United States Government Accountability Office

Report to Congressional Committees

November 2014

NOAA'S OBSERVING SYSTEMS

Additional Steps Needed to Achieve an Integrated, Cost-Effective Portfolio

GAO-15-96

GAO Highlights

Highlights of GAO-15-96, a report to congressional committees

November 2014

NOAA'S OBSERVING SYSTEMS

Additional Steps Needed to Achieve an Integrated, Cost-Effective Portfolio

Why GAO Did This Study

NOAA operates and maintains a portfolio of observing systems to capture the environmental data needed to achieve its diverse missions. Some of these systems focus on the oceans, coasts, and Great Lakes. An observing system is a collection of one or more sensing elements that measures specific environmental conditions and resides on fixed or mobile platforms, such as buoys or satellites.

The House Appropriations Committee fiscal year report for the Department of Commerce's 2013 appropriations bill mandated GAO to review NOAA's ocean and coastal data collection systems. This report (1) identifies and describes the ocean, coastal, and Great Lakes observing systems NOAA operates; (2) identifies the annual operations and maintenance costs of these systems for fiscal years 2012 through 2014; and (3) examines the extent to which NOAA has taken steps to integrate and improve the cost-effectiveness of its observing systems portfolio. GAO analyzed agency documentation on, among other things, the characteristics and management of NOAA's observing systems, reviewed cost data from fiscal year 2012 through 2014, and interviewed NOAA officials.

What GAO Recommends

GAO recommends that NOAA develop a plan to guide the integration of its observing systems, analyze whether unnecessary duplication exists in its observing systems portfolio, and develop a standardized methodology for the routine preparation and reporting of observing systems costs. NOAA generally agreed with the recommendations.

View GAO-15-96. For more information, contact Anne-Marie Fennell at (202) 512-3841 or fennella@gao.gov.

What GAO Found

The National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce operates 41 ocean, coastal, and Great Lakes observing systems. NOAA's Office of Oceanic and Atmospheric Research and National Ocean Service manage 25 of these observing systems, with management of the remaining 16 systems split among four other NOAA offices. The majority of NOAA's ocean, coastal, and Great Lakes observing systems use one of three platforms—buoys, satellites, or ships—to collect a range of environmental data, which are used to produce a variety of products, such as weather forecasts and navigational tools.

NOAA estimates it spent an average of approximately $430 million annually to operate and maintain its ocean, coastal, and Great Lakes observing systems in fiscal years 2012 through 2014. This is approximately 9 percent of NOAA's total annual appropriations for these years. In reviewing these estimates, GAO found NOAA's annual costs for these observing systems ranged from about $22 million for systems managed by the National Marine Fisheries Service to $198 million for systems managed by the Office of Marine and Aviation Operations in fiscal year 2014.

NOAA has not taken all of the steps it has identified as important to integrate and improve the cost-effectiveness of its observing systems portfolio. Since 2002, NOAA has identified the need to move toward an integrated observing systems portfolio. GAO's previous work has found that, in undertaking initiatives such as this, federal agencies can benefit from following leading practices for strategic planning, which include defining goals and performance measures to track progress. NOAA has not, however, developed a plan that clearly sets forth its vision for an integrated observing systems portfolio, the steps it needs to take to achieve this vision, or how it will evaluate its progress. NOAA officials said they have focused on taking specific steps toward integration rather than developing an integration plan. Without a plan, however, NOAA cannot be assured it has established a framework to effectively guide and assess the success of its observing system integration efforts. NOAA has also not assessed whether its observing systems are collecting unnecessarily duplicative data even though NOAA documents have identified the need to reduce duplication. NOAA officials told GAO that duplication is not a significant problem requiring further analysis. However, in the absence of an analysis, NOAA cannot know whether it is missing opportunities to achieve cost savings. NOAA has taken steps to integrate the management of its observing systems, including creating an observing systems council to provide a more centralized perspective on systems management. The agency has also developed analytical tools to assess its observing system capabilities and requirements, including a model to analyze investment options. Reliable cost data are needed to ensure the most accurate results from this model, but NOAA does not have a standard methodology for tracking its observing systems costs. NOAA officials said the agency is considering developing a better method for tracking observing system costs but has not established a time frame for doing so. Without accurate and consistent cost information, it will be difficult for NOAA to reliably compare the cost-effectiveness of its observing systems and make informed investment decisions.

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Abbreviations

GPRA	Government Performance and Results Act of 1993
IOOS	Integrated Ocean Observing System
NOAA	National Oceanic and Atmospheric Administration
NOSC	NOAA Observing System Council
OMB	Office of Management and Budget
TPIO	Technology, Planning and Integration for Observation

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November 17, 2014

The Honorable Barbara Mikulski
Chairwoman
The Honorable Richard Shelby
Ranking Member
Subcommittee on Commerce, Justice, Science and Related Agencies
Committee on Appropriations
United States Senate

The Honorable Frank Wolf
Chairman
The Honorable Chaka Fattah
Ranking Member
Subcommittee on Commerce, Justice, Science and Related Agencies
Committee on Appropriations
House of Representatives

The nation depends on data collected by ocean and coastal observing systems to help produce a wide variety of products including weather forecasts, tsunamis warnings, and nautical charts to support marine commerce. An observing system is a collection of one or more sensing elements that reside on a fixed or mobile platform, such as a buoy or satellite. The sensing elements collect data to measure specific environmental conditions, such as sea surface temperature or wave height. The National Oceanic and Atmospheric Administration (NOAA), in the Department of Commerce, is the federal agency responsible for managing and operating a large portfolio of observing systems, a subset of which gather ocean and coastal environmental data.

The House Appropriations Committee report for the Department of Commerce's fiscal year 2013 appropriations bill mandated GAO to report on NOAA's ocean and coastal data collection systems.[1] This report (1)

[1]H.R. Rep. No. 112-463, at 20 (2012); *see also* 159 Cong. Rec. S1287, S1300 (daily ed. Mar. 11, 2013) (explanatory statement with regard to H.R. 933, which became the Consolidated and Further Continuing Appropriations Act, 2013, Pub. L. No. 113-6 (2013), and which incorporated the House report by reference). The National Oceanic and Atmospheric Administration (NOAA) refers to its systems that collect data on the oceans and coasts not as "data collection systems" but rather as "observing systems," which is the term we use throughout this report.

identifies and describes the ocean, coastal, and Great Lakes observing systems NOAA operates; (2) identifies the annual operations and maintenance costs of these systems for fiscal years 2012 through 2014; and (3) examines the extent to which NOAA has taken steps to integrate and improve the cost-effectiveness of its portfolio of observing systems, including ocean, coastal, and Great Lakes systems.[2]

To identify which of NOAA's observing systems collect data on oceans, coasts, and the Great Lakes, we first identified a list of environmental variables, known as "parameters," related to the ocean, coast, and Great Lakes. We identified 75 environmental parameters, such as wave direction, salinity, and ocean temperature. We then reviewed NOAA's entire observing systems portfolio to identify which of the systems collect data on at least one of these environmental parameters. We provided the list of ocean, coastal, and Great Lakes observing systems we identified to NOAA officials and incorporated their views into our final list as appropriate. To obtain descriptive information about the systems, we reviewed agency documentation, such as NOAA's observing system summary reports, and we interviewed NOAA officials.[3] To identify NOAA's costs to operate and maintain its ocean, coastal, and Great Lakes observing systems, we asked NOAA officials to provide cost data for these systems. NOAA does not have a process to track observing system operations and maintenance costs. However, as part of an analysis of its observing systems portfolio, NOAA gathered cost information for fiscal years 2012 through 2014 by surveying agency officials. We assessed the reliability of the information they provided by, among other things, reviewing documentation of NOAA's data collection procedures and interviewing agency officials, including observing system program managers. We found the data to be sufficiently reliable for the purpose of our report, which is to provide an overview of the costs for NOAA's ocean, coastal, and Great Lakes observing systems. The data may not, however, be sufficiently reliable for other purposes that require more accurate cost data, such as for making comparisons of the relative cost-effectiveness of different observing systems. To determine the extent to which NOAA has taken steps to integrate and improve the cost-

[2]We included the Great Lakes in our review because some of the ocean and coastal observing systems we identified also maintain observing platforms in the Great Lakes.

[3]Observing system summary reports provide basic information about an observing system, such as the system's name, its acronym, and the environmental parameters it measures, among other things.

effectiveness of its portfolio of ocean, coastal, and Great Lakes observing systems, we reviewed agency and external documentation. Specifically, we reviewed NOAA plans related to managing the agency's observing systems portfolio and documentation of the agency's observing systems management activities. In addition, we reviewed internal NOAA reports and external reviews that identified opportunities to improve the management and integration of the agency's observing systems portfolio. We also interviewed NOAA officials regarding the agency's observing systems management plans and activities. Appendix I contains a more detailed description of our objectives, scope, and methodology. See appendix II for a list of the ocean, coastal, and Great Lakes environmental parameters we identified.

We conducted this performance audit from September 2013 to November 2014 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

Six organizational entities within NOAA have responsibilities related to its ocean, coastal, and Great Lakes observing systems. NOAA has six line offices, which are responsible for executing the agency's broad mission and programs. Five of those line offices operate and maintain observing systems.[4] Staff offices support the line offices in achieving their missions and one staff office—the Office of Marine and Aviation Operations—also operates and maintains ocean, coastal, and Great Lakes observing systems. The missions of the six offices with responsibilities related to ocean, coastal, and Great Lakes observing systems are as follows:

- **National Environmental Satellite, Data, and Information Service:** Provides timely access to global environmental data from satellites and other sources to promote, protect, and enhance the nation's economy, security, environment, and quality of life.

[4]The sixth line office, known as the Office of Program, Planning, and Integration, is responsible for coordinating agency-wide planning and evaluation activities.

- **National Marine Fisheries Service:** Promotes stewardship of living marine resources through science-based conservation and management and the promotion of healthy ecosystems.
- **National Ocean Service:** Provides science-based solutions through collaborative partnerships to address evolving economic, environmental, and social pressures on the nation's oceans and coasts.
- **National Weather Service:** Provides weather, water, and climate data, forecasts, and warnings for the protection of life and property and enhancement of the national economy.
- **Office of Oceanic and Atmospheric Research:** Provides the research foundation for understanding the complex systems that support the planet.
- **Office of Marine and Aviation Operations:** Delivers effective earth observation capabilities, integrates emerging technologies, and provides a specialized, flexible, and reliable team responsive to NOAA and the nation. This office manages, maintains, and operates NOAA's fleet of ships and aircraft, which the line offices use to gather data they need to help achieve their missions.

NOAA is the lead federal agency responsible for implementing the Integrated Coastal and Ocean Observation System Act of 2009 and has established the U.S. Integrated Ocean Observing System (IOOS) program office.[5] This office is part of NOAA's National Ocean Service and works with 18 federal agencies and 11 regional associations to expand, standardize, and integrate ocean observing systems and data.[6] The U.S. IOOS program relies on the voluntary participation of its federal and regional partners to achieve its coordination objectives, which have focused primarily on increasing the data compatibility and integration among the observing systems owned by NOAA, other federal agencies, and regional partners. According to NOAA officials, the program does not manage any of these systems, including those ocean, coastal, and Great Lakes observing systems operated by NOAA.

[5]Pub. L. No. 111-11, tit. XII, subtit. C, 123 Stat. 991, 1427 (2009), *codified at* 33 U.S.C. §§ 3601-3610.

[6]Regional associations are made up of representatives of federal, state, local, and tribal governments; academic and research institutions, and other private entities. These associations have primary responsibility for coordination of the observing systems within their geographic regions, developing and integrating these assets with the federal system, data management, education, outreach, and delivering timely and effective products to meet user needs.

On the basis of our review of NOAA documents and discussions with agency officials, there are several ways in which integration could take place in the context of an observing systems portfolio. One way is by changing how a portfolio of observing systems is managed. This type of management integration could occur to different degrees along a continuum. At one end of the continuum, each individual observing system would be operated and managed separately by its program manager, with little or no higher-level organizational oversight. This would result in little to no integration because decisions about operating and maintaining each individual system would be made in isolation from each other. At the other end of the continuum, all the observing systems would be managed centrally, rather than at the individual program level. In this scenario, top-level managers would make decisions about operating and maintaining the organization’s portfolio of systems by considering trade-offs among all of the systems the organization manages. Between the two extremes of individual and central management, a number of other management approaches would offer different degrees of integration. For example, several observing systems within the portfolio could be grouped together and managed by a small number of organizational units or individual programs could manage their systems but also have some sort of oversight from higher levels in the organization. Another way that integration can occur is for data collected by observing systems to be integrated. For example, using a standardized data collection format and quality control protocols increases the comparability of data obtained from different observing systems. This would allow data from multiple systems to be combined more efficiently for analysis and to produce products, such as weather forecasts. Integration can also occur by combining physical components (hardware) of various observing systems, for example, by placing additional sensors on an existing platform to collect data on different environmental parameters.

NOAA recognized the need to begin taking steps toward integrating its observing systems portfolio in 2002, when the Under Secretary of Commerce for Oceans and Atmosphere initiated a review to examine NOAA’s strengths and identify opportunities for improvement.[7] Historically, most of NOAA’s observing systems were designed individually to meet specific data collection needs. For example, the Marine Optical Buoy observing system was designed to collect data on an environmental

[7] National Oceanic and Atmospheric Administration, *Program Review Report to Vice Admiral Conrad C. Lautenbacher, Jr. USN (Retired) Under Secretary of Commerce for Oceans and Atmosphere/ NOAA Administrator* (May 22, 2002).

parameter that is used by multiple satellites to validate their ocean color imagery data.[8] Most observing systems also used different data collection formats, which historically made it difficult to combine and use data from different systems. Management of NOAA's observing systems portfolio was decentralized and, according to NOAA documents, the agency considered its systems to be "stovepiped." The 2002 review generated many recommendations, one of which called for NOAA to centrally plan and integrate all observing systems. The report did not specify what central planning and integration of NOAA's observing systems portfolio would look like or how the agency would accomplish these goals. NOAA officials we spoke with described this review as the catalyst for the actions the agency has taken since 2002 to address observing systems integration issues.

