

NOAA's Response to:

Exploration of Ecosystem Based Fisheries Management in the United States

A Report to the
NOAA Science Advisory Board

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Submitted by

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INTRODUCTION

At the request of the National Oceanic and Atmospheric Administration's Science Advisory Board (SAB), the Ecosystem Sciences and Management Working Group (ESMWG or Working Group) undertook a review in early 2012. The purpose of the review was to assess the progress toward implementation of Ecosystem-Based Fishery Management (EBFM) since the 1996 reauthorization of the Fisheries Conservation and Management Act (FCMA, 1976). A Report was presented to NOAA in 2014 and this document serves as the NOAA Response to the recommendations within that Report.

The key question of the review was to determine how much progress has been made in ecosystem sciences and their application in fisheries management in U.S. management regions between 1996 and 2014. The working group selected an approach that divided this question into two parts. Part I asked 'What actions have been taken by council regions to implement an EBFM approach?' Part II asked "What is the state of the science to support EBFM?" Part II was divided further to ask "What is the state of regional EBFM science for fisheries management?" and "How is the regional fisheries management council using EBFM science for fisheries management?"

The Report calls out the prevention of overfishing, rebuilding of overfished stocks and protection of essential fish habitat as important steps toward implementing EBFM. NOAA agrees with these findings and works to support the activities as part of a progression to EBFM.

Principally, the Working Group recommended a needs assessment to prioritize ecosystem science: *"We conclude that a needs assessment should be undertaken to prioritize ecosystem science inputs that will really contribute to improving the performance of Councils. We are aware that several 'needs assessments' have been or will be conducted, and that some non-government bodies are planning others, (e.g., Pew Charitable Trusts). We are also aware that a full quantitative needs assessment is itself costly in terms of expertise, time and resources [...]."* The working group provided seven recommendations including this principal recommendation. .

While this Review was underway, changes within NOAA Fisheries aligned the agency in a manner that advances EBFM. New senior scientist positions, a cross-agency Science Program Review, and a National Climate Science Strategy for NOAA Fisheries all serve as a strong foundation for future expansion and refinement of EBFM.

Three new senior scientist positions were established within NOAA Fisheries to establish a focal point for ecosystem science, stock assessment science, and economics. Hiring a senior scientist for ecosystem science demonstrates the importance of ecosystem science and EBFM to the NOAA Fisheries mission. In addition to accelerating the work within each of their disciplines, these senior scientists coordinate science activities across NOAA Fisheries while reaching out to other parts of NOAA and our partners around the world. The combination of serving as a senior scientific authority and inspiring nationwide coordination has enhanced their

leadership role in initiatives focused on the impacts of climate change on our living marine resources, the development the next generation of stock assessments, and the development and use of new social and economic indicators for successful management.

A strong science enterprise is essential in advancing EBFM. Since 2013, NOAA Fisheries has undertaken Science Program Reviews focused on data collection and management, stock assessment, and protected species. In 2016, the Review will focus on ecosystem science. With the intention of revisiting these focus areas on a regular cycle, experts from within and outside the agency will carefully examine our science programs to improve integration, identify best practices, and share successes and challenges within our science enterprise. The review process will include opportunities for public involvement, which will be part of our broader dialog with fishery management councils, fishing industry, and other stakeholders. Working in concert with surveys related to Fishery Ecosystem Plans and Fishery Management Plans, the Science Program Review provides a valuable tool to guide NOAA Fisheries as EBFM advances.

Establishment of a National Climate Science Strategy for NOAA Fisheries helps accelerate the production, delivery, and use of climate information. NOAA Fisheries looks to this acceleration to help fulfill its mission to sustain living marine resources and their environment for the benefit of the nation. Climate change has an effect on valuable living marine resources and the response of ecosystems to these effects is an essential element within EBFM. The Strategy describes seven objectives that define a path that can be used by all NOAA Fisheries offices and laboratories to meet science information requirements. Implementation of the Strategy can help reduce the impacts of climate change and increase the resilience of living marine resources and the communities that depend on them.

The establishment of new senior scientist positions, the progression of a Science Program Review, and the publication of a National Climate Science Strategy are a few NOAA accomplishments that contribute to the advancement of EBFM in the spirit of the ESMWG Report. The recommendations within the Report help guide EBFM development in NOAA as well as validate many of the recent steps NOAA has taken to advance this approach to its mission.

RECOMMENDATION 1

CONTINUE AND EXPAND SUPPORT TO COUNCIL PROCESSES FOR ECOSYSTEM SCIENCE

Continue and expand support for Council processes for ecosystem science based on a prioritized needs assessment, including, for example, retrospective performance evaluations to investigate how much difference various types of ecosystem inputs could have made, had they been available and wisely used in past ecosystem decision-making

NOAA Response

NOAA understands this recommendation and the principal recommendation articulated in the ESMWG Report to be identical and thus the following response applies to both.

NOAA agrees with the essence of this recommendation and places a high priority on fostering relationships that elucidate what ecosystem inputs have made significant impacts to management decisions and what ecosystem science priorities exist to maintain this level of excellence.

