EXPLORATION OF ECOSYSTEM BASED FISHERY MANAGEMENT IN THE UNITED STATES

A Report from the NOAA Science Advisory Board

July 2014

Contents

EXECUTIVE SUMMARY

As requested by the National Oceanic and Atmospheric Administration (NOAA) Science Advisory Board (SAB), this report by the Ecosystem Sciences and Management Working Group (ESMWG) assesses the progress toward implementation of Ecosystem-Based Fishery Management (EBFM) in United States (US) regional fisheries management council system during the period 1999-2014 as well as the status and use of ecosystem science in management

Background and Methodology

The US Congress required review of the use of EBFM in the 1996 reauthorization of Fisheries Conservation and Management Act (FCMA) 1976 [Sustainable Fisheries Act 1996]. In this report the ESMWG undertook a current assessment to:

1) To assess the fishery management council regions taking actions to implement EBFM.

2) To determine the availability and adequacy of ecosystem science in management of marine fisheries in the US

3) To examine the use of ecosystem science in support of regional fishery management council actions

4) To determine to what extent is there a mandate to use EBFM in US fishery management

Historically, regional fishery science centers (RFSC) and regional fishery management councils (RFMC) have made a number of efforts to implement EBFM in the context of fishery management, particularly through execution the mandated stock assessment requirements of the MSA 2007 and Essential Fish Habitat (EFH) requirements of the Sustainable Fisheries Act 1996. To varying degrees the RFMCs have implemented actions consistent with an EBFM approach as outlined in the 1999 Ecosystem Principles Advisory Panel (EPAP 1999) report although none has taken every action outlined in the Report. Additionally, the Magnuson Stevens Act (MSA) and other US legislation encourage the councils to use the best available ecosystem science in decision making and management. These actions together with the Marine Mammal Protection Act, Endangered Species Act, National Environmental Policy Act and Presidential Executive Orders have encouraged and pushed US fishery management to move in the direction of EBFM. Finally, there are challenging questions about ecosystem change and use of EBFM for management of sustainable fisheries that go beyond current efforts by science centers and management councils but which affect the ability to meet mandates and other legislative requirements.

In consideration of these advances, the ESMWG sought to assess the progress made in aspects of ecosystem sciences most relevant to fisheries management, and their application in fisheries management from 1999 to present. Specifically, we reviewed actions taken by RFMCs to implement an EBFM approach (Report Section I), and the state of science to support an ecosystem-based approach to fishery management (Report Section II).

Representatives of RFSCs and RFMCs (Table 1) presented information to the ESMWG over a course of meetings based upon a series of questions posed to elicit their progress towards EBFM. To identify progress toward EBFM through council actions, a simple framework was developed to organize this information (Table 2). This framework was based upon advice from the Ecosystem Principles Advisory Panel (1999), which emphasized EBFM as a process that moves from traditional fisheries management toward a broader consideration of ecosystem and socio-economic information. The framework comprises action taken and decisions made to stop overfishing, delineate

ecosystem interactions, quantify and address uncertainties, set goals and indicators for ecosystem health, develop and apply ecosystem models and management tools.

Progress of RFMCs towards components of this framework was qualitatively evaluated based upon specified actions (Table 3), and summarized per council region as to its implementation of actions toward EBFM (Table 4). Overall, moderate progress was made by all councils in many of the components. Several factors contributed to variability in progress, including regional constraints on resources or competencies, differences in applicability of certain criteria, and differential regional adoption of various components of EBFM.

To assess the state of EBFM science for fisheries management, a synthesis of observations was created from the responses to questions posed to RFSCs and RFMCs. In summary, the science enterprise is strong, with a large amount of the effort going into stock assessments, EFH, and other mandates are at the foundation of EBFM. Additionally, a considerable amount of research is being performed to support council decision making. Investment in social science needed for EBFM as a coupled socio-ecological system was quite limited. RFMCs are using EBFM science in management, but the demand for and use of ecosystem science is highly variable by council region. Where RFMC commit to development and implementation of Fishery Ecosystem Plans the demand for and use of EBFM science increases.

The ESMWG makes the following recommendations for improving EBFM science and its utilization.

Primary Recommendations

1.) Continue and expand support to 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.

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

3.) 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.

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

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

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

7.) 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.

Principal Recommendation

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. Hence a useful first step would be a major workshop of perhaps a week's duration. It would have participants from all Councils and their direct clients, Science Centers, and as close as possible to balanced representation of "natural" and social-economic science experts (again with balance between NOAA-based experts and external experts).

In order to better define what is being recommended as a needs assessment and a prioritization to ways to conceptualize how it could be performed are outlined below:

As preparation for the workshop the NOAA science experts would prepare a list of the best managed stocks in the region(s) which they support, and the stocks / fisheries where they feel management is not achieving an appropriate level of sustainability. For the former they would identify the factors most important in achieving their successes. For the latter, they would document, as much as the existing information allowed, what factors are contributing substantially to the failure to achieve or maintain sustainability. They would also list the types of science products which, if available, would address the shortcomings. Those external science experts invited to participate would be invited to undertake the same analyses, although their access to the necessary information for their analyses might be more limited.

An alternative approach would be to use the same type of process but ask the Councils and science centers to identify the gaps they perceive to exist in terms of understanding the marine ecosystem with respect to fishery management. They would develop a needs assessment and a prioritized list to carry to the Workshop].

Importantly, the Council preparations for this needs assessment and prioritization the NOAA/expert preparation should be done as independently as possible. This is because a major task of the workshop would be to compare, region by region, the similarities and differences between the policy-management and the science/expert communities, with regard to perceptions of successes and the less-than-successes in management of fisheries in each region, and in their perceived reasons for each. Both groups should be provided with a comprehensively long list of ALL the things that might be part of EBFM – ecological, social, and economic.

Where Councils and science experts agree on what is a success and why it is a success, and what is not a success and why it is not a success, no further needs assessment is really needed. The task is clearly is to keep doing that which is contributing to the successes, and work together on what both agree are the factors impeding successes. Only in the cases when there are differences in views on what is and is not a success or lack of success in management, and particularly in why the successes and lack of successes are occurring, or in what can be done about the latter, is there a need for a more in-depth assessment of what is really needed.

Challenges

The benefits from implementations of these recommendations are a better focus of NOAAs resources on the parts of EBFM that clients/ stakeholders are prepared to use and on parts of EBFM that will address the greatest challenges to sustainability in each Council region. There remain major challenges requiring serious and strategic attention to EBFM (in sensu Borja 2014). We have addressed them only tangentially in this report.

•How can we demonstrate the results of EBFM are making a difference in fisheries management and protection of marine diversity? Can these be compared across ecosystems? [The Comparative Analysis of Marine Ecosystem Organization (CAMEO) program, for example, showed the promise and value of efforts to answer this question.

•Can we actively manage for different ecosystem objectives, e.g., maximum economic yield as opposed to maximum sustainable yield and achieve better results using EBFM?

•To what extent is climate change/ocean acidification an ecosystem game changer for fisheries and their management? Fished ecosystems appear to be undergoing remarkable change, e.g., Gulf of Maine, Gulf of Mexico, California Current, Bering Sea and Arctic Ocean. Can we predict how they will continue to change?

•How can historic ecosystem state be used to inform fishery management by Council regions – or is this the right question to ask given climate change?

Marine ecosystems of the United States are important for fisheries and other ecosystem services. EBFM is one component of ocean management for which there is a significant but still not sufficient annual commitment of funding for monitoring and assessment at the ecosystem scale. The necessity of NMFS to partner with other NOAA line offices and other agencies to provide the nation with ecosystem sciences (natural and social) for decision-making is only going to increase. NOAA is moving toward an overall Ecosystem-Based Management approach across the agency; however continued and well-targeted efforts in fisheries are necessarily a part of that effort.

PURPOSE

The purpose of this report is to assess the progress toward implementation of Ecosystem-Based Fishery Management (EBFM) in United States (US) fisheries during the **intervening decade and a half** since Congress first required review of this topic in the 1996 reauthorization of the Fisheries Conservation and Management Act (FCMA) 1976 [Sustainable Fisheries Act 1996This exploration seeks to: 1) determine the adequacy of ecosystem science in providing advice on management of marine fish in the US; 2) examine the use of ecosystem science in management decisions by fisheries management councils in the US; and 3) document management measures to implement EBFM in federal fisheries of the Exclusive Economic Zone of the US. In many respects this review parallels that performed by NOAA Fisheries at the request of Congress (Magnuson-Stevens Act 2007 section 406(f) which resulted in the report on "The State of Science to Support an Ecosystem Approach to Regional Fishery Management (NMFS 2009) www.nmfs.noaa.gov/msa2007/docs/tm_96_repto_congress_final.pdf) . As an independent scientific review body, the NOAA Science Advisory Board (SAB), through its Ecosystem Sciences and Management Working Group, provides external expertise to complement that contained within NOAA line offices.

PROCESS

At the request of the National Oceanic and Atmospheric Administration's Science Advisory Board, the Ecosystem Sciences and Management Working Group undertook this review in early 2012. No formal terms of reference for this report were specified. Its scope and coverage have evolved through dialogue with NOAA principal participants and the ESMWG to become the assessment outlined above.

After a subcommittee of the ESMWG was constituted there was a request (via email, March 15, 2012) from NOAA Line Office liaisons indicating that risk and uncertainty in decision making for fisheries management would be of interest as well. Discussion of this proposal determined that this task requires more time and detailed work. The ESMWG decided to undertake risk and uncertainty as a separate task to follow this report at a later date. In the meantime, we call attention to other recent efforts to address this topic (e.g., Fisheries Leadership & Sustainability Forum 2012, 2013; Gaichas et al. 2010; Link et al. 2012, Cormier et al. 2013) and makes use of these sources partially to address risk and uncertainty in this report.

ACKNOWLEDGEMENTS

A subcommittee of the ESMWG led this activity. It is composed of Victor Adamowicz, Mike Beck, Tim Essington, David Fluharty (chair), Jo-Ann Leong, Jake Rice and Jim Sanchirico. Mary Anne Whitcomb assisted in the editing and formatting of the report as well as keeping impeccable notes on subcommittee meetings. Tara Dolan and Tony Marshak have assisted in completing research for the report. Peter Kareiva serves as liaison to the NOAA SAB. Scott Jackson, School of Marine Affairs, University of Washington provided research assistance. The EBFM implementation process is a dynamic one and every effort has been made to make the evaluations and content of this report current to June 2014.]

BACKGROUND

In 1996 Congress asked NMFS to report on the use of ecosystem principles in fisheries management in the Magnuson-Stevens FCMA reauthorization. This resulted in a 1999 report to Congress by a panel of scientists and

managers engaged to advise NMFS on its response (Ecosystem Principles Advisory Panel 1999; see also National Research Council 1999). Although the Congressional "mandate" is focused on fisheries it allows consideration of the full interactions of fisheries management in an ecosystem context. Following that report there has been a large increase in the number of EBFM books and articles in peer review and agency literature as well as considerable experimentation at the regional fishery management level to implement EBFM (e.g., Alaska Sea Grant 1999; Ward et al. 2002; Walters and Martell 2004; McLaughlin (Ed.) 2008; McLeod and Leslie (Eds.) 2009; Holland et al. 2010; Link 2010; Christensen and Maclean (Eds.) 2011); Belgrano and Fowler (Eds.) 2011; Fogarty and McCarthy (Eds.) 2014; Fogarty 2014) . The International Council for Exploration of the Seas (ICES) (2000) convened conferences and advisory committees and the Food and Agriculture Organization (FAO) convened expert and technical consultations to provide guidance for implementation of EBFM or Ecosystem Approach to Fisheries (EAF) (FAO 2003 updated 2009).

Of particular relevance to EBFM in the United States are draft guidelines for EBFM prepared under the auspices of the Marine Fisheries Advisory Council (Busch et al. 2003), the Chesapeake Bay Fisheries Ecosystem Plan (NOAA Chesapeake Bay Office 2003; Chesapeake Bay Ecosystem Advisory Committee 2006) developed by NOAA's Chesapeake Bay Office and a later exploration of EBFM by Holliday and Gautam (Eds.) (2005) In addition, groups of academic scientists, practitioners and environmental non-governmental organization have convened to generate discussion and develop consensus statements on EBFM or broader Ecosystem Based Management (e.g., Pikitch et al. 2004, COMPASS 2005).

NOAA Fisheries defines EBFM in the following manner: "Ecosystem-based fishery management recognizes the physical, biological, economic and social interactions among the affected components of the ecosystem and attempts to manage fisheries to achieve a stipulated spectrum of societal goals, some of which may be in competition" (Osgood 2013).

Absent a clear Congressional mandate, e.g., a requirement to adopt EBFM as an approach in fishery management plans, fishery science center and regional fishery management councils have made a number of efforts to explore what EBFM might mean in the fishery management context. The Magnuson Stevens Fishery Management Conservation Act (referred to in this document as the Magnuson-Stevens Act or MSA) allows fishery managers to consider ecosystems in setting management objectives. National Standard 1 requires conservation and management measures to "prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery" (Sec 301(a) (1). The "optimum" yield is defined as providing "the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems" Sec 3(28)(A). Moreover, the optimum yield is prescribed as "the maximum sustainable yield from each fishery, as reduced by any relevant economic, social or ecological factor" 3(28) (B). In addition, the Act states as one of its purposes "to promote the protection of essential fish habitat" (Sec. 2(b) (7). It was the Sustainable Fisheries Act (SFA) that required this report to Congress (EPAP 1999).

By far the most direct language for EBFM is in implementation of the Essential Fish Habitat (EFH) requirements of the Sustainable Fisheries Act 1996. Councils were required to amend fishery management plans to protect habitats on which fish depend, to minimize impacts of fishing on habitat, and to protect habitat areas of particular concern (MSA Section 3(10). This has focused attention on habitat protection by regional fishery management councils and has resulted in significant habitat protections in many council areas. EFH is expected to be reviewed and adapted on a regular cycle by regional fishery management councils as scientific information increases (Rosenberg et al. 2000, Rosenberg and McLeod 2005). The 2006 Magnuson-Stevens Act made it clear that fishery management councils could "include management measures… to conserve target and non-target species and

habitats, considering the variety of ecological factors affecting fishery populations" in fishery management plans (MSA Section 303(b)12). Finally, Councils have implemented and are in the process of implementing actions consistent with an EBFM approach as outlined in the Ecosystem Principles Advisory Panel report (1999).

Requirements of the Magnuson Stevens Act and other US legislation encourage the Councils to use ecosystem science in decision making. The obligation to use Best Available Scientific Information (BASI) in management, for example, makes it a requirement to consider ecosystem science in management decisions (NRC 2006) although some "available" science may not be good enough to serve as a basis for management decisions, and some desired ecosystem science may not be "available". Management obligations under the National Environmental Policy Act 1969 call for use of ecosystem information, in particular, with respect to preparation of environmental impact statements and addressing cumulative effects of management actions. In addition, the Marine Mammal Protection Act and the Endangered Species Act require investment in scientific understanding of other non-fish species and management actions that result in decisions by fishery management councils that take into account a broad range of species and their ecosystem relationships (Environmental Law Institute (ELI) 2007). The sum total of actions taken under this complex set of laws and regulations allows fishery management in the US to move in the in the direction of EBFM in an incremental fashion, i.e., evolution versus revolution in fishery management (Berkes 2011).

Since 1996, the policy discourse on ecosystem-based marine management has expanded in scope from EBFM largely through Presidential and other high level processes. In 2000, President Clinton issued an Executive Order 13158 for all federal agencies to work within their jurisdictional authorities and to cooperate in the development of Marine Protected Area Networks. The US Commission on Ocean Policy 2004 (USCOP 2004) and the parallel Pew Oceans Commission (2003), among other recommendations, advised the development of Ecosystem-Based Management of the oceans and Great Lakes. In response, President Bush established the White House Committee on Ocean Policy in 2004. In addition, NOAA undertook to develop a cross-cutting approach to develop a key part of the scientific underpinnings for Ecosystem-Based Management (EBM) through Integrated Ecosystem Assessments (IEA) (NOAA 2006, Levin et al. 2009). Most recently, President Obama issued Executive Order 13547 (2009) regarding "Stewardship of the Ocean, Our Coasts, and the Great Lakes" which has been termed the first National Ocean Policy, and in which EBM is a fundamental component. It establishes a National Ocean Council to direct the preparation of regional marine spatial plans among other responsibilities. The National Ocean Council has developed a National Ocean Policy Implementation Plan (NOC 2013a) and Marine Planning Handbook (NOC 2013b). Finally, there is a marked change in the discourse about how ocean ecosystem services are valued with a distinct shift from a dominant interest in provisioning services to other ecosystem services (See for example, Tallis et al. 2012, Guerry et al. 2012, and Plantier-Santos, Carollo and Yoskowitz 2012). Part of this shift in discourse affirms that humans are part of the ecosystem. However, the extent to which fisheries management recognizes itself as a socio-ecological system appears limited. A systematic approach where social sciences are as highly valued as biological and ecological sciences and integrated with them is only starting to emerge (Berkes and Folke 2003, FAO 2009).

At this juncture, it is useful to assess how far EBFM has served to advance use of ecosystem science in fishery management as tool and a pathway to broader Ecosystem-Based Management in the future. The ESMWG envisions this report as a down payment on further exploration of how NOAA can engage more broadly with EBM (Hennessey and Sutinen 2005). Ideally a report such as this should focus on outcomes of the actions taken, however, with lack of agreement on objectives and or clear statement of objectives this task would be futile. In addition, laying aside issues of causality (Sugihara et al. 2012) further work is needed to gain expert consensus on baselines, metrics and methods for broad measures of changes in ecosystem structure and functioning. This lack

of consensus has been perpetuated, and probably amplified, by a combination of failure to acknowledge true regional differences in what matters to sustainability of fisheries (viewing sustainability in an ecosystem context), and strong preconceptions by many key players in the dialogue regarding what processes have to be present in an ecosystem approach to fisheries policy and management. The frequent failure to undertake strong retrospective performance evaluations of increasingly complex ecosystem-inclusive assessment and management models may be a greater deterrent to progress on EBM than any lack of metrics, methods and tools that might be applied. These retrospective studies would examine the degree to which Council decisions might have been different had specific types of ecosystem information been available to inform a series of decisions, and, importantly if using the ecosystem information systematically would have consistently resulted in improved management decisions. Such retrospective examination of model use would be particularly valuable if it explored how well ecosystem information could have reduced risk on all dimensions of sustainability not just the environmental sustainability. The most promising and innovative scientific program that encompassed these concepts was the innovative Comparative Analysis of Marine Ecosystem Organization (CAMEO) program sponsored briefly by the National Science Foundation and the National Marine Fisheries Service. The approach followed below consists of qualitative evaluation of input measures associated with regional fishery management council actions. Each action, in and of itself does not constitute EBFM but the composite of such measures defines management direction toward a broader consideration of ecosystem functioning in decision making. Clearly, the development of a Fishery Ecosystem Plan or a Fishery Management Plan accomplishes much more than a bycatch reduction measure by itself unless the problem of bycatch is pervasive in the ecosystem.

APPROACH TO ASSESSMENT OF EBFM

Key Question: *The question is how much progress has been made in ecosystem sciences and their application in fisheries management in the United States management regions between 1996 and 2014?*

In order to answer this question, the ESMWG divided the task into two parts. First, we asked "What actions have been taken by council regions to implement and EBFM approach?" This is termed SECTION I of the Report. Second, we asked, "What is the state of science to support an ecosystem-based approach to fishery management? This is termed SECTION II of the Report. The latter question was split into two parts. 1. What is the state of regional EBFM science for fisheries management? and2. How is the regional fishery management council using EFBM science in management? (Are Councils getting the science they need for management?). To obtain regional perspectives on these questions we invited representatives of regional fishery science centers and regional fishery management councils to make presentations over the course of Ecosystem Sciences and Management Working Group meetings. We posed a set of questions to presenters from the fishery management regions on the adequacy of ecosystem science to provide advice (Appendix A). The ESMWG received a series of presentations as noted in Table 1. [Presentations are available on ESMWG website http://www.sab.noaa.gov/Working_Groups/membersonly/ecosystem/index.htm

. In addition, the ESMWG built off of presentations made at earlier meetings (see Table 1 below).

TABLE 1. INVITED PRESENTATIONS
Mike Fogarty, New England Fisheries Science Center*
Roger Pugliese, South Atlantic Fisheries Science Center*
Kerim Aydin, Alaska Fisheries Science Center
John Boreman, Mid-Atlantic Fishery Management Council*
Diana Evans, North Pacific Fisheries Management Council
Yvonne deReynier, Pacific Fisheries Management Council*
Jake Rice, Chief Scientist, Department of Fisheries and Oceans, Canada*
Eric Kingma, [for Paul Dalzell], West Pacific Fisheries Management Council*

*Most presenters provided observations spanning science and management for a given region. (The ESMWG was not able to invite presentations from all Council regions and all Fisheries Science Centers. It therefore it used its limited resources to obtain as representative a sample geographically as possible. We appreciate the willingness of all who contributed to this enterprise.)

SECTION I. MANAGEMENT ACTIONS TO ASSESS PROGRESS TOWARD EBFM IN REGIONAL COUNCILS

To identify progress toward implementation of EBFM through council actions, a simple framework was developed to organize information from each of the eight fisheries management regions to record management actions being implemented in ways that move regional fisheries management toward ecosystem-based management Table 2 (Appendix B). In developing the framework we examined a wide range of EBM and EBFM literature to select appropriate "actions" that could be identified as moving fishery management toward an ecosystem-based approach (Arkema et al. 2010, Grieve and Short 2010, Link 2002, Ward et al. 2002, EPAP 1999, Fluharty 2010, Witherell (Ed.) 2005). The starting point for this review framework is the advice from the Ecosystem Principles Advisory Panel (EPAP) (1999) because it was directly intended to outline an incremental approach to developing EBFM within the US regional fishery science and management context. In that framework, EBFM is a coupled social-ecological system where humans are a key component. EBFM is described as a process that moves from traditional fisheries management toward a broader consideration of ecosystem and socio-economic consideration of management. Progress toward EBFM is seen in actions taken by Councils based on scientific advice about the fishery and ecosystem trends as well as socio-economic information. There is significant overlap between the EPAP (1999) advice and that from other efforts cited above, however a few other actions were added to the framework to capture actions being taken in practice but not necessarily identified by EPAP.

One significant component of the EBFM is stakeholder engagement in the fishery management process. EBFM depends on effective public involvement (deReynier, Levin and Shoji 2009); however, the ESMWG chose not to explore this element in part because it would vastly expand the scope of this report and in part because in the US Council process stakeholder engagement in fisheries is not widely studied.

TABLE 2. MANAGEMENT ACTIONS TO ASSESS PROGRESS TOWARD EBFM IN REGIONAL COUNCILS

1. Cease overfishing and develop rebuilding plans for overfished species. [A-B]
2. Delineate extent of ecosystem/interactions. [B-C]
3. Develop a conceptual model of the foodweb [B-C]
4. Describe habitat needs of different life history stages of animals and plants in the "significant foodweb" and develop conservation measures [A-B-C]
5. Calculate total removals – including incidental mortality and relate them to standing biomass, production, optimum yields, natural mortality and trophic structure [A-B]
6. Assess how uncertainty is characterized and define what buffers against uncertainty are included in management actions [B-C]
7. A. Set ecosystem goal[s] [A] B. Develop indices of ecosystem health as targets for management? [B]
8. Describe long term monitoring data and how they are used. [B-C]
9. Assess the ecological, human and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/NMFS jurisdiction and define a strategy to address those influences. [B-C-H]
10. Is there a Fishery Ecosystem Plan/ Fishery Management Plan employing EBFM? [A-B]
11. Does the Council have a lead entity designated to advance EBFM in the Council process? [A]
12. Are ecosystem models developed and available for use in the Council process? [B-C]
13. Are decision support tools for EBFM / trade-off analysis employed [e.g., management strategy evaluation, risk assessments, ecosystem indicators, and scenarios]? [B-C-H]
14. To what extent are spatial management tools applied (besides Essential Fish Habitat measures above) to accomplish EBFM? [A-B]
15. Other – Unique actions furthering EBFM [B-C-H]
Based on review of (EPAP 1999) and other literature evaluating EBFM definition and implementation. Note it may be useful to identify the various aspects of EBFM addressed by each management action. Therefore we have supplied our categorization based on the legend below: A= action; B=biological; C=concept and H=human dimension.

While we have selected 15 types of actions in a broad sense, e.g., use of a concept or a biological measure, that contribute to implementation of EBFM, there are a number of issues raised. First, this is obviously not an exhaustive list and it is not a "perfect" list. We deem the list indicative of some of the common actions that Councils might take to implement EBFM. Second, such a list invites one to think that there is some "magic" list of actions that constitute EBFM. EBFM, however, can take on many forms and processes. The type of action that advances EBFM in one Council region may be of little benefit in another region. In the PFMC region, for example, environmental drivers are known to strongly influence productivity, recruitment and growth for some species. In another region, like the Caribbean, environmental forcing is not so prominent. Thus, one would expect to see different levels of research or management effort devoted to obtaining and using scientific information on environmental variability among council regions. Similar considerations exist for size and value of fish stocks, predator/prey interactions, role of forage, etc. Third, **EBFM is a moving target** with actions being taken over time. This review presents a snapshot as of June 2014. It does not distinguish among actions taken by a Council many years prior to the present and those taken recently. Fourth, given the dynamics of marine ecosystems**, EBFM must accommodate a constantly changing context in which management occurs.** Fifth, not all of these actions are equally important. One prominent fishery scientist has advised, "The most important elements of EBFM are keeping fishing mortality rates low enough to prevent ecosystem-wide overfishing, reducing or eliminating by-catch and avoiding habitat-destroying fishing methods" which he regards as the core issues (Hilborn 2011, p.235). Beyond the core issues, management of trophic interactions and area-based management which are based largely on models is being implemented in some areas but Hilborn (2011) asks if we are prepared scientifically and administratively to implement these approaches because they are high cost and involve trade-offs among goals and objectives that are not clearly defined. This is the context in which this report is directed and to which recommendations are made.

Given the previous discussion, it is fair to ask when can a Council be considered to have crossed over the threshold from traditional fishery management to EBFM. This is an issue that has been debated along four principal lines. 1. If a Council commits to taking any one or several of the actions listed above, it is eligible to be said to have implemented EBFM with respect to those actions. 2. If a Council can be seen to be fully implementing all of the [perhaps arbitrarily defined or other similar] actions it deserves to be considered as implementing EBFM. 3. If there are detectable effects of fisheries on the marine ecosystem it cannot be considered to be consistent with EBFM. 4. If a Council uses ecosystem science in a consistent and iterative manner to address the "core" elements identified by Hilborn (2011) then it is eligible to be termed EBFM. The ESMWG can only identify but not resolve this debate. For the purposes of this evaluation we are most consistent with the Hilborn (2011) approach. The ESMWG sees this type of review as an initial step in identifying general recommendations for NOAA Fisheries to ensure the kinds of social and ecosystem science are being delivered as needed in the fishery management process given management mandates, limited human and financial resources, complex ecosystems and complicated socio-economic environments.

A simple qualitative approach to assess the level of actions implemented at the fishery management council level was constructed as shown in Table 3. This approach was applied to each Council region by one member of the ESMWG EBFM subcommittee for the sake of consistency. The assessments were reviewed by at least one other member of the subcommittee and sent for ground-truthing to the Council region to ensure validity in late March 2014.

TABLE 3. DEFINITION OF QUALITATIVE RATING SYSTEM FOR COUNCIL ACTIONS IMPLEMENTING EBFM

Action	**Assessment Rating**
Cease overfishing and develop rebuilding plans for overfished species	Overfishing stopped and rebuilding plans in place [stocks may not be rebuilt] Overfishing for some species still occurring – rebuilding plans in place Overfishing and rebuilding plans not in place Not being addressed
Delineate extent of ecosystem/interactions	Formal recognition by regional action Consideration given but not formal Under discussion Not under discussion
Develop a conceptual model of the foodweb	One or more conceptual foodweb model is available and their use evaluated in decision-making for stock assessments and other management decisions Consideration given but incomplete and /or ad hoc Under discussion Not under discussion
Describe habitat needs of different life history stages of animals and plants in the "significant foodweb" and develop conservation measures.	Full implementation of EFH Limited implementation of EFH Not used because MSA requirements constitute baseline, i.e., they require that EFH is implemented according to national standards. EFH implementation is, thus, not a choice.

Calculate total removals-including incidental mortality and relate to standing biomass, production, optimum yields, natural mortality and trophic structure	Full implementation of MSA requirements with good estimates of all significant sources of incidental mortality, etc. Implementation of MSA requirements but incidental mortality insufficiently accounted for. Not used – compliance with MSA required
Does council assess how uncertainty is characterized and define what buffers against uncertainty are included in management actions?	Full accounting of uncertainty /use of risk based assessments Partial accounting of uncertainty /ad hoc use of risk based assessments Discussion of uncertainty and risk No discernible progress in this area
A. Has council set an ecosystem goal (s) and B. Developed indices of ecosystem health as targets for management?	Clearly articulated set of ecosystem goals that quantitatively or qualitatively describe desired ecological, economic and social outcomes of management. Conceptual descriptive (qualitative) ecosystem goals set for ecological, economic and social outcomes. Conceptual descriptive goals set for some outcomes of management No goals set Indicators selected for all three types of goals and quantitative benchmarks and the indicators have been identified and applied. Indicators selected for all three types of goals, but quantitative reference points consistent with the goals not identified. Goals articulated but indices not defined as targets Ecosystem goals and indices not under discussion

Describe long-term monitoring data and how they are used	Region developed monitoring plan relative to EBFM can be identified and reported on a regular basis Regional monitoring plan for fisheries but not necessarily ecosystem based fishery Regional monitoring plan under discussion Not under discussion
Assess the ecological, human and institutional elements of the ecosystem which most significantly affect the fisheries, and are OUTSIDE Council/NMFS jurisdiction and define a strategy to address those influences	Proactive plan with respect to outside impacts, taking account of all major known exogenous drivers of fisheries performance No plan but region is responsive to threats as they arise Region discusses but has limited engagement with outside influences Limited or no response to external influences
Is there a Fishery Ecosystem Plan (FEP)/Fishery Management Plan (FMP) employing EBFM?	FEP or comprehensive FMP using EBFM appropriately for the relevant ecosystem FEP or FMP covering significant portions and or management actions for the relevant ecosystem (less comprehensive than above) Discussion of FEP or FMP for relevant ecosystem No discussion of FEP or FMP for relevant ecosystem
Does the Council have a lead entity designated to advance EBFM in the Council process?	Yes, a focal point and process for developing EBFM actions for Council consideration Mostly follows Council direction as a whole Being developed No lead entity and limited or no discussion

Are ecosystem models developed and available for use in the Council process?	Models of appropriate complexity are available and in use Models available but not systematically in use Use of models is under discussion/development No discussion or use of models
Are decision support tools for EBFM/trade-off analysis employed (e.g., management strategy evaluation risk assessments, ecosystem indicators, scenarios)?	All significant uses of ecosystem considerations in management are informed by appropriate decision-support tools Some of the considerations are informed by appropriate decision-support tools A few considerations are informed by decision-support tools or are under discussion No discussion and no use of formal tools
To what extent are spatial management tools applied (besides EFH measures above) to accomplish EBFM?	Significant spatial management tools applied as well as EFH where appropriate Some spatial management tools applied as well as EFH Spatial management tools discussed and under development Not under discussion

Is there a Fishery Ecosystem Plan (FEP)/Fishery Management Plan (FMP) employing EBFM?	FEP or comprehensive FMP using EBFM appropriately for the relevant ecosystem FEP or FMP covering significant portions and or management actions for the relevant ecosystem (less comprehensive than above) Discussion of FEP or FMP for relevant ecosystem No discussion of FEP or FMP for relevant ecosystem or because it is not appropriate

Does the Council have a lead entity designated to advance EBFM in the Council process?	Yes, a focal point and process for developing EBFM actions for Council consideration Mostly follows Council direction as a whole Being developed No lead entity and limited or no discussion
Are ecosystem models developed and available for use in the Council process?	Models of appropriate complexity are available and in use Models available but not systematically in use Use of models is under discussion/development No discussion or use of models
Are decision support tools for EBFM/trade-off analysis employed (e.g., management strategy evaluation risk assessments, ecosystem indicators, scenarios)?	All significant uses of ecosystem considerations in management are informed by appropriate decision-support tools Some of the considerations are informed by appropriate decision-support tools A few considerations are informed by decision-support tools or are under discussion No discussion and no use of formal tools
To what extent are spatial management tools applied (besides EFH measures above) to accomplish EBFM?	Significant spatial management tools applied as well as EFH where appropriate Some spatial management tools applied as well as EFH Spatial management tools discussed and under development Not under discussion
Other	Verbal description

Besides the information from the presentations, the inventory of each council's activity was made via examination of its website and other documents. Further, the proceedings of three national level meetings where councils self-reported activity with respect to ecosystem-based management offer insights into the progress (Witherell

2004, 2005; and 2013 www.managingfisheries.org). In addition, the 2011 meeting of regional fishery management council Scientific and Statistical Committees focused on ecosystem considerations at each council (Seagraves and Collins 2012). Finally, extensive review of scientific papers and academic literature on US fisheries management has been made. Detailed results of this research using multiple sources are recorded for each council region in Appendix D and displayed in summary form in Table 4.

