

NOAA'S NEXT-GENERATION STRATEGIC PLAN

DECEMBER 2010





**NOAA'S MISSION:
SCIENCE, SERVICE & STEWARDSHIP**

To understand and predict changes in climate, weather, oceans, and coasts,
To share that knowledge and information with others, and
To conserve and manage coastal and marine ecosystems and resources



U. S. DEPARTMENT OF COMMERCE • NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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OVERVIEW OF NOAA'S STRATEGY

Through its long-standing mission of science, service, and stewardship, the National Oceanic and Atmospheric Administration (NOAA) generates tremendous value for the Nation—and the world—by advancing our understanding of and ability to anticipate changes in the Earth's environment, by improving society's ability to make scientifically informed decisions, and by conserving and managing ocean and coastal resources.

NOAA's Mission: *Science, Service, and Stewardship*

*To understand and predict changes in climate, weather, oceans, and coasts,
To share that knowledge and information with others, and
To conserve and manage coastal and marine ecosystems and resources.*

NOAA's mission is central to many of today's greatest challenges. Climate change. Severe weather. Natural and human-induced disasters. Declining biodiversity. Ocean acidification. Threatened or degraded ocean and coastal resources. These challenges convey a common message: human health, prosperity, and well-being depend upon the health and resilience of coupled natural and social ecosystems. Managing this interdependence requires timely and usable information to make decisions and the science that underpins our knowledge of these systems. NOAA's mission of science, service, and stewardship is directed to a vision of the future where societies and their ecosystems are healthy and resilient in the face of sudden or prolonged change.

NOAA's Vision of the Future: *Resilient Ecosystems, Communities, and Economies*

Healthy ecosystems, communities, and economies that are resilient in the face of change

Resilient ecosystems, communities, and economies can maintain and improve their health and vitality over time by anticipating, absorbing, and diffusing change. This vision of resilience will guide NOAA and its partners in a collective effort to reduce the vulnerability of communities and ecological systems in the short-term, while helping society avoid or adapt to long-term environmental, social, and economic changes. To this end, NOAA will focus on four long-term outcomes within its primary mission domains.

NOAA's Long-term Goals:

Climate Adaptation and Mitigation

An informed society anticipating and responding to climate and its impacts

Weather-Ready Nation

Society is prepared for and responds to weather-related events

Healthy Oceans

Marine fisheries, habitats, and biodiversity are sustained within healthy and productive ecosystems

Resilient Coastal Communities and Economies

Coastal and Great Lakes communities are environmentally and economically sustainable

NOAA cannot achieve these goals on its own, but neither can society achieve them without NOAA. This plan describes long-term outcomes where NOAA will contribute in each of the goal areas, along with specific objectives that NOAA will pursue over the next five years. As a whole, NOAA's capacity to achieve these goals and objectives will depend upon the continued strengthening and integration of NOAA's enterprise-wide science and technology, stronger partnerships and stakeholder engagement, and effective organizational and administrative functions.

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NOVEMBER 2010 — UPDATE THIS TO THE ACTUAL DATE OF PUB (MONTH YEAR)

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Letter from the NOAA Administrator

NOAA's mission is central to many of today's greatest challenges. The state of the economy. Jobs. Climate change. Severe weather. Ocean acidification. Natural and human-induced disasters. Declining biodiversity. Threatened or degraded oceans and coasts. These challenges convey a common message: Human health, prosperity, and well-being depend upon the health and resilience of both managed and unmanaged ecosystems. Combined with the capabilities of our many partners in Government, universities, and the private and nonprofit sectors, NOAA's science, service, and stewardship capabilities can help transition to a future where societies and the world's ecosystems reinforce each other and are mutually resilient in the face of sudden and prolonged change.

We clearly have a long way to go in order to realize this vision. We know much about the steep rise of global greenhouse gases and their current and potential impacts on the environment and on society. But our level of uncertainty about many of these impacts is far too high, particularly at regional to local scales. Our society's ability to mitigate and adapt to a changing climate will require far greater knowledge of climate trends and their impacts than we can deliver currently. At the same level, our ability to sustainably use and protect ocean and coastal resources will drive, in substantial measure, the prosperity, health, and safety of future generations—as will our ability to forecast and predict a wide range of environmental events, from hurricanes and tornados, to regional water supplies and pollutants along our coasts.

All of these challenges entail problems at the intersection of society, economy, and the environment—where NOAA's mission has its greatest impact. My optimism about the future is rooted in NOAA's long-standing record of science, service, and stewardship. We must address challenges and opportunities proactively and shape a better future for generations to come. This is the purpose of NOAA's Next Generation Strategic Plan.

This Plan conveys NOAA's mission and vision of the future, the national and global issues NOAA must address, the specific outcomes NOAA aims to help society realize, and the actions that the Agency must undertake. It emerged from extensive consultations with NOAA employees and our stakeholders—the extended community of partners and collaborators in the public, private, and academic sectors who contribute to NOAA's mission. In stakeholder forums across the country; a national forum in Washington, DC; as well as in Web-based engagement and idea generation, we took a fresh look at the major trends facing the Nation to stimulate our best thinking on how NOAA might respond.

Informed by these consultations, this Plan represents our assessment of the highest priority opportunities for NOAA to contribute substantially to the advancement of society. The availability and quality of fresh water, the exposure of people and communities to high impact weather, stresses of urbanization of the coasts, the exploitation of ocean and coastal resources, and above all the pervasive effects of climate change on society and the environment—these are the central challenges we must face if we are to improve human welfare and sustain the ecosystems upon which we depend. These are the challenges that define NOAA's strategic goals. Through the concerted efforts of NOAA and many other organizations, we can navigate our way toward a future where people, communities, and ecosystems prosper and are resilient in the face of change.

Thank you for engaging in NOAA's strategy. Your continued interest and involvement in NOAA is vital to the work of the Agency and to the health of our society, economy, and environment.



Jane Lubchenco, Ph.D.
Undersecretary of Commerce for Oceans and Atmosphere

NOAA's Mission: Science, Service, and Stewardship

NOAA generates tremendous value for the Nation—and the world—by advancing our ability to understand and anticipate changes in the Earth's environment, improving society's ability to make scientifically informed decisions, and by conserving and managing ocean and coastal ecosystems and resources. NOAA's world-class research and information services continuously advance our scientific understanding of a changing climate and its impacts. NOAA monitors and models the environment to forecast daily weather; warns us of hurricanes, tornados, and tsunamis; and supports private enterprise with the information necessary to sustain economic growth. NOAA is directly responsible for managing the Nation's fisheries and for supporting the responsible management of coastal habitats and species. NOAA is a global leader in understanding the processes by which ecosystems provide services crucial for human survival on Earth, and in helping to educate businesses and Federal, State, and local decision makers about how the health of human society and the health of the environment are interconnected.

NOAA's mission statement summarizes the Agency's fundamental mission responsibilities.

NOAA's Mission: *Science, Service, and Stewardship*

To understand and predict changes in climate, weather, oceans, and coasts,

To share that knowledge and information with others, and

To conserve and manage coastal and marine ecosystems and resources

Science at NOAA is the systematic study of the structure and behavior of the ocean, atmosphere, and related ecosystems; integration of research and analysis; observations and monitoring; and environmental modeling. NOAA science includes discoveries and ever new understanding of the oceans and atmosphere, and the application of this understanding to such issues as the causes and consequences of climate change, the physical dynamics of high-impact weather events, the dynamics of complex ecosystems and biodiversity, and the ability to model and predict the future states of these systems. Science provides the foundation and future promise of the service and stewardship elements of NOAA's mission.

Service is the communication of data, information, and knowledge to others for use in their businesses, communities, and daily lives. NOAA services include climate predictions and projections; weather and water reports, forecasts and warnings; nautical charts and navigational information; and the continuous delivery of a range of Earth observations and scientific data sets for use by public, private, and academic sectors.

Stewardship is NOAA's direct use of its knowledge to protect people and the environment, as the Agency exercises its direct authority to regulate and sustain marine fisheries and their ecosystems, protect endangered marine and anadromous species, protect and restore habitats and ecosystems, conserve marine sanctuaries and other protected places, respond to environmental emergencies, and aid in disaster recovery.

The foundation of NOAA's long-standing record of scientific, technical, and organizational excellence is its people. NOAA's diverse functions require an equally diverse set of skills and constantly evolving abilities in its workforce. Also underlying NOAA's continued success is its unique infrastructure. NOAA's core mission functions require satellite systems, ships, buoys, aircraft, research facilities, high-performance computing, and information management and distribution systems. NOAA provides research-to-application capabilities that can recognize and apply significant new understanding to questions, develop research products and methods, and apply emerging science and technology to user needs. NOAA invests in and depends heavily on the science, management, and engagement capabilities

of its partners. Collectively, NOAA’s organizational enterprise—its people, infrastructure, research, and partnerships—provide the foundation to achieve NOAA’s vision and long-term goals.

NOAA’s Vision of the Future: Resilient Ecosystems, Communities, and Economies

Through its mission of science, service, and stewardship, NOAA helps society address some of the most pressing questions of our time. Can we secure an economic future that is both prosperous and environmentally sound? Can we spare future generations the potential calamities foretold by unchecked greenhouse gas emissions? Can we improve public safety and security of our communities in the face of high-impact weather and water events? Can we both use and preserve the ocean and coastal ecosystems upon which the Nation’s communities and economy depend?

These challenges reveal the intimate connection between people and the natural environment. Human health, prosperity, and well-being depend upon the health and resilience of coupled natural and social ecosystems. Managing this interdependence requires timely and usable information to make decisions and the science that underpins our knowledge of these systems. Earth’s ecosystems support people, communities, and economies. Similarly, human well-being requires preparing for and responding to changes within these natural systems. NOAA’s mission of science, service, and stewardship is directed to a vision of the future where societies and their ecosystems are healthy and resilient in the face of sudden and prolonged change.

NOAA’s Vision of the Future: *Resilient Ecosystems, Communities, and Economies*
Healthy ecosystems, communities, and economies that are resilient in the face of change

Resilient ecosystems can absorb impacts without significant change in condition or function. A resilient ecosystem continues to provide both the expected and new, as well as yet undiscovered goods to human communities. A vision of resilience will guide NOAA and its partners in a collective effort to reduce the vulnerability of communities and ecological systems in the short-term, while helping society avoid or adapt to potential long-term environmental, social, and economic changes. To achieve this vision we must understand current Earth system conditions, project future changes, and help people make informed decisions that reduce their vulnerability to environmental hazards and stresses that emerge over time, while at the same time increase their ability to cope with them.

Resilient human communities and economies maintain or improve their health and vitality over time by anticipating, absorbing, diffusing, and adapting to change. Resilient communities and institutions derive goods from ecosystems in a way that does not compromise ecosystem integrity, yet is economically feasible and socially just for future generations. To this end, NOAA will focus on four long-term goals that are central determinants of resilient ecosystems, communities, and economies—and that cannot be achieved without the Agency’s distinctive mission and capabilities.

NOAA’s Long-term Goals:

Climate Adaptation and Mitigation

An informed society anticipating and responding to climate and its impacts

Weather-Ready Nation

Society is prepared for and responds to weather-related events

Healthy Oceans

Marine fisheries, habitats, and biodiversity are sustained within healthy and productive ecosystems

Resilient Coastal Communities and Economies

Coastal and Great Lakes communities are environmentally and economically sustainable

Unified by an overarching vision of resilience, these goals are mutually supportive and complementary. Just as economic prosperity depends upon a healthy environment, the sustainability of ocean and coastal ecosystems depends on society's ability to mitigate and adapt to a changing climate and other environmental changes. Similarly, sustainable economic growth along the Nation's coasts, in arid regions, and in countries around the world depends upon regional-scale climate predictions and projections. Likewise, the resilience of coastal communities depends on their understanding of and preparedness for sudden or prolonged adverse weather and water extremes. By accounting for these interconnections, NOAA can magnify the effect of each goal on its common vision of resilient ecosystems, communities, and economies.

As a science-based organization, NOAA's unique enterprise capabilities provide the foundation to achieve ambitious long-term strategies: a world-class Earth system research capability that spans natural and social science disciplines; accurate and sustained environmental observations, interoperable data, and information on physical, chemical, and biological systems; and numerical models, projections, and predictions of possible future conditions of the Earth's systems. To address the interconnected and complex challenges associated with a changing climate, uncertain weather and water conditions, and overstressed ocean and coastal resources, NOAA must be agile and possess the ability to deploy highly trained scientific and technical experts and specialized infrastructure and information technology assets, and to collaborate effectively with a diverse network of global and local partners.

