United States Department of Commerce
National Oceanic and Atmospheric Administration

Oceanic and Atmospheric Research

Strategic Plan

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Credit: Charles Vann

Contents

A Myriad of Colours. Credit: Ajay Krishnan Subramaniam

Introduction

The Office of Oceanic and Atmospheric Research (OAR) creates improved understanding and predictions of tornadoes, hurricanes, climate variability, changes in the ozone layer, El Niño/La Niña events, ocean acidification, fisheries productivity, ocean currents, deep sea thermal vents, and coastal ecosystem health. The science and technology that OAR produces and transfers to partners (in NOAA’s service lines and beyond) is instrumental to preventing the loss of human life, managing natural resources, and maintaining a strong economy. OAR's position at the intersection of NOAA’s science and service missions and the broader research community enables it to lead a research agenda and forge partnerships that advance understanding and prediction of the Earth System to enhance society's ability to make effective decisions.

OAR’s vision

Be a trusted world leader in observing, modeling, understanding and predicting the Earth system.

OAR’s mission

Conduct research to understand and predict the Earth system; develop technology to improve NOAA science, service and stewardship; and transition the results so they are useful to society.

Within NOAA, OAR serves a unique role. NOAA’s other line offices specialize in operational services: managing environmental data, providing information on ocean environments, delivering weather forecasts and warnings, and acting as stewards of living marine resources and habitats. OAR, on the other hand, specializes in *improving* these capabilities, and *improving* our understanding of the Earth system across these mission areas. OAR conducts R&D that increases our knowledge of climate, weather, oceans and coasts, and it increases the effectiveness of NOAA's service lines, as well as a great range of partners in the public, private, and academic sectors.

OAR supports the R&D for ocean, Great Lakes, and atmosphere that private, academic, and other government organizations would not otherwise provide. The results of R&D at OAR are essential public goods that are produced nowhere else. They include environmental data sets; peer-reviewed journal articles; predictive models of weather, climate, and ecological systems; training and education on the science and technology we create; new commercial technologies; as well as the next generation of scientists, engineers, and entrepreneurs. The anticipated benefits of these outputs are not always predictable, may not even be measurable, and could take many years to realize. Nevertheless, we know that we cannot benefit from the science and technology of tomorrow without investing in research and development today. Reward requires risk, and this is the role of OAR.

This document details OAR's strategy. It is a rationale for what OAR does and how it will move forward in the coming years. The strategy for such a multifaceted research organization can be complex; there are many different activities to conduct, many reasons to conduct them, different approaches to take. As such, we have adopted a simple but powerful model for our strategic plan,[1] framed as answers to five types of questions:

Aims

What is our vision of the future? What goals and questions drive our enterprise?

Activities

What is our mission? What types of products will allow us to achieve our aims?

Organizations

Who does what? Who are our different partners and what do they bring to the table?

Approaches

How do we do it? In what ways will we conduct activities with our organizations?

Evaluations

How do we judge our success? What evidence informs programmatic decisions?

This document provides a narrative so that OAR leadership, staff, and partner organizations can have common ground for fruitful discussion and debate. Additional details on goals, objectives, performance expectations — as well as how OAR aligns with the strategies of NOAA and the Department of Commerce — are provided in a companion document, the multiannual OAR Implementation Plan.

[1] This approach adopted from Lafley, A. G., & Martin, R. L. (2013) *Playing to win : How strategy really works.* Boston, Mass: Harvard Business Review Press.

Bahamian Lobster in the grass. Credit: Sam Farkas

Aims

NOAA is a science-based agency with a mission to understand and anticipate changes in climate, weather, oceans, and coasts; share that knowledge and information with others; and to conserve and manage marine resources. NOAA has responsibilities to regulate coastal and marine resources and provide environmental information services. To fulfill these responsibilities, it is essential that NOAA maintain a vigorous and forward-looking research and development (R&D) enterprise. OAR is the heart of that enterprise and the innovation engine for achieving NOAA's strategic vision: healthy ecosystems, communities, and economies that are resilient in the face of change.

OAR's own, concomitant vision is *to be a trusted world leader in observing, modeling, understanding and predicting the Earth system.* OAR works with its partners to reduce the vulnerability of social and ecological systems in the short-term, and help society avoid or adapt to long-term environmental changes. As a trusted world leader in observing, understanding, and predicting the Earth system, OAR focuses on NOAA's outcome-oriented goals for climate, weather, oceans and coasts, which are themselves derived from the NOAA vision. The questions that direct R&D toward each of these goals are listed below. (Note that these questions are high-level drivers that do not detail all of OAR's activities.)

