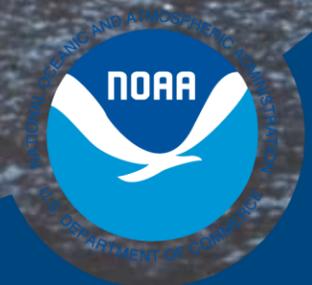


Strategic Science Plans: An Overview

2013



NOAA
FISHERIES

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LETTER FROM THE CHIEF SCIENTIST



I am pleased to present this overview of the 2013 National Marine Fisheries Service (NMFS) Strategic Science Plans. The NMFS mission—stewardship of living marine resources through science-based conservation and management and the protection and restoration of healthy ecosystems—embraces a wide range of scientific disciplines and expertise, and that breadth is reflected here. Strategic planning informs

us on how we can best use our available resources to achieve this scientific mission. Moreover, planning provides us with a roadmap to innovation and success by bringing to bear technologies that will improve the conservation and management of NOAA trust resources.

Each Science Center has an individual detailed plan, which is only summarized here. Those plans were developed internally and vetted with the many stakeholders served by each Center. The plans are available to the public on each Science Center’s website and will serve as a guide for meeting the wide-ranging demands of our stakeholders, as well as mandated conservation and management requirements. Our primary mandates—the Magnuson-Stevens Fishery Conservation and Management Act, Marine Mammal Protection Act, and Endangered Species Act—confer diverse obligations:

- Single- and multi-species assessments of both fisheries stocks and protected species.
- Impacts of fisheries on habitats and ecosystem structure and function.
- Understanding how the impacts of climate change are altering ecosystem structure and function.
- Understanding and forecasting the impacts of fisheries management decisions on the socio-economics of fishing and coastal communities, and fishing and seafood industries.
- Forecasting the impacts of anthropogenic stressors on NOAA trust resources.
- Supporting the scientific underpinnings of aquaculture.
- Ensuring robust data collection and synthesis with long-term storage and public access.

All these obligations are addressed in these strategic plans.

I want to express my appreciation for all the time and effort of so many in the development of each individual plan and the very real choices that were required to reach agreement.

A handwritten signature in black ink that reads "Richard L. Merrick".

Richard Merrick
Chief Science Advisor and Director of Scientific Programs
National Marine Fisheries Service

INTRODUCTION

NATIONAL PRIORITIES FOR OCEANS

The priorities and core functions of the National Oceanic and Atmospheric Administration’s (NOAA) National Marine Fisheries Service (NMFS) are articulated in guidance at several levels.

The National Ocean Policy (2010)¹ serves as the overarching policy that recognizes that “America’s stewardship of the ocean, our coasts, and the Great Lakes is intrinsically linked to environmental sustainability, human health and well-being, national prosperity, adaptation to climate and other environmental changes, social justice, international diplomacy, and national and homeland security.” This National Ocean Policy includes guiding principles for management decisions and actions toward achieving the vision of the policy. Under the Policy, NOAA is recognized as a primary steward of U.S. ocean, coastal, and Great Lakes resources.

The National Ocean Policy strives to achieve an America whose stewardship ensures that the ocean, our coasts, and the Great Lakes are healthy and resilient, safe and productive, and understood and treasured so as to promote the well-being, prosperity, and security of present and future generations...

NOAA’s mission reflects science, service, and stewardship: “NOAA seeks 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.” In support of these goals, NMFS’ mission is “stewardship of living marine



Surf fishing

resources through science-based conservation and management and the protection and restoration of healthy ecosystems,” and is mandated by Congress under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), Endangered Species Act (ESA), and Marine Mammal Protection Act (MMPA). These interconnected mandates make it clear that stewardship of living marine resources and the ecosystems on which they depend are central to everything NMFS does.

NMFS’ science underpins all our efforts in meeting core mandates. The Strategic Science Plan is a roadmap for achieving priorities articulated in the goals presented in NOAA’s Next Generation Strategic Plan and congressional mandates, as well as the National Ocean Policy.

¹ Executive Order No. 13547, July 22, 2010

- Advancement of efforts to ensure the long-term sustainability of marine fisheries and recovery of protected species and their habitats.
- Advancement of observations, modeling, and research necessary to understand climate change and its impacts.
- Delivery of integrated data, information, products, and services needed to support resilient coastal communities and economies.
- Understanding ecosystems and phenomena—across missions and disciplines—with the goal of increasing the resilience of ecosystems, economies, and communities.²

NOAA is currently updating the NOAA 5-Year Research Plan (2008)³ and NMFS is updating the Strategic Plan for Fisheries Research (2007)⁴ as required by the reauthorized MSA as amended by the Sustainable Fisheries Act (1996)⁵. These plans will reflect the goals and objectives of the Next Generation Strategic Plan (2010)⁶ and align with this strategic science plan to help meet the agency’s goals.

NMFS SCIENCE PORTFOLIO

NMFS has a responsibility to provide the best available information for the management of living marine resources, and the habitats upon which they depend. Our science supports three primary elements: sustainable fisheries, recovery of protected species, and habitat conservation. Together these elements form the core of NMFS’ stewardship mission. In addition, we must address these core elements against a backdrop of increasing need to understand ecosystem interactions and climate effects, while continuing to improve the way we assess resources and manage the data and information required to further our understanding.

LONG-TERM SUSTAINABILITY OF MARINE FISHERIES AND RECOVERY OF PROTECTED SPECIES AND THEIR HABITATS



Salmon traveling upstream

To advance effective management policies, NMFS requires reliable and current information on the population status of fish and protected resources, their habitat requirements, and the effects of fishing and other human and environmental impacts. Nationwide, NMFS continues to develop new and improved methods for assessing the abundance and distribution of species protected under the MSA, MMPA, and ESA, and for the evaluation of the impacts of various anthropogenic threats. NMFS strives to conduct more and higher quality fishery and protected species assessments to enhance traditional forecasts by incorporating information collected through advanced

² Priorities from NOAA FY 2013 Annual Guidance Memorandum

³ Research in NOAA: Toward Understanding and Predicting Earth’s Environment (http://nrc.noaa.gov/sites/nrc/Documents/5yrp_2008_2012_final.pdf)

⁴ NMFS. 2007. NMFS strategic plan for fisheries research. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/SPO-80, 170p.