Long-term goal: Climate Adaptation and Mitigation

An informed society anticipating and responding to climate and its impacts

Projected future climate-related changes include increased global temperatures, melting sea ice and glaciers, rising sea levels, increased frequency of extreme precipitation events, acidification of the oceans, modifications of growing seasons, changes in storm frequency and intensity, air quality, alterations in species' ranges and migration patterns, earlier snowmelt, increased drought, and altered river flow volumes. Impacts from these changes are regionally diverse, and affect numerous sectors related to water, energy, transportation, forestry, tourism, fisheries, agriculture, and human health. A changing climate will alter the distribution of water resources and exacerbate human impacts on fisheries and marine ecosystems, which will result in such problems as overfishing, habitat destruction, pollution, changes in species distributions, and excess nutrients in coastal waters. Increased sea levels are expected to amplify the effects of other coastal hazards as ecosystem changes increase invasions of non-native species and decrease biodiversity. The direct impact of climate change on commerce, transportation, and the economy is evidenced by retreating sea ice in the Arctic, which allows the northward expansion of commercial fisheries and provides increased access for oil and gas development, commerce, and tourism.

These changes already have profound implications for society, underscoring the need for scientific information to aid decision makers develop and evaluate options that mitigate the human causes of climate change and adapt to foreseeable climate impacts. While the Nation has made significant progress in understanding climate change and variability, more work is needed to identify causes and effects of these changes, produce accurate predictions, identify risks and vulnerabilities, and inform decision

making. No single organization can accomplish these tasks alone. NOAA will advance this long-term goal of climate adaptation and mitigation as it builds upon a strong scientific foundation and decades of engagement with interagency, academic, and private sector partners to strengthen scientific understanding of climate; monitor changes in the atmosphere, oceans, and land; produce climate assessments; develop and deliver climate services at global and regional scales; and increase public knowledge of climate change and its impacts. Through its stewardship responsibilities and expertise, NOAA will improve its capacity to monitor, understand, and predict the impacts of a changing climate on weather patterns, water resources, and ocean and coastal ecosystems.

NOAA Partnerships for Climate Adaptation and Mitigation—NOAA fulfills a key role in an international global climate enterprise that already has made significant progress in understanding climate variability and change. NOAA is a national leader on the Intergovernmental Panel on Climate Change (IPCC) and, at the Federal level works with the Interagency Climate Change Adaptation Task Force and the U.S. Global Change Research Program. Recipients of NOAA’s climate science and services include the Environmental Protection Agency (EPA) and Agencies within the U.S. Departments of Energy, State, Agriculture (USDA), Transportation (DOT), Interior (DOI), Health and Human Services, Homeland Security (DHS), and Defense (DOD). NOAA also partners with the National Aeronautics and Space Administration (NASA) to develop satellite technology that detects climate trends. Sustained partnerships among Federal Agencies, international, State, local and tribal governments, academia, non-governmental organizations, and the private sector are required to observe and monitor the climate system; improve scientific understanding; produce more useful climate predictions; identify climate risks and vulnerabilities; deliver climate-relevant information for decision making; and better inform society about climate variability, change, and their impacts. Through its stewardship responsibilities and expertise, NOAA will focus its collaboration activities on the impacts of a changing climate on the Nation’s ocean and coastal ecosystems, which include living marine resources, salt and freshwater resources, as well as coastal communities.

Objective: Improved scientific understanding of the changing climate system and its impacts

The need to advance understanding of the climate system and climate impacts, improve climate predictions and projections, and better inform adaptation and mitigation strategies is urgent. Key scientific uncertainties limit scientists’ ability to understand and predict changes in the climate system. This is particularly true for monthly-to-decadal timescales and at the regional and local levels for which scales are highly relevant to planning and decision making. Research on the connections between weather and climate, for instance, is necessary to understand how a changing climate may affect precipitation patterns and severe weather events, including hurricanes. On decadal-to-centennial timescales, research is needed to understand feedback between atmospheric greenhouse gases and the rate of global-to-regional climate impacts, such as changes in sea level, heat waves, droughts, and air and water quality. Adaptation and mitigation strategies must be informed by a solid scientific understanding of the climate system. Research is required to understand how changes in the global ocean circulation affect the climate system and their subsequent impacts on coastal regions, including sea level rise, ocean acidification, and living marine resources. Improved understanding of climate change and variability requires sustaining and advancing climate observation systems and platforms that monitor the state of the climate system. International, National, State, and local efforts to limit greenhouse gases require reliable information to support emissions verification, as do efforts to track climate changes and mitigate impacts.

To achieve this objective, NOAA will continue its world-class observation, monitoring, research, and modeling efforts, and increase efforts to close gaps in understanding the climate system and the role of humans within the system. This effort will require expanding and sustaining comprehensive, global- and regional-scale climate observing and monitoring networks that provide high-resolution information, and conducting and sponsoring fundamental physical, chemical, and biological research to discover new approaches and opportunities to understand the climate system, along with research to explore the effects of a changing climate on social and economic systems. NOAA will conduct and sponsor research on how climate variability and change affect different regions, particularly those especially vulnerable to climate impacts. This will require answering key questions that limit scientific understanding of the ocean's role in climate (such as ocean variability, ocean circulation and heat content), atmospheric composition (clouds, aerosols, precipitation), ice sheets, global energy budget, biogeochemical cycles, and socio-economic parameters. NOAA must integrate this knowledge into models to improve predictive capabilities, and increase the number and quality of climate predictions through high-performance computing and modeling advancements. Actively engaging the external research community through competitive research programs will be vital to ensure NOAA's successful realization of this objective.

Over the next five years, evidence of progress toward this objective will include:

- More comprehensive knowledge of greenhouse gases and other climate forcing agents;
- Climate observing systems are sustained and the state of the climate system is routinely monitored;
- Improved basis for confidence in understanding key oceanic, atmospheric, hydrologic, biogeochemical, and socioeconomic components of the climate system and impacts;
- Advances in climate modeling leading to improved scientific understanding and a new generation of climate predictions and projections on global to regional scales and from monthly to centennial time scales
- Increased confidence in assessing and anticipating climate impacts; and
- Quantitative short- to long-term outlooks and projections of Arctic sea ice.

Objective: Assessments of current and future states of the climate system that identify potential impacts and inform science, service, and stewardship decisions

Stakeholders and the general public need a clear understanding of the best available science that describes the state of the climate and the likely impacts of climate change. Scientific assessments at the global, national, regional, and local levels integrate knowledge from many disciplines to provide decision makers with authoritative information on climate impacts, identify gaps in understanding, and help prioritize future research and service development efforts to fill those gaps. When pursued on a sustained basis, assessments build relationships between researchers and users and provide context for climate services that are developed and delivered by NOAA and others.

To achieve this objective, NOAA will play a lead role in international and national assessments that survey and summarize current scientific understanding about the causes and consequences of climate change and its impacts. NOAA will work closely with partner agencies and the external research community to ensure that these assessments are of the highest scientific quality. Internationally, this objective entails sustained contributions and leadership of scientific

assessments, such as those of the IPCC and the international assessments of ozone layer depletion. Special attention will be given to generating state-of-the-art simulations of future climate conditions and ensuring model simulations and analyses are directed to inform assessments of impacts, mitigation and adaptation strategies, and vulnerability. This objective requires NOAA's continued work to assess potential climate impacts in the United States. NOAA will develop high-resolution climate information to identify key vulnerabilities and inform the development of climate services that meet the needs of targeted audiences and better define and implement adaptive and mitigating management strategies. To supplement its own work, NOAA will rely on and support efforts undertaken by partners at other Agencies and research institutions around the world to understand economic, environmental, and social risks, and to communicate these findings. Through its stewardship responsibilities and expertise, NOAA will play a lead role with respect to assessing economic and environmental risks to ocean and coastal ecosystems, living marine resources, and air and water resources.

Over the next five years, evidence of progress toward this objective will include:

- Potential climate impacts and key international, national, and regional vulnerabilities are identified and inform the development of useful climate services;
- Model simulations and analyses inform IPCC assessments of climate impacts, adaptation, and vulnerabilities; and
- National and regional assessments address particular needs of NOAA's unique stewardship responsibilities for ocean and coastal ecosystems, living marine resources, and water resources.

Objective: Mitigation and adaptation choices supported by sustained, reliable, and timely climate services

Human-induced changes in Earth's climate, as well as natural climate variability, complicate the ability to effectively plan for the future, manage resources, support national and food security, meet international and other intergovernmental agreements, and sustainably develop the economy. Resource managers, Governments, public and private businesses and organizations recognize that a changing climate complicates their ability to achieve their goals. Existing information is not readily available to those who need it or formatted in a way that makes it easy to use. The Nation needs a comprehensive, authoritative, and coordinated source of climate information to support adaptation and mitigation strategies and to incorporate into risk and vulnerability assessments and related decision-making processes.

To achieve this objective, NOAA will build upon its strong scientific foundation and internal and external partnerships to develop and deliver climate services. These services will include up-to-date descriptions of the state of the climate; regional information derived from global climate models; useful predictions of likely climate impacts; and the timely delivery of climate information, short-term and long-term forecasts, and early warnings. These products will be accompanied by services that help decision makers use climate information, model outcomes, and understand the associated uncertainties. NOAA's initial service development efforts will focus on producing climate predictions, information, and ecosystem impact assessments for the water, coastal, and living marine resources sectors, including improved sea level rise and ocean acidification monitoring, predictions, and information on related ecosystem and infrastructure impacts. Over time, NOAA will also develop and improve similar services for other sectors, such as health, traditional and renewable energy, agriculture, transportation, terrestrial resources, tourism, and national security. Developing services that meet these diverse needs will require

increased coordination and collaboration across NOAA and with other Federal Agencies, governments, academia, non-governmental organizations, and the private sector. To ensure that a diverse community of customers can access and use NOAA’s data products and information services, NOAA will produce new and improved data management and access systems—including the NOAA Climate Services (NCS) Portal—that enhance the communication and dissemination of climate information and products.

Over the next five years, evidence of progress toward this objective will include:

- National, State, local, and tribal governments and water resource managers are better able to prepare for, adapt, and respond to drought and flooding, and can more confidently manage water resources;
- Coastal resource managers incorporate a greater understanding of the risks of sea level rise, changes in Great Lakes hydrology and water levels, and other climate impacts to reduce the vulnerability of coastal communities and ecosystem resources;
- Living marine resource managers prepare for and respond to the impacts of a changing climate, ocean acidification, and other climate impacts, and develop management strategies for marine ecosystem conditions;
- Decision makers prepare for and adapt to climate extremes, including deviations in temperatures and precipitation patterns; and
- Policy makers have the information and understanding they need to implement and manage options that mitigate climate change.

Objective: A climate-literate public that understands its vulnerabilities to a changing climate and makes informed decisions

The success or failure of climate adaptation and mitigation in the United States and around the world will depend on the ability of leaders, organizations, institutions, and the public to understand the challenges and opportunities climate change presents. The routine incorporation of climate information into decisions requires an awareness of how a changing climate may affect individuals, families, businesses, and communities. A society educated about climate change and actively engaged in dialogue about its causes and effects will better address today’s problems and plan for tomorrow.

To achieve this objective, NOAA will work with diverse internal and external partners in academia and elsewhere to increase understanding of the likely impacts of climate variability and change through investments in climate awareness efforts, capacity building, education, and outreach. NOAA will engage stakeholders at multiple levels, foster community dialogue, and educate citizens and students both formally and informally. Engagement efforts will be highly adapted to meet the needs of various segments of society. NOAA will work to ensure continuous and sustained dialogue among partners in order to understand capabilities and identify climate-related risks that are of the most urgent concern to decision makers and the public. This engagement will help NOAA understand how user needs for climate services are changing, how users perceive climate risks and uncertainty, and consequently, how to design future climate products and services. In addition to data and products, the NCS Portal will offer a broad array of climate communications and educational materials that stem from NOAA’s climate research, observations, modeling, and services.

Over the next five years, evidence of progress toward this objective will include:

- Key segments of society understand climate risks and use that knowledge to increase resilience to likely climate impacts;
- Consumers of climate information understand the strengths and limitations of climate information and utilize this knowledge in their decision making processes;
- Educators and other outreach professionals increase comprehension and use of climate science concepts and education resources; and
- NOAA is better able to identify and monitor stakeholder needs and refine its information products to enhance their value and meet evolving needs.