Climate Adaptation and Mitigation: An informed society anticipating and responding to climate and its impacts.

Projected future climate-related changes include increased global temperatures, rising sea levels, acidification of the oceans, changes in storm frequency and intensity, alterations in species' ranges and migration patterns, and increased drought. Impacts from these changes are regionally diverse, and affect numerous sectors related to water, energy, transportation, forestry, tourism, fisheries, agriculture, and human health. Toward this goal, OAR supports R&D that answers these questions:

- What is the state of the climate system and how is it evolving?
- What causes climate variability and change on global to regional scales?
- What improvements in global and regional climate predictions are possible?
- How can NOAA best inform and support the Nation's efforts to adapt to the impacts of climate variability and change?

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, and injuries; and that operates with greater economic efficiency. Toward this goal, OAR supports R&D that answers these questions:

- How can we improve forecasts, warnings, and decision support for high-impact weather events?
- How does climate affect seasonal weather and extreme weather events?
- How can we improve forecasts for freshwater resource management?
- How are atmospheric chemistry and composition related to each other and ecosystems, climate, and weather?

Healthy Oceans: Marine fisheries, habitats, and biodiversity are sustained within healthy and productive ecosystems.

Ocean ecosystems provide us with food, recreational opportunities, and they support economies, yet these services are stressed by environmental change and human uses. 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. This directly affects human health and well-being.   Depleted fish stocks reduce opportunities for employment and economic growth. NOAA's goal of healthy oceans is to ensure that ocean, estuarine, and related ecosystems —and the species that inhabit them — are vibrant and sustainable in the face of challenges. Toward this goal, OAR supports R&D that answers these questions:

- How do environmental changes affect marine and coastal ecosystems?
- How can emerging technologies improve ecosystem-based management?
- How is the chemistry of our ocean changing and what are the effects?
- What exists in the unexplored areas of our oceans?
- How can we ensure aquaculture is sustainable?

Resilient Coastal Communities and Economies: Coastal and Great Lakes communities are environmentally and economically sustainable.

Coastal and Great Lakes communities are 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. Continued growth in coastal populations, and global trade increase the need for safe and efficient maritime commerce. The Nation's need for energy presents many economic opportunities, but will also result in greater competition for ocean space, challenging our ability to make decisions that balance conflicting demands. Toward this goal, OAR supports R&D that answers these questions:

- What is the value of coastal ecosystems?
- How do coastal species respond to and relate to habitat loss, degradation and change?
- How do we reduce the economic, ecological, and health impacts of degraded water quality?

Across the Enterprise: Observing, Modeling, and Engaging for all Goals.

In addition to its goals, NOAA has enterprise-wide, function-oriented objectives for environmental data, environmental modeling, and stakeholder engagement. Across all goals there is a need for: accurate and reliable data from sustained and integrated Earth observing systems; an integrated environmental modeling system; and an engaged and educated public with an improved capacity to make scientifically informed environmental decisions. To achieve these objectives, OAR supports R&D that answers these questions:

- What are the best observing systems to meet NOAA's mission?
- How can we best use current and emerging environmental data?
- How can we improve the way we manage data?
- How can modeling be best integrated and improved with respect to skill, efficiency, and adaptability?
- What information technology developments can help NOAA improve quantitative predictions?
- How can we support informed public response to changing environmental conditions?
- How can we improve the way scientific information and its uncertainty are communicated?

Fundamental to all of these goals is the agency's cross-cutting, long-term R&D objective: a holistic understanding of the Earth system. In popular language, "holistic" means that the whole is more than the sum of its parts. In a scientific context, it means that systems' properties are often "emergent," that is, they cannot be deduced from the properties of components.[2]

A holistic understanding of the Earth system means an integration of diverse perspectives and professional expertise, and connecting otherwise separate R&D endeavors. For ecosystem research, a holistic understanding demands that we study ecology as distinct from individual species and their habitats. For research on climate systems, it is the bridging of phenomena at different spatial and temporal scales and taking into

[2] Von Bertalanffy, Ludwig (1950). "An outline of general system theory." British Journal for the Philosophy of Science, Vol 1, pp.134-165.

account the interactions between the atmosphere, oceans, land, and ice. For the development of observation systems, it is the architecture of interwoven technologies to collect and manipulate data. For the orchestration of NOAA's entire innovation system, it is the translation of knowledge and technologies across the institutional boundaries of research and applications. In these cases, we are focusing on synthesis rather than analysis — *connecting* the dots, rather than *collecting* the dots.