NOAA Operates 41 Ocean, Coastal, and Great Lakes Observing Systems

We identified 41 ocean, coastal, and Great Lakes observing systems at NOAA. The Office of Oceanic and Atmospheric Research manages 14 of NOAA's ocean, coastal, and Great Lakes observing systems and the National Ocean Service manages 11 observing systems. Management of the remaining 16 systems is split between four other NOAA offices. Table 1 shows the number of ocean, coastal, and Great Lakes observing systems each NOAA office manages. See appendix III for an alphabetized list of the entire portfolio of NOAA's ocean, coastal, and Great Lakes observing systems we identified and appendix IV for a list and descriptions of the systems organized by the office that manages them.

[8]Ocean color is the water hue due to the presence of tiny plants containing the pigment chlorophyll, sediments, and colored dissolved organic material.

Table 1: Number of National Oceanic and Atmospheric Administration Ocean, Coastal, and Great Lakes Observing Systems by Office

Office	Number of ocean, coastal, and Great Lakes observing systems
National Environmental Satellite, Data, and Information Service	5
National Marine Fisheries Service	3
National Ocean Service	11
National Weather Service	6
Office of Oceanic and Atmospheric Research	14
Office of Marine and Aviation Operations	2[a]
Total	**41**

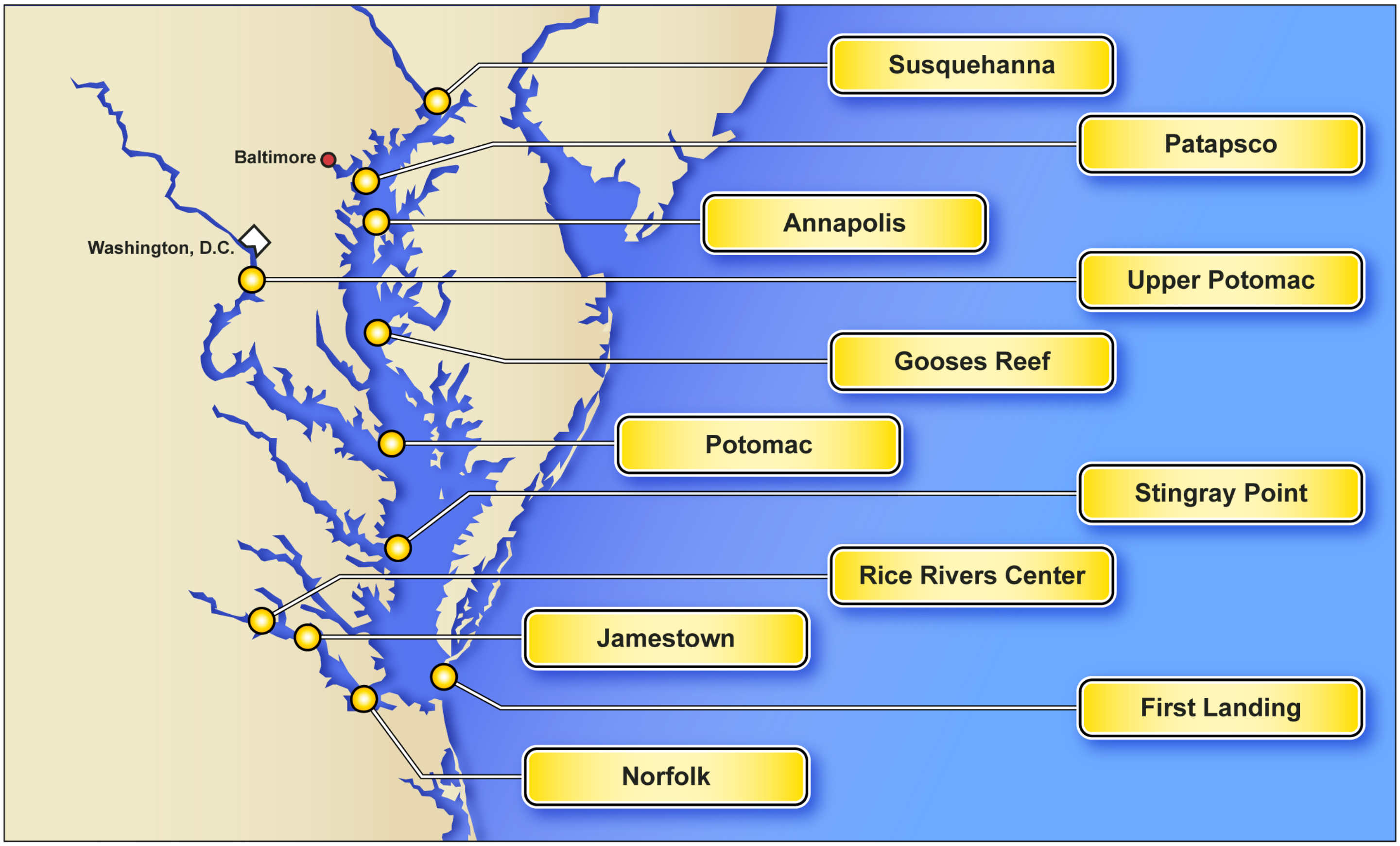
Source: GAO analysis of National Oceanic and Atmospheric Administration documentation. | GAO-15-96

[a]The Office of Marine and Aviation Operation's two observing systems—NOAA Ships and NOAA Aircraft—are fleets of 16 ships and 9 aircraft.

The majority of NOAA's ocean, coastal, and Great Lakes observing systems use one of three types of platforms—buoys, ships, or satellites—to collect data on environmental parameters.[9] Buoys are used by 18 of the agency's ocean, coastal, and Great Lakes observing systems. For example, the Chesapeake Bay Interpretive Buoy System consists of 11 buoys located in the Chesapeake Bay that collect meteorological, oceanographic, and water-quality data used to help protect and restore the area. (See fig. 1 for a map of the buoy's locations in the Chesapeake Bay.) Five of the observing systems use a combination of NOAA ships or chartered vessels to collect data. The National Marine Fisheries Service's Fish Surveys, for example, are conducted from ships and collect data on the distribution and abundance of commercially-targeted and ecologically-important fish species. Four of the observing systems use satellites as their primary platform. For example, the Jason Ocean Surface Topography Mission satellite collects data for use in ocean models to predict severe storm intensity. Other ocean and coastal observing systems also use satellites to transmit their data to land-based data centers.

[9]A platform is the physical object where an observing system's sensing element resides to collect or transmit data. While NOAA considers its fleets of ships and aircraft each to be observing systems, the individual ships and aircraft also serve as observing platforms.

Figure 1: Locations of Chesapeake Bay Interpretive Buoy System Buoys



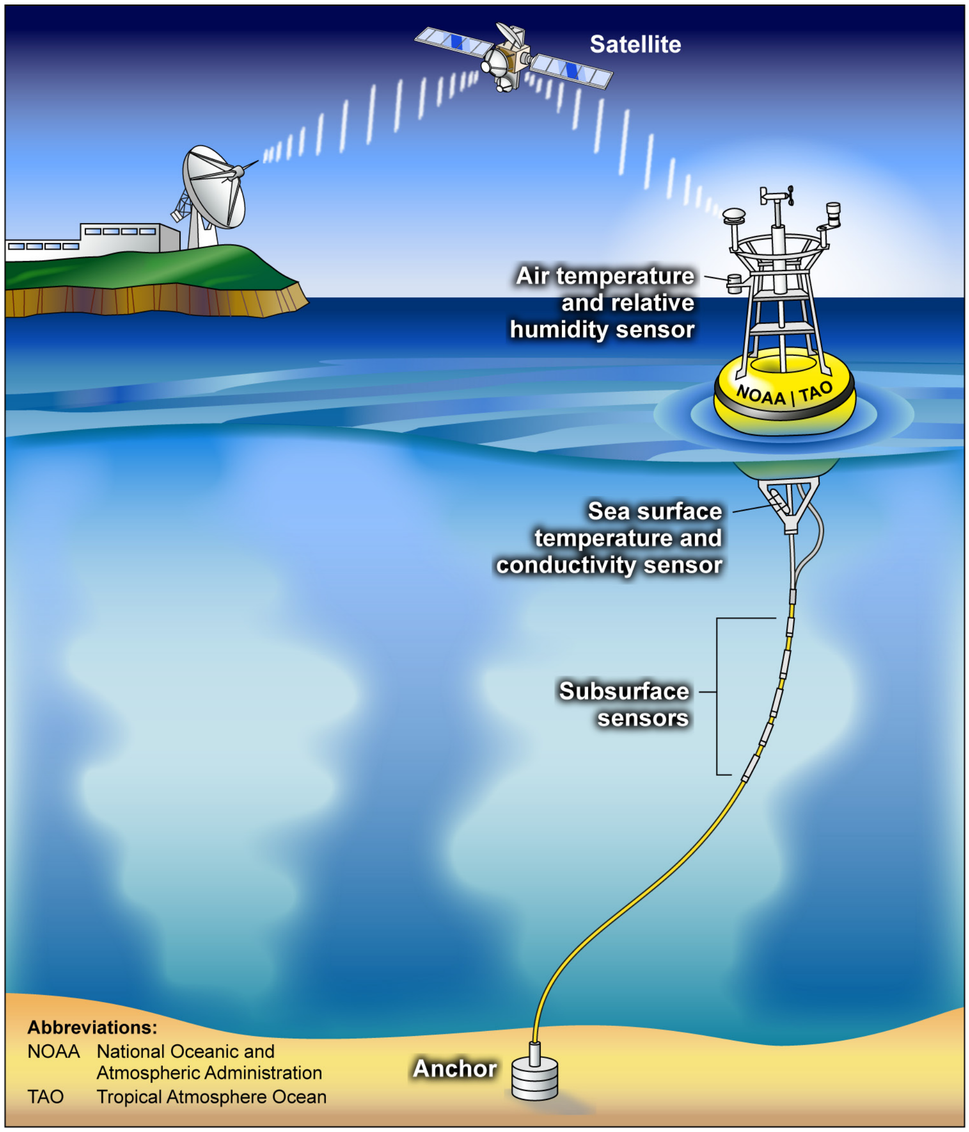
Source: National Oceanic and Atmospheric Administration documentation. | GAO-15-96

Thirty-three of the 41 ocean, coastal, and Great Lakes observing system platforms are located in situ—meaning situated where the data are measured. For these systems, that means in the water. The other systems are located remotely (either on land or in the atmosphere) and look down at the environment they are measuring. Some in situ systems are on a fixed platform, such as a moored buoy. These types of platforms are used to obtain a series of measurements over a long time at the same location. For example, the National Weather Service's Tropical Atmospheric Ocean buoy array was designed to study and predict climate variations due to the El Niño

Southern Oscillation on a year-to-year basis.[10] This moored buoy system is located in the equatorial oceans and it collects data on several environmental parameters, such as air temperature and sea surface temperature, as shown in figure 2. The data are transmitted via satellite to NOAA and are used to assist in monitoring, predicting, and understanding El Niño and La Niña events.

[10]The El Niño Southern Oscillation is a naturally occurring phenomenon that involves fluctuating ocean temperatures in the equatorial Pacific Ocean. The pattern generally fluctuates between two states: warmer than normal temperatures in the central and eastern equatorial Pacific (El Niño) and cooler than normal temperatures in the central and eastern equatorial Pacific (La Niña).

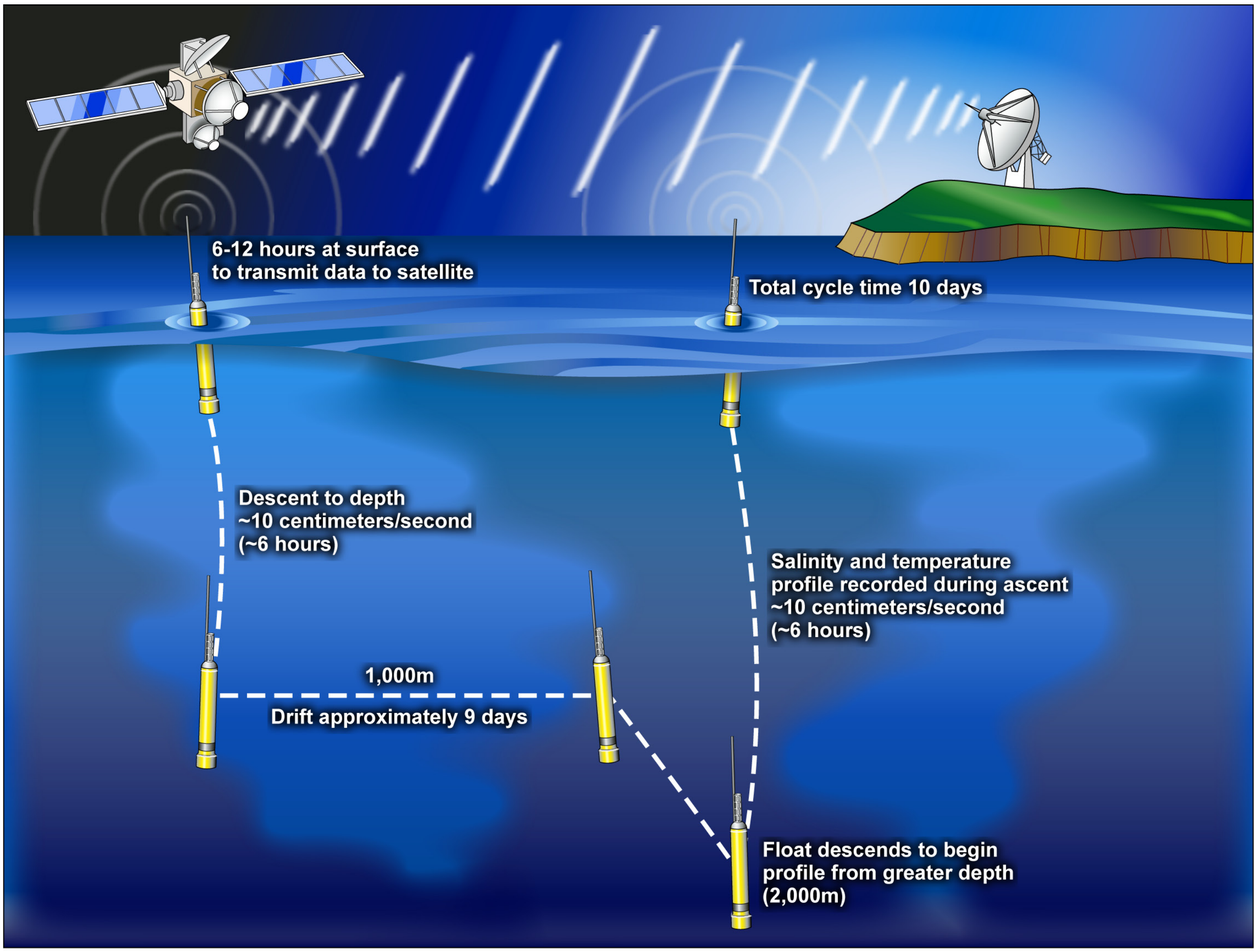
Figure 2: Configuration of a Tropical Atmospheric Ocean Buoy



Sources: GAO and NOAA's National Data Buoy Center. | GAO-15-96

In contrast, other in situ systems use mobile platforms that measure how environmental parameters vary spatially, temporally, and geographically. For example, the Global Ocean Observing System Argo Profiling Floats use a free-drifting buoy system to collect data on the heat content and salinity of the upper ocean over a predetermined depth (up to 2,000 meters) and cycle time (10 days) as shown in figure 3. Data collected by an Argo float is available within hours of collection, which allows for continuous monitoring of the state of the ocean and provides data for other scientific uses, such as weather forecasting and climate modeling, according to a NOAA official.

