

# Oceanic and Atmospheric Research (OAR)

## Strategic Plan

### In Support of NOAA's NGSP

Draft for SMM comment

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Provide your feedback at [OAR.PLAN@NOAA.GOV](mailto:OAR.PLAN@NOAA.GOV)

## **Vision**

To be the Nation's trusted source for oceanic and atmospheric research, technology, and related extension services that enable healthy, productive and resilient ecosystems, communities, and economies

## **Mission**

### **Innovate, Incubate, and Integrate**

*To apply innovative research and technology towards Earth-system discovery, understanding, and prediction*  
*To incubate long-term research and extend knowledge that supports NOAA services and societal needs*  
*To integrate research across NOAA, and with our external partners, to maximize NOAA's value to society*

## **Values**

- Pre-eminence in Science
- Relevance to Society
- Culture of Transparency

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Letter from the Assistant Administrator of OAR

## OAR's Vision and Mission

OAR's leadership role as a centralized research line office is critical to NOAA and to society. Through world-class research and development, OAR, along with our partners inside and outside of NOAA, characterizes and predicts complex environmental phenomenon. Moreover, OAR continues to be successful in high-risk, high-reward research and delivering products and services to society and other Line Offices in support of NOAA's mission. Over the next five years, OAR will expand its role as a leader of the scientific enterprise, and work to integrate the various research domains across the agency. Reflecting on this role, the NOAA Administrator stated in congressional testimony:

“OAR will continue to serve as NOAA's centralized research Line Office, serving all of NOAA by supporting and producing pre-eminent research and technology innovation that advances NOAA's mission. OAR will innovate—make new discoveries and find new technology applications, incubate—conduct long term research and develop technology to make new discoveries that are useful to NOAA's operations, and integrate—strengthen research and technology across NOAA and with partners.”

To support the goal of strengthening all of NOAA's research and development, the Administrator has charged OAR with supporting the Chief Scientist in evaluating NOAA's work and implementing a balanced portfolio focused on NOAA's mission priorities.

Supporting the administration and the goals outlined in NOAA's Next Generation Strategic Plan, OAR has established the following mission as a guiding framework for strategic planning over the next five years.

### **Mission Innovate, Incubate, and Integrate**

*To apply innovative research and technology towards Earth-system discovery, understanding, and prediction*  
*To incubate long-term research and extend knowledge that supports NOAA services and societal needs*  
*To integrate research across NOAA, and with our external partners, to maximize NOAA's value to society*

This mission embraces the view that advances in NOAA's four long-term agency goals – *Climate Adaptation and Mitigation, Weather-Ready Nation, Healthy Oceans, and Resilient Coastal Communities and Economies* – will require the continued strengthening and integration of NOAA's enterprise-wide science and technology, stronger partnerships and stakeholder engagement, and effective organizational and administrative functions. In pursuit of its mission, OAR has developed three primary goals:

#### **Science Goal**

Holistic understanding and effective predictions of future states of the Earth-system

#### **Service Goal**

Engaged, educated public capable of making informed environmental decisions

#### **Support Goal**

An efficient and high performing organization

This strategic plan describes OAR's long-term goals along with specific objectives that will be pursued over the next five years. Each objective will be pursued and evaluated against outcome-oriented performance measures to determine level of progress. Ultimately, this plan provides a framework by which OAR will deliver significant benefits to society through NOAA's mission of science, service, and stewardship.

## Background—History of OAR

The Line Office of Oceanic and Atmospheric Research (OAR) serves as the primary research arm of the National Oceanic and Atmospheric Administration (NOAA), and maintains a strong history of pre-eminent and innovative research. The origins of OAR date back more than 200 years to the creation of the Survey of the Coast in 1807 by Thomas Jefferson. The Coast Survey, which became the U.S. Lake Survey office in 1841, was developed to undertake “a hydrographic survey of northwestern [Great] lakes.” Research executed by the scientists of this group was innovative and holistic: the first current meters were developed to understand water flow rates, and forecasting techniques were greatly enhanced to predict water levels and the relationship to lakefront property. The same traits of world class, long-term research continue to define OAR today.

In 1965, prior to creation of NOAA, President Johnson transferred the Central Radio Propagation Laboratory from the National Bureau of Standards (the forerunner of the National Institute of Standards and Technology) to join the United States Weather Bureau and the Coast and Geodetic Survey in a new scientific agency of the Department of Commerce: the Environmental Science Services Administration (ESSA). The coupling of these divisions recognized the importance of dedicated research of both the world’s ocean and atmosphere. ESSA’s mission was to respond to the national need for adequate warnings of severe and natural hazards, for technological advances in capabilities to observe the physical environment and for investigations into the physical environment as a “scientific whole” rather than a “collection of separate and distinct fields of scientific interest.”