Aurora Australis over NOAA's Atmospheric Research Observatory. South Pole, Antarctica. Credit: Ross Burgener

Activities

OAR's intends to lead the world in understanding the Earth system through observations, models, predictions, and associated scientific information, tools, and methodologies. Its mission is *to conduct research to understand and predict the Earth system; develop technology to improve NOAA science, service and stewardship; and transition the results so they are useful to society.* These three functions of research, development, and transition are intimately connected, but it is useful to clarify the distinct purposes and different product types of each.

Research

Research yields ideas, knowledge, and understanding of systems. Research is defined as the "systematic study directed toward fuller scientific knowledge or understanding of the subject studied."[3] OAR conducts research to advance NOAA's mission. This includes research that is concerned with both fundamental understanding and ultimate use — what Stokes called "use-inspired" research, and what others have called "strategic" or "purposive" research.[4]

Observations and Data

OAR collects data on the Earth system for use in models and studies. This includes analyzing observations and developing insights based on those observations, as well as procuring and maintaining observing systems, quality control of data, and archive and access. Examples: Global

[3] National Science Foundation (2009). Federal Funds for Research and Development: Fiscal Years 2006-08. Detailed Statistical Tables NSF 10-303. Arlington, VA.
[4] Stokes, Donald (1997). Pasteur's Quadrant, Washington: Brookings Institute Press.

monitoring of atmospheric composition, global ocean observations, and exploration of the undersea environment.

Models and Experiments

Models codify our understanding of a system in terms of the relationships among its elements, both qualitatively and quantitatively. Scientific experiments test hypotheses about these relationships as the basis for creating, refining, and rethinking models. This combines lab and field work with coding algorithms and running simulations. Examples: High-Resolution Rapid Refresh model for short-range weather prediction.

Studies and Assessments

Studies and assessments synthesize scientific knowledge of Earth systems into tools for decision making and future research, often using observational data, model output, experimental results, and other research as source material. Examples: peer reviewed publications, assessments for the Intergovernmental Panel on Climate Change, the National Climate Assessment, Great Lakes ecosystem characterizations.

Development

Development yields inventions, techniques, and engineering of systems. Development is defined as “the systematic use of the knowledge or understanding gained from research, directed toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes.” To improve capabilities for scientific research, and for operations in NOAA's service lines, and for partners around the world, OAR develops sensors, models, and other tools.

Predictions and Projections

OAR applies advanced models of Earth systems to make predictions about the future (using present-day conditions) or projections (using plausible scenarios). They are pre-operational products intended for use in regular services. They require models, data, advanced computing architectures and techniques, and the publication and interpretation of information. Examples: hurricane prediction improvements, regional climate projections, and ecosystem forecasts for the Great Lakes.

Emerging Technologies

OAR creates new or significantly improved technology for observation and modeling systems, as well as tools for information delivery and stakeholder engagement. Typically, this involves the development or application of new hardware or software, or the integration of technologies into systems. Examples: Deep Ocean Assessment of Tsunami (DART) buoys for tsunami forecasting, and Forecasting a Continuum of Environmental Threats (FACETs) to communicate clear and simple hazardous weather information to serve the public.

Transition

Transition yields outcomes for stakeholders, either within NOAA or in the broader community. Transition includes activities of transferring technology and knowledge transfer to partners' operations. (This includes transferring of physical instruments and tools as well as methodologies and other tacit knowledge.) Innovation requires that an idea or invention has been translated into an application, that it is used, and it is valuable.[5] [6] [7] The science and technology that OAR produces is not only relevant to society, it anticipates and responds to partners' needs. OAR demonstrates the value of technologies so that partners can deploy them into their applications.