Long-term goal: **Weather-Ready Nation**

Society is prepared for and responds to weather-related events

A weather-ready nation is a society that is able to prepare for and respond to environmental events that affect safety, health, the environment, economy, and homeland security. Urbanization and a growing population increasingly put people and businesses at greater risk to the impacts of weather, water, and climate-related hazards. NOAA's capacity to provide relevant information can help create a society that is more adaptive to its environment; experiences fewer disruptions, dislocation, and injuries; and that operates a more efficient economy.

Over the long-term, climate change may increase the intensity and even the frequency of adverse weather events, which range from drought and floods, to wildfires, heat waves, storms, and hurricanes. Changing weather, water, and climate conditions affect the economic vitality of communities and commercial industries, including the energy, transportation, and agriculture sectors. Environmental information aligned with user needs will become ever more critical to the safety and well-being of those exposed to sudden or prolonged hazards and is essential to sustain competitive advantage, expand economic growth, and to secure the Nation. All of the objectives within the *Weather-ready Nation* goal are highly dependent on progress toward the objectives under the *Climate Adaptation and Mitigation* goal. Likewise, progress toward this goal will benefit many of the objectives of the *Healthy Oceans* and *Resilient Coastal Communities and Economies* goals, and vice versa.

NOAA Partnerships for a Weather-Ready Nation—Achieving a weather-ready nation requires the work of NOAA, and the combined efforts of numerous public, private, and academic partners. The dissemination, communication, and validation of NOAA forecasts and warnings depend on the media, the emergency management community, and the U.S. weather and climate industry. NOAA views this diverse and growing industry of companies, media outlets, and others that create weather programming, provide consulting services, and deliver information to American society as a key strategic partner, which provides valuable services to many businesses while also being an important economic sector in its own right.

NOAA will work closely with local, State, and national emergency managers and other Government Agencies to understand better the information they need to assess risk and make decisions. This will lead to more integrated, usable, and relevant information and services. NOAA must strengthen relationships with many existing partners and develop new relationships that enable better integration of information into emerging areas that have economic, environmental, and health impacts. Examples of long-standing partnerships include other Department of Commerce (DOC) Agencies; DHS; the Federal Emergency Management Agency; DOT; DOD; the U.S. Geological Survey (USGS); the U.S. Army Corps of Engineers (USACE); NASA; and numerous regional, State and local Agencies. NOAA's collaboration and partnership does not stop at U.S. borders. NOAA will continue to foster global collaboration, working through the United Nations (UN) process and international agreements. Global cooperation on

observations, data exchange, modeling, research, and development is essential to NOAA's continued and future success.

Objective: Reduced loss of life, property, and disruption from high-impact events

Essential components of a weather-ready nation are integrated, impact-based information and decision-support services so that citizens, businesses, communities, governments, and first responders are prepared, ready to act, and able to minimize risk. Impact-based information means NOAA understands the information needed, how it will be used to make decisions, and the value such information brings to minimizing risk and impact. Increasing the use of weather-related information by making it more relevant to citizens, businesses, and Government can reduce the impact of weather-related events on lives and livelihoods.

To achieve this objective, NOAA will focus its efforts on service, which will require a deeper understanding of user needs through continuous user engagement; alignment of products, services, research, and development to user needs; and an improved capacity to monitor and evaluate service performance and outcomes. Specifically, NOAA will provide forecasts and information that compare weather risk to user-defined risk tolerance and redefine warnings to be applicable to a broad range of high-impact events. This is especially important in densely populated urban areas where cities impact and are impacted by weather and climate events. Cities increase heat stress, exacerbate poor air quality, increase flood hazards, alter precipitation patterns, and are responsible for greenhouse gas emissions. In collaboration with its partners, NOAA will provide direct, interpretive support to public sector officials and emergency responders, and expand environmental education and weather safety programs. Key science and technology needs to achieve this objective include improving forecasts of hurricanes, severe weather, space weather, fire weather, and greater knowledge of the weather-climate linkage. Other needs include a better understanding of human behavior and decision-making during weather-related events and the formulation and communication of forecast uncertainty, or forecast confidence. Improving forecast and decision-support tools, NOAA Information Technology (IT) infrastructure, and data architecture (including the four-dimensional environmental information database known as the 4-D Cube, which is discussed further below) will ensure data and information are available, accessible, and timely.

Over the next five years, evidence of progress toward this objective will include:

- Fewer weather-related fatalities;
- Improved community preparedness leading to fewer weather-related fatalities; and
- Avoidance of economic loss from property damage and unnecessary evacuations.

Objective: Improved freshwater resource management

Managing freshwater quantity and quality is one of the most significant challenges the U.S. must address in the 21st century. Demands for water continue to escalate, driven by agricultural, energy, commercial, and residential usage, particularly in urban areas. Sustained growth requires viable long-term municipal water supplies and, by extension, sophisticated predictions and management practices. The Nation's water resource managers need new and better integrated information to manage limited or excessive water supplies more proactively and effectively in a changing and uncertain environment. Working with core partners—the USGS and the USACE—

NOAA will integrate and extend its water prediction capabilities to provide information and forecasts for a full suite of water services. NOAA will improve its outreach to resource managers to improve their understanding and application of models and forecasts as they make decisions and manage risk. Interrelated to NOAA's objective to improve coastal water quality in the *Resilient Coastal Communities and Economies* goal, this objective applies to all coastal and inland waterways and addresses challenges associated with too much, not enough, or poor quality water.

To achieve this objective, NOAA and its partners will enhance the integration and utility of water services by developing integrated decision-support tools for water resource managers based on high resolution summit-to-sea data and information. NOAA will expand water services by providing forecasts for such parameters as water quality, flow, temperature, dissolved oxygen content, and soil moisture conditions for inland and coastal watersheds. Improved and expanded water services will require new technologies to increase information access and dissemination, as well as research and development to advance understanding of precipitation, temperature, evaporation and other hydrologic processes in an Earth system framework. NOAA will improve modeling and prediction capabilities by implementing high-resolution hydrologic and hydraulic models, integrating long-range weather and water forecasting, and improving the confidence of hydrologic forecasts. Critical to NOAA's success will be the ability to expand river, surface, and remote observations, and leverage the observations of partners.

Over the next five years, evidence of progress toward this objective will include:

- Avoidance of economic loss and property damage from flooding as a result of impact-based decision support;
- More efficient and effective management of municipal water supplies using integrated water forecasts; and
- Economic benefits from increased efficiencies in water usage in the transportation, hydropower, and agriculture sectors.

Objective: Improved transportation efficiency and safety

The transportation sector is critical to our society and uniquely sensitive to weather, making it a key component to achieve a weather-ready nation. Weather accounts for approximately 70 percent of all air traffic delays within the U.S., costing billions of dollars to the Nation's economy. Winter storms can cripple surface transportation networks for days at a time and are hazardous to drivers. Hurricanes and storms at sea and on the Great Lakes disrupt marine transportation, causing delays, loss of cargo, and lives. Volcanic ash can cause widespread flight cancellations. In partnership with local and State government as well as other Federal Agencies, NOAA will enhance data and services to minimize the impacts of weather-related events on the national transportation system. Progress toward this objective is interrelated to the objective to provide safe, efficient and environmentally sound marine transportation in the *Resilient Coastal Communities and Economies* goal.

To achieve this objective, NOAA will improve engagement with transportation user communities in the aviation, surface, and marine transportation sectors to gain a better understanding of their needs and integrate that knowledge into improved weather-related products and services that support safety, mobility, and efficiency. NOAA will improve access to and interoperability of weather data to better integrate with decision-support systems and increase the scope of available data by integrating observations from road, marine, aircraft, and other sources, while improving data in such remote areas as the Arctic. NOAA will develop and deploy a four-dimensional

environmental database known as the 4-D Cube, which will enhance decision-support systems by offering consistent information at high temporal resolutions. Information will be available and usable in real-time, enabling two-way information-sharing. While the 4-D Cube will be applied initially in the aviation industry, it will ultimately benefit all commercial sectors that require environmental information. This objective requires better forecasts of low clouds, fog, turbulence, visibilities, and precipitation type and duration, as well as improved methods to formulate and communicate forecast confidence. Modeling enhancements will improve storm prediction accuracy, coastal wave modeling, and space weather prediction.

Over the next five years, evidence of progress toward this objective will include:

- Fewer aviation delays due to weather-related events;
- Reduced grounding or sinking of cargo vessels due to weather-related events; and
- A reduction in transportation fatalities and economic losses due to weather-related events.

Objective: Healthy people and communities due to improved air and water quality services

Poor air quality causes people to suffer from chronic respiratory illnesses and is responsible for up to 60,000 premature deaths in the U.S. each year, while access to clean, safe water is a growing concern for communities and ecosystems. Our rivers and estuaries—and the species living in them—are affected by changing water temperatures and increases in salinity, nutrients, and other pollutants. Such pollutants impact fish and shellfish populations and lead to harmful algal blooms, expansive dead zones, and increased incidence of human illness. NOAA is in a unique position to combine predictive weather information with its understanding of water, climate, oceans, and coasts to develop integrated environmental predictions and analyses that can improve the health of ecosystems and communities. This objective is closely linked with the objective to improve coastal water quality in the *Resilient Coastal Communities and Economies* goal, but is broader in scope as it includes water quality for inland waterways. Many of the same activities and requirements will help to achieve both objectives.

To achieve this objective, NOAA will develop and deploy a suite of integrated, nationwide health- and ecosystem-based weather, water, and climate services to address regional and urban needs. Critical to the success of this objective will be partnerships with public health officials, educators, and the media to help inform and educate people on the dangers of poor air and water quality. Key requirements include high-resolution ozone, smoke, dust, and other particulate matter forecasts; data on extreme temperatures; and expanded predictive capabilities that include water quality. The ability to predict water quality will allow resource managers and public health officials to plan better and minimize risk to the environment and to people who rely on coasts, rivers, lakes and estuaries for recreation and commercial activities. Enabling this objective are strong, collaborative partnerships with local, State, tribal, and national health, water, and environmental managers. NOAA scientists and partners will conduct research and develop health- and ecological-based predictions, scenarios, and projections for multiple time and space scales. Observations will be expanded in partnership with public health agencies to support environmental monitoring. NOAA will improve modeling and prediction capabilities within an Earth system framework for air and water quality and initiate development of an ecological forecasting system, coupling air, land, water, and sea with biological, geological, chemical, and ecosystem processes. A key use of this data will be to inform national environmental planning policies.

Over the next five years, evidence of progress toward this objective will include:

- Improved information on the linkages among human health, weather, water and climate for decision makers;
- Fewer adverse health impacts attributable to air pollution; and
- Positive economic and ecological impacts from improved water quality forecasts.

Objective: A more productive and efficient economy through environmental information relevant to key sectors of the U.S. economy

The capacity to increase renewable energy generation, which is fundamental to economic security and sustainable development, is based in part on the ability to predict and harness precipitation, wind, and cloud patterns. Burgeoning renewable energy industries need more accurate resource assessments with better observations tailored to sources such as wind profiles over sea and land, solar irradiance and cloud cover measurement, as well as forecasts that support load balancing and energy supply planning on hourly, daily, weekly, seasonal, and interannual scales. Geomagnetic storms and other space weather phenomena affect electrical grid stability as well as satellite communications. Weather events impact health services both through effects on the healthcare delivery infrastructure and through direct impacts of weather on human health—especially on sensitive populations. The productivity of U.S. agriculture requires weather, water, and climate information over a wide range of time and space scales. Timely and accurate weather, climate, and water information and forecasts can make a significant contribution to a secure and reliable infrastructure for energy, communications, health care, and agriculture.

To achieve this objective, NOAA will develop integrated environmental information services for the unique needs of weather-sensitive sectors, including solar, wind, and oceanic. NOAA will develop information that is critical to the development, production, and transmission of renewable energy; forecasts and warnings of space weather and geomagnetic storms that are within the accuracy and confidence levels required for decision making; improved understanding of how to use NOAA information to mitigate health sector impacts; and enhanced modeling and prediction capabilities needed to address global food supply and security challenges. Through partnerships with other Federal agencies; the UN; and energy, communication, health services, and agriculture industries, NOAA will support sector-specific planning and decision making with environmental information. NOAA's partnership with America's weather and climate industry enables the Agency to provide information relevant to key sectors of the economy and rely on market forces to develop decision tools and other specialized services for the specific companies, farms, hospitals, etc. that compose these sectors. Key components of the objective require improved long-range forecasting and regional downscaling; increased accuracy of space weather models, predictions, and forecasts; expanded ability to observe, understand, and model planetary boundary layer processes (especially in complex terrain and offshore); and accessible, real-time environmental data and information.