NOAA, however, does not agree with the proposal to generate a needs assessment in the manner recommended. A workshop of the design proposed in the Report embraces a national scope of attendees and, as a result, a broad array of issues. It would be costly in terms of expertise, time, and resources to execute.

Regional Fishery Management Councils (Councils) can develop Fishery Ecosystem Plans (FEPs) as a mechanism for incorporating ecosystem principles, goals, and policies into their current fishery management structure (<http://www.st.nmfs.noaa.gov/ecosystems/ebfm/fishery-ecosystem-plan>). Fishery managers can use them as a metric to determine whether EBFM is being addressed. NOAA is conducting an analysis of FEPs which is nearly complete (Appendix B). The goal of the analysis is to better understand the approaches taken by the Councils to develop FEPs and to track how these plans have been used. FEPs are in place with Councils in the North Pacific, Western Pacific, Pacific, and South Atlantic. Plans in the Northeast, Mid-Atlantic, and other parts of the North Pacific are under consideration.

An additional review of FEPs has just begun. In 2014, NOAA Fisheries partnered with the Lenfest Ocean Program to charge a team of non-NOAA scientists with creating a practical blueprint that managers can use to make ecosystem-based fisheries management operational (<http://www.lenfestocean.org/en/research-projects/fishery-ecosystem-task-force>). The Fishery Ecosystem Task Force formed under the Lenfest Ocean Program has begun a series of meetings and will provide recommendations in 2015 and 2016. The Task Force's main output will be an outline of the components of effective FEPs. It will provide a set of specific topics that every

FEP might consider and a set of recommendations for how each question can be answered, based on a review of international best practices. The group will focus on guidance for Councils but will also provide a framework that can be adapted by other management bodies.

A NOAA survey of NOAA Fisheries Regional Offices about EBFM practices and Fishery Management Plans (FMPs) is underway. This survey is designed to determine the degree to which NOAA Fisheries Regional Offices and the Councils incorporated the principles of EBFM into FMPs, as well as identify areas where improvements could possibly be made (Appendix C). The survey touches all 46 managers of FMPs around the country (http://www.nmfs.noaa.gov/sfa/domes_fish/FMPS.htm). The expectation is that these activities will deliver retrospective information as well as information relevant for planning future elements of EBFM.

Adding to this, a planned NOAA Fisheries Program Review in 2016 will, *inter alia*, strive to document how well NOAA ecosystem science is being used in the management setting. Table 4 and 6 in the EMSWG Report will serve as excellent sources of information here. Previously, the NOAA Program Review evaluated the successes, shortcomings, and needs of fish assessment science and protected species science that included ecosystem linkages. All three of these reviews are providing important information about NOAA's science operations, many of which provide the basis for EBFM (Appendix D).

NOAA would like to continue to accomplish the goals sought by this recommendation regionally, where Science Centers, Regional Offices, and Councils continue to engage in discussions about their jurisdictions using proven connections and regular meetings already in place. NOAA has supported workshops of the Council Coordination Committee's Scientific Subcommittee (aka the National Science and Statistical Committee (SSC)) where NOAA Fisheries, academic, and SSC scientists and Council staff have discussed means to improve inclusion of ecosystem and climate factors in fishery management.

NOAA Fisheries is developing a next generation Stock Assessment Improvement Plan (SAIP). A major focus of this new SAIP is on the incorporation of ecosystem dynamics in fish stock assessments. In particular, a framework is being developed in which target stock assessment levels will be established, including the degree to which assessments should be calibrated by ecosystem information.

Also, NOAA Fisheries is on the verge of releasing a national protocol for prioritizing fish stock assessments that can be used to guide regional assessment scheduling. This protocol will rely on objective criteria to identify which stocks are in need of assessment, how frequent assessment updates should occur, and the relative level at which assessments should be conducted. For the latter, relative assessment levels can be used in conjunction with the next generation SAIP to

prioritize stocks for which the inclusion of ecosystem dynamics is one of the more important facets to consider.

To formalize and accelerate the implementation of EBFM within NOAA Fisheries and our partners, an EBFM Policy Statement is under development. The Policy Statement will affirm EBFM as an important mechanism for NOAA's broader efforts to sustainably manage and conserve productive marine ecosystems. It will build on the past progress by NOAA Fisheries and clarify the agency's commitment to integrating its management programs for living marine resources and their habitats. With the agency's mandates as a basis, the Policy Statement presents guiding principles for the execution of the NOAA Fisheries mission while being cognizant of EBFM considerations.

To bring the aspirations of the EBFM Policy Statement to the everyday execution of NOAA Fisheries, an EBFM Roadmap is under development. The design of the Roadmap includes 8-10 objectives that are applicable in each geographic region. The objectives strive to achieve goals under the themes of (1) outreach and policy measure; (2) ecosystem-level advice; and (3) ecosystem considerations into trust species advice. The EBFM Roadmap describes what EBFM looks like in an operational context and tracks the progress of EBFM implementation.