Extension and Outreach

OAR works directly with stakeholders on the ground to understand their needs, conduct research that meets those needs, and translate results so that they are meaningful and actionable. Ensuring that the results of R&D are accessible to and understood by stakeholders that might use them. Examples: Sea Grant extension and outreach, Regional Integrated Science and Assessments (RISAs), publication of climate, weather, and other environmental data sets on data.gov

Technology Transfer

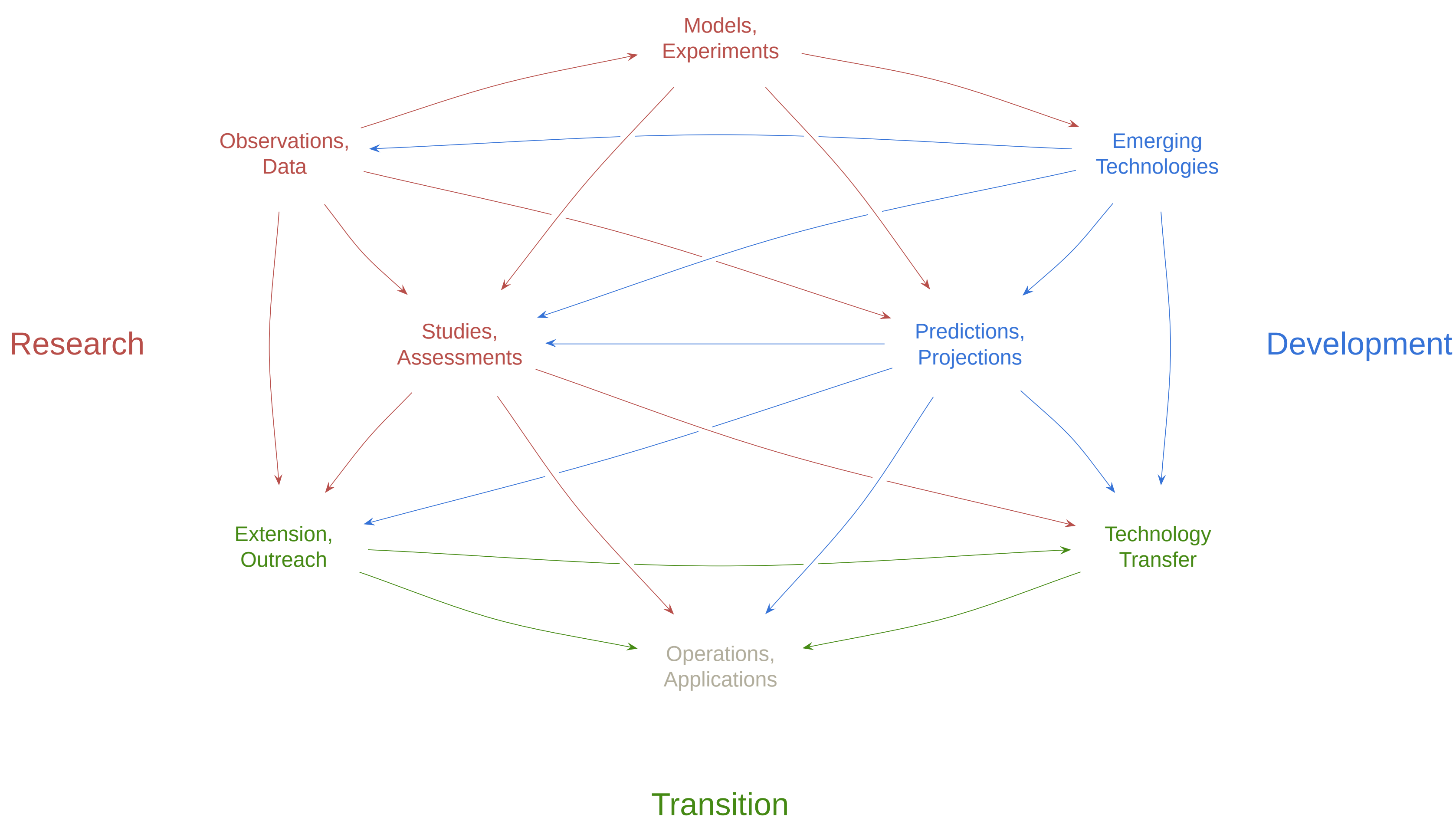
OAR works with end-users to integrate mature technologies (and associated expertise) into larger systems, either in NOAA operations or partner applications, via testbeds, patents, etc. Examples: Quantitative observing system assessments (QOSA) to assess the value of observing systems, Unmanned Aerial Systems (UASs) and Autonomous Underwater Vehicles (AUVs) to reduce the cost and improve the scope of data we collect, and the Hazardous Weather Testbed (HWT) to test weather models in a simulated operational environment.