⁵ Public Law 94-265

⁶ National Oceanic and Atmospheric Administration’s Next Generation Strategic Plan (http://www.ppi.noaa.gov/wp-content/uploads/NOAA_NGSP.pdf)

technologies, habitat assessments, and ecosystem analyses (including climate) into stock forecast models. These advanced assessments—including multispecies assessments and regulatory examination through integrated biological and socio-economic analyses—will provide the best scientific insights into the interdependencies and tradeoffs in the ecosystem that result from alternative policy choices.

ADVANCEMENT OF OBSERVATIONS, MODELING, AND RESEARCH NECESSARY TO UNDERSTAND CLIMATE CHANGE AND ITS IMPACTS

Marine ecosystems are transforming as a result of climate change. Advancement in observations, modeling, and on-the-ground research is necessary to better understand climate change and its near- and long-term impacts. Climate change effects are of particular concern to NMFS because they can affect the productivity and distribution of the ecosystems and resources we manage. As marine environments warm, species demographics may shift and waters become more corrosive (i.e., ocean acidification effect). This leads to disruptions in the food web in ways we do not fully understand and consequently, are unprepared to adapt to or mitigate. NMFS collaborates with NOAA and academic partners to expand our understanding of the effects of climate change on myriad ecosystem components, such as sea level rise, sea ice extent, ocean pH, freshwater volume and timing, ocean temperature, and ocean currents—all of which influence NOAA trust resources.



Seal resting on sea ice

DELIVERY OF INTEGRATED DATA, INFORMATION, PRODUCTS, AND SERVICES NEEDED TO SUPPORT RESILIENT FISHING AND COASTAL COMMUNITIES AND ECONOMIES



Shrimp being landed on a boat

NMFS is responsible for the delivery of integrated data, information, products, and services needed to support fishing and seafood industries as well as resilient fishing and coastal communities and economies. Collecting, processing, and assimilating data is a core agency function that provides the science underpinning assessments of fish stocks, essential fish habitat, and protected species. NMFS collects data using survey vessels and other observation platforms, observers on

fishing vessels, and various statistical, economic, and social science surveys. These methods provide oceanographic and biological data, fishery-dependent and fishery-independent data on commercial and recreational fisheries catch and bycatch, and socio-economic data required for assessments. As NMFS moves toward integrating ecosystem-based management (EBM) principles into agency activities, these data are increasingly important for achieving ecosystem- and habitat-level assessments. In addition to collecting data on the biota, understanding human use patterns in marine ecosystems is crucial since human activities are considered a principal ecosystem stressor, and humans also derive considerable benefit from sustainable marine ecosystems. Socio-economic research and forecast models allow NMFS to

complement our biological and physical science and better understand and predict what is socially and economically sustainable. We need to balance our biological understanding of fish and protected resource species with information and forecasting capacity relating to the human environment. Ultimately, both living marine resource assessment and social and economic science products are needed to inform management decisions based on science.

UNDERSTANDING ECOSYSTEMS AND PHENOMENA—ACROSS MISSIONS AND DISCIPLINES—WITH THE GOAL OF INCREASING THE RESILIENCE OF ECOSYSTEMS, ECONOMIES, AND COMMUNITIES

NMFS integrates scientific and socio-economic information to provide a more holistic understanding of ecosystem processes and how human activities and ecosystems interrelate. This integration—ecosystem-based management (EBM)—requires understanding the factors controlling production at various trophic levels, predator-prey interactions, climate pressures, and the interaction of these factors with human behavior. Monitoring these impacts will require improvement of current ecosystem indicators and development of additional indicators of fishing and climate impacts and incorporation of these indicators into assessments. At the broadest level, NOAA must advance more holistic approaches to understand and balance human use, sustainability, and preservation of ecosystem resources and functioning. These advanced assessments will provide the best scientific insights into the interdependencies and tradeoffs in the ecosystem that result from alternative policy choices.



Shellfish aquaculture

NMFS SCIENCE CAPABILITIES

Each NMFS region has unique features and challenges. The themes and foci articulated within each Science Center's strategic science plan focus on core functions in the context of current fiscal conditions to address those unique conditions. These plans will guide NMFS scientific endeavors and staff in executing mission responsibilities in FY 2013 and in planning for activities over the next 5 years. The execution of this diverse portfolio is achieved by approximately 2,000 full-time and contract staff with overall funding of approximately \$300 million. These independent Science Centers constitute NMFS' scientific infrastructure.