The need for a consolidated research agency dedicated to the study of our oceans and atmosphere was further characterized by the Stratton Commission, which was established by President Nixon to develop an implementation plan for the Marine Resources and Engineering Development Act of 1966). The final report from this commission came as document titled, “Our Nation and the Sea: A Plan for National Action” which called for the creation of NOAA with a mission to predict environmental changes on a wide range of time and space scales in order to protect life and property, and provide industry and government decision-makers with a reliable base of scientific information. It was not until 1977, that NOAA was reorganized into five principal Line Offices: the Office of Fisheries, the Office of Coastal Zone Management, the Office of Satellites, the Office of Oceanic and Atmospheric Services, and the Office of Research and Development. It was these last two line offices which provided the organizational foundation for today’s OAR. OAR is predicated upon innovative research as well as the development and the delivery of products, tools, and information services to meet the needs of the nation.

The Office of Research and Development was responsible (in NOAA laboratories and in the academic community) for environmental research that supports NOAA program needs, for implementation of the Sea Grant program, and to provide Federal leadership for interagency, international research programs like the Global Atmospheric Research Program. In 1983, the Office of Research and Development evolved into the Office of Oceanic and Atmospheric Research (OAR) and began to manage major research efforts to support improvements to NOAA’s service arms, as well as to fulfill the agency’s responsibilities for leadership in science to improve our understanding of the oceanic and atmospheric components of the global Earth-system. One stated purpose of OAR was to “strengthen NOAA’s position in fundamental

research in those areas that are pertinent to NOAA’s mission and to remove any programmatic myopia that might come from coupling development and application to the more fundamental areas of research.” The same core elements continue to define OAR today; pre-eminent research, culture of transparency, and value to society. Regardless of the organizational structure, OAR has continued to provide a leadership role in NOAA’s research portfolio and provide services to its constituents from policy makers, to the academic community, to the general public.

Moving forward, OAR will leverage its core capability as a world-class research enterprise and work to strengthen its current research focal areas, in addition to integrating the various research domains across NOAA towards the understanding and prediction of globally interconnected environmental systems. Such integration is critical to the preservation of life and property. Acute and catastrophic, natural and human-induced pressures on the Earth’s environment and ecosystems are increasing, and changing demographics are causing a rising demand for scarce resources and putting more people in the path of natural hazards. OAR strives to understand changes in our oceanic and atmospheric systems at local, regional, and global levels in support of the agency’s efforts to provide effective services and stewardship to the Nation. This approach recognizes the importance of understanding the earth-system on time scales ranging from minutes to decades and even longer when investigating processes associated with global environmental changes.

To provide science, service, and stewardship to NOAA and the nation, OAR has established three long-term goals that are discussed in this strategic plan: Earth-system understanding and prediction capability; Engaged Society; and a high performing organization. These goals embrace a view that the planet is an amalgam of complex systems – physical, chemical, biological, and social - which interact with and respond to one another through complex and dynamic processes. A key feature of this view is that people are an integral component whereby ecosystems are influenced both positively and negatively by society. The ability to predict the earth-system must include this interdependency—the balance between societal needs and the integrity of ecosystems. As a research and outreach line office, OAR is well positioned to develop a better understanding of the Earth-system through world-class research and provide predictive assessments of how long-term environmental changes will impact people, places, and natural resources.

Along with its internal and external partners, OAR will help build a future where society is able to anticipate and take appropriate precautions against oncoming hurricanes, tornadoes, tsunamis, as well as significant heat, snow, and rain events. In addition, OAR will engage society to address the global impacts of climate change on oceans, sea level rise on coastal communities, agriculture supplies, ocean and coastal biodiversity, and declining usable fresh water supplies. These issues are connected on a global scale. The ability to deliver meaningful results will depend on OAR’s capacity to simultaneously strengthen its research and development programs as well as engagement services with the public towards far reaching and meaningful goals.

## Science Goal

### *Holistic understanding and useful predictions of future states of the Earth-system*

OAR maintains the scientific expertise to understand and predict some of the most complex environmental phenomena in our world's oceans, atmosphere, coasts, and Great Lakes. Such capabilities have been developed through decades of world class research executed with great planning, foresight, and recognition that the ability to monitor, understand, and predict key aspects of the environment is essential to the preservation of life and property. Recent events, both natural and human induced, remind us of the intimate relationship between humans and the environment: Indonesian Tsunami of 2004, Hurricane Katrina in 2005, Chilean Earthquake of 2010, Deepwater Horizon Oil Spill of 2010, Japanese Tsunami and related nuclear contamination events of 2011 and countless others. These events were sudden, catastrophic and occurred across the globe. The need for global monitoring and providing relevant and rapid information to the public, policy makers and other science groups is clear. OAR will continue to engage with key stakeholders to provide relevant tools, products and services that help protect lives and property.

