expenditures in that ecosystem. The marine protected species included in each assessment are as follows:

Ecosystem	Marine Protected Species
Gulf of Mexico	Loggerhead turtle, bottlenose dolphin
Pacific Islands	Loggerhead turtle, Hawaiian monk seal
Alaska & California Current	Gray whale, California sea otter, northern elephant seal
California Current	California sea otter, northern elephant seal

Table 1

For those marine protected species included in the study that have a geographic range exceeding a single ecosystem, benefits have been pro-rated by the appropriate number of ecosystems, e.g., bottlenose dolphins can be found in three of the large marine ecosystems thus national benefits are pro-rated for the Gulf of Mexico by dividing by three.

"reduced value data" captures that improved data will result in better management decisions. Lacking a rigorous analysis of the relationships between monitoring, analysis, management decisions to resource benefits, it has instead been assumed that the deployment strategies deemed not to yield the highest quality data would only have a small impact on annual benefits. For this exercise, the cost of reduced value data used in the analyses of alternatives is a 0.1% decrease in the value of marine resource benefits, as defined above.

The estimated annual value of lost data for each ecosystem geographic area and the requirements groups in which those values were used is provided below.

Gulf of Mexico

The value of Gulf of Mexico marine resources (Table 2 below) was calculated as the sum of commercial landings, angler expenditures and the value of loggerheads and bottlenose dolphin (benefits for both species pro-rated to reflect species presence in multiple ecosystems).

Value of GoM Marine Resources		Total Value (in billions)
Commercial Ex-vessel Value:		$0.620
Angler Expenditures:		$4.070
Marine Protected Species:		$1.786
Loggerheads	$0.109	
Bottlenose Dolphins	$1.677	
Total:		**$6.476**

Table 2. The 2005 Value of Gulf of Mexico Marine Resources

Calculation of Reduced Value of Data

The new construction alternative to meet requirements in the Gulf of Mexico provides the highest quality data because of acoustic quieting capability, functionality and potential calibration issues.

The calculation of the reduced value of data for the other alternatives that lack acoustic quieting is described below.

> Reduced Value of Data= **0.1%** decrease in the value from commercial fish harvests, angler expenditures, loggerhead turtles and bottlenose dolphins. Loss=$7.150 million. This reduced value of data was used for requirements group 2 and group 9**.** The reduced value of data has been converted to FY10 dollars.

<u>Hawaiian Islands</u>

The value of the Hawaiian Islands marine resources (Table 3 below) was calculated as the sum of commercial landings, angler expenditures and the value of Hawaiian monk seals and humpback whales (benefits for humpback whales have been pro-rated to reflect that species presence in multiple ecosystems).

Value of HI Marine Resources		**Total Value (in billions)**
Commercial Ex-vessel Value:		$0.071
Angler Expenditures:		$0.688[2]
Marine Protected Species:		$1.352
Hawaiian Monk Seal	$0.118	
Humpback Whale	$1.233	
Total:		**$2.111**

Table 3. The 2005 Value of Hawaiian Island Marine Resources

Calculation of Reduced Value of Data

The new construction alternative to meet requirements in the Hawaiian Islands provides the highest quality data because of acoustic quieting capability, functionality and potential calibration issues. The calculation of the reduced value of data for the other alternatives that lack acoustic quieting is described below.

> Reduced Value of Data= **0.1%** decrease in the value from commercial fish harvests, angler expenditures, humpback whales and Hawaiian monk seal. Loss=$2.111 million. This reduced value of data was used for requirements group 7. The reduced value of data has been converted to FY10 dollars.

<u>Alaska & Pacific Coast</u>

The value of the Alaska and Pacific Coast marine resources (Table 4 below) was calculated as the sum of commercial landings (groundfish and Alaska salmon only), angler expenditures, and the value of California sea otters, gray whales, and the northern elephant seal (benefits for gray whales and the northern elephant seals are pro-rated to reflect species presence in multiple ecosystems).

Value of Alaska and Pacific Coast Marine Resources		**Total Value (in billions)**
Commercial Ex-vessel Value:		$.712

[2] Angler expenditures estimated by multiplying 2005 trips (estimated by NMFS Marine Recreation Information Program) by the national average trip expenditure because no trip expenditure estimate is currently available for Hawaii.

Angler Expenditures:		$1.375
Marine Protected Species:		$10.878
California Sea Otter	$6.216	
Gray Whale	$2.000	
Northern Elephant Seal	$2.664	
Total:		**$12.965**

Table 4. The 2005 Value of Pacific Coast and Alaska Marine Resources

Calculation of Reduced Value of Data

The new construction alternative to meet requirements on the Pacific coast and Alaskan waters provides the highest quality data because of acoustic quieting capability, functionality and potential calibration issues. The calculation of the reduced value of data for the other alternatives that lack acoustic quieting is described below.

> Reduced Value of Data= **0.1%** decrease in the value from commercial fish harvests, angler expenditures, California sea otters, gray whales, and the northern elephant seal. Loss=$12.965 million. This reduced value of data was used for requirements group 3. The reduced value of data has been converted to FY10 dollars.

<u>Pacific Coast</u>

The value of the Pacific Coast marine resources (Table 5 below) was calculated as the sum of commercial landings (tunas and groundfish only), angler expenditures, and the value of California sea otters, gray whales, and the northern elephant seal (benefits for gray whales and the northern elephant seals are pro-rated to reflect species presence in multiple ecosystems).

Value of Pacific Coast Marine Resources		Total Value (in billions)
Commercial Ex-vessel Value:		$0.114
Angler Expenditures:		$1.375
Marine Protected Species:		$8.880
California Sea Otter	$6.216	
Northern Elephant Seal	$2.664	
Total:		**$10.483**

Table 5. The 2005 Value of Pacific Coast Marine Resources

Calculation of Reduced Value of Data

The new construction alternative to meet requirements on the Pacific coast provides the highest quality data because of acoustic quieting capability, functionality and potential calibration issues. The calculation of the reduced value of data for the other alternatives that lack acoustic quieting is described below.

Reduced Value of Data= **0.1%** decrease in the value from commercial fish harvests, angler expenditures, California sea otters and the northern elephant seal. Loss=$10.483 million. This reduced value of data was used for Requirements Group1. For marine protected species only, the Loss=$8.880 million. The marine protected species only was used for requirements group 6. The reduced value of data has been converted to FY10 dollars.

Appendix I – Sensitivity Analysis Rationale

Sensitivity Analysis Rationale

For those cost estimates that include significant uncertainty, a sensitivity analysis was conducted to determine the changes in the NPV of each alternative due to potential changes in the estimated costs. The estimates for which costs were varied are described below.