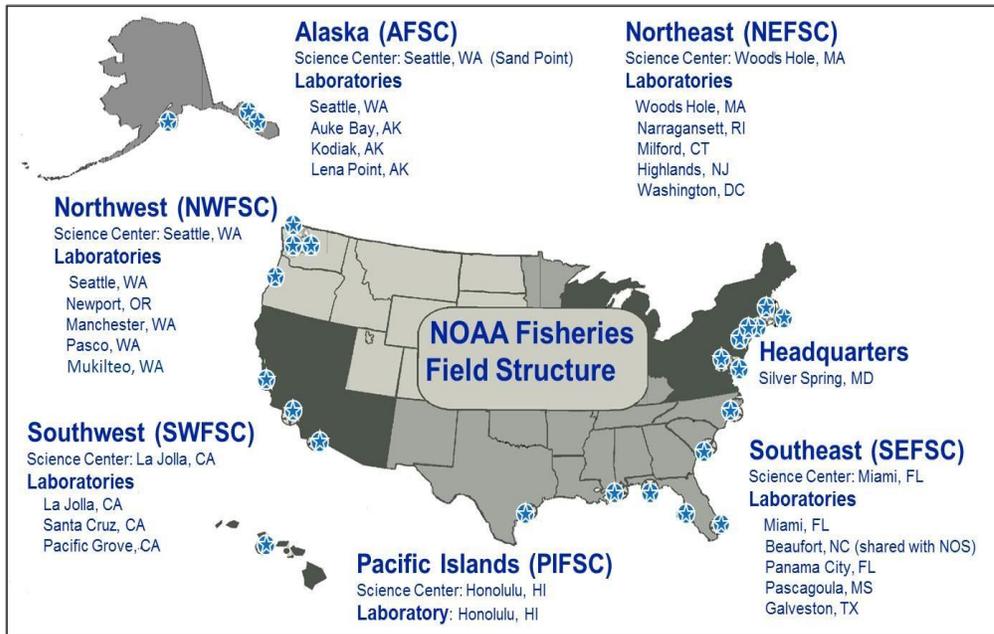


Figure 1 Map of NOAA Fisheries Science Centers and associated laboratories

NMFS SCIENCE PARTNERHIPS

Each Science Center benefits from internal and external partnerships. Within NOAA the Regional Offices are viewed as one of NMFS’ important clients. The Science Centers work with their Regional Offices to ensure the best available information is provided for making living marine resource management decisions. Likewise, the Regional Fishery Management Councils and Interstate Fishery Commissions are critical partners in developing fishery management plans and measures, and in managing and conserving the nation’s fisheries.

NOAA Line and Staff Offices—such as the Office of Oceanic and Atmospheric Research, National Ocean Service, Office of Marine and Aviation Operations, and the National Environmental Satellite, Data, and Information Service—are vital for maintaining research, monitoring, and data collection activities.

These internal resources are complemented by partners in cooperative institutes, academic institutions, states, tribes, non-governmental organizations, and industry who bring their myriad experiences and perspectives to bear on the management of our trust resources.

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KEY RESEARCH WITHIN SCIENCE CENTERS AND THE OFFICE OF SCIENCE AND TECHNOLOGY

The key research activities of each Science Center and the NMFS Office of Science and Technology support:

- Single-species stock assessments for fish (i.e., commercial and recreational) and protected species both nationally and internationally, as appropriate.
- Understanding impacts of climate change, including ocean acidification.
- Development of multi-species ecosystem and assessment models.
- Studies on impacts of bycatch on non-target species.
- Socio-economic studies to support information needs of the Regions and Fishery Management Councils.
- Projecting of impacts of commercial and recreational fishing on habitats important to healthy marine ecosystem function.
- Quantifying anthropogenic impacts on habitat important to healthy marine (and watershed) ecosystem function.
- Advances in aquaculture.
- Placement and analysis of data collected by observers on commercial fisheries.
- Development and application of advanced technology for the purpose of supporting marine stewardship.

THE NMFS OFFICE OF SCIENCE AND TECHNOLOGY

Housed at NOAA Headquarters, the NMFS Office of Science and Technology (ST) serves a unique and critical role for the agency as liaison among NMFS' field scientists and the leadership of both NMFS and NOAA. ST staff and scientists also facilitate collaboration between NOAA leadership and Congress as well as with international partners and other governmental, academic, and private entities. ST coordinates the science programs at the national level and across the six regional Fisheries Science Centers—Alaska, Pacific Islands, Northeast, Northwest, Southeast, and Southwest. These relationships, required for mission success and regional science endeavors, are maintained through proactive and responsive communications. ST has organized its activities into four themes that are linked to those of the Centers.

OFFICE OF SCIENCE AND TECHNOLOGY THEMES

Theme 1: Collect data and conduct assessments. ST will coordinate collection, compilation, and analysis of national fisheries statistics to assess the performance and impacts

of U.S. commercial and recreational fisheries, and compiles and reports information on domestic and international U.S. fishery product market performance. ST will continue to support at-sea data collection and fishery observer programs that contribute to these information products and the assessment of living marine resources, ecosystem, and habitats. ST will collect economic and socio-cultural data on U.S. fishing activities and communities. The economic and social science advice provided by NMFS can be used to evaluate the benefits and costs of alternative management actions, prioritize management needs, and facilitate policy design that maximizes societal benefits from ocean and coastal resources.

Theme 2: Advance science: activities to improve data collection and assessment. NOAA mandates require comprehensive research programs to support marine resource management. ST will research areas such as advancing the science of fisheries, protected species, and habitat and ecosystem assessments, including programs that will enable incorporation of ecosystem approaches and climate considerations into living marine resource management. Improvements to data collection will include new and innovative use of observing platforms, survey methods, emerging technologies, and survey design. In addition to scientific assessments, ST will continue to develop state of knowledge reports, assessment improvement plans, research priorities, decision support tools, and guidance materials for use by agency scientists, partner agencies, academia, resource managers (including the Regional Fishery Management Councils), policymakers, industry partners, non-governmental organizations, and the public.

Theme 3: Manage and disseminate information. Effective information management and dissemination are essential to ST's vision of serving as a trusted source of scientific information and advice. ST will approach this through interrelated focal areas. NMFS will collect, analyze, and make data available to meet legislative mandates and science needs through its developing Enterprise Data Management (EDM) program. EDM will address priority areas of concern such as data inventory, data gaps, insufficient metadata, data quality and consistency, data integration, and timeliness of data delivery. ST will provide a national focal point for regional and national biological, ecological, and socio-economic data collections, and in some cases provides a worldwide view of ecosystem-related data through use of geographic data visualization tools. To achieve these goals ST will work with NMFS scientists and other partners to develop and maintain modern information systems. NMFS will continue publishing scientific materials, as it has since 1872. Scientific publications are the primary basis for communicating research results, stimulating future research, and supporting fisheries management and policy statements.

Theme 4: Integrate and coordinate support services. ST performs a number of diverse integration and coordination support services. ST will continue to engage strategic planning of science activities across Science Centers, line offices, and goal teams to address agency objectives and goals. ST will engage in standardizing processes across the Science Centers, NMFS, and NOAA to aid in managing the science enterprise and monitor science quality with independent peer-review processes. Through coordination of educational training efforts, ST will work to increase fisheries capacity and capability for the future. ST will also participate in coordination and support of intra-agency, interagency, and international working groups that exchange information to develop policy and scientific strategy.

For more information about ST science activities visit www.st.nmfs.noaa.gov.