Albeit less acute and visually dramatic, our environment is currently facing additional unprecedented challenges and changes. The concentration of carbon dioxide is increasing in the atmosphere and the oceans, oceans are become more acidic, global sea surface temperatures are rising as are global air temperatures, polar ice caps are melting, and usable fresh water is declining. The full effects of this inter-related phenomenon are not yet fully known. However, understanding the extent, causal mechanisms, and future impacts of these conditions will require OAR to develop the capacity to integrate various research domains of expertise, whether those domains exist within OAR, across NOAA, or within other agencies. OAR must leverage its capacity as a world-class leader of innovative science to take a pro-active approach towards understanding and predicting environmental phenomena occurring on a global scale. To begin to understand and make useful predictions of future states of the Earth-system, OAR will pursue four specific objectives:

1. Increase the development and utilization of accurate and reliable observing platforms and systems using integrative and cost-effective strategies
2. Improve the accuracy and reliability of Earth-system models
3. Increase the integration of ecosystem models and prediction capabilities ranging in time-scales from minutes to decades
4. Increase the accuracy of next-generation forecasts, tools, and technologies to predict the effects of oceanic and atmospheric interactions on people, places, and natural resources

Through measurable success in these five objectives, OAR will be better equipped to monitor key environmental processes, gather and model the data, integrate the various research domains, and use the models to perform various sophisticated forecasting assessments. Ultimately, these forecasting capabilities will be designed and executed to protect lives and property and promote the sustainable use of natural resources.

## Objective 1: Increase development and utilization of accurate and reliable observing platforms and systems using integrative and cost-effective strategies

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Accomplishments across the NOAA's mission goals are dependent upon the continued innovative development and utilization of global observation platforms and systems. Deferring investments into maintaining and upgrading systems puts NOAA at risk for significant degradation of the observing systems on which it depends for data collection, leading to a greater reliance on non-NOAA sources of data—an unreliable strategy over the long-term.

Anticipating a fiscally challenging environment in the coming years, OAR must employ innovative solutions to prioritize investments and implement cost-effective strategies which reduce spending overlap. Example near-term strategies that will be developed include: Utilizing a “network of networks” for mesoscale observing of the planetary boundary layer serving multiple environmental applications and cross sharing of information and designing and evaluating new cost-efficient tools to improve observing technology and data collection. With cost-effective observation strategies in place, OAR will be well positioned to increase its investments in priority focus areas including:

- Collecting hydrography data (e.g., regarding ocean carbon uptake and storage);
- Conducting observations and assessments of oceanic, atmospheric, land, and vegetation interactions for CO<sub>2</sub> and non-CO<sub>2</sub> GHGs as well as monitoring marine aerosols and air quality;
- Enhancing and maintaining oceanic and atmospheric observing systems, including floats and moored arrays (e.g., Prediction and Research Moored Array in the Atlantic [PIRATA], The Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction [RAMA], Argo, etc...)
- Increasing ground based (*in-situ*) observing capabilities in support of ocean acidification, sea ice movement, sea level rise, incoming solar radiation (SEB), vertical temperature and water vapor measurements;
- Expanding ocean observations below the Tropic of Capricorn

While these represent just a few activities that demonstrate innovation in observation capabilities that increase our understanding of the Earth-system, investments must be made strategically and with prioritization. Furthermore, innovative ideas which increase OAR's capacity to collect relevant data more rapidly and with less cost, must continue to be explored. OAR will continue to manage a high-risk high-reward research portfolio that pursues novel concepts: deployment of animal-borne observing systems at the scale of NOAA's regional ecosystems; development of DNA-based tools for identifying managed species; development and integration of suite sensors that can be used on any NOAA vessel. Through the utilization of strategic investments into innovative global observation platforms and systems, OAR and our partners will be well positioned to gather relevant data necessary to develop a holistic understanding of the earth-system.

While data gathering for the holistic understanding of the Earth-system is essential, it is of little use if the data are not accurate, reliable, or easily manipulated into usable ensembles and which increases our understanding of the Earth-system. The second objective of OAR's strategic plan is therefore to improve the accuracy and reliability of Earth-system data and models. To accomplish this objective, OAR will:

- Improve the assimilation of a growing suite of observations and determine uncertainty
- Increase the computational power to run more accurate models
- Develop advanced models that can be tested and applied at higher resolutions to make accurate short and long-term predictions.

As a means of assessing error rates and optimizing observing systems, OAR will also promote Observing System Simulation Experiments (OSSEs) to quantitatively evaluate tradeoffs in the design and configuration of proposed observing systems (e.g. coverage, resolution, accuracy and data redundancy). In turn, this will lead to better planning and decision making for the observing system portfolio. Understanding error estimates and calibrating the data used in models will also improve model accuracy. For example, OAR is partnering with NWS and NASA to conduct research on the use of the Ensemble Kalman Filter (EnKF) that uses uncertainty estimates from an ensemble to better estimate uncertainty in a forecast and improves data assimilation.

To further increase the accuracy of environmental models, OAR will need to make significant advancements in computational power. Because of power, cooling, reliability, cost, and application scaling, it is not practical to use Central Processing Units (CPUs) to run models designed for global cloud resolving scales of 3-4 kilometer resolution. Rather, Massively Parallel Fine Grain (MPFG) computing such as with Graphical processing units (GPUs) are needed for high resolution computing. GPUs are considered by many to be the next frontier in High Performance Computing (HPC). Early results have already demonstrated a 25 fold performance improvement in GPUs relative to CPUs and are a viable solution to meet the computational needs of the next generation of prediction models. However, research and development is required to determine how to best utilize GPUs and models must also be ported to system architecture.