Over the next five years, evidence of progress toward this objective will include:

- Production gains in renewable energy through better information;
- Mitigated economic loss due to advanced warning of geomagnetic storms;
- Health sector efficiencies due to improved use of weather, water, and climate information;
- An integrated suite of information targeted to food security needs; and
- Growth of America's weather and climate industry.

Long-term goal: **Healthy Oceans**

Marine fisheries, habitats, and biodiversity sustained within healthy and productive ecosystems

Ocean ecosystems provide many benefits to humans. They provide food and recreational opportunities, and they support economies. Yet the resources that our marine, coastal, and Great Lakes environments present to us are already stressed by human uses. Habitat changes have depleted fish and shellfish stocks, increased the number of species that are at-risk, and reduced biodiversity. Because humans are an integral part of the ecosystem, declines in ecosystem functioning and quality directly impact human health and well-being. As long-term environmental, climate, and population trends continue, global demands for seafood and energy, recreational use of aquatic environments, and other pressures on habitats and over-exploited species will increase as will concerns about the sustainability of ecosystems and safety of edible fish. Depleted fish stocks and declines in iconic species (such as killer whales, salmon, and sea turtles) result in lost opportunities for employment, economic growth, and recreation along the coasts. In addition, climate change impacts to the ocean, including sea level rise, acidification, and warming, will alter habitats and the relative abundance and distribution of species. Climate change poses serious risks to coastal and marine ecosystems productivity, which, in turn, affects recreational, economic, and conservation activities.

NOAA's goal of healthy ocean ecosystems will ensure that ocean, estuarine, and related ecosystems—and the species that inhabit them—are vibrant and sustainable in the face of challenges. A strong understanding of these systems supports an ecosystem-based approach to management. The approach accounts for the complex connections among organisms (including humans); their physical, biotic, cultural, and economic environments; and the wide range of processes that control their dynamics. An ecosystem-based approach will assist policy makers to weigh trade-offs between alternative courses of action. By working toward the long-term sustainability of all species, NOAA will also help ensure for present and future generations that seafood is a safe, reliable, and affordable food source; that seafood harvest and production, recreational fishing opportunities, and non-consumptive uses of living marine resources continue to support vibrant coastal communities and economies; and that species of cultural and economic value can flourish.

NOAA Partnerships for Healthy Oceans—Achieving healthy and sustainable ocean ecosystems will require strong coordination and integration across NOAA and with Federal, State, local, and tribal stakeholders. Collaboration with academic institutions, non-governmental organizations, Federal agencies, and NOAA's operational and research programs will help to provide the scientific foundation for ocean resource management decisions and strengthen ecosystem science. Strong partnerships and enhanced coordination and cooperation among NOAA scientists, policymakers, the Fishery Management Councils, the commercial and recreational fishing industries, non-governmental organizations, coastal stewards, and academic centers will ensure a transparent and effective approach to manage ocean resources.

Objective: Improved understanding of ecosystems to inform resource management decisions

Fully implementing ecosystem-based approaches to resource management requires ongoing scientific exploration in marine, coastal, and riverine systems, and increased understanding of the complex linkages among human, biological, and physical components of an ecosystem. Such understanding will allow decision makers to evaluate trade-offs between desired outcomes—including increased economic activity and long-term species viability—and to assess likely outcomes of different management approaches. The current understanding of many marine

species, their links to other components of the ecosystems, and the benefits they provide to society is limited; in many instances, scientists have virtually no data. Adequate assessments have been performed for fewer than 60 percent of the key fish stocks and complexes, fewer than 25 percent of all protected species, and an even smaller percentage of the habitat upon which all of these species depend. In addition, it is not yet fully understood how complex ecosystems or individual species will respond either to a changing climate or available approaches to managing living marine resources. These management approaches themselves are the subject of active research. In order to preserve the wide range of benefits humans derive from healthy ecosystems, decision makers in fishery management, protected species recovery, habitat conservation, and coastal and marine spatial planning need information on individual species, the quantity and quality of habitat they occupy, the effects of human activities on ecosystem health and resilience, and the consequences of ecosystem condition on human populations.

To achieve this objective, NOAA will coordinate internal and external research on the linkages among biological, physical, and human components of marine, estuarine, and riverine ecosystems and the goods they provide. Key components include maintaining observation platforms to collect global, regional, and local ecosystem data and exploring innovative technologies such as genomics, ecosystem models, and alternative sampling techniques to improve the ability to accurately assess the status and health of living marine resources and the ecosystems on which they depend. Producing accurate status assessments for harvested, protected, and potentially at-risk species—based on enhanced, consistent, long-term observations—is a key component. Just as importantly, NOAA will work to enhance coordination and cooperation among scientists, policy makers, and stakeholders to ensure that information is understood and incorporated in management practices. NOAA also will support socioeconomic research and policy analyses to evaluate ecological and social outcomes of potential environmental and management changes, and will help partners develop ecosystem-based plans that include all aspects of the biological, social, and economic environment. NOAA will work to ensure that this information is used in transparent regulatory and policy decision-making frameworks, and that it is well-communicated to a wide range of stakeholder communities.

Over the next five years, evidence of progress toward this objective will include:

- Increased use of ecosystem information (such as Integrated Ecosystem Assessments) in natural resource decisions in marine, estuarine, Great Lake and riverine systems;
- Increased development and use of climate considerations in fishery and protected resource decisions and in coastal and marine spatial planning processes;
- Next-generation fish and protected resource stock assessments incorporating habitat, ecosystem, and climate information;
- Living marine resource managers using high-quality data to inform management plans and decisions;
- Increased understanding of the role of habitat in providing ecosystem services, supported by improved habitat assessments; and
- Increased use of social and economic indicators in the conservation and management decision making processes.

Objective: Recovered and healthy marine and coastal species

The wide range of human and natural impacts on marine, estuarine and diadromous (that is, fish that migrate between marine and freshwater habitats) species has led to listing of many of these species as threatened or endangered under the Endangered Species Act (ESA), with petitions to list additional species received every year. NOAA has statutory responsibility for such listed species

as well as for most marine mammals under the Marine Mammal Protection Act. As human populations increase and the impacts of global climate change are realized, ensuring the recovery and long-term health of all these species is an important goal for the Nation. To ensure the sustainability and resilience of these species and the ecosystems that support them, NOAA, Federal, State, tribal and local agencies, non-governmental organizations, and industry require science-based policy guidance, economic incentive programs, and sound regulations and enforcement.

To achieve this objective, NOAA will improve its understanding of the status of listed and at-risk species and develop and implement robust recovery and conservation for those species listed and at-risk. Rigorous single-species and ecosystem assessments, as well as a stronger understanding of the impacts of changes on species' status that are planned in this objective, will be a key component. Coupled with this information, NOAA will undertake efforts to effect robust listing decisions, and conduct consultations for listed and at-risk species, permitting processes, and similar regulatory efforts. NOAA will continue to work in strong partnership with other Federal, State, local and tribal agencies, non-governmental organizations, and stakeholder groups to ensure that recovery and conservation plans are robust, useful and implemented. The international dimensions of this objective require participation in international species management for anadromous fish (fish that live in the ocean mostly and breed in fresh water), and marine mammals. Together these efforts will ensure that iconic and at-risk species can flourish.

Over the next five years, evidence of progress toward this objective will include:

- Stabilized or increased abundance of species that are depleted, threatened, or endangered;
- Decreased bycatch of protected species; and
- Increased number of protected species with improving status.

Objective: Healthy habitats that sustain resilient and thriving marine resources and communities

Healthy marine, coastal, and riverine systems provide valuable habitats for the species that humans value for economic and non-economic uses. Humans use these places for renewal, for swimming, recreational fishing, and a host of other activities. And habitats provide the basis of many other ecosystem benefits, such as control of pests and pathogens, protection of coastal areas from storm damage, and nutrient cycling. Thoughtful and appropriate management of these areas is vital to ensuring that treasured locations maintain their value and ecosystem functioning remains intact in the face of human and natural changes to these systems. Healthy habitats are critical for sustaining healthy marine ecosystems. NOAA has broad habitat conservation responsibilities that include protecting and restoring essential fish habitat under the Magnuson-Stevens Fisheries Conservation and Management Act (MSA) and the critical habitat of species listed under the ESA. These requirements are intended to ensure that key habitats are identified, protected, and restored to support important species. However, in carrying out these and other conservation mandates, NOAA is not only sustaining healthy marine ecosystems, but also supporting other valuable ecosystem services. Recreational opportunities, stabilized shorelines, reduced erosion, and buffered impacts of hurricanes and flooding are all benefits of healthy habitats. NOAA will increase the scale and effectiveness of habitat conservation to improve marine, coastal, and riverine habitats and the ecosystem services they provide.

To achieve this objective, NOAA will apply robust habitat science to develop effective policy measures, strengthen collaboration among all NOAA programs engaged in habitat conservation,

and enhance capacity to support conservation actions. NOAA and its partners will use rigorous assessments of habitat quantity, quality, and integrity to prioritize marine, coastal, and riverine habitats that support Federal trust species (that is, threatened or endangered species, interjurisdictional fish, marine mammals, and other species of concern) for conservation actions. NOAA will also focus protection and restoration efforts in key geographic areas. Measuring social and economic impacts of habitat conservation and restoration efforts will provide policy makers with key information to develop effective management plans. Working with NOAA's own climate service information, as well as academic and Agency partners, NOAA will develop and implement habitat adaptation strategies to reduce the effects of a changing climate on habitat conditions. This will support fishery management, ecosystem, and recovery plans that incorporate appropriate habitat conservation measures, and will ensure financial and technical assistance for on-the-ground conservation projects.

Over the next five years, evidence of progress toward this objective will include:

- Increased protection and restoration of habitats to enhance vital ecosystem services;
- Habitat conservation targets and evaluation protocols set to focus and improve habitat protection and restoration actions in priority areas;
- Essential fish habitat designations that encompass key habitats as informed by habitat assessments;
- Increased use of partnerships, scientifically sound conservation measures, coastal and marine spatial planning, and regional ecosystem conservation approaches to protect and restore priority habitats; and
- Climate change impacts addressed in conservation actions to promote long-term habitat resilience and adaptation.

Objective: Sustainable fisheries and safe seafood for healthy populations and vibrant communities

Fisheries—both recreational and commercial—are one of the most visible ecosystem services marine environments provide. Americans are already the third largest consumer of seafood in the world and are global leaders in marine sport fishing. Beyond food and economic benefits from marine fisheries, the public health benefits of consuming safe seafood are increasingly recognized and documented. As human populations grow, demand on marine ecosystems to provide seafood and recreational opportunities will also increase. However, as domestic demand for safe seafood and recreation opportunities grow, these demands will far exceed domestic supply from wild stocks. This places a premium on effective management of natural fish stocks and development of ecologically sustainable aquaculture programs. NOAA's legal responsibilities in this regard encompass management of more than 500 fish stocks or stock complexes under MSA. Currently, more stringent regulation, including reduced quotas and shortened fishing seasons, has become commonplace, limiting recreational and commercial fishing opportunities. Implementing management strategies that rebuild and manage fish stocks, maintain access to fisheries, and improve opportunities for aquaculture can build and sustain economically robust coastal communities and contribute to long-term food security for the Nation. An additional, often overlooked component of food security is reducing seafood-related health hazards, such as paralytic shellfish poisoning and industrial toxins in fished species. These hazards pose serious risks to humans, yet only a very small percentage of seafood in the United States is inspected for toxins and pathogens. Imported seafood—more than 80 percent of the seafood consumed in the

United States—is typically inspected less frequently. Maintaining sustainable fisheries and safe marine-origin foods is a priority for NOAA.

To achieve this objective, NOAA will pursue science and policies to promote a suite of practices that ensure the long-term stability of wild stocks, support sound aquaculture programs, and improve seafood safety. Specifically, NOAA will continue ongoing work to eliminate overfishing, rebuild overfished stocks, and improve long-term economic stability of recreational and commercial fisheries. Rigorous ecosystem and single-species assessments will inform fisheries management plans and support long-term sustainability of stocks. Management efforts, such as catch-share programs, will be implemented with monitoring to evaluate their impact on stock status, while improved socio-economic data collection will allow managers to evaluate and improve the social sustainability of recreational and commercial fishery programs. NOAA will also work to strengthen the enforcement of fishery regulations concerning international imports and exports; support improving stock status; and in international species management programs, such as those for highly migratory species of fish and for fisheries in polar regions. Another key component of this objective is the development and implementation of a national aquaculture policy that provides information and guidance to implement ecologically and economically sustainable aquaculture programs. As part of this effort, NOAA will work with academic and industry partners to develop and improve best aquaculture practices, land- and ocean-based siting guidance, and alternative-feed technologies. Together these efforts will work toward the long-term abundance and sustainability of marine food sources. Finally, increased seafood inspection and developing health hazard warning systems will ensure that seafood consumers have safe and healthful food options.