It is worthwhile noting according to a global review of EBFM, using multiple criteria, the United States is ranked fifth in overall implementation of EBFM among 33 of the major fishing nations studied (Pitcher et al. 2009). Similarly a review of 53 countries also showed the United States as a whole in ranking among the top fishing countries in terms of aggregate performance in managing marine ecosystems (Arkema et al. 2010). However there remains considerable room for improvement of management.

PROGRESS TOWARD EBFM IN FISHERIES MANAGEMENT REGIONS

Here we summarize the progress across the various actions councils are implementing to obtain an understanding of the level of implementation of such measures. Details for the judgments are available in Appendix D. The results of this review are presented in the aggregate for each action category followed by a regional composite describing the trajectory of each Council region in terms of adopting actions to implement EBFM. The role of NOAA headquarters in leading and coordinating the development of EBFM is provided. Finally, NOAA Fisheries international engagement in regional fisheries management organizations (RFMOs) is reviewed with respect to promoting EBFM science and management.

- **Cease overfishing and develop rebuilding plans for overfished species.** Councils have made significant progress in ending overfishing and developing rebuilding plans [16 U.S.C. 1851 and 16 U.S.C. 1854(e)]. For some long-lived species, life history parameters may ensure that these species will take years to change from a condition defined as overfished despite not being fished. In 2012, Annual Catch Limits (ACLs) were in place for all major target fisheries, assuring a scientifically consistent management basis for these stocks. Stock assessments are required to be developed for stocks of previously unknown status, and without assessments, the portion of these that are overfished is unknown. Although many stocks are in some stage of being rebuilt (NMFS 2012), overfished stocks, whether assessed or unassessed, indicate ecosystem components that are presently in low abundance compared with the levels expected from a sustainably managed stock. This could have impacts on ecosystem community structure and function depending on the extent of functional redundancy (or "portfolio effect") (Rosenfeld 2002, Figge 2004) in the system. The number and current status of overfished stocks could contribute to assessments of ecosystem health. In fact, some urge that ecosystem-based management requires a solid understanding of the historical baselines of marine ecosystems in order to fully understand the ecological implications of their current status (Field and Francis 2006, FAO 2003 and 2009, McClenachan et al. 2012). However, EBFM requires more than "understanding" the historic patterns of stock dynamics. It is how that information is used in management (which usually has to be more than just choosing some historical average and using it as a benchmark) than makes EBFM meaningful. Historical contexts need to be used in the light of current policy goals.

- **Delineate extent of ecosystem/interactions.** Councils should strive to manage fisheries to ecosystem scales appropriate for a particular fishery, and these scales will differ for sedentary species (e.g., New England scallops, some species of Pacific rockfish), strongly migratory species (e.g., Pacific whiting and Pacific sardine, etc). However, often Council management boundaries are defined by EEZ or geopolitical borders that may not coincide with either functional ecosystem such as Large Marine Ecosystem (LME) (Hempel and Sherman Eds. 2003) or population boundaries. The operational feasibility of administratively defined regions for management can compensate somewhat for such shortcomings.

However, this requires that Councils try to match management scales to ecosystem scales appropriately. We observed that fishery management councils are increasingly recognizing the need for explicit management measures that are sub regional and place-based as seen in New England, South Atlantic, West Coast and North Pacific fisheries management plans. The Western Pacific Council is extensively revising its fishery management plan approach to conform to the archipelagic nature of its fishery ecosystems. The Caribbean Council is particularly challenged to work at appropriate scales due to the number of stocks with internationally shared jurisdiction. Correspondingly the Caribbean Council may be moving more swiftly than other councils to forge arrangements with other nations for fishery management across ecosystem boundaries.

- **Develop a conceptual model of the foodweb**. Nearly all councils have received scientific advice with respect to a conceptual model of the foodweb. The nature of that advice and how it is used in management decision-making is highly variable as best we can tell. Some councils incorporate foodweb relationships into setting of ACLs explicitly or implicitly while others treat the information as a description of the way the ecosystem functions but do not actively make decisions on the basis of foodweb relationships. Moreover, much ecological work suggests that these foodweb relationships would contribute varying amounts of information to sustainable management of different stocks. There is not yet systematic guidance on when variation in food webs should be a major factor in setting Annual Catch Limits (ACLs) and when accounting for such variation would be unlikely to improve estimates of ACLs.

- **Describe habitat needs of different life history stages of animals and plants in the "significant foodweb" and develop conservation measures.** The mandated implementation of the Essential Fish Habitat (EFH) [16 U.S.C. 1853(a)(7)] requirements by Council amendments to their fishery management plans ensures that life history requirements of managed fish species are documented but not those of other fish species and not plants or other components of the foodweb. Regional management councils have designated EFH for more than 1000 managed species; have identified and protected more that 100 habitat areas of particular concern, which has resulted in more than 700 million acres of EFH being protected from damaging effects of fishing. Consultations with other agencies on non-fishing effects on EFH number in the thousands. (Managing Our Nations Fisheries III 2013). Despite these impressive results, EFH applies only to a limited aspect of habitat protection in an ecosystem context because of its focus on managed fish species. In cases where there is a documented dependence of harvested stocks on ecosystem components or where fishing is documented to have detrimental effects on biogenic or other habitat, the associated EFH of these should be a fisheries consideration. This is a significant achievement in and of itself. As scientific understanding increases about fishery habitats, a regular adaptive management cycle requires reassessment of additional EFH every five years. As long as EFH retains its fisheries centric orientation, these EFH reassessments may not capture other aspects of habitats and marine biodiversity. Nevertheless, the reassessments offer a process for dealing with many of the rough edges of fisheries impacts on habitat and the requirements certainly have resulted in protection of significant areas of vulnerable habitats. (Note that NMFS also administers the Marine Mammal Protection Act and the Endangered Species Act where other species and their habitats are considered. Seabirds are also taken into consideration. Some Council Fishery Management Plans (FMPs), like the SAFMC plan for Sargassum or the WPFMC FMP incorporating coral take other ecosystem components into consideration. The extent to which other activities beyond fishery management jurisdiction are taken into account is discussed below].

- **Calculate total removals – including incidental mortality and relate removals to standing biomass, production, optimum yields, natural mortality and trophic structure.** Many Councils attempt to calculate total removals by effective reporting and monitoring and relate them to trophic status. The ACLs used by the fishery management councils focus on optimum yields, taking into account recruitment variation and natural mortalities. Whether these alone are adequate to constrain total removals from a system is not known. However in cases where all piscivorous top predators are being fully harvested, top down control, and when it occurs, stabilization, of ecosystem dynamics may be weakened and possibly

jeopardized, even when all species-level exploitation rates are individually sustainable. The bycatch requirement [16 U.S.C. 1853(a) (11)] of the MSA to count and minimize bycatch has increased Council attention to this matter but few Councils have comprehensive measures to implement this provision. The NPFMC uniquely has established caps on total "removals" by fisheries in the Gulf of Alaska and the Bering Sea which for approximately three decades has constrained fish harvests to ecologically determined maximum levels. This cap has generally been a constraint on fish harvests but it has been held constant over large changes in natural mortality and stock structure over that period. This has resulted in generally conservative TACs or ACLs but this practice may forego sustainable yield and not tightly track changes in natural mortality and trophic structure but it is thought to contribute to long term sustainable yield and to maintain resilience in the fished ecosystem.

- **Does council assess how uncertainty is characterized and define what buffers against uncertainty are included in management actions?** The primary area where risk and uncertainty is quantified is in the stock assessment science and almost always only with regard to the harvested stocks and possibly a few key related species or habitats. There is very little systematic input on risk and uncertainty in the human aspects of EFFM. Given the amount of information provided on uncertainty and risk, the chief variation in its use in decision-making across councils is in the treatment of data poor vs. data rich stocks (FLSF 2013). Some Councils are promoting Management Strategy Evaluations to deal with uncertainty more explicitly and systematically, but usually for single stocks or single fisheries. With regard to uncertainty across fisheries in the broader socio-ecological system, Councils have not adopted systematic approaches to take this into account except for the NPFMC. Rather, Councils seem to take socio-ecological uncertainty into account but in ad hoc and not systematic ways (Cormier et al. 2013).

- **Has council set an ecosystem goal[s] and developed indices of ecosystem health as targets for management?** The Western Pacific, South Atlantic, Pacific and North Pacific Councils have set ecosystem goals and some have developed indicators of ecosystem status, e.g., North Pacific Bering Sea Ecosystem Report Card, Pacific Council California Current Status Report. These goals are quite variable both with regard to their specificity, from little more than high level platitudes to specific states for specific ecosystem components and with regard to the parts of the ecosystem covered. It does not appear that any Council has set indices of "ecosystem health" as targets although in some of the cases where management strategy evaluation has been used. Ecosystem models and MSEs can provide indicators for ecosystem components other than the target species, and if overarching policy goals are provided for how ecological, economic and social outcomes are to be balanced, they can operationalize those goals through identifying corresponding benchmarks on those indicators, e.g., in the North Pacific council region.

- **Describe long term monitoring data and how they are used.** In fishery management periodic survey data on fish populations are collected. Depending on the survey design, gear and instrumentation these can include other biological or physical oceanographic parameters. However, these efforts represent just a snapshot in time for biological surveys – usually the distribution of the main species taken in the survey gear during a time of year when conditions for surveys are favorable. Which information is needed for effective EBFM will vary regionally and among stocks within a region. In the Pacific, North Pacific and West Pacific council regions, information on state of the El Nino Southern Oscillation and the Pacific Decadal Oscillation is critical. Regional councils are key consumers of products based on data and results from physical oceanographic monitoring and therefore are highly dependent on the ocean monitoring agencies for key inputs of information. We are not able to assess the adequacy of these data and their use given our limited study. We have found strong linkages between fisheries science centers and NOAA and other partners and especially within the relevant regional integrated ocean observing system (IOOS) entities in their region.

- **Assess the ecological, human and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/NMFS jurisdiction and define a strategy to address those influences.** As mentioned earlier, the SFA 1996 gave Councils/NMFS the opportunity to consult with

other agencies and entities about proposed actions affecting EFH. Other agencies (US FWS, US Army Corps, EPA, etc.) are required to engage with NMFS when proposing new activities (Fluharty 2000). The fact is that fisheries [except for Endangered Species] have had variable levels of success in affecting decisions by other agencies or industries, e.g., offshore energy development or when fisheries are only one of the multiple parties at the table. One of the current challenges for fishery management is on how to engage in broader marine spatial planning under the new National Ocean Policy when fisheries are just one set of interests at the table. In all cases fishery management councils are players in the regional arrangements for region-wide discussions and planning, e.g., Governors' Alliances and regional Forums.

- **Is there a Fishery Ecosystem Plan/ Fishery Management Plan employing EBFM?** Regional fishery management councils have taken several pathways with respect to this indicator. The South Atlantic and the West Pacific Councils have amended their Fishery Management Plans to incorporate EBFM. The North Pacific has developed a Fishery Ecosystem Plan (FEP) for the Aleutian Islands because of the high priority to better understand that archipelago and its fisheries relative to the Bering Sea and in part to the Gulf of Alaska. It has also included EBFM as a core part of FMP amendments for the revision of its Groundfish FMP and in its development of reasonable and prudent alternatives for Endangered Species protection, e.g., Steller sea lion, Steller's eider, etc. The Pacific Council has adopted a FEP for the California Current area under its jurisdiction. Similarly, the NEFMC has agreed to pursue the development of a FEP (Strategic Plan) for its jurisdiction over the next approximately five years. The Mid-Atlantic has stated in its Strategic Plan that it will develop an Ecosystem Approach to Fisheries Management Guidance document. The Gulf of Mexico Council has enormous problems on an ecosystem scale, e.g., Gulf Hypoxia, Deep Horizon Blowout, and response to Hurricane Katrina but it has not adopted an approach to developing a FEP or other instrument. Finally, the Caribbean Council area is hard to posit as a marine ecosystem given its small size and dependence on actions of other countries for fish conservation but it is adopting a Comprehensive Fishery Management Plan for the EEZ of Puerto Rico which has many elements of a FEP. Some argued that NMFS should provide standardized guidance for RFMC implementation of FEP through its National Standards regulations and others, including the Administration, proposed legislation in the reauthorization process for the MSA in 2006. The leisurely pace of FEP adoption in the period 2000-2014 would indicate that Councils may not see sufficient value added from the incremental work to produce a good FEP or have concerns about the implication of the outcomes of FEPs. It is pretty clear from the FEP products so far that there are a variety of ways to approach the task consistent with the nature of the ecosystem and the institutions and drivers in the eight Council regions.

- **Does the Council have a lead entity designated to advance EBFM in the Council process?** There are many approaches in response to this question by regional fishery management councils. The North Pacific has a dedicated Ecosystem Committee to lead discussions but it also has a very significant component of the annual planning for setting quotas that develops an Ecosystems Considerations report that is integrated into the decision process for quotas. The Pacific Council has an Ecosystem Committee that has developed the FEP proposal and the California Current Status Report. In addition, a subcommittee of the Scientific and Statistical Committee is dedicated to work on development of EBFM and to ensure quality of science. The Western Pacific has acted as a committee of the whole to develop its approach but has devolved to the archipelagic level as time moves on. The Mid-Atlantic and Northeast Councils also operate as committee of the whole while the South Atlantic has essentially transformed its structure into an EBFM planning body – or so it appears. The Gulf of Mexico Council has assigned its interest in EBFM to the Scientific and Statistical Committee (SSC). However, the Caribbean Council is not exploring EBFM to any significant degree largely because of the fragmented ecosystem in which it resides where habitat protection measures are more relevant. At this time there is no basis to judge if any of the approaches is globally superior to the other approaches or even what conditions favor one approach over another [except by not having a focal point for discussion]. Perhaps the goal here is for EBFM to permeate all Council decision-making.

- **Are ecosystem models developed and available for use in the Council process?** The short answer is yes. The most active EBFM relevant modeling exercises are in the North Pacific, Pacific, Northeast and South Atlantic with modest activity in the Gulf, Western Pacific, Mid-Atlantic and Caribbean Council areas. So far, this modeling effort is being performed at the science centers with the idea that eventually the models can be of utility to the Councils. The Councils may or may not have the capacity to absorb the information and assumptions from models but the advisory processes informing the Councils certainly have this capacity.

- **Are decision support tools for EBFM / trade-off analysis employed (e.g., Management Strategy Evaluation, risk assessments, ecosystem indicators, and scenarios)?** Only the North Pacific and Pacific Councils reported to the ESMWG on how each of these tools was employed in fishery management decisions. Even for those councils, the use was embryonic but was proceeding as a result of mutual interests by science and management to explore new possibilities. The Northeast Council region reported significant efforts to develop trade-off analyses and decision tools, including scenarios, but the direct application to management does not seem to be triggered at this point in time.

- **To what extent are spatial management tools applied [besides EFH measures above] to accomplish EBFM?** As indicated above EFH has been a major thrust in developing EBFM spatially in the Council arena. It should be recognized that prior to the EFH requirements, many of the fishery council regions had made management decisions to close some areas to protect spawning fish or nursery areas as well as to reduce impacts of specific gear types on benthic habitat. Other measures afforded protection of non-fish species, e.g., walrus and seabirds. Science centers and Council managers are rapidly employing techniques to assess genetic composition and distribution of stocks for management purposes. The field of research on when and how to apply spatial tools in managing fisheries, including when the can replace other measures (e.g., input and output controls) and when they should complement and enhance existing tools is very active nationally and internationally. Although consensus has not yet emerged on most applied questions, decisions yet to be made by employing such tools represent an exciting future.

- **Other.** From the review of Council implementation three unique actions stand out as providing possible guidance for further discussion about how Councils can take action. First, the North Pacific Council's approach to place a cap on fishery removals from the Bering Sea and the Gulf of Alaska points to the need to examine cumulative effects of fishing within an ecosystem context. While this concept of limiting impacts could be pursued in many different ways, the idea of placing limits on impacts may be a useful way to raise ecosystem science and management questions through models, scenarios, etc. A second idea comes from the Pacific Council's appendix to its Fishery Ecosystem Plan. The Appendix lays out a series of possible follow on actions that might be logically pursued that Council. The listing and prioritization of actions most likely would be different across Councils. The list of actions provided by Councils could well be different from a list of ecosystem needs developed by science experts, but would have the advantage that the Councils would likely be more receptive to using the inputs and have a better idea how results might be used in management. The third important concept is the need to "right size" the ecosystem for management. This need is most obvious the Western Pacific Council's FMPs for archipelagos and for the pelagic ecosystem. For the most part the large marine ecosystems of Council regions can be broken into smaller sized ecosystems. While, the previous ideas come from the Council arena, NOAA's partners, e.g., The Nature Conservancy and other non-governmental entities are developing approaches and seeking the opportunity to partner with on-going fisheries management in new ways to pursue EBFM. This includes definition of biogeographical provinces that may augment knowledge for sub regional spatial management and development of trade-off analysis tools and working in smaller geographic areas to reduce gear impacts on habitats. As with the use of spatial tools mentioned above, there is extensive research on what scales of management have better or worse performance for various kinds of species. (See, for example, Devillers et al. 2014; Jarre, Ragaller and Hutchings 2013; Perry and Ommer 2010; Bernsted-Smith and Kirkman 2010) Moreover, social science research has documented clearly how scales of management have to match well both the biology of the

species being harvested and the structure of the social and economic system prosecuting the fishery (Ekstrom et al. 2009, Turnipseed et al. 2009, Young et al. 2009). This is another area where tradeoffs and adaptive actions may be needed, and where social and natural sciences will have to collaborate much more extensively.

TABLE 4 SUMMARY OF COUNCIL REGION IMPLEMENTATION OF ACTIONS TOWARD EBFM PROGRESS

Extent of Implementation of EBFM – Qualitative Assessment	**Caribbean FMC**	**Gulf of Mexico FMC**	**Mid-Atlantic FMC**	**New England FMC**	**North Pacific FMC**	**Pacific FMC**	**South Atlantic FMC**	**Western Pacific FMC**
Cease overfishing (OF) and develop rebuilding plans for overfished species.	OF stopped; rebuilding plans in place [stocks may not be rebuilt]	OF for some species still occurring; rebuilding plans in place	OF stopped; rebuilding plans in place [stocks may not be rebuilt]	OF for some species still occurring; rebuilding plans in place	OF stopped; rebuilding plans in place [stocks may not be rebuilt]	OF stopped; rebuilding plans in place [stocks may not be rebuilt]	OF and rebuilding plans not in place	OF and rebuilding plans not in place
Delineate extent of ecosystem/ interactions.	Under discussion	Under discussion	Consideration given but not formal	Formal recognition by Regional Action	Formal recognition by Regional Action	Formal recognition by Regional Action	Formal recognition by Regional Action	Formal recognition by Regional Action
Develop a conceptual model of the foodweb.	Under discussion	Model(s) available and evaluated in stock assessments, management decisions	Consideration given but incomplete and/or *ad-hoc*	Model(s) available and evaluated in stock assessments, management decisions	Model(s) available and evaluated in stock assessments, management decisions	Model(s) available and evaluated in stock assessments, management decisions	Model(s) available and evaluated in stock assessments, management decisions	Model(s) available and evaluated in stock assessments, management decisions
Describe habitat	Not used because	EFH fully implemen	Not used because	EFH fully implemen	EFH fully implemen	EFH fully implemen	EFH fully implemen	Not used because

needs of different life history stages of animals and plants in the "significant foodweb" and develop conservation measures.	MSA requirements constitute baseline	ted	MSA requirements constitute baseline	ted	ted	ted	ted	MSA requirements constitute baseline
Calculate total removals-including incidental mortality and relate to standing biomass, production, optimum yields, natural mortality and trophic structure.	MSA requirements implemented but incidental mortality insufficiently accounted for	MSA requirements fully implemented with good estimates of incidental mortality, etc.	Compliance with MSA as required	MSA requirements implemented but incidental mortality insufficiently accounted for	MSA requirements fully implemented with good estimates of incidental mortality, etc.	MSA requirements implemented but incidental mortality insufficiently accounted for	MSA requirements implemented but incidental mortality insufficiently accounted for	Compliance with MSA as required
Does council assess how uncertainty is characterized and define what buffers against uncertainty are included in management actions?	Partial accounting of uncertainty / use of risk based assessments	Partial accounting of uncertainty / use of risk based assessments	Partial accounting of uncertainty / use of risk based assessments	Partial accounting of uncertainty / use of risk based assessments	Partial accounting of uncertainty / use of risk based assessments	Partial accounting of uncertainty / use of risk based assessments	Partial accounting of uncertainty / use of risk based assessment	Partial accounting of uncertainty / use of risk based assessments
Has council: A. set an ecosystem	Ecosystem goals under discussio	Ecosystem goals under discussio	Ecosystem goals articulated	Ecosystem goals articulated	Ecosystem goals articulated	Ecosystem goals articulated	Ecosystem goals articulated	Ecosystem goals articulated

goal (s) and	n	n						
B.developed indicators of ecosystem health as targets for management?	Ecosystem indicators under discussion	Ecosystem indicators under discussion	Ecosystem indicators not defined as targets	Ecosystem indicators not defined as targets	Ecosystem indicators not defined as targets	Ecosystem indicators not defined as targets	Ecosystem indicators not defined as targets	Ecosystem indicators not defined as targets
Describe long-term monitoring data and how they are used.	Regional monitoring plan under discussion	Regional monitoring plan for fisheries but not necessarily ecosystem based fishery	Regional monitoring plan for fisheries but not necessarily ecosystem based fishery	Region developed monitoring plan relative to EBFM can be identified	Region developed monitoring plan relative to EBFM can be identified	Regional monitoring plan for fisheries but not necessarily ecosystem based fishery	Region developed monitoring plan relative to EBFM can be identified	Regional monitoring plan for fisheries but not necessarily ecosystem based fishery
Assess the ecological, human and institutional elements of the ecosystem which most significantly affect the fisheries, and are outside Council/NMFS jurisdiction and define a strategy to address those influences.	Limited or no response to external influences	Region discusses but has limited engagement with outside influences	Region discusses but has limited engagement with outside influences	Fully proactive plan with respect to outside impacts	Fully proactive plan with respect to outside impacts	No plan but region is responsive to threats as they arise	Fully proactive plan with respect to outside impacts	Fully proactive plan with respect to outside impacts (C)

Is there a Fishery Ecosystem Plan/Fishery Management Plan employing EBFM?	Discussion of FEP or FMP for relevant ecosystem	FEP or FMP covering significant portions of the relevant ecosystem	Discussion of FEP or FMP for relevant ecosystem	FEP or FMP covering significant portions of the relevant ecosystem	*FEP or thorough FMP using EBFM for the relevant ecosystem	FEP or thorough FMP using EBFM for the relevant ecosystem	FEP or thorough FMP using EBFM for the relevant ecosystem	FEP or thorough FMP using EBFM for the relevant ecosystem
Does the Council have a lead entity designated to advance EBFM in the Council process?	No lead entity and limited or no discussion	Being developed	Yes, proactive lead in developing EBFM actions for Council	Yes, proactive lead in developing EBFM actions for Council	Yes, proactive lead in developing EBFM actions for Council	Yes, proactive lead in developing EBFM actions for Council	Yes, proactive lead in developing EBFM actions for Council	Yes, proactive lead in developing EBFM actions for Council
Are ecosystem models developed and available for use in the Council process?	No discussion or use of models	Use of models is under discussion / development	Yes, models available but not in use	Yes, models available and in use	Yes, models available and in use	Yes, models available and in use	Yes, models available and in use	Use of models is under discussion / development
Are decision support tools for EBFM/trade-off analysis employed (e.g., management strategy evaluation, risk assessments, ecosystem indicators and scenarios)?	No discussion and no use of formal tools	Yes to some of the elements	Yes to some of the elements	Yes to some of the elements	Yes to some of the elements	Yes to some of the elements	Yes to some of the elements	Some or all elements under discussion
To what extent are spatial	Some spatial managem	Some spatial managem	Some spatial managem	Significant spatial managem	Significant spatial managem	Significant spatial managem	Significant spatial managem	Some spatial managem

management tools applied (besides EFH measures above) to accomplish EBFM?	ent tools applied as well to EFH	ent tools applied as well to EFH	ent tools applied as well to EFH	ent tools applied as well to EFH	ent tools applied as well to EFH	ent tools applied as well to EFH	ent tools applied as well to EFH	ent tools applied as well to EFH
Other					ACL-Cap on Total Removals BS/GOA	EBFM Initiative Agenda for Council		Archipelagic FMPs

COUNCIL-BY-COUNCIL REVIEW OF PROGRESS TOWARD EBFM

This section essays to provide a narrative of EBFM by Council region. The main emphases are on the nature of the ecosystem definition, the primary actions the Council has taken and the status of development of FEPs or FMPs. The purpose is to show the variety and practicality of Council efforts in light of the scientific information required and the priorities of the Council. This approach definitely supports the one size does not fit all assumption that is implied by specifying a wide range of management actions in the framework for this investigation. The bases for these narratives are documented in Appendix D.

Caribbean FMC (CFMC)

The CFMC is a small part of a much larger Caribbean ecosystem. Its small size and remoteness from its sources of scientific expertise make the investment in comprehensive EBFM science difficult. The CFMC does engage with fishery management with other nations through the Caribbean Regional Fisheries Mechanism and the Caribbean Lionfish Response Network among others. A key EBFM focus for CFMC is in designation of EFH. CFMC is currently developing a series of three island-based FMPs, starting with Puerto Rico, which will look at how island ecosystems interact. Presently, fisheries are managed under four species FMPs across islands.

Gulf of Mexico FMC (GMFMC)

The GMFMC is heavily burdened by multiple interacting and ecosystem-wide disasters, i.e., hypoxia from the outflow of the Mississippi River draining the whole agricultural and urban Midwest; residuals of pushing the reset button for hurricane Katrina; and the legacy of the Deepwater Horizon Oil spill. Much of the Gulf of Mexico ecosystem is outside US jurisdiction. The GMFMC is one of the Councils receiving funding to explore EBFM in 2004 and it used these funds to provide training for the Council associates to learn about EBFM. The GMFMC has established an Ecosystem SSC to advise its actions. The GMFMC is presently in discussions about developing a FEP.

Mid Atlantic FMC (MAFMC)

The MAFMC seems well aware of its jurisdiction and notes interactions with species arriving from the south and departing to the north, i.e., highly migratory species. It has developed a Strategic Plan 2014-2018 to prepare and

ecosystems guidance document to serve as an umbrella for Council actions under MSA and its fishery management plans. MAFMC works with NEFMC and SAFMC with respect to shared stocks. The purpose of the Ecosystems Guidance document is to eventually see it realized in the next five years. However, there seems to be some level of interplay between CMSP as working on the topics. MAFMC has recently appointed an Advisory Panel on Ecosystems and Ocean Planning to advise it but it continues as well to the Council SSC.

New England FMC (NEFMC)

Fishery science in support of EBFM is among the most advance in the United States and globally but it has only recently seemed to be obtaining traction and trust in the fishing community. NEFMC's jurisdiction is over a relatively small but productive area shared by Canada. Thus, working on EBFM requires significant cross-boundary discussion and negotiation. In 2013 the NEFMC, after a significantly prolonged ramping up period, has opted to prepare a Strategic Plan to implement EBFM with a FEP. This development has long been supported by the NEFMC SSC. The planning for the FEP indicates that it will be spatially based using "Ecosystem Production Units" that have been designated.

North Pacific FMC (NPFMC)

NPFMC has been a long-term advocate of EBFM. It has taken this type of approach from the beginning of its management in 1977 with the idea that the international fisheries occurring in the Bering Sea and Aleutians and the Gulf of Alaska should not be allowed to exceed ecosystem-based harvest limits and therefore an ecosystem cap was assessed and implemented. As the US fisheries developed, the same practices of conservative fisheries management were applied to domestic fleets based on scientific advice. NPFMC has one FEP for the Aleutian Islands archipelago where fisheries interactions were prioritized with respect to Steller sea lion ESA listing and the perceived need to mitigate these impacts. NPFMC has closed the northern Bering Sea and the US Arctic to fishing using FMPs. NPFMC is actively redefining its approach to fisheries and developing goals and objectives. It has had an Ecosystems Considerations report at the time of setting of catch limits since 1994 and a dedicated Ecosystem Committee to work to infuse ecosystem information into Council decision processes. The NPFMC is acutely aware of the need to monitor climate change. A state of the Bering Sea Ecosystem and another for the Arctic are issued annually.

Pacific FMC (PFMC)

PFMC has recently stepped up to the EBFM approach by developing a FEP for the California Current Ecosystem and dealing with forage fish and long-lived rockfish using ecosystem-based measures. PFMC recognizes that for species like Pacific whiting [hake] and Pacific sardines it shares the stock with Mexico and Canada and is actively engaged in management across borders. The PFMC has a comprehensive FEP that guides it toward EBFM solutions. The collective work to establish these measures mean there is buy-in and support from the fishing industry. A State of the California Current Ecosystem is issued annually.

South Atlantic FMC (SAFMC)

The SAFMC has taken the approach to use a Comprehensive Ecosystem-Based Amendments to Council FMPs to develop ecosystem savvy management actions [as opposed to FEPs that merely inform management]. It uses a Committee on Ecosystem-Based management to advise on further measures. The SAFMC seems to have reached out more than others to establish partnerships with other ocean and watershed managers to deal with critical marine fisheries ecosystem issues.

Western Pacific FMC (WPFMC)

The WPFMC covers a very large and diverse ocean jurisdiction. It has made a major shift in its FMPs to accommodate EBFM. Instead of four FMPs dealing with different components of tropical fisheries [e.g., nearshore reef species, bottomfish, corals and pelagics], it now has four place-based FMPs based on its main archipelagos as well as a highly migratory pelagics FMP for species ranging over the Pacific Ocean. Regional ecosystem advisory committees and archipelago advisory panels are established to provide advice on implementation of the Archipelagic Fishery Management Plans. This approach was developed over a multi-year period where a series of three workshops were held to identify ecological and socio-economic issues and then integrate them into a culturally sensitive engagement with traditional leaders of place-based fisheries (traditional ecological knowledge) as well as commercial fisheries.