Relevant Milestones

1. Complete the analysis of Fishery Ecosystem Plans (2015)
2. Complete the NOAA Fisheries Program Review for Ecosystem Science (2016)
3. Publish the new Stock Assessment Improvement Plan (SAIP) (2016)
4. Publish NOAA Fisheries Policy Statement on EBFM (2016)
5. Complete draft EBFM Roadmap (2016)
6. Complete the survey and analysis of ecosystem information in Fishery Management Plans (2017)

RECOMMENDATION 2

INVESTMENTS TO UNDERSTAND FISHERY MANAGEMENT AS COUPLED SOCIO-ECOLOGICAL SYSTEM

Invest more in development of science to understand fishery management as a coupled socio-ecological system.

NOAA Response

NOAA agrees that a greater understanding of the interaction between the human dimensions of fisheries and the ecological system can lead to improved management outcomes. At the time of the writing of this Response, the ESMWG is embarking on a review of valuation of ecosystem services for NOAA, as well as one on traditional ecosystem knowledge. These reviews will address this issue. NOAA looks forward to future recommendations to more fully consider the topic of this recommendation.

What We Have Done

Economic and social science research at NOAA Fisheries is conducted to understand and predict the behavioral response of fishermen to changing management actions as well as changes in the ecosystem. Research is also conducted to determine the net benefit to society from management actions.

A recent accomplishment of that research comes in the form of a NOAA Fisheries effort to build computer modeling tools that predict how fishermen will shift fishing spots in response to changing rules or environmental conditions. FishSET—the Spatial Economic Toolbox for Fisheries—is already being used to improve the management of sea turtle bycatch in the Gulf of Mexico, identify low-cost wind power areas off the New England coast, and anticipate how the multi-billion-dollar Bering Sea pollock industry will adapt to climate change (<https://www.st.nmfs.noaa.gov/economics/fisheries/commercial/spatial-choice-behavior/index>).

The Bioeconomic Length Age Statistical Tool (BLAST) is based on research on recreational angler preference for trip characteristics that vary based on catch rates, size, and bag limits. It can be used to predict how fishermen respond to changes in those characteristics, as well as measure the change in economic benefits that occur. Two major advances of BLAST are 1) it is embedded in the fishery management process and doesn't leave it up to the Council members to figure out how to use the economic information; 2) it uses a coupled biological-behavioral model instead of an isolated economic model. BLAST will be an important tool in predicting changes in recreational fishing due to changing environmental conditions.

An important element of NOAA's approach to EBFM is the Integrated Ecosystem Assessment (IEA). IEAs consider ecosystem status relative to societal and ecological goals (Appendix E). It then evaluates the benefits, risks, and tradeoffs of alternative management actions from social and ecological perspectives. As exemplified by NOAA's most mature IEA in the California Current – social and economic indicators are placed alongside ecological indicators of ecosystem state to allow simulations of possible management actions. In line with this recommendation, NOAA plans to create a Human Dimensions Working Group for the IEA Steering Committee to enhance the integration of human dimensions in IEA products and fill a dedicated post-doctoral position to explore ways to integrate economics into ecosystem based fisheries management (<http://www.noaa.gov/iea/>).

Advances in IEAs in 2015 included the development of conceptual models of the integrated socio-ecological system of the California Current. With the intent to replicate this activity around the country, the conceptual model for the California Current establishes a unified approach to the system. It places human activities at the center and forms a link between biophysical drivers and social systems. This advance enhances the IEA focus on socio-ecological systems.

Relevant Milestones

1. Hire post-doc (2015), and initiate project on economics of forage fish (2016)
2. Hold a BLAST workshop to improve its utilization in fisheries management (2016)
3. Review the ESMWG Report on Valuation of Ecosystem Services (2016), and Traditional Ecosystem Knowledge (2017)
4. Create the Human Dimensions Working Group under the IEA Steering Committee (2016)

RECOMMENDATION 3

FACILITATE CROSS-REGION AND COUNCIL INTERACTIONS

Facilitate cross-region and council interactions on EBFM Science and Management. Examples exist where the importance of sharing ideas and making use of peer effects can be used to overcome inertia.

NOAA Response

NOAA agrees that sharing ideas between Science Centers, Regional Offices, and Regional Fishery Management Councils is valuable to the evolution of EBFM and will continue to support existing efforts.

What We Have Done

NOAA supports several national-level meetings designed to facilitate the sharing of approaches, techniques, models, and experiences related to fisheries science, protected species science, habitat science, ecosystem science, and EBFM. The communities that come together at these workshops and fora establish organizational and individual connections that serve to accelerate the development of EBFM science and use of EBFM information. NOAA Fisheries has facilitated cross-region interactions on EBFM science and management through numerous activities. In particular, a number of workshops, such as ongoing National Ecosystem Modeling Workshops, and National Stock Assessment Workshops have focused on this issue. We suggest a joint meeting between NOAA Fisheries, NOAA's Office of Oceanic and Atmospheric Research (OAR) and the Council SSCs be held in 2017-18 to focus on EBFM.

Each region is challenged with a changing climate and ocean. A new National Climate Science Strategy for NOAA Fisheries provides a nationally consistent path for regional efforts to address climate impacts on fisheries. Objectives in this strategy are designed to increase the production, delivery, and use of climate-related information that is critical for effective EBFM (<http://www.st.nmfs.noaa.gov/ecosystems/climate/national-call-for-comments>).