Figure 3: Data Collection Process for the Global Ocean Observing System Argo Profiling Floats



Source: National Oceanic and Atmospheric Administration documentation. | GAO-15-96

The agency's ocean, coastal, and Great Lakes observing systems gather a broad range of data that NOAA uses to create a variety of products. In some cases, NOAA prepares products directly from data from an individual observing system and, in other cases, the agency prepares products by combining and analyzing data from a number of observing systems. Some of NOAA's products include the following:

- **Forecasts and warnings.** NOAA provides weather, water, and climate forecasts and warnings for the nation, its territories, adjacent waters, and ocean areas that are used by the private and public sectors. The forecasts and warnings are derived from weather prediction models that use the data collected by the ocean, coastal, and Great Lakes observing systems. For example, the Coastal Weather Buoys observing system measures barometric pressure, wind direction, and air and sea temperature, and these data are used in weather prediction models to create forecasts. In addition, data from aircraft and satellites that observe ocean environmental parameters are used to develop severe storm and flash flood warnings.
- **Scientific research.** Data collected by the agency's ocean, coastal, and Great Lakes observing systems are used to support NOAA's research projects and activities.[11] For example, the Ecosystems and Fisheries-Oceanography Coordinated Investigations observing system was established in 1984 and collects data on ecosystem changes in the Gulf of Alaska, Bering Sea, and Arctic Ocean. Scientists use the data to determine how biological and physical environmental trends, such as the loss of sea ice in the Bering Sea, are affecting Alaska's marine ecosystems. In addition, the observing systems that comprise the Global Ocean Observing Systems collect long-term measurements of environmental parameters such as sea surface temperature and ocean current speed that can be used to help assess climate change.[12]
- **Navigation tools.** Navigation tools are some of NOAA's most important products, according to NOAA documents, because they help ensure the safe navigation of ports and harbors. Data collected by some of NOAA's ocean, coastal, and Great Lakes observing systems are used to generate nautical charts. For example, the National Ocean-Shoreline observing system surveys the nation's shorelines, and the Hydrographic Surveying observing system measures, among other things, the depth between the sea's surface and the sea floor and the locations of

[11]NOAA's data are also used by external organizations, such as federal, state, local, and tribal entities, according to NOAA officials.

[12]The Global Ocean Observing System is made up of several observing systems including Argo Profiling Floats, Ocean Carbon Networks, Ocean Reference Stations, Global Drifter Program, and the Global Tropical Moored Buoys.

potentially hazardous obstructions. Data from both of these systems are used to create nautical charts of coastlines and ports that are used by ships engaged in maritime commerce. These charts are also used for other activities, such as port and harbor maintenance.

- **Emergency management and response**. NOAA uses its ocean, coastal, and Great Lakes observing systems to provide data and information that the agency uses in its emergency response and management efforts. For example, the National Ocean Service's National Water Level Observation Network observing system collects data on water levels and currents that are used to develop plans to contain oil spills. In addition, the Office of Marine and Aviation Operations uses its ships and aircraft to collect data on severe weather events, such as hurricanes, and in federal disaster response efforts.

NOAA Spent about $430 Million Annually from Fiscal Year 2012 through 2014 on the Operations and Maintenance of Its Ocean, Coastal, and Great Lakes Observing Systems

NOAA estimates it spent approximately $430 million annually on average to operate and maintain its ocean, coastal, and Great Lakes observing systems in fiscal years 2012 through 2014.[13] That amount is about 9 percent of NOAA's total annual appropriations for these years.[14] NOAA provided us with estimated cost information because its budget structure and accounting system are not designed to capture costs at the observing system level.[15] Of the 41 ocean, coastal, and Great Lakes observing systems, 4 have line items in NOAA's budget that identify the amount of money dedicated to operating and maintaining those systems.[16] Funding for the other observing systems comes from the budgets of various NOAA programs that cover multiple program activities, including the observing

[13]NOAA's estimated costs for fiscal years 2012 and 2013 were based on final appropriations for those years. The estimates for fiscal year 2014 were based on the fiscal year 2014 President's budget request.

[14]NOAA's discretionary appropriation was $4.91 billion in fiscal year 2012 and $4.75 billion in fiscal year 2013, and the agency requested $5.45 billion in appropriations for fiscal year 2014.

[15]Federal cost accounting standards require agencies to accumulate and report the costs of their activities on a regular basis for management information purposes. These standards establish objectives for agency cost accounting systems, but the standards do not impose a specific methodology on federal agencies to meet the objectives. Federal agencies have the flexibility to design cost accounting systems that best meet their needs. See Federal Accounting Standards Advisory Board: *The Statement of Federal Financial Accounting Standards No. 4: Managerial Cost Accounting Standards and Concepts* (Washington, D.C.: July 1995).

[16]The four observing systems are Hydrographic Surveying, Regional Ocean Observing System, NOAA Ships, and NOAA Aircraft.

systems. For example, the Sustained Ocean Observations and Monitoring program[17] in the Office of Oceanic and Atmospheric Research provides funding for a variety of activities, including operating several observing systems, such as the Global Ocean Observing System Argo Profiling Floats, Ocean Reference Stations, and Ocean Carbon Networks, that are key components of the Global Ocean Observing System.[18] All of the activities and observing systems within the Sustained Ocean Observations and Monitoring program are funded through a single line item in the NOAA budget, which does not identify specific amounts for each of the observing systems.

According to NOAA's estimated cost information, the agency's annual operations and maintenance costs ranged from about $22 million at the National Marine Fisheries Service to $198 million at the Office of Marine and Aviation Operations in fiscal year 2014 (see table 2).

Table 2: National Oceanic and Atmospheric Administration's Estimated Annual Operations and Maintenance Costs for Its Ocean, Coastal, and Great Lakes Observing Systems by Office, Fiscal Years 2012 to 2014

Dollars in millions			
Office	**Fiscal year 2012**	**Fiscal year 2013**	**Fiscal year 2014**
Office of Marine and Aviation Operations	$175	$181	$198
National Ocean Service	72	73	76
National Environmental Satellite, Data, and Information Service	72	66	69
Office of Oceanic and Atmospheric Research	54	40	41
National Weather Service	34	33	37
National Marine Fisheries Service	25	24	22
Total	**$432**	**$417**	**$443**

Source: National Oceanic and Atmospheric Administration. | GAO-15-96

Note: Amounts rounded to nearest million.

[17]The program's objectives include improving the understanding of the physics, chemistry, and ecology of oceanic, coastal, and Great Lakes systems, and changes in these environments and the impacts of stressors such as pollution and invasive species.

[18]The Global Ocean Observing System provides data for climate research and prediction, weather and ecosystems research, weather and ocean predictions, and validation for NOAA satellite products.

The two line offices with the highest reported annual costs for their observing systems for fiscal years 2012 through 2014 were the Office of Marine and Aviation Operations and the National Ocean Service. For the Office of Marine and Aviation Operations, these costs include operation and maintenance of NOAA's fleet of specialized ships and aircraft, including the scientific and technical equipment they carry to collect data, according to NOAA documentation. For example, in fiscal year 2013, NOAA's fleet included 16 active ships that provided 1,702 days at sea and 9 aircraft that provided 2,503 flight hours to programs in each of NOAA's line offices to support observational activities needed to achieve their environmental and scientific missions.[19] The National Ocean Service's costs include operating 11 ocean, coastal, and Great Lakes observing systems that collect data NOAA describes as being essential to safe, efficient, and sustainable uses of busy coastal areas and waterways. For example, some of these costs were for the Hydrographic Surveying observing system that provides data that are used primarily to develop nautical charts. The costs also included operating and maintaining the National Water Level Observation Network and the National Current Observation Program observing systems that monitor tides, currents, water levels, and other environmental parameters. The data from these systems are used to create navigational products and provide other services.

NOAA's estimated annual costs vary widely across the different observing systems. In fiscal year 2014, NOAA's costs ranged from nearly $170 million to operate the NOAA-owned ships that collect ocean and fisheries-related data, to $80,000 for the Ocean Acoustic Monitoring System. That system consists of mobile underwater hydrophones in the Pacific Ocean that are primarily used to listen for earthquakes, but they can also be used for observing some endangered marine species. The 10 systems with the highest estimated annual costs, as shown in table 3, together accounted for approximately 79 percent of NOAA's annual costs to operate and maintain its ocean, coastal, and Great Lakes observing systems in fiscal year 2014. The largest item in the annual operations and maintenance costs for the 10 systems varies depending on the type of observing system. For example, most of the costs for the Global Ocean Observing System Argo Profiling Float system are for the acquisition of new floats since deployed floats are not retrieved for maintenance. But, for the Coastal Weather Buoys, the

[19]These totals include ship days and flight hours provided using the Office of Marine and Aviation funding. They do not include additional ship days and flight hours that programs can obtain on NOAA's ships and aircraft using their own funding.

major cost is labor to maintain the systems' stations, sensors, and instruments. For other systems, such as Fish Surveys, ship time accounts for a majority of the annual operations costs. See appendix V for the annual costs for each of NOAA's 41 ocean, coastal, and Great Lakes observing systems for fiscal years 2012 to 2014.

Table 3: Ten National Oceanic and Atmospheric Administration Ocean, Coastal, and Great Lakes Observing Systems with the Highest Estimated Annual Operations and Maintenance Costs, Fiscal Years 2012 to 2014

Dollars in millions

Observing system	Office	Fiscal year 2012	Fiscal year 2013	Fiscal year 2014
NOAA Ships	Office of Marine and Aviation Operations	$147	$153	$170
Polar-Orbiting Operational Environmental Satellite	National Environmental Satellite, Data, and Information Service	32	29	29
NOAA Aircraft	Office of Marine and Aviation Operations	28	28	28
Geostationary Operational Environmental Satellite N/O/P	National Environmental Satellite, Data, and Information Service	33	26	26
Hydrographic Surveying	National Ocean Service	27	25	25
Regional Ocean Observing System	National Ocean Service	16	18	19
Coastal Weather Buoys	National Weather Service	20	18	18
Fish Surveys	National Marine Fisheries Service	17	16	14
Deep-Ocean Assessment and Reporting of Tsunamis	National Weather Service	7	9	12
Global Ocean Observing System Argo Profiling Floats	Office of Oceanic and Atmospheric Research	10	10	10
Total		**$337**	**$332**	**$351**

Source: National Oceanic and Atmospheric Administration. | GAO-15-96

Note: Amounts rounded to the nearest million.

NOAA Has Not Taken All of the Steps It and Others Have Identified to Integrate and Improve the Cost-Effectiveness of Its Observing Systems Portfolio

NOAA has not developed a plan for achieving an integrated observing system nor has it assessed whether there is unnecessary duplication in its observing systems. NOAA has created an observing systems council to provide a more centralized perspective on observing systems management and is working to obtain the capability to conduct analyses to help understand how to make its portfolio more cost-effective. However, NOAA has not developed a methodology to consistently capture accurate observing systems cost information for use in these analyses.

NOAA Has Not Developed a Plan for Achieving an Integrated Observing Systems Portfolio

In a variety of plans and reports NOAA has identified the need to move toward an integrated observing systems portfolio. For example:

- **Strategic Plan for Systems Integration.** This 2004 plan states that NOAA "will manage our processes on a corporate-wide basis to include standardizing processes and practices at the enterprise level, moving away from the current practice of managing at the system level. We will design and plan, engineer and develop, and control and manage at the enterprise level as we move away from stovepipe systems and programs."[20]
- **Buoy Recapitalization Strategic Plan.** This 2009 plan, which focused on 19 of NOAA's in situ buoy ocean observing systems, found that allowing individual programs within NOAA's line offices to make portfolio management and funding decisions has created "an ever-increasing burden on NOAA to sustain a growing number of established systems, while continuing to develop new and innovative ones. In addition, the systems in the pipeline may not be the ones that NOAA deems most critical to the achievement of its future strategy."[21]

[20]National Oceanic and Atmospheric Administration, *Strategic Direction for NOAA's Integrated Global Environmental Observation and Data Management System* (July 2004). Management at the "corporate-wide" and "enterprise level" in this context refers to centralized management across all of NOAA as opposed to management by individual programs or line offices.

[21]National Oceanic and Atmospheric Administration, *Buoy Recapitalization Strategic Plan: Review of Current Processes* (August 2009).

- **2012 Implementation Plan.** NOAA's 2012 implementation plan for its objective to produce accurate observation data identifies the need for NOAA to integrate the planning, operation, and data management of its observing systems.[22]
- **NOAA Science Advisory Board Report.** An April 2013 report from NOAA's Science Advisory Board found that there was room for improvement—both in effectiveness and cost-efficiency—for NOAA observing systems.[23] The report said that "given the need to protect and sustain resilient coastal communities, the absence of an integrated coastal observation system is a matter of particular concern." [24]

Our previous work has found that, in developing new initiatives, federal agencies can benefit from following leading practices for strategic planning.[25] Taking steps toward managing NOAA's observing systems as an integrated portfolio is a significant initiative for NOAA. The Government Performance and Results Act of 1993 (GPRA), as amended by the GPRA Modernization Act of 2010, was enacted to improve the efficiency and accountability of federal programs, among other purposes.[26] The act, as amended, requires, among other things, that federal agencies develop long-term strategic plans that include agency-wide goals and strategies for achieving those goals. We have reported that these requirements also can serve as leading practices at lower levels within federal agencies, such as at NOAA, to assist with

[22]National Oceanic and Atmospheric Administration, *NGSP Implementation Plan: Enterprise Objective: Accurate and Reliable Data from Sustained and Integrated Earth Observing Systems FY 2013-2019* (Nov. 26, 2012). NOAA prepares implementation plans for each of the goals and objectives in its strategic plan. The plans describe specific program activities and identify their budget requirements, assess risks of not funding these requirements, and present options for addressing these risks.