THE ALASKA FISHERIES SCIENCE CENTER



Ringed seal

The Alaska Fisheries Science Center (AFSC) is responsible for research on living marine resources in the coastal oceans of Alaska. This region of nearly 3 million square miles includes waters in the Gulf of Alaska, Bering Sea, Aleutian Islands, and the Arctic Ocean, and supports some of the most important and abundant commercial fisheries in the world. These waters are also home to the nation's largest and most critically endangered marine mammal population. The AFSC conducts scientific research that improves the ability of NMFS to understand, manage, and conserve Alaska's fish, crabs, and marine mammals and to protect the habitats essential for their existence. AFSC scientists collect, compile, and analyze extensive information on fisheries, resource-dependent communities, and many fish, crab, and marine mammal species and their food sources and habitats, including oceanography and environmental research. Analyses based on these data are used to develop policies and strategies for fisheries and protected species management within the U.S. Exclusive Economic Zone, monitor and assess the health of the region's marine mammal populations, and develop the scientific understanding and predictive methodologies needed to implement NMFS' ecosystem-based approach to management. In addition to ongoing survey and assessment activities, the AFSC is engaged in cutting-edge research related to global warming, which focuses on concerns such as ocean acidification and the loss of sea ice in the Bering Sea. As the high Arctic waters increasingly open to commercial traffic (e.g., for transportation and for oil and gas exploitation), the AFSC research efforts will need to further address this dynamic environment.

ALASKA FISHERIES SCIENCE CENTER THEMES

Theme 1: Monitor and assess fish, crab and marine mammal populations, fisheries, and marine ecosystems and the associated communities which rely on these resources. Stock assessments provide critical information to fishery and protected resource managers. Maintaining stock assessment activities requires adequate resources to collect fishery-independent and fishery-dependent data, as well as to conduct stock assessments and evaluate the likely biological and socio-economic outcomes of management options. AFSC research activities will include conducting field surveys of population abundance; determining age composition of stocks, age at maturity, fecundity, stock structure, and spawning behavior; estimating fishing mortality, natural mortality, and growth rate; and identifying of geographical boundaries and essential habitat. Generally, assessment information available for marine mammal stocks is more limited than for fish stocks. AFSC will support marine mammal assessment scientists' ability to conduct abundance surveys and analyze the resulting data—activities needed for developing population estimates, evaluating stock structure, and assessing trends in abundance—to increase the number assessed stocks for which the AFSC is responsible. AFSC will support science-based management, reporting, and decision-making while striving to improve and expand data collection, move toward next generation stock assessments, and develop Integrated Ecosystem Assessments.

Theme 2: Understand and forecast effects of climate change on marine ecosystems. AFSC will research how climate change will dramatically impact all the waters under the

research responsibility of the AFSC. The strategy of the AFSC to gain a better understanding of these effects is four-fold.

- *Loss of sea ice.* Dramatic changes in the coverage and thickness of sea ice in the Arctic have impacted the oceanography of the Bering Sea, and are likely to have influenced the abundance and distribution of high-latitude species.
- *Ocean acidification.* Corrosive waters reach shallower depths in Alaskan waters, so biological impacts are expected to occur earlier than in other places.
- *Shifting ecological interactions within and between species.* Understanding ecological interactions between trophic levels, the impact of ocean conditions, predator-prey interactions, inter- and intra-specific competition, and parasites and pathogens influencing the survival, growth, and reproductive success of fish, crabs, and marine mammals.
- *The indirect effects of climate change.* Forecasting population changes in response to climate change on fish, crab, and marine mammals but also forecasting socio-economic consequences of those changes on coastal communities and effects on the Alaska Native marine mammal subsistence harvest.

Theme 3: Describe and assess the role of habitats in supporting healthy marine ecosystems and populations of fish, crab, and marine mammals. The AFSC conducts research to understand the role habitat (Essential Fish Habitat (EFH) and Critical Habitat) plays in the health and sustainability of Alaska’s fish, crab, and marine mammal populations. The Science Center will determine which habitats are essential to the sustainability of these populations. Habitat assessment is essential for analysis of potential impacts to species for the coastal use permit review process, ESA stock assessments and activities related to oils spills. In addition, AFSC will evaluate ecosystem impacts of fishing and non-fishing activities to understand factors affecting impacts such as bycatch, anthropogenic noise, and exposure to contaminants and to develop mitigation strategies. These activities support planning for compatible uses of the marine ecosystem.

For more details, access the full AFSC plan at www.afsc.noaa.gov.

NORTHEAST FISHERIES SCIENCE CENTER

The Northeast Fisheries Science Center (NEFSC) has a strong cultural identity as a place founded on fishing. The waters of the approximately 100,000 square miles of the Northwest



Northern right whale

Atlantic are temperate, structurally complex, and characterized by marked temperature and climate changes, winds, river runoff, estuarine exchanges, tides, circulation regimes, and functions supporting a diversity of sea life. This area is defined as the Northeast Continental Shelf Large Marine Ecosystem (LME) and is one of the world’s most studied and commercially exploited LMEs. The NEFSC focuses its multidisciplinary data-gathering, sampling, processing and research effort on developing ecosystem-level knowledge, sustainable aquaculture, and a better understanding of human influence on the ocean environment. Within this environment, the NEFSC has

maintained a longstanding commitment to research, assessment, and monitoring at all levels in

the ecosystem, from phytoplankton to apex predators, protected species, and human communities. The NEFSC looks to the future, toward a science program that can support managing ocean use on an ecosystem level by preserving core capabilities and building a broad-based science program, and engaging in extensive collaboration with external research partners and fishermen. This allows better support of multi-level management of ocean use, responsiveness to legislative and treaty mandates, and leveraging assets with multiple research partners in the region.