1. **Ship Construction Costs -** New ship design and construction cost estimates were varied by -10% / +10%. The elements upon which the cost estimates were developed were evaluated for their individual levels of variation and the resulting potential impact on the total cost estimate.
2. **Hydro Charter -** Charter cost estimates for collection of nautical charting data are based on Office of Coast Survey actual charter costs for FY07 and those costs were varied by -10/+10%.
3. **Fisheries Charter -** A NOAA market survey completed in the spring of 2007 requested information from the private sector on available charter ships that could at least provide the same capability as existing NOAA ships for fishery and marine mammal data collection. NOAA received no responses to that market survey. The Military Sealift Command (MSC) charters some research ships for the Navy and cost data for those charters are available. Although the capability of the MSC chartered ships are different than the ships that NOAA requires, there are similarities and the MSC charter cost information provided a reasonable point of reference for estimating NOAA costs to charter ships with capability similar to existing NOAA ships that support fishery and marine mammal data collection and that support the El Nino/Southern Oscillation data collection requirement. The charter cost estimates for that data collection were varied by -25%/+25%
4. **Value of Acoustic Quieting -** The value of lost data estimate (due to acoustic quieting) was varied by 0%/+25% because a conservative approach was used.
5. **Value of Hydrographic data -** The value of hydrographic data was varied by -5%/+10% based on the variance in annual production from the three-year average used to calculate the value.
6. **Charter for Multibeam Data -** Charter cost estimates for multibeam data collection to meet fishery needs for bottom depiction for habitat research and for biomass determination were based on Office of Coast Survey estimates using prior actual costs to collect similar data and those costs were varied by -25/+25% due to differences in requirements and system capability. At this time NMFS has not chartered multibeam data so there are no historical costs for this capability.
7. **Current O&M Cost Estimates -** Operation and maintenance costs of current NOAA ships were varied by -5/+5%. NOAA has recent experience with these costs.
8. **New Ship O&M Cost Estimates -** Operation and maintenance cost estimates of new construction ships were varied by -10/+10%. There is more uncertainty in these estimates because details on staffing levels have not been determined.
9. **Ship Sale Value Estimates -** The estimated income from sale of an existing NOAA ship was varied by -50%/+50% because there is no demand in the market place for these purpose designed ships and the most recent NOAA experience in selling NOAA ships was a very low demand and low bids for the ships. NOAA has never sold a NOAA Ship with remaining Book value. They had all been fully depreciated when they were sold.
10. **Service Life Extension (SLE) -** Existing ship service life extension cost estimates were varied by -0%/+15%. NOAA's marine and electronic engineers that are routinely involved with maintenance and repair of existing NOAA ships are familiar with the

current ships, ship systems and related instrumentation and other electronics. Those engineers have experience estimating costs for items that would be similar to the items involved with a ship service life extension. Once in a shipyard, the engineers have found that when ship compartments or systems are opened and inspected, unexpected repair needs frequently arise. Based on prior experience, the engineers estimate that SLE costs could exceed their estimates by up to 15% and would most likely not be less than the projected costs.

11. **Conversion Estimate for ASSERTIVE -** Conversion of the NOAA T-AGOS ASSERTIVE cost estimates were varied by -0/+15%. NOAA's marine and electronic engineers that have been involved in previous conversions of T-AGOS to meet NOAA program needs are familiar with these ships, ship systems and related instrumentation and other electronics. Those engineers have experience estimating costs for items that would be similar to the items involved with with T-AGOS conversion considered as an alternative. The engineers have found that, once in a shipyard, when ship compartments or systems are opened and inspected, unexpected repair needs frequently arise. Based on prior experience, the engineers estimate that conversion costs could exceed their estimates by up to 15% and would most likely not be less than the projected costs.

The Excel spreadsheet for the Sensitivity Analysis is available upon request.

Appendix J – Living Marine Resource (LMR) - Economic Impacts and GPRA Link to Operating Days

Economic Impacts

As shown in Table 1, domestic commercial and recreational fishing activities contribute a total of $36.5B to GNP (Column C Total; excluding the North Atlantic, $28.4B total). The Magnuson-Stevens Reauthorization Act (MSRA) annual catch limit requirement on all federally-managed stocks is expected to result in a 25% decrease in GNP of $9B ($7B excluding the North Atlantic). Data sources and assumptions are described below.

	Column A	Column B	Column C	Column D
	Estimated Contribution of Commercial Fishing to GNP	Estimated Contribution of Recreational Fishing to GNP	Total Contribution of Fishing to GNP	Potential Decrease in GNP due to overly restrictive ACLs
Alaska[3]	**$6.5B**	**0**	**6.5B**	**$1.6B**
West Coast	**$2.2B**	**$1.5B**	**3.7B**	**$0.928B**
Gulf of Mexico	**$3.3B**	**$6.0B**	**9.4B**	**$2.3B**
South Atlantic	**$1.7B**	**$6.0B**	**7.8B**	**$1.9B**
North Atlantic	$5.7B	$2.4B	8.1B	$2.0B
Hawaii	**$.326B**	**$.669B**	**$1B**	**$0.248B**
Total:	**$19.726**	**$16.569B**	**$36.50B**	**$8.976B**

Table 1. Contribution of Commercial & Recreational Fishing to GNP by Ecosystem (Chapter 12, Table 2)

Data Sources

Column A & Column B

The data source for these estimates is the NMFS Value Added Model for Commercial and Recreational Fishing published annually in *Fisheries of the U.S.* Note that the published commercial fisheries value added number includes imports. The estimates provided above in Table 1 do not include imports but, rather, only the economic contribution of domestic harvest.

Column C

Column A + Column B

Column D

The Magnuson-Stevens Reauthorization Act (MSRA) requires the establishment of Annual Catch Limits (ACLs) on all Federally-managed stocks by 2011. Where stock assessment precision is low, ACLs must be set conservatively to avoid the potential of overfishing any stock and, in fact, some fishery management plans have already set targets at 75% of the overfishing limit.

Accordingly, the potential annual economic consequences of the ACL requirements are shown in Column D, the Potential Decrease in GNP Due to Overly Restrictive ACLs, as 25% of Column C, Total Contribution of Fishing to GNP.

Column D= 0.75 * Column C

Based on past management decisions, NMFS considers this a reasonable "rule of thumb" for predicting the economic impacts of ACLs.

[3] No information currently available on recreational fishing effort or angler expenditures.

Living Marine Resource GPRA Measure

NMFS tracks its long-term performance using the *Fish Stock Sustainability Index (FSSI)* and *Percentage of Living Marine Resources (LMRs) with Adequate Population Assessments and Forecasts*.

FSSI

NMFS uses the FSSI to gauge progress toward achieving optimum yield of the Nation's fisheries. The FSSI is a compound measure constructed from two annual measures and two long-term outcome metrics. It is a holistic measure designed to track the full process for reaching the optimum yield on a continuing basis for the 230 highest priority commercial and recreational fish stocks.

Each stock is assigned a score from 1 to 4 based on whether: (1) sufficient information exists to determine whether the stock is overfished or experiencing overfishing, (2) the harvest rate is below the overfishing threshold, (3) its biomass is above the overfished threshold, and (4) its biomass is within the natural range necessary for producing optimum yield. The total FSSI score is the sum of the scores of all the individual stocks.

NMFS works to improve the FSSI by improving its knowledge of stock status (#1) and by taking conservation and management action to keep harvest rates below the overfishing threshold (#2). Once sustainable fishing levels are achieved, the biomass of overfished stocks should then increase over time above the overfished threshold (#3) to levels that support optimum yield on a continuing basis (#4).

Percentage of Living Marine Resources (LMRs) with Adequate Population Assessments and Forecasts -FISH

The information needed to determine the FSSI score comes from stock assessments. To evaluate gaps in and measure progress toward meeting these information needs, the measure *Percentage of LMRs with Adequate Population Assessments and Forecasts* was established. To be deemed adequate, a population assessment must meet the standards set forth in the Stock Assessment Improvement Plans for a level 3 assessment, which includes a time series of the estimated level of abundance and fishing mortality. This is necessary to determine whether a stock is overfished and whether overfishing is occurring.

Such information requires monitoring of catch, abundance, and biological characteristics. Data must be gathered from several sources, including statistically independent surveys performed by vessels and aircraft, fisheries observers placed aboard fishing vessels, and fishers. These primary sources of data feed into mathematical models that represent the demographics of the harvested fish stock and produce estimates of relevant fishery management factors. Information on ecosystem and environmental effects is incorporated into the models, when possible, to improve the interpretation of historical information and the precision of forecasts.

There are immense practical difficulties in estimating the abundance of marine species. The area covered by the U.S. EEZ is vast, larger than the U.S. land area, and there is enormous inherent variability in the abundance of fish populations and the marine environment, which causes uncertainty at every step of the process.