[23]The NOAA Science Advisory Board was established in 1997 and assists NOAA in maintaining a complete and accurate understanding of scientific issues critical to the agency's missions. It has responsibility for advising the Under Secretary of Commerce for Oceans and Atmosphere on long- and short-range strategies for research, education, and the application of science to resource management and environmental assessment and prediction.

[24]National Oceanic and Atmospheric Administration's Scientific Advisory Board, *A Report from the NOAA Science Advisory Board: In the Nation's Best Interest: Making the Most of NOAA's Science Enterprise* (Apr. 12, 2013).

[25]For example, see GAO*, Environmental Justice: EPA Needs to Take Additional Actions to Help Ensure Effective Implementation*, GAO-12-77 (Washington, D.C.: Oct. 6, 2011) and GAO, *Environmental Protection: EPA Should Develop a Strategic Plan for Its New Compliance Initiative*, GAO-13-115 (Washington, D.C.: Dec. 120, 2012).

[26]Pub. L. No. 103-62, 107 Stat. 285 (1993), *amended by* Pub. L. No. 111-352, 124 Stat. 3866 (2011).

planning for individual programs or initiatives.[27] Taken together, the strategic planning elements established under the act and associated Office of Management and Budget guidance and practices we have identified provide a framework of leading practices in federal strategic planning.[28] These practices include defining a program's or initiative's goals, defining strategies and identifying the resources needed to achieve the goals, and developing and using performance measures to track progress in achieving them.

NOAA has not, however, developed a plan that sets forth a clear vision of (1) what it wants its integrated portfolio of observing systems to look like and how it will be managed, (2) its strategy for taking the steps necessary to move toward this target systems architecture and management approach, or (3) how to measure progress toward the goal of an integrated observing systems portfolio. A NOAA official told us that the 2004 strategic plan for systems integration is not being used to guide its current systems integration efforts, and no other integration plan exists. One of the actions identified in the 2004 strategic plan was the development of a NOAA observing systems architecture master plan. This plan would "allow NOAA leaders to determine which future observing and data management systems NOAA needs to meet our users' current and evolving environmental information requirements."[29] According to a NOAA official, this plan was never developed. One of the long-term outcomes identified by the 2012 implementation plan, to be accomplished between fiscal years 2014 and 2018, is the development of a plan for an integrated observing system portfolio that meets the full range of needs of NOAA's strategic objectives. A NOAA official also told us that they are not working on developing this observing systems integration plan. Instead, the NOAA official said the

[27]For example, see GAO, *Foreign Aid Reform: Comprehensive Strategy, Interagency Coordination, and Operational Improvements Would Bolster Current Efforts*, GAO-09-192 (Washington, D.C.: Apr. 17, 2009) and GAO, *Pipeline Safety: Management of the Office of Pipeline Safety's Enforcement Program Needs Further Strengthening*, GAO-04-801 (Washington, D.C.: July 23, 2004).

[28]For example, see GAO, *Executive Guide: Effectively Implementing the Government Performance and Results Act,* GAO/GGD-96-118 (Washington, D.C.: June 1, 1996); GAO, *Tax Administration: IRS Needs to Further Refine Its Tax Filing Season Performance Measures,* GAO-03-143 (Washington, D.C.: Nov. 22, 2002); GAO, *Managing for Results: Strengthening Regulatory Agencies' Performance Management Practices*, GAO/GGD-00-10 (Washington, D.C.: Oct. 28, 1999); and Office of Management and Budget, Circular No. A-11, *Preparation, Submission, and Execution of the Budget (*2014).

[29]National Oceanic and Atmospheric Administration, *Strategic Direction for NOAA's Integrated Global Environmental Observation and Data Management System.*

agency has focused on taking tangible actions. For example, the agency established an observing systems council to provide a more centralized perspective on observing systems management. However, without a plan describing what NOAA's integrated observing systems portfolio should look like and how it will be managed, a strategy for moving toward this target architecture and management approach, and performance measures related to systems integration, NOAA cannot be assured that it has established a framework to effectively guide and assess the success of its observing systems integration efforts and for its stakeholders to track the agency's efforts and hold it accountable. In addition, without a detailed plan and performance measures, NOAA could waste resources, time, and effort in a constrained budget environment, pursuing activities that may not prove effective in creating an integrated observing systems portfolio.

NOAA Has Not Assessed Whether There Is Unnecessary Duplication in Its Observing Systems Portfolio

Since 2010, some NOAA planning documents have identified the need to reduce systems costs by eliminating unnecessary duplication.[30] For example, one of the agency-wide objectives in NOAA's 2010 strategic plan was to collect accurate and reliable data through a sustained and integrated observing system. The plan said that pursuing this objective would include reducing the costs of observations through, among other things, "reducing unnecessarily duplicative capabilities."[31] Similarly, NOAA's 2012 implementation plan for its objective to produce accurate observation data included as a short-term outcome "[r]educed, consolidated, and/or closed observing sites and sensors based on quality and utility of observations supporting all NOAA needs."[32] NOAA officials did not, however, provide documentation of any observing sites that have been reduced, consolidated, or closed since the agency developed the 2012 implementation plan even though these outcomes were to be accomplished in fiscal years 2012 or 2013.

[30]According to NOAA officials, duplication in data collection can sometimes be necessary if the data are needed to meet a critical mission need. The duplicative data would serve as a backup to the primary data source if it failed.

[31]National Oceanic and Atmospheric Administration, *NOAA's Next-Generation Strategic Plan* (Silver Spring, MD.: December 2010).

[32]National Oceanic and Atmospheric Administration, *NGSP Implementation Plan: Enterprise Objective: Accurate and Reliable Data from Sustained and Integrated Earth Observing Systems FY 2013-2019*.

Although NOAA documents have indicated a need for the agency to reduce unnecessary duplication in observing systems capabilities, NOAA officials we spoke with said they were not aware of any duplication in the geographic distribution of NOAA's ocean, coastal, and Great Lakes observing systems or of unnecessarily duplicative data being collected. One official said that given the vastness of the ocean environment, NOAA's observing systems were more likely under-sampling than over-sampling. In addition, officials we spoke with said the agency had not identified any unnecessary duplication in the data collected by its observing systems portfolio. NOAA officials could not, however, provide documentation of any analyses that NOAA has conducted to support its conclusion that unnecessary duplication does not exist in the data collected by its ocean, coastal, and Great Lakes observing systems. NOAA officials said the agency's existing analytical tools have limited ability to determine whether there is duplication in the data collected by its observing systems.

In our analysis of the 75 environmental parameters measured by NOAA's ocean, coastal, and Great Lakes observing systems, we identified several parameters that are measured by multiple observing systems, suggesting the potential for unnecessary duplication in the data being collected. For example, as shown in table 4, 21 observing systems, including at least 1 system operated by each of NOAA's line offices, currently collect data on sea surface temperature. Not all of these systems may need to collect sea surface temperature data to meet the needs of NOAA's programs. However, according to NOAA officials, there are a variety of reasons why multiple observing systems might measure the same parameters. First, the systems may all be collecting data, such as sea surface temperature, in different locations. Second, in some situations, collecting data on the same environmental parameter is done purposefully to maintain continuity of data collection in the event that one system failed. Third, different observing systems may collect data on the same environmental parameter but at different times or with different degrees of accuracy. While one or more of these reasons, or some other reasons, may be why 21 observing systems collect data on sea surface temperature, NOAA officials could not provide analysis or documentation to show that unnecessary duplication does not exist. NOAA officials told us they do not believe unnecessary duplication in data collection in the agency's observing systems portfolio is a significant problem requiring further analysis. However, without analyzing whether there is unnecessary duplication or opportunities to reduce or consolidate observations, NOAA would not know if there were opportunities to achieve cost savings.

Table 4: Environmental Parameters Measured Most Often by National Oceanic and Atmospheric Administration's Ocean, Coastal, and Great Lakes Observing Systems

		Number of observing systems by line office					
Environmental parameter	Number of observing systems collecting data for this parameter	National Environmental Satellite, Data, and Information Service	National Ocean Service	National Marine Fisheries Service	National Weather Service	Office of Oceanic and Atmospheric Research	Total number of offices
Sea surface temperature	21	3	5	1	3	9	5
Ocean surface winds: speed	14	1	4	1	3	5	5
Ocean temperature: profiles[a]	12	0	0	0	1	11	2
Ocean surface winds: direction	11	0	3	0	3	5	3
Salinity: surface	11	0	4	1	1	5	4
Ocean currents: speed, surface	10	0	4	1	1	4	4
Ocean currents: speed, profiles	9	0	1	0	1	7	3
Atmospheric pressure: sea level	8	0	1	0	3	4	3
Ocean currents: direction, surface	8	0	3	1	1	3	4
Ocean currents: direction, profiles	7	0	1	0	1	5	3

Source: GAO analysis of National Oceanic and Atmospheric Administration documentation. | GAO-15-96

[a]A "profile" is a type of measurement collected at different depths or heights depending on the variable being measured.

NOAA Has Created a Council to Help Integrate the Management of Its Observing Systems Portfolio

NOAA's 2002 agency-wide review recommended the development of a "cross-cut team" to centrally plan and integrate the management of its observing system portfolio.[33] In response to the recommendation, the agency created the NOAA Observing System Council (NOSC), which held its first meeting in July 2003. The NOSC consists of representatives from each of the six line offices, the Office of Marine and Aviation Operations, the Chief Financial Officer, and the Chief Information Officer. The

[33]NOAA, *Program Review Report to Vice Admiral Conrad C. Lautenbacher, Jr. USN (Retired) Under Secretary of Commerce for Oceans and Atmosphere/ NOAA Administrator*.

Assistant Secretary of Commerce for Environmental Observation and Prediction chairs the NOSC, with support provided by three vice chairs.[34] The purpose of the NOSC is to provide a more centralized, agency-wide perspective on the management of NOAA's observing systems. However, according to NOAA officials, individual programs within NOAA's line offices are still responsible for operating and managing their observing systems.

According to NOAA officials and documents, the NOSC coordinates all of the agency's observing systems portfolio and data management activities and provides recommendations to the NOAA Executive Council on observing system investments. For example, in 2009, the NOSC appointed a team, with representation from each line and one staff office, to review analyses of 25 alternatives related to NOAA's observing system portfolio. The team recommended whether the various options should or should not be funded. For example, the team recommended funding to expand annual fish surveys that provide data for fish stock assessments conducted by the National Marine Fisheries Service, in part, because the assessments were both a line office and agency priority. According to NOAA documentation, NOAA's Program Analysis and Evaluation Office planned to use the team's recommendations as part of the agency's planning and budgeting process for fiscal years 2013 through 2017.[35]

The NOSC, in 2004, established the Technology, Planning and Integration for Observation (TPIO) program office to assist in conducting technical analyses to support the NOSC's recommendations to NOAA leadership on integrating and improving the cost-effectiveness of the agency's observing system portfolio. According to NOAA documentation, TPIO identifies: (1) NOAA's observation requirements, (2) NOAA's observing system and data management capabilities, (3) gaps between observation requirements and capabilities, and (4) observing system and data management solutions to fulfill NOAA's observational requirements. For example, in 2011, TPIO conducted an analysis of observational needs for six of NOAA's high priority

[34]The vice chair positions on the NOAA Observing System Council are held by the Assistant Administrator for Satellite and Information Services (National Environmental Satellite, Data, and Information Service), the Assistant Administrator for Weather Services (National Weather Service), and the Director of the Office of Marine and Aviation Operations.

[35]NOAA's Program Analysis and Evaluation office oversaw the agency' planning and budgeting process until a new process—called strategy, execution, and evaluation—was implemented in 2011. The Office of Program Planning and Integration is responsible for the current process.

program areas, including fisheries management and tide and current data. Specifically, the analysis examined the effect to the programs if NOAA no longer collected data on key observational requirements.[36] For example, TPIO's analysis found that four observing systems collect data on key requirements related to tides and currents and, if these systems were no longer funded, key data on these requirements would no longer be available. The purpose of the analysis was to provide an agency-wide perspective to NOAA leadership on which high-priority programs were critical to fund in an increasingly constrained fiscal environment. NOAA officials told us this particular analysis was only conducted once as the agency decided to invest in other analytical tools to assist with its decision making.

In 2009, the NOSC formed a subcommittee—the Observing Systems Committee—consisting of representatives from NOAA's line and staff offices. According to NOAA documentation, the Observing Systems Committee's purpose is to conduct analyses of the current observing systems portfolio and provide recommendations to the NOSC for changes in the configuration of the portfolio to maximize its benefits. For example, according to NOAA officials, one of the Observing Systems Committee's first activities was to develop the criteria to identify NOAA's "observing systems-of-record." Observing systems-of-record are those systems that the agency deems necessary to meet its mission and receive sustained funding. As of 2014, the Observing Systems Committee has identified 108 observing systems of record, which includes nearly all of the 41 ocean, coastal, and Great Lakes systems we identified.[37]

The NOSC also established a second subcommittee in 2009—the Environmental Data Management Committee—which includes members from each line office and the Office of Marine and Aviation Operations. This subcommittee (1) coordinates the development of NOAA's data management strategy related to its observing systems, (2) provides guidance to promote consistent implementation across NOAA, and (3)

[36]An observation requirement is an environmental parameter that a line office needs to measure to be able to help achieve its mission.