Summary

There is obviously a wide range of approaches to incorporating EBFM into management council actions. Even though the progress toward EBFM has been relatively slow, it is happening in ways that seem to be Council ecosystem appropriate. Councils seem to have pragmatic reasons for developing FEPs or ecosystem FMPs or for not pursuing that route. The reasons behind this difference of approach are complex and not easily explained. Clearly, it would be difficult to develop one size fits all guidelines for how to implement EBFM. Further, it is clear that the incentive structure required to accomplish EBFM so far differs distinctly across Council areas. Could standardized guidelines be developed to advance EBFM implementation? The answer is probably not unless the guidelines were fairly flexible. In this respect, it appears that the role NMFS headquarters can play in encouraging EBFM is in increasing capacity of Councils to take the lead on EBFM and resolving real regional ecosystem problems.

HEADQUARTERS EFFORTS WITH RESPECT TO DEVELOPING EBFM AND EAM

The bases for this review are presentations made to the ESMWG as it began its organizational activity. Briefings from the NOAA Ecosystem Goal Team helped ESMWG members to cover this key element. The ESMWG study process has benefited greatly by participation of NMFS and other NOAA Line Office leadership. (See, for example, presentation by Steve Murawski "Overview of NOAA and Background for ESMWG" ppt. Feb. 11, 2009; Kristen Koch, "Ecosystem Goal" ppt. Feb. 11, 2009; Phil Levin, Pacific Fisheries Science Center, "Integrated Ecosystem Assessments and Atlantis Model California Current Ecosystem"; Ned Cyr, Science and Technology, "NOAA's Climate and Ecosystem Science and Management Challenges"; Feb. 12, 2009; Anne Hollowed, "CAMEO" July 9, 2009;Who made this presentation? Steve Murawski, "Ecosystem Approach to Fisheries Management" Oct. 8, 2009; Laura Letson and Bob Wood. "NOAA's Ecosystem Research Agenda"; Gary Matlock, NOS, "NOAA-wide Ecological Forecasting System"; Paul Sandifer, Science Advisor, "A Framework and Strategy to Develop and Ecosystem Research Agenda to Support NOAA's Mission" ppt. Feb. 1, 2012; Jason Link "Science and Management of Marine Ecosystems" ppt. Feb. 26, 2012; and Isaac Kaplan, "Atlantis Model for IEAs" Feb. 26, 2012). [These presentations are available on the ESMWG website http://www.sab.noaa.gov/Working_Groups/membersonly/ecosystem/index.htm. Tara Dolan, researched Headquarters documents and interviewed knowledgeable EGT participants to provide additional insights.]

Like most agencies with a scientific core and resource management responsibilities, NOAA and NMFS in particular became interested in ecosystem-based management as a potential new paradigm embedded in integrated

management. It is generally agreed that NOAA's start in this path can be found in a 1987 NMFS Program Development Plan for Ecosystem Monitoring and Fisheries Management (NMFS 1987). This promising start lost momentum in the change of Presidential administrations. It was not until the Sustainable Fisheries Management Act reauthorization of the Magnuson Fisheries Management and Conservation Act in 1996 that attention was again focused on EBFM. In that reauthorization, Congress requested the NMFS to appoint a committee to develop a report on how ecosystem principles were being employed in federal fishery management. The report of the Ecosystem Principles Advisory Panel (EPAP 1999) report defined ecosystem principles and examined how they were employed by the eight regional fishery management councils. While there were some Council regions where progress was observable (Witherell et al. 2000) the status of EBFM was embryonic. The primary recommendation of the EPAP was that regional fishery management councils develop fisheries ecosystem plans (FEP) for each ecosystem under their jurisdiction. The FEP was expected to be an umbrella document into which would place existing Fishery Management Plans into larger ecosystem perspectives. In 2001-2003 the NOAA Marine Fisheries Advisory Committee considered EBM and recommended pilot projects to develop FEPs (Busch et al. 2003). Discussion continued in NMFS Headquarters on how to encourage development of FEPs. In 2004 Congress appropriated $250,000 to each of the four Atlantic fisheries councils and commissions for EBM pilot workshops. (Senate Report 108-144).
http://thomas.loc.gov/cgibin/cpquery/?&dbname=cp108&sid=cp108jdq0p&refer=&r_n=sr144.108&item=&&&sel=TOC_287583& (Summaries of each workshop available (e.g., New England (Demarest 2005), Gulf of Mexico (Jepson 2005) and references in Appendix D). Another of the outcomes of the EBFM funding was an effort by headquarters to provide a guidance document for regional marine ecosystem approaches to management (Holliday and Gautam 2005).

The NMFS Strategic Plan for Fisheries Research 2005-2010 recognizes that the status of a fish stock and how it would be affected by alternative harvest strategies requires an ecosystem-based approach. Goal 1 from the Plan is to "provide scientifically sound information and data sufficient to support ecosystem-based fishery conservation and management." It calls for models of habitat linkages in order to implement ecosystem-based management and for ecosystem-based practices for sustaining marine fisheries and their environments (NOAA 2004). Similar commitments are made in the NOAA Habitat Assessment Improvement Plan and the Marine Fisheries Stock Assessment Improvement Plan. Similar wording is found in NOAA Fisheries Strategic Plan for Fisheries Research 2010-2015..

The 1996 Sustainable Fisheries Act reauthorization required Council attention to management and protection of Essential Fish Habitat through Fishery Management Plan Amendments within 18 months after passage. This became a building block for Councils to make progress towards EBFM. NMFS supplied considerable leadership and guidance on how to implement EFH in the first iteration and now Councils regularly consider incremental EFH requirements. In the early 2000s NMFS sponsored wide-spread training on implementation of the National Environmental Policy Act to assist in bringing its actions into greater compliance especially with respect to cumulative effects analysis of management actions (Osgood 2013). This contributes greatly to implementing an EBFM approach.

In 2004 the Pew Ocean Commission and President's Ocean Policy Task Force reports were issued and EBM was endorsed in general terms in each report. In response, in 2005 the NMFS and others proposed MSA reauthorization language to require the development of FEPs to Congress as part of reauthorization of the SFA. In the reauthorization of the Magnuson Stevens Act Congress chose not adopt specific EBFM provisions but did increase the power of the Councils to stop overfishing and to implement rebuilding plans. These long-established components of traditional fisheries management require measures that also contribute to progress on EBFM goals.

On a different track, the Ecosystems Goal Team (EGT) was created to focus efforts of four of NOAA's line offices on EAM: National Ocean Service (NOS); National Marine Fisheries Service (NMFS); Ocean and Atmospheric Research (OAR); and the National Environmental Satellite, Data and Information Service (NESDIS). The EGT included nine Ecosystem Goal Programs that matrix across these four line offices. Among EGT objectives were some relating to stakeholder outreach, e.g.,

- provide tools, technologies, and information services that are effectively used by NOAA partners and customers to improve ecosystem based management;
- more effectively meet its ever broadening management and stewardship objectives by engaging more diverse sets of partners and stakeholders, with programs integrated across NOAA's Line Offices;
- combine science and outreach products in ways that allow more efficient delivery and imaginative analysis and forecasting; and,
- deliver new products that evaluate the states and pressures on regional ecosystems as well as the constituent parts.

The effectiveness of this EGT approach was limited by not having budget authority over the decisions to be made by separate line offices within NOAA. (See Appendix E for Information on Headquarters Administrative Budget Requests 2002-2014).

On the scientific front, headquarters took the lead in developing the capacity for generating ecosystem scientific advice, e.g., the workshop on building environmentally explicit stock assessments (Watters 2004). Along the same lines a national ecosystem modeling workshop was held in 2008 (Levin, Cyr and Aydin 2008). Another workshop devoted to how to incorporate modeling products into the living marine resource management process was held in Woods Hole in summer 2013 (NMFS and ASMFC 2013). In March 2014 continued to explore the use of multiple and ensemble models for marine resource management (NMFS 2014). As noted above, a national meeting of Council SSCs was held to consider scientific advice on ecosystem and social science considerations in US fishery management (Seagraves and Collins 2012. This is not a complete listing of all such workshops but it is indicative of Headquarters' role in developing the scientific capacity to support EBFM.

Not only did Headquarters leadership work internally to develop EBFM fisheries capacity, staff published widely and encouraged NMFS scientists to assist the broader scientific community and public to better understand EBFM (e.g., Murawski 2000; Murawski 2006; Francis et al. 2007; Ruckelshaus et al. 2008; Levin and Lubchenco 2008; Hollowed et al. 2011; Link et al. 2012; Link and Browman 2014).

The MSA reauthorization of 2006 requested that NOAA report to Congress on the state of science to support an ecosystem approach to regional fishery management and NOAA through the NMFS responded (NMFS 2009). Section 406 of the 2006 MSFCMA Reauthorization Act charged the NMFS in consultation with the RFMC to study the, "state of science for advancing the concepts and integration of ecosystem consideration in regional fishery management". It specifies four objectives: 1) form recommendations for scientific data, information and technology requirements for understanding ecosystem processes and methods for integrating this information from federal, state and regional sources; 2) form recommendations for processes for incorporating broad stakeholder participation; 3) form recommendations for processes to account for effect of environmental variation on fish stocks and fisheries; and 4) describe existing and developing Council efforts to implement ecosystem approaches, including lessons learned by the Councils. (NMFS 2009) [See Appendix F for the Executive Summary of this report]. Within the SFA 1996 there was specific provision for training of new Council members with respect to NMFS mandates and policies including EBFM. [This was already a practice NMFS headquarters provided at least as early as the mid-1990s].

In a separate initiative, NOAA asked its Science Advisory Board to report on ways to implement ecosystem based management across NOAA. The NOAA SAB established an ad hoc working group in 2005 which recommended Integrated Ecosystem Assessments (IEAs) as one of several measures to advance ecosystem-based management across NOAA's mandates and missions and as a way to engage partners and the public. (NOAA SAB 2006; Levin et al. 2009). NOAA is moving to implement this IEA recommendation. Presidential Executive Order 13547, July 2010 asks federal agencies to join in Coastal and Marine Spatial Planning (CMSP) by developing regional marine plans which also requires support from IEAs. Not only do the two different purposes for IEAs add complexity to their development in the current Congressional context, no funding is supposed to be spent for CMSP per se. However, because much of NOAA's mandated responsibilities rest on developing the scientific basis for management, the essential work on IEAs continues.

Therefore the ESMWG through the NOAA SAB requested clarification of how NOAA defined and intended to operationalize these different initiatives. [See NOAA SAB Letter to NOAA, April 5, 2010 www.sab.noaa.gov/Reports/2010/SAB-eam-iea-cmsp-let-trans-Final.pdf]. NOAA's response helped to better define how these initiatives could be addressed simultaneously [Letter to NOAA SAB, March 2, 2011 www.sab.noaa.gov/Report_report_reply_IEA-CSMSP-EBM_final_03_02_11.pdf]. NOAA continued to explore the Ecosystem Approach to Management (EAM) 2011 by holding an Ecosystem Research Science Challenge Workshop. (Allen (Ed.) 2013) and outreach reported in peer review publications (Reiter et al. 2013; Samhouri et al. 2013). The trajectory of NOAA engagement in ecosystem-based science is likely to broaden it into an Ecosystem Approach to Management or Ecosystem-Based Management to include more than a fisheries focus. Concomitantly EBFM is expanding its scope to include other living marine resources, habitats and anthropogenic effects outside NMFS control.

Recently Headquarters decided to schedule reviews of Fishery Science Centers on a five year cycle in order to evaluate the quality, relevance and performance of science and research performed. http://www.st.nmfs.noaa.gov/science-program-review/. In the first year (2013) the reviews of the six science centers focused on data collection and management. In subsequent years the focus is on stock assessment processes (2014), protected species science (2015), ecosystem and climate sciences (2016), economic and social sciences (2017) and strategy plan review and update (2018). The fundamental goal is to strategically position the science centers in planning future science and research. http://www.st.nmfs.noaa.gov/science-program-review/.

EBFM IN MAJOR REGIONAL FISHERY MANAGEMENT ORGANIZATIONS (RFMOS) TO WHICH THE US IS A MEMBER

This section is a qualitative survey of RFMOs to which the US is a Party to observe the extent to which EBFM-like measures are being taken. The global coverage of RFMOs is shown in Figure 1 but the United States is not Party to all agreements. In the 2006 MSA Reauthorization, Congress required the United States to advocate [certify] for conservation of fish and other living marine organisms 16 U.S.C. 1829MSA § 20757 109-479. We quote this section at length because it explains what Congress expects NOAA Fisheries to do to build EBFM science and management into RFMOs.

"SEC. 207. INTERNATIONAL MONITORING AND COMPLIANCE. 16 U.S.C. 1829

(a) IN GENERAL.—The Secretary may undertake activities to promote improved monitoring and compliance for high seas fisheries, or fisheries governed by international fishery management agreements, and to implement the requirements of this title. (b) SPECIFIC AUTHORITIES.—In carrying out subsection (a), the Secretary may—(1) share information on harvesting and processing capacity and illegal, unreported and unregulated fishing on the high seas, in areas covered by international fishery management agreements, and by vessels of other nations within the United States exclusive economic zone, with relevant law enforcement organizations of foreign nations and relevant International organizations; (2) further develop real time information sharing capabilities, particularly on harvesting and processing capacity and illegal, unreported and unregulated fishing; (3) participate in global and regional efforts to build an international network for monitoring, control, and surveillance of high seas fishing and fishing under regional or global agreements; (4) support efforts to create an international registry or database of fishing vessels, including by building on or enhancing registries developed by international fishery management organizations; (5) enhance enforcement capabilities through the application of commercial or governmental remote sensing technology to locate or identify vessels engaged in illegal, unreported, or unregulated fishing on the high seas, including encroachments into the Exclusive Economic Zone by fishing vessels of other nations; (6) provide technical or other assistance to developing countries to improve their monitoring, control, and surveillance capabilities; and (7) support coordinated international efforts to ensure that all large-scale fishing vessels operating

on the high seas are required by their flag State to be fitted with vessel monitoring systems no later than December 31, 2008, or earlier if so decided by the relevant flag State or any relevant international fishery management organization" MSA 2006.

TABLE 5 REGIONAL FISHERY MANAGEMENT ORGANIZATIONS TO WHICH THE UNITED STATE IS PARTY
Pacific Ocean InterAmerican Tropical Tuna Commission
West Central Pacific Fisheries Commission
International Pacific Halibut Commission
Pacific Salmon Commission
Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea
Atlantic Ocean
International Commission for the Conservation of Atlantic Tunas
North Atlantic Fisheries Organization
North Atlantic Salmon Conservation Organization
West Central Atlantic Fishery Commission
Southern Ocean
Convention for the Conservation of Antarctic Marine Living Resources
Indian Ocean
Indian Ocean Tuna Commission

This raises the standard to which US participation in regional fisheries management organizations (RFMO) (Figure 1) with respect to many of the actions that could be taken by RFMOs to implement EBFM among other

conservation and management issues.

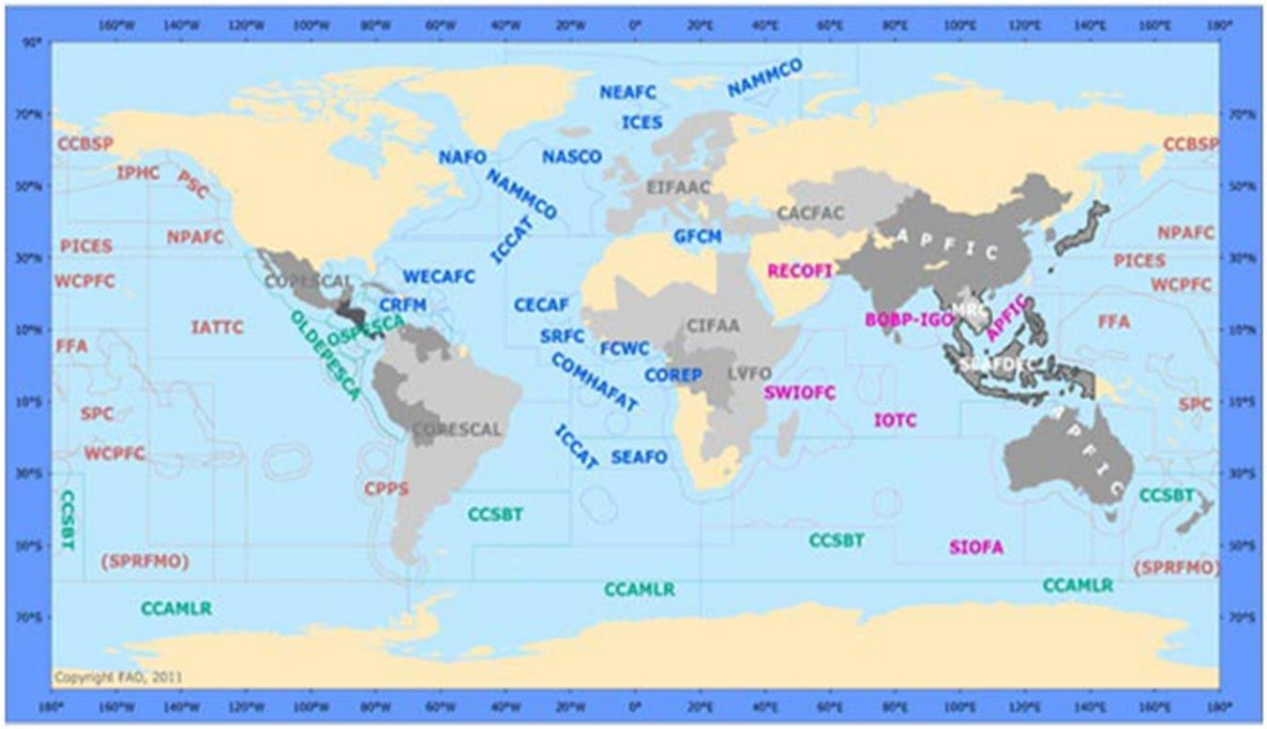


Figure 1. Global Map of Regional Fishery Management Organizations [Note: ICES, PICES and NPAFC have no responsibility for fisheries management but serve various roles as international scientific bodies for fisheries].

A series of six questions were asked about each of the main RFMOs in which the US is a participant. Results are summarized below in a series of bullet points. More detailed discussion of the practice for each RFMO is provided in Appendix G.

1) **Does the RFMO have ecosystem science on its research agenda?** Most of the RFMOs have ecosystem science as part of its research agenda but the implementation is highly dependent on interests and capacities of member states. The ecosystem science is generally dominated by larger science efforts for classical stock assessment and management.
2) **Does the RFMO have an ecosystem advisory committee?** Roughly half of the RFMOs have an ecosystem advisory committee, i.e., a focal point within the RFMO to lead research or discussion of ecosystem effects of fishing, bycatch or other issues.
3) **Does the RFMO make decisions taking ecosystem information into account?** A majority of the RFMOs can be using ecosystem information in decision making but usually as ancillary to information on fish harvests and surveys of target fisheries.
4) **Does the RFMO articulate any ecosystem goals in management?** All non-tuna RFMOs have at least ecosystem goals for protection of Vulnerable Marine Ecosystems consistent with United Nations General Assembly (UNGA) Resolution 61/105, and most RFMOs have goals for bycatch management. Few have ecosystem goals for other ecosystem properties such as food web relationships, and there is great variability in the measures adopted and implemented to achieve even the habitat impact or bycatch goals. This finding is consistent with reviews by the FAO (Ceo et al. 2012) and others (Willock and Lack 2006; Cullis-Suzuki and Pauly 2010).

5) **Does the RFMO have a fishery management plan that is ecosystem-based?** Only a few RFMOs have a fishery management plan that is described as being ecosystem-based.
6) **Does the RFMO use ecosystem science in any other way in management**? Despite the discussion of the restricted application of ecosystem-base science and management in RFMOs, nearly all appear to claim that they used ecosystem science in management.

Conclusion. Based on the results of the review of RFMOs to which the US is party (as summarized in Table 6) it appears that Northwest Atlantic Fisheries Organization (NAFO), West Central Atlantic Fisheries Commission (WECAFC) and the Convention on Conservation of Antarctic Living Marine Resources (CCALMR) are most coherent with the actions expected by RFMOs to which the United States is a Party.

TABLE 6. EBFM IN REGIONAL FISHERY MANAGEMENT ORGANIZATIONS TO WHICH THE UNITED STATES IS MEMBER

	IATTC	WCPFC	IPHC	PSC	CCBSP	ICCAT	NAFO	NASCO	WECAFC	CCAMLR	IOTC
Does the RFMO have ecosystem science on its research agenda?	YES	NO	NO	YES	NO	YES	YES	YES	YES	YES	YES

Does the RFMO have an ecosystem advisory committee?	YES	NO	NO	NO	NO	YES	YES	YES	NO	YES	YES
Does the RFMO make decisions using ecosystem information?	NO	NO	YES	YES	NO	NO	YES	YES	YES	YES	NO
Does the RFMO articulate an ecosystem goal in management?	YES	NO	NO	NO	YES	YES	YES	YES	YES	YES	NO
Does the RFMO have a fishery management plan that is ecosystem-based?	NO	NO	NO	NO	NO	NO	YES	YES	YES	YES	NO
Does the RFMO use ecosystem science in any other way in management?	YES	YES	NO	YES	NO	YES	YES	YES	YES	YES	YES

Note: US is not a signatory to the Law of the Sea Convention III and has not ratified the Convention on Biodiversity.

SECTION 2. EBFM SCIENCE FOR FISHERIES MANAGEMENT – SYNTHESIS OF OBSERVATIONS

Given the wide differences in approach to EBFM seen in the fishery management regions, the ESMWG subcommittee determined that it was beyond our scope to try to evaluate and compare implementation by region. Instead we propose to make a synthesis of observations about the general questions listed above and to use these observations to formulate recommendations on how to improve regional fishery management implementation of EBFM. This includes opportunity to make observations and recommendations about the state of fisheries science in a broader Ecosystem Approach to Management across NOAA.

WHAT IS THE STATE OF SCIENCE TO SUPPORT AN ECOSYSTEM-BASED APPROACH TO FISHERY MANAGEMENT? SYNTHESIS OF OBSERVATIONS

The science enterprise is strong – a large amount of effort goes to stock assessments, EFH and other mandated actions; moderate amounts of effort go into evaluating and modeling interactions among species and between species and their environments; much less effort goes into spatial aspects of linking exploitation to human community dependencies and harvest strategies through the ecosystem. In some regions there is a significant unmet need for better understanding functioning of nearshore ecosystems. Overall, a focus on influence of ecosystem processes (biological and physical) on variations in recruitment and natural mortality rates remains a key demand from Councils given the heavy emphasis on use of ecosystem information in stock assessments. When attention turns to harvest strategies, the greatest gap is integrative work between ecological, economic, and social outcomes of fisheries under different harvest regimes.

A considerable amount of ecosystem research is being performed and made available to Councils, (likely more than can be used in terms of food web models and environmental drivers of productivity). At this time, it seems that foodweb relationships are being viewed as the *sine qua non* of EBFM. However, truly reliable, accurate and precise models to quantify the dynamics of predation, mortality and growth in stock assessments are extremely costly to build, parameterize and validate. It remains an open question whether the foodweb relationships are better addressed through robust harvesting strategies or through incorporation into stock assessments. The science and management would be different depending on which approach is taken. More focused research on this question would likely have high payoff.

Social sciences investments for EBFM (in sensu coupled social-ecological systems) research is quite limited and insufficient for developing coupled social-ecological systems models regionally. The incipient shift in discourse from a commodity-based emphasis to ecosystem services valuation creates a significant gap in scientific understanding. Until these gaps are filled, a major part of EBFM will remain unachievable, and the absence of human considerations in the more limited framework may well impede timely uptake of progress on the ecological dimension. [Note that the EMSWG is embarking on a review of valuation of ecosystem services for NOAA which is intended to address this issue].

There is increasing emphasis on more and more sophisticated fisheries ecosystem models and management scenarios that demand more ecosystem monitoring data. Again, simulation work with our best studied systems is needed to gain a more systematic view of when there is added value to increased breadth or density of monitoring and when returns begin to diminish.

A question is raised about the approaches being applied in ecosystem science and habitat science across NOAA and whether these tracks can be more mutually supportive.

HOW IS THE FISHERY MANAGEMENT COUNCIL USING EFBM SCIENCE IN MANAGEMENT? (ARE COUNCILS GETTING THE SCIENCE THEY NEED FOR MANAGEMENT?) SYNTHESIS OF OBSERVATIONS

Demand for and use of EBFM scientific information is highly variable by council region for many reasons, e.g., different objectives [stated or unstated], biogeophysical, socio-cultural, and history of fisheries management and use of science.

As councils develop Fishery Ecosystem Plans or Fishery Management Plans the demand for and use of EBFM science increases. Thus the Plan function is perhaps the best focus because it incorporates many activities.

The nature of EBFM science demanded and used is [no surprise] place-based and specific to actions taken.

It appears that councils have a steep learning curve on use of modeling in management decision-making.

Councils may need more assistance in developing capacity for analyzing trade-offs in management scenarios in ecosystem and socio-economic contexts. In order to accomplish this goal the striking imbalance between natural and human dimensions science for EBFM must be overcome.

COUNCIL PERSPECTIVES

From the Councils who spoke to us or provided information to us we heard a broad spectrum of responses:

a. Each Council was familiar with the general notion of EBFM. They might have had different or incomplete understanding of what it entails, but that is true of most communities, including fisheries science experts.

b. Each felt their Councils were receptive to the general idea of EBFM, but with some qualifications.

c. Key qualifications expressed included statements that some were concerned their mandates did not include at least some factors that might be part of EBFM, and some were concerned that there could be significant new costs incurred to deal with some aspects of EBFM and there were few or no new resources to deal with such incremental costs. Some also needed demonstrations or evidence that the most pressing challenges they face would actually be addressed by EBFM.

d. Each considered that change in legislation and policy could be a major driver in adoption of EBFM but they had different perspectives on what was needed.

e. Some of the participants from Councils could identify key ecosystem / EBFM factors that they considered important to address in their deliberations and decision-making.

f. In all cases in “e” the participants from Councils considered their Councils to be prepared to deal with EBFM factors in their activities, and often already were.

g. In all cases the participants expressed general satisfaction with the support they were getting from NOAA (usually but not exclusively NMFS). In some of those cases the support was actually operational advice (example North Pacific relative to physical oceanographic drivers on stock dynamics), whereas in others it was still work in progress (example trophodynamic interaction for New England stocks). The common message though was that the NOAA RFSC were hearing the Council’s expressions of their needs, and responding to those needs.

h. None of the participants from Councils expressed a desire for comprehensive science advice on some all-inclusive ecosystem-based management plan with large suites of associated new management measures. Rather they wanted ways to address key problems that they were facing in doing their work. When those problems had an ecosystem dimension to them, they wanted ecosystem-based scientific support In addition, they wanted to know how ecosystem factors would affect fisheries business and communities in the future.

SCIENCE CENTER PERSPECTIVES

From the NOAA (and other) science experts who spoke or provided information to us we heard:

a. Each enthusiastically endorses the concept of EBFM.

b. Although there were differences in detail among the experts, the science participants expressed more similar visions of what constitutes "EBFM" than did the participants from Councils.

c. All the versions of EBFM in play in NOAA acknowledge more or less the same long list of possible actions to implement for EBFM, but differ in the weight given to different factors on the list. High weight is being given to accounting for variation in natural mortality of most or all species (not just harvested forage species) and low weight given to livelihood considerations and many other aspects of the human dimensions of EBFM. Although some social science research on EBFM considerations is being supported in NOAA, it does not appear to be conceptually integrated with the much greater amount of work being on consideration of the marine ecosystem.

d. There seems to be a widespread but not universal desire in the NOAA expert community to develop a systematic EBFM framework, providing similar, inputs to all Councils ("similar" in the sense that the issues contained in the EBFM advice would be the same for all Councils, not that the numbers would be identical, of course). This reflects an unstated assumption that if an ecosystem issue is important enough to be addressed in an ecosystem approach to managing some fisheries, it is important enough to be included in the deliberations of all the Councils.

e. Whatever the details envisioned for science support on EBFM to be provided to Councils, in the science presentations, modeling, forecasting, and use of indicators were always central pillars of the support.

f. From points "d" and "e" there seemed to follow an idea that generic support tools, particularly models capable of forecasting and lists of "ecosystem indicators", should be designed for use across all regions. One region might leave development and testing of any given type of model or set of indicators, but once considered operational, it could be adapted for implementation in support of all Councils.

g. Although quite a few Fisheries Ecosystem Plans or enforceable ecosystem-based Fishery Management Plans have been developed scientific support was always positive. These plans appear to be envisioned as part of the grail of true EBFM. However, when they were discussed, little or no attention was given to a human component to an FEP.

h. Adaptive management arose often in the discussions with science experts. Again, when it arose, opinion was always positive. However, often few details were provided about how "adaptive management" would work. When details were offered, they were generally indicator-based decision rules with triggers for pre-identified actions, with the rules developed in the context of "e" and "f".

DISCUSSION

There appears to be little conceptual resistance to progress on implementation of EBFM. However, there are differences in what the policy-management and the science expert communities want to achieve in that implementation. To the policy-management community, in those cases when ecosystem drivers, interactions, or scales/patterns are posing major challenges to achieving either consensus decisions on management, or sustainable outcomes of decisions that have been made, they want those drivers, interactions or scales/patterns addressed. This represents a strongly empirical and pragmatic view – use ecosystem concepts when they solve problems, otherwise keep things as simple as possible. To the science expert community EBFM is about moving a

list of ecological processes and concepts into management practice. Although in each region the science expert community is focusing on the larger management problems of the region, they view their goal as moving EBFM concepts into global practice.

These differences in vision pose some challenges for NOAA and NMFS in particular:

1. The preferred modeling, forecasting, and comprehensive indicator approach of experts is costly to develop and implement. When doing so contributes to solving a major challenge to sustainable management, the investment can be justified. The subsequent step of exporting the models, forecasting tools and suites of indicators to other regions where similar challenges to management may be smaller still requires major investments in data archaeology and collection, and expert work to re-parameterize all the models and define appropriate benchmarks on all the indicators. Return on these investments is more questionable and should be evaluated on a case-by-case basis. While this may not be a universally shared perspective it is intended to flag the need for strategic development of new tools in concert with Councils developing the capacity to use them in decision-making.

2. To the extent that NOAA tries to "impose" even a good ecosystem model on a region that has not expressed a need for the products, tensions could result. These inputs could be perceived as making the work of Council members much more difficult, without solving any problems seen as major by the Council perspective.

3. Although NOAA has taken meaningful actions to increase its expertise in social and economic science, its science is still overwhelmingly dominated by physical and biological scientists. Few of these appear to have accommodated the human dimension into their thinking about their own work. Rather they leave the human dimension for these "other experts", to be cobbled onto their work in some later time and in some unspecified way. For the Councils the social and economic challenges to sustainability are inseparable from the ecological challenges in their decision-making. Failure to integrate these dimensions from the outset in framing what EBFM might limit greatly how useful the Councils find the EBFM guidance received from the science community / NOAA.

4. There is considerable debate in the current MSA Reauthorization in the US Congressional arena how to improve the legislation. Principal issues appear to be over the need to adjust rebuilding timelines, weak stock management, definition of overfishing, etc. with strong differences being expressed across Council regions. The idea of adding ecosystem-based management measures to the MSA as part of reauthorization is being raised by prominent scientists (Pikitch 2014) and influential environmental organizations http://www.pewenvironment.org/uploadedFiles/PEG/Publications/Fact_Sheet/Ecosystem-Based-Fisheries-Management.pdf. To the extent these initiatives are coordinated or not, they each propose increased bycatch measures, habitat protection from non-fishing activities, conservation of forage fish and ecosystem-based fishery management plans. So far, these initiatives are very light on specific measures and legislative language.