Many activities blend two or all three of these functions together. For example, atmospheric data might be collected and used in an experimental climate model, itself developed to run projections of possible climate scenarios, the results of which would be published in a peer-reviewed journal article and possibly in an international assessment. A project that puts university scientists together with local resource managers to study estuarine water quality also blends activities; such co-created science can result in data, publications, as well as education and outreach. These examples illustrate how individual efforts incorporate multiple functions.

[5] National Economic Council & Office of Science and Technology Policy (2011). A strategy for American innovation: Securing our economic growth and prosperity. Washington, DC: Executive Office of the President.
[6] US Council on Competitiveness. (2005). Innovate America: National innovation initiative summit and report. Washington DC: US Council on Competitiveness.
[7] Freeman, C., & Soete, L. (1997). The economics of industrial innovation. Cambridge, MA: MIT Press.

Figure 1:

Research, Development, and Transition



Shadow Bands along the Salmon River at high noon. Credit: Phyllis Gunn

Organization

OAR, as an organization, is an open research network consisting of seven federal research laboratories, six program offices, sixteen Cooperative Institutes (which are non-federal, non-profit research institutions in 5-10 year collaborative partnerships with NOAA), and 33 university-based Sea Grant programs. OAR also relies on work performed at numerous public, private, and academic institutions. Through its laboratories, programs, and external partners, OAR seeks to balance the activities that benefit from the long-term, dedicated capabilities of federal facilities with those that require the diverse expertise of our university partners.

OAR Laboratories

OAR's laboratories are critical to long-term research endeavors, particularly those that require major infrastructure, such as monitoring oceans and atmosphere for climate assessments. For example, the Global Monitoring Division of the Earth System Research Laboratory measures climate forcing agents in the atmosphere at 269 sites around the world. Through its laboratories, OAR maintains highly specialized expertise in keys areas. By maintaining in-house expertise on a variety of professional and disciplinary specializations, OAR is prepared to address immediate needs of national security and diplomacy, such as the Deepwater Horizon oil spill in the Gulf of Mexico and the crisis in Fukushima. The diversity of expertise present in OAR laboratories also makes them an ideal venue for translating results into applications. Through its labs, OAR has developed many operational products for the National Weather Service and other service lines.

OAR Programs

Program offices manage competitive and noncompetitive awards to focus on specific topics, including emerging areas of research. Program offices at OAR are well suited to address research needs that are relatively short-term in nature or that require infrastructure that exists beyond OAR laboratories. Programs can foster collaboration across NOAA, with other agencies, and academic institutions. OAR benefits from supercomputing capacity at the Department of Energy, for example, to conduct Climate modeling. Program offices are often required to execute programs specifically authorized by Congress. These include the Office of Ocean Exploration and Research, the Climate Program Office, the Ocean Acidification Program, as well as the Office of Weather and Air Quality.

OAR Partners

OAR manages the National Sea Grant program, a national network of university-based programs dedicated to serving citizens in coastal communities throughout the Nation. It also manages NOAA’s Cooperative Institutes, which are non-federal, non-profit research institutions in a long-term (5-10 year) collaborative partnership with NOAA. Many of the Cooperative Institutes are collocated with NOAA research laboratories, creating a strong, long-term collaboration between scientists in the laboratories and in the university. Through external partners, OAR can access the kinds of expertise OAR doesn't have in-house, but are critical to its mission, for example, in emerging areas of technology, as well as social science expertise in behavioral psychology, and decision science. Partnerships are a means to leverage external funding sources, and afford OAR the flexibility to rapidly shift priorities. They also provide a conduit for new talent to enter and improve the agency, through work with students, post-docs and early career scientists. OAR has a number of other partners, including federal agencies and universities receiving grants.

OAR also oversees NOAA’s Technology Partnerships Office (TPO), which is responsible for the Technology Transfer Program, and the Small Business Innovation Research (SBIR) Program. TPO is a technology “matchmaker” that supports private-sector adoption of NOAA innovations — originating in OAR as well as NOAA’s other Line Offices — through Cooperative Research and Development Agreements (CRADAs), patents, and licenses, and contracts with small businesses. OAR also manages relations with NOAA’s Science Advisory Board, an external federal advisory committee that focuses on agency science.