[37]Thirty-nine of the 41 ocean, coastal, and Great Lakes observing systems we identified are NOAA systems of record. The other two observing systems—Airborne Oceanographic Product and the Ocean Acoustic Monitoring System—NOAA categorizes as "innovative technologies" rather than observing systems of record. According to NOAA documentation, innovative technologies are promising new concepts or technologies that NOAA funds but has not yet transitioned to sustained operations.

identifies opportunities to improve the usability of its data. For example, in response to a recommendation from NOAA's Science Advisory Board, in 2013 the committee developed an agency-wide environmental data management framework that defines the policies, requirements, activities, and technical considerations relevant to the management of NOAA's observational data and products.[38]

NOAA Is Working to Develop Analytical Capabilities to Improve the Cost-Effectiveness of Its Observing Systems but Has Not Developed a Methodology to Consistently Capture Cost Information

To enhance NOAA's ability to understand and make cost-effective management decisions for its entire observing system portfolio, of which the ocean, coastal, and Great Lakes observing systems are a part, the agency has developed some analytical tools:

- **NOAA Observing System Architecture database.** The database, initially created in 2003, provides a comprehensive list of NOAA's observing systems and their capabilities. Currently, the NOAA Observing System Architecture database includes documentation on more than 200 observing systems that are operational, planned, in development, used for research purposes, retired, or canceled. About half of the systems are associated with other federal agencies, states and localities, the commercial sector, or foreign countries. NOAA includes these systems in the database because they are deemed important to the agency's mission, according to NOAA officials. TPIO is responsible for updating and managing the database and uses it to analyze NOAA's observing system capabilities. In 2008 and 2009, TPIO used the database to help prepare analyses to support observing system investment decisions. For example, TPIO examined whether to fund additional aerial data collection for shoreline and coastal areas for use in nautical maps.
- **Consolidated Observation Requirements List.** The NOSC developed this database in 2003 to create a more formalized process for NOAA to identify, collect, document, and update its observational needs and requirements. After a line office has identified the environmental parameters that it believes need to be measured, it assigns each one a priority level.[39] TPIO and the line office then initiate a validation process

[38]National Oceanic and Atmospheric Administration, *NOAA Environmental Data Management Framework, Version 1.0* (Mar. 14, 2013).

[39]NOAA's three priority levels are: 1 (mission critical), 2 (mission optimal), and 3 (mission enhancing).

for those observing requirements identified as priority-1.[40] According to NOAA documentation, the purpose of the validation process is to confirm that a program needs to observe a specific environmental parameter. After the NOSC reviews and concurs with the validated observation requirement, it is added to the database.[41] NOAA officials told us the database now contains information on more than 1,000 validated observation requirements. NOAA officials said the agency still needs to document the observing requirements for about 15 percent of the agency's ocean and coastal programs. According to NOAA officials, they use the Consolidated Observation Requirements List and the NOAA Observing System Architecture databases as analytical tools to help focus their investment decisions on high-priority observation requirements. For example, TPIO can compare observational capabilities listed in the system architecture database with observational requirements listed in the requirements list database to identify gaps between capabilities and requirements.

- **NOAA Observing Systems Integrated Analysis.** The NOAA Observing Systems Integrated Analysis model is a tool intended to help compare the cost-effectiveness of the agency's observing systems in obtaining mission-critical data and to inform investment decisions. Two external reviews conducted in 2010 at the request of NOAA found that the agency had developed tools such as the NOAA Observing Systems Architecture and Consolidated Observation Requirements List databases, but there was no mechanism to evaluate the observing systems portfolio agency-wide.[42] As a result, NOAA developed a pilot integrated analysis model, known as NOSIA-I, which was completed in December 2011. The NOSC, in March 2012, decided to expand the pilot model so it could analyze the agency's entire observing systems portfolio including operational observing systems and satellites under

[40]The NOSC only reviews and concurs with priority-1 observation requirements; however, the Consolidated Observation Requirements List database includes all the observation requirements regardless of their priority status.

[41]An example of a validated observing requirement is "benthic habitat mapping and characterization." A program office within the National Ocean Service needs to map and gather data to characterize the benthic habitat—the ecological region at the lowest level of the ocean—at 200 sites in the coastal United States to meet its objective of better understanding, protecting, and restoring the health and resilience of coastal ecosystems.

[42]MITRE, *Process Improvement Assessment of NOAA TPIO's Investment Analysis Approach: Final Report*, (Aug. 27, 2010) and The Pleiades Institute, *Process Improvement Assessment of NOAA Technology, Planning and Integration Office Investment Analysis Methodology: Final Report* (July 29, 2010).

development. As of September 2014, the expanded model (NOSIA-II) is still in development but, according to NOAA officials, it is expected to be fully operational by August 2015. The expanded model includes information on NOAA's strategic goals and objectives, key products, qualitative performance ratings of the observing systems, and their costs. According to NOAA officials, the cost information is important because it will be used in analyses to help inform management decisions on observing system investments. For example, NOAA could use it to show different ways that the agency could absorb a 5 percent budget cut for its observing systems and how best to allocate those cuts to still allow the agency to meet its mission.

However, the two external reviews conducted in 2010 identified concerns with the quality of the cost information NOAA collected on its observing systems. Specifically:

- One review found that NOAA does not have guidance on how to capture costs associated with its observing systems and has limited documentation to support its reported observing systems costs. It also found a major weakness in the apparent lack of any formal, documented process for preparing and reporting observing system costs. Based on their assessment, the reviewers were concerned that there was a low level of consistency in observing system cost information across line offices.[43]
- The other review similarly found (1) accurate cost data for NOAA's observing systems appeared very difficult to determine due to accounting differences and no standard process for how to record and report the data within programs and (2) a lack of consistency in what programs included in their observing system costs.[44] The review concluded that more work was needed to improve the quality and accounting of costs for NOAA's observing systems.

NOAA documents have also recognized the need for accurate cost information for its observing systems in order to assess the cost-effectiveness of its portfolio. For example, NOAA's 2012 implementation plan for its objective to collect accurate observation data states that "it is critical that NOAA have the capability to determine the optimum portfolio of

[43]MITRE, *Process Improvement Assessment of NOAA TPIO's Investment Analysis Approach: Final Report*.

[44]The Pleiades Institute, *Process Improvement Assessment of NOAA Technology, Planning and Integration Office Investment Analysis Methodology: Final Report*.

observing systems that enable it to accomplish its mission in the most cost-effective, efficient, and economic manner possible."[45] The implementation plan further stated that it is critical that NOAA's Chief Financial Officer develop a standardized methodology for obtaining accurate cost information to support investment analyses and to improve the cost-effectiveness of NOAA's observing systems portfolio. Specifically, according to NOAA documents, it is important that the NOAA Observing Systems Integrated Analysis model include accurate, consistent, and up-to-date cost information on all of NOAA's individual observing systems. Without reliable, consistent cost data, comparisons of the cost-effectiveness of various systems would not be accurate. However, in a 2013 presentation on the status of the development of the model, TPIO noted that observing system cost data needs to be improved and is likely the weakest component of the model.[46]

NOAA has taken limited steps to improve the quality of these data. Officials from the Office of the Chief Financial Officer told us they were not working on developing the methodology identified in NOAA's 2012 implementation plan. The officials told us they do not have the technical expertise and knowledge of the operational requirements of the observing systems to develop this methodology, and suggested it should be done through the NOSC. TPIO officials told us they do not have in-house expertise in this area, and that is why the implementation plan delegated this responsibility to the NOAA Chief Financial Officer. TPIO officials said that earlier this year they had informal discussions with the staff from NOAA's budget and finance offices to address the need for a standardized methodology for estimating the costs of its observing systems. According to NOAA officials, the NOAA Chief Financial Officer has since asked a committee to explore developing a better method for tracking observing system costs though no time frame for doing so has been established. Without accurate, consistent, and reliable cost information, the observing system integrated analysis model will not provide decision makers with the best information to make decisions regarding investment trade-offs and to improve the cost-effectiveness of NOAA's observing systems portfolio.

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[45]National Oceanic and Atmospheric Administration, *NGSP Implementation Plan: Enterprise Objective: Accurate and Reliable Data from Sustained and Integrated Earth Observing Systems FY 2013-2019*.

[46]National Oceanic and Atmospheric Administration, *NOAA Observing Systems Integrated Analysis (NOSIA) & National Earth Observation Assessment (EOA) PALMA Models: Technology, Planning and Integration for Observation Briefing for Dr. Uccellini* (Mar. 12, 2013).

Conclusions

NOAA has identified a need to better integrate and improve the cost-effectiveness of its portfolio of observing systems, including ocean, coastal, and Great Lakes systems. The agency has taken some positive steps toward integrating its portfolio, such as creating an observing systems council to provide a more centralized, agency-wide perspective on the management of its observing systems and developing databases that catalogue the agency's observing requirements and capabilities. The agency has not, however, developed a plan for systems integration that identifies what it wants the portfolio of observing systems to look like in the future and includes ways for NOAA to measure and track its progress toward its goals. Without such a plan, NOAA does not have a detailed, transparent framework to effectively guide and assess the success of its observing systems integration efforts, and it will be difficult for stakeholders to hold the agency accountable for meeting its integration goals. Also, because NOAA has not assessed whether there is unnecessary duplication in its observing systems portfolio, the agency may be missing opportunities to reduce duplication and achieve cost savings. Finally, NOAA does not have consistent, reliable information on the costs associated with operating and maintaining each of its observing systems. This will make it difficult for NOAA to use its observing systems integrated analysis model to produce accurate comparisons of the cost-effectiveness of its observing systems or provide decision makers with the best information for making informed investment decisions.

Recommendations for Executive Action

To help strengthen the management and cost-effectiveness of NOAA's observing systems portfolio, including ocean, coastal, and Great Lakes systems, we recommend that the Secretary of Commerce direct the NOAA Administrator to take the following three actions:

- Develop a plan for observing systems integration that includes
    - a description of what an integrated portfolio of observing systems will include and achieve and how it will be managed,
    - the steps necessary to move toward an integrated portfolio of observing systems, and
    - how to measure progress toward the goal of an integrated observing systems portfolio.
- Analyze the extent to which unnecessary duplication exists in NOAA's portfolio of observing systems.
- Develop a standardized methodology for the routine preparation and reporting of observing systems cost data.

Agency Comments and Our Evaluation

We provided a draft of this report to the Department of Commerce for comment. In its written comments, (reproduced in appendix VI), NOAA, providing comments on behalf of Commerce, generally agreed with our recommendations. In commenting on the recommendation that NOAA develop a plan for observing systems integration, NOAA's response focused on the 41 ocean, coastal, and Great Lakes observing systems identified in the report and acknowledged there is no single observing plan for these systems. NOAA listed existing observing plans for several of its ocean, coastal, and Great Lakes observing systems and said it plans to build off of these and other existing documents to explore the feasibility of enacting this recommendation. From NOAA's response, it appears the agency believes that our recommendation was directed only at its 41 ocean, coastal, and Great Lakes observing systems. This is not the case. NOAA does not manage the 41 ocean, coastal, and Great Lakes observing systems as a separate portfolio and we are not recommending that they do so. Rather, we recommended that NOAA develop a plan for integrating the agency's entire observing systems portfolio, including the ocean, coastal, and Great Lakes observing systems. In response to the recommendation that NOAA analyze the extent to which unnecessary duplication exists in NOAA's portfolio of observing systems, NOAA acknowledged a continued need to do so and said it has taken steps in this regard with the development of the NOAA Observing Systems Integrated Analysis model. In response to our recommendation that NOAA develop a standardized methodology for the routine preparation and reporting of observing systems cost data, NOAA said that it agrees with this recommendation and has already begun talks to address how its accounting system could collect and report cost data for all observing systems of record.

NOAA also provided three general comments. First, NOAA said that the title of the report should refer to NOAA's ocean, coastal, and Great Lakes observing systems, since that was the original scope of our study. While two of the report's objectives address only ocean, coastal, and Great Lakes observing systems, the third objective examines the extent to which NOAA has taken steps to integrate and improve the cost-effectiveness of its portfolio of observing systems, including ocean, coastal, and Great Lakes systems. Our recommendations address the third objective and consequently we believe the report title is both accurate and appropriate. Second, NOAA said that it has long seen the need for an integrated and cost-effective observing systems portfolio, which is vital to maximizing the benefits of ocean, coastal, and Great Lakes information for the nation. NOAA said it has dedicated a large effort over the past decade to systematically develop management structures as well as tools to address these issues. We agree that NOAA has developed management structures and tools and the report includes examples of both. Third, NOAA said that the fact that key parameters, such as temperature, are measured by multiple observing systems is not in itself an indicator of potential duplication. We agree. However, our report noted that multiple systems measuring the same parameter suggested the potential for unnecessary duplication and we recommended that NOAA analyze the extent to which unnecessary duplication exists in its portfolio of observing systems. NOAA also provided technical comments that we incorporated into the report as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Commerce, the NOAA Administrator, and other interested parties. In addition, the report is available at no charge on the GAO website at http://www.gao.gov.

If you or your staff members have any questions about this report, please contact me at (202) 512-3841 or fennella@gao.gov. Contact points for our Office of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix VII.

Anne-Marie Fennell
Director, Natural Resources and Environment

Appendix I: Objectives, Scope, and Methodology

This report (1) identifies and describes the ocean, coastal, and Great Lakes observing systems the National Oceanic and Atmospheric Administration's (NOAA) operates, (2) identifies the annual operations and maintenance costs of these systems for fiscal years 2012 through 2014, and (3) examines the extent to which NOAA has taken steps to integrate and improve the cost-effectiveness of its portfolio of observing systems, including ocean, coastal, and Great Lakes systems.

To identify which of NOAA's observing systems collect data on oceans, coasts, and the Great Lakes, we first identified a list of environmental variables, known as "parameters" related to the ocean, coast, and Great Lakes. After consulting with NOAA officials, we determined that National Aeronautics and Space Administration's Global Change Master Directory contained the federal government's most complete list of these environmental parameters. The directory is a Web-based catalogue that we accessed in October 2013 to identify the 74 environmental parameters it contained related to the oceans, coasts, and Great Lakes.[1] For example, the environmental parameters we identified included wave direction, sea level, salinity, and ocean temperature. In addition, we also identified another environmental parameter, stock assessment, based on NOAA documentation and interviews with NOAA officials. Our final number of environmental parameters related to NOAA's ocean, coastal, and Great Lakes observing systems totaled 75. See appendix II for a list of the 75 environmental parameters we identified.