Over the next five years, evidence of progress toward this objective will include:

- Improving trends in stocks categorized as overfished shown in increases in abundance;
- Reduced numbers of stocks subject to overfishing;
- Increased allowable catch levels as fish stocks reach rebuilt status;
- Decreased bycatch of target and non-target species;
- Expanded recreational and commercial fishing opportunities;
- Increased research focused on sustainable aquaculture activities;
- Increased numbers of aquaculture facilities that are ecologically sustainable;
- Increased proportion of inspected seafood; and
- Implementation of a national aquaculture policy and NOAA aquaculture priorities.

Long-term goal: Resilient Coastal Communities and Economies

Coastal and Great Lakes communities are environmentally and economically sustainable

The complex interdependence of ecosystems and economies will grow with increasing uses of land, marine, and coastal resources, resulting in particularly heavy economic and environmental pressures on the Nation’s coastal communities. Continued growth in coastal populations, economic expansion, and global trade will further increase the need for safe and efficient maritime transportation. Similarly, the Nation’s profound need for conventional and alternative energy presents many economic opportunities, but will also result in greater competition for ocean space, challenging our ability to make informed decisions that balance conflicting demands as well as economic and environmental considerations. At the

same time, the interdependence of ecosystems and economies makes coastal and Great Lakes communities increasingly vulnerable to chronic—and potentially catastrophic—impacts of natural and human-induced hazards, including climate change, oil spills, harmful algal blooms and pathogen outbreaks, and severe weather hazards.

NOAA’s long-term coastal goal will invigorate coastal communities and economies, and lead to increased resiliency and productivity. Comprehensive planning will help protect coastal communities and resources from the impacts of hazards and land-based pollution to vulnerable ecosystems by addressing competing uses, improving water quality, and fostering integrated management for sustainable uses. Geospatial services will support communities, navigation, and economic efficiency with accurate, useful characterizations, charts and maps, assessments, tools, and methods. Coastal decision makers will have the capacity to adaptively manage coastal communities and ecosystems with the best natural and social science available.

NOAA Partnerships for Resilient Coastal Communities and Economies—Resilient coastal communities and economies cannot be achieved without strong partnerships. NOAA will build on existing strategic partnerships in our coastal communities with other Federal Agencies (such as the U.S. Coast Guard) to help provide services to adapt to coastal hazards and provide safe conditions in the Arctic, the DOI to conserve and manage special marine and coastal places, and the EPA and USDA to improve coastal water quality and encourage smart growth. Comprehensive ocean and coastal planning also will require an unprecedented level of engagement and collaboration with state, local and tribal partners, as well as a wide range of stakeholders in the private and academic sectors. The complex and interdependent vulnerabilities that the coasts face will require enduring partnerships to help develop environmentally and economically sustainable community practices. NOAA, its strategic partners in coastal communities, and the Nation must have a shared understanding of the challenges to address so that the benefits, beauty, and heritage of coasts can be appreciated by current and future generations.

Objective: Resilient coastal communities that can adapt to the impacts of hazards and climate change

Coastal communities contain over one half of the U.S. population, generate nearly 60 percent of U.S. economic output, and account for hundreds of millions of dollars in flood loss claims. Their vulnerability to coastal hazards increases with growing populations, declining coastal ecosystems, and changing climate conditions. The Nation’s coastal communities need to improve their capacity for resilience in order to absorb impacts while maintaining an acceptable level of functioning, need to reduce the amount of time and resources required to return to full-functioning, and to adapt to future risks by learning from past disasters and adopting risk-reduction measures. Reducing vulnerabilities depends on healthy coastal economies proactively adapting to climate impacts, land use, conservation, hazard response, and recovery planning; maintaining sustainable and ecologically sound uses, such as commercial and recreational fisheries and seafood production efforts; mitigating chronic stressors; and on infrastructure decisions made at the Federal, regional, State, and local levels. Coastal decision makers require current science-based information, accurate tools and technology, and the skills to apply them to effectively reduce the vulnerabilities of their communities.

To achieve this objective, NOAA will develop and provide coastal decision makers with updated decision-support tools, technical assistance, training, and management strategies related to adaptation, risk communication, hazard response and recovery, and resource conservation. Spatially relevant and integrated data, including social and economic data, will be delivered to support risk analyses, mapping, scenario analyses, adaptation planning, and implementation. State-of-the-coast analyses and trend information on ecosystem status and valuation, along with

community risk and vulnerability assessment methods and policy assistance, will be provided to support implementation of resilience adaptation strategies. Hydrodynamic models, forecasts, and visualization tools based on an improved geospatial framework will improve understanding of the impacts of coastal hazards and climate impacts on livelihoods and ecosystem services. NOAA will continue to work with partners to acquire, protect, and restore habitat, biodiversity, and ecosystem services to support the resilience of both ecosystems and the built environment. NOAA's strong, collaborative partnerships with those responsible for improving management of coastal communities and ecosystems, and close coordination across NOAA—especially as relates to climate capabilities and capacities—will ensure that the science and data needed to achieve this critical objective are generated.

Over the next five years, evidence of progress toward this objective will include:

- An increase in the percentage of U.S. coastal States and territories demonstrating annual improvements in resilience to coastal and climate hazards;
- Appropriate science-based tools and information for assessing hazard risk, vulnerability, and resilience that coastal decision makers and community leaders can understand and use;
- Effective community plans and strategies that improve community readiness to cope with natural and human-induced coastal hazards; and
- Healthy natural habitats, biodiversity, and ecosystem services support local coastal economies and communities.

Objective: Comprehensive ocean and coastal planning and management

The Nation's coastal zones have become busy places, with people living and recreating alongside a diverse and growing array of industries, such as commercial and recreational fishing and aquaculture, oil and natural gas production, and the production of renewable energy. While an increasing range of uses will allow coastal communities to create diverse economies, care must be taken to ensure continued access to coastal areas, sustained ecosystems, maintained cultural heritage, and limited cumulative impacts. A coastal and marine spatial planning framework is a comprehensive management approach that is designed to support sustainable uses and ensure healthy and resilient ocean and coastal ecosystems. Combined with its capacity to collaborate with State, territory, and Federal partners, NOAA's expertise in ocean and coastal management and planning is needed to provide leadership and support for the development of regional and place-based spatial plans, as well as the data streams, research, and tools necessary for implementation. In some areas, NOAA and its partners collaboratively protect and manage critical coastal and ocean ecosystems.

To achieve this objective, NOAA will promote sustainable resource use and stewardship by continuing to implement key NOAA mandates, including the National Marine Sanctuaries Act, the Coastal Zone Management Act, MSA, and the National Sea Grant College Program Act, Coral Reef Conservation Act, and further its programmatic efforts to support coastal and marine spatial planning and management. Through these efforts, NOAA will balance the use of coastal and ocean resources with long-term planning and management of coastal and other unique marine conservation areas. NOAA will support institutional infrastructure needed to coordinate and facilitate the planning process, engage stakeholders, execute management actions, and enhance geospatial data and visualization tools. NOAA will require and sustain resource monitoring networks that are capable of integrating across spatial and temporal scales to determine the effectiveness of local management actions, and develop and disseminate models, tools, and best

practices for long-term planning and management. NOAA will conduct social and economic studies needed to evaluate and improve the effectiveness of management decisions.

Over the next five years, evidence of progress toward this objective will include:

- National, regional, and local stakeholders engaged in the coastal and marine spatial planning process;
- Coastal and Great Lakes managers use of new or enhanced models, data, tools, and best practices for informed spatial planning, management and stewardship of resources and ecosystems;
- Key coastal, marine, and Great Lakes areas acquired or designated for long-term conservation and managed to maintain critical ecosystem function and support coastal economies;
- Predictable and transparent regulatory mechanisms for ocean and coastal energy, and other sectors; and
- An enhanced geospatial framework and data available to underpin decision-support tools.

Objective: Safe, efficient and environmentally sound marine transportation

The Marine Transportation System (MTS) spans ports and inland waterways across U.S. coastal waters and oceans to support commerce, recreation, and national security. MTS supports the Nation's economy, with more than 77 percent by weight and 95 percent by volume of U.S. overseas trade carried by ship. By 2020, the value of domestic maritime freight is forecasted to nearly double. MTS is increasingly vulnerable to natural and human-caused disruptions that will potentially impact the viability of the economy. Increased maritime activity can stress sensitive marine and freshwater environments and increase the risk of maritime accidents. Improving the reliability and resilience of MTS will decrease risks to the economy and the environment.

To achieve this objective, NOAA will support operational decisions for oceans and coasts with such fundamental services as marine weather forecasts, nautical charts, surveying and mapping data, real-time oceanographic information, oceanographic predictions and forecasts, and an accurate national positioning framework. NOAA will bring science and search and rescue functions to bolster emergency preparedness and response to the MTS, helping to save lives and mitigate the environmental and economic impacts of hazardous incidents, including oil spills. To ensure efficient and environmentally sound operations throughout MTS, NOAA will continue to work with Federal, State, and local partners to boost technology and bring improvements to MTS products and services, reducing the hydrographic survey backlog in navigationally significant areas. NOAA will strengthen international partnerships to encourage the production and distribution of navigation information, and ensure that global standards and policies are consistent with U.S. interests.

Over the next five years, evidence of progress toward this objective will include:

- Reduced maritime incidents in U.S. waters through timely and accurate navigational information;
- Increased capacity in MTS to promote greater efficiency and economic growth;
- Improved national geospatial framework for increased accuracy of navigation products and services;
- Reduced hydrographic survey backlog in navigationally significant areas;

- Increased percentage of national ports with access to real-time navigation products and services; and
- Increased preparedness and response to maritime incidents and emergencies.

Objective: Improved coastal water quality supporting human health and coastal ecosystem services

Coastal communities in the U.S. and economies, including tourism, recreation, and commercial fisheries, rely on healthy coastal environments. Through work and recreation, more than 70 percent of the U.S. population comes into contact with coastal waters that can contain a diverse array of chemical contaminants, excessive nutrients, pathogens, biotoxins, and marine debris, which degrade habitat quality and negatively impact human health and the services provided by ecosystems in the coastal zone. Beach advisory days due to biological contamination have more than tripled, levels of contaminants in coastal waters have risen, and marine debris has become one of the most widespread pollution problems in the world's oceans and waterways. More than 10 percent of coastal waters are considered unfit for designated uses, and more than 50 percent of the Nation's estuaries experience hypoxia (that is, reduced dissolved oxygen content). In the face of these trends, State, tribal, and Federal partners need (1) coordinated efforts to address drivers of this degradation and reverse trends; and (2) early warning networks to identify and predict threats to human and ecosystem health, and to implement effective and timely management efforts.

To achieve this objective, NOAA will build upon its capabilities in assessing climate impacts to human health and ecosystem services, conserving habitat, and delivering integrated nationwide health and ecological decision-support services. Incorporating these scientific advancements, research will examine the transport and fate of chemicals, nutrients, sediments, pathogens, harmful algal blooms, toxins, and marine debris in waterways. Chemical and biological data, as well as economic and other social data, will be collected to expand coastal habitat characterizations. Marine and biological sensors will be developed to monitor, assess, and predict ecological and human health threats. Efforts to remove marine debris from coastal habitats will continue, and research will more clearly identify the damage marine debris causes to coastal economies and habitats. NOAA and its partners will develop, implement, and improve advanced water quality monitoring programs for nationally significant areas, trust resources, and coastal and Great Lakes areas to improve resource managers' knowledge of ecological stressors, and to assess the efficacy of management decisions. Results of water quality monitoring and research activities will be provided to NOAA collaborators to further inform their development and refinement of nationwide early warning efforts, predictions, and ecological forecasts.

Over the next five years, evidence of progress toward this objective will include:

- Greater understanding of the effects of natural and human-induced contaminants on the health of humans and marine life;
- Reduced impacts to human health and ecosystem services due to degraded water quality;
- Faster detection of sediments and contaminants in coastal waters; and
- Accelerated recovery and restoration of coastal resources and revitalization of coastal communities through improved water quality.