Table 1: OAR Laboratories and Program Offices

Laboratories
Air Resources Laboratory (ARL)
Atlantic Oceanographic & Meteorological Laboratory (AOML)
Earth System Research Laboratory (ESRL)
Geophysical Fluid Dynamics Laboratory (GFDL)
Great Lakes Environmental Research Laboratory (GLERL)
National Severe Storms Laboratory (NSSL)
Pacific Marine Environmental Laboratory (PMEL)

Program Offices
Climate Program Office (CPO)
National Sea Grant College Program (NSGCP)
Office of Ocean Acidification (OA)
Office of Ocean Exploration & Research (OER)
Office of Weather and Air Quality (OWAQ)
Office of Unmanned Aerial Systems (UAS)

Table 2: NOAA Cooperative Institutes

Cooperative Institutes
Cooperative Institute for Climate Science, University of Maryland (CICS-M)*
Cooperative Institute for Climate Science, Princeton University (CICS-P)
Cooperative Institute for Alaska Research (CIAR)
Cooperative Institute for Limnology and Ecosystem Research (CILER)
Cooperative Institute for Marine and Atmospheric Studies (CIMAS)
Cooperative Institute for Marine Ecosystems and Climate (CIMEC)
Cooperative Institute for Mesoscale Meteorological Studies (CIMMS)
Cooperative Institute for Meteorological Satellite Studies (CIMSS)*
Cooperative Institute for Marine Resources Studies (CIMRS)
Cooperative Institute for the North Atlantic Region (CINAR)
Cooperative Institute for Ocean Exploration, Research and Technology (CIOERT)
Cooperative Institute for Research in the Atmosphere (CIRA)
Cooperative Institute for Research in Environmental Sciences (CIRES)
Joint Institute for Marine and Atmospheric Research (JIMAR)*
Joint Institute for the Study of the Atmosphere and Ocean (JISAO)
Northern Gulf Institute (NGI)

* Note: CICS-M and CIMSS are managed by NOAA's National Environmental Satellite Data and Information Service, and JIMAR is managed by NOAA's National Marine Fisheries Service.

A brittle star settles in for a night of filter feeding atop a coral off the northwest coast of Grand Cayman. Credit: Katrina Phillips

Approach

Managing an R&D portfolio is a dynamic process. National priorities evolve over time, new challenges and opportunities present themselves, and the resources OAR has to stimulate innovation rise and fall, so it is critical to actively balance R&D such that the total portfolio is always in the Nation's best interest. There are two opposing forces at play in any research activity: "push" by the researcher who supplies science and technology, and "pull" by the ultimate customer who demands science and technology. The former is anticipates stakeholder needs, the latter responds to them.

Pushed (or "anticipatory") research tends to have a lower likelihood of paying off, owing to longer timeframes and greater scientific, technical, and institutional uncertainties. R&D directed by researchers and engineers (on the supply side) is less likely to pay off in ways we would expect, but when they do, the payoff is big and game-changing. This tends to be R&D that is long-term in nature, where the economic value may not be measurable for decades, and for which beneficiaries may not yet know they can benefit. OAR's development of Dual Polarized Radar, and the Argo float system are examples of pushed research.

Pulled (or "responsive") research tends to have a higher likelihood of paying off, owing to shorter timeframes and lower scientific, technical, and institutional uncertainties. R&D that is directed by well-defined requirements of a stakeholder (on the demand side) are more likely to pay off, though that pay off may be incremental.[8] [9] This tends to be R&D aimed at immediate benefit to known

[8] Christensen, C. (2003) The innovator's dilemma: The revolutionary book that will change the way you do business. New York: Harper Collins.
[9] Dosi, G. (1982). 'Technological paradigms and technological trajectories: A suggested interpretation of the determinants and directions of technical change', Research Policy, 11/3: 147-62.

stakeholders, particularly the service providers in NOAA's operational lines. OAR's development of hurricane forecast models for the National Weather Service is an example of research that is pulled.