NOAA Fisheries participates in ongoing engagement with the Councils on EBFM science and management in numerous fora. Aspects of EBFM are a frequent topic discussed at the National SSC meetings where NOAA Fisheries and Council representatives come together to have open dialogue on a range of pertinent topics. EBFM topics are frequently discussed at the Council Coordination Committee meetings, where NOAA Fisheries and Council representatives participate. Additionally, the Fisheries Leadership and Sustainability Forum (Fisheries Forum) is

an organization that facilitates building connections within the federal fisheries management community. The Fisheries Forum holds regular meetings that bring together Council and NOAA Fisheries representatives to discuss various topics, including EBFM. Recent Fisheries Forum topics have included habitat and management strategy evaluations in the face of uncertainty.

Most Fisheries Science Centers already have ecosystem science branches, and most Councils have EBFM working groups and ecosystem planning teams that include NOAA scientists. In the next year, NOAA will establish EBFM and Climate Change Points of Contact within our Regional Offices and Fisheries Science Centers. The assemblage of these new professional positions represent a community that will have excellent vantage points from which to articulate EBFM activities and provide information for cross-regional discussions and enhance existing discussions between Science Centers, Regional Offices, and Councils.

Relevant Milestones

1. Support National Scientific and Statistical Committee Meeting (2016)
2. Complete establishment of EBFM and Climate Change Points of Contact in Regional Offices (2016)
3. Encourage and Participate in the Fisheries Leadership and Sustainability Forum (2017)
4. Conduct National Stock Assessment Workshop focusing on the implementation of EBFM (2018)
5. Conduct a meeting between NOAA Fisheries, OAR, and SSCs to focus on EBFM (2017-2018)

RECOMMENDATION 4

INVEST IN TOOLS FOR ASSESSING TRADE-OFFS

Invest in tools for assessing trade-offs [spatial and temporal] of alternative management decisions.

NOAA Response

NOAA agrees that investments in tools to assess trade-off options are important and will continue to support Management Strategy Evaluations (MSEs) in the NOAA Fisheries Toolbox and as part of its process to generate Integrated Ecosystem Analyses.

What We Have Done

Assessing the condition of ecosystems and the fishery resources under different management decisions is an essential part of the work of stock assessment scientists and ecosystem scientists within NOAA. Heeding NOAA Fisheries Program Reviews (two on fish assessment science and another on protected resource science) recommendations that were developed after the publication of the ESMWG Report, NOAA established an MSE Working Group to develop MSE techniques and established positions at each Science Center to specialize in MSE modeling. These two improvements strive to invest in tools to guide trade-off analyses. The MSE Working Group will connect with ecosystem modelers across NOAA who continue to advance multispecies, food web, and end-to-end models as tools to assist in MSEs. To this end, NOAA Fisheries has established a new FTE at each Fisheries Science Center to be the MSE expert in each region.

Integrated Ecosystem Assessments (IEAs) are being implemented in five regions in the United States. Understanding and communicating how management of one area (e.g. energy production) will impact others (e.g. fishing, shipping) is critical to effective decision-making. IEAs provide a structure to assess ecosystem status relative to objectives, account for the holistic impact of management decisions, and guide management evaluations. IEAs draw on both the natural and human-dimensions sciences to determine the status of these coupled Social-Ecological Systems (SESSs) and to evaluate management options. IEAs use an incremental and iterative process that starts with defining management goals and targets and builds off these in subsequent steps to ultimately provide scenario evaluations for trade-off analyses for use in management actions.

Many Science Centers are engaged with Regional Fishery Management Councils in discussions on how to construct and evaluate MSEs and use this capability to guide fisheries management

decisions. This is true for the currently productive engagements between the Alaska Fisheries Science Center and the North Pacific Fishery Management Council, the Northeast Fisheries Science Center and the Mid-Atlantic and New England Fishery Management Councils, the Southwest and Northwest Fisheries Science Centers and Pacific Fishery Management Council, and the Southeast Fisheries Science Center and the South Atlantic and Gulf Fishery Management Councils.

The NOAA Fisheries Research Program in fisheries oceanography called Fisheries and the Environment (FATE) provides parts of the scientific foundation for this part of the enterprise (<http://www.st.nmfs.noaa.gov/fate/>). Leading oceanographic and ecological indicators are developed from new understanding developed within its projects. These indicators, models, and ecosystem insights are, in addition to other places, transferred into the IEA Program and MSEs. NOAA scientists provided input to a recent evaluation conducted by the Moore Foundation with the National Aquarium (<http://www.aqua.org/care/fisheries>) in which they suggested FATE should be expanded to assess risk related to large-scale and long-term environmental change.

Relevant Milestones

1. Maintain engagements between Science Centers, Regional Offices, and Councils that support development and evaluation of MSEs (ongoing)
2. Complete the formation of the MSE working group for NOAA (2016)
3. Establish staff at each Center focusing on MSEs (2016)

RECOMMENDATION 5

ASSESS AND IMPLEMENT BEST PRACTICES FOR COORDINATING AND INTEGRATING ECOSYSTEM SCIENCE

Assess and implement best practices for coordinating and integrating ecosystem science across NOAA and with partners.