Objective: Safe, environmentally sound Arctic access and resource management

No region better exemplifies the complex interdependence of communities and changing climate and ecosystem conditions than the Arctic. There is evidence of widespread, dramatic change in the Arctic region, with local to global implications. National security concerns are increasing as reductions in sea ice increase access to Arctic resources and opportunities for economic development and resource extraction. These economic drivers can further threaten ecosystems and Arctic inhabitants already impacted by the rapidly changing climate. The Arctic region needs accurate land and tidal elevations to build flood protections, harden infrastructure, ensure safe and efficient marine transportation, model storm surge, and monitor sea levels. The breadth and complexity of the cultural, societal, economic, and environmental impacts within this region requires a concerted, systematic and rapid management effort with partners from local to international levels.

To achieve this objective, NOAA will build on its other capabilities including climate data, marine weather, improved ecosystem understanding, and increased observing capacity to assist Arctic coastal communities in understanding and adapting to climate impacts, prepare for severe weather, and sustainably manage Arctic resources. NOAA will support the development of resilient Arctic coastal communities with mapping and charting services for safe navigation to and through the Arctic. Modernizing the Arctic geospatial framework will provide the foundation for many of NOAA's activities in the region, including effective climate adaptation, community resilience, and coastal resource and marine spatial planning strategies. NOAA will support the Arctic region with accurate land and tidal elevations to monitor sea level and ice conditions. NOAA will bring to the region such essential services as accurate weather and navigation tools, capacity-building to respond to natural and human-induced coastal hazards, and research to improve Arctic oil spill response and restoration capabilities. Arctic communities will rely on NOAA for climate information to inform decisions for relocating communities, safeguarding human health, and conduct adaptive strategies. Throughout this effort, NOAA will engage domestic and international partners to promote cooperation and sharing of data, observational platforms, and intellectual resources.

Over the next five years, evidence of progress toward this objective will include:

- Reduced risk and impact of maritime incidents on the Arctic environment;
- Arctic communities and ecosystems prepared for climate change and weather events with adaptation strategies and plans;
- A stronger foundational geospatial framework to better support economic and community resilience and inform policy options and coastal management responses to the unique challenges in the region; and
- Increased international collaboration to strengthen NOAA and U.S. policy objectives in the region.

NOAA's Enterprise Objectives

NOAA's strategy would be incomplete without detailing the enterprise-wide capabilities that will be required to achieve the environmental, social, and economic outcomes targeted by NOAA's strategic goals. NOAA's enterprise functions consist of three groups:

- The foundational science and technology functions that generate research and development, models, and environmental observations;
- The distinct functions for engaging partners and customers; and
- The underlying administration and management functions that support all of NOAA’s work.

These cross-cutting functions define NOAA’s distinctive capabilities as an organization. The objectives set forth below represent cross-cutting requirements for addressing NOAA’s strategic goals as a whole.

NOAA’s Science and Technology Enterprise

NOAA’s vision centers on a holistic understanding of the interdependencies between human health and prosperity, and the intricacies of the Earth system. Achieving this level of understanding presents an overarching, long-term scientific and technical challenge to NOAA: *to develop and apply holistic, integrated Earth system approaches to understand the processes that connect changes in the atmosphere, ocean, space, land surface, and cryosphere with ecosystems, organisms, and humans over different scales*. Over the long-term, drawing upon its world-class research, observation, and modeling capabilities, NOAA is uniquely positioned to:

- Acquire and incorporate knowledge of human behavior to enhance understanding of the interaction between human activities and the Earth system;
- Understand and quantify the interactions between atmospheric composition and climate variations and change;
- Understand and characterize the role of the oceans in climate change, and variability and the effects of climate change on the ocean and coasts;
- Assess and understand the roles of ecosystem processes and biodiversity in sustaining ecosystem services;
- Improve understanding and predictions of the water cycle from global to local scales;
- Develop and evaluate approaches to substantially reduce environmental degradation;
- Sustain and enhance atmosphere-ocean-land-biology and human observing systems;
- Characterize the uncertainties associated with scientific information; and
- Communicate scientific information and its associated uncertainties accurately and effectively to policy makers, the media, and the public at large.

To address this long-term challenge and meet the near-term science requirements within and across its strategic goals, NOAA must simultaneously pursue three objectives within its core scientific and technical enterprise: a holistic understanding of the Earth system, accurate and reliable data from sustained and integrated Earth observing systems, and an integrated environmental modeling framework.

NOAA Partnerships in its Science and Technology Enterprise—NOAA will take advantage of its broad national and international network of partners in other agencies, in Cooperative Institutes and Sea Grant colleges, in external academic institutions and professional societies, and in the private sector to better understand the complex connections between the physical Earth system and its biological components—including human beings. NOAA’s partnerships with NASA and DOD will continue to maintain the continuity of critical remotely sensed satellite data and products to support weather and climate applications. NOAA’s international partners include the European Organisation for the Exploitation of Meteorological Satellites; and the space agencies of Canada, China, Europe, France, India, and Taiwan. NOAA’s international partners will continue to share data, ground processing, and reception sites, and

collaborate on the operation of satellite assets. NOAA will communicate scientific information that is accurate and reliable through adherence to the highest levels of scientific integrity, transparency, and accountability.

Objective: A holistic understanding of the Earth system through research

NOAA's strategic progress and future operational capacity will depend upon a strong and vibrant scientific enterprise that draws from NOAA research capabilities and the extended community of public, private, and academic researchers with whom NOAA collaborates routinely, including Cooperative Institutes, NOAA grants and programs, and interagency coordination and funding efforts. NOAA's long-term goals and objectives hinge on an enhanced understanding of the complex interrelationships that exist across NOAA's climate, weather, ocean, and coastal domains. To explore, observe, and understand Earth system dynamics and enable the Nation to make informed decisions about our changing environment, NOAA needs to advance innovative research that pushes the boundaries of scientific understanding and integrates information across scientific disciplines. This innovative research will enable improved understanding of the Earth system from global to local scales, and improve the ability to forecast weather, climate, water resources, and ecosystem health.

To achieve this objective, NOAA will expand and maintain a reliable and accessible suite of climate, weather, ocean, marine ecosystem, and living marine resource and geospatial information, to improve the understanding of key environmental processes—including occurrence and effect of high impact events—and build capacity in the social, behavioral, and economic sciences to support the valuation of ecosystem services, risk and vulnerability assessments, and decision-support services. NOAA will develop advanced technologies in sensors, computing and networking, and user interfaces to better observe, understand, model, and communicate knowledge of complex systems, and promote existing and future scientific excellence and collaborations in its science workforce. Connecting new capabilities to operations will require test beds to accelerate the transition of technologies to applied use. NOAA will balance technology development, deployment, and relatively low-risk applied research and development, providing steady increases to current understanding through high-risk research that fosters unpredictable, radical innovation and transforms NOAA science and mission functions. Across all domains, NOAA will need to characterize the uncertainties inherent in the process of scientific discovery, and effectively communicate scientific information and its associated uncertainties to policy makers, the media, and the public.

Over the next five years, evidence of progress toward this objective will include:

- Increased understanding of climate, weather, oceans, ecosystems, human activities, and their interrelationships;
- Improved understanding of the processes contributing to, and impacts of ocean acidification, changes in ocean temperature and freshwater input, and sea level change;
- Improved understanding of ecosystems (e.g., Gulf of Mexico, Arctic, Great Lakes) and the effects of human activities on the ecosystem, and coastal communities and economies;
- Increased investigation and assessment of unexplored and ecologically, economically and culturally important coastal and oceanic regions;
- Research on ecosystem impacts, processes, dynamics and biodiversity transitioned to enable ecosystem approaches to management and coastal community resilience;

- Social, behavioral, and economic research advanced and transitioned into NOAA’s delivery of climate, weather, ocean, and coastal services;
- Meteorological, atmospheric, climatic, and oceanic research advanced and transitioned to NOAA’s production of enhanced weather, climate, and marine forecasts and services, including those supporting renewable energy;
- More effective development and transition of technologies to operational services and stewardship applications; and
- An integrated research agenda supported by portfolio management that promotes transformative research and innovation.

Objective: Accurate and reliable data from sustained and integrated Earth observing systems

NOAA’s mission is rooted in *in situ* and space-based Earth observations. The Nation’s efforts to mitigate and adapt to a changing climate require accurate, continuous, and comprehensive climate data records. Weather forecasters require observations of the state of the atmosphere and oceans to initiate and verify the models and to make accurate forecasts. Fisheries cannot be sustained without data on current and historical states of the stocks and their living environment. Coastal communities need observations to understand changing coastal ecosystem conditions and manage coastal resources sustainably. Nautical charting and navigation activities require consistent observations of the depth and surface characteristics of the oceans and Great Lakes, and changes that may occur due to ongoing physical processes. All of these capabilities draw upon diverse observing system assets, including satellites, radar, manned and unmanned aircraft, ground stations, sea-going vessels, buoys, and submersibles. The varied and growing requirements levied upon these systems greatly exceed the current capacity. NOAA’s observing system portfolio needs to balance growing demands with continuity concerns and implementation of emerging technologies. Over the long-term, NOAA must sustain and enhance observing systems (atmospheric, oceanic, inland waters, terrestrial, solar, cryospheric [Earth’s surface where water is in solid form, including glaciers, sea ice and ice caps], biological, and human)—and their long-term data sets—and develop and transition new observing technologies into operations, while working in close collaboration with its governmental, international, regional, and academic partners.

To achieve this objective, NOAA will gather environmental data by researching, developing, deploying, and operating systems to collect remote and *in situ* observations, and manage and share data through partnerships and standards. To this end, NOAA will advance the development of next-generation satellites to serve future space-based observations and provide data continuity, launch and operate environmental observation satellites, and sustain and advance *in situ* weather and climate observation networks. NOAA will calibrate climate sensors to maintain the integrity of climate data records over time, and integrate ground-based networks maintained by different domestic entities in the National Mesonet Program (a network of automated weather stations) to maximize the effectiveness of ground-based weather observations. NOAA will assimilate and fully exploit the observations data from the next-generation of polar and geostationary satellites, space weather observing systems, ground-based radars and *in situ* sensors, airborne sensors, unmanned observing platforms, and such ship-deployed systems as buoys and submersibles. Fundamental to ensuring effective use of the wealth of environmental information collected by observing systems is an increased focus on information management standards and strategies to improve access, interoperability, and usability of NOAA’s environmental information resources. NOAA will maintain and develop the next-generation of research vessels and aircraft to serve multiple

observation requirements, and deploy Autonomous Underwater Vehicles and Unmanned Aircraft Systems to explore such hard-to-observe regions as deep oceans and the Arctic. Throughout this effort, NOAA will pre-plan the transition of research observing platforms to operations, and will maintain strong partnerships with domestic and foreign partners through agreements to share expertise, instrumentation, data, data processing, and related costs.

Environmental information is critical to achieving the objectives of all of NOAA's goals. NOAA is, at its foundation, an environmental information generating organization. Fundamental to ensuring that the wealth of environmental information generated by NOAA is used effectively now and in the long-term is an increased focus on information management standards and strategies to improve access, interoperability, and usability. This will only be possible if operational and scientific users (both internal and external to NOAA) and environmental information providers work collaboratively. Environmental information becomes more valuable with use. Strategies to increase ease of access and improve documentation of NOAA's environmental information will further enhance its value to stakeholders.

Over the next five years, evidence of progress toward this objective will include:

- Increased percentage of environmental measurement needs (legacy and new) satisfied within objectives of the four strategic goals;
- Reduced gaps in sustained environmental measurements;
- Improved data interoperability and usability through application and use of common data management standards;
- Enhanced access and use of environmental data through data storage and access solutions, integration of systems, and long-term stewardship; and
- Reduced life cycle cost of observations through increased partnerships, integration of systems leveraging available data, and reducing unnecessarily duplicative capabilities.

Objective: An Integrated environmental modeling system

To fulfill current and emerging science and service requirements for all of NOAA's strategic goals, the agency must ultimately evolve toward an interconnected and comprehensive Earth system modeling enterprise that links atmospheric, oceanic, terrestrial, cryospheric, ecological, and climatic models. This evolution will advance the ability to provide forecasts that incorporate dynamic responses from natural and human systems, and provide results at spatial and temporal scales capable of assessing impacts on ecosystem services, economies, and communities. NOAA and other Federal Agencies support significant modeling research and development carried out by broad external research communities across the Nation. This objective will transform these existing environmental modeling efforts from disparate enclaves into a coordinated, scientifically robust effort that serves as a foundation for integrated environmental analysis, forecasting, and model-based user support and services. Key benefits of this integrated effort include enhanced service capabilities—a cornerstone of NOAA's decision support efforts—and greater access to, ease-of-use, and reliance on NOAA's models and guidance, providing clearly articulated model confidence; continued advancement of a national environmental prediction and assessment capability; and optimization of NOAA's investments in research, observations, and monitoring.