While NOAA and its Science Advisory Board do not engage in these issues politically, these issues potentially affect the directions to be taken internally. In 2005-2006 the Administration proposed language for the MSA reauthorization that included "ecosystem management" and requiring the NMFS to develop a draft guidelines for FEPs within 24 months after passage "which shall not have the force and effect of law" (H.R. 5015 section 115). The version eventually passed by Congress deleted this provision and substituted a requirement that NMFS report to Congress on the state of science to support and ecosystem approach to regional fishery management (H.R. 5946; NMFS 2009). (See full texts of these provisions in Appendix H). There have been several efforts to develop such guidelines internally (Busch et al. 2003; Holliday and Gautam 2005) but they do not seem to have significantly influenced Council actions, rather Councils have invented their own pathways toward EBFM. Until Congress acts

either to approve or ignore provision of an EBFM related mandate NOAA Fisheries may be in somewhat of a limbo in terms of decisive actions. Among the types of actions NOAA Fisheries might consider could be:

1) revising its regulations under the National Standards for Fishery Management Plans to require harmonization among each Council's FMPs under an umbrella Fishery Ecosystem Plan that meets certain specifications, or other measures for bycatch accounting/ avoidance or habitat protections;

2) using its planned 2016 Science Center review of ecosystem science for fishery management as a springboard for EBFM initiatives;

3) continuing and enhancing workshops on EBFM in stock assessments, modeling, habitat protection, etc.

Consistent with NOAA SAB practice, the recommendations that evolve from our research and discussion on progress towards EBFM in regional fishery management Councils leave open a wide range of choice for how NOAA Fisheries can respond.

ESMWG RECOMMENDATIONS FOR IMPROVING EBFM SCIENCE AND ITS UTILIZATION

In this report, we have responded to the request of the NOAA SAB for evaluation of EBFM as implemented across the regional fishery management councils in the US and the sufficiency of ecosystem scientific advice – social and natural as used in fishery management councils. We offer a set of primary recommendations that result from our assessment; a principal recommendation that constitutes a comprehensive approach for NMFS to use to assist in prioritization of its research investment and some observations on the grand challenges facing EBFM.

Primary Recommendations

1.) Continue and expand support to 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.

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

3.) 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.

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

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

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

7.) 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.

PRINCIPAL RECOMMENDATION FOR A WAY FORWARD

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. Hence a useful first step would be a major workshop of perhaps a week's duration. It would have participants from all Councils and their direct clients, Science Centers, and as close as possible to balanced representation of "natural" and social-economic science experts (again with balance between NOAA-based experts and external experts).

In order to better define what is being recommended as a needs assessment and a prioritization to ways to conceptualize how it could be performed are outlined below:

As preparation for the workshop the NOAA science experts would prepare a list of the best managed stocks in the region(s) which they support, and the stocks / fisheries where they feel management is not achieving an appropriate level of sustainability. For the former they would identify the factors most important in achieving their successes. For the latter, they would document, as much as the existing information allowed, what factors are contributing substantially to the failure to achieve or maintain sustainability. They would also list the types of science products which, if available, would address the shortcomings. Those external science experts invited to participate would be invited to undertake the same analyses, although their access to the necessary information for their analyses might be more limited.

An alternative approach would be to use the same type of process but ask the Councils and science centers to identify the gaps they perceive to exist in terms of understanding the marine ecosystem with respect to fishery management. They would develop a needs assessment and a prioritized list to carry to the Workshop].

Importantly, the Council preparations for this needs assessment and prioritization the NOAA/expert preparation should be done as independently as possible. This is because a major task of the workshop would be to compare, region by region, the similarities and differences between the policy-management and the science/expert communities, with regard to perceptions of successes and the less-than-successes in management of fisheries in each region, and in their perceived reasons for each. Both groups should be provided with a comprehensively long list of ALL the things that might be part of EBFM – ecological, social, and economic.

Where Councils and science experts agree on what is a success and why it is a success, and what is not a success and why it is not a success, no further needs assessment is really needed. The task is clearly is to keep doing that which is contributing to the successes, and work together on what both agree are the factors impeding successes. Only in the cases when there are differences in views on what is and is not a success or lack of success in management, and particularly in why the successes and lack of successes are occurring, or in what can be done about the latter, is there a need for a more in-depth assessment of what is really needed.

Challenges

The benefits from implementations of these recommendations are a better focus of NOAAs resources on the parts of EBFM that clients/ stakeholders are prepared to use and on parts of EBFM that will address the greatest

challenges to sustainability in each Council region. There remain major challenges requiring serious and strategic attention to EBFM (*in sensu* Borja 2014). We have addressed them only tangentially in this report.

•How can we demonstrate the results of EBFM are making a difference in fisheries management and protection of marine diversity? Can these be compared across ecosystems? [The Comparative Analysis of Marine Ecosystem Organization (CAMEO) program, for example, showed the promise and value of efforts to answer this question.

•Can we actively manage for different ecosystem objectives, e.g., maximum economic yield as opposed to maximum sustainable yield and achieve better results using EBFM?

•To what extent is climate change/ocean acidification an ecosystem game changer for fisheries and their management? Fished ecosystems appear to be undergoing remarkable change, e.g., Gulf of Maine, Gulf of Mexico, California Current, Bering Sea and Arctic Ocean. Can we predict how they will continue to change?

•How can historic ecosystem state be used to inform fishery management by Council regions – or is this the right question to ask given climate change?

Marine ecosystems of the United States are important for fisheries and other ecosystem services. EBFM is one component of ocean management for which there is a significant but still not sufficient annual commitment of funding for monitoring and assessment at the ecosystem scale. The necessity of NMFS to partner with other NOAA line offices and other agencies to provide the nation with ecosystem sciences (natural and social) for decision-making is only going to increase. NOAA is moving toward an overall Ecosystem-Based Management approach across the agency; however continued and well-targeted efforts in fisheries are necessarily a part of that effort.

REFERENCES

Alaska Sea Grant. 1999. Ecosystem Approaches for Fisheries Management. University of Alaska Sea Grant, AK-SG-99-01. Fairbanks, AK. 756 pp.

Allen, M. (Ed.). 2011. Ecosystem Research Science Challenge Workshop: Informing NOAA's Ecosystem Research Agenda. NOAA. Silver Spring. MD. 34 pp.

Arkema, K., J. Alder, J. Cullis-Suzuki, V . Karpouzi, K. Kaschner, S. Mondoux, W. Swartz, P. Trujillo, R. Watson, D. Pauly, 2010. Aggregate performance in managing marine ecosystems in 53 maritime countries. Marine Policy 34:468-476.

Belgrano, A, and C. Fowler (Eds.) 2011. Ecosystem-Based Management for Fisheries: An Evolving Perspective. Cambridge University Press, Cambridge.

Berkes, F., J. Colding and C. Folke (Eds.) 2003. Navigating Socio-ecological Systems: Building Resilience for Complexity and Change. Cambridge University Press, Cambridge. 393 pp.

Berkes, F. 2011. Implementing ecosystem-based management: evolution or revolution?. Fish and Fisheries. DOI: 10:1111/j-1467-2979:00452.x.

Bernsted-Smith, R. and H. Kirkman. 2010. Comparison of Approaches to Management of Large Marine Areas. Fauna and Flora International, Cambridge, UK and Conservation International, Washington, DC. 144 pp.

Borja, A. 2014. Grand challenges in marine ecosystems ecology. Frontiers in Marine Science. Doi: 10.3389/fmars.2014.00001.

Busch, W-D, B. Brown, and G. Mayer. (Eds.) 2003. Strategic Guidance for Implementing and Ecosystem-based Approach to Fisheries Management. Prepared for MAFAC by the Ecosystem Approach Task Force, Department of Commerce, NOAA, NMFS. 62 pp.

Ceo, M., S. Fagnani, J. Swan, K. Tamada, H. Watanabe. 2012. Performance reviews by regional fishery bodies: introduction, summaries, synthesis and best practices. Vol. 1 CCAMLR, CCSBT, ICCAT, IOTC, NAFO, NASCO, NEAFC. FAO Fisheries and Aquaculture Circular No. 1072. FIPI/C1072 (En). 65 pp.

Chesapeake Bay Fisheries Ecosystem Advisory Panel (NOAA Chesapeake Bay Office. 2006. Fisheries Ecosystem Planning for Chesapeake Bay. American Fisheries Society. Trends in Fisheries Science and Management 3, Bethesda, MD. 450 pp.

Christensen, V. and J. MacLean (Eds.). 2011. Ecosystem Approaches to Fisheries: A Global Perspective. Cambridge University Press. New York. 325 pp.

Cormier, R., A. Kannen, M. Elliott, P. Hall and I. Davies (Eds.). 2013. Marine and Coastal Ecosystem-Based Risk Management Handbook. ICES Cooperative Research Report No. 317. ICES. Copenhagen. 60 pp.

Cullis-Suzuki, S. and D. Pauly. 2010. Failing the high seas: A global evaluation of regional fisheries management organizations. Marine Policy doi:10.1016/j.marpol.2010.03.002.

deReynier, Y., P. Levin, and N. Shoji. 2009. Bringing stakeholders, scientists, and managers together through an integrated ecosystem assessment process. Marine Policy doi:10.1016/j.marpol.2009.10.010.

Devillers, R., R. Pressey, A. Grech, J. Kittinger, G. Edgar, T. Ward and R. Watson. 2014. Reinventing residual reserves in the sea: Are we favouring ease of establishment over need for protection. Aquatic Conservation: Marine and Freshwater Systems. DOI: 10.1002/aqc.2445.

Ecosystem Principles Advisory Panel. 1999. Ecosystem-Based Fishery Management: Report to Congress by the Ecosystem Principles Advisory Panel. US Department of Commerce, NOAA, NMFS, Silver Spring, MD. 54 pp.,

Ekstrom, J., O. Young, S. Danines, M. Gordon and B. McCay. 2009. A tool to navigate overlaps in fragmented ocean governance. Marine Policy 33: 532-535.

Environmental Law Institute. 2007. Ecosystem-Based Management: Laws and Institutions. ELI. Washington, DC. 41 pp. and Appendices.

Field, J. and R. Francis. 2006. Considering ecosystem-based management in the California Current. Marine Policy 30:552-560.

Figge, F. 2004. Bio-folio: applying portfolio theory to biodiversity. Biological Conservation 13:827-849.

Fisheries Leadership & Sustainability Forum. 2012. Risk Policy and Managing for Uncertainty Across the Regional Fishery Management Councils. Prepared in support of the New England Fishery Management Council Risk Policy Workshop, March 20-21, 2013 www.fisheriesforum.org

Fisheries Leadership & Sustainability Forum. 2013. NEFMC Risk Policy Workshop: Workshop Summary, NEFMC and FLSF. 35 pp. www.fisheriesforum.org.

Fluharty, D. 2000. Habitat protection, ecological issues, and implementation of the sustainable fisheries act. Ecological Applications 10(2) 325-337.

Fluharty, D., C. Harvey, G. Jamieson, X. Jin, P. Livingston, M. Makino, V. Radchenko and C. Zhang. 2010. Developing an Ecosystem-Based Approach for Ocean Management in the PICES Region. Chapter 2 in Jamieson, G., P. Livingston and C. Zhang (Eds.). 2010. Report of Working Group 19 on Ecosystem-Based Management Science and its Application to the North Pacific. PICES Scientific Report No. 37. Sydney, BC. www.pices.int/publications/scientific_reports/Report37/Rep37.pdf.

Fogarty, M. 2014. The art of ecosystem-based fishery management. Perspective. Canadian Journal of Fisheries and Aquatic Science. 71:479-490.

Fogarty, M. and J. McCarthy (Eds.). 2014. The Sea: Marine Ecosystem-Based Management. The Sea Ideas and Observations on the Progress in the Study of the Seas. Volume 16. Harvard University Press. Cambridge, MA. 552 pp.

Food and Agriculture Organization, Fisheries Department. 2003. The Ecosystem Approach to Fisheries. FAO Technical Guidelines for Responsible Fisheries. No.4, Suppl 2. FAO, Rome. 112 pp.

Food and Agriculture Organization. 2009. Fisheries Management. 2. The Ecosystem Approach to Fisheries. 2.2 Human Dimensions of the Ecosystem Approach to Fisheries. FAO Technical Guidelines for Responsible Fisheries. No. 4, Supplement 2, Add.2. Food and Agriculture Organization of the United Nations. Rome.

Francis, R., M. Hixon, E. Clarke, S. Murawski, and S. Ralston. 2007. Ten commandments for ecosystem-based scientists. Perspective: Fisheries Management. Fisheries 32:5 217-233.

Gaichas, S., K. Aydin, and R. Francis. 2010. Using food web model results to inform stock assessment estimates of mortality and production for ecosystem-base fisheries management. Canadian Journal of Aquatic and Fishery Sciences 67: 1490-1506.

Grieve, C. and K. Short. 2010. Implementation of Ecosystem-Based Management in Marine Capture Fisheries: Case Studies from WWF's Marine Ecoregions. WWF, Australia. 80 pp.

Guerry, A. and 28 others. 2012. Modeling benefits from nature: using ecosystem services to inform coastal and marine spatial planning. International Journal of Biodiversity Sciences, Ecosystem Services and Management 1: 1-15.

Hempel,G. and K. Sherman, Eds. 2003. Large Marine Ecosystem of the World: Trends in Exploitation, Protection and Research. Vol. 12. Elsevier. Amsterdam. 423 pp.

Hennessey, T. and J. Sutinen, Eds. 2005. Sustaining Large Marine Ecosystems: The Human Dimension. Vol. 13. Elsevier, Amsterdam. 368 pp.

Hilborn, R. 2011. Future directions in ecosystem-based fisheries management: A personal perspective. Fisheries Research. 108 235-239.

Holland, D., J. Sanchirico, R. Johnston, D. Joglekar. Economic Analysis for Ecosystem-Based Management: Applications to Marine and Coastal Environments. Resources for the Future. RFF Press. Washington, DC. 225 pp.

Holliday, M. and A. Gautam (Eds.) 2005. Developing Guidelines for Regional Marine Ecosystem Approaches to Management. US Department of Commerce, NOAA, NMFS. 50 pp.

Hollowed, A., K. Aydin, T. Essington, J. Ianelli, B. Megrey, A. Punt, and A. Smith. 2011. Experience with quantitative ecosystem assessment tools in the northeast Pacific. Fish and Fisheries 12 189-208.

International Council for Exploration of the Sea (ICES). 2000. Report of the Working Group on Ecosystem Effects of Fishing Activities ICES CM 2000/ACME:02.

Jarre. A., S. Ragaller, and L. Hutchings. 2013. Long-term ecosystem-scale changes in the Southern Benguela marine pelagic social-ecological system: Interactions of natural and human drivers. Ecology and Society 18(4):55 http://dx.doi.org/10.5751/ES-05917-180455.

Kirkman 2010.

Levin, P., N. Cyr and K. Aydin. (Eds.). 2008. Report of the National Ecosystem Modeling Workshop. NOAA Fisheries, NOAA Technical Memorandum NMFS-F/SPO-87. 80 pp.

Levin, P., M. Fogarty, S. Murawski, D. Fluharty. 2009. Integrated ecosystem assessments: developing the scientific basis for ecosystem-based management of the ocean. PLoS Biology 7:1 1-6 e10000014.

Levin, S. and J. Lubchenco. 2008. Resilience, robustness, and marine ecosystem-based management. BioScience 58:1 1-7.

Link, J. 2002. Ecological considerations in fisheries management : When does it matter? Fisheries 27(4) 10-17.

Link, J., J. Brodziak, S. Edwards, W. Overholtz, D. Mountain, J. Jossi, T. Smith and M. Fogarty. 2002. Marine ecosystems assessment in a fisheries management context. Canadian Journal of Fisheries and Aquatic Sciences. 59 1429-1440.

Link, J. 2010. Ecosystem-Based Fisheries Management: Confronting Tradeoffs. Cambridge University Press, New York. 207 pp.

Link. J., T. Ihde, C. Harvey, S. Gaichas, J. Field, J. Brodziak, and H. Townsend. 2012. Dealing with uncertainty in ecosystem models: the paradox of use for living marine resource management. Progress in Oceanography 102:102-114.

Link, J., and Browman, H. 2014. ICES Journal of Marine Science, doi:10:1093/icesjms/fsu026.

McClancihan 2012.

Managing Our Nations Fisheries. 2013. Managing Our Nations Fisheries 3: Advancing Sustainability. Solicitation for registration. http://www.cvent.com/events/managing-our-nations-fisheries-3/event-summary.

McLaughlin, K.(Ed.). 2008. Mitigating Impacts of Natural Hazards on Fishery Ecosystems. American Fisheries Society Symposium 64. AFS Press, Bethesda, MD. 456 pp.

McLeod, K. and H. Leslie (Eds.). 2009. Ecosystem-Based Management for the Oceans. Island Press, Washington, DC. 367 pp.

McLeod, K., J. Lubchenco, S. Palumbi and A. Rosenberg (and 221 others). 2005. Scientific Consensus Statement on Marine Ecosystem-Based Management. Communication Partnership for Science and the Sea. http://compassonline.org/?q-EBM.

Murawski, S. 2000. Definitions of overfishing from an ecosystem perspective. ICES Journal of Marine Science 57: 649-658.

Murawski, S. 2006. Ten myths concerning ecosystem approaches to marine resource management. Marine Policy 31: 681-690.

National Marine Fisheries Service. 2004. NMFS Strategic Plan for Fisheries Research. US Department of Commerce. NOAA Technical Memo. NMFS F/SPO-61. 148 pp. www.st.nmfs.gov/st2/indes.html .

National Marine Fisheries Service. 2009. The State of Science to Support and Ecosystem Approach to Regional Fishery Management. Pursuant to the Magnuson-Stevens Fishery Conservation and Management Act, Section 406(f). NOAA Technical Memo. NMFS F/SPO-96. 17 pp. www.nmfs.noaa.gov/msa2007/docs/tm_96_repto_congress_final.pdf .

National Marine Fisheries Service. 2013. 2012 Report to Congress on the Status of U.S. Fisheries. US Department of Commerce, NOAA, NMFS, Office of Sustainable Fisheries. Silver Spring, MD. 20 pp.

National Marine Fisheries Service. 2014. National Ecosystem Modeling Workshop 3 (NEMoW3): Multi-Model Inference – Mingling Models for Marine Resource Management. Workshop Announcement and Agenda. Seattle. 4 pp.

National Marine Fisheries Service and Atlantic States Marine Fisheries Commission. 2013. How to incorporate ecosystem modeling products into the living marine resource management process. Workshop Summary , Woods Hole, MA, July 30-31, 2013

NOAA Chesapeake Bay Office. 2004. Fisheries Ecosystem Plan for Chesapeake Bay. NOAA/NMFS. Annapolis, MD. 350 pp.

NOAA 2006. Evolving an ecosystem approach to science and management through NOAA and its partners. http://www.sab.noaa.gov/Reports/eETT_Final_1006.pdf.

National Ocean Council 2013a. Implementation Plan for Marine Spatial Planning, Council on Environmental Quality, Office of the President. Washington, DC pp.

National Ocean Council 2013b. Marine Planning Handbook. Council on Environmental Quality, Office of the President, Washington, DC, 24 pp.

National Research Council. 1999. Sustaining Marine Fisheries. National Academy Press. Washington, DC 164 pp.

Osgood, K. 2013. Ecosystem-based fishery management: Council member training. Presentation, October 23, 2013, Silver Spring, MD.

Perry, I. and R. Ommer 2010. Introduction: Coping with global change in marine social-ecological system. Special Issue. Marine Policy 34:739-741.

Pew Oceans Commission. 2003. America's Living Oceans, Charting a Course for Sea Change: A Report to the Nation, Arlington, VA. The Pew Oceans Commission. 143 pp www.pewoceans.org .

Pikitch, E. and (16 others). 2004. Ecosystem-based fishery management. Science 305:346-347.

Pitcher, T., D. Kalikoski, K. Short, D. Varkey, and G. Ramod. 2009. An evaluation of progress in implementing ecosystem-based management of fisheries in 33 countries. Marine Policy. 33:223-232.

Plantier-Santos, C., C. Carollo, D. Yoskowitz. 2012. Gulf of Mexico ecosystem service valuation database (GecoServ): Gathering ecosystem services valuation studies to promote their inclusion in the decision-making process. Marine Policy 36:214-217.

Reiter, M., G. Matlock, J. Gentile, M. Harwell, R. Kelty , J. Barko, S. Baker and G. Scott. 2013. An integrated framework for informing coastal and marine ecosystem management decisions. Journal of Environmental Assessment Policy and Management. 15:1 (22 pp.)

Rosenberg, A., and K. McLeod. 2005. Implementing ecosystem-based approaches to management for the conservation of ecosystem services. Marine Ecology Progress Series: 300:270-274.

Rosenberg, A., T. Bigford, S. Leathery, R. Hill, and K. Bickers. 2000. Ecosystem approaches to fishery management through essential fish habitat. Bulletin of Marine Science 66:3 535-542.

Rosenfeld, J. 2002. Functional redundancy in ecology and conservation. Oikos 98:156-162.

Ruckelshaus, M., T. Klinger, N. Knowlton, and D. DeMaster. 2008. Marine ecosystem-based management in practice: Scientific and governance challenges. BioScience 58:1 53-63.

Samhouri, J., A. Haupt, P. Levin, J. Link and R. Shuford. 2013. Lessons learned from developing integrated ecosystem assessments to inform marine ecosystem-based management in the USA. ICES Journal of Marine Science; doi:10.1093/icesjms/fst141.

Seagraves, R. and K. Collins (Eds.) 2012. Fourth National Meeting of the Regional Fishery Management Council's Scientific and Statistical Committees. Report of a National SSC Workshop on Scientific Advice on Ecosystem and Social Science Considerations in US Federal Fishery Management. Mid-Atlantic Fishery Management Council, Williamsburg, VA.

Sugihara, G., R. May, H. Ye, C-H Hsieh, E. Dehle, M. Fogarty and S. Munch. 2012. Detecting causality in complex ecosystems. Scienceexpress/http://www.sciencemag.org/content/early/recent/21 September 2012/Page 1/10.1136/science.1227079.

Tallis. H. and 22 others. 2012. New metrics for managing and sustaining the ocean's bounty. Marine Policy 36: 303-306.

Turnipseed, M.. L. Crowder, R. Sagarin, and S. Roady. 2009. Legal bedrock for rebuilding America's ocean ecosystems. Science. [missing vol. pp.]

US Commission on Ocean Policy. 2004. Ocean Blueprint for the 21st Century. Washington, DC. US Commission on Ocean Policy. approx. 350 pp. www.oceancommission.gov .

Walters, C. and S. Martell. 2004. Fisheries Ecology and Management. Princeton University Press. Princeton, NJ. 325 pp.

Ward, T., D. Tarte, E. Hegerl and K. Short. 2002. Policy Proposals and Operational Guidance for Ecosystem-based Management of Marine Capture Fisheries. World Wide Fund for Nature. Sydney, Australia. 83 pp.

Watters 2004.

Willock, A. and M . Lack. 2006 Follow the leader: Learning from experience and best practice in regional fisheries management organizations. WWW International and Traffic International.

Witherell, D., C. Pautzke and D. Fluharty. 2000. An ecosystem-based approach for Alaskan groundfish fisheries. ICES Journal of Marine Science. 57 771-777.

Witherell, D.(Ed). 2004. Managing Our Nations Fisheries: Past, Present, Future. Proceedings of a Conference on Fisheries Management in the United State, Washington, D. C., November 13-15, 2003. 254 pp.

Witherell, D.(Ed). 2005. Managing Our Nations Fisheries II: Focus on the Future. Proceedings of a Conference on Fisheries Management in the United State, Washington, D. C., March 24-26, 2005. 283 pp.

ECOSYSTEM SCIENCES AND MANAGEMENT WORKING GROUP -- EXPLORATION OF EBFM – APPENDICES

Appendix A. Questions Posed to Presenters from Regional Fisheries Management Councils and Science Centers

Appendix B. Regional Council EBFM Tabulation Template and Key to Scoring

Appendix C. Frameworks Reviewed for Assessing Implementation of Ecosystem-Based Fisheries Management

Appendix D. Review of US Engagement in EBFM in Regional Fishery Management Organizations

Appendix E: NOAA Planning and Budgeting for EBFM 2003- 2014

Appendix F. Executive Summary of NMFS Report to Congress 2009

Appendix G. Review of US Engagement in EBFM in Regional Fishery Management Organizations

Appendix H. Legislative Mandates for Ecosystem-Based Fishery Management in United States

APPENDIX A QUESTIONS POSED TO PRESENTERS FROM REGIONAL FISHERIES MANAGEMENT COUNCILS AND SCIENCE CENTERS

Text from the January 2012 invitations (for February 2012 ESMWG meeting) follows:

Hello. We are the Co-Chairs of the NOAA Science Advisory Board's Ecosystem Sciences and Management Working Group (ESMWG). Our group is chartered to: provide advice to the NOAA Science Advisory Board (SAB) regarding NOAA's ecosystem related programs, in the context of national and international activities. The ESMWG focuses on the broad research, monitoring, and management components of NOAA's ecosystem portfolio, and assists the SAB assist in establishing plans, assessing progress, and reviewing priorities on a continuing basis.

Within that context, at our next meeting we are focusing on NOAA's Ecosystem-Based Fisheries Management activities, and in particular, how the ecosystem approach is changing NOAA science, science advice, policy and management decisions in fisheries.

The ESMWG members are meeting in Charleston, S.C. on February 1-3 and we invite you to discuss your perspectives from fisheries management, particularly how well NOAA is providing science to support ecosystem-based management of fisheries.

Our discussion of fisheries management is planned for the morning of February 2. If you are able to attend, we ask you to address the following issues:

In the Region in which you work, and in the context of the last 5-6 years, please address:

1. How much have you been pushed by CLIENT demands to broaden the range of ecosystem considerations going into you management decision-making?
2. How much have you been pushed by INSTITUTIONAL demands to broaden the range of ecosystem considerations going into you management decision-making?
3. If the pressures from the two directions are not working in harmony, how do you manage the discrepancies?
4. What are the major changes you have observed in the science advice you have been receiving over that period?
5. How much of the new components of the science advice have you actually been able to use in your decision-making?
6. What are NOAA's successes and shortcomings in providing the kind of management guidance you are looking for?
7. Are you not getting some advice that you need to complete an EAF (and do you think have you communicated those needs clearly)?
8. Most of the key documents on EBFM discuss FOUR facets to its implementation. How much appetite do you see in the management circles for each of the four components:

   --Taking more complete account of the main environmental drivers (physical oceanography, species interactions, habitat quality etc.) affecting the productivities of the stocks being managed.

   --Taking more complete account of the impact of the fishery on the ecosystem (e.g., bycatch, habitat impacts, changes in community structure, etc.).

--Making the management process more stake-holder inclusive (and empowered, not just consultation).

-Integrating decision-making in fisheries with decision-making in other ocean-industry sectors.

9. How well Is NOAA collaborating with academia, external researchers, and other agency partners in ecosystem- based plans for fisheries? Do you have any suggestions for improvement?

We are also inviting other speakers from two other FMCs in to participate in our meeting. Each speaker has 45 minutes: about a third of the time is for presentation (15-20 minutes), the other two thirds for discussion with members. There is also a discussion period after all the presentations have been made.

Please let us know by January 13 if you can attend. NOAA will pay for your travel costs; information on travel and logistics will be provided in a subsequent email.

If you have any questions on this request or the topics to be covered, please contact David Fluharty (fluharty@u.washington.edu).

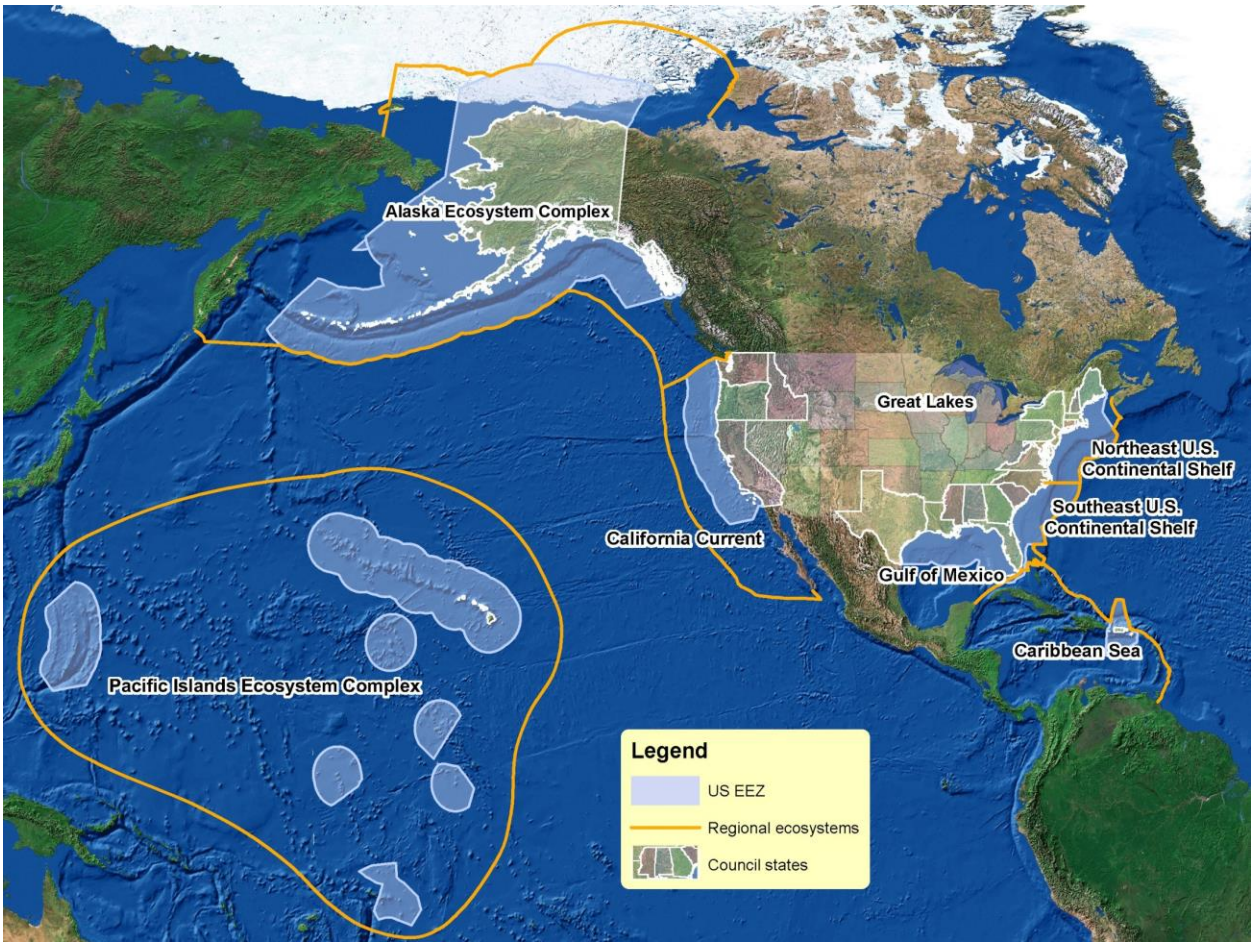
Signed by ESMWG CoChairs

Jo-Ann Leong

David Fluharty

APPENDIX B. REGIONAL COUNCIL EBFM TABULATION TEMPLATE AND KEY TO SCORING

Map Showing Region



Council Name

I. Questions on Science for Management

What is the state of regional EBFM science for fisheries management?

How is the fishery management council using EBFM science in management? Concomitantly, are Councils getting the science they need for management?

II. Questions for progress toward EBFM in fisheries management regions

Cease overfishing and develop rebuilding plans for overfished species

Delineate extent of ecosystem/interactions

Develop a conceptual model of the foodweb

Describe habitat needs of different life history stages of animals and plants in the "significant foodweb" and develop conservation measures

Calculate total removals – including incidental mortality and relate them to standing biomass, production, optimum yields, natural mortality and trophic structure

Assess how uncertainty is characterized and define what buffers against uncertainty are included in management actions

Develop indices of ecosystem health as targets for management. Has council set an ecosystem goal[s]?