NOAA Response

NOAA concurs that the provision of the best scientific advice on ecosystems requires the activities in multiple scientific disciplines originating in many parts of NOAA. Attention to coordination is critical as we mobilize to address complex ecosystems.

What We Have Done

Recently, NOAA Fisheries has emphasized the use of Ecosystem Status Reports (also known as state of the ecosystem reports, or ecosystem considerations chapters) as a vehicle to exchange information about the conditions in the ecosystem with respect to climate, ocean physics, lower trophic level biology, living marine resources, and fishing communities. These conditions are described in a similar manner to NOAA's El Nino forecasts with a focus on what these conditions might mean for the condition of valuable living marine resources. Through the EBFM Roadmap, NOAA Fisheries will encourage the publication and advancement of Ecosystem Status Reports in each of its five regions. All Science Centers are currently developing or updating Ecosystem Status Reports related to ecosystems in their region.

Coordination across NOAA is bringing multidisciplinary information into fisheries management. Ecological forecasting coordinates science between different Line Offices (notably NOAA National Ocean Service (NOS) and NOAA National Weather Service (NWS)) to bring advanced warnings of ecological phenomena that may have adverse effects on living marine resources, such as harmful algal blooms and hypoxia. OAR laboratories and NOAA Fisheries laboratories have been collaborating on new modeling projects designed to integrate the finest scale climate information with new ecosystem models in pursuit of preparing living marine resource managers for climate change effects. Many of these connections are prescribed in the NOAA Fisheries National Climate Science Strategy completed in 2015. In the Pacific Islands, there is excellent and long-running coordination between NOAA Fisheries, NOS, and OAR on coral reef ecosystems that have led to EBFM successes for both fisheries and the supporting habitat.

An important element of long-term EBFM is addressing climate change. Under the President's Climate Action Plan

(<https://www.whitehouse.gov/sites/default/files/image/president27scclimateactionplan.pdf>), federal agencies are directed to identify and evaluate additional approaches to protect biodiversity and conserve natural resources in the face of a changing climate. To prepare for and respond to current and future changes in climate and oceans, fisheries managers and scientists need tools to identify what fisheries resources may be most vulnerable in a changing climate and why certain fish stocks are vulnerable. The NOAA Fisheries National Climate Science Strategy aims to increase the production, delivery, and use of climate-related information to apprise and fulfill NOAA Fisheries' living marine resource stewardship mission. Although the information needed to understand, prepare for, and respond to climate change impacts on living marine resources is diverse, this Strategy identifies common themes and priorities for action. The Strategy identifies seven key objectives to meet the science information requirements for fulfilling NOAA Fisheries' mandates in a changing climate. This strategy seeks to connect Science Centers, Regional Offices, and Councils on these topics. One of the elements is to develop Climate Vulnerability Analyses in each region to determine which fishery resources are most sensitive and most exposed to climate change effects. Analyses are being planned for each region in the U.S. with an intended completion date of 2017; one in the Northeast has already been completed, and one in the Alaskan region and one for the California Current region are underway. A vulnerability tool is presently under development for protected species, as well. By providing this information, these methodologies will help fisheries and protected resources managers identify ways to reduce risks and impacts to our living marine resources and the people that depend on them.

Relevant Milestones

1. Update Ecosystem Status Reports currently in place (2017)
2. Execute elements of the National Climate Science Strategy, including the production of Climate Vulnerability Analyses (2017)

RECOMMENDATION 6

DEVELOP TRAINING AND CAPACITY BUILDING FOR LONG TERM EBFM

Develop training and capacity building in Council/ Science Center interactions to experiment with model results, scenarios and trade-off analyses for long term EBFM.

NOAA Response

NOAA agrees that building capacity and training to improve interactions between the Science Centers and the Regional Fishery Management Councils (Councils) is important, and the commitment to that interaction continues.

What We Have Done

The provision of the best scientific advice into the management discussion is central among the goals of NOAA. In an effort to maintain the connection NOAA Fisheries and Councils with respect to science, NOAA assigned scientific staff to serve on Council committees for ecosystem science and on EBFM planning teams.

To engage a broadest audience and reach across Science Centers, Regional Offices, and Councils, NOAA Fisheries has developed communications tools within an outreach strategy. NOAA Fisheries (?) established a new visualization tools and an enhanced EBFM webpage. In addition, an EBFM seminar series, new online materials, and training for new Council members provide more continuous exposure to NOAA's principles of EBFM.

Conceived, managed, and presented by fishermen, for fishermen, the Marine Resource Education Program (MREP) arose from ongoing conversations among fishing community leaders active in the New England fishery management process. It strives to provide fishermen information they need to participate effectively in collaborative science and management through multi-day classes. Tailored to the fisheries management process of each region, MREP has expanded from its origins in New England to the Southeast, Caribbean, and the West Coast of the U.S. The latest class offerings include a focus on improving the communication between fishermen, scientists, and managers – an element that is essential to EBFM (<http://www.gmri.org/our-work/fisheries-convening>).