The actual cost per assessment will vary widely depending on geographic extent of the stock, the type of technology and ships needed to do surveys, and the number of commercial and recreational fisheries needing to be monitored in order to record the level of catch. Most observation systems will collect information on several co-occurring stocks, thus effectively spreading the cost across all those stocks. Prevention of overfishing and tracking the rebuilding of overfished stocks requires periodic updates of assessments because stock abundance responds to both the effects of fishing and to unpredictable natural factors. The nominal period beyond which an assessment is considered to be no longer adequate is 5 years and some stocks require more frequent updates than this. NMFS is not fully internalized because factors unrelated to efficiency could have a significant negative impact on increasing the number of adequate assessments. These include: escalating expectations for the precision and comprehensiveness of assessments, non-programmatic infrastructure needs such as Fishery Survey Vessels. In particular, the reauthorized MSFCMA now requires establishment of annual catch limits for each managed fishery, thus increasing the need for more timely updates of assessments that include short-term forecasts of stock abundance and available catch.

It is important to note that when assessment activities with the lowest cost and the highest return are undertaken first, unit costs for increasing the number of adequate assessments may increase over time. To counterbalance this, NOAA Fisheries is continually striving to improve fisheries assessments by making them less expensive, faster, and more accurate. NMFS has been actively pursuing the development of new methodologies (e.g., Toolbox of standardized assessment models[4]) and technologies (e.g., improved FSCS[5], acoustically quiet survey ships[6], AUV surveys[7], etc.) to be made available for the collection, processing, and analysis. This should reduce the cost per adequate assessment.

DEFINITIONS

Assessment: A population assessment, also commonly termed a stock assessment, is an analysis of the abundance and mortality of a living marine resource with respect to relevant management targets and limits.

Stock: A stock is the demographic unit for which the assessment is conducted. A stock is all or part of a species that is found in a defined geographic region and that is sufficiently homogeneous to support management as a unit.

FSSI Stock: Out of the 530+ stocks and stock complexes now managed through U.S. Fishery Management Plans, 230 stocks were selected by regional fishery managers to represent the stocks

[4] Standardized stock assessment models facilitate a streamlined review process, thus letting one review panel cover 2-3 stocks rather than just one stock and its customized model. This expedites scientific advice to management.

[5] The deployment of the Fisheries Scientific Computing System (FSCS) on survey vessels speeds the acquisition of data from fish samples, thus allowing more samples to be taken per day and reducing the number of days necessary to complete a survey. FSCS also allows for a seamless data transfer from ship to shore operation. Data can be supplied in near-real time to the NMFS regional Science Center. This reduces data editing and integration time significantly.

[6] The use of acoustically quiet fishery survey vessels reduces fish avoidance, thus reducing the time and expense to calibrate the fish avoidance factor and reducing the total number of days necessary to conduct a survey. Further efficiency advancements from acoustically quiet vessels come from their ability to detect small concentrations of fish against the noise background created by the ship.

[7] AUVs can make survey vessels more efficient by having more instrumentation in the water on a given sea day (i.e., more area surveyed per given sea day).

that were most important to track. These stocks are used to calculate the Fish Stock Sustainability Index and are the set of stocks for which the percentage adequate assessment measure is calculated.

SAIP: The Marine Fish Stock Assessment Improvement Plan, published in 2001, described the state of stock assessment knowledge at that time and laid out a plan for improvement.

SAIP Tier: The SAIP described three tiers of improvement in the stock assessment enterprise. Tier 2 most closely matches the performance measure for adequate stock assessments. Tier 2 called for elevating all assessments to new national standards of excellence. This included upgrading assessments for core species to at least SAIP level 3 and for adequate baseline monitoring for all managed species.

SAIP Level: the SAIP levels were developed to rank the level of data completeness, complexity and sophistication of stock assessments. There are 5 levels for the stock assessment model category now used to gauge adequacy of assessments.

Adequate: For the purposes of this Performance Measure, an assessment is gauged as adequate if it has a SAIP assessment level of 3 or higher and it has been done or updated within the past 5 years. An adequate assessment is able to produce a time series of the estimated level of abundance and fishing mortality from which status determinations and projections of sustainable catch can be made.

Completion: An assessment is considered to be completed when it has completed its regional technical review and has been judged to be the best available science. Extensive external peer reviews may be used for new or controversial assessments, and internal panels may serve for routine updates of previously reviewed assessments.

Update: An assessment update occurs when existing data streams are extended forward in time (e.g. another year of catch data and another year of fishery-independent survey observations) and the existing model framework is updated with this additional information in order to provide information on the current status of the stock and to extend short-term forecasts. Assessment updates do not normally have extensive reviews because they depend upon previously reviewed methods and types of data.

Percentage of Living Marine Resources (LMRs) with Adequate Population Assessments and Forecasts –PROTECTED RESOURCES

Tier II — Elevate Stock Assessments to New National Standards of Excellence

- Meet ESA and MMPA Mandates by achieving Level 2 under Categories for abundance, assessment (frequency and quality), fishery mortality and stock ID for all stocks
- Upgrade assessments of core species stocks to Level 3 under Categories for abundance life history, assessment (frequency and quality), anthropogenic impacts and stock ID. Achieve for other Categories, Levels 1-4 as appropriate
- Conduct "process-like" research

The Protected Resources portion of the GPRA measure "*Percentage of Living Marine Resources (LMRs) with Adequate Population Assessments and Forecasts*" represents stock assessment work for species protected under both the Endangered Species Act and the Marine Mammal Protection Act. Protected Resources assessments are currently done for all marine mammals, 13 populations of sea turtles, 27 ESU's of salmon, several populations of sturgeon, smalltooh sawfish, white abalone, Acropora corals, and Johnson seagrass. Adequate PR assessments are defined by the 2004 SAIP (below) as "Assessments which are adequate to meet NOAA's ESA and MMPA mandates." This is further refined within the

SAIP document as those assessments meeting Tier II criteria (box below).

The ESA and MMPA have specific language on both the frequency of assessments and the content of assessments. All marine mammal species must be reassessed every three years, with depleted species being reassessed every year. Species with ESA protection must be assessed at listing, and every five years thereafter.

Data for Protected Resources stock assessments are gathered using ship surveys, shore based counts, stream surveys and underwater transects, depending on the species in question. In addition, certain mortality estimates and other life history characteristics (e.g. size at age, fecundity) are collected from both field sampling and available scientific literature. Ship transect surveys are especially critical for marine mammals, and male sea turtles who do haul out on nesting beaches annually. Assessments also usually describe ecological and habitat conditions for the species, and give any known threats or impacts. Once data are gathered, mathematical models of populations are run using the available data, and assumptions about the population. The model results and other conclusions and observations from the data are compiled into reports, which are published by NMFS as technical bulletins. Marine mammals are grouped by three broad geographic zones (Atlantic/Pacific/Gulf of Mexico), while other species are presented on a species by species basis. The stock assessment process is ongoing for all species enjoying MMPA protection, and continues for a certain amount of time after delisting for ESA species. Thus Protected Resources stock assessments are considered by NMFS to be an ongoing activity.
The percent change to the EOP GPRA was calculated by multiplying the percent change in Days at Sea (%ΔDAS) for a specific FSV against the number of Adequately Assessed LMR's associated with that FSV. These changes were used to obtain a "new" percentage. The original percentage was subtracted from the "new" calculated percentage to show the change in the number of LMR's with adequate assessments (Table 1).

Table 1. Capacity Change on the EOP LMR GPRA.