Describe long term monitoring data and how they are used.

Assess the ecological, human and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/NMFS jurisdiction and define a strategy to address those influences.

Is there a Fishery Ecosystem Plan/ Fishery Management Plan employing EBFM?

Does the Council have a lead entity designated to advance EBFM in the Council process?

Are ecosystem models developed and available for use in the Council process?

Are decision support tools for EBFM / trade-off analysis employed [e.g., management strategy evaluation, risk assessments, ecosystem indicators, and scenarios]?

To what extent are spatial management tools applied [besides EFH measures above] to accomplish EBFM? [as opposed measures for allocation].

Other – Unique efforts that offer information

References

APPENDIX C. FRAMEWORKS REVIEWED FOR ASSESSING IMPLEMENTATION OF ECOSYSTEM-BASED FISHERIES MANAGEMENT

This Appendix contains references consulted when defining different ways to frame the evaluation of ecosystem based fisheries management.

Arkema,K., Alder, J., S. Cullis-Suzuki, V. Karpouzi, K. Kaschner, S. Mondoux, W. Swartz, P. Trujillo, R. Watson, D. Pauly. 2010. Aggregate performance in managing marine ecosystems of 53 maritime countries. Marine Policy 34:468-476.

Convention on Conservation of Antarctic Marine Living Resources (CCAMLR) www.ccamlr.org

Ecosystem Principles Advisory Panel. 1999. Ecosystem-Based Fishery Management: A Report to Congress by the Ecosystem Principles Advisory Panel. National Marine Fisheries Service. NOAA. Silver Spring, MD. 54 pp.

Fluharty, D., C. Harvey, G. Jamieson, X. Jin, P. Livingston, M. Makino, V. Radchenko and C. Zhang. 2010. Developing and Ecosystem-Based Approach for Ocean Management in the PICES Region. Chapter 2 in Jamieson, G., P. Livingston and C. Zhang (Eds.). 2010. Report of Working Group 19 on Ecosystem-Based Management Science and its Application to the North Pacific. PICES Scientific Report No. 37. Sydney, BC. www.pices.int/publications/scientific_reports/Report37/Rep37.pdf

Grieve, C., K. Short. 2010. Implementation of Ecosystem-Based Management in Marine Capture Fisheries: Case Studies from WWF's Marine Ecoregions. WWF Australia. 80 pp.

Hoff, T., D. Evans, and R. Shipp.2005. Developing an ecosystem approach to fisheries: Advisory Panel Report. In Witherell, D. (Ed.) Managing Our Nation's Fisheries II: Focus on the Future. Proceedings of a Conference on

Fisheries Management in the United States . Washington, DC March 24-26 NOAA Fisheries, Silver Spring, MD. 283 pp.

Link, J. 2002. Ecological considerations in fisheries management: when does it matter? Fisheries 27:4 10-17.

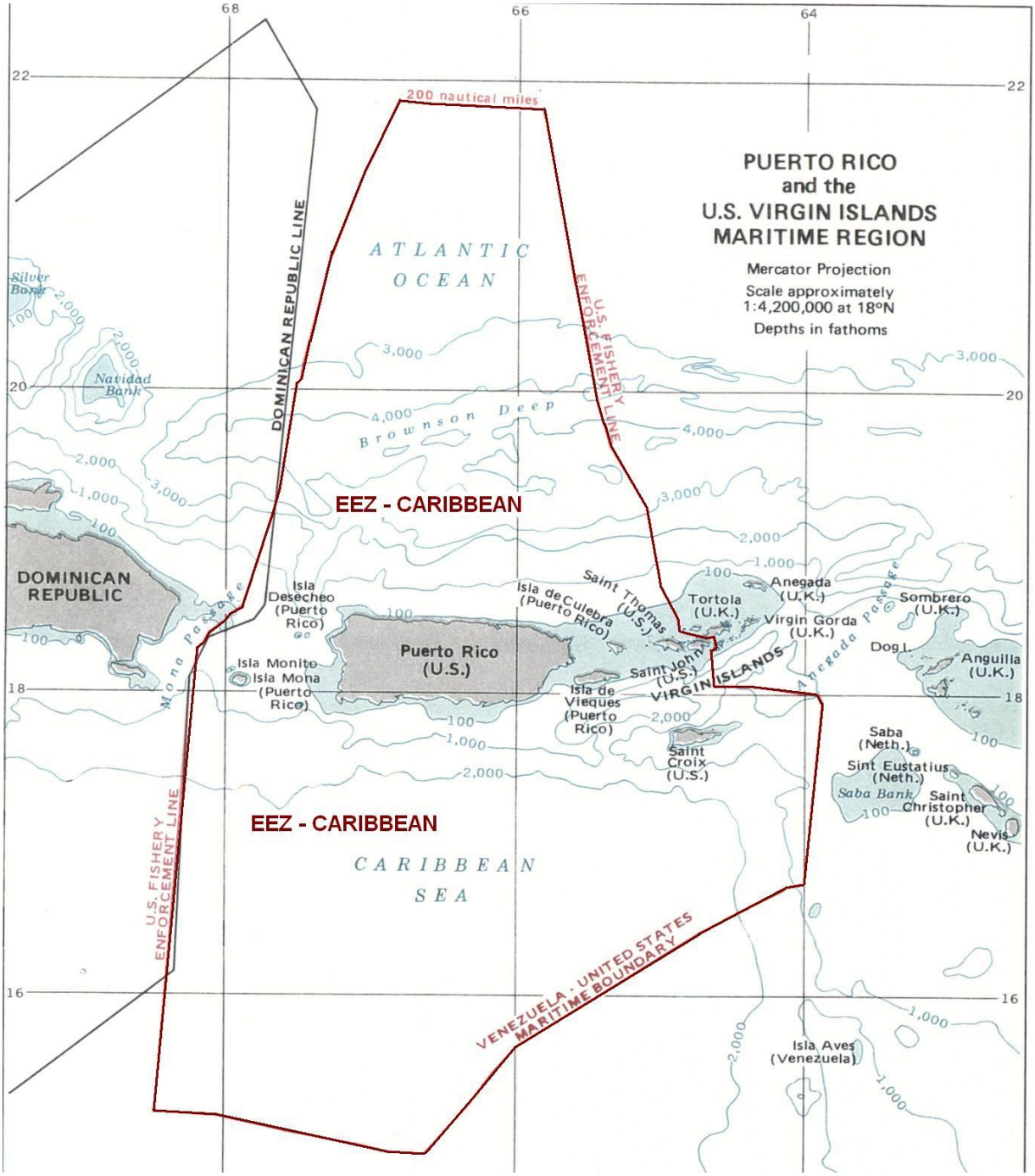
Ward, T., D. Tarte, E. Hegerl and K. Short. 2006. Ecosystem-Based Management of Fisheries: Policy Proposals and Operational Guidance for Ecosystem-Based Management of Marine Capture Fisheries. WWF Australia (2002) and WWF International (2006). 83 pp.

APPENDIX D. REGIONAL EBFM IMPLENTATION REPORTS

This Appendix is supplemental material to document the basis for the description of Council progress toward implementing EBFM. The overfishing and rebuilding plan evaluations are from the NMFS Fish Stock Sustainability Index (FSSI) 2013 Fourth Quarter reports. Similarly, Council approach to risk and uncertainty are primarily based Seagraves and Collins [Eds.] Fourth Meeting of the Regional Fishery Management Council's Scientific and Statistical Committees and Fisheries Leadership and Management Forum. 2012. Risk policy and management for uncertainty across the regional fishery management councils www.fisheriesforum.org . Report of a National SSC Workshop on Scientific Advice on Ecosystem and Social Considerations in US Federal Fishery Management, Mid-Atlantic Fishery Management Council, Williamsburg, VA. Other sources used for self-reporting by Council regions come from the Proceedings of three national conferences Managing Our Nation's Fisheries organized by the regional fishery management councils in 2003, 2005, and 2013. Regional reports for this study are reported in alphabetical order below.

These supplemental materials were developed by one member of the ESMWG on EBFM and then vetted by at least one additional subcommittee member to evaluate if sufficient information was provided to reach a similar conclusion about the level of Council action undertaken. These were then sent to a knowledgeable individual in each Council region for ground-truthing of the results. For all Councils that responded the evaluations have been considered accurate by these reviewers and they have provided additional and more up-to-date information on Council actions.

Regional Council EBFM – Caribbean Fisheries Management Council



I. Questions about science and management

What is the state of regional EBFM science for fisheries management?

The CFMC region lacks dedicated science capacity within the region. It depends on the South Atlantic Fisheries Science Center and the NOAA Coral Reef program for scientific support. Complementary studies that may enhance EBFM have been performed by the University of Puerto Rico, University of the Virgin Islands, and the NOAA NOS Biogeography Team. Members of the CFMC SSC have directed or collaborated upon many of these projects, and they and other institutional scientists communicate their work to the council. While no EBFM science has been directed by the council, onsite staff includes a habitat specialist. See comments in MON 3 – 2013 below. No presentation was made to the ESMWG.

How is the fishery management council using EBFM science in management? Concomitantly, are Councils getting the science they need for management?

The CFMC primarily uses available science for management of fished habitats. No presentation was made to the ESMWG. This assessment relies on Seagraves and Collins (Eds.) 2012.

II. What can be seen as progress toward EBFM in fisheries management regions?

Cease overfishing and develop rebuilding plans for overfished species

Some stocks were not well assessed in 1997 when three species groups were considered overfished. By 2007 five species were assessed as overfished, Queen conch, Grouper Unit 1,

Grouper Unit 4, Parrotfishes, Snapper Unit 1. In 2011, parrotfish and Snapper Unit 1 were not considered overfished. In 2012, overfishing is not occurring but four others remained in the overfished category with rebuilding plans. (Status of Stocks 2013)

As of the fourth quarter for 2013, the following Fish Stock Sustainability Index (FSSI) stocks were listed as overfished: Queen conch and Caribbean Grouper Units 1, 2, and 4. Rebuilding plans ranging from 9-30 years are in place for these four stocks. Additionally, Caribbean Snapper Unit 1 is listed as approaching the overfished condition, while the overfished status of Caribbean Snapper Units 3 and 4, and spiny lobster, are listed as unknown. No overfishing is occurring for the eight listed FSSI stocks.

For non-FSSI Caribbean stocks, the overfished status of these groups is unknown, except for parrotfishes which are approaching an overfished condition. No overfishing is identified as occurring for any non-FSSI stocks, although this status remains unknown for the angelfish, squirrelfish, and wrasse complexes within Puerto Rico, St. Thomas/St.Croix, and St. John.

Delineate extent of ecosystem/interactions

As can be seen the CFMC Area is part of a much larger Caribbean ecosystem over which jurisdiction is not exercised. CFMC participates in Caribbean-wide fisheries fora, e.g., Caribbean Regional Fisheries Mechanism, Caribbean Lionfish Response Network

Develop a conceptual model of the foodweb

Foodweb models exist for the Caribbean that are relevant to the US Caribbean Region but not explicitly developed for the Council management (Bascompte, Melian and Sala 2005). Main interest seems to be focused on change in trophic level over time.

Describe habitat needs of different live history stages of animals and plants in the "significant foodweb" and develop conservation measures

Those managed species are covered in the 1998 EFH Amendment [and FEIS 2004]

Calculate total removals – including incidental mortality and relate them to standing biomass, production, optimum yields, natural mortality and trophic structure

Did not find except with respect to required Annual Catch Limits and Accountability Measures for managed species

Assess how uncertainty is characterized and define what buffers against uncertainty are included in management actions

The Caribbean region is regarded as data poor for the most part and therefore has developed a tiered approach to stock assessments (FLSF 2012).

Develop indices of ecosystem health as targets for management. Has council set an ecosystem goal[s]?

Did not find except as represented in MSA requirements

Describe long term monitoring data and how they are used.

Only monitoring is of fish catch. Fishery-independent monitoring of reef fishes from Puerto Rico and USVI waters (and portions of the federal EEZ) has occurred since 1988 by the Caribbean South East Area Monitoring and Assessment Program (SEAMAP-C). Additionally, this program was expanded in 1995 to include recurring spiny lobster recruitment monitoring, and queen conch stock abundance surveys. Queen conch data collected by the Caribbean SEAMAP (overseen by the Puerto Rico Department of Natural Resources) have been spatially analyzed with which Marshak et al. (2006) identified large scale regions of the Caribbean EEZ critical to the life history of queen conch, the findings of which may be likewise applied towards EBFM. This program is overseen by the Puerto Rico Department of Natural and Environmental Resources, and results have been communicated to the council. For Puerto Rico, fisheries landings and biostatistical port sampled data are collected by the Puerto Rico Department of Natural and Environmental Resources Fisheries Research Laboratory, with information communicated periodically to the council. Again, these programs occur outside of council direction, especially given the limited habitat availability species within the deeper federal jurisdiction of the EEZ. From shoreline to 9 nautical miles offshore is Puerto Rico territorial jurisdiction where the bulk of habitats supporting these major fisheries exist. It is believed the situation is similar for USVI too, but data from federal waters are included in these programs too.

Additionally, SEAMAP-C data and fishery dependent data have been used to evaluate the effectiveness of seasonal closures of identified spawning aggregation sites off the west coast of Puerto Rico (Marshak and Appeldoorn 2008), but not in an ecosystem context. However, these findings have been used to justify extending seasonal closures and enacting seasonal moratoria of fishing in key platform regions (Tonioli and Agar 2009), in addition to emphasizing the socioeconomic components of these strategies.

Assess the ecological, human and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/NMFS jurisdiction and define a strategy to address those influences.

Did not find specific reference to a strategy although Council participation in Caribbean Regional Fisheries Mechanisms and Forums is taking place

Is there a Fishery Ecosystem Plan/ Fishery Management Plan employing EBFM?

Scoping is being undertaken to develop species-based fisheries management to island-based fishery management, i.e., moving from four species-based Fishery Management Plans to three island-based comprehensive management plans (CFMC 2013).

Does the Council have a lead entity designated to advance EBFM in the Council process?

Habitat Committee is most likely the most likely to consider ecosystem science in its deliberations on Essential Fish Habitat

Are ecosystem models developed and available for use in the Council process?

Similar to foodweb models, ecosystem models for the Caribbean are not explicitly targeted on the Council area. See review (Smikle, Christensen, and Aiken 2010).

Are decision support tools for EBFM / trade-off analysis employed [e.g., management strategy evaluation, risk assessments, ecosystem indicators, and scenarios]?

Did not find discussion of this in Council documents

To what extent are spatial management tools applied [besides EFH measures above] to accomplish EBFM? [as opposed measures for allocation].

Spatial habitat measures are being taken under EFH. Again, there is spatial work being done in studies by other aforementioned groups, especially the NOS Biogeography team (habitat and fish/invertebrate associations), but not specifically by the council or applied in tools to my knowledge. An extensive mapping of benthic habitats of the US Caribbean exists, and some detailed mapping by side-scan sonar throughout the EEZ. The findings of these studies are applicable toward EBFM, but it does not appear to be actively being used in that way. There may be a lot of data available on many subjects related to fisheries management, but have yet to be analyzed or applied rigorously in any format.

Other

References:

Council Website: http://www.caribbeanfmc.com [Last accessed March 10, 2014]

Appeldoorn, R. 2008. Transforming reef fisheries management: application of an ecosystem-based approach in the US Caribbean. Environmental Conservation 35(3) 232-241.

Bascompte, J., C. Melian and E. Sala. 2005. Interaction strength combinations and the overfishing of a marine food web. PNAS 102(15) 5443-5447.

Caribbean Fishery Management Council, NOAA. 2013 (June). Development of A Comprehensive Fishery Management Plan for the Exclusive Economic Zone of Puerto Rico: Scoping Document. San Juan, Puerto Rico. Pp. 12.

Fanning, L, R. Mahon, and P. McConney. 2013. Appling the large marine ecosystem (LME) governance framework in the Wider Caribbean Region. Marine Policy 42: 99-110.

Fisheries Leadership and Management Forum. 2012. Risk policy and management for uncertainty across the regional fishery management councils. www.fisheriesforum.org

Managing Our Nation's Fisheries. 2012. Pp. 31-31 /

Marshak, A.R. and R.S. Appeldoorn. 2008. Evaluation of seasonal closures of red hind, Epinephelus guttatus, spawning aggregations to fishing off the west coast of Puerto Rico using fishery-dependent and independent time series data. Proceedings of the Gulf and Caribbean Fisheries Institute 60: 566-572..

Marshak, A., R. Appeldoorn, and N. Jimenez. 2006. Utilization of GIS mapping in the measurement of the spatial distribution of queen conch (Strombus gigas) in Puerto Rico. Proceedings of the Gulf and Caribbean Fisheries Institute 57: 31-47.

Seagraves, R. and K. Collins [Eds.] Fourth Meeting of the Regional Fishery Management Council's Scientific and Statistical Committees. Report of a National SSC Workshop on Scientific Advice on Ecosystem and Social Considerations in US Federal Fishery Management, Mid-Atlantic Fishery Management Council, Williamsburg, VA.

Smikle, S. V. Christensen and K. Aiken. 2010. A review of Caribbean ecosystems and fishery resources using ECOPATH models. Etudes Caribeennes 15 Avril 2010.

Tonioli, F. and J. Agar. 2009. Extending the Bajo de Sico, Puerto Rico, seasonal closure: An examination of small-scale fishermen's perceptions of possible socio-economic impacts on fishing practices, families, and community. Marine Fisheries Review 71(2): 15-23.

Regional Council EBFM – Gulf of Mexico Fisheries Management Council

I. Questions regarding science and management

What is the state of regional EBFM science for fisheries management?

No presentation was made to the ESMWG. In recent years the issues have been on how to implement fishery management requirements under a TAC program and responding to the Deep Water Horizon spill. Sources include, Southeast Fisheries Science Center, NMFS Galveston, TX Laboratory, Gulf of Mexico Research Institute, Gulf States Marine Fisheries Commission, Northern Gulf Institute, Harte Research Institute as well as State Agencies. A very recent development is the preparation of an ecosystem status report for the Gulf of Mexico that would seem to contribute greatly to the synthesis of ecosystem science for management (Karnauskas et al. 2013)

How is the fishery management council using EBFM science in management? Concomitantly, are Councils getting the science they need for management?

No presentation was made to the ESMWG. In 2004 the GMFMC was allocated $250,000 which it used to sponsor a series of workshops on EBFM (Jepson 2005). In 2007-2008 the GMFMC sponsored a series of three ecosystem modeling workshops. There appears to be an active dialogue between the Council and the scientific community on EBFM. (GMFMC 2007/08). A GMFMC Ecosystem Scientific and Statistical Committee was established around 2007. Its initial focus is providing ecosystem advice to the Council with emphasis on enhancing the quality of ecological information used in stock assessments and to incorporate socio-economic into EBFM. (GMFMC Ecosystem SSC 2010).

II. What can be seen as progress toward EBFM in fisheries management regions?

Cease overfishing and develop rebuilding plans for overfished species

Knowledge of the status of stocks in the GOM relative to overfishing improved from 1997 so that by the end of 2007 four species were considered overfished [red snapper, greater amberjack, gag grouper and gray triggerfish]. In 2012, overfishing for red snapper was no longer occurring, but remained classified as overfished. As of the fourth quarter of 2013, all FSSI overfished stocks have rebuilding plans in place ranging from 6-32 years. (SOS 2013) Additionally the statuses of hogfish, snowy grouper, and royal red shrimp remain unknown, although overfishing is still occurring for hogfish.

For non-FSSI stocks, overfishing is occurring for the Gulf of Mexico jacks complex, while the overfished status remains unknown for non-FSSI antipatharians, hydrozoans, corals, jacks, snappers, groupers, and tilefishes.

Delineate extent of ecosystem/interactions

The US EEZ in the Gulf is only the northern portion of a much vaster Gulf of Mexico ecosystem still it is large enough to have significant management issues, e.g., upstream with the drainage of the Mississippi River into the Gulf of Mexico producing a large hypoxic zone and more broadly what happens in Cuban and Mexican waters. Sub-regional ecosystem boundaries have been discussed in workshops [Jepson 2005]. GOM Council works with the Gulf States Marine Fisheries Commission, Gulf of Mexico Alliance and the GOM Research Institute among others. The new ecosystem status report for the Gulf of Mexico fills a large gap in terms of synthesizing what is known (Karnauskas et al. 2013

Develop a conceptual model of the foodweb

GMFMC sponsored two workshops on ecosystem modeling in 2007 and 2008 (GMFMC 2007/2008; Walters et al. 2008; Vidal and Pauly 2004; de Mutsert et al. 2008).

Describe habitat needs of different life history stages of animals and plants in the "significant foodweb" and develop conservation measures

GMFMC has developed EFH amendments to its FMPs for managed species 2005 which resulted in some marine reserves for sea turtles and some spawning aggregations of fish. Some prohibitions on anchoring and use of certain gear types we also made. Updates will be made as scientific information becomes available.

Calculate total removals – including incidental mortality and relate them to standing biomass, production, optimum yields, natural mortality and trophic structure

GMFMC efforts here can be characterized as full implementation of MSA requirements with good estimates of all significant sources of incidental mortality, etc.. Total removals including discard mortality is calculated in the stock assessments and incorporated into the estimates of fishing mortality and stock status. The assessment does not always report the total removals or discard mortality in the written report, but discard mortality is removed prior to reporting of future landings projections. After the massive red tide event of 2005-2006, the assessment model was modified to allow this additional mortality event to be incorporated into the assessment. On occasion, the Council may account for additional discard mortality. A case in point is the current commercial gag quota. Gag, along with other groupers, are managed under an IFQ system. In 2011, Reef Fish Amendment 32 reduced the

commercial gag quotas for 2012-2014 to 86% of the ACT to account for additional discard mortality that was expected to occur as a result of fishermen targeting red grouper and having an incidental catch of gag, but being unable to keep them due to a scarcity of gag IFQ shares (personal communication Atran)

Assess how uncertainty is characterized and define what buffers against uncertainty are included in management actions

Did not find specific efforts to do this systematically across the ecosystem.

Develop indices of ecosystem health as targets for management. Has council set an ecosystem goal[s]?

Council's Ecosystem SSC has Defined and set the Goal of EBFM:

Definition: " EBFM means making a decision concerning the management of a fishery species or species complex based Knowledge of ecosystem-level considerations that will improve the quality of the decision; Knowledge of how the decision will affect the ecosystem or ecosystem s to which the species belongs." An ecosystem-based management measure is one that includes explicit consideration of non-target species and/or habitat/climate"

Ecosystem Goal "Restore and conserve marine resources, taking into account the protection of marine ecosystem, and foster the long-term sustainable use of marine resources in an ecologically and culturally sensitive manner through the use of a science-based ecosystem approach to resources." (GMFMC Ecosystem SSC 2010).

Describe long term monitoring data and how they are used.

Did not find an authoritative source for EBFM monitoring. Fisheries are part of the large scale post-Katrina and Deep Water Horizon monitoring efforts

Assess the ecological, human and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/NMFS jurisdiction and define a strategy to address those influences.

This issue is recognized and was discussed at the GOM Council's 2005 Workshop but there does not appear to be any action taken or continued dialogue. The annual hypoxic zone is a consequence of terrestrial and river discharge from a significant part of the United States and oil spills – both chronic and catastrophic are dominating the institutional issues far beyond fisheries. The strategy is to be a player in all these issues.

Is there a Fishery Ecosystem Plan/ Fishery Management Plan employing EBFM?

Discussion has taken place but apparently no further action.

Does the Council have a lead entity designated to advance EBFM in the Council process?

GOM Council has designated an Ecosystem Scientific and Statistical Committee to lead these discussions but since the Deep Horizon spill there does not seem to have been much progress of the Ecosystem SSC since 2010.

Are ecosystem models developed and available for use in the Council process?

Yes, although it is not clear what has happened since 2010 based on information on the website. Presumably, work has continued.

Are decision support tools for EBFM / trade-off analysis employed [e.g., management strategy evaluation, risk assessments, ecosystem indicators, and scenarios]?

Did not find examples except possibly the modeling exercises from the Workshops

To what extent are spatial management tools applied [besides EFH measures above] to accomplish EBFM? [as opposed measures for allocation].

Did not find any measures beyond EFH FMP amendments. Council is engaged with the Gulf of Mexico Alliance [led by Governors of the Gulf of Mexico States]

Other

References:

Council Website: www.gulfcouncil.org [last accessed March 10, 2014]

De Mutsert, K, J. Cowan, T. Essington and R. Hilborn. 2008. Reanalysis of Gulf of Mexico fisheries data: Landings can be misleading in assessments of fisheries and fisheries ecosystems. PNAS 105(7) 2740-2744. www.pnas.org/cgi/doi/10.073/pnas.0704354105.

Fisheries Leadership and Management Forum. 2012. Risk policy and management for uncertainty across the regional fishery management councils. www.fisheriesforum.org

Gulf of Mexico Fishery Management Council. 2007/2008. A series of three ecosystem modeling workshops were held

Gulf of Mexico Fishery Management Council Ecosystem SSC 2010. Report of the Ecosystem SST.

Jepson, M. 2005. Ecosystem Fisheries Management: A Summary of Workshops Conducted Along the Gulf Coast: A Report Prepared for the Gulf of Mexico Fishery Management Council. 35 pp.

Karnauskas, M. M. Schirripa, C. Kelble, G. Cook, and K. Craig. 2013. Ecosystem Status Report for the Gulf of Mexico. NOAA Technical Memorandum NMFS-SEFSC-653. US Department of Commerce. National Marine Fisheries Service, Southeast Fisheries Science Center. Miami. 57 pp.

Managing Our Nation's Fisheries. 2012. Pp. 31-35 /

See also Seagraves, R. and K. Collins [Eds.] Fourth Meeting of the Regional Fishery Management Council's Scientific and Statistical Committees. Report of a National SSC Workshop on Scientific Advice on Ecosystem and Social Considerations in US Federal Fishery Management, Mid-Atlantic Fishery Management Council, Williamsburg, VA.

Vidal, L, and D. Pauly. 2005. Integration of subsystems models as a tool toward describing feeding interactions and fisheries impact in a large marine ecosystem, the Gulf of Mexico. Ocean and Coastal Management 47 709-725;

Walters, C S. Martell, V. Christensen and B Mahmoudi. 2008. An ECOSIM model for exploring Gulf of Mexico Ecosystem management option: Implication of including multistanza, life history models for policy prediction. Bulleting of Marine Science 83(1) 251-271.

MID ATLANTIC FISHERY MANAGEMENT COUNCIL

I. Questions for Science and Management

What is the state of regional EBFM science for fisheries management?

ESMWG received a PowerPoint. presentation from John Boreman that covered science and management [ESMWG website]. Science advice covers quota setting process and ecosystems-related advice is expanding and the Council is learning as it goes. Ecosystems-related advice has convinced the Council that EBFM is more complex than originally envisioned.

How is the fishery management council using EBFM science in management? Concomitantly, are Councils getting the science they need for management?

A key need is scientific information on influence of ecosystem processes [biological and physical] on natural mortality especially with respect to stock assessments. Scientific advice on ecosystems seems to differ from habitat sciences with the programs appearing to be on different tracks from the vantage point of fisheries management [Boreman ppt.].

I. What can be seen as progress toward EBFM in fisheries management regions?

Cease overfishing and develop rebuilding plans for overfished species

According to the US Status of Stocks (2013) the Mid Atlantic has no species where overfishing is occurring and none that are overfished. As of the fourth quarter of 2013, no FSSI stocks are listed as overfished; while a 10-year rebuilding plans continues to be in effect for mid-Atlantic coast tilefish. The overfished status of northern shortfin squid of the NW Atlantic Coast remains unknown. No non-FSSI stocks are included for the mid-Atlantic.

Delineate extent of ecosystem/interactions

MAFMC seems well aware of its EEZ and with interactions with species crossing those boundaries to the north and south. It has forged relationships in science and management with the New England FMC and with the South Atlantic FMC as well as the Atlantic States Fisheries Commission. A $250k appropriation allowed MAFMC to hold public meetings, identify needs and available information, synthesize public input and prepare a final report on EBFM (MAFMC 2006).

It continues to discuss these as part of its Strategic Plan 2014-2018 where it is anticipated that a Council Ecosystem Guidance document will be developed to serve as an umbrella for Council actions under MSA and it's Fishery Management Plans (MAFMC 2014)

Develop a conceptual model of the foodweb

Yes, a model exists and was developed with a lot of cooperation from the NEFSC but it is not clear how this is being used in the Council process. (Okey n.d.)

Describe habitat needs of different life history stages of animals and plants in the "significant foodweb" and develop conservation measures

Presumably much of this has been done but specific reference not on Council website or cited in FMPs, e.g., (Shepherd et al. 2012).

Calculate total removals – including incidental mortality and relate them to standing biomass, production, optimum yields, natural mortality and trophic structure

This is done to some extent in compliance with the MSA mandates for TAC and ACL but not systematically across the ecosystem. Council focus seems to be more on habitat/ecosystem interactions. (Packer, 2011).

Assess how uncertainty is characterized and define what buffers against uncertainty are included in management actions

Strategic plan calls for work to be done on this set of issues 2014-2018. (MAFMC 2013)

Develop indices of ecosystem health as targets for management. Has council set an ecosystem goal[s]?

The Council is moving toward science and management with the "ultimate goal of the Ecosystem Approach to Fishery Management is to manage for ecologically sustainable utilization of living marine resources while maintaining ecosystem productivity, structure and function (www.mafmc.org)

Describe long term monitoring data and how they are used.

Primary data are of fish harvests and population parameters used in stock assessments. Strategic plan points in the direction of developing climate monitoring relative to fish mortality and distribution (MAFMC 2013).

Assess the ecological, human and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/NMFS jurisdiction and define a strategy to address those influences.

Primary linkages are with New England FMC, South Atlantic FMC and Atlantic States Marine Fisheries Commission. MAFMC is attempting to be pro-active with respect to the National Ocean Policy directives on marine spatial planning (MAFMC 2013).

Is there a Fishery Ecosystem Plan/ Fishery Management Plan employing EBFM?

The Council has been moving toward the development of an Ecosystem Approach to Fisheries Management Guidance Document and completion is envisioned in its Strategic Plan (MAFMC 2014).

Does the Council have a lead entity designated to advance EBFM in the Council process?

The Council has recently appointed an Advisory Panel on Ecosystems and Ocean Planning to advise it on the approach. The Council's SSC has been a leading element for the Council's transition from single species management toward ecosystem approaches to management. (Seagraves and Collins 2012).

Are ecosystem models developed and available for use in the Council process?

These have been primarily habitat / fisheries related and not ecosystem models per se but greater use of such models is envisioned in the Strategic Plan (MAFMC 2014)

Are decision support tools for EBFM / trade-off analysis employed [e.g., management strategy evaluation, risk assessments, ecosystem indicators, and scenarios]?

Decision support tools for trade-off analysis in fisheries, climate change and marine spatial planning are seen as important new areas of development in the Strategic plan (MAFMC 2013)

To what extent are spatial management tools applied [besides EFH measures above] to accomplish EBFM? [as opposed measures for allocation].

Primary use is for implementation of EFH with respect to fisheries and deep water corals and other habitats.

Other – Unique efforts that offer information

References: **www.mafmc.org .** Last accessed March 10 2014]

Fisheries Leadership and Management Forum. 2012. Risk policy and management for uncertainty across the regional fishery management councils. www.fisheriesforum.org

Mid Atlantic Fishery Management Council, 2006. MAFMC – Evolution towards an ecosystem approach to fisheries. MAFMC NOAA Award NAO4NMF4410368. 497 pp.

Mid Atlantic Fishery Management Council 2013. Mid-Atlantic Fishery Management Council: 2014-2018 Strategic Plan.

Okey, T. n.d., A "straw-man" Eco path model of the Middle Atlantic Bight, continental shelf United States. Web reference incomplete. Part of the Sea Around Us Project at the Fisheries Centre, University of British Columbia.