Beyond communications, there are educational opportunities to train future NOAA scientific staff. NOAA Fisheries has recently expanded the scope of a primary graduate training program to now be more inclusive of quantitative ecosystem research. The Population and Ecosystem Dynamics Fellowship Program (Fellowship) is jointly supported by NOAA Fisheries and NOAA

Sea Grant. The Fellowship provides support and training to graduate students pursuing doctoral degrees in marine population and ecosystem research and provides applied experience through partnering with NOAA Fisheries mentors. NOAA Fisheries and Sea Grant are committed to supporting eight new fellows per year to build capacity in these mission-critical areas, including ecosystem modeling. To date, approximately 40% of the fellows have pursued careers with NOAA Fisheries, and through the Fellowship have gained the experience necessary to facilitate Council-Science Center interactions on topics related to EBFM (<http://seagrant.noaa.gov/fundingfellowships/nmfssgfellowship.aspx>).

NOAA Fisheries conducts the Quantitative Ecology and SocioEconomics Training (QUEST) Program to further build capacity in fields such as ecosystem modeling. NOAA Fisheries currently supports several faculty positions in universities with strong marine science programs, including faculty that specialize in ecosystem modeling. These individuals all participate in the fisheries management process to varying degrees, and regularly expose their students to this process. These training opportunities create a next generation of NOAA Fisheries scientists that have the skills needed to support effective EBFM in all regions (<http://www.st.nmfs.noaa.gov/quest/>).

NOAA Fisheries considers the connections made under its Council Coordination Committee (CCC) as an important one to share and discuss utilization of developments at the Science Centers with all representatives from all Councils. A recent meeting of the CCC included a discussion of the NOAA Fisheries Climate Science Strategy. Similarly, the National Meeting of the Scientific and Statistical Committees and Fisheries Leadership and Sustainability Forum augment connections between the Science Centers and Councils.

Relevant Milestones

1. Continue to enhance communications efforts on EBFM to contact and connect Science Center, Regional Office, and Council audiences (ongoing)
2. Seat the next class of Fellows in The Population and Ecosystem Dynamics Fellowship Program (2016)

RECOMMENDATION 7

CONTINUE TO LEAD INTERNATIONAL EFFORTS TO USE EBFM

Continue to lead international efforts to use EBFM in fishery management, e.g., in Regional Fishery Management Organizations as well as bi and multilateral fora.

NOAA Response

NOAA agrees with this recommendation and will continue to support international efforts as it has for many years.

What We Have Done

NOAA provides support and maintains a significant membership in both the International Council on the Exploration of the Sea (ICES) and the North Pacific Marine Science Organization (PICES). These international scientific groups contain standing committees and working groups that address issues germane to EBFM. The NOAA scientific staff along with U.S. academic colleagues benefit from the international connections which help advance fisheries and ecosystem science. NOAA scientists are members of and, in some cases, chairs of committees and working groups within ICES and PICES. ICES and PICES are platforms for promoting, advancing, and sharing the approaches to EBFM and associated advances in science.

As illustrated in the Report, NOAA interacts with many Regional Fisheries Management Organizations (RFMOs). These interactions help promote EBFM in many ecosystems around the world. The Northwest Atlantic Fisheries Organization has adopted the Ecosystem Approach to Fisheries Management and the NOAA Fisheries design for Integrated Ecosystem Assessments. NOAA Fisheries has significant interactions with over 15 RFMOs. RFMOs like the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Inter-American Tropical Tuna Commission (IATTC), the Commission for the Conservation of Antarctic Living Marine Resources (CCAMLR), and the International Whaling Commission (IWC) have experienced the long-term and significant involvement of NOAA Fisheries and its ecosystem principles.

NOAA ecosystem scientists were engaged in the 3rd International Symposium on the Effects of Climate Change in the World's Oceans in Santos City, Brazil in 2015. This meeting was the third in a series of climate change meetings coordinated by ICES, PICES, and the Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO). Several NOAA

scientists were among the invited and plenary speakers and many NOAA scientists presented scientific papers at the Symposium. Climate change is a major forcing element considered in most analyses related to EBFM.

NOAA maintains an active role in ICES with many of our scientists being fully engaged in ICES working groups. The same can be said of PICES - allowing NOAA to be fully involved in the global conversation on both sides of the globe. NOAA is engaged in planning and executing many international conferences in support of EBFM that range from ecosystem modeling to how to incorporate ecosystem information into decision making. Next fiscal year an Atlantis Summit will be held to bring together developers and users of the Atlantis ecosystem modeling framework. The International Society of Ecological Modeling will be held in Baltimore, MD and will be connected to the NOAA National Ecological Modeling Workshop (NEMoW 4). Next year will feature a joint ICES/FAO Conference on EBFM to review the state of the art in EBM with a focus on when it made a difference globally and what steps are being taken to make EBM an operational element within many countries.