Lastly, to increase the fidelity of models through better representation of the Earth-system, OAR will further improve numerical modeling capacity by generating models that can be tested and forecasted on multiple geographic and time-scales. For example, OAR has developed a new global finite-volume Non-hydrostatic Icosahedral Model (NIM) for weather and climate prediction. NIM is a multi-scale model designed to extend weather forecasts into intra-seasonal predictions beyond 0-2 weeks. Using GPU technology, NIM models can generate weather models across several geographic scales, each with an associated error that allows forecasting with varying measures of accuracy. Additional models such as the ocean model, Hybrid Coordinate Ocean Model (HYCOM) developed with a number of agency partners, also help us to better understand complex global ocean events. OAR must continue to develop multiple sophisticated models to improve our ability to understand the Earth-system.

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### Objective 3: Increase the integration of environmental models to understand complex ecosystem

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By using advanced global platforms to collect and subsequently assimilate accurate and reliable data, OAR will be well positioned to integrate models across various research domains to develop a better understanding of the interrelated processes of complex ecosystems. Ecosystems encompass physical, chemical, biological and social processes which together provide a multivariate suite of benefits to society, from food production, to water regulation and treatment, to recreation. Such benefits, however, depend upon a society that is knowledgeable and interacts with ecosystems sustainability. To provide relevant information for effective management of ecosystems through sound environmental decisions, OAR will increase the integration of data models to better understand complex ecosystem processes and generate decision support tools.

To accomplish this objective, a NOAA-wide Ecosystem Research Agenda, led by OAR, will provide a vision for how science, research, tools and technologies, and information sharing must be integrated to address to emerging issues within key geographically defined regions on specific issues including, coral reef habitats, ocean acidification, biodiversity, the extended continental shelf, invasive species, and hydrothermal communities. For these and other issues, OAR will provide leadership by observing and modeling key interrelated processes, integrating multidisciplinary research, and breaking down organizational barriers to data sharing to answer the key challenges of ecosystem management.

To maximize the utility of ecosystem models, OAR will effectively engage across NOAA, with the external science community, and the public to both learn from and inform where research is needed and to communicate decisions regarding ecosystem uses and impacts. Similar to observation networks, investments in integrated ecosystem models must also be prioritized. The following are example areas of priority areas which will be set by the Ecosystem Research Agenda:

- Ocean acidification—Improve understanding of ocean acidification and its impacts as mandated by Federal Ocean Acidification Research and Monitoring Act (FOARAM).
- Great Lakes—Develop and use an integrated ecological framework to identify impacts of multiple stressors (invasive species, hypoxia, land-use, climate change, nutrient enrichment, fishery harvest) on the pelagic food web and broader ecosystem.
- Gulf of Mexico—Develop a cohesive framework to monitor and integrate models of physical (currents, salinity, water quality, contaminants), biological (harmful algal blooms, plankton, fish), and chemical (dissolved oxygen, CO<sub>2</sub>) ecosystem processes, in order to improve coastal forecast systems, and provide a decision support framework for guiding research and management actions.

An ecosystem research approach towards these issues must integrate biological, chemical, and physical observational capacities across NOAA and the larger research community to understand the dynamic processes between oceans, the atmosphere, coasts, and Great Lakes. Only by bridging the gap between science domains across NOAA and with our external partners, will OAR be successful in developing a holistic understanding of the key ecosystems within the Earth-system.

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Objective 4: Increase the development of next-generation forecasts, tools, and technologies to predict the effects of the Earth-system on people, places, and natural resources

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Understanding the interrelated processes of complex environmental systems is not sufficient to meet OAR's mission. Rather, an Earth-system analysis and prediction framework to support one-day to decadal predictions is needed. Information, tools and technologies generated from advances in Earth-system prediction capabilities will help to create a society that is more adaptive to its environment; experiences fewer disruptions, dislocation, and injuries; and operates a more efficient economy. To accomplish this objective, OAR will continue to build upon its core capacity as a leader of environmental science by:

- Accelerating the development of innovative decision support systems technologies that merge information in a way that can be quickly understood by users such as forecasters and emergency managers
- Testing new technologies and social science linkages within test bed environments
- Utilizing integrated environmental models to generate long-term forecasts of global climate change and its associated impacts on people, places, and natural resources.

New observing and modeling systems will significantly increase the information available to forecasters. OAR, working with its customers and partners, will develop approaches that allow forecasters to quickly and easily identify data relevant to specific situations and questions.

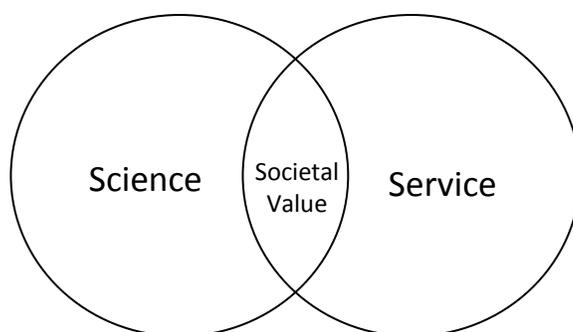
In addition to severe weather and physical events, OAR will improve its capacity to generate meaningful long-term assessments and projections of global change events including the impacts of increasing carbon dioxide in the atmosphere and oceans on biota; ; the impacts of climate change on fresh water supplies and agriculture; and the impacts of increasing water levels on coastal communities .