Balance

OAR balances a portfolio of both pushed and pulled research. Both are necessary to satisfy the short- and long-term interests of the agency. The importance of push/pull balance to advancing NOAA's mission has been addressed explicitly by the NOAA Science Advisory Board:

> It is important to ensure that the research programs respond directly to the other mission activities. For developmental and longer-term objectives, it is important to ensure that the ability to undertake higher risk research that may not have a near-term application is not compromised by immediate operational needs. Similarly, it is imperative that the products of NOAA's research, be they operational advancements or expanded information services, reach the user... NOAA must address the proper agency balance between research push and operations pull for research investment... The push-pull tension between research and service is inherent to the enterprise.[10]

Maintaining this balance occurs at the portfolio level, through the allocation of resources to projects that respond to the forces of push and pull, respectively. Balance can also happen at the project level, with single endeavors that align user needs with developing capabilities in an iterative process of co-creation. Such "connected" innovation models are distinct from those that are purely push or pull. [11] Managers at Google refer to this as a "hybrid" research model.[12] Examples of this include Regional Integrated Science and Assessments (RISA) program, which works directly with local communities, as well as the Hurricane Forecast Improvement Project, on which OAR works with the National Weather Service.

Connect

The OAR Assistant Administrator, as the Champion for several NOAA-wide goals and objectives, guides and connects the research from all NOAA line offices toward the agencies strategic goals, with particular attention to how the whole of R&D at NOAA can be more than the sum of its parts. OAR's role as "connector" does not stop with NOAA; it plays a pivotal role coordinating interagency efforts and international efforts (such as International Panel on Climate Change and the RAMA Buoy Array). In aiming for an integrated, holistic understanding of the Earth system, OAR coordinates R&D across NOAA to link diverse perspectives and professional expertise.

Whether through portfolio balance, connected/hybrid

[10] Moore, Rosen, Rosenberg, Spinrad, Washington, & West. (2004). *Review of the organization and management of research in NOAA: A report to the NOAA science advisory board by the research review team*. SIlver Spring, MD: National Oceanic and Atmospheric Administration (NOAA) Science Advisory Board.

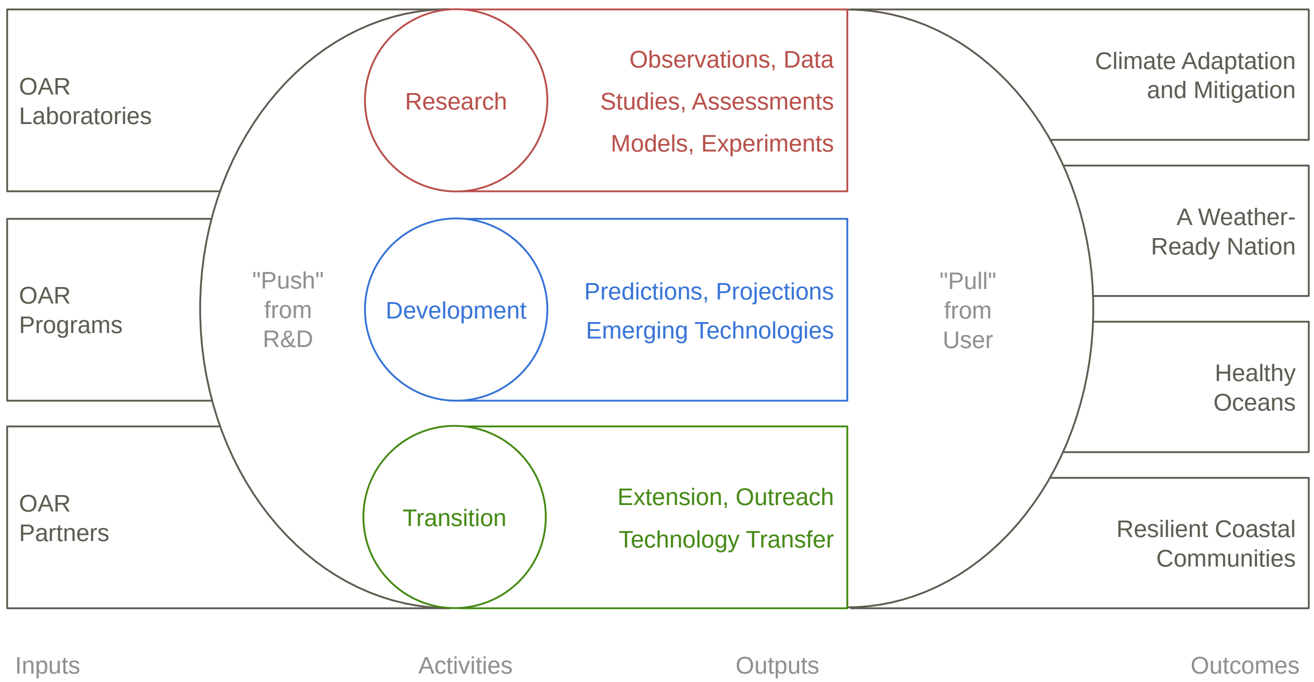
[11] Bonvillian, W. B. (2009). 'The Connected Science Model for Innovation: The DARPA Role'. In: *21st century innovation systems for Japan and the United States: Lessons from a decade of change: Report of a symposium*, pp. 206-237. Washington, DC: National Academies Press.