NORTHEAST FISHERIES SCIENCE CENTER THEMES

Theme 1: Monitor, value, and assess fish, invertebrate and marine mammal populations; fisheries; marine ecosystems; and the natural and human communities associated with them. The NEFSC has a longstanding, multifaceted monitoring and observing program conducted from a number of platforms including aircraft, research ships, and fishing vessels. Many of these activities were initiated decades ago with an explicit ecosystem focus and provide an extremely data-rich environment for supporting management and advisory requirements. These monitoring programs will continue to collect information essential for assessments of fish, invertebrates, and protected species including abundance and demographic characteristics, the effects of human activities, and social and economic considerations. NEFSC will provide data, analyses, information assessments, and scientific support to NMFS, other federal agencies, Regional Fishery Management Councils and Commissions, and treaty organizations. NEFSC intends to improve assessments and, if possible, expand the number of populations surveyed through technological innovation and adoption of more efficient, integrative sampling designs. Management advice in an ecosystem context will require integrated management plans that consider all the species within a region and integrated ecosystem assessments that provide a counterpart to single-species stock assessments.

Theme 2: Understand, forecast, and mitigate effects of environmental change (including climate change) on marine ecosystems, coastal communities, and economies. The significant changes in the structure of the marine environment in the Northwest Atlantic in recent decades have affected the oceanography of the continental shelf and have influenced the abundance and distribution of fish, invertebrates, marine mammals, sea turtles, and seabirds. These changes also have implications for human communities that depend on marine resources. The NEFSC will continue to monitor and understand these changes in order to advise management bodies striving to mitigate their ecological, social, and economic impacts. NEFSC has assembled comprehensive data sets to use in studying interactions among species. NEFSC continues to develop tools to understand impacts of disease, anthropogenic contaminants, and climate and environmental change as well as how species such as filter feeders may mitigate discharge of wastes into marine environments.

Theme 3: Describe and assess the role of habitats in ensuring healthy marine ecosystems; healthy populations of fish, invertebrates, marine mammals, and sea turtles; and resilient coastal communities and economies. The NEFSC conducts research to understand the role pelagic and benthic habitat plays in the health and sustainability of fish, invertebrate, and marine mammal populations within the Northeast Shelf LME, and the relationship of these to fisheries, economies, and communities. For diadromous fish, the NEFSC will work to understand how the marine environment connects to the freshwater environment that is equally critical for these animals. Habitat-related research will provide data for improving stock assessments, constructing Integrated Ecosystem Assessments (IEAs), informing coastal planning, and supporting climate change research. The human population and activities are increasing along the coastal margin from Maine to North Carolina, already among the nation's

most heavily populated areas. Managers continue to need information about how these human activities affect fish, invertebrate, turtle, and marine mammal species in order to mitigate those effects as necessary. Understanding the ecological footprint and the cumulative impacts of these activities on managed species is an important and challenging topic of research that will provide information needed to support coastal use planning that considers tradeoffs, potential conflicts, and participatory decision-making.

Theme 4: Understand the anthropogenic and ecological interactions of aquaculture on the continental shelf to ensure a safe and healthy supply of food. Research at the NEFSC addresses physiological, biochemical, and DNA-based processes in cultured shellfishes, borrowing heavily from biomedical techniques. These include studies to determine the mechanisms of environmental adaptation, metabolism, disease resistance, and reproduction. The NEFSC will continue efforts to improve the efficiency of environmentally friendly shellfish and finfish cultivation.

For more information on NEFSC science activities, access the full plan at www.nefsc.noaa.gov.

THE NORTHWEST FISHERIES SCIENCE CENTER



Resident orcas

The Northwest Fisheries Science Center (NWFSC) conducts research to conserve and manage living marine resources and their marine, estuarine, and freshwater habitat in the waters off Washington and Oregon. NWFSC researchers are dedicated to producing scientific products that will strengthen decision-making at all levels, enhance socio-economic benefits, support sustainable resource use, and conserve biological diversity. The NWFSC's research supports the management of more than 90 commercially important fish species, recovery of over 30 threatened and endangered fish and marine mammal species, and identification and mitigation of

coastal and ocean health risks. The NWFSC also fills an important role, together with the Southwest Fisheries Science Center, in providing the scientific knowledge to inform management decisions on the stewardship of the California Current LME. The California Current encompasses a broad range of coastal ecosystems, habitats, and biological communities, and provides vital habitat for living marine resources, economic development within coastal communities, and aesthetic enjoyment. The NWFSC's research effort is organized around the following four major themes (order does not reflect importance), with climate change as an overarching topic that crosses into each of the themes. In addition, each theme also integrates social science research that seeks to improve understanding of human values, actions, communities, and institutions that influence marine and anadromous fish, marine mammals, and other species and ecosystems on the U.S. West Coast.

NORTHWEST FISHERIES SCIENCE CENTER THEMES

Theme 1: Sustainable, safe, and secure seafood for healthy populations and vibrant communities. Effective fisheries management provides economic opportunities and ensures

the long-term sustainability of fisheries and the habitats on which they depend. The NWFSC seeks to improve stock assessment, ecosystem sustainability, and human impacts information provided to fisheries managers. The NWFSC will also provide state-of-the-art science and technology to support aquaculture while protecting and maintaining ecosystem health. Further, pathogens, toxins from harmful algal blooms (HABs), chemical contaminants, and other stressors of marine ecosystems pose significant risks to health of seafood resources and of humans. The NWFSC focus on research will improve our understanding of those risks and how to forecast them, and identify means to mitigate their impacts.

Theme 2: Ecosystem approach to improve management of marine resources. The California Current LME, Puget Sound, and the Columbia River Basin are home to a wide range of marine resources that provide a wealth of ecosystem goods and services. Ensuring the resiliency and productivity of the California Current and Pacific Northwest ecosystems requires an integrated understanding of their structure, function, and vulnerability to increased human population growth in coastal communities and competing uses of coastal waterways and oceans. The NWFSC's approach to understanding these large ecosystems will integrate studies across ecosystems (terrestrial, freshwater, and marine) and scientific disciplines to inform resource managers responsible for conserving marine resources.

Theme 3: Recovery and rebuilding of marine and coastal species. The Pacific Northwest is home to several iconic endangered species, including Pacific salmon and killer whales, and several rockfish species. Humans depend on these at risk species for sustenance, other economic benefits, and ways of life, thus achieving recovery and rebuilding of these species is a high priority for the region and the nation. The NWFSC will contribute to species recovery through research, monitoring, and analysis, providing NOAA managers and regional stakeholders the tools and information they need to develop effective regulations and develop sustainable plans for recovery.