Climate change impacts occur over decades, thus requiring long-term research dedicated to understanding complex inter-related processes. No one single NOAA line office is able to perform all of the relevant research necessary to understand and predict the full impacts of global climate changes. However, OAR, as a dedicated research line, is committed to continue executing world-class research and integrating the research domains that are necessary for prediction of the effects of environmental changes in the Earth-system system on people, places, and natural resources.

## Service Goal

Engaged, educated public capable of making informed environmental decisions

OAR is recognized for its pre-eminent research and is dedicated to the goal of generating a holistic understanding and prediction capability of the Earth-system. To meet this goal, however, OAR will embrace and pursue its service goal of engaging society towards and facilitating an educated public that is capable of making informed environmental decisions. This goal also supports OAR's mission to *incubate long-term research and deliver information that supports NOAA services and societal needs*. By engaging the public, as well as internal and external partners, OAR will be better equipped to evaluate societal demands and respond through investments into research that is relevant to society and which encourages the public to make sound environmental decisions. The service goal embraces the view OAR delivers an optimal value to society through the integration of its science and service sectors.



To achieve its service goal, OAR will not only increase its capacity to deliver relevant information to the public, but also develop a stronger linkage to the science goal. The needs for OAR data, products, tool, and services are significant as well as diverse, whereby various stakeholders are best served through tailored delivery of information and products. While scientists typically disseminate findings through formal mechanisms such as peer-reviewed journals and professional meetings, the general public is better served through more generalized and tailored information. Neither the science nor the service sectors alone are able to meet these diverse needs. To further develop the application of delivering information to meet societal demands, OAR has defined the following specific objectives in which to enhance OAR services;

5. Enhance NOAA's social science capabilities
6. Improve public engagement through the use of extension, education, and communications tools and resources
7. Increase the efficiency of OAR's transition of research to applications

Similar to the science objective, successes in these three objectives will be monitored and measured. Through these successes, OAR will be better equipped to engage with stakeholders and improve its service offerings, deliver significant value to society, and facilitate the development of an engaged, educated public capable of making informed environmental and societal decisions.

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## Objective 5: Enhance NOAA’s social science capabilities

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OAR must enhance its social science capabilities to better address the needs of the nation. Although many applications of social science can be gathered from “off the shelf” products and tools, much of OAR’s social science needs are unique and require a specialized and dedicated approach. In fact, nearly every environmental science objective in OAR requires the services of applied social science to determine social behavior trends, costs and socioeconomic benefits, optimal delivery of information and services, and the determination of risk in environmentally sensitive societal sectors. Social science capabilities must be developed to not only answer these questions but also help prioritize future research endeavors.

The example of improving hurricane forecasting technologies demonstrates this need. While investing in hurricane forecasting technology will help protect lives and property, quantifying the extent of these benefits as a function of enhancing forecasting lead times through technology improvement, has yet to be done. In addition, realizing the benefits of hurricane forecasting technology requires that society understand and appropriately respond to it. Enhancing social science capabilities would not only help to answer the expected socioeconomic returns of the R&D investments such as with hurricane forecasting, but also determine the best mechanisms to engage relevant stakeholders and tailor technology implementation to ensure its successful adoption.

Enhancing social science capabilities will underscore the importance of engaging stakeholders, from policy makers to audiences at local and regional levels to not only identify the value but also streamline the efficient delivery of OARs products and services to user groups. Additional areas that would largely benefit from enhanced social science capabilities include but are not limited to; understanding the impacts and societal responses to extreme weather events and OAR’s tools and information to reduce risk exposure; Understanding tsunami and storm surge risk and OAR’s tools and information to reduce risk exposure and; Understanding global climate change events and what it means for society.

As social science research is a relatively new activity in some parts of OAR, several actions must be taken to enhance its social science capabilities;

- Identify and prioritize social science needs;
- Streamline efforts across OAR and NOAA to identify and prioritize areas of social science needs;
- Utilize in-house as well as external social science capabilities;
- Create a stronger linkage between social and traditional research scientists. Core research scientists must embrace and integrate social science into their research endeavors, and social scientists must work closely with scientists to fully understand the technical nature of the research enterprise.

By overcoming these challenges, OAR will better be able to develop sound social science capabilities which greatly complement the research enterprise.

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Objective 6: Improve public engagement through the use of extension, education, and communications tools and resources

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Equally important to understanding and characterizing the value of OAR to society, is the ability to deliver relevant data, information, and tools to the public in order to promote better understanding of the Earth-system. Understanding the Earth-system is necessary for policy makers and other stakeholders to make informed environmental decisions. Often times, however, such decision or lack of decision making, occur without understanding of long-term social, environmental, and economic consequences. Filling this gap and promoting a better understanding of the world around us is a strategic priority for OAR.