Packer, D. (Ed.). 2010. Proceedings of the Mid-Atlantic Fishery Management Council's Habitat-Ecosystem Workshop, Virginia Beach, VA, December 13-14, 2010. NOAA/NMFS Office of Habitat Conservation, Silver Spring, MD. 67 pp.

Seagraves, R. and K. Collins [Eds.] Fourth Meeting of the Regional Fishery Management Council's Scientific and Statistical Committees. Report of a National SSC Workshop on Scientific Advice on Ecosystem and Social Considerations in US Federal Fishery Management, Mid-Atlantic Fishery Management Council, Williamsburg, VA.

Shepherd, G, K. Shertzer, J. Coakley, and M. Caldwell (Eds.). 2012. Proceedings on a workshop on modeling protogynous hermaphrodite fishes, Raleigh, NC. 33 pp. or online at www.mafmc.org.

NEW ENGLAND FISHERY MANAGEMENT COUNCIL

I. Questions for science and management

What is the state of regional EBFM science for fisheries management?

ESMWG received a presentation by Michael Fogarty, Northeast Fisheries Science Center whose ppt. is on the WG website. This is further augmented by materials found on the NEFSC website www.nefsc.noaa.gov/ecosys/ . The state of regional science has to be considered to be among the best in the world in every dimension (Link et al. 2011). A regional ecosystem advisory is issued since 2013 two times per year (nefsc.noaa.gov/ecosys/advisory/current).

How is the fishery management council using EBFM science in management? Concomitantly, are Councils getting the science they need for management?

Despite world class scientific information being available it is difficult to characterize the relationship between the New England Council and the NEFSC. The SSC has been a good source of information that the Council wants. Its role in developing the present implantation approach toward a Fisheries Ecosystem Plan is quite strong. It appears that reliance on and trust of the available science is increasing.

II. What can be seen as progress toward EBFM in fisheries management regions?

Cease overfishing and develop rebuilding plans for overfished species

New England still has eight species on the overfishing list and twelve stocks on the overfished list as defined by the US Status of Stocks Report to Congress for 2012 (NMFS, 2013). All these stocks are subject to rebuilding plans

Delineate extent of ecosystem/interactions

New England has delineated extent of ecosystems interaction quite extensively because of the transboundary issues with Canada but also because the area is well studied as documented in many ways (e.g. NEFMC, SSC 2010; Pershing et al. 2013; Link et al. 2011)

Develop a conceptual model of the foodweb

Foodwebs and other models for the New England FMC area are very well developed as can be seen in the recent Center for Independent Experts peer review of the models (Smith 2011)

Describe habitat needs of different life history stages of animals and plants in the "significant foodweb" and develop conservation measures

An accessible review of the basis for ecosystem based management using life history information is available as (NEFSC 2013)

Calculate total removals – including incidental mortality and relate them to standing biomass, production, optimum yields, natural mortality and trophic structure

This has been done as a result of fishery management mandates under the MSA. The NEFMC prioritizes research on all aspects of bycatch (NEFMC n.d.)

Assess how uncertainty is characterized and define what buffers against uncertainty are included in management actions

While the scientific ability to address this exists in the NEFSC it is not clear the extent to which it is utilized in management advice by the SSC except with respect to MSA requirements in stock assessments.(FLSF 2012). The NEFMC research and priorities for 2009-2013 indicate that the Council would like to develop a management strategy evaluation program to address scientific and management uncertainty (NEFMC n.d.)

Develop indices of ecosystem health as targets for management. Has council set an ecosystem goal[s]?

The Council has discussed goals for ecosystem-based management starting in 2004-2005 and as the starting point for its Ecosystem-Based Fishery Management Plan process there is an expectation to establish goals in the near future. (NEFMC, SSC ppt. April 2011) available at www.nefmc.org. It is not clear to what extent indices of ecosystem "health" are anticipated but indicators to be tracked are likely to be defined according to the NEFMC Strategic Plan.

Describe long term monitoring data and how they are used.

NEFMC through the NEFSC has access to a robust monitoring system that includes satellites, vessels, buoys, voluntary programs, etc. Scientific advice to the Council is driven by these data. Most recently, the parameters modeled have been used to report comprehensively on the status of the NE US Continental Shelf and Large Marine Ecosystem (NEFSC 2009).

As of the fourth quarter of 2013, several FSSI stocks continue to be listed as overfished with overfishing still occurring: Georges Bank Atlantic cod, Gulf of Maine Atlantic cod, Gulf of Maine/Georges Bank windowpane, NW

Atlantic Coast witch flounder, Cape Cod/Gulf of Maine yellowtail flounder, Georges Bank yellowtail flounder, and Gulf of Maine thorny skate. Rebuilding plans are in effect for these species ranging from 7-25 years.

Three FSSI stocks continue to be overfished with a cessation in overfishing: NW Atlantic coast Atlantic halibut, NW Atlantic coast ocean pout, and southern New England/Mid-Atlantic winter flounder, with 10-52 year rebuilding plans in effect.

While these stocks are no longer classified as overfished, rebuilding plans continue to be in effect for six stocks: Gulf of Maine/Georges Bank American plaice, Gulf of Maine/Georges Bank white hake, Georges Bank white flounder, Georges Bank/southern New England barn door skate, and Gulf of Maine smooth skate. Additionally the overfished statuses of NW Atlantic red deep sea crab, NW Atlantic coast offshore hake, and Gulf of Maine winter flounder remain unknown. Stocks that are not classified as overfished, but experiencing overfishing include: Gulf of Maine haddock and Georges Bank/southern New England winter skate.

Two non-FSSI stocks continue to be overfished with a cessation in overfishing: Gulf of Maine Atlantic salmon and Gulf of Maine/Georges Bank Atlantic wolf fish. A rebuilding plan timeline is included for Atlantic wolffish (currently in year 4), while Atlantic salmon are under ESA listing, but with no specific rebuilding plan given.

Assess the ecological, human and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/NMFS jurisdiction and define a strategy to address those influences.

As illustrated by the Figure for the NEFMC area above, the NEFMC is engaged first and foremost with Canada on fisheries issues but is also mindful of traditional and emerging multiple uses of the continental shelf. The emphasis on marine spatial planning at the federal level as well as among states in the region has generated science to inform these issues. The extent to which the NEFMC has engaged with institutions beyond fisheries is not evaluated here. (NEFMC, SSC ppt. April 2011).

Is there a Fishery Ecosystem Plan/ Fishery Management Plan employing EBFM?

After a significant ramping up period to the idea of preparing an Strategic Plan to implement ecosystem based fishery management, the NEFMC decided in June 2011 to embark on a formal five stage, five year process to develop the plan (with the commitment to update it at intervals of five years) NEFMC 2011).

Does the Council have a lead entity designated to advance EBFM in the Council process?

The Council SSC has more or less supported the EBFMP process. It has now appointed an Ecosystems Based Management Committee to provide advice to It on the development of the Plan and other ecosystem issues before the council (www.nefmc.org).

Are ecosystem models developed and available for use in the Council process?

Yes, extremely well developed. See response on foodweb models above (Smith, 2011; Link et al. 2011).

Are decision support tools for EBFM / trade-off analysis employed [e.g., management strategy evaluation, risk assessments, ecosystem indicators, and scenarios]?

Development of such tools is strongly supported in the Council's research priorities (NEFMC n.d.) and especially in the EBFMP development. There is recognition of the need to trade off fisheries habitat impacts as well as potential interactions with other uses in a broader approach to marine spatial planning (NEFMC, SSC 2010)

To what extent are spatial management tools applied [besides EFH measures above] to accomplish EBFM? [as opposed measures for allocation].

The EBFMP anticipates partitioning the NE Continental Shelf into Ecosystem Production Units based on the ecosystem characteristics. Some of this partitioning is already done in terms of spatial management fish stocks (NEFMC, SSC 2010)

Other – Unique efforts that offer information

References : Council Website: www.nefmc.org. Last accessed March 10, 2014

Fisheries Leadership and Management Forum. 2012. Risk policy and management for uncertainty across the regional fishery management councils. www.fisheriesforum.org

Link, J., A. Bundy, W. Overholtz, Nancy Shackell, J. Manderson, D. Duplisea, J. Hare, M. Koen-Alonso and K. Friedland. 2011. Northwest Atlantic ecosystem-based management for fisheries. Chapter 2 in A. Belgrano and C. Fowler (Eds.). Ecosystem-Based Management for Marine Fisheries: An Evolving Perspective, Cambridge University Press. Pp. 384.

New England Fishery Management Council. n.d. Draft New England Fishery Management Council Research Priorities and Data Needs 2009-2013.

New England Fishery Management Council, Scientific and Statistical Committee. 2010. White Paper on Ecosystem-Based Fishery Management for New England Fishery Management Council. 25 pp.

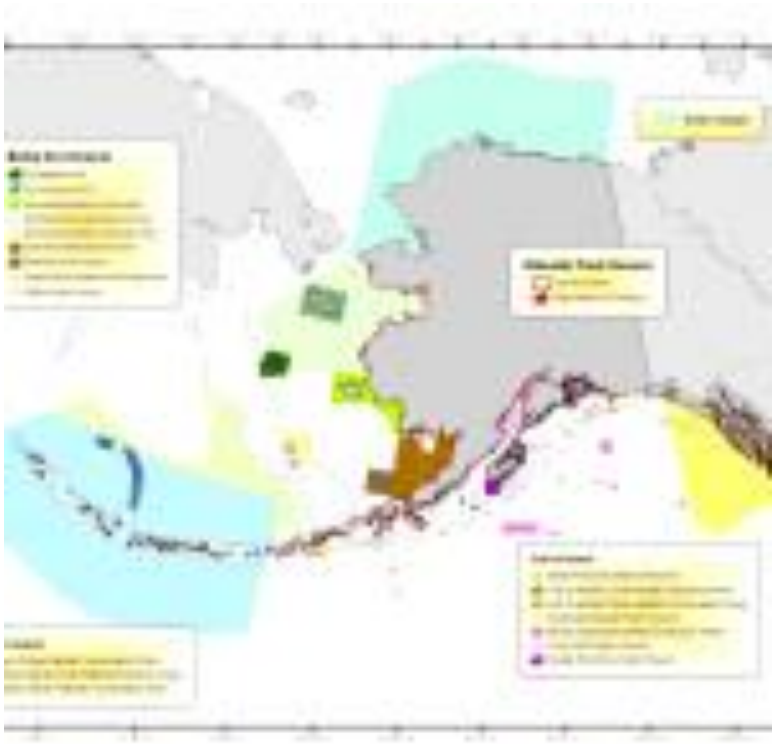
Northeast Fisheries Science Center, Ecosystem Assessment Program. 2009. Ecosystem Status Report: for the Northeast US Continental Shelf Large Marine Ecosystem. Northeast Fisheries Science Center Reference Document 09-11 Woods Hole, MA. 61 pp. www.nefsc.noaa.gov/nefsc/publications/.

Northeast Fisheries Science Center. n.d. Ecology of the Northeast Continental Shelf: Toward and Ecosystem Approach to Fisheries Management, NMFS. Woods Hole, MA.

Pershing, A., J. Annala, S. Eayrs, L. Kerr, J. Labaree, J. Levin, K. Mils, J. Ruge, G. Sherwood, J. Sun and S. Caporossi. 2013. The Future of Cod in the Gulf of Maine. Gulf of Maine Research Institute.

Smith, T. 2011. Modeling Approaches in Support of Ecosystem-Based Fishery Management at the Northeast Fisheries Science Center, Woods Hole, MA: External Independent Peer Review. Center for Independent Experts.

North Pacific Fishery Management Council



I. Questions for science and management

What is the state of regional EBFM science for fisheries management?

Despite the huge size of the North Pacific region and the fact that over 50% of fish harvests by volume take place there, the Alaska Fisheries Science Center (Seattle and Auke Bay), like NEFSC, is as providing scientific information and advice for EBFM (Witherell et al. 1999). Since 1994 it has developed an ecosystem report to accompany its stock assessments and fisheries evaluations. http://access.afsc.noaa.gov/reem/ecoweb/index.cfm. Kirim Aidyn from AFSC presented an overview of the scientific capabilities and advice to the ESMWG (ppt. on ESMWG website). Livingston et al. (2011) provides the most sophisticated and comprehensive review of ecosystem science and research for management in the NPFMC region.

How is the fishery management council using EBFM science in management? Concomitantly, are Councils getting the science they need for management?

The North Pacific Fishery Management Council (NPFMC) has been very receptive and reliant on scientific advice since its inception and an exceptionally good relationship between scientific advice and utilization by management has developed. Diana Evans, North Pacific Fisheries Management Council provided a PowerPoint presentation (available on the ESMWG website) attesting to this relationship. In addition, the annual Ecosystem chapter of the Stock Assessment Fishery Evaluation document is a critical factor (Zador et al. 2011 and 2013). However, ecosystem efforts are recognized across industry and environmental NGOs (Warren 2007). In response to the

ESMWG, the NPFMC cited improvements in the advice the Council was receiving in terms of modeling and stock assessment and in the form of Center of Independent Experts peer review of stock assessments (Evans 2012).

II. What can be seen as progress toward EBFM in fisheries management regions?

Cease overfishing and develop rebuilding plans for overfished species

In the US Status of Stocks 2012, NPFMC is surprised by a finding of overfishing for Pacific octopus – a very small fishery. A rebuilding plan is being developed. However, this listing was found to be erroneous as of 2013. In addition one fishery for Pribilof Island blue king crab is considered overfished, but there has been no fishery for many years and a ten-year rebuilding plan is in place. As of the fourth quarter of 2013, no overfishing is occurring for any FSSI listed stocks, while the overfished statuses of Aleutian Islands blue king crab, western Aleutian Islands red king crab, and the Gulf of Alaska demersal shelf rockfish and thornyhead rockfish complexes remain unknown. Likewise no overfishing is occurring for any non-FSSI listed stocks, but the majority have an unknown overfished status.

Delineate extent of ecosystem/interactions

NPFMC in conjunction with the AFSC, North Pacific Research Board and State of Alaska has had extensive discussions and made management decisions that effectually delineate the extent of ecosystem interactions. It successfully used the development of an Aleutian Islands Fishery Ecosystem Plan to explore the nature of interactions between the Bering Sea fisheries and those located in the Aleutian Islands chain and with the Gulf of Alaska and areas south of the Aleutians.(NPFMC, 2008). Where these interactions are ambiguously known as in the Northern Bering Sea and in the American Arctic EEZ, the NPFMC has restricted trawling in the former and banned fisheries in the latter. www.fakr.noaa.gov/npfmc/current_issues/AIFEP12_07.pdf

Develop a conceptual model of the foodweb

AFSC scientists have developed robust models of the foodwebs in the Gulf of Alaska, Aleutian Islands and Bering Sea. Due to the lack of knowledge in the Arctic the precautionary approach is applied. www,fakr.noaa.gov/npfmc/current_issues/Arctic/arctic.htm

Describe habitat needs of different life history stages of animals and plants in the "significant foodweb" and develop conservation measures

Significant work to implement the Essential Fish Habitat provisions of the 1996 Reauthorization of the MSA has focused on this issue with the result that the Council and AFSC have developed a tier level knowledge for each species of plan and animal that ranges from zero knowledge to the full life cycle. Is information is used to prioritize research as it also used in management.

Calculate total removals – including incidental mortality and relate them to standing biomass, production, optimum yields, natural mortality and trophic structure

This is normally done in the context of TAC and ACL setting but with an added constraint that the total removals not exceed two million metric tons of fish in the Bering Sea and 1.2 million tons in the Gulf of Alaska. All these data are brought into the TAC setting process through the Ecosystem Chapter of the SAFE process. Increasingly, ecosystem information is being used to explain and justify stock assessments. This is done through the normal TAC / ACL setting process in the Council as a matter of course. (Livingston et al. 2011).

Assess how uncertainty is characterized and define what buffers against uncertainty are included in management actions

Scientific expertise exists to provide advice in this dimension but fisheries management is not yet ready to incorporate these concepts into practice. There is active research and discussion on how to make it work. (Livingston et al. 2011)

Develop indices of ecosystem health as targets for management. Has council set an ecosystem goal[s]?

As early as 1999, the NPFMC developed a definition of what it meant by an ecosystem approach and defined the objective, "To provide future generations the opportunities and resources we enjoy today." To achieve that objective ecosystem goals were set, guidelines established and a declaration relative to its understanding of the marine ecosystem (Witherell 1999) The NPFMC currently is in the process of visioning its future and setting an ecosystem goal. A proposed goal statement developed by the Ecosystem Committee is before the Council for approval or modification (pending Council action March 2014). Multiple indices are displayed in the Ecosystem Considerations reports developed as part of the annual Stock Assessment Fishery Evaluation process (Zador et al. 2012,2013; and discussed in Livingston et al. 2011).

Describe long term monitoring data and how they are used.

Like other Councils, NPFMC utilizes data from multiple sources. Because of the long history of variability and cycles on the North Pacific [ENSO and PDO] Council interest in and use of climate variability science is substantial and integrated science support from the Pacific Marine Environmental Laboratory is critical. (AFSC 2013)

Assess the ecological, human and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/NMFS jurisdiction and define a strategy to address those influences.

NPFMC has been a catalyst among state and federal agencies on developing a forum for taking the marine ecosystem into account. The comprehensive engagement of fisheries management across the total EEZ makes it a leader for other agencies with equal range of jurisdiction but limited scope of engagement (Alaska Marine Ecosystem Forum 2006). EFH consultation requirements have been used occasionally (Evans 2012) Performance for Endangered and Protected species is another of NPFMC responsibilities (Heltzell et al. 2011).

Is there a Fishery Ecosystem Plan/ Fishery Management Plan employing EBFM?

Currently there exists an Aleutian Islands FEP and the Council is considering developing additional place-based FEPs. In the past the NPFMC has used the FEP concept to assist in resolving particular science based management in an area more or less devoid of humans. If this approach is to be used more broadly in Alaska there may be difficulties. www.fakr.noaa.gov/npfmc/current_issues/AIFEP12_07.pdf.

Does the Council have a lead entity designated to advance EBFM in the Council process?

NMFS scientists took the lead in 1994 to begin developing a contribution to the stock assessment process to provide insights into how changes in the ecosystem could possibly influence the stock size being assessed. In 1996 Council members at the request of the SSC suggested to the NPFMC that an Ecosystem Committee could be appointed to assist it with major issues.

Are ecosystem models developed and available for use in the Council process?

Yes, Aidyn was one of the early model developers and he and his colleagues have provided significant support to Council processes (Townsend et al. 2008).

Are decision support tools for EBFM / trade-off analysis employed [e.g., management strategy evaluation, risk assessments, ecosystem indicators, and scenarios]?

Decision support tools that assist in fishery management are being developed --mostly at the scale of the individual as opposed to the aggregate. It can be argued that some of this is being done but we are far from systematic applications. (Seung and Zhang 2011; Sethi et al. 2012; NPFMC 2013).

To what extent are spatial management tools applied [besides EFH measures above] to accomplish EBFM? [as opposed measures for allocation].

Already there is significant area placed off limits to fishing in general and trawling in particular (AFSC 2012). In addition as genetic or other stock distribution information is being generated it is being used in fisheries management for spatial management of catch limits (NPFMC 2013).

Other – Unique efforts that offer information

The NPFMC applies a cap on total removals from the Bering Sea and Aleutian Islands and Gulf of Alaska [and the FMP for the Arctic does not permit fishing until it can be demonstrated that fishing can be sustainably managed in the region. The result of the cap on removals is a very conservative level of fishing on most species because the sum of the Allowable Biological Catches is always greater than the cap. It is generally believed that these caps represent long-term ecosystem fishery yields that will sustain fish and their associated species in the ecosystem.

References: **www.npfmc.org**. Last accessed March 10, 2014.

Alaska Fisheries Science Center. 2012. Considerations for Research Planning in the Northern Bering Sea Research Area. Prepared for the NPFMC. 118 pp.

Alaska Marine Conservation Forum. 2006. Memorandum of Understanding. [draft document for interagency cooperation for the North Pacific.

Evans. D. 2012. Ecosystem-Based Fisheries Management in NOAA. Memo to ESMWG in response to questions.

Fisheries Leadership and Management Forum. 2012. Risk policy and management for uncertainty across the regional fishery management councils. www.fisheriesforum.org

Heltzel, J., D. Witherell, and W. Wilson. 2011. Ecosystem-based Management for Protected Species in the North Pacific Fisheries. Marine Fisheries Review 73(3) 20-35.

Livingston, P., K. Aydin, J. Boldt, A. Hollowed and J. Napp. 2011. Alaska marine fisheries management: advances and linkages to ecosystem research. Chapter. 3. In A. Belgrano and C. Fowler (Eds.). Ecosystem Based Management: An Evolving Perspective. Cambridge University Press. 384 pp.

North Pacific Fishery Management Council. 2008. Overview of the Aleutian Islands Fishery Ecosystem Plan. Anchorage, AK. 22 pp.

North Pacific Fishery Management Council 2013. Consideration of Conservation, Management, and Policy in Spatial Management of Catch Limits: Report of the NPFMC Workshop. Seattle, WA. 14 pp.

Sethi, A., M. Dalton and R. Hilborn. 2012. Quantitative risk measures applied to Alaskan commercial fisheries. Canadian Journal of Aquatic and Fishery Sciences. 69: 487-498.

Seung, C. and C. Zhang, 2011. Developing socioeconomic indicators for fisheries off Alaska: A multi-attribute utility function approach. Fisheries Research. 112:117-126.

Townsend, H., J. Link, K. Osgood, T. Gedamke. G. Watters, J. Polovina, P. Levin, N. Cyr and K. Ayden (Eds.) 2008. Report of the National Ecosystem Modeling Workshop (NEMoW) NOAA Technical Memorandum NMFS-F/SPO-87.

Warren, B. 2007. Change: Ecological Progress in US Fishery Management. Institute of Social and Economic Research, University of AK, Fairbanks and Marine Conservation Alliance. Anchorage, AK. 26 pp.

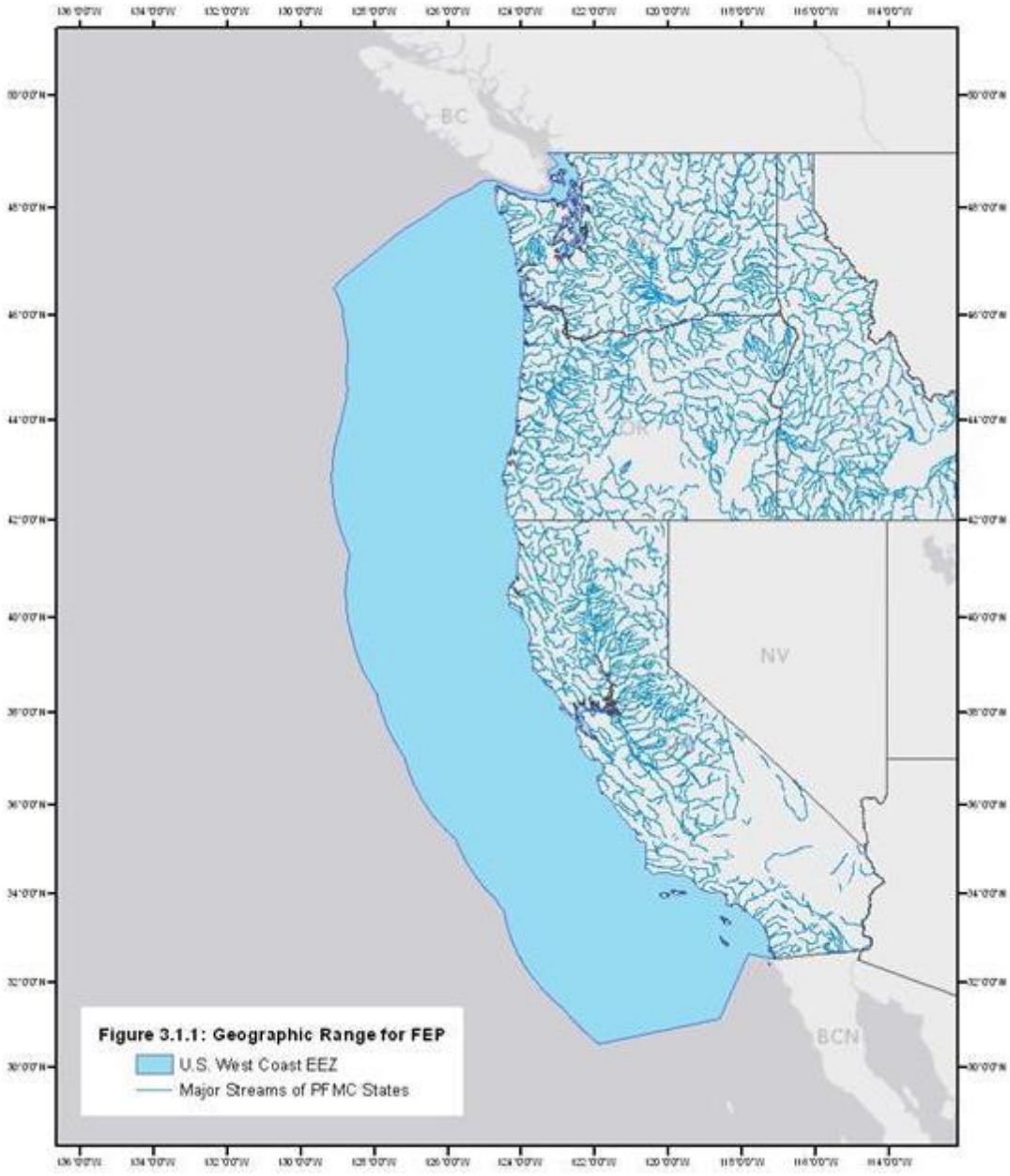
Witherell, D. 1999. Incorporating ecosystem considerations into management of Bering Sea groundfish fisheries. Pp. 315-327 in Ecosystem Approaches for Fisheries Management. Lowell Wakefield Fisheries Symposium, University of Alaska Sea Grant, AK-SG-99-01, Proceedings of the Symposium, September 30-Octoer 3, 1998, Anchorage, AK.

Witherell, D., C. Partake and D. Fluharty. 2000. An ecosystem-based approach for Alaska groundfish fisheries. ICES Journal of Marine Sciences 57: 771-777.

Zador, S. and 74 others. 2011. Ecosystem Considerations for 2012: Appendix C in the NPFMC SAFE documents. Anchorage, AK. 254 pp.

Zador, S. and 44 others. 2013. Ecosystem Considerations for 2013. Appendix C in the NPFMC SAFE documents. Anchorage, AK. 235 pp.

Pacific Fishery Management Council



I. Questions for science and management

What is the state of regional EBFM science for fisheries management?

Extremely good. Science Centers provide good ecosystem information for management. Phil Levin, NWFSC provided an excellent overview of role science is playing in the California Current marine ecosystem with his discussions of the Puget Sound IEA and the West Coast Atlantis model developments (PowerPoint presentations on ESMWG website). (Kaplan, Horne and Levin 2012)

How is the fishery management council using EBFM science in management? Concomitantly, are Councils getting the science they need for management?

Yvonne de Reynier, who has shepherded the Pacific Council's EBFM proposal through to completion made a presentation that endorsed the various roles of the scientific contributions into management applications. In her view [see PowerPoint presented to the ESMWG] there has been a strong hand and glove approach to use of science for management.

II. What can be seen as progress toward EBFM in fisheries management regions?

Cease overfishing and develop rebuilding plans for overfished species

The Pacific Fishery Management Council is not overfishing but has five species on the overfished list and maybe more if more salmon species ESUs were counted. The Council has rebuilding plans (up to 26 years) for all species except Pacific bluefin tuna. Note – Pacific FMC is listed as co-manager with Western Pacific of Pacific bigeye and bluefin tuna where overfishing is still occurring (SOS 2012). These species are primarily in Western Pacific waters where the majority of the fishery occurs so they are assigned to Western Pacific.

As of the fourth quarter of 2013, overfished FSSI stocks are: Pacific coast canary rockfish, Pacific coast Pacific ocean perch, Pacific Bluefin tuna, and Pacific coast yelloweye rockfish.

While no longer listed as overfished, rebuilding plans (up to 67 years) continue for southern Pacific bocaccio, southern California cowcod, Pacific coast darkblotched rockfish, and Pacific coast Petrale sole. The overfished status of nine FSSI stocks remains unknown: Pacific coast jack mackerel, northern Pacific coast northern anchovy, southern Pacific coast northern anchovy, Pacific coast opalescent inshore squid, Pacific coast Pacific cod, Pacific coast Pacific grenadier, Pacific coast sand sole, California vermillion rockfish, and Pacific dolphin fish.

For non-FSSI stocks, no overfishing is listed as occurring, but many salmon stocks are data poor, and the overfished condition of many stocks is unknown.

Delineate extent of ecosystem/interactions

The PFMC Fishery Ecosystem Plan accomplishes this (PFMC 2013).

Develop a conceptual model of the foodweb

These models are integral to the PFMC Fishery Ecosystem Plan (PMFC 2012)

Describe habitat needs of different live history stages of animals and plants in the "significant foodweb" and develop conservation measures

See PMFC Fishery Ecosystem Plan (PFMC 2012).

Calculate total removals – including incidental mortality and relate them to standing biomass, production, optimum yields, natural mortality and trophic structure

Many of these aspects but not all are addressed in PFMC actions.

Assess how uncertainty is characterized and define what buffers against uncertainty are included in management actions

To the extent that the MSA has requirements for how risk and uncertainty is taken into account for stock assessments, the Pacific FMC meets the standard (FLSF 2012). The FEP begins to address this issue more broadly but not with explicit measures (PFMC 2013).

Develop indices of ecosystem health as targets for management. Has council set an ecosystem goal[s]?

The FEP has a statement of Purpose and Need and a set of Objectives that provide the Council's goals for EBFM in the U.S. portion of the California Current Ecosystem (PFMC 2013 at 1.1 and 2.0). Considerable discussion is on-going with respect to indicators and indices (Kaplan, Horne and Levin 2012; NWFSC and SWFSC 2014).

Describe long term monitoring data and how they are used.

Long term monitoring data on fisheries are available through the cooperative CalCOFI program while some new efforts are aimed at ocean pH and baselines are being set. (Ruzicka et al. 2012: NWFSC and SWFSC 2014). The Council is a participant in the PACOOS and NANOOS programs.

Assess the ecological, human and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/NMFS jurisdiction and define a strategy to address those influences.

NOAA's Northwest and Southwest Fisheries Science Centers have conducted thorough reviews of the interacting anthropogenic, oceanographic, and climatic drivers and pressures affecting the ecosystem through the California Current Integrated Ecosystem Assessment (Andrews et al. 2013; Hazen et al. 2013). NOAA briefs PFMC on these drivers and pressures (e.g. NMFS 2014) and PFMC attempts to stay abreast to these issues through EFH. PFMC is engaged with the West Coast Governor's Alliance, but the Alliance's activities and funding have waned in recent years. Chapter 4 of the FEP assesses the interacting effects of fishing, non-fishing human activities, and environmental and climate change on the abundance of marine resources within the California Current Ecosystem. Chapter 5 of the FEP is directed at entities outside of the Council process, providing those entities with the Council's policy priorities for ocean resource management. The intent of Chapter 5 is ensure that outside entities have a clear summary of issues the Council considers important when those entities are considering the potential effects of their actions on the ocean ecosystem. Some research on these elements is also being performed outside the agency (Halpern et al. 2009, Halpern et al. 2013).

Is there a Fishery Ecosystem Plan/ Fishery Management Plan employing EBFM?

In April 2013 the PFMC implement a Fisheries Ecosystem Plan and is now implementing it. (PFMC 2013; deReynier 2012).

Does the Council have a lead entity designated to advance EBFM in the Council process?