Theme 4: Habitats to support sustainable fisheries and recovered populations: Healthy oceans, coastal waters, and riverine habitats provide the foundation for aquatic resources used by society. Protecting marine, estuarine, and freshwater ecosystems that support aquatic species relies on science to link habitat condition/processes and the biological effects of restoration actions on species. The NWFSC will provide the habitat science behind many management actions taken by NMFS and other natural resource agencies to protect and recover aquatic ecosystems and living marine resources. The NWFSC will also continue to maintain a longstanding focus on toxic chemical contaminants, as a foundation for regional and national research on pollution threats to fisheries and protected resources.

For more information about NWFSC science activities visit www.nwfsc.noaa.gov.

THE PACIFIC ISLANDS FISHERIES SCIENCE CENTER



Reef fish

The Pacific Islands Fisheries Science Center (PIFSC) provides timely, high-quality applied scientific information to support the conservation and management of fisheries, protected species, and marine habitats in the central and western Pacific Ocean. This area of greater than 1.5

million square miles encompasses broad geographical range and diverse indigenous communities. PIFSC faces the challenge of an expanding mission, in the types of research required to meet the nation's needs as well as needs of the community areas where research is conducted. The PIFSC's responsibilities include research on federally managed marine fisheries, protected species such as the critically endangered Hawaiian monk seal and other marine mammals and sea turtles, and ecosystems in the entire western and central Pacific Ocean, including coral reefs, insular (near island) habitats and pelagic (open ocean) environments, and the human communities that rely on these natural ecosystems. In providing scientific information to support an ecosystems approach to the conservation, management, and recovery of living marine resources, PIFSC has adopted a multidisciplinary strategy. The strategy involves integrated data collection and monitoring of marine resources and their environment and communities; scientific research programs with activities focused on near-shore and pelagic fisheries, coral reef species and habitats, marine mammals and sea turtles, marine ecosystems, and oceanography; socio-economic indicators such as demographics, knowledge, attitudes, and perceptions; and conservation and management advice directly related to domestic and international conservation and management obligations.

PACIFIC ISLANDS FISHERIES SCIENCE CENTER THEMES

Theme 1: Monitor and assess. PIFSC monitors and assesses the diversity, abundance, and distribution of fish and coral reef species, marine mammal and sea turtle populations, and marine ecosystems and the associated human communities that interact with these resources in the central and western Pacific. PIFSC will continue at-sea surveys and laboratory studies that employ advanced technologies, cooperative research with fishermen, and a variety of fishery-dependent modes of data collection as inputs to assessments of populations and stocks. PIFSC will collect socio-economic data and conduct surveys and studies of fishermen and fishing communities to better understand the dynamics and human dimensions of fisheries. PIFSC will provide needed scientific data, information and analysis, and technical advice to the Regional Office, Regional Fishery Management Council, and other conservation and management entities within NOAA. Additionally, PIFSC will maintain partnerships with relevant states, territories, commonwealths, and U.S. representatives participating in international fishery negotiations as well as the fishing industry, other government agencies, university and other scientific research partners—both domestic and international—and the general public.

Theme 2: Environment and ecosystems. Oceanographic and other physical features of the marine environment affect all areas of the central and western Pacific Ocean, including both insular and pelagic habitats. The PIFSC will describe and understand the environmental and ecosystem linkages; oceanography, habitat, and climate change; and human impacts within these marine ecosystems. PIFSC needs to further develop and conduct baseline assessments throughout the region with a focus on areas that support critical fisheries, protected species populations, and coral reef ecosystems and human communities. PIFSC will conduct research to understand the role both habitats and cultures play in the health and sustainability of the region's fish, marine mammal, and sea turtle populations and coral reef ecosystems. Differences between archipelagoes, individual islands, atolls, and islets and other features will allow the PIFSC to compare and contrast environmental and ecosystem effects across a broad spatial spectrum. With increased understanding of changes to marine ecosystems, the socio-economic dynamics and human dimensions, and fisheries interactions, PIFSC will develop ecosystem tools to support the conservation and management of marine resources.

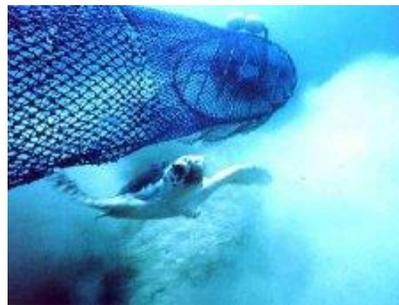
Theme 3: Maximizing effectiveness. PIFSC, the youngest Science Center, was previously a laboratory associated with the SWFSC, and has expanded substantially since its formation. As such, the PIFSC will develop the infrastructure to meet the growing and diverse needs of its stakeholders. PIFSC will seek to maximize the efficiency, effectiveness, transparency, and public accessibility of its research by strengthening partnerships and providing useful scientific information products, services, and advice to resource managers, policymakers, stakeholders, and the public. PIFSC will focus on several areas to maximize effectiveness, such as:

- Managing scientific operations, logistical coordination, methods development, and data management
- Conducting scientific work in a transparent and conscientious manner
- Enhancing external collaboration and partnerships
- Evaluating and employing emerging technologies and approaches
- Helping build scientific capacity in the local community and with local academic institutions
- Providing timely scientific advice

For more information about PIFSC science activities visit www.pifsc.noaa.gov.