Effect on FSSI

Requirement	FY 10 Δ in Capacity (OD) from Status Quo	Number of Fish Stocks surveyed	Number of Fish stock adequately assessed	Fish stock adequately assessed after capacity change	Percentage of Fish Stock with adequate assessment	Percentage of Fish Stock with adequate assessment after change in capacity	The delta from the capacity change
M2 - Status Quo	-14	230	126	125.80	54.80%	54.70%	-0.10%
M2 Full Op Tempo	45	230	126	126.64	54.80%	55.06%	0.26%
M2 Charter	45	230	126	126.64	54.80%	55.06%	0.26%
NSV 3	45	230	126	126.64	54.80%	55.06%	0.26%
MF - Status Quo	-40	230	126	122.64	54.80%	53.32%	-1.48%
MF Full Op Tempo	19	230	126	126.40	54.80%	54.96%	0.16%
MF Charter	19	230	126	126.40	54.80%	54.96%	0.16%
FSV 3	19	230	126	126.40	54.80%	54.96%	0.16%
DJ	-32	230	126	125.65	54.80%	54.63%	-0.17%
DJ Full Op Tempo	27	230	126	126.45	54.80%	54.98%	0.18%
DJ Charter	27	230	126	126.45	54.80%	54.98%	0.18%

AS* for DSJ	27	230	126	126.45	54.80%	54.98%	0.18%
GU	-3	230	126	125.71	54.80%	54.66%	-0.14%
GU Full Op Tempo	26	230	126	131.35	54.80%	57.11%	2.31%
GU Charter	26	230	126	131.35	54.80%	57.11%	2.31%
NSV5	26	230	126	131.35	54.80%	57.11%	2.31%
PISCES (replaces R2)	2	230	126	126.20	54.80%	54.87%	0.07%
R2 Full Op Tempo	61	230	126	131.97	54.80%	57.38%	2.58%
R2 Charter	61	230	126	131.97	54.80%	57.38%	2.58%
FSV5	61	230	126	131.97	54.80%	57.38%	2.58%
SE	-19	230	126	125.20	54.80%	54.44%	-0.36%
SE Full Op Tempo	40	230	126	127.67	54.80%	55.51%	0.71%
SE Charter	40	230	126	127.67	54.80%	55.51%	0.71%
FSV6	40	230	126	127.67	54.80%	55.51%	0.71%

Effect on Protected Resources GPRA

Requirement	FY 10 Δ in Capacity (OD) from Status Quo	Number of Protected Resources (PR) studied	Number of PR adequately assessed	Number of PR adequately assessed after capacity change	Percentage of PR with adequate assessment	PR_% after change in capacity	The delta of the capacity change
M2 - Status Quo	-14	234	72	70.33	30.80%	30.10%	-0.70%
M2 Full Op Tempo	45	234	72	77.36	30.80%	33.10%	2.30%
M2 Charter	45	234	72	77.36	30.80%	33.10%	2.30%
NSV 3	45	234	72	77.36	30.80%	33.10%	2.30%
MF - Status Quo	-40	234	72	66.53	30.80%	28.4%	-2.37%
MF Full Op Tempo	19	234	72	74.42	30.80%	31.8%	1.00%
MF Charter	19	234	72	74.42	30.80%	31.8%	1.00%
FSV 3	19	234	72	74.42	30.80%	31.8%	1.00%
DJ	-32	234	72	69.07	30.80%	29.52%	-1.28%
DJ Full Op Tempo	27	234	72	75.72	30.80%	32.36%	1.56%
DJ Charter	27	234	72	75.72	30.80%	32.36%	1.56%
AS* for DSJ	27	234	72	75.72	30.80%	32.36%	1.56%
GU	-3	234	72	71.97	30.80%	30.76%	-0.04%
GU Full Op Tempo	26	234	72	72.56	30.80%	31.01%	0.21%
GU Charter	26	234	72	72.56	30.80%	31.01%	0.21%
NSV5	26	234	72	72.56	30.80%	31.01%	0.21%
PISCES (replaces R2)	2	234	72	72.02	30.80%	30.78%	-0.02%

R2 Full Op Tempo	61	234	72	72.63	30.80%	31.04%	0.24%
R2 Charter	61	234	72	72.63	30.80%	31.04%	0.24%
FSV5	61	234	72	72.63	30.80%	31.04%	0.24%
SE	-19	234	72	69.44	30.80%	29.67%	-1.13%
SE Full Op Tempo	40	234	72	77.40	30.80%	33.07%	2.27%
SE Charter	40	234	72	77.40	30.80%	33.07%	2.27%
FSV6	40	234	72	77.40	30.80%	33.07%	2.27%

Effect on combined (LMR) GPRA

Requirement	FY 10 Δ in Capacity (OD) from Status Quo	Combined total of PR and Fish stocks (LMR) surveyed	Combined total of LMR adequately assessed	Combined total of LMR adequately assessed after capacity change	Percentage of LMR with adequate assessment	Percentage of LMR with adequate assessment after change in capacity	The delta of the capacity change for LMR
M2 - Status Quo	-14	464	198	196.13	42.70%	42.30%	-0.40%
M2 Full Op Tempo	45	464	198	204	42.70%	44.00%	1.30%
M2 Charter	45	464	198	204	42.70%	44.00%	1.30%
NSV 3	45	464	198	204	42.70%	44.00%	1.30%
MF - Status Quo	-40	464	198	168.72	42.70%	36.36%	-6.3%
MF Full Op Tempo	19	464	198	200.82	42.70%	43.28%	0.6%
MF Charter	19	464	198	200.82	42.70%	43.28%	0.6%
FSV 3	19	464	198	200.82	42.70%	43.28%	0.6%
DJ	-32	464	198	194.72	42.70%	41.97%	-0.7%
DJ Full Op Tempo	27	464	198	202.16	42.70%	43.57%	0.9%
DJ Charter	27	464	198	202.16	42.70%	43.57%	0.9%
AS* for DSJ	27	464	198	202.16	42.70%	43.57%	0.9%
GU	-3	464	198	197.68	42.70%	42.60%	-0.10%
GU Full Op Tempo	26	464	198	203.91	42.70%	44.00%	1.30%
GU Charter	26	464	198	203.91	42.70%	44.00%	1.30%
NSV5	26	464	198	203.91	42.70%	44.00%	1.30%
OREGON II	2	464	198	198.22	42.70%	42.70%	0.00%
R2 Full Op Tempo	61	464	198	204.60	42.70%	44.10%	1.40%
R2 Charter	61	464	198	204.60	42.70%	44.10%	1.40%
FSV5	61	464	198	204.60	42.70%	44.10%	1.40%
SE	-19	464	198	195.44	42.70%	42.00%	-0.60%
SE Full Op Tempo	40	464	198	203.40	42.70%	43.90%	1.20%
SE Charter	40	464	198	203.40	42.70%	43.90%	1.20%
FSV6	40	464	198	203.40	42.70%	43.90%	1.20%

Capability Change:

Capability changes were calculated using weighting factors assigned to each capability of the FSV with respect to LMR surveys and then multiplied by values for each capability assigned by OMAO. The weighting factors were developed from priority rankings that each center gave the capabilities with respect to gathering data for the LMR GPRA. The calculated percentage change was then multiplied by the associated number LMR for that vessel and used to calculate the change to the GPRA.

EVIDENCE

A description of the Fish Stock Sustainability Index; its latest score; and the report to Congress, *2005 Status of U.S. Fisheries,* can be found at: http://www.nmfs.noaa.gov/sfa/statusoffisheries/SOSmain.htm

The *FSSI* and *Percentage of LMRs with Adequate Population Assessments and Forecasts* GPRA are reported with the other Department of Commerce GPRA Measures in the annual Performance and Accountability Report (PAR). The FY 2006 report is available for download at (http://www.osec.doc.gov/bmi/budget/FY06PARlink.htm).