To achieve this objective, NOAA will develop a comprehensive modeling backbone; integrate observations, models, products, and services; and foster a culture of collaboration within and external to NOAA. The complexity of NOAA's modeling requirements and the challenges of transitioning research and development capabilities into operations will require extensive

coordination within NOAA and with other Federal Agencies for the optimized use of national investments, and external collaboration with the environmental modeling community in the academic (including academic consortia) and private sectors. To this end, NOAA will develop collaborative strategies involving internal and external partnerships and community-wide standards to ensure interoperability; integrate research monitoring and prediction plans for its strategic goals, including regional-scale climate models and integrated ecosystem modeling; enhance and expand existing capabilities for data integration from observing systems for model validation and verification; and institute a well-functioning governance structure for NOAA's environmental modeling enterprise.

Over the next five years, evidence of progress toward this objective will include:

- Effective and efficient collaboration and coordination within NOAA and with partners to enhance the scope and predictive accuracy of integrated Earth system models for global, national, and regional applications, and for specific phenomena;
- Increased capacity, capability, and use of models to support ecological forecast services;
- Improved predictive performance of global, regional, and local climate, weather, ocean, and ecosystem models for variable temporal scales;
- Increased development and implementation of integrated modeling science plans incorporating prioritization, and partnerships to accelerate the advancements of modeling capabilities, capacities, and enterprise solutions;
- Increased volume and diversity of data and information effectively integrated into models, particularly at different global, national, regional, and local scales;
- Increased evaluation and optimization of NOAA's investments in observation and monitoring through the use of models;
- Acceleration of model coverage, transitioning, and interoperability; and
- Increased development and use of enterprise and community models.

NOAA's Engagement Enterprise

As the challenges NOAA must address become more complex, the Agency will need increasingly sophisticated organizational mechanisms to understand user needs and engage stakeholders and customers across local, regional, and international levels. Many of the challenges that NOAA helps address do not stem from a lack of information, but from an uneven distribution of information. The best way for NOAA to meet the needs of its stakeholders is often to better deliver data and knowledge to those who have not yet accessed it. NOAA must understand these needs and respond to them. Conversely, NOAA's next breakthrough in research, development, operational improvement, or policy action may depend upon the unique knowledge or needs of a partner or customer. NOAA must fully engage with society to be most effective as a service agency.

NOAA's capacity to engage individuals and other organizations effectively will determine its long-term success. It is not sufficient for NOAA to conduct, fund, and direct science. NOAA must be aware of science conducted, funded, and directed by others and must integrate and convert that scientific information into applications used within the Agency, then harness its stewardship responsibilities by meeting society's broader needs for more information. Scientists must solicit management needs as early as possible in the design of research with a constant eye toward management's potential use of research results. Scientists must engage with their peers, but also with colleagues in other disciplines and with the public at large. Managers of NOAA's environmental data and information services must engage with

decision makers in local governments and industries. Regulators must engage with communities they regulate, as well as with their regulatory counterparts in other nations. NOAA must also engage with constituents, educators, and communicators to share knowledge and information.

NOAA Partnerships in its Engagement Enterprise—Engagement implies a commitment of service through a partnership between NOAA and society based on reciprocity and shared goals, objectives, and resources. Implicit to engagement is a respect for each partner that involves listening, dialogue, understanding, and mutual support. In the areas of weather and climate, NOAA is a major component of the public, commercial, and academic enterprises that provide a full suite of weather products and services to the Nation. In turn, partners have strong and ongoing relationships with such constituent populations as students (from kindergarten through undergraduate programs) and faculty, local governments, businesses and industries, and the general public.

NOAA has strong partner relations with many universities through Sea Grant, Cooperative Institutes, and the National Estuarine Research Reserve System programs. NOAA partners with organizations including Coastal Ecosystem Learning Centers; Centers for Ocean Sciences Education Excellence; non-governmental organizations such as the Nature Conservancy; and with numerous science centers, museums, zoos, and aquariums. NOAA actively engages such professional societies as National Science Teachers Association, National Marine Educators Association, and the American Meteorological Society. NOAA coordinates with other Federal Agencies that have similar engagement missions, including NASA, DOI, EPA, and the National Science Foundation. At the State and regional level, NOAA’s partners include such groups as Western Governors’ Association, the Northeast Regional Ocean Council, and the Gulf of Mexico Alliance. Internationally, NOAA works with such bodies as the World Meteorological Organization, the International Maritime Organization, and the International Whaling Commission.

Objective: An engaged and educated public with an improved capacity to make scientifically informed environmental decisions

Among the many environmental challenges facing the Nation, responding to climate change and the balancing the use of coastal and marine resources are paramount. To address these challenges, NOAA must rely not only on its own capabilities, but also on the ability of leaders, organizations, institutions, and the public to understand environmental conditions and the forces that affect them. Stakeholders and the public face a considerable challenge of understanding climate and ecosystem dynamics, parsing estimates of potential impacts, and integrating environmental information and uncertainties into routine decision making. Conversely, engagement for NOAA’s program development is needed, which requires an intimate knowledge of its stakeholders, their particular information needs, and ways of doing business. Finally, there is a widening gap between the science most students learn in U.S. schools and the knowledge they will need in the 21st century to foster the Nation’s innovation and competitiveness. To support climate, weather, ocean, and coastal science and management needs of the next-generation, NOAA must foster an environmentally literate society and future environmental workforce.

To achieve this objective, NOAA will engage stakeholders and the public at multiple levels to build awareness of environmental science, services, and stewardship responsibilities; foster community dialogue; and to educate citizens and students. To this end, NOAA will work with partners to increase climate, weather, ocean, and coastal literacy through investments in extension, training, education, outreach, and communications; outreach to community leaders and decision makers; through innovative technologies to engage stakeholders and the public; strategic connections with science education communities to advance scientific and technical education opportunities and attract populations who are currently underrepresented in the science workforce;

and through education and outreach initiatives of other Agencies, including other Federal scientific and environmental Agencies.

Over the next five years, evidence of progress toward this objective will include:

- Increased understanding and use of climate, weather, ocean, Great Lakes, and coastal environmental information to promote stewardship and increase informed decision making by stakeholders, educators, students, and the public who are interested in science;
- A diverse pool of students with degrees in science, technology, engineering, mathematics, and other fields critical to NOAA's mission, connected to career paths at NOAA and in related organizations; and
- NOAA effectively engages key stakeholders and the public to enhance literacy of climate, weather, ocean, and coastal environments.

Objective: Integrated services meeting the evolving demands of regional stakeholders

The challenges that NOAA's partners and customers face are often particular to communities within geographic regions and require that NOAA draw on its full range of mission responsibilities and capabilities to address them. NOAA routinely draws on its breadth of capabilities to respond to regional disasters, but must tailor the specific response depending on whether the disaster is a tsunami in American Samoa, flooding in the Midwest, or an oil spill in the Gulf of Mexico or Great Lakes. NOAA's capacity to effectively meet its responsibilities to the Nation will require firsthand knowledge of the needs and dynamics of each region, an integrated workforce that operates with awareness of the range of the Agency's mission and capabilities, and organizational flexibility to tailor its capabilities and services to meet distinctive regional needs. As regional and local conditions change, NOAA will need to quickly assess changes in user and stakeholder priorities and develop collaborative solutions that draw on the full range of capabilities available from NOAA and its community of partners.

To achieve this objective, NOAA will tailor services to meet regional demands by coordinating and integrating the capabilities of multiple Line Offices within that region. Through regional collaboration and engagement strategies, NOAA will strengthen relationships, improve the use and usability of its services, communicate the rationale behind significant regulatory action to stakeholders, and rapidly adapt to changing local and regional conditions and requirements. In particular, NOAA will focus on supporting and collaborating with established and emerging regional governance initiatives so they are better able to protect and restore coastal, ocean, Great Lakes, and other regional resources.

Over the next five years, evidence of progress toward this objective will include:

- Stakeholder needs continually and adequately assessed for NOAA science, service, and stewardship;
- Integrated products and services tailored to the needs of NOAA's regional stakeholders and customers;
- Organizational responsiveness to stakeholder needs through the evaluation of and adjustments to products and services;
- Two-way communication with regional stakeholders, including regional governance initiatives, to build understanding, trust, and partnerships; and

- A workforce operating with shared awareness and understanding of its cross-Agency missions and capabilities.

Objective: Full and effective use of international partnerships and policy leadership to achieve NOAA's mission objectives

NOAA's mission extends beyond the political boundaries of the U.S. to oceans, ecosystems, and the atmosphere. Climate change and its impacts, depletion of many of the world's fish stocks, global ocean degradation, changing weather patterns, and the increased need to take advantage of space-based and other observation platforms have drawn attention to the international nature of the many challenges and opportunities that the Nation faces. NOAA plays a key leadership role in international ocean, fisheries, climate, space, and weather policies, and is required to play a role in domestic and international activities. NOAA's many assets—including research programs, vessels, satellites, science centers and laboratories, and a vast pool of internationally recognized experts—make it an essential international resource. NOAA is well positioned to assist other nations improve their understanding and ability to predict changes in climate and other environmental conditions affecting natural resources, population safety, and economic activity. At the same time, NOAA can draw on those same resources to achieve its mission objectives. As more countries launch their own satellites, and ocean- and ground-based observing networks, there are more opportunities to leverage investments made by foreign partners. As such, the need for common data standards, service level agreements, and memoranda of understanding have increased.

To achieve this objective, NOAA will leverage multilateral and bilateral partnerships to take full advantage of research, observations, environmental science, and ecosystems management expertise and resources from outside the U.S. Continued international engagement will enable NOAA to promote goals and practices that can be adopted and adapted regionally or globally to benefit the Nation and advance NOAA's strategic goals. NOAA will lead, advocate, and support a science-based whole-government approach to addressing these challenges. Through these efforts, NOAA will improve the standardization, availability, and utility of environmental data for the Nation and our global partners.

Over the next five years, evidence of progress toward this objective will include:

- Full implementation of the provisions of the MSA to combat illegal, unregulated, and unreported fishing and bycatch of protected living marine resources in international fisheries;
- Fulfillment of the Coral Triangle Initiative objectives;
- Build transboundary relationships that support NOAA regional engagement, including that in the Arctic, Great Lakes, and Gulf of Mexico;
- Implement the International Marine Mammal Action Plan;
- Expanded collaborations and partnerships on international environmental observing capabilities and on climate observing systems, assessments, and services; and
- Reduced loss of life, property, and disruption from and response to high-impact international events.

NOAA's Organization and Administration Enterprise

Supporting all of NOAA's various functions is the management of resources, an essential function of any organization. NOAA's managers, whether at headquarters or in the field, have common responsibilities to manage the investment of tax-payer dollars, deploy physical infrastructure, and retain a qualified workforce. NOAA's managerial efforts provide the rest of the Agency with the staff, the infrastructure, and the financial capital needed to get the job done. Effective management of these resources fosters an organizational environment in which core competencies can be used most effectively and final products and services can have the greatest impact.

NOAA Partnerships in its Organization and Administration Enterprise—NOAA's partners in organization and administration are, first and foremost, its larger family of Government Agencies, such as the National Institute for Standards and Technology within DOC. NOAA will continue to work with DOC headquarters and the Office of Management and Budget to improve programmatic effectiveness and fiscal responsibility as a public organization. In this vein, NOAA also draws upon the expertise of independent, non-profit organizations, such as the National Academy of Sciences, the National Academy of Public Administration, and the Partnership for Public Service. It will rely upon the General Services Administration for broad-based services support for acquisitions, manufacturing, logistics, and a variety of centralized services. To hire, retain, and develop a highly qualified workforce, NOAA also relies upon the Office of Personnel Management. To ensure its next generation of scientists and administrators, NOAA partners extensively with colleges and universities around the country, and with such programs as Sea Grant, through education, outreach, and grants for research and professional development.