THE SOUTHEAST FISHERIES SCIENCE CENTER

The Southeast Fisheries Science Center (SEFSC) provides the scientific advice and products to guide living marine resource management and policy decision-making in the Gulf of Mexico, Caribbean, and South Atlantic ecosystems. This region is unique in that it encompasses three large marine ecosystems, shares federal region borders with Mexico and Cuba, and has numerous other Caribbean countries in close proximity. Each entity has shared research and management responsibilities, making strategic transboundary engagement paramount. The SEFSC strives to maintain healthy marine ecosystems and productive and sustainable fisheries, restore depleted populations and damaged habitats, and recover populations of protected, threatened, and endangered species in the southeast U.S. and associated international waters. The SEFSC achieves this goal by using the best science possible in conducting research and monitoring the condition and trends of living marine resources and marine ecosystems for highly migratory species on the high seas of the Western Atlantic Ocean and for three large coastal marine ecosystems: the Gulf of Mexico, the Southeast U.S. Continental Shelf, and Caribbean Sea (U.S. Virgin Islands and Puerto Rico). The SEFSC leverages its limited resources and strengthens its research activities by coordinating and collaborating with a multitude of other federal, state, and local agencies and academic institutions.



Turtle excluder device

SOUTHEAST FISHERIES SCIENCE CENTER THEMES

Theme 1: Monitor and assess fisheries and marine ecosystems, including populations of exploited and protected species, their habitats, and the associated human communities that rely on marine resources. The SEFSC collects, analyzes, maintains and archives scientific data on the condition, trends, and causes of change for living resources in three large marine ecosystems and for highly migratory species in the Western North Atlantic. The SEFSC will conduct research and monitoring to develop stock assessments and other scientific products that provide critical information to achieve optimum yields, prevent overfishing, and support consultations and listings of protected species. Fishing effort, total landings, and bycatch data, as well as economic and social information will be collected to evaluate impacts on people and coastal communities that depend on healthy populations of living marine resources. Field surveys and laboratory studies will provide data to determine vital parameters for fishery and protected resource species, habitat usage, and natural and fishing mortality. Through these actions the SEFSC will support regional fishery management councils, state commissions, international organizations and other partners in meeting management objectives. SEFSC will also work to improve stock assessments by incorporating scientific uncertainty, environmental change and ecosystem considerations, while optimizing sustainable landings. A major focal area for the SEFSC will be to expand data collections to reduce scientific uncertainty and improve the accuracy and precision of stock assessments. SEFSC researchers will continue to collaborate with fishers to develop and evaluate new fishing methods and gear to resolve bycatch problems in fisheries. SEFSC is pursuing the development of IEAs and use of ecosystem models that are capable of integrating biological, environmental, physical, and human processes in relation to management objectives. As with the collection of biological and environmental data, there is a need to expand socio-economic data collection efforts and further develop and use economic models.

Theme 2: Understand and forecast effects of climate change and other factors on marine ecosystems. All marine ecosystems are potentially vulnerable to climate change and environmental variability that could interact with and impact marine ecosystems in complex and unpredictable ways with direct and indirect economic and social consequences. An improved scientific understanding of climate is necessary to inform decision makers so they can develop appropriate management strategies. The SEFSC will develop the scientific basis for evaluating the vulnerability, condition, and sustainability of marine resources and their human systems under changing climate conditions. SEFSC laboratories will conduct collaborative interdisciplinary and shared climate research using laboratory, field, and modeling approaches to predict regional effects of climate and environmental variability on marine ecosystems and people in southeastern United States. Climate change may affect people by changing fishery productivity through variations in recruitment strength and prey availability, ecosystem resilience to disturbance, and recovery potential of exploited and protected species. SEFSC research seeks to better measure, understand, and predict major spatial and seasonal patterns in marine ecosystem structure and function. SEFSC will work to understand the effect of ocean acidification on fisheries, habitat, and ecologically important, exploited and protected living marine organisms. SEFSC will track changes, participate in research to investigate population and functional impacts of ocean acidification on marine ecosystems, and incorporate study results into population and ecosystem models to forecast population responses and ecosystem level impacts. SEFSC will use forecasts of population changes in response to climate change (ocean warming, ocean acidification) on exploited, ecologically important, and protected species to predict social and economic effects on coastal commercial fishing communities, and recreational fishing and tourism in the southeast region.

Theme 3: Describe and assess the role of habitats in supporting healthy marine ecosystems and populations of fish, invertebrates, and protected species. The SEFSC conducts research to understand the role habitat plays in the health and sustainability marine ecosystems and populations of fish, invertebrates, and protected species. The SEFSC conducts spatially explicit, fishery-independent habitat surveys, assessments, and research to evaluate regulatory effectiveness and determine impacts of fishery and other human activities on essential habitats essential for sustaining living marine resources. SEFSC scientists evaluate fishing impacts on ecosystem health, defined as the sustained ability for self renewal, and transmit scientific advice to managers to promote and sustain ecosystem health. Science activities include studies to reduce bycatch and habitat damage from fishing, and developing mitigation strategies and tools to restore damaged habitats. The SEFSC will evaluate a range of human activities on living marine resources, including habitat impacts of coastal development, runoff, and pollution on the sustained productivity and health of living marine resources. Increased the potential for impacts from non-fishery related activities on exploited, protected, and other living marine organisms, particularly for coral reefs and estuarine-dependent, mean managers continue to need information about how these activities potentially impact habitats for fishery and protected species and how to mitigate those impacts through coastal and marine spatial planning.

For more information about the SEFSC science priorities visit www.sefsc.noaa.gov.

THE SOUTHWEST FISHERIES SCIENCE CENTER



Sardine and kelp

The Southwest Fisheries Science Center (SWFSC) is the research arm of NMFS in the Southwest Region of the United States. The SWFSC generates the science necessary to manage and conserve the living marine resources of the California Current, the eastern tropical Pacific and portions of the North Pacific, and the Southern Ocean. These regions span millions of square kilometers; include a diverse range of coastal, shelf, and oceanic environments; and support important commercial and recreational fisheries, a wide variety of recreational activities, and endemic (native/indigenous)

and transboundary threatened and endangered living marine resources. The scope of SWFSC's research is diverse and scientifically challenging. The California Current—a cold, eastern boundary current—is characterized by seasonal upwelling, a narrow continental shelf, low and variable freshwater input, and exceptional interannual oceanographic variability heavily influenced by the El Niño-Southern Oscillation. Many of its commercially significant fisheries experience boom-bust population cycles and, in the case of salmon, are supplemented by large-scale artificial propagation in hatcheries. In addition to commercial fisheries interests, there are significant recreational and non-extractive users of the ecosystem as well as disparate needs of constituents for fresh water, resulting in impacts on habitat for anadromous and estuary-dependent species. The SWFSC, together with the NWFSC, provides the scientific information with which to inform management decisions on the stewardship of the California Current LME. Equally important to the SWFSC's scope is research conducted in tropical (eastern tropical Pacific) and polar (Southern Ocean) ecosystems involving a large stakeholder component represented by non-U.S. nations and multi-national agreements and

conventions, and a significant transboundary component of the living marine resources for which the SWFSC is responsible.