We then reviewed all of the systems that make up NOAA's observing systems portfolio, as captured in its observing system architecture database, to identify which ones collect data on at least one of the 75 environmental parameters. This review identified 47 ocean, coastal, and Great Lakes observing systems. To obtain our final list of 41 systems, we excluded observing systems that, according to NOAA documentation, are not yet deployed or collect data for short-term, limited-scope research experiments. If NOAA's documentation was unclear for a specific observing system, we spoke with the NOAA officials responsible for the system to determine whether the system was operational. The observing systems we excluded were (1) Joint Polar Satellite System, (2) Geostationary Operational Environmental Satellite I-P, (3) Marine Sound, (4) Jason Ocean Surface

[1]The National Aeronautics and Space Administration's Global Change Master Directory's url address is http://gcmd.nasa.gov/.

Topography Mission 3, (4) Autonomous Underwater Vehicles, (5) Unmanned Aerial System, and (6) Animal Borne Tagging and Bar Code. We provided the list of ocean, coastal, and Great Lakes observing systems we identified with NOAA officials for their review and comment and incorporated their views into our final list as appropriate. See appendix III for an alphabetized list of the 41 NOAA ocean, coastal, and Great Lakes observing systems we identified.

To obtain descriptive information about the systems we identified, we reviewed agency documentation, including NOAA's observing system summary reports, budget summaries, and agency reports and presentations.[2] We also interviewed NOAA officials, such as the principal investigators for individual observing systems, program managers that oversee more than one observing system, or line office officials familiar with the observing systems operated and maintained by their offices. We provided our descriptions of NOAA's ocean, coastal, and Great Lakes observing systems with NOAA officials for their review and comment and incorporated their views into our final descriptions as appropriate. See appendix IV for a list and descriptions of the observing systems organized by the office that manages them.

To identify NOAA's annual costs to operate and maintain its ocean, coastal, and Great Lakes observing systems, we asked NOAA officials to provide cost data for these systems. In response, NOAA officials explained that this information is not readily available as the agency does not routinely collect data on observing system operation and maintenance costs in the ordinary course of business. They indicated that the most recent and best available observing system cost data were collected in 2013 by its Technology, Planning and Integration for Observation (TPIO) office for use in NOAA's Observing Systems Integrated Analysis model.[3] To collect the data, TPIO developed a spreadsheet template that requested specific cost information in a particular format. TPIO sent the template to each line office and asked them to provide annual costs for their observing systems for fiscal years 2012 through 2014. TPIO officials told us they intended the cost information

[2]Observing system summary reports provide basic information about an observing system, such as the system's name, its acronym, and the environmental parameters it measures, among other things.

[3]The NOAA Observing Systems Integrated Analysis model is a tool intended to help compare the cost-effectiveness of the agency's observing system in obtaining mission-critical data and to inform investment decisions.

they requested from the line office to be actual expenditures for fiscal years 2012 and 2013 and estimates for costs in fiscal year 2014 based on amounts in the 2014 presidential budget request. However, they said the observing systems costs reported by the line offices for fiscal years 2012 and 2013 are estimates because NOAA's budget structure and accounting systems are not set up to track actual spending at the observing system level.

According to TPIO officials, the cost information provided by the line offices was not reviewed by TPIO or the Chief Financial Officers for each of the line offices prior to being entered into a database. After we requested the observing systems cost information TPIO had collected, NOAA's Budget Office requested the data be reviewed to assess the accuracy of the information prior to releasing it to us. According to NOAA budget officials, they asked program managers to review the data they reported to TPIO for their respective observing systems and they asked each of the line office Chief Financial Officers to review the combined costs for the observing systems operated by their line offices. The purpose of the review was to verify that the cost information NOAA was providing to us accurately represented the information that had been reported to TPIO. The line office Chief Financial Officers also evaluated whether the costs were consistent with the program's budget allocation based on NOAA's appropriation levels for the fiscal years covered by the request. According to NOAA officials, the review resulted in mostly minor adjustments to the cost information originally collected by TPIO, and the information we received was the most accurate cost information NOAA has for its ocean, coastal, and Great Lakes observing systems portfolio.

We also took steps to assess the reliability of NOAA's observing system cost information by, among other things, reviewing documentation of NOAA's data collection procedures and interviewing agency officials, line office Chief Financial Officers, and observing system program managers. We found the data to be sufficiently reliable for the purpose of our report, which is to provide a general sense of the costs for NOAA's ocean, coastal, and Great Lakes observing systems. While we believe the cost information are sufficiently reliable for this purpose, they may not be sufficiently reliable for other purposes that require more accurate cost data, such as for making comparisons of the relative cost-effectiveness of different observing systems. In addition, to obtain other information related to observing system costs, we reviewed agency documents, including budget requests, guidance, and policies, and documentation of NOAA's managerial cost accounting system. We also interviewed NOAA headquarters and line office officials about NOAA's budget structure and cost accounting practices. See appendix V for the annual costs of each of NOAA's 41 ocean, coastal, and Great Lakes observing systems for fiscal years 2012 to 2014.

To determine the extent to which NOAA has taken steps to integrate and improve the cost-effectiveness of its portfolio of observing systems, including ocean, coastal, and Great Lakes systems, we reviewed agency documents and interviewed NOAA officials responsible for implementing the agency's observing systems management activities. Specifically, we reviewed plans related to managing the agency's observing systems portfolio, such as a 2004 strategic plan for system integration and plans related to implementing aspects of NOAA's 2010 next generation strategic plan.[4] In addition, we reviewed internal NOAA reports and external reviews that identified opportunities to improve the management and integration of the agency's observing system portfolio.[5] We interviewed officials in NOAA's six line offices and in the one staff office that operates and maintains observing systems.[6] In these interviews, we discussed the offices' approaches to managing their observing systems, their budgeting processes, and NOAA's efforts to integrate its observing systems portfolio. We also interviewed officials on NOAA's Observing Systems Council about their efforts to create a more integrated, cost-effective observing systems portfolio and from TPIO about their development of analytical tools to support the agency's observing system integration efforts. In addition, we reviewed GAO's work on strategic planning and performance measurement to identify leading practices in

[4]National Oceanic and Atmospheric Administration, *Strategic Direction for NOAA's Integrated Global Environmental Observation and Data Management System* (July 2004); NOAA, *NOAA's Next-Generation Strategic Plan* (Silver Spring, Md.: December 2010); and NOAA, *Next Generation Strategic Plan Implementation Plan: Enterprise Objective: Accurate and Reliable Data from Sustained and Integrated Earth Observing Systems FY 2013-2019* (Nov. 26, 2012).

[5]National Oceanic and Atmospheric Administration, *Buoy Recapitalization Strategic Plan: Review of Current Processes* (August 2009); NOAA, *A Report from the NOAA Science Advisory Board: In the Nation's Best Interest: Making the Most of NOAA's Science Enterprise* (Apr. 12, 2013); MITRE, *Process Improvement Assessment of NOAA TPIO's Investment Analysis Approach: Final Report*, (Aug. 27, 2010.); and The Pleiades Institute, *Process Improvement Assessment of NOAA Technology, Planning and Integration Office Investment Analysis Methodology: Final Report* (July 29, 2010).

[6]NOAA's six line offices are the National Environmental Satellite, Data, and Information Service; the National Marine Fisheries Service; the National Ocean Service; the National Weather Service; the Office of Oceanic and Atmospheric Research; and the Office of Program Planning and Integration. The one staff office is the Office of Marine and Aviation Operations.

these areas.[7] We also reviewed Office of Management and Budget (OMB) guidance to identify leading practices in planning and management.[8]

We conducted this performance audit from September 2013 to November 2014 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

[7]For example, see GAO-09-192; GAO-04-801; and GAO-12-77.

[8]Office of Management and Budget, Circular No. A-11, *Preparation, Submission, and Execution of the Budget* (2014).

Appendix II: GAO Identified Ocean and Coastal Environmental Parameters

1. Ambient Noise: Biological
2. Ambient Noise: Total
3. Atmospheric Pressure: Sea Level
4. Bathymetry
5. Buoy Support
6. Carbon Dioxide: Partial Pressure
7. Carbon Dioxide: Profiles
8. Carbon Dioxide: Surface
9. Carbon: Profiles
10. Chlorophyll Concentration
11. Conductivity: Profiles
12. Conductivity: Surface
13. Convection
14. Coral Reef Assessment
15. Diffuse Attenuation Coefficient
16. Dissolved Gases: Oxygen
17. Gravity Field: Airborne
18. Gravity Field: Ground Based
19. Hydrography: Bathymetry + Water Depth
20. Ice Age
21. Ice Concentration
22. Ice Depth/Thickness
23. Ice Extent
24. Ice Motion: Direction
25. Ice Motion: Speed
26. Ice Origin
27. Ice Temperature
28. Ice Topography
29. Marine Debris Removal
30. Net Heat Flux
31. Nitrate Particles: Profiles
32. Nitrate Particles: Surface
33. Nitrogen Oxides: Profiles
34. Nitrogen Oxides: Surface
35. Nutrients: Profiles
36. Nutrients: Surface
37. Ocean Color
38. Ocean Color: Turbidity
39. Ocean Contaminants
40. Ocean Currents Subsurface

41. Ocean Currents: Direction, Profiles
42. Ocean Currents: Direction, Surface
43. Ocean Currents: Speed, Profiles
44. Ocean Currents: Speed, Surface
45. Ocean Optical Properties: Fluorescence
46. Ocean Optical Properties: Water-leaving Radiances
47. Ocean Surface Winds: Direction
48. Ocean Surface Winds: Speed
49. Ocean Temperature: Profiles
50. pH: Ocean
51. Photosynthetically Active Radiation
52. Radiance
53. Salinity: Profiles
54. Salinity: Surface
55. Sea Level
56. Sea Surface Height
57. Sea Surface Temperature
58. Shoreline Mapping
59. Significant Wave Height
60. Snow Depth
61. Stock assessment
62. Swell Direction
63. Swell Height
64. Swell Period
65. Total Alkalinity
66. Trace Gases/Trace Species
67. Tsunamis
68. Turbulence
69. Water Pressure
70. Water Quality/Physical Oceanographic Research
71. Wave Direction
72. Wave Height
73. Wave Period
74. Wave Spectra
75. Wind Shear

Appendix III: Alphabetized List of National Oceanic and Atmospheric Administration's 41 Ocean, Coastal, and Great Lakes Observing Systems and Office

Observing System	Office
Airborne Oceanographic Product	Office of Oceanic and Atmospheric Research
Arctic Observing Network	Office of Oceanic and Atmospheric Research
Chesapeake Bay Interpretive Buoy System	National Marine Fisheries Service
Coastal Weather Buoys	National Weather Service
Coastal-Marine Automated Network	National Weather Service
Coral Reef Ecosystem Integrated Observing System/ National Coral Reef Monitoring Plan	National Ocean Service
Deep-Ocean Assessment and Reporting of Tsunamis	National Weather Service
Ecosystem Surveys	National Marine Fisheries Service
Ecosystems and Fisheries-Oceanography Coordinated Investigations	Office of Oceanic and Atmospheric Research
Fish Surveys	National Marine Fisheries Service
Geostationary Operational Environmental Satellite N/O/P	National Environmental Satellite, Data, and Information Service
Global Ocean Observing System Argo Profiling Floats	Office of Oceanic and Atmospheric Research
Global Ocean Observing System Global Drifter Program	Office of Oceanic and Atmospheric Research
Global Ocean Observing System Global Sea Level Observing System	Office of Oceanic and Atmospheric Research
Global Ocean Observing System Global Tropical Moored Buoy Array-Prediction and Research Moored in the Atlantic	Office of Oceanic and Atmospheric Research
Global Ocean Observing System Global Tropical Moored Buoys Array-Research Moored for African-Asian-Australian Monsoon Analysis	Office of Oceanic and Atmospheric Research
Global Ocean Observing System Ocean Carbon Networks	Office of Oceanic and Atmospheric Research
Global Ocean Observing System Ocean Reference Stations	Office of Oceanic and Atmospheric Research
Global Ocean Observing System- Ships of Opportunity	Office of Oceanic and Atmospheric Research
Global Ocean Observing System Tropical Atmosphere Ocean Array	National Weather Service
Hydrographic Surveying	National Ocean Service
Integrated Ocean Observing System High Frequency Radars	National Ocean Service
Jason Ocean Surface Topography Mission (2, 3 & CS)	National Environmental Satellite, Data, and Information Service
Marine Optical Buoy	National Environmental Satellite, Data, and Information Service
National Current Observation Program	National Ocean Service
National Estuarine Research Reserves System System-Wide Management Program	National Ocean Service
National Marine Sanctuary System-Wide Monitoring Program: System-Wide Monitoring	National Ocean Service
National Ocean Service-Shoreline	National Ocean Service
National Status and Trends Program	National Ocean Service
National Water Level Observation Network	National Ocean Service
NOAA Aircraft	Office of Marine and Aviation Operations
NOAA Ships	Office of Marine and Aviation Operations

Observing System	Office
Ocean Acoustic Monitoring System	Office of Oceanic and Atmospheric Research
Pacific Tsunami Warning Center Sea Level Network	National Weather Service
Physical Oceanographic Real-Time System	National Ocean Service
Polar-Orbiting Operational Environmental Satellite	National Environmental Satellite, Data, and Information Service
Real-time Coastal Observation Network	Office of Oceanic and Atmospheric Research
Regional Ocean Observing System	National Ocean Service
Suomi National Polar-Orbiting Partnership Satellite	National Environmental Satellite, Data, and Information Service
Voluntary Observing Ship	National Weather Service
Western Boundary Time Series and South Atlantic Meridional Overturning Circulation	Office of Oceanic and Atmospheric Research

Source: National Oceanic and Atmospheric Administration. | GAO-15-96

Appendix IV: National Oceanic and Atmospheric Administration's 41 Ocean, Coastal, and Great Lakes Observing Systems by Office