The Council has an Ecosystem Advisory Subpanel, composed of members of the public, with the broad charge of reviewing EBFM products within the Council process. The Council's Ecosystem Workgroup, composed of government staff, is charged with developing Initiative 1 to the FEP (protections for unfished forage fish.) The SSC's Ecosystem Sub-Committee coordinates the SSC's reviews of ecosystem science. The Council's Habitat Committee addresses EFH and assesses non-fishing activities that affect EFH. Council website: www.pfmc.org

Are ecosystem models developed and available for use in the Council process?

Yes**.** (Kaplan, Horne and Levin 2012)

Are decision support tools for EBFM / trade-off analysis employed [e.g., management strategy evaluation, risk assessments, ecosystem indicators, and scenarios]?

Somewhat. Aspects of adaptive management are available through fishery management plans. The Council has used risk assessments when evaluating species of concern. The FEP expresses concerns for having indicators but it does not supply them.

To what extent are spatial management tools applied [besides EFH measures above] to accomplish EBFM? [as opposed measures for allocation].

The Groundfish FMP uses an extensive network of spatial management tools to both protect EFH and to minimize bycatch of overfished species. The HMS FMP uses area closures that vary by climate conditions to minimize sea turtle bycatch. Ocean salmon fisheries management relies on an adaptive management process of opening and closing geographic control zones on a seasonal basis to allow fisheries access to more abundant salmon runs while minimizing bycatch of more constrained salmon runs. Also along these lines is study of the spatial ecology of krill in the California Current (Field and Francis 2006; Santora et al. 2012). Similarly, debate over the management of sardines in the California Current has prompted research inputs (Kaplan et al. 2013; Ruzicka et al. 2012; Copps et al. 2007). Human uses are an important addition to Council deliberations and work is being performed to assist in assessing cumulative human impacts in the California Current (Halpern et al. 2009).

Other – Unique efforts that offer information

Appendix A from the Pacific FEP outlines a series of "Ecosystem Initiatives" that can potentially be taken by the PFMC with respect to EBFM (PFMC 2013). They include initiatives ranging from greater protections for unfished forage species, to bycatch and monitoring and even to effects of climate shifts. The PFMC process for Ecosystem Initiative 1: Protecting Unfished and Unmanaged Forage Fish Species is underway right now (PFMC 2014). In April 2014, the Council reviewed and initial analysis for it FEP Initiative 1: Protecting unfished and unmanaged forage fish species. The Council plans to develop this initiative as a multi-FMP amendment throughout 2014. http://www.pcouncil.org/wp-content/uploads/I1a ATT1 Eco Initiative1 forage APR2014BB.pdf

References

Andrews, K.S., G.D. Williams, and V.V. Gertseva. 2013. Anthropogenic Drivers and Pressures. In, CCIEA Phase II Report 2012: Drivers and Pressures – Anthropogenic. 106 pp. http://www.noaa.gov/iea/CCIEA-Report/drivers/index.html

Copps. S., M. Yoklavich, G Parkes, W. Wakefield, A. Bailey, H. Greene, C. Goldfinger, R. Burn. 2007. Applying marine habitat data to fishery management on the US West Coast: Initiating a policy-science feedback loop. In B. Todd and J. Greene, Eds. Mapping the Seafloor for Habitat Characterization: Geological Association of Canada, Special Paper 47, 451-462.

deReynier, Y. 2012. Making ecosystem-based management a reality: The Pacific Fishery Management Council and the California Current Ecosystem Assessment. CalCOFI Report 53: 1-8.

Field, J and R. Francis. 2006. Considering ecosystem-based fisheries management in the California Current. Marine Policy 30: 552-569.

Fisheries Leadership and Management Forum. 2012. Risk policy and management for uncertainty across the regional fishery management councils. www.fisheriesforum.org

Fisheries Leadership and Management Forum. 2013. Risk policy and management for uncertainty across the regional fishery management councils (an updated report).

Hazen, E.L., I.D. Schroeder, J. Peterson, W.T. Peterson, W.J. Sydeman, S.A. Thompson, B.K. Wells, and S.J. Bograd. Oceanographic and Climatic Drivers and Pressures. In, CCIEA Phase II Report 2012: Drivers and Pressures – Ocean and Climate. 60 pp. http://www.noaa.gov/iea/CCIEA-Report/drivers/index.html

Halpern, B., C. Kappel, K. Selkoe, F. Micheli, C. Ebert, C. Kontgis, C. Crain, R. Martone, C. Shearer and S. Teck. 2009. Mapping cumulative human impacts to California Current marine ecosystems. Conservation Letters, 2:138-148. Doi: 101111/j.1755-263X.2009.00058.x

Halpern, B., C. Longo, K. McLeod, R. Cooke, B. Fischhoff, J. Samhouri, C. Scarborough. 2013. Elicited preferences for components of ocean health in the California Current. Marine Policy. 42: 68-73.

Kaplan, I., P. Horne, and P. Levin 2012. Screening California Current fishery management scenarios using the Atlantis end-to-end ecosystem model. Progress in Oceanography 102 5-18.

Kaplan, I.P., C.J. Brown, E.A. Fulton, I.A. Gray, J.C. Field, and A.D.M. Smith. 2013. Impacts of depleting forage species in the California Current. Environmental Conservation, 1-14. doi:10.1017/S0376892913000052

Northwest and Southwest Fisheries Science Centers . 2014. Annual State of the California Current Ecosystem. Seattle and La Jolla. 20 pp.

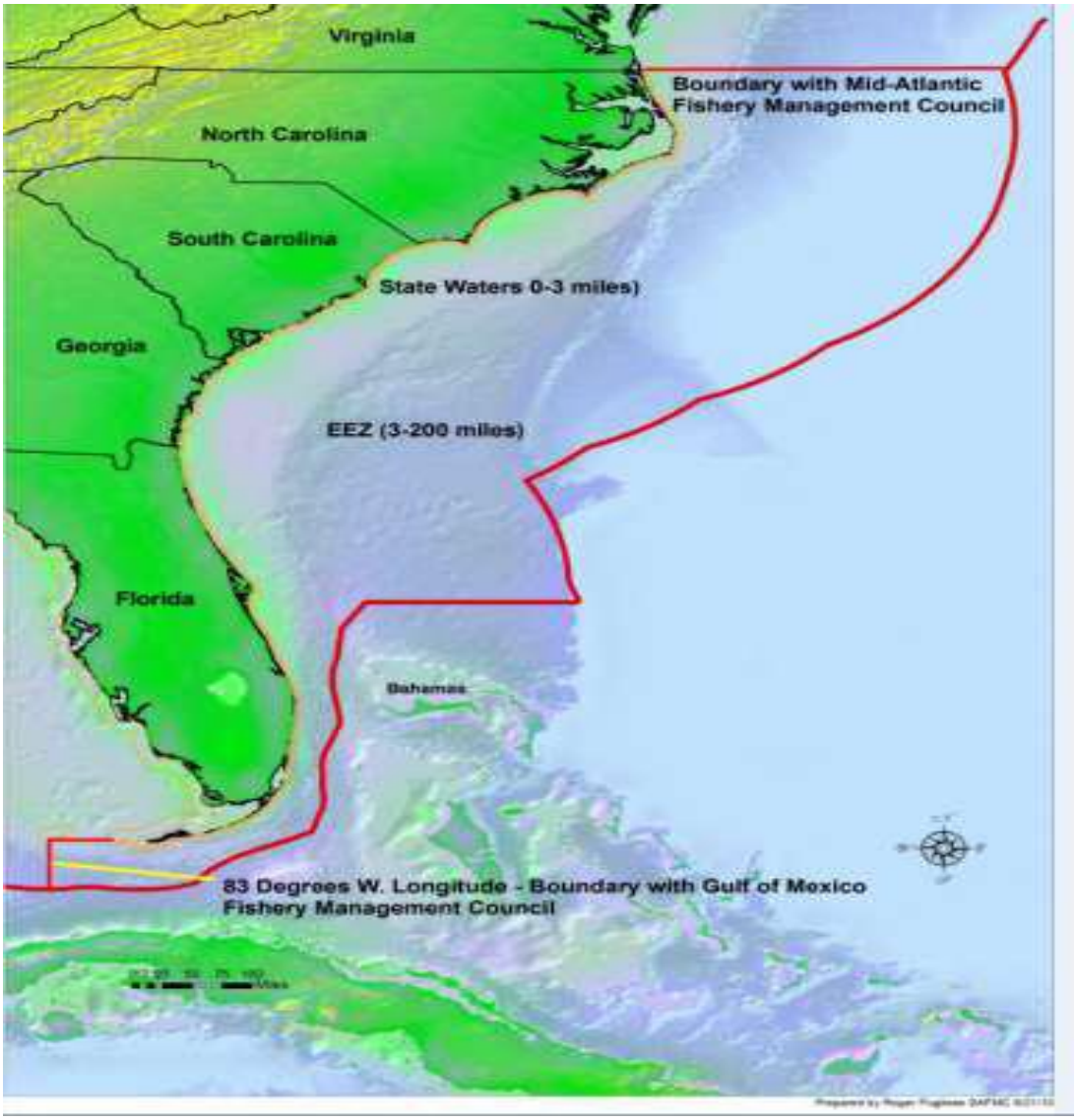
Pacific Fishery Management Council. 2013. Fisheries Ecosystem Plan for the US Portion of the California Current Ecosystem Large Marine Ecosystem. PMFC. Portland, OR.190 pp. + Appendix 23 pp.

Pacific Fishery Management Council. 2014. Ecosystem Initiative 1: Protecting Unfished and Unmanaged Forage Fish Species of the U.S. Portion of the California Current Large Marine Ecosystem. 50 pp.

Ruzicka, J,, R. Brodeur, R. Emmett, J. Steele, J. Zamon, C. Morgan, A. Thomas, T. Wainwright. 2012. Interannual variability in the Northern California Current foodweb structure: Changes in energy flow pathways and the role of forage fish, euphausids, and jellyfish. Progress in Oceanography 102: 19-41.

Santora, J. F. Field, I. Schroeder, K. Sakuma, B. Wells. 2012. Spatial ecology of krill, micronekton and top predators in the central California Current: Implications for defining ecologically important areas. Progress in Oceanography 102: 154-174.

South Atlantic Fishery Management Council



I. What is the state of regional EBFM science for fisheries management?

Very good. Roger Pugliesi, Senior Fishery Biologist, SAFMC. (Pugliesi ppt. presentation to ESMWG.

How is the fishery management council using EBFM science in management? Concomitantly, are Councils getting the science they need for management?

Arrangements between Southeast Fisheries Science Center and Council are good (Roger Pugliesi PowerPoint presentation to ESMWG). Areas of monitoring and scientific emphasis are moving from single to multi-species management, development of regional tools to understand ecosystem impacts of fishing, by-catch, predator-prey interactions, fleet mobility/dynamics and climate change.

II. What can be seen as progress toward EBFM in fisheries management regions?

Cease overfishing and develop rebuilding plans for overfished species

South Atlantic has five FSSI species in the overfishing classification (southern Atlantic coast gag, red snapper, snowy grouper, speckled hind, and warsaw grouper) and three FSSI stocks on the overfished list (southern Atlantic coast red porgy, red snapper, and snowy grouper). Rebuilding plans do not exist for gag, speckled hind, or warsaw grouper, while the other stocks have rebuilding plans up to 35 years.(SOF 2013). Additionally, the southern Atlantic coast blueline tilefish non-FSSI stock is listed as overfished, with overfishing still occurring. No rebuilding plan exists at the moment.

As of the fourth quarter of 2013, the overfished status of 11 FSSI stocks remains unknown: southern Atlantic coast brown rock shrimp, gray triggerfish, hogfish, scamp, speckled hind, warsaw grouper, white grunt, wreckfish, Goliath grouper, and southern Atlantic coast/Gulf of Mexico Nassau grouper and spiny lobster. Southern Atlantic coast red grouper is no longer listed as overfished, and is in its second year of a 10-year rebuilding plan. For non-FSSI stocks, the majority are listed with an unknown overfished status .

Delineate extent of ecosystem/interactions

This has been done in Ecosystem FMP but restricted to US 200 nm EEZ. Fishery Ecosystem Plan (http://www.safmc.net/ecosystem-management/fishery-ecosystem-plan-1)

Develop a conceptual model of the foodweb

Yes http://www.safmc.net/ecosystem-management/fishery-ecosystem-plan-1)

Describe habitat needs of different life history stages of animals and plants in the "significant foodweb" and develop conservation measures

Yes, http://www.safmc.net/ecosystem-management/fishery-ecosystem-plan-1)

Calculate total removals – including incidental mortality and relate them to standing biomass, production, optimum yields, natural mortality and trophic structure

Yes, to the extent required by MSA. (www.safmc.org)

Assess how uncertainty is characterized and define what buffers against uncertainty are included in management actions

Under discussion and development. "Most of the species in the South Atlantic region are characterized as data-poor, and a large proportion of catch is landed by the substantial recreational sector. As a result, the Council utilizes a broad tiered approach that employs P* and a decision tree that allow the SSC and Council to decide on scalar reductions to set buffers from OFLs to ABCs." FLSF 2012 p. 28.

Develop indices of ecosystem health as targets for management. Has council set an ecosystem goal[s]?

Yes in FEP 1. Maintaining and improving ecosystem structure and function; 2. Maintaining/improving economic, social and cultural benefits from resources; maintaining/improving biological, economic and cultural diversity. (Roger Pugliesi PowerPoint. presentation 10/12/11) ESMWG website

Describe long term monitoring data and how they are used.

SAFMC well ensconced in regional monitoring as seen on www.safmc.net. and Southeast USA Recent Marine Data (C-MAN). See also Southeast Atlantic Atlas (ocean.floridamarine.org/safmc.atlas). Member of Southeast Coastal Ocean Observing Regional Association (SECOORA)- IOOS, and Southeast Area Monitoring Program (SEAMAP).

Assess the ecological, human and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/NMFS jurisdiction and define a strategy to address those influences.

Lots of partnerships and efforts to implement EFH provisions for marine aquaculture, submerged aquatic vegetation, beach dredging and filling, energy exploration, transportation and hydropower relicensing, alteration in riverine, estuarine and nearshore flows, and invasive species (Pugliese PowerPoint.). Council partners with the Southeast Aquatic Resource Partnership (SARP), Governors South Atlantic Alliance, South Atlantic Landscape Conservation Cooperative.

Is there a Fishery Ecosystem Plan/ Fishery Management Plan employing EBFM?

Yes, Fishery Ecosystem Plan used as a source document for a series of Comprehensive Ecosystem-Based Amendments to Council Fishery Management Plans ((http://www.safmc.net/ecosystem-management/fishery-ecosystem-plan-1)

Does the Council have a lead entity designated to advance EBFM in the Council process?

Yes. Council has a Committee on Ecosystem-Based Management (www.safmc.net).

Are ecosystem models developed and available for use in the Council process?

Yes – see Pugliese, Okey and Brouwer n.d. University of British Columbia Fisheries Centre, Sea Around Us Project. See as well www.safmc.net website; Pugliese PowerPoint presentation; and, for example, SAFMC 2008.

Are decision support tools for EBFM / trade-off analysis employed [e.g., management strategy evaluation, risk assessments, ecosystem indicators, and scenarios]?

Starting to use some of these tools – see Council website and Pugliese PowerPoint.

To what extent are spatial management tools applied [besides EFH measures above] to accomplish EBFM? [as opposed measures for allocation].

Because the Council FEP evolved out of extensive EFH measures for deep water coral and other specific habitat management measures taken under the Comprehensive Ecosystem-Based Amendments have a large spatial component. Based on monitoring and other data SAFMC maintains a South Atlantic habitat and ecosystem webpage and is developing a digital dashboard. Ecosystem-wide questions are being raised about interactions among managed species (Frias-Torres 2013; Harter et al. 2008).

Other – Unique efforts that offer information

References: Council Website www.safmc.net [last accessed March 13, 2014].

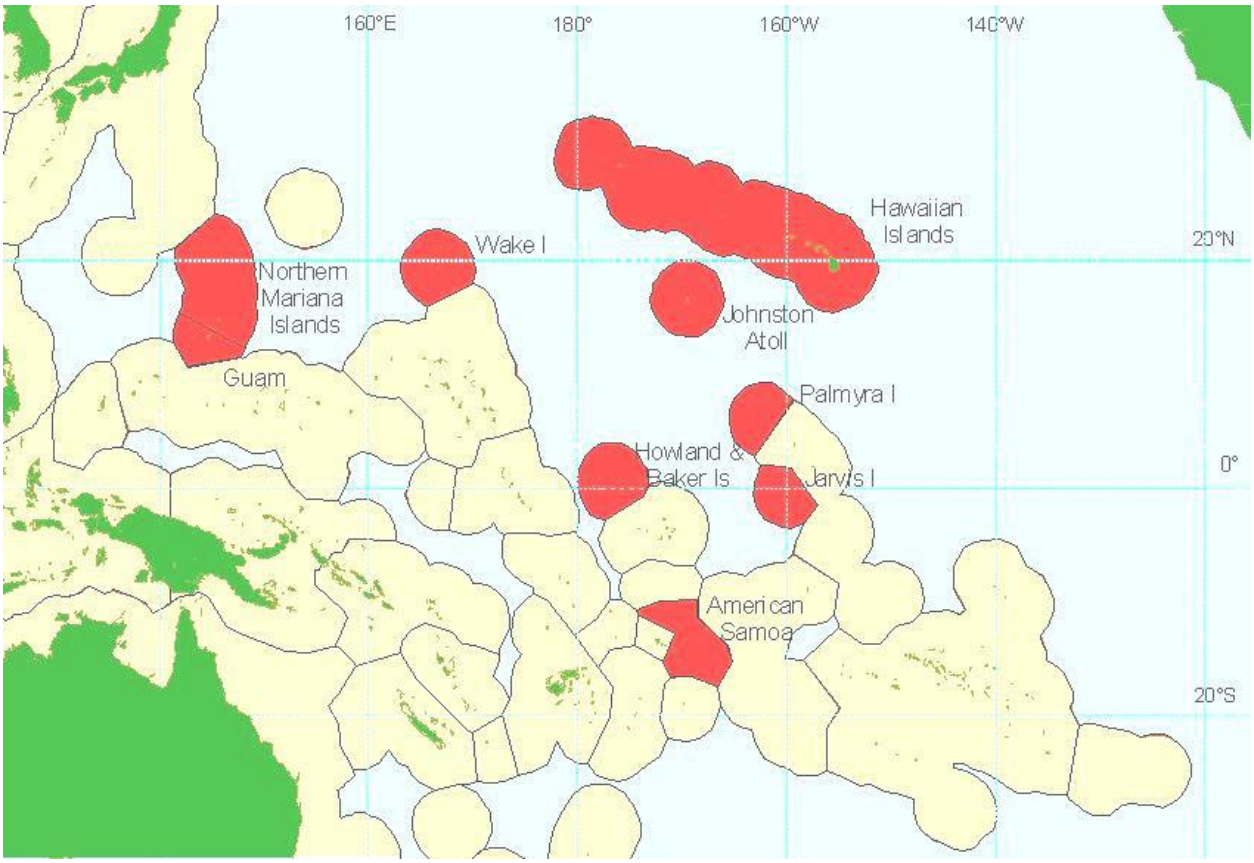
Fisheries Leadership and Sustainability Forum. 2012. Risk Policy and Managing for Uncertainty Across the Regional Fishery Management Councils. www.fisheriesforum.org

Frias-Torres, S. 3013. Should the critically endangered Goliath grouper *Epinephelus itajara* be culled in Florida? Oryx 47(1) 88-95.

Harter, S. , M. Ribera, A. Shepard, and J. Reed. 2008. Assessment of fish populations and habitat on Oculina Bank, a deep-sea coral marine protected area of eastern Florida. Fishery Bulletin 107(2) 195-206

SAFMC 2008. Report of the Ecosystem Modeling Workshop #3, Tampa, FL May 6-7. 2008.

Western Pacific Fishery Management Council



I. Questions for science and management

What is the state of regional EBFM science for fisheries management?

Eric Kingma, WPFMC, gave a very candid assessment of scientific needs for fishery management. (Kingma ppt.) The WPFMC has some stock assessments and ecosystem modeling on pelagic species and some bycatch research in pelagic fisheries. It needs comprehensive nearshore ecosystem decision models and stock assessments. Despite long history of fishing, life history research on reef fish is inadequate for meeting new requirements under MSA.

Based on the latest science plan for the Pacific Islands Fisheries Science Center progress is being made to address these concerns (Pooley 2013). Initiatives since the presentation and under the science plan have occurred

sufficiently to permit utilizing biomass data from the coral reef surveys to set ABCs and hence ACLs (Paul Dalzell personal communication, March 26, 2014 email).

How is the fishery management council using EBFM science in management? Concomitantly, are Councils getting the science they need for management?

Council is able to use all the information provided and feels reasonably comfortable with pelagics and Main Hawaiian Islands bottom fish. There appears to be a gap between WPFMC's prioritized science needs and those of the Pacific Islands Fisheries Science Center (Kingsma PowerPoint). Examples of the gaps include lack of tropho-dynamic models of the near shore ecosystem, limited socio-economic studies of reef fisheries and as noted, limited life history information for reef fish. Again, PIFSC seems to be attempting to close these gaps in its latest science plans (Pooley 2013).

II. What can be seen as progress toward EBFM in fisheries management regions?

Cease overfishing and develop rebuilding plans for overfished species

Two species of tuna – Pacific Bluefin and bigeye - are listed in the overfishing category and two FSSI stocks – the Hancock Seamount groundfish Complex and central western Pacific striped marlin – are listed as overfished. Additionally, overfishing is occurring for striped marlin. Only a rebuilding plan is in place for the groundfish complex, which is in year 28.

As of the fourth quarter of 2013, the overfished statuses of seven FSSI stocks remain unknown: Hawaiian Archipelago bigeye scad, coral reef ecosystem multi-species complex, and mackerel scad, and Pacific kawakawa, opah, shortbill spearfish, and wahoo.

For non-FSSI stocks, their overfished status is mostly unknown.

Delineate extent of ecosystem/interactions

Yes – revised FMPs according to Pelagics/ and Archipelagic (Dalzell ppt.; Glazier 2011)

Develop a conceptual model of the foodweb

Yes, pelagic foodweb is well developed but nearshore reef fish models need more development to account for all life stages. Models have been developed for monk seals and loggerhead turtles (Townsend et al. 2008.)

Describe habitat needs of different life history stages of animals and plants in the "significant foodweb" and develop conservation measures

Efforts to implement new requirements of the MSA reveal that life histories of some managed reef fish are insufficiently known. (Kingsma ppt.) . There is little information on life histories of ecosystem component (non-managed species) (Glazier, 2011).

Calculate total removals – including incidental mortality and relate them to standing biomass, production, optimum yields, natural mortality and trophic structure

WPFMC is struggling to meet the new mandates under MSA, lacks bycatch information and landings from Main Hawaiian Islands nearshore and reef fisheries (Kingsma ppt. and FLSF 2012).

Assess how uncertainty is characterized and define what buffers against uncertainty are included in management actions

WPFMC has started discussion but most stock assessments (other than the deep seven bottom fish species) lack adequate data for full assessments. Because of the lack of very much fishery independent data, the WPFMC region uses a qualitative risk-based approach to assessment and applies it conservatively. (FLSF 2012).

Develop indices of ecosystem health as targets for management. Has council set an ecosystem goal[s]?

While goals are part of the discussion surrounding the shift from species-based to place-based (archipelagic) plans it does not appear that they have been set in detail. The prime goal is to implement the move to ecosystem-based management which requires refocusing on archipelagic fisheries ecosystems near islands and large scale ecosystem-based management for highly migratory pelagics. (WPFMC 2012).

Describe long term monitoring data and how they are used.

WPFMC and PIFSC seem well positioned and well-served by large scale monitoring done jointly with other state and federal agencies and laboratories. It appears that more efforts are needed for nearshore and reef fisheries areas.

Assess the ecological, human and institutional elements of the ecosystem which most significantly affect fisheries, and are outside Council/NMFS jurisdiction and define a strategy to address those influences.

The shift to Archipelagic fishery management plans has required significant attention to the cultural contexts in which fisheries exist and are managed in very different regions. The focus on narrow continental shelves and reefs instead of broad open ocean has necessitated building close partnerships with those engaged in fisheries systems in the region. The focus has been primarily on fishing and fishing communities and less on other sectors (WPFMC 2012). Implementation of the sea to mountain management concept will require considerable additional effort to engage on the terrestrial side (Kingma ppt. and Glazier 2011.). The Presidential proclamation of the Papahanaumokuakea Marine National Monument in the Northwest Hawaiian Archipelago and the subsequent management plan that phases out all fishing was considered a shock to the WPFMC and to the PIFSC research program. (Kingma ppt.).

Is there a Fishery Ecosystem Plan/ Fishery Management Plan employing EBFM?

There are now four place-based fishery ecosystem plans (having the full force of Fishery Management Plans in aligning management actions) – Mariana Archipelago FEP, Pacific Remote Island Areas FEP, American Samoa Archipelago FEP and Hawaii Archipelago FEP -- and one Pacific Pelagic FEP. www.wpcouncil.org

Does the Council have a lead entity designated to advance EBFM in the Council process?

Regional Ecosystem Advisory Committees and Archipelago Advisory Panels are established to provide advice on implementation of the FEPs.

Are ecosystem models developed and available for use in the Council process?

Large scale models for pelagic fisheries, monk seals, and sea turtles are available and in use (FLSF 2008). Modeling is more limited with respect to nearshore and reef fisheries (Kingma ppt.) but this seems to be improving.

Are decision support tools for EBFM / trade-off analysis employed [e.g., management strategy evaluation, risk assessments, ecosystem indicators, and scenarios]?

Island-based fisheries place stronger emphasis on cultural approaches, especially in light of limited monitoring, catch reporting, mix of fisheries, etc. (Dalzell PowerPoint. from ESMWG meeting in Hawaii, Glazier 2011).

To what extent are spatial management tools applied [besides EFH measures above] to accomplish EBFM? [as opposed measures for allocation].

Spatial management tools are used extensively to manage bycatch in pelagic fisheries but less so in archipelagic fisheries. (www.wpcouncil.org)

Other – Unique efforts that offer information

WPFMC converted a set of five species based fishery management plans to four place based archipelagic fishery management plans while retaining one species based plan for pelagics that migrate across the Pacific. In contrast to other scientific underpinnings for FEPs, the specific cultural and traditional ecological needs of place based management receive significant emphasis (Glazier 2011)

References Council Website www.wpcouncil.org [Last Accessed March 13, 2014]

Fisheries Leadership and Sustainability Forum. 2012. Risk Policy and Managing for Uncertainty Across the Regional Fishery Management Councils. www.fisheriesforum.org

Glazier, E. (Ed.). 2011. Ecosystem-Based Fisheries Management in the Western Pacific. Wiley-Blackwell, Ames, IA. 280 pp.

Pooley, S. 3 2013. Pacific Islands Fisheries Science Center Science Plan 2013. Administrative Report H-13-01. 22 pp.

Townsend, H., J. Link, K. Osgood, T. Gedamke. G. Watters, J. Polovina, P. Levin, N. Cyr and K. Ayden (Eds.) 2008. Report of the National Ecosystem Modeling Workshop (NEMoW) NOAA Technical Memorandum NMFS-F/SPO-87.

Western Pacific Fishery Management Council. 2012. Archipelagic Fishery Ecosystem Annual Report. Honolulu, HI. 178 pp.

APPENDIX E: NOAA PLANNING AND BUDGETING FOR EBFM 2003- 2014.

Compiled by Tara Dolan, NOAA SAB, Knauss Fellow

The purpose of this Appendix is to report efforts to fund EBFM directly or indirectly through program support for the types of agency actions that would contribute to increased production and use of ecosystem science for management of fisheries. It is intended to be illustrative and not definitive. The President's Budget request for each year are shown first, followed by the final budget appropriated or enacted by Congress.

Planning process (specific to EBFM): - ($ amounts are total including base).

NOAA FY2003 President's Budget Request :

- Fisheries Research and Management Services $348.8 B included activities such as "building forecast models for marine resource populations, ecosystems and fisheries systems".
- $16 M requested for Regional Fisheries Management Councils. [this did not mention the $1M for ecosystem activities specifically]
- $5.6 M for environmental improvement and restoration fund – includes fisheries and ecosystem research in the N. Pacific.
- $5.6 M for "building sustainable fisheries" which includes support for the Fisheries and the Environment Program which develops ecosystem indicators.

FY2004 President's Budget Request

- Strategic initiatives included the development of a bycatch database for use by NOAA and partner agencies (state & Fed + the FMCs).

FY2005 President's Budget Request

- NOAA requests $1.16B for Ecosystem Strategic Goal to "perform social science research, reduce bycatch and improve NMFS IT access to ecosystem information".
- NOAA requests $1M for fisheries oceanography to improve stock assessments.
- Formation of the Ecosystem Research Matrix Program.
- Proposed environmental modeling matrix program which includes the development of coupled biophysical models for fisheries-environment interactions.

FY2006 President's Budget Request

- Requests $90M for "Ecosystem Based Fisheries Management" – however this is really just a relabeling of current fisheries management activities. GPRA Performance measures in the ecosystem category don't reflect metrics relevant to an ecosystem based fisheries management context.
- $25.9M requested for Regional FMC "allow FMCs to analyze a greater number of alternatives as the develop new or amend current Fisheries Management Plans to reduce levels of overfishing and overcapacity while considering the impacts of proposed actions on other components of the marine ecosystem".
- $2M research funding to study effects of climate change on ecosystem productivity in support of fisheries.

NOAA FY2007 President's Budget Request

- $32.1M and 59 FTE requested for Expand Annual Stock Assessment, one of the stated objectives of which is to "initiate new ecosystem based stock assessments".
- $26M requested for Regional FMCs "This funding will expand the Regional Fisheries Management Councils (RFMCs) operational capability to analyze a greater range of alternatives and more fully consider the impacts of proposed actions on the marine ecosystem as they develop new Fishery Management Plans (FMPs) or amendments to current plans". – language is still in there, but not specifically linked to any actions.
- An increase of $500k for climate regimes and ecosystem productivity.
- Center for Ecosystem Based Fish Management was terminated in FY2006

NOAA FY2008 President's Budget Request

- Requests increase of $6.5M to support implementation of new MSA requirements. This included funds directed towards FMC's and bycatch reduction.
- $5M and 6 FTEs for CAMEO "Forecasting marine ecosystem resource stability and sustainability requires an understanding of the underlying dynamics (e.g., species interactions, population structure, food webs, climate, and anthropogenic impacts) that control and regulate ecosystem processes. This request will support research focused on developing cutting-edge quantitative models and science-based forecasting tools to assess how marine ecosystems respond to human impacts and environmental variation".
- Increase of $600K for Antarctic research, using an "ecosystem approach" to management of the Antarctic Oceans.
- One of the 2008 Saltonstall-Kennedy RFP's was for "Understanding the ecosystem effects of reduced fishing effort in the Gulf of Mexico".

NOAA FY2009 President's Budget Request

- First year GPRA performance measures include " Percentage of tools, technology and information services that are used by NOAA/Partners/Customers to improve ecosystem based management.
- Increase of $31.8M to implement MSA activities, including EBM (Magnuson, so a fisheries context).
- $3.75M increase for CAMEO, this time with added justification of the U.S. Ocean Action Plan
- $5.67K for bycatch reduction

NOAA FY2010 President's Budget Request

- Requested increase of 3M and 1 FTE for Ocean Research Priorities Plan (via NOS) "Information gained will be used to support improved ecosystem management strategies and protection of public health, including use for beach closure forecasts related to pathogens and harmful algal blooms, fisheries and protected species management, and coastal ecosystem health assessments" - This is the closest thing to EBFM that I have seen from NOS yet. Though NOS (and NMFS) for that matter have many activities that could be described as EBM which are not included here.
- $1M for the Gulf of Mexico regional collaboration (via NOS) which includes "ensure healthy beaches and shellfish beds; support habitat conservation and restoration; increase environmental education; promote ecosystem integration and assessment" (not sure if this is EBFM)
- First mention of the U.S. Ocean Action Plan and ecosystem approach to management as a requirement of MSA.