To improve public outreach and promote better understanding of the Earth-system, OAR must engage stakeholders through multi-directional communication. Data and information generated from pre-eminent researchers must be translated and disseminated to the public through engagement services and at the same time, OAR must communicate with the stakeholder community (from the general public, to other NOAA line offices, to the private sector) to determine the information, tools, and resources needed from the OAR's research enterprise.

Several specific priorities areas have been identified in which to improve public engagement to promote a better understanding of Earth-systems:

- Increasing extension and outreach to K-12, undergraduate, graduate, professional, and technical education programs in coastal and Great Lakes-related areas;
- Increase the development and utilization of innovative educational tools and concepts;
- Increase partnerships that leverage the transfer of OAR research to the public;

Firstly, increasing extension and outreach to K-12, undergraduate, graduate, professional, and technical education programs in coastal, ocean, and Great Lakes-related areas is a targeted approach for high impact delivery of OAR information and tools. Educational settings should be targeted as individuals are more likely to acknowledge and assimilate information presented to them. Moreover, the education and training of younger generations will ensure a future society that is environmentally aware and is able to make informed decision that reflect natural resource conservation and stewardship practices.

Secondly, OAR is well suited to promoting understanding of the Earth-system through the delivery of information and services using innovative solutions. As demonstrated through two examples; the *Okeanos Explorer* and *Science on a Sphere*, innovative solutions provide a modern outlook to education mechanisms. The NOAA Ship, *Okeanos Explorer* is the only federal vessel assigned to systematically explore our largely unknown ocean for the purpose of discovery and advancement of knowledge which uses telepresence capabilities to bring live ocean discoveries to classrooms, newsrooms, and living rooms from across the planet. *Science On a Sphere* (SOS)<sup>®</sup>, is another intuitive and captivating tool which uses computers and video projectors to visualize planetary data onto a six foot diameter sphere, analogous to a giant animated globe. Researchers at OAR developed Science On a Sphere<sup>®</sup> as an educational tool to help illustrate Earth-system science to people of all ages. Both of these concepts were are promoted as

educational tools that provide valuable information to people of all ages and scientific understanding. Further development of innovative tools and concepts would greatly enhance the public understanding of the Earth-system.

Lastly, the number strategic partnerships that leverage the transfer of OAR research to academic and public groups will be enhanced. Within OAR, the Sea Grant program is a champion of engagement and service extension efforts. The National Sea Grant College and Program Act of 1966 designates extension to impart “useful information to persons currently employed or interested in the various fields related to the development of marine resources, the scientific community and the general public.” With more than 30 Sea Grant Programs that span across 18 coastal states, it is well positioned to work more closely with OAR researchers and deliver those products, tools, and information that promote the better understanding of the Earth-system. The NOAA Office of Education, which is dedicated to the advancement of ocean, and Great Lakes literacy, extension, and outreach, is another program which could provide leveraged outreach. Partnerships with the academic community including university and cooperative institutes must also continue to be maintained.

Ultimately, OAR will be able to improve public outreach by actively engaging educational programs, creating and using innovative educational tools and concepts, and leveraging strategic partnerships. Accomplishments in these areas will help deliver relevant tools and information to multiple user groups towards the creation of a society capable of making informed environmental decisions.

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## Objective 7: Increase the efficiency of OAR's transition of research to applications

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OAR, is charged with delivering information, products, and tools to meet the needs of the other line offices of NOAA, the academic community, and the general public. A significant component of meeting this charge is to ensure the efficient transition of OAR's research to applications. To accomplish the objective of increasing the efficiency of transition of research to application, OAR will continue to transfer knowledge to the broader scientific community through peer review publications and contributions to scientific assessments (e.g. IPCC) and also increase the number of products, services, and tools to the commercial application.

The foremost aspect of demonstrating OAR's commitment to transitioning research to application is the transfer of knowledge to the broader scientific community through peer review publications. OAR is committed to ensuring the continued high standards and dissemination of its leading edge research through active publishing in both peer reviewed scientific journals as well as non-peer reviewed popular science articles. In FY 2010 alone, OAR scientists authored or contributed to over 800 peer reviewed articles in science areas relevant to NOAA's mission. This contribution is being tracked and reported on a quarterly basis to the Department of Commerce.

In addition to generating high caliber peer-reviewed publications, OAR will continue to work with partners across NOAA and the private sector to transition numerous modeling, observing, and decision support technologies from research to operations (R2O) or applications (R2A). OAR is actively working with the NOAA Line Office Transition Managers (LOTM) to optimize processes and partnerships that will improve the rate and efficiency of transitions. For example, a project database is currently in development within OAR and which is being expanded to include the portfolio of the National Weather Service. As part of its strategic plan, OAR will expand the OAR database to include all research line office research projects. A full spectrum analysis of research projects across NOAA, will allow strategic management and investment into those projects which are most promising for success. In addition, a cross NOAA review of transition projects is necessary to streamline R2A and reduce spending overlap. As research projects often require many years to develop the robust science needed for transition to operations, OAR will maintain a research portfolio that includes a mix of projects in various stages of development