SOUTHWEST FISHERIES SCIENCE CENTER THEMES

Theme 1: Population assessment: Provide assessments and management advice to rebuild and sustain fisheries, fishing communities, protected species, and their ecosystems. Stock assessments are critical to ensuring that domestic and international fisheries and protected species are managed based on the best available scientific information. SWFSC scientists use fishery-dependent data from U.S. and international fisheries and fishery-independent data from their surveys to conduct assessments. Maintaining stock assessment activities will require a suite of expertise and field, technical, and analytical resources in order to collect fishery-independent and fishery-dependent data, conduct stock assessments, and evaluate the likely biological and socioeconomic outcomes of management options. The SWFSC will develop and apply techniques to define conservation units at both demographic (stock) and evolutionary (species and subspecies) scales, while incorporating new analytical methods to improve assessments of those conservation units. Approaches will include incorporating ecosystem information, developing methods to address populations with limited data, innovating new methods to assess threats to species such as bycatch, and understanding ecological impacts of using forage fish in aquaculture feeds.

Theme 2: Ecosystem analysis: Assess and predict how environmental changes and human activities affect ecosystems and design and implement new management paradigms to manage fisheries and recover protected species. Ecosystem analysis is integral to comprehensive and proactive assessment of living marine resources. The SWFSC will improve the understanding of marine, coastal, estuarine, and freshwater ecosystem structure and function in response to climate and anthropogenic forcing, to predict how such forcing affects living marine resources and to develop and enable ecosystem approaches to management that incorporate this variability. The SWFSC will evaluate physical habitat conditions and use by marine and anadromous fish, marine invertebrates, sea turtles, and marine mammals; link habitat conditions to distribution and vital rates of focal species; document spatial patterns and temporal trends in habitat conditions; and ultimately attempt to predict how climate change will alter the distribution, abundance, and productivity of focal species through effects on their habitat and interactions with other species. Increased understanding of energy flow through trophic levels in an ecosystem, as well as human and natural pressures on ecosystems, will be incorporated into IEAs and other developing tools to evaluate alternative management strategies.

Theme 3: Observations, measurements, and surveys: Provide information and data to support population assessments and analyses of ecosystem variability and change.



Bluefin tuna

Observations, measurements, and surveys form the basis for the research conducted by the SWFSC. Time series and the data they contain create the baseline for addressing emerging issues, and for predicting future and hind-casting past patterns related to the assessment of living marine resources and ecosystem dynamics. Time series form the basis not only for monitoring managed species, but also for addressing unexpected or emerging issues. When long-term time series are lacking, interpretation of data can be critically flawed and result in poor understanding of

the baseline against the current state of an ecosystem. The SWFSC has a long history of maintaining time series data and will remain a leader in incorporating ecosystem measurements into time series for abundance and trends of managed species, whether they be directly targeted or protected. The SWFSC will continue to collect data on a variety of additional biological parameters—life history, movements, ecology, and behavior of living marine resources—to support assessments and predict population-level responses. Access to a wide variety of distributed data underlies the ability to carry out IEAs, habitat assessment and modeling, and managing endangered and protected species. These distributed datasets include satellite data, in situ oceanographic data, and baseline biological data, and the user must be able to access and combine these data in a seamless fashion. SWFSC is at the forefront of agency directives in the development, management, and distribution of data to make the process of finding, subsetting, and obtaining data seamless to scientists, managers, web developers, and the public.

Theme 4: Technological innovation and development: Improve ecosystem observations and survey methodologies through a variety of advanced technologies and sensor development. Traditional fishery-independent survey methods are insufficient to meet the need for improved stock assessments. Available ship time is insufficient to tow as many nets as needed, and many important areas cannot be sampled with nets because of their structural complexity. Technological innovation and development is essential to cutting-edge science and is a hallmark of the SWFSC. With its state-of-the-art facilities, the SWFSC will play a key role within NMFS to create the next generation of technologies needed to improve effectiveness of surveys, characterize populations, observe the ecosystem, and provide improved assessments. Technologies include LIDAR; satellite remote sensing; manned and unmanned submersibles and aerial platforms; instrumented buoys; novel applications of multi-frequency, sidescan, and multibeam sonars and acoustic Doppler current profilers; and towed acoustic arrays, in addition to a suite of biotechnology and biologging applications.

For more information about the SWFSC science priorities visit www.swfsc.noaa.gov.

FURTHER INFORMATION ON NOAA FISHERIES SCIENCE PRIORITIES

This overview is drawn from the strategic science plans crafted by the leadership and staff of each individual NOAA Fisheries Science Center and the Office of Science and Technology. Each plan contains further details addressing each theme and focus presented here. These plans and more information about the work conducted by NMFS can be accessed at the following websites:

- www.afsc.noaa.gov
- www.nefsc.noaa.gov
- www.nwfsc.noaa.gov
- www.pifsc.noaa.gov
- www.st.nmfs.noaa.gov
- www.sefsc.noaa.gov
- www.swfsc.noaa.gov

GLOSSARY

AFSC – Alaska Fisheries Science Center
NEFSC – Northeast Fisheries Science Center
NWFSC – Northwest Fisheries Science Center
PIFSC – Pacific Islands Fisheries Science Center
SEFSC – Southeast Fisheries Science Center
SWFSC – Southwest Fisheries Science Center
ST – Office of Science and Technology
ESA – Endangered Species Act
IEA – Integrated Ecosystem Assessment
MMPA – Marine Mammal Protection Act
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NOP – National Ocean Policy



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