The Stock Assessment Improvement Plan
http://www.st.nmfs.noaa.gov/StockAssessment/index.html

The Magnuson Stevens Fishery Conservation and Management Act can be found at: http://www.nmfs.noaa.gov/sfa/sfweb/

"The Act sets a firm deadline to end overfishing in America." Presidential statement on H.R. 5946, the "Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006." (http://www.whitehouse.gov/news/releases/2007/01/20070112-3.html)

EOP-specific: ST/4 description of the stock assessment process http://www.st.nmfs.noaa.gov/StockAssessment/StockAssessment.html

NMFS Marine Fisheries Stock Assessment Improvement Plan http://www.st.nmfs.noaa.gov/StockAssessment/index.html

"A Requirements Plan for Improving the Understanding of the Status of U.S. Protected Marine Species, Report of the NOAA Fisheries National Task Force for Improving Marine Mammal and Turtle Stock Assessments" 2004. http://www.nmfs.noaa.gov/pr/sars

NRC, Science and its Role in the NMFS; SERO's Stock Assessment and Fishery Evaluation (SAFE) Report webpage: http://sero.nmfs.noaa.gov/sf/safereports/safe.htm.

Appendix K – Net Present Value Economic Analysis Summary

NPV Economic Analyis Summary By Alternative and Requirements Group																							
Group 1: DAVID STARR JORDAN			**FY10**	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**	**FY20**	**FY21**	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**
	Total $	($775,950)	($47,200)	($3,350)	($7,850)	($4,350)	($4,500)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($4,500)	($31,800)
Conversion	Total NPV	($463,873)																					
	Total $	($723,350)	($12,550)	($32,850)	($11,600)	($3,350)	($3,350)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($3,350)	($21,300)
Service Life Extension (SLE)	Total NPV	($430,687)																					
	Total $	($925,800)	($12,700)	($9,200)	($9,350)	($9,350)	($18,700)	($27,300)	($27,300)	($27,300)	($36,650)	($27,300)	($27,300)	($27,300)	($36,650)	($27,300)	($27,300)	($27,300)	($36,650)	($27,300)	($27,300)	($9,350)	($36,650)
Charter	Total NPV	($541,808)																					
	Total $	($325,550)	($49,350)	($21,975)	($23,575)	($6,100)	($10,250)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($14,700)	($41,950)	($14,700)
New Build	Total NPV	($224,725)																					
Group 2: OREGON II			**FY10**	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**	**FY20**	**FY21**	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**
	Total $	($525,125)	($12,600)	($29,450)	($3,250)	($3,250)	($3,250)	($3,250)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($12,600)
Service Life Extension (SLE)	Total NPV	($308,165)																					
	Total $	($752,350)	($12,600)	($9,200)	($9,350)	($9,350)	($18,700)	($9,350)	($21,000)	($21,000)	($30,350)	($21,000)	($21,000)	($21,000)	($30,350)	($21,000)	($21,000)	($21,000)	($30,350)	($21,000)	($21,000)	($21,000)	($18,700)
Charter	Total NPV	($436,358)																					
	Total $	($302,700)	($7,250)	($41,500)	($37,450)	($5,250)	($10,400)	($9,750)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($14,650)	($32,500)
New Build	Total NPV	($206,765)																					
Group 3: MILLER FREEMAN			**FY10**	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**	**FY20**	**FY21**	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**
	Total $	($940,450)	$0	($4,600)	($4,600)	($4,600)	($4,600)	($14,150)	($49,950)	($33,400)	($25,750)	($25,750)	($25,750)	($25,750)	($25,750)	($25,750)	($25,750)	($25,750)	($25,750)	($25,750)	($25,750)	($25,750)	($25,750)
Service Life Extension (SLE)	Total NPV	($515,001)																					
	Total $	($1,104,350)	$0	($9,400)	($9,550)	($9,550)	($19,100)	($9,550)	($9,550)	($30,700)	($40,250)	($30,700)	($30,700)	($30,700)	($40,250)	($30,700)	($30,700)	($30,700)	($40,250)	($30,700)	($30,700)	($30,700)	($40,250)
Charter	Total NPV	($597,009)																					
	Total $	($400,850)	$0	($7,500)	($23,350)	($70,400)	($50,100)	($17,200)	($8,500)	($21,300)	($16,250)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)
New Build	Total NPV	($278,659)																					
Group 4: RAINIER			**FY10**	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**	**FY20**	**FY21**	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**
	Total $	($579,381)	($5,500)	($5,500)	($5,500)	($5,500)	($5,500)	($21,663)	($5,500)	($5,500)	($5,500)	($22,200)	($17,150)	($17,150)	($17,150)	($17,150)	($17,150)	($17,150)	($17,150)	($17,150)	($17,150)	($17,150)	($17,150)
Service Life Extension (SLE)	Total NPV	($314,960)																					
	Total $	($807,150)	($16,200)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)
Charter	Total NPV	($457,854)																					
	Total $	($358,200)	($5,500)	($5,500)	($5,500)	($5,500)	($26,000)	($61,300)	($26,000)	($8,000)	($12,650)	($6,950)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)
New Build	Total NPV	($232,205)																					
Group 5: HI'IAKAKAI			**FY10**	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**	**FY20**	**FY21**	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**
	Total $	($436,100)	($4,550)	($4,550)	($4,550)	($39,000)	($10,050)	($4,550)	($4,550)	($4,550)	($4,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)
Service Life Extension (SLE)	Total NPV	($247,427)																					
	Total $	($473,850)	($7,200)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)
Charter	Total NPV	($258,854)																					
	Total $	($328,400)	($4,550)	($4,550)	($4,550)	($13,250)	($4,550)	($25,050)	($66,450)	($18,950)	($7,050)	($11,700)	($6,100)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)
New Build	Total NPV	($214,337)																					
Group 6: MCARTHUR II			**FY10**	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**	**FY20**	**FY21**	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**
	Total $	($781,950)	($4,350)	($4,350)	($4,350)	($11,700)	($41,050)	($10,000)	($4,350)	($4,350)	($4,350)	($4,350)	($20,050)	($20,050)	($18,150)	($20,050)	($20,050)	($20,050)	($20,050)	($20,050)	($20,050)	($20,050)	($20,050)
Service Life Extension (SLE)	Total NPV	($403,437)																					
	Total $	($898,200)	($11,700)	($7,200)	($7,350)	($7,350)	($14,700)	($7,350)	($7,350)	($7,350)	($14,700)	($7,350)	($23,050)	($23,050)	($30,400)	($23,050)	($23,050)	($23,050)	($30,400)	($23,050)	($23,050)	($23,050)	($30,400)
Charter	Total NPV	($455,957)																					
	Total $	($354,100)	($4,350)	($4,350)	($4,350)	($8,025)	($19,575)	($4,350)	($4,350)	($51,750)	($51,250)	($6,850)	($6,850)	($11,500)	($10,200)	($4,450)	($4,450)	($4,450)	($4,450)	($4,450)	($4,450)	($4,450)	($4,450)
New Build	Total NPV	($222,560)																					
Group 7: OSCAR ELTON SETTE			**FY10**	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**	**FY20**	**FY21**	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**
	Total $	($548,950)	($4,100)	($4,100)	($4,100)	($4,100)	($4,100)	($4,100)	($4,100)	($13,500)	($39,950)	($12,200)	($4,100)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)
Service Life Extension (SLE)	Total NPV	($283,581)																					
	Total $	($780,350)	($13,500)	($9,250)	($9,400)	($9,400)	($18,800)	($9,400)	($9,400)	($9,400)	($18,800)	($9,400)	($9,400)	($17,800)	($27,200)	($17,800)	($17,800)	($17,800)	($27,200)	($17,800)	($17,800)	($17,800)	($27,200)
Charter	Total NPV	($404,702)																					
	Total $	($383,250)	($4,100)	($4,100)	($4,100)	($4,100)	($4,100)	($4,100)	($8,800)	($16,600)	($40,600)	($56,900)	($11,600)	($6,600)	($11,250)	($10,800)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)
New Build	Total NPV	($228,045)																					
Group 8: KA'IMIMOANA			**FY10**	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**	**FY20**	**FY21**	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**
	Total $	($278,350)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($41,000)	($10,050)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)
Service Life Extension (SLE)	Total NPV	($157,269)																					
	Total $	($323,250)	($7,200)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)
Charter	Total NPV	($178,123)																					
	Total $	($347,375)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($33,975)	($78,350)	($7,100)	($7,100)	($11,700)	($6,050)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)
New Build	Total NPV	($210,343)																					
Group 9: GORDON GUNTER			**FY10**	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**	**FY20**	**FY21**	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**
	Total $	($668,250)	($4,000)	($4,000)	($4,000)	($4,000)	($4,000)	($4,000)	($4,000)	($4,000)	($13,350)	($38,950)	($11,900)	($4,000)	($4,000)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)
Service Life Extension (SLE)	Total NPV	($326,440)																					
	Total $	($908,700)	($13,350)	($9,200)	($9,350)	($9,350)	($18,700)	($9,350)	($9,350)	($9,350)	($18,700)	($9,350)	($9,350)	($9,350)	($18,700)	($21,950)	($21,950)	($21,950)	($31,300)	($21,950)	($21,950)	($21,950)	($31,300)
Charter	Total NPV	($452,891)																					
	Total $	($383,900)	($4,000)	($4,000)	($4,000)	($4,000)	($4,000)	($4,000)	($4,000)	($4,000)	($8,675)	($35,175)	($48,200)	($36,100)	($6,500)	($11,150)	($10,700)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)
New Build	Total NPV	($221,519)																					
Group 10: FAIRWEATHER			**FY10**	**FY11**	**FY12**	**FY13**	**FY14**	**FY15**	**FY16**	**FY17**	**FY18**	**FY19**	**FY20**	**FY21**	**FY22**	**FY23**	**FY24**	**FY25**	**FY26**	**FY27**	**FY28**	**FY29**	**FY30**
	Total $	($802,500)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)
Service Life Extension (SLE)	Total NPV	($376,801)																					
	Total $	($901,800)	($16,200)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($16,350)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)
Charter	Total NPV	($462,583)																					
	Total $	($471,550)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($16,350)	($16,350)	($61,950)	($65,050)	($26,550)	($18,850)	($17,100)	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)
New Build	Total NPV	($273,923)																					