The Office of Research and Technology Application (ORTA) in addition to the Small Business Innovation Research (SBIR) will also help play a key role in the transition of research to application. OAR recognizes that the private sector, especially small businesses, have the capacity and expertise to promote OARs mission through innovative discovery and development of new technologies. To realize this potential, the SBIR/ORTA program will streamline efforts with OAR leadership to develop a strategic plan that incorporates an evaluation of strategic investments to date and outline a plan to enhance its ability to invest in promising technologies that not only benefit NOAA but all of OAR. Ultimately, this program will help create new jobs and foster economic growth across the Nation in support of OAR's mission

## Support Goal

### An efficient and high performing organization

OAR is committed to the goal of a holistic understanding and prediction capability of the Earth-system. Through a stronger coordination with the goal of an engaged, educated public capable of making informed environmental decisions, OAR will be well positioned to maximize its value to society through the delivery of products, tools, and services that help protect lives and property. The ability to carry out these goals, however, is also dependent upon an efficient and high performing organization.

OAR will be challenged in the coming years with among other things, financial constraints and an aging workforce, which will impede OAR's success without adequate strategies and objectives in place. Recognizing these challenges and their potential impacts on the success of the science and service objectives, OAR has created the following objectives:

8. Increase the coordination of research and technology planning across NOAA
9. Advance the modernization of facilities, equipment, and IT infrastructure
10. Maintain an innovative, diverse and capable workforce
11. Increase strategic engagements and external partnership

The plans to coordinate the research and technology planning across NOAA are being drafted as a NOAA Administrative Order (NAO) for Optimizing NOAA's Research and Development (R&D) Enterprise. The purpose of this NAO being led by OAR is to improve the coordination of research efforts across NOAA and deliver science products and services more efficiently to OAR stakeholders. Also important to a high performing organization are advances in the modernization of facilities, equipment, and IT infrastructure which are necessary to ensure that OAR's workforce is equipped with the necessary tools to accomplish its work.

To ensure the success of OAR over the long-term, it will develop and implement a strategy to maintain an innovative, diverse and capable workforce. This is especially critical as OAR's workforce is aging. Not only does this present a risk through loss of expertise through attrition but also poses a difficulty in the retention of scientific leaders as a result of competition from other government agencies and the private sectors.

Lastly, the need to increase strategic engagement and external partnerships is paramount. For the same underlying reasons that warrant the development of a NOAA NAO on R&D, increasing engagement and partnerships beyond NOAA is necessary to increase the efficiency of carrying out OAR's mission. Innovative engagement practices must also be utilized to meet this objective. Engagement with not-for profit including non-government agencies and foundations, and also with the private sector including small businesses must all be explored for potential as mechanism to generate a high performing organization.

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## Objective 8: Strengthen research and technology through integration across NOAA

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The NOAA administrator, Dr. Jane Lubchenco, stated the following to the Committee on Science, Space, and Technology, U.S. House of Representatives on June 22, 2011:

“OAR will continue to serve as NOAA’s centralized research Line Office, serving all of NOAA by supporting and producing pre-eminent research and technology innovation that advances NOAA’s mission. OAR will innovate—make new discoveries and find new technology applications, incubate—conduct long term research and develop technology to make new discoveries that are useful to NOAA’s operations, and integrate—strengthen research and technology across NOAA and with partners.”

In support of this testimony, OAR will serve NOAA as its centralized research line office, and will be responsible for increasing the coordination of research and technology planning across the agency through the streamlining and efficient delivery of research to key stakeholders. In addition, OAR will strengthen research and technology throughout the agency through identification, development, and dissemination of best management practices. OAR already utilizes a rigorous process for the review of science and research across its laboratories. This process ensures that its science is meets the highest level of scientific integrity. The same practices of science integrity and review will be utilized as a base to review the research activities across the agency.

The mechanism through which OAR will be responsible for the integral role across the agency is characterized in the NOAA administrative order (NAO): Strengthening NOAA’s Research and Development (R&D) Enterprise. This NAO establishes the principles, policies, and responsibilities for planning, monitoring, evaluating, and reporting research and development (R&D) activities comprising the entire NOAA R&D enterprise. Coordination of the research and development efforts, applies to internal and external R&D activities, and includes R&D conducted by NOAA and sponsored by others. Guidance will further be developed within a procedural Handbook that covers; R&D Planning, Enterprise R&D Monitoring Database, Program/Laboratory/Science Center Reviews, Portfolio Reviews, Benchmarking Reviews, Performance Measures, R&D Reporting. A critical component that will support coordination efforts across the agency is a project level database.

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## Objective 9: Advance the modernization of facilities and equipment

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OAR's facilities and equipment must be maintained at optimal performance levels and sustained over the long-term to achieve OAR's mission. OAR therefore recognizes the importance of the goal to advance the modernization of facilities and equipment. Three specific challenges must be overcome to meet this goal: The accurate estimation of full asset life cycle costs, cross NOAA prioritization of asset acquisition or development, and the innovative development of facilities and equipment with reduced infrastructure costs.