NOAA Fisheries maintains connections with many countries with the goal of advancing the concepts within EBFM. Ongoing work under our Partnership between NOAA Fisheries and Norway's Institute of Marine Research (IMR) makes advances in mutual interest such as Arctic fisheries science and the inclusion of ecosystem information into stock assessments. New collaborations, cruises, and scientific conferences between the United States and Cuba have the potential for advancements in fisheries science and fisheries oceanography for the Gulf of Mexico and Caribbean regions. More broadly, NOAA Fisheries has developed an International Fellowship Program with the potential to enable science and capacity building between NOAA and other countries in the form of projects and personnel exchanges. In the period from 1999 to today, many achievements have been made with international collaborations in support of EBFM.

Relevant Milestones

1. Maintain NOAA's presence in ICES and PICES work, meetings, and publications (2016)
2. Support and participate in the Atlantis Summit in (2016)

APPENDIX A

ESMWG Contributors

A subcommittee of the ESMWG led the development of the ESMWG Report on EBFM. The subcommittee was composed of Victor Adamowicz, Mike Beck, Tim Essington, David Fluharty (chair), Jo-Ann Leong, Jake Rice and Jim Sanchirico. Mary Anne Whitcomb (NOAA) assisted in the editing and formatting of the report. Tara Dolan and Tony Marshak (NOAA) assisted in completing research for the report. Peter Kareiva served as liaison to the NOAA SAB. Scott Jackson, School of Marine Affairs, University of Washington provided research assistance.

APPENDIX B

Analysis of Fishery Ecosystem Plans (FEPs)

The 1999 Ecosystem Principles Advisory Panel (EPAP) report is the most recent statement from NOAA Fisheries about how to implement Ecosystem Based Fishery Management (EBFM) using Fishery Ecosystem Plans (FEPs; http://www.nmfs.noaa.gov/msa2007/docs/tm_96_repto_congress_final.pdf). Since then, several Fishery Management Councils have developed FEPs in the North Pacific, Pacific, Western Pacific, and South Atlantic. In response to renewed interest nationally in EBFM and the use of FEPs in the fishery management process, **NOAA Fisheries Office of Sustainable Fisheries (OSF), reviewed the eight EPAP recommendations for developing FEPs and benchmarked them against existing FEPs. The results will be published as a NOAA Technical Memorandum.**

The purpose of this review is to

- **Summarize how Council's actual ecosystem planning in FEPs compares with the 1999 EPAP recommendations**
- **Characterize the diverse ecosystem planning needs and approaches across Councils**
- **Better understand how Council's use their FEPs to meet their goals and objectives**

Federal agencies, including NOAA Fisheries, have promoted ecosystem based fisheries management since at least the mid 1990's. A 1994 GAO report on ecosystem management identifies steps to more effectively implement ecosystem based management across government agencies. In 1996, the Magnuson Steven's Fishery Conservation and Management Act (MSA) was reauthorized and called for the creation of an Ecosystem Principle Advisory Panel (EPAP) to develop recommendations to expand the application of ecosystem principles in fisheries management (16 U.S.C.§1882). The 1996 MSA also authorized the Secretary of Commerce to support regional pilot programs with Fishery Management Councils (Council) to implement the EPAPs recommendations. More recently, the U.S commission on Ocean Policy Report called for ecosystem based management in 2004.

In 1999, the EPAP published its report to Congress and identified Fishery Ecosystem Plans as an important mechanism for implementation of EBFM in U.S. fisheries. This approach is distinct from the existing fishery management framework required by the MSA, which requires that Fishery Management Councils develop Fishery Management Plans (FMPs) that contain conservation and management measures consistent with ten National Standards. The Secretary of Commerce is responsible for developing regulations to implement the recommendations contained in FMPs. The EPAP recommended that Councils should continue to use existing FMPs for single species or species complexes, but they should be amended to reflect approaches consistent with a Fishery Ecosystem Plan. The EPAP further clarified that Fishery Ecosystem Plans are useful mechanisms for incorporating core ecosystem principles, goals, and policies, and that they do not replace Fishery Management Plans. To operationalize the use of Fishery

Ecosystem Plans, the EPAP laid out eight recommendations for all future Fishery Ecosystem Plans. EPAP also identified five national policy level recommendations to support the implementation of FEPs including oversight, training, and preparation of guidance.

The eight EPAP recommendations for FEPs are:

1. Delineate the geographic extent of the ecosystem(s) that occur with Council authority, including characterization of the biological, chemical, and physical dynamics of those ecosystems and “zone” the area for alternative uses
2. Describe the habitat needs of different life history stages for all plants and animals that represent the “significant food web” and how they are considered in conservation and management measures.
3. Develop a conceptual model of the food web.
4. Calculate total removals- including incidental mortality. Show how they relate to standing biomass, production, optimum yields, natural mortality and trophic structure.
5. Assess how uncertainty is characterized and what kinds of buffers against uncertainty are included in conservation and management.
6. Develop indices of ecosystem health as targets for management.
7. Describe available long term monitoring data and how they are used
8. Assess the ecological, human, and institutional elements of the ecosystem which most significantly affects fisheries, and are outside Council/Department of Commerce authority. Included should be a strategy to address those influences in order to achieve both FMP and FEP objectives.