NPV Economic Analyis Summary By Alternative and Requirements Group

Group 1: DAVID STARR JORDAN	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40	FY41	FY42	FY43	FY44
Conversion	($73,950)	($30,100)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($22,450)	($7,100)
Service Life Extension (SLE)	($30,650)	($50,800)	($29,550)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($21,300)	($12,800)
Charter	($27,300)	($27,300)	($27,300)	($36,650)	($27,300)	($27,300)	($27,300)	($36,650)	($27,300)	($27,300)	($27,300)	($36,650)	($27,300)	($27,300)
New Build	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,150)

Group 2: OREGON II	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40	FY41	FY42	FY43	FY44	FY45
Service Life Extension (SLE)	($41,100)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($14,900)	($19,575)	($9,400)
Charter	($21,000)	($21,000)	($21,000)	($30,350)	($21,000)	($21,000)	($21,000)	($30,350)	($21,000)	($21,000)	($21,000)	($30,350)	($21,000)	($21,000)	($21,000)
New Build	($3,150)	($3,150)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,150)

Group 3: MILLER FREEMAN	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40	FY41	FY42	FY43	FY44	FY45	FY46	FY47	FY48
Service Life Extension (SLE)	($25,750)	($25,750)	($4,600)	($25,750)	($35,300)	($71,100)	($33,400)	($25,750)	($25,750)	($25,750)	($25,750)	($25,750)	($25,750)	($25,750)	($25,750)	($25,750)	($25,750)	($10,650)
Charter	($30,700)	($30,700)	($9,550)	($40,250)	($30,700)	($30,700)	($30,700)	($40,250)	($30,700)	($30,700)	($30,700)	($40,250)	($30,700)	($30,700)	($30,700)	($40,250)	($30,700)	($30,700)
New Build	($32,700)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,150)

Group 4: RAINIER	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40	FY41	FY42	FY43	FY44	FY45	FY46	FY47	FY48
Service Life Extension (SLE)	($17,150)	($17,150)	($17,150)	($11,300)	($17,150)	($17,150)	($17,150)	($17,169)	($17,150)	($17,150)	($17,150)	($17,150)	($17,150)	($17,150)	($17,150)	($17,150)	($17,150)	($17,150)
Charter	($22,200)	($22,200)	($22,200)	($16,350)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)	($22,200)
New Build	($5,550)	($5,550)	($5,550)	($40,050)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)	($5,550)	($5,400)

Group 5: HI'IAKAKAI	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40	FY41	FY42	FY43	FY44	FY45	FY46	FY47	FY48	FY49
Service Life Extension (SLE)	($10,550)	($10,550)	($45,000)	($10,050)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($10,550)	($4,750)
Charter	($13,350)	($13,350)	($13,350)	($7,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)	($13,350)
New Build	($4,700)	($4,700)	($4,700)	($30,200)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,550)

Group 6: MCARTHUR II	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40	FY41	FY42	FY43	FY44	FY45	FY46	FY47	FY48	FY49	FY50	FY51	FY52
Service Life Extension (SLE)	($20,050)	($20,050)	($27,400)	($56,750)	($10,000)	($20,050)	($20,050)	($20,050)	($20,050)	($20,050)	($20,050)	($18,150)	($20,050)	($20,050)	($20,050)	($20,050)	($20,050)	($20,050)	($20,050)	($20,050)	($20,050)	($16,950)
Charter	($23,050)	($23,050)	($23,050)	($30,400)	($7,350)	($23,050)	($23,050)	($32,450)	($23,050)	($23,050)	($23,050)	($30,400)	($23,050)	($23,050)	($23,050)	($30,400)	($23,050)	($23,050)	($23,050)	($30,400)	($23,050)	($23,050)
New Build	($4,450)	($4,450)	($4,450)	($4,450)	($4,450)	($11,800)	($30,100)	($4,450)	($4,450)	($4,450)	($4,450)	($4,450)	($4,450)	($4,450)	($4,450)	($4,450)	($4,450)	($4,450)	($4,450)	($4,450)	($4,450)	($4,300)

Group 7: OSCAR ELTON SETTE	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40	FY41	FY42	FY43	FY44	FY45	FY46	FY47	FY48	FY49	FY50	FY51	FY52	FY53
Service Life Extension (SLE)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($21,900)	($39,950)	($20,600)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($12,500)	($5,550)
Charter	($17,800)	($17,800)	($17,800)	($27,200)	($17,800)	($17,800)	($17,800)	($18,800)	($17,800)	($17,800)	($17,800)	($27,200)	($17,800)	($17,800)	($17,800)	($27,200)	($17,800)	($17,800)	($17,800)	($27,200)	($17,800)	($17,800)	($17,800)
New Build	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($14,700)	($32,550)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,150)

Group 8: KA'IMIMOANA	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40	FY41	FY42	FY43	FY44	FY45	FY46	FY47	FY48	FY49	FY50	FY51	FY52	FY53
Service Life Extension (SLE)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($41,000)	($10,050)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	($4,600)	$3,150
Charter	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)	($7,350)
New Build	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($2,800)	($32,050)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,700)	($4,550)