- Increase of $2.9 M to support habitat conservation for salmon at all life stages
- Increase of $2.5 M to support research on hurricane impacts to fisheries (not sure if this is EBFM)
- Requests $3M and 10 FTEs to manage 3 new national monuments in Pacific. This includes spatial closures to fishing, EFH assessment and designation, population assessments, ecosystem observation platforms.
- Increase of $5 M for CAMEO
- Fisheries Research and Management requests $590K increase to improve regional marine ecosystem based management strategies;
- Expand Annual Stock Assessments (EASA) requests $9.9M for activities such as (but not limited to) "including ecosystem considerations in stock assessments"
- Increase of $1M and 3FTE's for IEAs
- Increase of $1M and 3 FTEs for fisheries oceanography (FATE) to support ecosystem indicator information
- $2.7 M increase and 2 FTEs for climate regimes and ecosystem productivity to support research on species distribution shifts (among other things).
- $1.5 M increase to study ocean acidification.
- $56M for MSRA related activities total.

2010 Appropriation

- $. 750 M within NMFS under line item "Ecosystem Based Fisheries Management"

NOAA FY2011 President's Budget Request

- Increase of $80 million (total) to implement transformational changes in how fisheries and ecosystems are managed by the Department of Commerce. Under the reauthorized Magnuson Stevens Fishery Conservation and Management Act of 2006,
- $1M and 3FTE for salmon & sturgeon habitat research CALFED- Bay
- $5.4 M & 5 FTEs for fisheries oceanography (FATE) and support the expedited creation of IEAs in 3 of 8 of NOAAs regional ecosystem
- $10.3 M for community based fish habitat restoration
- $6.1M and 3 FTEs for ocean acidification research including effects on marine fisheries.

2011 Appropriation

- $3.383 M for Climate Regimes and Ecosystem Productivity
- $6.358 for Integrated Ocean Acidification

2012 NOAA FY2012 President's Budget Request

- $6.7M and 9 FTEs for Coastal and Marine Spatial Planning in budget of National Ocean Service(not sure if this involves MPAs or areas where fishing is limited, but "fisheries benefits" were mentioned).
- Increase of $1M and 3FTE or salmon & sturgeon habitat research CALFED- Bay (this request is identical to the one in the previous year. Not sure if that means this failed the first time). - NMFS
- Expand Annual Stock Assessments budget request of $15M this year does not mention ecosystem linked assessments as it did in previous years. This funding could have been shifted to another line, or could have been discontinued.
- $5.4 M and 5 FTEs requested for IEAs - NMFS
- $5 M for community-based fish habitat restoration (+ $1.5 M for Great Lakes projects) - NMFS

- $1.5 M to transfer NMFS Climate Regimes and Ecosystem Productivity projects and line items to the OAR-hosted integrated Ocean Acidification program.
- $6.1M and 3 FTEs for Ocean Acidification research including “fisheries impacts” – OAR

2012 Appropriation

- $1,731K for Climate Regimes and Ecosystem Productivity
- $6,206K for Ocean Acidification

2013 NOAA FY2013 President’s Budget Request

- This language in the introduction: “NOAA will also continue to invest in the future of fisheries management by improving our understanding of the complex ecosystem interactions that impact the resources that are most economically valuable”.
- Puget Sound ecosystem survey was eliminated
- $4.9M increase for IEAs -NMFS
- $1.085M for EBFM in the Antarctic under the U.S. Antarctic Marine Living Resources Conservation Act. – NMFS

2014 NOAA FY2014 President’s Budget Request

- $2.5M for interjurisdictional fisheries grants
- $1.4M for EBFM in the Antarctic under the U.S. Antarctic Marine Living Resources Conservation Act. – NMFS
- $2 M for Climate Regimes and ecosystem productivity focusing on climate impacts on fisheries in Arctic marine ecosystem - NMFS
- $10M and 1 FTE for research on Climate impacts on fish stocks – OAR
- $2.1 M and 1 FTE for ocean acidification research including fisheries impacts – OAR

APPENDIX F. EXECUTIVE SUMMARY OF NMFS REPORT TO CONGRESS 2009

Section 406 of the 2006 Magnuson Stevens Fishery Conservation and Management Reauthorization Act charged NMFS, in consultation with the Fishery Management Councils, to undertake a study on the "state of the science for advancing the concepts and integration of ecosystem considerations in regional fishery management." Section 406 specifies four objectives: 1) form recommendations for scientific data, information, and technology requirements for understanding ecosystem processes and methods for integrating this information from federal, state, and regional sources; 2) form recommendations for processes for incorporating broad stakeholder participation; 3) form recommendations for processes to account for effects of environmental variation on fish stocks and fisheries; and 4) describe existing and developing Council efforts to implement ecosystem approaches, including lessons learned by the Councils.

Regarding objective 1, the most important action should be to maintain and expand current fishery-dependent and fishery-independent surveys. These surveys provide the critical information on exploited and unexploited species required to support stock assessments, as well as long-term data on ecosystem status and trends. Most current surveys do not provide sufficient information to effectively manage all stocks, and there is a particular need to increase their spatial and temporal coverage. Additional time-series data on benthic environments are also needed to improve understanding of the relationship between habitat, benthic organisms, and fish species. Increased socioeconomic surveys are needed to help us understand and predict the behavior of harvesters, an important component of the ecosystem, with regard to different management options. Although we need improved ecological models to better understand dynamic ecosystem processes, in many cases modelers lack key ecological data, upon which predictive models depend. Research is needed to fill those gaps and the Comparative Analysis of Marine Ecosystem Organization (CAMEO) program has significant potential to do so. Finally, an ecosystem approach to management will require easily interpretable products to help integrate and convey complex ecosystem information to managers. Integrated Ecosystem Assessments (IEAs) will facilitate this information transfer, and it is recommended that IEAs be developed on both regional (large marine ecosystem) and sub-regional scales.

Regarding objective 2, broader stakeholder participation can be most effectively incorporated by expanding membership on Council committees to include non-fishing interests, and by increasing methods of communication among stakeholder groups and between these groups and the Councils. This broader stakeholder participation is needed to ensure that a more comprehensive ecosystem perspective is considered. It is also recommended that the rotation of Council meeting locations may help ease the cost and logistical burdens of stakeholder attendance and therefore encourage more stakeholders to participate. Stakeholder surveys should also be expanded to help ensure that a range of non- fishing views are considered in the fisheries management process. Previous survey results have demonstrated that stakeholders value ecosystem goods and services beyond fisheries and have resource use patterns that are important to consider in the management process. Finally, the level of interagency communication must be increased. Multiple agencies have jurisdiction over various ecosystem components, and it is crucial for these agencies to communicate ecosystem knowledge with each other and coordinate their management actions from a holistic and integrated ecosystem perspective. To achieve this, these agencies must be involved in the Council processes.

Regarding objective 3, processes to account for the effects of environmental variation on fish stocks and fisheries must consider climate- scale variability. Climate change is a growing concern for marine ecosystem management, and climate-induced change is inevitable. Thus, it is recommended that collaborations with climate change researchers be maintained and that climate and ecosystems modeling efforts be strengthened. Simultaneously, efforts to better understand the role

of non-climate, human- induced changes in coastal systems on fish populations also must be pursued with added vigor. Burgeoning populations in U.S. areas adjacent to coasts, estuaries, and rivers directly and indirectly impact habitats vital to harvested fish and their forage.

It is recommended that management strategy evaluations be used to determine the appropriate environmental variables necessary to improve stock assessment performance. Incorporating environmental variables or indices into stock assessments is not an easy task, and environmental indices need to be very reliable in order to offset the potential risk associated with erroneous predictions. Management strategy evaluations are a means of determining which indices are beneficial. To improve predictive models it is also recommended that there be a focus on understanding critical mechanisms underlying correlations between environmental variability and fish productivity. Programs such as FATE (Fisheries and the Environment) and NPCREP (North Pacific Climate Regimes and Ecosystem Productivity) are examples of programs aimed at such integration. Environmental variations can influence physiological conditions, such as growth and reproduction, and finer spatial and temporal scale sampling may help to clarify these relationships. Finally, while multi-species and ecosystem models are being developed and improved, there is a need to maintain conventional single-species stock assessments, as there is no indication these new models will reduce the need for conventional models in the near term.

Regarding objective 4, existing and developing Council efforts to implement ecosystem approaches vary by region and many challenges remain. While some Councils are actively moving forward with ecosystem approaches to management (EAM), others are awaiting more definitive national guidance. Efforts include establishing Fishery Ecosystem Plans (FEPs), holding public meetings and workshops to discuss EAM, conducting ecosystem user surveys, developing ecosystem models, and mapping essential fish habitat. It is also important to recognize that many existing Council management efforts (such as bycatch reduction, area closures, and fishing fleet reduction) already represent significant progress toward an ecosystem approach. Despite this progress, additional effort is required. One challenge is the lack of sustained, annual support for FEP development and implementation. Another challenge concerns the complex jurisdictional environment in which ecosystem components are managed. Multiple federal, state, and local agencies have authority over different aspects of the ecosystem, and these roles need to be further defined and coordinated at the agency, inter-agency, and Council levels. Councils should consider ways to conduct more extensive outreach with these other entities to better incorporate their input into the Council process. Similarly, other entities should look for opportunities to engage the Councils, where appropriate, in their processes and issues. This will help to improve inter-agency communication and support a broad ecosystem perspective.

APPENDIX G. REVIEW OF US ENGAGEMENT IN EBFM IN REGIONAL FISHERY MANAGEMENT ORGANIZATIONS

Research Contribution by Scott Jackson, School of Marine Affairs, University of Washington

Research Contribution by Tara Dolan, NOAA SAB, ESMWG Assistant

Critical Review and Modification by Jake Rice, Chief Scientist, Department of Fisheries and Oceans, Canada

InterAmerican Tropical Tuna Commission (IATTC) http://www.iattc.org/HomeENG.htm

The Inter-American Tropical Tuna Commission (IATTC) has been poised to perform EBFM since the 2003 adoption of the Antigua convention. There are several articles in the convention that give the governing body the capabilities of managing more than just target species. In particular article 7.1 (f) specifies that IATTC should adopt as necessary measures to take into consideration the conservation of other species belonging to the same ecosystem as targeted fish species. The main EBFM issue in IATTC is bycatch management. There is little reason to expect at this time that all the trophic modeling would alter the desired management strategy by much at all, compared to exploitation levels and size composition of catch that would come from good single-species management models and sustainability considerations.

The IATTC splits itself into four research programs: Stock Assessment, Biology and Ecosystem, Data Collection and Database, Bycatch and International Dolphin Conservation Program. Each of the programs could play a hand in the goals of EBFM. The Stock Assessment group focusing on maintaining target species from being overfished and ensure sustainable use of fish stocks. The Biology and Ecosystem group focus on the conservation and management of fish stocks covered by the Antigua convention as well as for species that share the ecosystem with target fishes. The Data Collection and Database group works to make sure that there are standard operations for the identification, monitoring, and recording of the numbers not only of target species but also bycatch. The Bycatch and IDCP group work to develop measures to lower bycatch of non-target fish as well as other fauna such as sharks, sea turtles, marine mammals and birds. These have led to management resolutions that just to name a few include: sea turtle bycatch mitigation, releasing and handling of sea turtles caught in fisheries, implementation of observer programs, mitigation measures for reducing sea bird bycatch, develop techniques to safely release incidental bycatches, protections of whitetip sharks.

There is a large amount of information available from various studies that also show the IATTC is using or developing the scientific basis for using EBFM including: trophic interaction studies, life history studies that involved the captive rearing of target species, bycatch studies, ongoing recording of oceanological and meteorological data in the fisheries area. There has also been an ecosystem model of the Eastern Pacific pelagic ocean available from 2003 as well. There are currently no overfished stocks in the IATTC convention area. However, there are some stocks that the state of the fishery is uncertain at this time.

This summary of the IATTC was conducted through review of the IATTC website as well as the Antigua Convention, and the 11th Fishery Status Report:

http://www.iattc.org/HomeENG.htm

http://iattc.org/IATTCdocumentationENG.htm

http://iattc.org/FisheryStatusReportsENG.htm

West Central Pacific Fisheries Commission (WCPFC) http://www.wcpfc.int

The Western and Central Pacific Fisheries Commission (WCPFC) is currently operating under the Convention on the Conservation and Management of High Migratory Fish Stocks in the Western and Central Pacific Ocean. The capacity for WCPFC to consider the ecosystem in its deliberations is described in the convention in articles 5 and 6 which have sections that specify the responsibility of the WCPFC target stocks, non-target stocks, species

belonging to the same ecosystem, preserving biodiversity, other human activities within the convention area including artisanal fishing.

While the WCPFC's convention provides grounds for ecosystem based management there appears to be little attention paid to it. The only conservation management measures and resolutions that relate to EBM are those that relate to bycatch of sharks and birds. It does not appear that ecosystem factors in stock productivity have been documented to be large enough to need to be addressed in management.

The WCPFC does have an active observer program that monitors the species of all bycatch and implements mitigation to reduce these bycatches through the ongoing Bycatch Mitigation Information System. But besides this program there does not seem to be much else being done by the WCPFC to conduct EBFM.

This summary of WCPFC was created through review of the WCPFC website as well as the Convention on the Conservation and Management of High Migratory Fish Stocks in the Western and Central Pacific Ocean and the following websites:

http://www.wcpfc.int

http://www.wcpfc.int/convention-text

http://www.wcpfc.int/conservation-and-management-measures

http://www.wcpfc.int/regional-observer-programme

http://www.wcpfc.int/bmis

International Pacific Halibut Commission (IPHC) http://www.iphc.int

The International Pacific Halibut Commission (IPHC) established in 1923 by a convention between the United States and Canada does not appear to have a strong focus in EBFM. However it has devoted a lot of attention to environmental / oceanographic factors including the Pacific Decadal Oscillation that might have affected the distribution of various ages/sizes as well as growth and maturity rates of halibut from lower US to Alaska. Also there is significant attention given to the apparent declining trend in productivity (recruits per spawner). The decline in biomass has been taken into account in the setting of quotas in the second half of the 2000s and continues to be a high level concern today.

This review of IPHC was conducted using the IPHC website which can be found at the following URLs:

http://www.iphc.int

http://www.iphc.int/library/annual-reports.html

http://www.iphc.int/about-iphc.html

Pacific Salmon Commission (PSC) http://www.psc.org/index.htm

The Pacific Salmon Commission (PSC) was formed to implement the Pacific Salmon Treaty between the United States and Canada. The commission does not directly manage the salmon fisheries but rather gives management advice to participating countries. There is minimal language in the treaty that incorporates EBFM but the treaty does use ecosystem indicators, and ecosystem benefits to other species when addressing Chinook salmon. The

national inputs to PSC give a great deal of attention to environmental productivity regimes, to ecosystem-scale carrying capacity and density dependent feedback, to how environmental conditions affected migration routes (and therefore national splits of quotas), predation mortality on first-sea-year salmon and many other ecosystem issues.

The PSC focuses on habitat wide management and restoration of salmon habitats. This supports restoration and research on ecosystem wide management of salmon populations and enhance salmon stocks.

The summary of PSC was created from reviewing the PSC website and the Pacific Salmon Treaty specific websites of interest are:

http://www.psc.org/index.htm

http://www.psc.org/pubs/Treaty/Treaty.pdf

http://fund.psc.org/about_fund.htm

http://www.psc.org/pubs/psctr24.pdf

Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea (CCBSP)

http://www.afsc.noaa.gov/refm/cbs/convention_description.htm

The Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea was signed in 1994. While the convention's main focus is on pollock one of the four goals of the conventions includes "other marine living resources" as a target of the convention opening up the possibility of considering a broader EBM.

This convention is limited on what capabilities it has for future endeavors due to its scope. Without having a commission or self-contained science programs the pollock convention must rely on participating countries to take action. And the parties do perform ecosystem-drivers research to make the respective cases for their quota shares.

The review of the CCBSP was conducted using its website and convention:

http://www.afsc.noaa.gov/refm/cbs/convention_description.htm

http://www.afsc.noaa.gov/refm/cbs/convention_description.htm

International Commission for the Conservation of Atlantic Tunas (ICCAT) http://www.iccat.int/en/

The International Commission for the Conservation of Atlantic Tunas (ICCAT) convention texts prepare the organization for the capability of EBFM. The convention mentions including non-tuna fish in studies, ecology of fish, the physical characteristics of the ocean the fish use, as well as the human impacts upon the fish.

However, the ICCAT has engaged very little in terms of EBFM. The ICCAT created a sub-committee on ecosystems in 2006. The committee is responsible for developing and incorporating EBFM into ICCAT and includes such tasks as creating a list of ecosystem indicators and creating an ecosystem status report that will be utilized for individual species. The committee has not been very successful in integrating into the existing ICCAT framework and receives little participation and buy-in from the rest of the commission. Reasons why there has not been a lot of uptake of all the ecosystem indicators and other initiatives in the work of ICCAT are clear. The main problems with

sustainability of Atlantic BFT are first order direct exploitation issues, and questions about migration and sharing of substocks between east and west Atlantic. Getting the fishing mortality rate down to a level where stocks can be maintained, much less, recover – or even getting agreement on what "stocks' need to recover – are first-order fisheries biology and management questions. Moreover, the studies of migration and sharing substocks have given huge attention to environmental covariates to movement.

Bycatch has on the other hand become more relevant and there has been a growing focus on looking into the impacts on seabirds, sharks, and sea turtles and what mitigations can be used to reduce these impacts. ICCAT also has developed a committee to address the Sargasso Sea on an ecosystem wide approach looking into how ICCAT species use the region and what biological indicators can be developed for managing those species. [Preceding paragraph from Tara Dolan's research].

This summary of ICCAT was conducted through the review of the ICCAT website as well as an interview with Shannon Calay by Tara Dolan:

http://www.iccat.int/en/

http://www.iccat.int/Documents/Commission/BasicTexts.pdf

North Atlantic Fisheries Organization (NAFO) http://www.nafo.int

The North Atlantic Fisheries Organization (NAFO) has a growing interest in EBFM. Originally the NAFO convention only mentioned assessing environmental and ecological factors in the guidelines of the Scientific Council. But an amendment to the NAFO convention in 2007 more explicitly includes concepts of EBM into the overall duties of the organization. However, NAFO has been considering environmental changes and their impacts on fisheries in since the nineties through the Standing Committee on Fisheries Environment.

There is an entire "ecosystem roadmap" for NAFO that has been adopted by both the Scientific Council and the General Council and member states are doing a lot of work to implement the components. First order trade-offs among some predator-prey stocks (cod – shrimp) have already been conducted and there is much in the pipeline, awaiting science advice. Also Management Strategy Evaluations have been performed for several major NAFO stocks and all of them include scenarios with environmentally driven productivity regimes.

Since the inclusion of the 2007 amendment of the NAFO convention, EBFM is primarily approached through a working group inside of NAFO. Originally, the working group operated under the name Working Group on the Ecosystem Approach to Fisheries Management but in 2013 the working group changed its name to the Working Group on Ecosystem Science and Assessment.

These groups have resulted in management responses such as Vulnerable Marine Ecosystems. Vulnerable Marine Ecosystems are identified by the presence of indicator species listed by NAFO. NAFO has closed many areas of the ocean to bottom fishing and has begun to increase restrictions on boats abilities to fish near fragile ecosystems that include sponges and corals. NAFO has also mandated that in order for an area that has been previously un-fished to be open to be reviewed by NAFO for impacts on marine species.

NAFO does have a moratorium in effect for half of the species protected under its convention. However, NAFO is working to create and implement Rebuilding Plans for these species to recover the stocks to levels that can be sustainably fished again. Overall NAFO has an increasing focus on EBFM.

This summary of NAFO was created by reviewing the NAFO website as well as the following URLs:

http://www.nafo.int/publications/frames/publications.html

http://www.nafo.int/fisheries/frames/fishery.html

http://www.nafo.int/science/frames/science.html

http://www.nafo.int/about/frames/ann-rep.html

http://www.nafo.int/about/frames/about.html

North Atlantic Salmon Conservation Organization (NASCO) http://www.nasco.int/about.html

The potential for the North Atlantic Salmon Conservation Organization (NASCO) to actively pursue EBM is not outlined in the convention. However, NASCO has adopted a precautionary approach to managing salmon fisheries in the Atlantic. Through the Precautionary Approach there are agreements, which can be applied to habitat protection and restoration, management of fisheries as well as the use of socio-economic factors in implementing management.

NASCO's plan for habitat restoration and protection takes into account the life history of salmon and the need to assess the Atlantic salmon population at all life stages. However, because the International Council for the Exploration of the Sea (ICES) thinks that environmental conditions may have a large impact on origins of stocks that mix and are fished in Greenland, and on migratory routes back to European and North American home waters, which influences harvesting opportunities (and needs for constraints on harvesting) on interception fisheries off Iceland, the Faroes, and some farther-west European countries. All these factors have received a lot of attention in ICES advice to NASCO, and by NASCO in its advice to Parties on management of fisheries.

NASCO also has developed guidelines to include socio-economic considerations in its management. These guidelines include taking into account the impacts that management would have on the Atlantic salmon's ecosystem. But it also stresses the importance of the impacts decisions will have on the stakeholders associated with the salmon fishery, particularly the social, economic and environmental costs to those stakeholders.

The implementation of these guidelines is left up to the participating members of NASCO but NASCO does require members to provide detailed reports as to how member nations are following through on the recommendations of NASCO

This summary of NASCO was created through the review of the NASCO website as well as relevant documents connected through the website:

http://www.nasco.int/about.html

http://www.nasco.int/pa_agreement.html

http://www.nasco.int/pdf/far_habitat/Habitat%20Guidelines%20Brochure.pdf

http://www.nasco.int/pdf/agreements/socioeconomics.pdf

http://www.nasco.int/fisheries.html

http://www.nasco.int/pdf/agreements/socioeconomics.pdf

http://www.nasco.int/implementation_plans.html.

West Central Atlantic Fishery Commission (WECAFC) http://www.fao.org/fishery/rfb/wecafc/en#Org-Outputs-NEMS.2

The Western Central Atlantic Fishery Commission (WECAFC) has some demonstrated management that includes aspects of EBFM. One of the guiding principles of the WECAFC is to include ecosystem-based fisheries management. This is further supported by the species stated by the WECAFC to be covered by its management responsibilities, which includes all living marine resources in the area. The origin of the focus on EBFM in WECAFC comes from the Commission's relation to the Food and Agriculture Organization of the United Nations as WECAFC follows the rules and recommendations put forward by the FAO Code of Conduct for Responsible Fisheries.

The WECAFC in its latest report recommended the use of EBFM in several different sections stressing the importance of incorporating the entirety of the ecosystem as well as the socio-economic factors in management. The focus of EBFM is throughout the Commission, as such there is no specific working group that works on EBFM. Although the Working Group on the management of deep-sea fisheries is more specifically focused on EBFM than other groups.

Because the regulation of the fisheries are left to the participating nations WECAFC serves the purpose of promoting EBFM to its member nations through much of its work.

This review was conducted using the WECAFC website:

http://www.fao.org/fishery/rfb/wecafc/en#Org-Outputs-NEMS.2

ftp://ftp.fao.org/FI/DOCUMENT/wecafc/statutes.pdf

http://www.fao.org/docrep/017/i2677t/i2677t.pdf

Convention for the Conservation of Antarctic Marine Living Resources (**CCAMLR)** http://www.ccamlr.org

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) has many of the attributes that qualify as EBFM. Its convention outlines the capabilities of CCAMLR to utilize EBFM in Article II of its convention, which specifies that all associated species of an ecosystem are to be protected as well as the overall state of the ecosystem should be protected as well.

The scientific committee of the CCAMLR has a working group named The Working Group on Ecosystem Monitoring and Management, as well as a separate program called the CCAMLR Ecosystem Monitoring Program. The working group's contribution to EBFM has been focused on marine protected area and identifying vulnerable marine ecosystems. The CEMP with dependent species and associated species which are the species who share the ecosystem with the target species and may or may not be directly connected with the food web of the target species. Much of the work of these two programs has been focused on krill and its importance to the convention area's fisheries.

CCAMLR provides a list of all active conservation measures in effect for a fishing season. There are many measures in this list that could be used towards EBFM. In this list the measures to establish the many marine protected areas inside the CCAMLR convention area are outlined. The CCAMLR has made great strides to implement marine protected areas in many critical habitats throughout the convention area. However, CCAMLR has no competence to institute MPAs whose provisions must be respected by non-parties to the Convention. Even among Parties, there are a few that to this point have NOT supported creation of "MPAs" in the CCAMLR area, and are showing no signs of changing their views. Without consensus the "MPAs" remain just a proposal.

Overall the CCAMLR appears to be very progressive towards implementing EBFM. Constable (2011) demonstrates that in many ways CCAMLR is a leader in EBFM around the world, but that there is still work that needs to be done before CCAMLR can effectively implement EBFM in all of the aspects of its management.

This summary of CCAMLR was conducted through reviewing the CCAMLR website as well as use of Constable (2011):

http://www.ccamlr.org

http://www.ccamlr.org/en/document/publications/convention-conservation-antarctic-marine-living-resources

http://www.ccamlr.org/en/science/ccamlr-ecosystem-monitoring-program-cemp,
http://www.ccamlr.org/en/science/working-group-ecosystem-monitoring-and-management-wg-emm

http://www.ccamlr.org/en/system/files/e-CMs-2012-13_1.pdf

http://www.ccamlr.org/sites/drupal.ccamlr.org/files//91-02.pdf

Constable A.J. 2011. Lessons from CCAMLR on the implementation of the ecosystem approach to managing fisheries. Fish and Fisheries. 12:138-151.

Indian Ocean Tuna Commission (IOTC) http://www.iotc.org/English/index.php

The Indian Ocean Tuna Commission (IOTC) is a commission established under the rules and guidance of the Food and Agriculture Organization of the United Nations. As such it has adopted the Code of Conduct for Responsible Fisheries, which has in its framework guidelines, which can be used to conduct EBFM. This also means that the IOTC has the capability of adopting the FAO's Ecosystem Approach to Fisheries which, would further the work of EBFM in the IOTC.

Much of the EBFM work of the IOTC has been focused on the regulation of bycatch of sharks, sea turtles, cetaceans, and sea birds. But in 2012 the IOTC adopted as one of its management resolutions to use the Precautionary Approach outlined by UNFSA. This approach calls for taking into consideration uncertainties in the fishery including, biological, environmental, socio-economic uncertainties as well as the related uncertainties of non-target species.

The IOTC also has a working group that was formally known as the Working Party of Bycatch that was renamed the Working Party of Ecosystem and bycatch that performs research and makes recommendations based off of EBFM. Much of this group's focus is still primarily on bycatch mitigation.

This summary of the IOTC was created through reviewing the IOTC website:

http://www.iotc.org/English/index.php

http://www.iotc.org/English/info/basictext.php

http://www.fao.org/fishery/topic/2880/en

http://www.iotc.org/files/CMM/IOTC%20-%20Compendium%20of%20ACTIVE%20CMMs%2015%20September%202013.pdf

http://www.iotc.org/files/proceedings/2013/wpeb/IOTC-2013-WPEB09-R[E].pdf

APPENDIX H. LEGISLATIVE MANDATES FOR ECOSYSTEM-BASED FISHERY MANAGEMENT IN UNITED STATES

Sustainable Fisheries Act (SFA) 1996

The MSA allows fishery managers to consider ecosystems in setting management objectives. National Standard 1 requires conservation and management measures to prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery" (Sec 301(a)(1). The "optimum" yield is defined as providing "the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities, and taking into account the protection of marine ecosystems" Sec 3(28)(A). Moreover, the optimum yield is prescribed as "the maximum sustainable yield from each fishery, as reduced by any relevant economic, social or ecological factor" 3(28)(B). In addition, the Act states as one of its purposes "to promote the protection of essential fish habitat" (Sec. 2(b)(7). It was the SFA that required this report to Congress (EPAP 1999).

Proposed EBFM Language in House Bill HR 5051 – 2005 Magnuson-Stevens Act (MSA) [reauthorization]

HR 5051 IH

SEC. 115. ECOSYSTEM MANAGEMENT.

Title III (16 U.S.C. 1851 et seq.), as amended by

section 204, is further amended by adding at the end the

following:

''SEC. 318. ECOSYSTEM MANAGEMENT.

(a) GUIDELINES

(1) IN GENERAL

.—The Secretary shall, in consultation with the Councils and within 24 months after the date of the enactment of the Magnuson-Stevens Fishery Conservation and Management Amendments Act of 2006, publish draft guidelines (which shall not have the force and effect of law) for the Councils concerning ecosystem considerations in fishery conservation and management.

(2) CONTENTS

.—The guidelines shall include definitions of the term 'ecosystem' for purposes of

this Act.

''(b) FISHERY ECOSYSTEM PLANS

.—Each Council, or the Secretary as appropriate, may prepare a fishery ecosystem plan in order to assist in implementing an eco-system approach to managing fisheries within its area of authority. In preparing a fishery

ecosystem plan, a Council shall coordinate with Federal and State agencies responsible for scientific understanding and management of other marine resources and sector activities.

‘‘(c) CONTENTS OF FISHERY ECOSYSTEM PLANS

Fishery ecosystem plans shall be consistent with the advisory guidelines established in subsection (a) and shall contain conservation and management measures applicable to fishery resources throughout the fishery ecosystem, including measures that the Council or the Secretary may consider appropriate to—

‘‘(1) avoid or minimize adverse effects of fishing on fish habitat, as well as other components of theecosystem;

‘‘(2) establish marine managed areas in the exclusive economic zone or the high seas;

‘‘(3) manage fishing capacity; and

‘‘(4) coordinate fishery science and management actions with Federal and State agencies responsible for scientific understanding and management of other marine resources and sector activities,

such as pollution prevention and habitat modification.

(d) JOINT PLANS

.—If a fishery ecosystem encompasses waters under the authority of more than one Council, or a Council or Councils and the Secretary, for fisheries under section 302(a)(3), the Councils, or the Council or Councils and the Secretary, as appropriate, may collaborate to jointly prepare a fishery ecosystem plan for that ecosystem. In preparing a joint fishery ecosystem plan, a Council or Councils, or the Council or Councils and the Secretary, as appropriate, shall coordinate with Federal and State agencies managing other marine re-

sources and sector activities.’’.

MSA As passed by the House and Senate 2006 [signed by President 2007]

Section 406 (16 U.S.C. 1882) is amended by adding at the

end the following:

‘‘(f) REGIONAL ECOSYSTEM RESEARCH

‘‘(1) STUDY

.—Within 180 days after the date of enactment of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, the Secretary, in consultation with the Councils, shall undertake and complete a study on the state of the science for advancing the concepts and integration of ecosystem considerations in regional fishery management. The study should build upon the recommendations of the advisory panel and include—

‘‘(A) recommendations for scientific data, information and technology requirements for understanding ecosystem

processes, and methods for integrating such information from a variety of federal, state, and regional sources;

‘‘(B) recommendations for processes for incorporating broad stake holder participation;

‘‘(C) recommendations for processes to account for effects of environmental variation on fish stocks and fisheries; and

‘‘(D) a description of existing and developing council efforts to implement ecosystem approaches, including les-

sons learned by the councils.

‘‘(2) AGENCY TECHNICAL ADVICE AND ASSISTANCE REGIONAL PILOT PROGRAMS

.—The Secretary is authorized to provide necessary technical advice and assistance, including grants, to the Councils for the development and design of regional pilot programs that build upon the recommendations of the advisory panel and, when completed, the study.’’

‘‘(e) SENSE OF CONGRESS REGARDING FISH HABITAT

.—It is the sense of the Congress that the United States Commissioners should seek to include ecosystem considerations in fisheries management, including the conservation of fish habitat.’’