APPENDIX C

Analysis of Fishery Management Plans (FMPs)

Ecosystem-based fisheries management (EBFM) recognizes the combined physical, biological, economic and social trade-offs for managing the fisheries sector as an integrated system, and specifically addresses competing objectives and cumulative impacts to optimize the yields of all fisheries in an ecosystem. For over twenty years, NMFS has made great strides in advancing the science behind EBFM and implementing management measures that align with the principles of EBFM. A new survey of EBFM related to Fishery Management Plans strives to document those successes.

This 29-question survey is designed to identify the extent to which NMFS and the Regional Fishery Management Councils have already been implementing the principles of EBFM in its management efforts, as well as identify areas where improvements could possibly be made. This information is critical as NMFS moves forward with implementing EBFM and discussing EBFM issues with policy makers, scientists, managers and our stakeholders.

There are 9 principles of EBFM that this survey will cover:

1. Maintain a resilient ecosystem by minimizing the impacts of fisheries on marine habitat, bycatch, and protected resources.
2. Specify long-term ecological, economic, and social goals and objectives for the fishery or fisheries.
3. Identify ecosystem-level reference points that align with the goals and objectives of the fishery.
4. Conduct interdisciplinary trade-off analysis to optimize the yields of fisheries and provide the greatest benefits to the nation.
5. Understand ecosystem dynamics and incorporate ecosystem considerations into management decisions.
6. Sustainably manage fisheries by preventing overfishing and rebuilding overfished stocks.
7. Use precaution in the face of uncertainty when managing fisheries.
8. Incentivize stakeholders to participate in the management process.
9. Coordinate with regional partners to more effectively manage fisheries.

APPENDIX D

NOAA Fisheries Science Program Reviews: EBFM in 2016

Sound science is critical for making the right decisions when it comes to managing our nation's fisheries and protected species. To maintain world-class science, NOAA Fisheries continually strives to improve its research and monitoring programs. In 2012 we NOAA Fisheries began a systematic peer review process at all six of our regional science centers and our headquarters Office of Science and Technology. Experts from within and outside the agency carefully examine our science programs on a 6-year review cycle to improve integration, find best practices, and share successes and challenges across our science enterprise. This process is part of a broader dialog with Regional Fishery Management Councils, fishing industry, and other stakeholders. Year one is dedicated to strategic planning.

Peer reviews are an opportunity for scientific exchange, while maintaining and improving standards, performance, and scientific credibility. They are an important feedback mechanism to provide fresh ideas and contributions toward improving fisheries science programs. The newly established agency-wide peer review process will help NOAA Fisheries more effectively standardize and advance science nationally throughout all our science centers. Results will also provide guidance for future science investments.

NOAA Fisheries selects the science topic area and defines the scope of the review. Independent experts in the topic area who are unassociated with the science center are selected to participate in the review as members of a peer review panel. Each science center prepares background information and presentations for the week-long review. In addition to presentations, reviewers will have time to discuss the state of the science with management and staff, as well as prepare their individual review report and recommendations. The review panel chair will summarize the meeting proceedings and highlight key recommendations. NOAA Fisheries will consider and respond to recommendations during the following year.

This 6-year cycle will review a new topic each year. The reviews will cover the same topic every six years to ensure progress. This process is the best way to fully evaluate our approaches, find opportunities for improvement, and learn from the successes and challenges found across the nation.

Review presentations and most of the discussions will be open to the public, and agendas for each NOAA Fisheries Science Center review will list times for public engagement to allow interested individuals to provide input to the reviewers. NOAA Fisheries will publish results of each science center's review on NOAA Fisheries science center and national websites, as well as a national synthesis of the reviews.

More Information:

NOAA Fisheries has developed a centralized website that provides access to:

- Terms of reference, schedule and location of reviews

- Links to science center program review websites
- Reviewer reports and agency responses to recommendations
- Synthesis of recommendations best addressed nationally

<http://www.st.nmfs.noaa.gov/science-program-review/>

APPENDIX E

Integrated Ecosystem Assessments: A Next Generation Tool for Ecosystem-Based Management

Once societal objectives for the collective use of different ecosystem services have been established, we require a way to assess the current state of the ecosystem (including its human and non-human dimensions) and to evaluate the implications of alternative management decisions along with associated risks. Management decisions impact the broad spectrum of services and resources provided by ecosystems (e.g. fishing, recreation, energy production, shipping, agriculture, forestry, food, and clean water) in diverse ways.

Understanding and communicating how management of one area (e.g. energy production) will impact others (e.g. fishing, shipping) is critical to effective decision-making. Integrated Ecosystem Assessments (IEAs) are intended to provide a structure to assess ecosystem status relative to objectives, account for the holistic impact of management decisions, and guide management evaluations. IEAs are intended to provide ‘a synthesis and integration of information on relevant physical, chemical, ecological, and human processes in relation to specified management objectives’. IEAs therefore draw on both the natural and human-dimensions sciences to determine the status of these coupled Social-Ecological Systems (SESs) and to evaluate management options. This requires coordination and cooperation among different state and federal agencies and drawing on the expertise of partners in native communities, academia, and non-governmental organizations.

The program is currently being implemented in five regions across the United States: the Alaska Complex Large Marine Ecosystem, the California Current Large Marine Ecosystem, the Gulf of Mexico, the Kona coast of Hawaii, and the Northeast Shelf.