Observing system managing office and name	System description	Data uses and products	Primary type of platform used by system	Number of operational platforms as of September 2014[a]	Initially deployed (fiscal year)
National Environmental Satellite, Data, and Information Service					
Geostationary Operational Environmental Satellite N/O/P	This two-satellite system maintains a constant view of the earth from an orbit of about 22,000 miles in space and focuses primarily on the United States. The system provides timely environmental data about the earth's atmospheric, cloud cover, and surface conditions. The system observes the development of hazardous weather conditions, such as hurricanes, and tracks their movement and intensity to protect life and property. The satellite sensors also provide the capability to detect ice fields and map the movements of sea and lake ice.	The data are primarily used by meteorologists for weather observation, monitoring, and forecasting. The data also support improved atmospheric science research, weather prediction models, and environmental sensor design and development.	Satellite	2	1994
Jason Ocean Surface Topography Mission (2, 3 & CS)	The system measures sea surface height using a sensor mounted on a low-earth orbiting satellite.	The data are used to model the ocean, forecast weather events such as El Niño and La Nina, and predict hurricane intensity.[b]	Satellite	1	2008
Marine Optical Buoy	The system consists of a single moored buoy deployed off the coast of Hawaii. The system's primary purpose is to measure visible and near-infrared radiation entering and emanating from the ocean. Measurements are taken at the sea surface and three deeper depths.	The data collected by the system are used by satellite systems to adjust their sensors that measure ocean color.[c] Because of their remote location, satellites may experience interference in their measurements of ocean color. This system provides data to correct this interference.	Buoy	1	1995
Polar-orbiting Operational Environmental Satellite	The system uses polar-orbiting satellites to support environmental observations for imaging and measuring the earth's atmosphere, surface, and cloud cover. The system measures three ocean and coastal environmental parameters—sea surface temperature, sea ice extent, and coral reef assessments.	The data are processed to provide graphical weather images and specialized weather products. The data are also primary inputs into models used for developing weather forecasts up to 3 days in advance, and can be used to monitor environmental phenomena such as ozone depletion. The data can also be used in climate studies.	Satellite	3	1976

Observing system managing office and name	System description	Data uses and products	Primary type of platform used by system	Number of operational platforms as of September 2014[a]	Initially deployed (fiscal year)
Suomi National Polar-Orbiting Partnership Satellite	The system has a joint mission to gather data to support long-term monitoring of climate trends and for weather forecasts. The satellite is equipped with five different sensors that collect environmental data such as ice thickness, ocean color, and sea surface temperature.	The data are used in models to generate advance forecasts and warnings for severe weather. The data are also used for fisheries and coastal zone management and long-term monitoring of climate trends such as El Niño.	Satellite	1	2011
National Marine Fisheries Service					
Chesapeake Bay Interpretive Buoy System	The system is a network of buoys in the Chesapeake Bay that collect meteorological, oceanographic, and water-quality data.	Data collected by the buoys are delivered to users in real-time via wireless technology.[d] Users include scientists and students who use the data to help protect, restore, and manage the Chesapeake Bay. In addition, the data are used as a resource for boaters to alert them to boating conditions.	Buoy	11	2009
Ecosystem Surveys	The system is designed to monitor the health and status of living marine resources and their habitats in Alaska and New England. The goal of the observing system is to characterize the changing states of the ecosystems and forecast any subsequent impact on fisheries productivity. Data are collected primarily by research ships; however, satellites, buoys, and other methods are also used.	The data are used for the assessment and management of fish species and in a wide variety of research programs.	Mix	Varies annually	1940
Fish Surveys	The system monitors the distribution and abundance of commercially-targeted and ecologically-important fish species. The surveys occur in all of the oceans surrounding the nation; however, the frequency of the surveys is contingent on available funding each year.	The data are used in models by fishery managers to determine the effects of fishing on fish populations.	Ship	Varies annually	1963

Observing system managing office and name	System description	Data uses and products	Primary type of platform used by system	Number of operational platforms as of September 2014[a]	Initially deployed (fiscal year)
National Ocean Service					
Coral Reef Ecosystem Integrated Observing System/National Coral Reef Monitoring Plan	The system uses buoys to collect data to understand the condition of, and the processes influencing, the nation's coral reef ecosystems. Since 2013, the system has been part of the National Coral Reef Monitoring Plan, with a goal of monitoring the status and trends of the country's coral reefs.	The data are used to make better informed and timely management decisions related to the conservation of coral reefs. For example, the data are used to model and forecast climate-related risks and vulnerabilities to coral reefs.	Buoy	49	2001
Hydrographic Surveying	The system uses boats to conduct surveys of the physical parameters and waterbody features in the nation's coastal areas. The areas covered by the surveys are prioritized based on a variety of factors, including the amount of time elapsed since an area was previously surveyed. The data include information on water depth and the nature of the sea floor, which has implications for anchoring, dredging, and fisheries habitat.	The data are used to support a variety of products including nautical charts. The charts are then used for port and harbor maintenance, coastal engineering, coastal zone management, and resource development offshore.	Ships	Varies annually	1970
Integrated Ocean Observing System High-Frequency Radars	This system measures the speed and direction of ocean surface currents in near real-time. The radars can measure currents up to 200 kilometers offshore and can operate under any weather conditions. The radars are located along both the east and west coastlines of the United States.	The data from the radars are used in a variety of applications including to support pollutant tracking, search and rescue efforts, and management of the country's coastal resources.	Radar	123	2011
National Current Observation Program	The buoy system collects data on ocean velocity, salinity, and temperature to determine the circulation along the United State's coasts and estuaries.	The data are used to principally produce the National Oceanic and Atmospheric Administration's (NOAA) Tidal Current Tables. These tables predict the daily tidal current for each location where the data are collected. The tables are publicly available in an electronic format.	Buoy	70	1840

Observing system managing office and name	System description	Data uses and products	Primary type of platform used by system	Number of operational platforms as of September 2014[a]	Initially deployed (fiscal year)
National Estuarine Research Reserves System System-Wide Management Program	The system is located in the nation's major coastal regions—west, northeast, Great Lakes, mid-Atlantic, southeast, Gulf of Mexico, and Caribbean Sea—to determine how reserve conditions, including water quality associated environmental parameters, are changing in both the short-term and long-term.	The data are used by many groups including researchers, educators, and coastal managers. For example, data from the network of reserves is used to help understand the effects of climate change in the nation's coastal regions.	Buoy	139	1996
National Marine Sanctuary System-Wide Monitoring Program: System-Wide Monitoring	The system monitors environmental conditions, such as water quality, at 13 marine sanctuaries. The data are collected from a variety of platforms, including ships and buoys.	The data collected are used to measure progress toward maintaining and improving the natural and archaeological quality of the national marine sanctuary system.	Mix	13	2007
National Status and Trends Program	The system consists of two programs—Mussel Watch and Bioeffects—that monitor the environmental quality of estuarine and coastal waters throughout the nation. Data are collected from multiple sites along the entire United States coastline, including the Great Lakes.	The data are used to characterize and assess the environmental impact of new and emerging contaminants and extreme events (hurricanes and oil spills) on the nation's estuarine and coastal waters.	Human-observer	170	1986
National Water Level Observation Network	The system is a network that has over 200 coastal observing stations around the United States that collect continuous, long-term water level observations.	The data are used primarily to support safe navigation of the country's waterways by computing tidal and water-level datums, producing tide prediction tables, and estimating sea-level trends.[e] The data are collected and transmitted via satellite to their users.	Ocean-fixed	210	1840
National Ocean Service-Shoreline	The system uses aircraft to collect aerial imagery of the nation's coastal areas.	The data are primarily used to produce nautical charts, which are used for a variety of purposes including coastal zone management and emergency response.	Aircraft	4	1919

Observing system managing office and name	System description	Data uses and products	Primary type of platform used by system	Number of operational platforms as of September 2014[a]	Initially deployed (fiscal year)
Physical Oceanographic Real-Time System	The system was developed to provide accurate and reliable real-time information about environmental conditions in seaports. It collects data on wind, water, and air environmental parameters.	The data are provided primarily to ship masters and pilots in real-time to avoid groundings and collisions in the nation's ports. Data on water levels, currents, and other oceanographic variables are available through a variety of formats, including the Internet.	Mix	23	1991
Regional Ocean Observing System	The system is a network of observing instruments and platforms used by the U.S. Integrated Ocean Observing System program's regional associates to collect data on a variety of environmental parameters in the nation's coastal waters.	Data collected by the regional associations are being integrated with other data collected by NOAA's National Data Buoy Center into a database, which the U.S. Integrated Ocean Observing System program plans to make publicly available.	Buoy	537	2003
National Weather Service					
Coastal Weather Buoys	The system uses floating buoys that are moored at specific locations but able to drift up to 2 miles in all directions. The buoys are located throughout the nation's oceans and coastal waters.	The data are used to produce forecasts, warnings, and atmospheric models. Other uses of the data include scientific and research programs and to assist in emergency response to chemical spills.	Buoy	109	1972
Coastal-Marine Automated Network	The system has 60 stations in the nation's coastal zones. Its platforms include buoys or land-based tower stations. The system was designed in the early 1980s in response to the need to maintain meteorological observations in U.S. coastal areas that had previously been gathered by U.S. Coast Guard personnel stationed at lighthouses.	The data are used to produce meteorological observations in coastal areas and are relayed to users at least once per hour from the system's platforms.	Buoy	51	1982
Deep-Ocean Assessment and Reporting of Tsunamis	The system consists of an anchored seafloor bottom pressure recorder and a companion moored surface buoy to detect tsunamis in U.S. coastal areas.	The data are transmitted in real-time to NOAA's Tsunami Warning Centers via satellite. The centers then decide which coastal communities are in danger and issue warnings.	Buoy	39	2006

Observing system managing office and name	System description	Data uses and products	Primary type of platform used by system	Number of operational platforms as of September 2014[a]	Initially deployed (fiscal year)
Global Ocean Observing System Tropical Atmosphere Ocean Array	The system is part of the multinational Global Ocean Observing System. It was designed in response to an early 1980s El Niño event, which was neither predicted nor detected until nearly its peak. The system collects data on a variety of meteorological parameters, such as wind speed, and relative humidity, as well as ocean current profiles and upper ocean temperatures.	The data are collected to help predict El Niño events. They are transferred to shore in real-time using satellites.	Buoy	55	1970
Pacific Tsunami Warning Center Sea Level Network	The system detects tsunami activity around Hawaii using sea-level gauges.	The data are used to confirm the generation of a tsunami and to predict locations where it may strike.	Ocean-fixed	43	1967
Voluntary Observing Ship	The system uses ships, both U.S. and internationally owned, that voluntarily collect data on meteorological conditions. The data are encoded in a standardized format and sent via satellite or radio to services that provide marine weather forecasts.	The data are used for a variety of purposes, including weather forecasts, and to help measure extreme weather events and long-term climate changes. The data are also archived for future use by climatologists and other scientists.	Ship	Varies annually	1853
Office of Marine and Aviation Operations					
NOAA Aircraft[f]	NOAA uses its aircraft to collect data on multiple environmental parameters, including atmospheric pressure and ocean temperature.	The data are used to support global climate change studies, assessing marine mammal populations, surveying coastal erosion, investigating oil spills, flight checking aeronautical charts, and improving hurricane or winter storm prediction models.	Aircraft	9	1975
NOAA Ships	NOAA's fleet of ships collects data and supports federal disaster response around the world. The system collects data on multiple environmental parameters, including ocean pH and water depth.	The data are used for hydrographic surveys, oceanographic research, and fisheries research, among other things.	Ship	16	1967

Observing system managing office and name	System description	Data uses and products	Primary type of platform used by system	Number of operational platforms as of September 2014[a]	Initially deployed (fiscal year)
Office of Oceanic and Atmospheric Research					
Airborne Oceanographic Product	The system uses aircraft to collect data via aircraft 30 days a year in coastal Washington state, the Pacific Northwest, and Chesapeake Bay on fish and the thin plankton layer.[g]	The data are used to support scientific research on specific parameters such as waves.	Aircraft	Varies annually	1997
Arctic Observing Network	The system uses four major types of platforms: ocean or sea ice platforms, ships, aircraft, and land based climate atmospheric observatories to study meteorological, sea ice, and subsurface environmental parameters in the Arctic Ocean.	The data are used to understand long-term trends in the physical and biological state of the Arctic Ocean.	Mix	11	2004
Ecosystems and Fisheries-Oceanography Coordinated Investigations	The system is used in the Gulf of Alaska, Bering Sea, and Arctic to understand ecosystem dynamics and the life cycle of commercially valuable fish and shellfish stocks.	The data are used to produce ecosystem forecasts that help guide resource managers in making catch share allocations to commercial fishermen and to mitigate the effects of climate change on marine species and coastal communities.	Buoy	15	1984
Global Ocean Observing System Argo Profiling Floats	The system uses free-drifting floats to observe the ocean's upper 2,000 meters. The mission of the system is to describe and understand the physical processes responsible for climate variability and predictability.	The data are transmitted real-time via satellites to land-based receiving stations and are used in weather forecasting and climate prediction models.	Buoy	3311	2001
Global Ocean Observing System Global Drifter Program	The system is part of the multinational Global Ocean Observing System and was designed to use drifting buoys around the world to measure sea surface temperature and currents at 15 meters below the water's surface.	The data are used to adjust satellite sea surface temperature observations and provide real-time data on the structure of global surface currents, among other things.	Buoy	1250	1988
Global Ocean Observing System Global Sea Level Observing System	The system is part of the multinational Global Ocean Observing System and uses fixed platforms that are stationed on islands and in the coastal zones around the world to measure and report sea-level information. The data are transmitted in real-time using satellites.	The data are used in multiple NOAA missions including climate monitoring and prediction.	Mix	50	1983

Observing system managing office and name	System description	Data uses and products	Primary type of platform used by system	Number of operational platforms as of September 2014[a]	Initially deployed (fiscal year)
Global Ocean Observing System Global Tropical Moored Buoy Array-Prediction and Research Moored in the Atlantic	The system is located in the Atlantic Ocean and is part of the multinational Global Ocean Observing System. It is a buoy system used to study ocean-atmosphere interactions in the tropical Atlantic Ocean that affect regional climate variability on seasonal, interannual, and longer time scales.	The data are transmitted via satellite in near real-time and are used for developing and improving models of the ocean.	Buoy	17	1997
Global Ocean Observing System Global Tropical Moored Buoys Array-Research Moored for African-Asian-Australian Monsoon Analysis	The system is part of the multinational Global Ocean Observing System. It is a buoy system located in the Indian Ocean that gathers data to address scientific questions related to ocean conditions and monsoons. The system collects data on air temperature, atmospheric pressure, and the direction of ocean currents.	The data are real-time measurements that are used in climate research and forecasting.	Buoy	21	2004
Global Ocean Observing System Ocean Carbon Networks	The system obtains ocean measurements from around the world that contribute to NOAA's understanding of the carbon cycle and is part of the multinational Global Ocean Observing System.[h]	The data are used to help with forecasting long-term climate trends.	Mix	34	2005
Global Ocean Observing System Ocean Reference Stations	The system is part of the multinational Global Ocean Observing System and uses buoys to maintain long-term observing capabilities on ocean and climate environmental parameters.	The data are transmitted by satellites, which enables users (scientists and the public) access in near real-time for use in products such as climate studies.	Buoy	21	1970