[12] Spector, A., Norvig, P., & Petrov, S. (2012, July). 'Google's Hybrid Approach to Research'. Communications of the ACM, 55/7: 34-37.

projects, or cross-NOAA coordination of research activities, OAR conducts the critical function of synthesis and integration of R&D across the agency. It blends the forces of supply with those of demand, connecting the dots among R&D endeavors conducted at OAR, at other Line Offices at NOAA, and at the agency's many research partners.

Figure 2:

Balance and Connect



Rainbow on Na Pali Coast, Island of Kauai, Hawaii, from Helicopter on 06 Jan 2013. Credit: Jeremiah Gee

Evaluation

Evaluation is a critical function at any federal agency. Through evaluation, OAR can learn if a program works the way it is intended, identify unknown causes of program outcomes and unanticipated consequence, and make better decisions about whether to continue, halt, or change a program. OAR implements review procedures for all laboratories, research programs, and competitive extramural R&D awards. These procedures align with the performance management requirements of the Government Performance and Results Act (GPRA) Modernization Act, the Office of Management and Budget (OMB), and the standards set by the Information Quality Act and Peer Review Bulletin.

In particular, the criteria on which OAR assesses R&D also reflect the National Academies' Best Practices.[13] Three overarching elements are used to assess R&D organizations. Scientific and technical quality focuses on the outputs of the R&D system: scientific knowledge and technical capability. Societal relevance and impact focuses on the outcomes: economic and social utility. Performance and management focuses on inputs: people, facilities, equipment, and funding.

Quality

Quality refers to the merit of R&D within the scientific community. Assessing the quality of scientific and technical work done involves the time honored tradition of peer review. Bibliometric data on peer-reviewed publications and citations, as well as awards and other

[13] National Research Council, Division on Engineering and Physical Sciences, Laboratory Assessments Board, Panel for Review of Best Practices in Assessment of Research and Development Organizations (2012). "Best Practices in Assessment of Research and Development Organizations." National Academies Press, Washington, DC. Available at: http://www.nap.edu/catalog.php?record_id=13529.

professional recognitions, are used to understand the performance of individuals, and organizations, particularly for benchmarking against other organizations of similar size and scope.

Relevance

Relevance refers to value of R&D to users beyond the scientific community. Relevance includes not only hypothetical value, but actual impact. Assessing OAR's relevance involves measuring the broader benefits of the work. Often, it means tracing impacts back to research, and understanding them in the context of other factors. The impact of R&D is realized through the application of scientific knowledge to policy decisions, through the improvement of operational capabilities at NOAA's service lines, or by patenting and licensing of inventions for commercial use.

Performance

Performance refers to the effectiveness and efficiency with which R&D activities are organized, directed, and executed. Assessing performance involves ensuring that the work it performs supports NOAA's goals and that it has the kind of workforce, infrastructure, and leadership necessary to achieve those goals. This necessarily involves understanding the quality of management, including interaction with stakeholders, clear articulation of strategic direction, as well as the balance of the R&D portfolio across time frames and intended applications.

Strawberry Hermit Crab on Palmyra Atoll. Credit: Christina Morrisette

Conclusion

NOAA’s Office of Oceanic and Atmospheric Research, along with our partners, conducts the R&D that underpins NOAA’s products and services. Whether improving warning lead times for tornadoes or hurricanes or understanding the response of ecosystems in a rapidly changing ocean environment, OAR’s preeminent research ultimately enables solutions that prevent loss of human life, improve management of natural resources, build understanding of the Earth-system, and strengthen the economy.

To conduct its mission most effectively, OAR will rely upon the strategy laid out in this document. The OAR strategic plan is intended to enable well-reasoned, transparent decisions; alignment of resources with requirements; and common understanding of roles, responsibilities, and the meaning of “success.” As such, this strategic plan will serve as the basis for evaluating and managing OAR's portfolio and its performance.