Group 9: GORDON GUNTER	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40	FY41	FY42	FY43	FY44	FY45	FY46	FY47	FY48	FY49	FY50	FY51	FY52	FY53	FY54
Service Life Extension (SLE)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)	($25,950)	($38,950)	($24,500)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)	($16,600)	($9,850)
Charter	($21,950)	($21,950)	($21,950)	($31,300)	($21,950)	($21,950)	($21,950)	($31,300)	($9,350)	($21,950)	($21,950)	($31,300)	($21,950)	($21,950)	($21,950)	($31,300)	($21,950)	($21,950)	($21,950)	($31,300)	($21,950)	($21,950)	($21,950)	($21,950)
New Build	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($14,650)	($32,500)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,300)	($5,150)

Group 10: FAIRWEATHER	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38	FY39	FY40	FY41	FY42	FY43	FY44	FY45	FY46	FY47	FY48	FY49	FY50	FY51	FY52	FY53	FY54	FY55
Service Life Extension (SLE)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($16,350)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)
Charter	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($16,350)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)	($20,800)
New Build	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)	($39,800)	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)	($5,400)	($5,250)

Appendix L – NOAA Ships versus Private Charter Vessels

Advantages of Operating NOAA Ships versus Private Charter Vessels

FSV6 vs. Charter – FSV6 will fulfill the requirements currently met by NOAA Ship DAVID STARR JORDAN, which collects primary data for about 30 adequately assessed living marine resource (LMR – includes both fish and marine mammals) stocks in the California Current region. FSV6 will collect more and better quality data to support fish stock and marine mammal assessments compared to a Charter vessel. This is due to capabilities such as acoustic technology (biomass and bottom mapping multibeams), acoustic quieting and endurance, among others, that cannot be found in the private sector. The new ship's capability will improve the current status of the LMR total GPRA measure by an estimated 19% in one year over Charter.

FSV5 vs. Charter – FSV5 will fulfill the requirements currently met by NOAA Ship OREGON II, which collects primary data for 20 adequately assessed LMR stocks in the Southeast and the Gulf of Mexico. FSV5 will collect more and better quality data to support LMR and Ecosystem assessments compared to a Charter vessel. This is due to capabilities such as acoustic technology (biomass and bottom mapping multibeams), acoustic quieting, data collection in shallow depths, and endurance that cannot be found in the private sector. Additionally, FSV5 will have sufficient berthing space, crew to allow 24-hour operations, ship range to allow operations in remote areas, and a variety of equipment such as winches, davits, and A-frames to allow operation of oceanographic and biological sampling tools. The new ship's capability will improve the current status of the LMR total GPRA measure by almost 30% in one year over Charter.

FSV7 vs. Charter – FSV7 will fulfill the requirements currently met by NOAA Ship MILLER FREEMAN, which collects primary data for 35 LMR stocks in the Gulf of Alaska, the Bering Sea and throughout the Arctic Ecosystem. The need for FSV7 is critical to meet the well-defined fishery requirements and emerging issues (loss of sea ice, oil/gas, opening North West passage, marine mammal impacts, changes in fisheries, climate variability) unique to AK. FSV7 will collect more and better quality data to support fish stock and marine mammal assessments compared to a Charter vessel. This is due to capabilities such as acoustic technology (biomass and bottom mapping multibeams), acoustic quieting and endurance, among others, that cannot be found in the private sector. The new ship's capability will improve the current status of the Living Marine Resources total GPRA measure by an estimated 10% in one year over Charter.

NSV1 vs. Charter – NSV1 will fulfill the requirements currently met by NOAA Ship RAINIER, a ship that will be 42 years old in FY10, which collects hydrographic and bathymetric data for nautical charts in the Northwest and Alaska regions. NSV1 will be almost four times more cost effective than Charter based on the cost per square nautical mile (SNM) – $4,641/SNM vs. $17,347/SNM respectively. This is due to differences in operating costs as well as capabilities such as shipboard multibeam, AUV configuration, and endurance that together provide a unified and unique approach to collect required data for nautical charts. These capabilities provide a complete suite of tools tailored to optimally accomplish the mission that would be expensive to obtain on one Charter vessel. At the same time, NOAA is training physical scientists (up to 20 per year) and maintaining the expertise needed to ensure the quality of data obtained through hydrographic services contracts and 3rd party data sources before it goes onto a nautical chart.

NSV2 vs. Charter – NSV2 will fulfill the requirements currently met by NOAA Ship HI'IAKAKAI, which primarily collects data to monitor and map the National Marine Sanctuaries and corals in the Pacific Islands region. Coral mapping projects require necessary lab space, endurance, science berthing, and safe NITROX dive support for 15 scientists in extremely remote locations. NSV2 will also be zero discharge capable which is ideal for the environmentally sensitive marine area it operates in. Charter vessels of appropriate capacity and capability to support safe dive operations are not available in the Pacific Islands region. Although there would be an increased productivity due to an increase in endurance and capacity, a positive impact in GPRA performance cannot be quantified since the measure is based on assessing improved condition in the region.

NSV3 vs. Charter – NSV3 will fulfill the requirements currently met by NOAA Ship MCARTHUR II, which collects primary data for 28 adequately assessed LMR stocks as well as physical, chemical and biological data for ecosystem surveys, and monitors the National Marine Sanctuaries in the California Current Marine Ecosystem. Surveying marine sanctuaries requires large deck and lab working spaces, experienced crew support, and ship endurance to accommodate surveys lasting up to 20 days at sea. Round-the-clock missions are required using multiple sampling gear and methods (e.g. trawling at deep depths, remote photo-sampling, acoustical profiling, extensive scuba capability - requirements not attainable on charters), and ship speed needed to cover numerous stations over broad regions (improves quality of data for management decisions). Currently these capabilities cannot be found in the private sector. The new ship's capability will improve the current status of the Living Marine Resources total GPRA measure by an estimated 9% in one year over Charter.

NSV4 vs. Charter – NSV4 will fulfill the requirements currently met by NOAA Ship OSCAR ELTON SETTE, which collects primary data for 20 living marine resource stocks in the Pacific Islands regions. Stock assessments and scientific studies are conducted over an area incorporating more than 50 Pacific Ocean islands in an immense open area. NSV4 will collect more and better quality data to support fish stock and marine mammal assessments compared to a Charter vessel. This is due to capabilities such as acoustic technology (biomass and bottom mapping multibeams), acoustic quieting and endurance, among others, that cannot be found in the private sector. NSV4 will also be zero discharge capable which is ideal for the sensitive marine area it operates in. The new ship's capability will improve the current status of the Living Marine Resources total GPRA measure by over 2% in one year over Charter.

NSV5 vs. Charter – NSV5 will fulfill the requirements currently met by NOAA Ship KA'IMIMOANA and its mission to recover/deploy moorings and drifters while collecting in situ oceanographic data in the Equatorial Pacific region. Observations from these drifters and moorings provide data that reduce the error of global sea surface temperature and contribute to NOAA's seasonal climate forecasts. Charter capability might be available to perform this mission but utilizing the current asset dedicated to this mission is the most cost effective and efficient way to collect the data needed to forecast global climate trends.

NSV6 vs. Charter – NSV6 will fulfill the requirements currently met by NOAA Ship GORDON GUNTER, which collects primary data for 21 adequately assessed LMR stocks in the Gulf of

Mexico and Atlantic regions. NSV6 will collect more and better quality data to support fish stock and marine mammal assessments compared to a Charter vessel. This is due to capabilities such as acoustic technology (biomass and bottom mapping multibeams), acoustic quieting and endurance, among others, that cannot be found in the private sector. The new ship's capability will improve the current status of the Living Marine Resources total GPRA measure by over 10% in one year over Charter.

NSV7 vs. Charter – NSV7 will fulfill the requirements currently met by NOAA Ship FAIRWEATHER, a ship that will be 42 years old in FY10, which collects hydrographic and bathymetric data for nautical charts in the Northwest and Alaska regions. NSV7 will be over 3.5 times more cost effective than Charter based on the cost per square nautical mile (SNM) – $4,818/SNM vs. $17,347/SNM respectively. This is due to differences in operating costs as well as capabilities such as survey launch production, AUV configuration, and endurance that together provide a unified and unique approach to collect required data for nautical charts. These capabilities provide a complete suite of tools tailored to optimally accomplish the mission that would be expensive to obtain on one Charter vessel. At the same time, NOAA is training physical scientists (up to 20 per year) and maintaining the expertise needed to ensure the quality of data obtained through hydrographic services contracts and 3rd party data sources before it goes onto a nautical chart.

All new ship construction results in multi-mission capability that increases cost-efficiency and maximizes the utility of NOAA platforms. This concept is described in Appendix N.

The new fishery survey vessels currently being added to the NOAA fleet, and the new vessels now being planned, possess unique capabilities and design characteristics that are not available from charters from either the commercial fishing or the academic research fleets. These include acoustic quieting vital for optimal sampling of many fish and marine mammal populations, advanced sonar systems for surveying the water column and bottom, dynamic positioning for accurate station keeping, berthing for a scientific complement sufficient for conducting 24/7 operations, longer endurance and higher cruising speeds needed for sustained operations in remote areas, and the ability to conduct the multiple simultaneous sampling procedures needed for generating the data streams to provide the scientific basis for conducting ecosystem approaches to management.

In addition to the technical shortcomings, there are several other factors that militate against the over-reliance on charters. Charters are typically for five years, which means that the vessels used in a charter-based survey may change frequently. Different vessels have different fishing powers, necessitating extensive and costly studies to calibrate each new vessel with the previous. Greater uncertainty is added to a stock assessment each time a vessel is changed. Charter rates for commercial vessels are highest during the fishing season, which is when the National Marine Fisheries Services' (NMFS) surveys are typically conducted.

Appendix M – Concept for New Class of NOAA Ships

Concept for New Class of NOAA Ships
NOAA Survey Vessel (NSV)

The table below compares the legacy fleet with the new Fishery Survey Vessels presently being constructed and the proposed NOAA Survey Vessels (NSV). Details on the NSV capabilities are not available because the NSV is at the concept stage. The concept has the potential, using available technology and with some consolidation of mission profiles, to improve the quality and quantity of data collected on any one mission. The acquisition objective for the NSV is to ensure NOAA's ability to perform all of its multiple data collection and monitoring missions can be executed with optimal effectiveness and minimal ownership costs throughout its life. This capability is unavailable on many of the legacy ships as they were single-focus ships brought to NOAA when the agency was formed. Even the recently acquired Navy T-AGOS ships were converted as single purpose ships after they were transferred to NOAA. The NSV is expected to provide multi-mission capability. Some flexibility in mission space and equipment on the ship is required to provide this multi mission capability. Following the lead of other ship operators, a "plug and play" capability, where a container can be swapped out to change space configuration in a limited way, will allow added mission flexibility.

Acronyms Used in Table:

AUV: Autonomous Underwater Vehicle

ROV: Remotely Operated Vehicle

UAS: Unmanned Aerial System

Ship Dimension	**Legacy Ships**	**New Fishery Survey Vessels**	**Proposed NOAA Survey Vessel**
Mission Focus	Single purpose ship	Dedicated fisheries ship; potential for multi-mission capability, but limited space to expand.	Multiple mission capability; designed for primary mission but capable of meeting other mission data collection requirements
24/7 operations	Sails 24/7, but does not always conduct data collection 24/7	Sails 24/7, but does not always conduct data collection 24/7	Would conduct multiple missions each day, 24/7, on a not-to-interfere basis with priority mission focus for voyage
Plug & Play Capability to adjust mission	Dedicated mission ship without ability to change ship configuration to perform significantly different missions.	Dedicated mission ship without the ability to change ship configuration to perform significantly different missions.	Ability to swap out a shipping container much like those used on container ships; each self-contained unit would have the tools and capability to support a dedicated mission
Mission Equipment	Except for T-AGOS class Navy ships, all ships are one-of-a-kind; mission equipment varies between all ships	Mission equipment is the same, somewhat more capable than the legacy ships, but has a mission focus.	Mission equipment would be the same across the class of ships, address the breadth and flexibility of mission requirements defined for multi-mission ship.
AUV, ROV, and UAS handling and maintenance capability	Only if legacy was built for the capability.	Limited AUV handling capability; little to no maintenance support capability	Deck handling equipment that could launch and retrieve vehicles; dedicated maintenance support space with ability to swap out sensor modules for added mission flexibility.

Ship Dimension	Legacy Ships	New Fishery Survey Vessels	Proposed NOAA Survey Vessel
Simplify Logistics Support	Designed for lowest cost acquisition; one-of-a-kind ships negate value of common equipment for parts, maintenance, troubleshooting and personnel training.	Commonality of class to limited extent; acquisition strategy allowed for the interchange of major machinery between ships.	Acquisition strategy will require all ships to be built with latest version of same equipment and machinery;
Design Cost Strategy	Designed for lowest acquisition cost	Designed with limited lifecycle cost considerations; primarily bought as much as could be afforded without consideration for life cycle costs.	Design for Total Ownership Costs, to include acquisition, operations and maintenance, and disposal costs.
Common Platform Configuration to address some quality of life issues	One-of-a-kind ships limits ability to backfill vacancies or rotate crews during long deployments	Some commonality; ship crew rotation possible, but some differences in ship configurations are being delivered within class.	Crew rotation possible on similarly configured vessels; addresses quality of life issues for long deployments through crew rotation.
Use technology to leverage contributions of higher paid scientists	Scientists must ride ship and perform data collection; limited real-time communications capability; generating power limits ability to expand capability	Some real-time communications capability; scientists still must ride ship to perform data collection. Power generation can be upgraded to accommodate additional capability.	Leverage contribution and knowledge of scientists by using technology to provide real-time connectivity and communication to multiple scientists ashore at different locations with data collection operation. Data collection performed by lower cost science technicians.
Limit ship's environmental impact	Designed to discharge effluents overboard with little to no space to add holding tank capacity; exhaust from	First acoustically quiet ship design in NOAA fleet. Added holding capacity for effluents; may need to adapt machinery	To be designed acoustically quiet. Larger ship will accommodate greater holding tank capacity for effluents; will require alternative

Ship Dimension	Legacy Ships	New Fishery Survey Vessels	Proposed NOAA Survey Vessel
	old diesel machinery does not meet standards being considered for near future; ships generate a substantial amount of radiated noise affecting quality of data.	exhaust to limit exhaust pollution to newer standards.	power generation or strong exhaust pollution controls to meet standards.
Capability to support remote Diving operations	Most cannot support operations.	Cannot support operations. Limited space and equipment for diving operations.	Will have hyperbaric chambers and dive facility space to manage equipment, and recharge tanks with special gas mixtures.
Mapping capability	Installed mapping capability if ship is dedicated to bathymetry; no other capability.	Installed capability for biomass and habitat mapping.	Installed capability to address bathymetry, biomass, and habitat mapping needs
Hull strengthening to address operations in Arctic Region	A few ships have an ice belt installed providing limited protection.	Ice strengthening added to hull design, but should not operate by itself in Arctic Region	Ice strengthening installed to meet anticipated mission profile for ship. Specific requirements to be determined.