Observing system managing office and name	System description	Data uses and products	Primary type of platform used by system	Number of operational platforms as of September 2014[a]	Initially deployed (fiscal year)
Global Ocean Observing System-Ships of Opportunity	The system uses a network of cargo vessels, cruise ships, and research vessels that voluntarily collect ocean measurements by either using NOAA supplied instruments on specified routes or hosting NOAA technicians onboard to take measurements. These ships are also the primary vehicle for deploying NOAA's drifting buoy arrays, surface drifting buoys, and Argo profiling floats, as well as other instruments. Data are collected on three environmental parameters related to temperature: air, sea, and subsurface.	The data collected are used to produce more than 25 articles in peer reviewed scientific publications, scientific meeting presentations, and a large number of other products associated with monitoring the condition of the ocean.	Ship	51	1970
Ocean Acoustic Monitoring System	The system uses arrays of hydrophones to collect continuous digital acoustic data for ocean observation in the Pacific Ocean from the Arctic to tropical locations. The hydrophones are used primarily to listen for earthquakes, but can also observe icequakes, large waves, and some marine endangered species.	The data are used in research related to earthquakes and marine endangered species.	Hydro-phones	Varies annually	1970
Real-time Coastal Observation Network	The system is located in the Great Lakes and collects data on multiple environmental parameters including water temperature, extent of ice cover, wave direction, and turbidity.	The data are used by the National Weather Service to help verify its marine weather forecasts and for fisheries research.	Mix	20	2005
Western Boundary Time Series and South Atlantic Meridional Overturning Circulation	The system collects continuous, time series data on the strength of the Atlantic Ocean meridional overturning circulation, which includes many currents. The system uses submarine cables and measurements from ships, among others, to monitor the condition of the currents.	The data provide the only measurement of the strength of the meridional overturning circulation and are used to improve climate forecasts.	Mix	25	1982

Source: GAO analysis of NOAA data. | GAO-15-96

[a]The number of deployed platforms that are currently operational by NOAA. Some observing systems include platforms that are operated by other countries; however; we did not include those platforms in this table.

[b]The El Niño Southern Oscillation is a naturally occurring phenomenon that involves fluctuating ocean temperatures in the equatorial Pacific Ocean. The pattern generally fluctuates between two states: warmer

than normal temperatures in the central and eastern equatorial Pacific (El Niño) and cooler than normal temperatures in the central and eastern equatorial Pacific (La Niña).

[c]Ocean color is the water hue due to the presence of tiny plants containing the pigment chlorophyll, sediments, and colored dissolved organic material.

[d]"Real-time" is a relative measure that refers to the delivery time of the data. Information delivery times generally range between 10 to 20 minutes.

[e]A "datum" is a base elevation used as a reference from which to determine heights or depths. A tidal datum is a standard elevation defined by a certain phase of the tide and is used as a reference to measure local water levels.

[f]While NOAA considers its fleets of ships and aircraft each to be observing systems, the individual ships and aircraft also serve as observing platforms.

[g]A thin plankton layer is an aggregation of phytoplankton on the ocean's surface.

[h]The global carbon cycle is the process by which carbon is exchanged among various systems, including the earth's atmosphere, the oceans, geological sources of stored carbon (e.g., fossil fuels), and the vegetation and soils of the earth's terrestrial ecosystems.

Appendix V: National Oceanic and Atmospheric Administration's Annual Estimated Operations and Maintenance Costs for the Ocean, Coastal, and Great Lakes Observing Systems by Office for Fiscal Years 2012 through 2014

Dollars in millions

Observing system managing office and name	Fiscal year 2012	Fiscal year 2013	Fiscal year 2014[a]
National Environmental Satellite, Data, and Information Service			
Geostationary Operational Environmental Satellite N/O/P	$32.5	$25.9	$26.3
Jason Ocean Surface Topography Mission (2,3 & CS)[b]	1.6	1.6	1.6
Marine Optical Buoy	2.4	2.9	3
Polar-Orbiting Operational Environmental Satellite	32.2	29	28.8
Suomi National Polar-Orbiting Partnership Satellite	3.1	6.6	8.9
National Marine Fisheries Service			
Chesapeake Bay Interpretive Buoy System	0.8	0.8	0.8
Ecosystem Surveys	7.27	6.59	7
Fish Surveys	16.55	16.44	13.81
National Ocean Service			
Coral Reef Ecosystem Integrated Observing System/National Coral Reef Monitoring Plan	3.9	5.2	5.2
Hydrographic Surveying	26.9	25.1	25
Integrated Ocean Observing System High-Frequency Radars	5	5	5
National Current Observation Program	1	1	1
National Estuarine Research Reserves System System-Wide Management Program	3.7	3.7	3.7
National Marine Sanctuary System-Wide Monitoring	2.36	2.36	2.36
National Status and Trends Program	1.9	1.7	2.1
National Water Level Observation Network	5.05	4.7	6.5
National Ocean Service-Shoreline	6.2	6.1	6.7
Physical Oceanographic Real-Time System[c]	0	0	0
Regional Ocean Observing System	16.4	18.1	18.8
National Weather Service			
Coastal Weather Buoys	20.29	18.24	18.31
Coastal-Marine Automated Network	0.68	0.68	0.68
Deep-Ocean Assessment and Reporting of Tsunamis	6.82	8.77	11.45
Global Ocean Observing System Tropical Atmosphere Ocean Array	4.13	3.38	3.84
Pacific Tsunami Warning Center Sea Level Network	0.81	0.12	1.62
Voluntary Observing Ship	1.47	1.5	1.53
Office of Oceanic and Atmospheric Research			
Airborne Oceanographic Product	0.05	0.05	0.1
Arctic Observing Network	3.76	3.45	3.76
Ecosystems and Fisheries-Oceanography Coordinated Investigations	5	1	1

Dollars in millions

Observing system managing office and name	Fiscal year 2012	Fiscal year 2013	Fiscal year 2014[a]
Global Ocean Observing System Argo Profiling Floats	10.3	10.3	10.3
Global Ocean Observing System Global Drifter Program	3.47	3.47	3.47
Global Ocean Observing System Global Sea Level Observing System	1.37	1.33	1.28
Global Ocean Observing System Global Tropical Moored Buoy Array-Prediction and Research Moored in the Atlantic	1.25	1.18	1.2
Global Ocean Observing System Global Tropical Moored Buoys Array-Research Moored for African-Asian-Australian Monsoon Analysis	3.05	2.82	2.8
Global Ocean Observing System Ocean Carbon Network	7	7	7
Global Ocean Observing System Ocean Reference Stations	7.54	5.91	6.67
Global Ocean Observing System-Ships of Opportunity	9.5	2.05	2.05
Ocean Acoustic Monitoring System	0.05	0.14	0.08
Real-time Coastal Observation Network	0.45	0.45	0.45
Western Boundary Time Series and South Atlantic Meridional Overturning Circulation	1.06	0.82	0.52
Office of Marine and Aviation Operations			
NOAA Aircraft	28	28	28
NOAA Ships	147	153	170
Total	**$431.88**	**$416.44**	**$442.67**

Source: National Oceanic and Atmospheric Administration. | GAO-15-96

[a]NOAA's estimated costs for fiscal years 2012 and 2013 were based on final appropriations for those years. The estimates for fiscal year 2014 were based on the fiscal year 2014 President's budget request.

[b]The estimates reported for here include costs to operate and maintain the Jason-2 mission. Development costs for the Jason-3 mission, with the operational environmental satellite scheduled to be launched in fiscal year 2015, are not included.

[c]The Physical Oceanographic Real-Time System is a cost-sharing program where local partners provide funding for the sensor systems and their ongoing maintenance.

Appendix VI: Comments from the Department of Commerce

THE DEPUTY SECRETARY OF COMMERCE
Washington, D.C. 20230

October 29, 2014

Ms. Anne-Marie Fennell
Director, Natural Resources and Environment
U.S. Government Accountability Office
441 G Street NW
Washington, DC 20548

Dear Ms. Fennell:

Thank you for the opportunity to review and comment on the Government Accountability Office's (GAO) draft report entitled *NOAA's Observing Systems: Additional Steps Needed to Achieve an Integrated, Cost-Effective Portfolio* (GAO-15-96). Enclosed are the National Oceanic and Atmospheric Administration's programmatic comments to the draft report.

If you have any questions, please contact me or Margaret Cummisky, Assistant Secretary for Legislative and Intergovernmental Affairs at (202) 482-3663.

Sincerely,

Bruce H. Andrews
Deputy Secretary of Commerce

Enclosure

Department of Commerce
National Oceanic and Atmospheric Administration
Response to the Draft GAO Report Entitled
NOAA's Observing Systems: Additional Steps Needed to Achieve an Integrated, Cost-Effective Portfolio
(GAO-15-96)

General Comments

The Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) appreciates the opportunity to review the Government Accountability Office's (GAO) draft report on NOAA's observing systems. Please see below for our comments.

1. The original scope of this study was introduced to NOAA as a review on "Ocean, Coastal, and Great Lakes Observing Systems." The change in title between the statement of facts and draft report does not accurately reflect NOAA's observing capacity. The scope of this report includes 41 of NOAA's ocean, coast, and Great Lakes observing systems; NOAA manages 113 critical observing systems of record, as well as 34 innovative observing technologies. NOAA recommends keeping the name as previously used on the statement of facts.

2. NOAA has long seen the need for an integrated and cost-effective observing portfolio, which is vital to maximize the benefits of ocean, coastal, and Great Lakes information for the Nation. NOAA has dedicated a large effort over the past decade to systematically develop management structures, such as the NOAA established NOAA Observing Systems Council and the Observing Systems Committee, as well as tools to address these issues. To date, NOAA maintains a significant breadth and depth of information with respect to ocean, coastal, and Great Lakes observing systems. The process that GAO used to research and develop this report was largely informed by the following NOAA resources:

- "To identify which of NOAA's observing systems collect data on oceans, coasts, and the Great Lakes, we first identified a list of environmental variables, known as "parameters," related to the ocean, coast, and Great Lakes. We identified 75 environmental parameters..." *Made possible by the Consolidated Observing Requirement List (CORL).*

  "We then reviewed NOAA's entire observing system portfolio to identify which of the systems collect data on at least one of these environmental parameters."
  Made possible by the NOAA Observing System Architecture (NOSA).

- "To identify NOAA's costs to operate and maintain its ocean, coastal, and Great Lakes observing systems, we asked NOAA officials to provide cost data for these systems. NOAA does not have a process to track observing systems operations and maintenance costs. However, as part of an analysis of its observing system portfolio, NOAA gathered cost information for fiscal years 2012 through 2014…"
  Made possible by NOAA Observing Systems Integrated Analysis (NOSIA-II).

3. The fact that key parameters, such as temperature, are measured by multiple observing systems is not in itself an indicator of potential duplication. In fact, multiple temperature sensors

1

contained on multiple platforms can be an example of maximizing the capability of the observing system with minimal costs. Temperature parameters and requirements are spatial, temporal, and geographically delineated in the validated requirements based on the products that these measurements support. For example, some products require in-situ measurements in the vicinity of tropical cyclones specifically for the forecast model products. Other measurements specify temperature measurements specific to an atmospheric river phenomenon and targeted observations that cannot be measured by other observing systems. Some products require temperature at the surface of the ocean during certain times of the day. There is no single observing system that can collect these critical parameters for every spatial, temporal, and geographic condition. It is noted that while NOAA has not recommended an observing system in the area of oceans, coasts, and Great Lakes for elimination; however, there have been a small number of systems in other parts of NOAA that were recommended for, and were in fact, terminated.

NOAA Response to GAO Recommendations

The draft GAO report states, "To help strengthen the management and cost-effectiveness of NOAA's observing systems portfolio, including ocean, coastal, and Great Lakes systems, we recommend that the Secretary of Commerce direct the NOAA Administrator to take the following three actions:"

Recommendation 1: "Develop a plan for observing systems integration that includes: 1) a description of what an integrated portfolio of observing systems will include and achieve and how it will be managed; 2) the steps necessary to move toward an integrated portfolio of observing systems; and 3) how to measure progress towards the goal of an integrated observing systems portfolio."

NOAA Response: NOAA acknowledges there is no single observing plan for the 41 systems identified in this report. However, within the United States' Economic Exclusive Zone (EEZ), NOAA is guided by agency and interagency observing plans scoped at the national level for the major systems identified in the report, and by the Global Climate Observation System report for those observations outside the EEZ. National plans such as *A Plan to Meet the Nation's Needs for Surface Current Mapping*, *The National Operational Wave Observation Plan*, and *A Network Gaps Analysis For The National Water Level Observation Network* along with international reports such as the *Integrated Global Observing Strategy (IGOS): Coastal Theme Report* and *An Implementation Strategy for the Coastal Module of the Global Ocean Observing System (GOOS Report #148)* drive coordinated and integrated development of observing systems. NOAA will build off of these and other existing documents to explore the feasibility of enacting this recommendation.

Recommendation 2: "Analyze the extent to which unnecessary duplication exists in NOAA's portfolio of observing systems."

NOAA Response: NOAA acknowledges a continued need to analyze the observing portfolio for unnecessary duplication. NOAA has taken steps in this regard with the development of NOAA Observing Systems Integrated Analysis (NOSIA) model.

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Recommendation 3: "Develop a standardized methodology for the routine preparation and reporting of observing systems cost data."

NOAA Response: NOAA agrees with this recommendation and has already begun talks to address how NOAA's accounting system could collect and report cost data for all observing systems on record.

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Appendix VII: GAO Contact and Staff Acknowledgments

GAO Contact

Anne-Marie Fennell, (202) 512-3841 or fennella@gao.gov

Staff Acknowledgments

In addition to the individual named above, Stephen D. Secrist (Assistant Director), Cheryl Arvidson, Mark Braza, Heather Dowey, Richard Hung, Paul Kinney, Michael Meleady, and Jeanette Soares made key contributions to this report.

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