The first issue of estimating full asset life cycle costs requires an improved ability to assess acquisition, operational, and maintenance costs of significant assets (e.g. research vessels, planes, super-computing technology, etc...). While the acquisition or initial development costs may be more readily identified, long-term maintenance and operational costs must also be assessed in order to retain sufficient funding levels to maintain assets at their optimal performance. Accurate budget assessments prior to acquisitions or development, in addition to accurate yearly cost estimates would help resolve this issue and increase asset utilization.

In addition the ability to generate full cost-estimates, OAR must lead a cross line office prioritization of asset acquisition or development. Working with the other line offices to combine resources towards high priority mission objectives and execute collaborative projects is necessary to ensure that all Line Office needs are met—especially in a fiscally challenging environment. Open ocean research cruises, for example, may be coordinated between OAR and the other line offices to reduce cost overlap in certain priority objectives. The OAR project database, that is being expanded to include all of NOAA, will be used as an important valuation tool to identify areas of potential collaboration.

Lastly, OAR will continue to explore innovative solutions to achieve its goals and objectives but at less cost. Focal areas of innovation include but are not limited to manned (research and exploratory vessels) and unmanned system research vessels (AUVs, UASs, USVs), research equipment including sensor technology, and super computing technology (e.g. GPUs). The issue of innovation and modern facilities and equipment will be addressed annually by OAR's senior research council.

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## Objective 10: Maintain an innovative, diverse and capable workforce

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OAR is committed to the delivery of preeminent science to meet the diverse needs of society. Meeting these needs requires that OAR maintain a highly capable workforce that is enthusiastic, knowledgeable, and flexible. Specifically, OAR must maintain an optimally diverse workforce and provide training and development, both scientific and managerial, that is comparable to other government agencies and the private sector. Scientific and managerial training is needed to ensure that the workforce retains the knowledge and skill sets that would otherwise be lost through attrition and retirement.

In addition to providing leadership training, OAR must continue to acquire and retain world class talent, science and administrative career paths need to be supported with stepwise career advancement. To better support the professional development of NOAA scientists, the NOAA Research Council, OAR, and Workforce Management are working to:

- Allow NOAA scientists full participation in professional or scholarly societies, committees, task forces, and other specialized bodies of professional societies, including removing barriers for serving as officers or on governing boards of such societies (related to section on Promoting Scientific Integrity)
- Coordinate with the office of the NOAA Chief Scientist on a detailed set of formal recommendations to NOAA Senior Management on the broader uses of Senior Technologist/Senior Leader (ST/SL) positions within NOAA
- Increase the recruitment and advancement of promising young professionals to senior level positions on a limited or detail specific basis.

Empowering young professions to serve in senior level capacities with adequate an adequate support network is essential to transition the next generation of science leaders. Accomplishments in these actions will help to ensure that the preeminence in the OAR enterprise is maintained over the longterm.

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## Objective 11: Increase strategic engagements and external partnership

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Strategic engagements are paramount to the success of OAR, whether in research or services disciplines. Partnerships are especially important in the face of budget constraints that are anticipated in the coming years. Through engagement and partnership opportunities, OAR is able to leverage its investments and generate higher value to society. Specific engagement and partnership opportunities that should be strategically promoted are with cooperative institutes, the international community, and with other agencies.

Cooperative Institutes (CI) are NOAA-supported academic institutions that have established an outstanding research program in areas directly related to NOAA's long-term mission needs. Established at research institutions, they also have strong education programs with established graduate degree programs in NOAA-related sciences. As such, CIs must remain a strategic source in which to recruit academic professionals to advance OAR's mission. CIs engage in research that requires substantial involvement of one or more research units within the research institution and one or more NOAA laboratories or programs. Thus, CIs also provide significant coordination of resources among all non-government partners and promote students and postdoctoral scientist involvement in NOAA-funded research. To realize the full benefits through cooperation with CIs, OAR must continue to strengthen its engagement efforts. This will be achieved by closer alignment between senior leadership from both OAR laboratory programs as well as political leadership across NOAA.

The international community must also be strategically engaged. While increasing the number of international partnerships is not feasible in a fiscally challenging environment, specific geographic areas of particular interest to the OAR community and warrant an increase in directed engagement efforts. These areas include neighboring countries of the Gulf regions including the Caribbean, Canada with its relationship to the Great Lakes regions, Russia and other international partners related to efforts in Alaska and polar regions. OAR is actively involved in these regions and these associate international partners are critical to leveraging OAR science and services.

Lastly, stronger engagement is needed with other agencies, especially in the engagement of domestic regional entities. Increasing the support and cooperation between federal agencies and regional ocean governance groups is a strategic priority of the National Ocean Policy (NOP). NOAA and OAR are committed to supporting the development and implementation of the NOP and especially those policies affecting Coastal Marine Spatial Planning (CMSP). By working with the other federal agencies in this process, OAR will increase coordination with regional groups and leverage its ability to deliver products and services to the general public.

By increasing strategic partnerships through the cooperative institutes and academic partners, the international community, other federal agencies, and regional entities, OAR will greatly enhance its ability to cost-effectively deliver its products and services to meet the needs of society. This ability is critical to the goal of a high performing organization.