Objective: Diverse and constantly evolving capabilities in NOAA's workforce

At the heart of NOAA operations is the creative work of scientists, engineers, technicians, managers, NOAA Corps Officers, and administrative staff. Only by investing in this stock of intellectual capital can NOAA achieve its strategic goals to provide the public with scientific knowledge, information services, incident response and environmental stewardship capabilities. As the nation faces new challenges, NOAA will increasingly require a workforce of top-tier scientists, operational specialists, organizational leaders, science communicators, science managers, and program and project managers. NOAA will maintain a highly qualified, competent, mobile and adaptable workforce, able to respond to incidents and integrate quickly with other Government Agencies and uniformed services. Focusing on social and environmental outcomes will require not only the best skills in the scientific and engineering disciplines, but the best skills in interdisciplinary work. Understanding the natural, social, and economic systems that make up a dynamic ecosystem will require increased expertise in social and economic science as well as the physical sciences. Efficient operations within a complex scientific and technical organization will require expert-level mastery of the disciplines of program and project management. Finally, with a substantial portion of its workforce approaching retirement eligibility, NOAA will also need to attract, hire, train, and retain a new generation of professionals to accomplish its strategic goals.

To achieve this objective, NOAA will recruit and develop outstanding professionals with disciplinary, interdisciplinary, and managerial expertise. NOAA will regularly conduct analyses of its current workforce capabilities and future workforce needs, and cultivate both existing and new sources of talent to evolve its workforce capabilities over time. NOAA will place increased emphasis on hiring, developing, and retaining people with expertise in the social and economic sciences, and in developing performance plans and managing programs that reflect its priorities and strategic goals. NOAA will use knowledge capture tools and management practices to retain critical organizational and scientific knowledge to guide the future workforce. NOAA leadership

will ensure all performance plans reflect the Agency's priorities and strategic goals and that employees are effectively managed and supported to meet those goals. NOAA will strengthen its NOAA Corps and leverage the operational expertise and interdisciplinary experience of officers to lead the application of new observation technologies and integration between the Agency's Line Offices. NOAA will increase collaboration with academia and create opportunities to support undergraduate and graduate students' participation in NOAA activities that foster their interest in NOAA-related scientific study and a future career within the Agency.

Over the next five years, evidence of progress toward this objective will include:

- Increased leadership, managerial training, and certification in the career development of NOAA professionals and NOAA Corps Officers;
- Increased numbers of qualified program and project managers;
- Increased numbers of interdisciplinary professionals and science translators to enable functions of engagement and integration;
- Increased use of social scientists for research, service development, and operations;
- Increased capacity of the NOAA Corps to lead integration of advanced technologies into NOAA's missions; and
- Increased numbers of underrepresented groups in the NOAA workforce.

Objective: A modern IT infrastructure for a scientific enterprise

NOAA's mission requires a transformed, agile, service-oriented, and secure IT infrastructure to propel its scientific and operational goals with advanced computing capabilities. World-class delivery of reliable and scalable IT services is essential to meet growing demands and to efficiently process and disseminate ever increasing volumes and types of environmental information. High-performance computing (HPC) enables environmental modeling, and thus, all of NOAA's predictive products, including weather forecasts, climate analyses, and the transfer of mature research systems developed into operational capacities in collaboration with academic, private sector and other government partners. Consumer and professional use of social networking sites is becoming increasingly (and inextricably) intertwined. Modern collaborative technologies are essential to enabling NOAA's diverse and widely distributed staff to share knowledge more effectively, and to enable customers and stakeholders to engage with the extended NOAA community transparently and effectively.

To achieve this objective, NOAA will implement enterprise-wide solutions to gather, process, and disseminate environmental information; enable effective collaboration; and improve operational cost effectiveness, efficiency, and service quality. NOAA is committed to modernizing its IT infrastructure through the development of a common standards-based architecture and through a consistent approach to making decisions based upon the service needs of NOAA staff and stakeholders. NOAA will make available computing platforms, networks, data storage, and information analytics to collect, analyze, and disseminate efficiently and securely the massive quantities of observational data needed for reporting and for warning the public and partners. Significant and sustained investments will be required to establish and maintain an HPC architecture that meets NOAA's weather and climate modeling needs. Desktop services will include cloud computing, virtualization, and state-of-the-art business intelligence products and tools. NOAA will provide secure and flexible social media environments, collaboration tools, and web portals to promote innovation across mission, line, stakeholder, and user boundaries. The Agency will support unified communications by efficiently and reliably switching traffic across

formats, media, and channels. NOAA will support responsible and sustainable IT development in alignment with the Agency’s overall sustainability efforts to “go green.”

Over the next five years, evidence of progress toward this objective will include:

- Adoption of a common architecture and framework for IT services and solutions;
- Delivery of critical high-performance computing capabilities for evolving environmental modeling requirements;
- Implementation of enterprise-wide and holistic protection from cyber security threats; and
- An IT workforce that possesses the competencies required to fulfill NOAA’s evolving scientific mission.

Objective: Modern, safe, and sustainable facilities

NOAA’s research, operations, and management functions are conducted in specialized facilities dispersed across the Nation, and internationally. From highly-specialized laboratories to state-of-the-art data and computing centers, from satellite operations facilities to energy-efficient, sustainable office facilities, NOAA must ensure its facilities provide modern, sustainable, and safe environments to fulfill its mission successfully and to attract and retain a high-performance workforce. Like other NOAA capital assets, NOAA’s facilities require routine recapitalization, renovation, and modernization to provide state-of-the-art capabilities.

To achieve this objective, NOAA is committed to modernizing its facilities, and creating sustainable, energy-efficient, safe, and secure work environments. Reducing NOAA’s carbon footprint and energy costs through the use of sustainable design of new facilities and investments in energy-efficient building systems will be key strategies for more effective energy stewardship of NOAA facilities. Efficiencies are also planned by leveraging targeted consolidation of dispersed facilities. Key strategies for modernization will include sustained investments in recapitalizing NOAA’s aged facility portfolio, as well as investments in new facilities.

Over the next five years, evidence of progress toward this objective will include:

- Improved facility condition indices;
- Reduced accidents and injuries;
- Increased energy efficiency in facility operations, including an increased percentage of NOAA’s total facility portfolio certified by the U.S. Green Building Council’s Leadership in Energy and Environmental Design; and
- Increased operational efficiency.

Objective: A high-performing organization with integrated, efficient, and effective business systems and management processes

NOAA’s unique mission is particularly resource intensive, requiring diverse investments in land, structures, satellites, ships, aircraft, unmanned systems, sensors, equipment, software, and IT. In addition to its physical infrastructure, a large part of NOAA’s mission requires investing in the capabilities of its partners through grants, cooperative agreements, and contracts. Successfully managing these systems and partnerships to operate efficiently and effectively over their entire life cycle requires a long-term perspective. The technical sophistication, resource intensity, and long

time frames associated with NOAA’s physical assets and partnerships requires fully integrated, effective management and administrative systems and processes.

To achieve this objective, NOAA will strengthen financial and non-financial internal controls, develop and deploy improved risk-management methods, and reform NOAA-wide business processes to improve organizational efficiency and effectiveness continuously. Through improvements in acquisition, program management, and oversight practices, NOAA will ensure that programs and projects achieve their goals on schedule and within budget, and will provide a sound framework for routine monitoring and evaluation of program performance.

Over the next five years, evidence of progress toward this objective will include:

- Successful results from audits and evaluations of NOAA’s financial and non-financial control systems;
- Sound project engineering, cost estimation, and acquisition management practices that generate routine success in meeting cost, schedule, and performance targets for programs and major projects;
- Increased organizational efficiency and effectiveness through continuous improvements in NOAA-wide business processes and strategic and performance management systems; and
- Improved project and program management skills.

Strategy Execution and Evaluation

NOAA’s Next-Generation Strategic Plan will identify what NOAA should produce in the future (i.e., outputs), and why those outputs are important (i.e., outcomes). Distinguishing between outcomes and outputs gives NOAA the flexibility to change what it produces while staying true to its ultimate mission and vision. The purpose of the Plan is four-fold:

- So NOAA’s management can make well-reasoned, transparent investment choices based upon administration and stakeholder priorities and upon NOAA’s potential to satisfy them;
- So the Agency can properly align requirements for resources with requirements for services, and with administration and stakeholder priorities (and demonstrate this alignment);
- So NOAA’s managers (and stakeholders) can monitor Agency performance (i.e., the quality and efficiency of services) and the effectiveness of outputs in contributing to societal outcomes; and
- So NOAA’s business lines, staff, partners, and stakeholders can cooperate on solutions with a common understanding of roles, responsibilities, and the meaning of “success.”

The objectives identified in this plan are the basis for NOAA’s corporate planning, performance management, and stakeholder engagement over the next five years. Objectives are specific outcomes NOAA can achieve on the path to broader, long-term goals and toward a more capable, flexible enterprise. They are measureable and can be affected by specified activities over a five-year period. NOAA’s Line Offices and Staff Offices will be accountable for executing the strategy laid out in this document through implementation plans at a tactical (rather than strategic) level of detail. Where there are shared capabilities to achieve an objective, there will also be joint accountability for budgeting, executing, and performing toward that objective.

NOAA will systematically monitor and evaluate its performance toward the outcome-oriented goals and objectives in this plan. Evaluating performance will allow NOAA to learn from its successes and failures, improve continually as an organization, and deliver better on the promise of its mission of science, service, and stewardship. NOAA's performance measures, including those required under the Government Performance and Results Act, are published annually in the NOAA Annual Performance Plan and Performance Accountability Report.

NOAA's Next-Generation Strategic Plan supports the DOC's Strategic Plan and Annual Performance Plan. A direct relationship between NOAA's goals and objectives and the goals and performance measures is included in the annual budget submission to DOC. DOC uses this information for its Annual Performance Plan and Performance and Accountability Report, which integrate outcomes and performance measures across the Department.

References

For further information on the consultations and analyses that NOAA used in developing this plan, including NOAA's *Scenarios for 2035* and the results of NOAA's extensive stakeholder consultations, please visit: www.noaa.gov/ngsp

Glossary of Key Terms

Climate: The weather of a locality averaged over a long-term period (often 30 years), including its variability.

Climate Change: The change in the mean state of the weather over periods of time from decades to centuries to millions of years.

Climate Variability: Natural changes in climate that fall within the normal range of extremes for a particular region, as measured by temperature, precipitation, and frequency of events. Drivers include the El Niño Southern Oscillation and other phenomena.

Ecosystem: A geographically specified system of organisms (including humans), the environment, and the processes that control its dynamics.

Enterprise: A purposeful undertaking that generally requires the coordination of different organizations, types of expertise, and capital.

Environment: The biological, chemical, physical, and social conditions that surround organisms. When appropriate, the term should be qualified as biological, chemical, and/or social.

Goals: Specific components of NOAA's strategic vision of the future. A translation of the vision into a limited number of high-level results that NOAA will seek to achieve. Covering a time horizon that is multi-decadal (same as vision).

Strategy: A high-level explanation of what the agency intends to do and why it intends to do it. A mission statement (with a corresponding set of functions) relating to a vision statement (with a corresponding set of long-term strategic goals) to succinctly convey NOAA's fundamental purpose, strategic direction, and value to society.

Mission: A summary of the agency's fundamental mandates and responsibilities. A succinct and distinctive statement of what NOAA does. A mission statement encapsulating the set of statutory requirements that drive NOAA's mission functions, assumed to be stable over the planning period.

Objectives: For each long-term goal, a corresponding set of near-term, concrete, measured steps toward that respective goal. Outcomes that further describe each goal statement by detailing the societal and environmental benefits that NOAA will seek to achieve in the short-term. Evidence of Progress within each Objective form the basis of outcome-oriented performance measures.

Resilience: The ability of a system to absorb impacts without significant change in condition or functioning.

Vision: A description of an envisioned future state of society and the environment that, implicitly, cannot be achieved without NOAA. A description of long-term success in terms of the value NOAA will generate for society. Answering why NOAA exists. Covering a time horizon that is multi-decadal (same as goals).

Weather: The present condition of the atmosphere and its short-term (e.g., days up to 2 weeks) variation at a particular location.

List of Acronyms

DHS	U.S. Department of Homeland Security
DOC	U.S. Department of Commerce
DOD	U.S. Department of Defense
DOI	U.S. Department of the Interior
DOT	U.S. Department of Transportation
EPA	Environmental Protection Agency
ESA	Endangered Species Act
HPC	High-performance computing
IPCC	Intergovernmental Panel on Climate Change
IT	Information Technology
MSA	Magnuson-Stevens Fisheries Conservation and Management Act
MTS	Marine Transportation System
NASA	National Aeronautics and Space Administration
NCS	NOAA Climate Services
NOAA	National Oceanic and Atmospheric Administration
UN	United Nations
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey