NOAA FISHERIES

Northeast Regional

Implementation Plan of the NOAA Fisheries Ecosystem-Based Fishery Management Roadmap

Section 1: Northeast Plan Overview

Introduction

NOAA Fisheries has long recognized the importance of ecosystem-based fisheries management (EBFM). The Ecosystem Based Fishery Management Policy[1] and Road Map[2] describe how NOAA Fisheries implements EBFM based on six guiding principles. NOAA Fisheries defines EBFM in the Policy as "a systematic approach to fisheries management in a geographically specified area that contributes to the resilience and sustainability of the ecosystem; recognizes the physical, biological, economic, and social interactions among the affected fishery-related components of the ecosystem, including humans; and seeks to optimize benefits among a diverse set of societal goals." To implement EBFM, the Policy identifies and outlines six guiding principles:

1. Implement ecosystem-level planning
2. Advance our understanding of ecosystem processes
3. Prioritize vulnerabilities and risks of ecosystems
4. Explore and address trade-offs within an ecosystem
5. Incorporate ecosystem considerations into management advice
6. Maintain resilient ecosystems

The Road Map calls for the development of implementation plans to guide NOAA Fisheries' efforts in implementing EBFM over the next 5 years. The purpose of this Implementation Plan is to identify and coordinate priority EBFM milestones among the Greater Atlantic Regional Fisheries Office (GARFO), the Northeast Fisheries Science Center (NEFSC) and our partners in the Northeast region.

[1] National Marine Fisheries Service (NMFS) Policy Directive 01-120; May 23, 2016

[2] NMFS Instruction 01-120-01; November 17, 2016

Regional Context

For the purposes of this implementation plan, the Northeast region is defined as the marine and estuarine waters off the east coast of the United States from Cape Hatteras, NC, in the south through the Gulf of Maine in the north. This region is serviced by NOAA's Northeast Fisheries Science Center (NEFSC) and Greater Atlantic Regional Fisheries Office (GARFO), as well as three fishery management entities: The Mid-Atlantic and New England Fishery Management Councils and the Atlantic States Marine Fisheries Commission (ASMFC). There are other NOAA line offices, federal agencies, state agencies, non-government organizations, academic organizations, and industry groups that also partner with NOAA Fisheries within the region. Several NOAA line offices are involved with the NOAA Integrated Ecosystem Assessment (IEA) program. The Northeast regional IEA team is comprised heavily of members of the NEFSC. This team has been instrumental in much of the EBFM work conducted in the region, including close collaboration with Canadian colleagues via the International Exploration of the Seas (ICES) working group on the Northwest Atlantic Regional Seas (WGNARS). Many of the tenants of the EBFM Roadmap follow closely with those of the NOAA IEA program.

The Northeast region contains some of the most productive fishery grounds in the world. As such, the region has a long history of marine use and resource extraction. For the purposes of ecosystem-based management, the region has been divided into smaller Ecological Production Units (EPUs; Figure 1). Starting in the south is the narrow sandy shelf of the Mid-Atlantic Bight which includes several major estuaries that serve as nursery and forage areas. Just off the shores of Cape Cod is Georges Bank, a highly productive submarine plateau. To the north are the deep basins of the Gulf of Maine and shallow offshore banks of the Scotian Shelf. Of the four EPUs, three reside primarily within United States' jurisdiction while the Scotian Shelf EPU resides within Canadian jurisdiction.

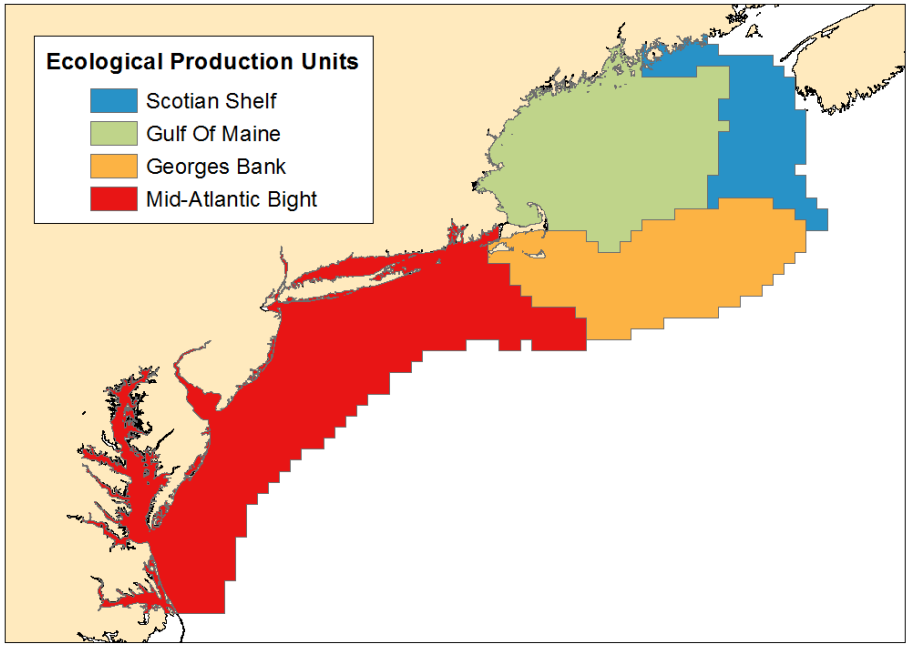

Figure 1 – The Northeast U.S. Continental Shelf divided into four Ecological Production Units (EPUs).

The two Federal Fishery Management Councils are approaching EBFM differently. This implementation plan will continue to support these individual development efforts. The Mid-Atlantic Council has adopted an incremental approach via its Ecosystem Approach to Fisheries Management (EAFM) guidance document[3]. This guidance document sets policy with how the Mid-Atlantic Council approaches forage fish, climate, habitat, and species interactions. Taking a different approach, the New England Council is exploring the possibility of a wholesale change in its management structure. If this possibility is pursued, the New England Council will require more time to develop and adopt its EBFM policies.

The NEFSC's vision statement[4] is to "Conduct ecosystem-based research and assessments of living marine resources…". The NEFSC's commitment to ecosystem science is further documented in its strategic science plan, which strives to increase multidisciplinary, cross-cutting science and scientific investigations that support the progression towards EBFM. As such, many parts of the NEFSC are actively working on ecosystem science and/or EBFM. Much of the coordination on ecosystem science between divisions is handled by the Ecosystems Dynamics and Assessment Branch. Members of the branch, as well as others throughout the NEFSC serve on the various ecosystem teams for both Councils.

The most recent version of GARFO's strategic plan[5] identified the importance of developing an integrated approach among programs to enhance fishing community resiliency and ensure sustainable fisheries, recovery of protected resources, and healthy habitat. Moving forward, it is expected that a more comprehensive regionally-based plan that includes both GARFO and NEFSC activities will be developed; however, it is expected that continued emphasis on EBFM support and development activities will be continued in the regional plan.

As EBFM moves forward within the Councils, GARFO will provide regional coordination under the Policy and Council-developed management programs. Consistent with the GARFO strategic plan goals the Sustainable Fisheries Division (SFD) will establish a plan to proactively identify and resolve fishery management issues that threaten fishery sustainability and community resilience. This work includes identifying potential avenues by which ecosystem approaches to management and climate change data and information can be integrated into existing single species management actions. GARFO will undertake development of regional guidance on national EBFM policies and management approaches, in collaboration with NOAA General Counsel, NMFS Headquarters, and the NEFSC. Within GARFO, SFD will coordinate and collaborate with other GARFO divisions and programs on Road Map activities and milestones, primarily through an Ecosystem Fishery Policy Analyst expected to be hired in 2019. GARFO's Habitat Conservation Division (HCD) has been actively involved with both Councils' EBFM initiatives as well as engaged in habitat vulnerability assessments.

[3] Mid-Atlantic Fishery Management Council; Mid-Atlantic Fishery Management Council Ecosystem Approach to Fisheries Management Guidance Document; Adopted August 8, 2016, Revised February 2, 2019.

[4] https://www.nefsc.noaa.gov/mission.html

[5] Strategy 1.1.4; Greater Atlantic Regional Fisheries Office Strategic Plan FY 2015-2019; February 1, 2015

Expected Outcomes and Benefits

The Northeast region has been a pioneer with respect to EBFM science. However, integration of broad scale EBFM principles in the management process within the region has been slow. While there have been instances of ecosystem principles considered in specific fishery management plans as well as in some broad fisheries decision making, EBFM remains a complex task with many challenges to fully develop. In order to continue moving EBFM forward requires a change in perspective. The implementation of the NOAA EBFM Roadmap relies on the ongoing commitment of both the NEFSC and GARFO to EBFM. Moving forward, it is expected that there will be a closer cooperation between NEFSC, GARFO, management entities, and other partners, which should lead to a more focused emphasis on incorporating ecosystem considerations into the management process. The milestones laid out in this plan initially provide an ecosystem context for fisheries managers to use during their decisions. To a varying degree, some of these products are already being provided to managers. Longer-term milestones will provide the necessary tools to further transition to EBFM in the region. An expected benefit of following this roadmap will be to leverage shorter milestones and embed ecosystem concepts at the lower technical levels of policy decision making (i.e., technical committees) which will help develop the longer-term milestones leading towards EBFM. The benefit of fully realizing this plan will be the explicit evaluation of trade-offs during management decisions which may provide a more stable socio-economic system as well as a resilient ecosystem.

Section 2: Actions and Milestones

Guiding Principle 1: Implement ecosystem-level planning

Develop engagement strategies to facilitate the participation of partners and stakeholders in the EBFM process

The Road Map calls for NOAA Fisheries to develop national and regional EBFM engagement strategies. National strategies will continue to leverage existing engagement efforts through various national programs and initiatives. Regional engagement will be handled by the science centers and regional offices. A national EBFM working group was established to identify regional points of contacts (POCs) for each science center and regional office. The Northeast region is represented by both the NEFSC and GARFO within the working group; in addition, the Mid-Atlantic and New England Councils have provided POCs to work with the regional POCs. The regional POCs will need to reach out to ASMFC to establish a similar relationship as with the other management entities. In the end, the regional working group will mirror the structure of the Northeast Regional Coordination Committee, which enhances regional coordination concerning assessment needs, management process-related issues, and data needs. The goal is to increase the engagement between the Mid-Atlantic and New England Councils, ASMFC, NEFSC, and GARFO. Collaboration with the ASMFC is expected to begin in 2019.

To further enhance the development of a regional engagement strategy, GARFO plans to hire an Ecosystem Fishery Policy Analyst in 2019 that will serve as its primary POC for EBFM-related activities. The majority of interactions between the Councils, NEFSC, and GARFO are expected to occur through continued NMFS support for the Councils' ecosystem-related working groups (e.g., Technical and Policy Development Teams, Committees, Advisory Panels). Long-term coordination will be necessary given the two different approaches the Councils are taking. It will also be important to consider states' needs during this coordination.

It is also pertinent to acknowledge that the Northeast region is not isolated. The region shares resources with Canada to the north. It will therefore be necessary to establish a transboundary EBFM working group that can augment the work already being conducted by the Transboundary Resource Assessment Committee. In addition, as the region continues to warm, interactions with species to the south are expected to increase. This will require coordination between the Northeast and Southeast regions. Preliminary plans are being developed to establish a Northeast/Southeast working group, with potential involvement of the Southeast Fisheries Science Center, Southeast Regional Office and South Atlantic Fishery Management Council. Including estuarine and freshwater components of the Northeast region is also necessary. This will require coordination with other elements of NOAA Fisheries (e.g., Office of

Habitat Conservation, NOAA Chesapeake Bay Office), other elements of NOAA (e.g., National Estuarine Research Reserves, Sea Grant), and the states primarily through ASMFC.

Support development of Fishery Ecosystem Plans

Fishery Ecosystem Plans (FEPs), or similar documents, form the basis of ecosystem-level planning. They typically describe the ecosystem objectives and priorities for a management entity. Within the Northeast, the two Councils are taking different approaches to implementing ecosystem-based policies. The Mid-Atlantic Council has developed an Ecosystem Approaches to Fisheries Management (EAFM) guidance document[3] that contains a series of strategies for forage fish, habitat, species interactions, and climate. The New England Council is developing an FEP that attempts to holistically manage multiple species within the Georges Bank EPU. NEFSC and GARFO have participated in the development of both approaches. Both the NEFSC and GARFO will continue to support these individual-Council efforts as well as contribute to any new efforts that may arise at the Councils, ASMFC, or within the region. Coordination of the various plans will be handled by GARFO's new Ecosystem Fishery Policy Analyst. To aid in the coordination of the ecosystem plans, GARFO will be leading an effort to catalog how ecosystem considerations are incorporated in current management efforts in the region. This effort is expected to begin in 2019.

Table 1 – Associated Milestones for the Northeast under Guiding Principle 1. The timing category in parentheses explains when a milestone has been achieved (**complete**), is expected to be achieved within a year (**short**), is expected to be achieved in the next few years (**mid**), or milestones that may take some time to achieve (**long**). Milestones can also be labeled as **annual** if they are occurring each year.

Roadmap Number and Action Item	Associated Milestone (timing)
1a1. Establish EBFM Point of Contacts	• Regional POCs identified; Regional management councils' POCs identified; DFO/NOAA EBFM WG established (complete) • ASMFC POC identified; Northeast/Southeast WG established (short) • Plan for incorporating estuarine and freshwater habitats into Northeast Regional ecosystem considerations developed (mid)
1a2. Develop regional engagement strategies	• NEFSC and GARFO participate in National EBFM working group (complete) • Regular engagement between NEFSC, GARFO, Mid-Atlantic and New England Councils, and ASMFC established (short)
1a3. Develop best practices where there are overlapping jurisdictions	• Plan for coordination between Councils and states relative to EPUs developed (mid) • A transboundary EBFM WG is established between the US and Canada (mid) • A Northeast/Southeast EBFM WG is established (mid)
1a5. NOAA Fisheries supports any Ecosystem Plan Development Teams, Ecosystem Committees (or equivalent groups) that Councils establish	• NEFSC and GARFO participate in the New England Council EBFM PDT; NEFSC and GARFO participate in the Mid-Atlantic Council EAFM working group (annual) • NEFSC and GARFO participate in ASMFC ecosystem-related working groups (short)
1b1. Establish Fishery Ecosystem Plan Coordinator/Analyst for each NOAA Fisheries Regional Office	• GARFO SFD hire Ecosystem Fishery Policy Analyst (short)
1b2. Review and develop inventory of existing Fishery Ecosystem Plans and Ecosystem Considerations in fishery management plans, documenting best practices	• Ecosystem considerations which are currently included in any Northeast region fishery management plans or assessment are cataloged by GARFO (mid)

1b3. Assist Councils, Commission, regional fishery management organizations, and other bodies as requested, in their development of new, or revision of existing, Fishery Ecosystem Plans	• See 1a5 (annual)

Guiding Principle 2: Advance understanding of the ecosystem processes

Conduct science to understand ecosystems

Ecosystem-level advice requires ecosystem-level science. Fortunately, the Northeast region has a rich history of conducting science to understand the ecosystem. The NEFSC Bottom Trawl Survey has operated throughout the region since the 1960s. Biological samples collected during the survey include age, maturity, and stomach data, in addition to lower trophic level information and oceanographic data. Additional biological data and environmental data are collected in a number of other ship-board surveys including species specific research cruises as well as Ecosystem Monitoring (EcoMon) cruises. The region also utilizes aerial surveys and satellites, most notably for protected resources and phytoplankton, respectively. In addition to NEFSC directed surveys and data collection, there are several surveys operated by states and academic partners including but not limited to the NEAMAP survey which surveys nearshore areas south of Block Island, RI which are no longer accessible by the NEFSC survey due to vessel changes. The region is serviced by two ocean observation networks: Mid-Atlantic Regional Association of Coastal Ocean Observation Systems (MARACOOS) and NERACOOS (Northeast Regional Association of Coastal Ocean Observation Systems). There is also a newly established National Science Foundation (NSF) Long-term Ecological Research (LTER) site led by Woods Hole Oceanographic Institution (WHOI) along with researchers at the University of Massachusetts, Wellesley College, and the University of Rhode Island.

Working in concert with fishery-independent data, fishery-dependent data, including socioeconomic data, is collected by observers, port samplers, mail surveys, and phone or in-person interviews. There is a project underway to modernize fisheries-dependent data collection, which should have ancillary benefits to EBFM efforts by improving data timeliness, quality, and accessibility.

As a result, the Northeast is commonly thought of as a very data rich system. These multiple data streams are used to investigate various aspects of the ecosystem and its services. It is therefore imperative that NEFSC and GARFO align their current investments with their strategic plans. It will also be important to consider other national strategic initiatives such as the NOAA Fisheries Climate Science Strategy or the next generation Stock Assessment Improvement Plan in addition to the EBFM Roadmap. Ensuring the complementarity of the various national initiatives at the regional level could help alleviate some of the struggles of resource limitations.

Provide Ecosystem Status Reports for each Large Marine Ecosystem

Ecosystem Status Reports (ESR) are a good way of providing ecosystem context for resource managers. The Northeast was one of the first regions to produce an ESR. More recently, NEFSC has moved to a set of more focused State of the Ecosystem (SOE) reports. These are annual reports focused on regional indicators appropriate to the Councils. The NEFSC has not provided a similar report for the ASMFC, but will engage with commission staff to develop one. The SOE contains a suite of indicators encompassing both ecological and socio-economic aspects of the system. The reports are designed with the most relevant human dimension indicators to the councils such as revenue and social vulnerability to climate at the beginning with supporting ecologically relevant indicators backing them up. It is the goal of the report to provide an ecosystem context for management decisions. The NEFSC is developing a more comprehensive Center Reference Document that will describe the methods used to develop the indicators contained within the SOE. These reports are increasingly integrating information from across the fisheries sciences to more completely reflect a broader range of ecosystem components.

To achieve this, workshops and a synthesis meeting are held to coordinate and collaborate across disciplines. The goal is to develop a cohesive message on the state of the ecosystem. The indicators contained within the Mid-Atlantic version of the SOE were used extensively for the Mid-Atlantic Council's ecosystem risk analysis[6], an ongoing process that they intend to update periodically. The NEFSC has also extended the SOE reporting to a new Ecosystem Considerations for Stock Assessment (ECSA) report which is a tailored towards an individual species. With the anticipated hire of a new Ecosystem Fishery Policy Analyst, GARFO will become more involved in the SOE development process.

[6] Gaichas, S. et al. Mid-Atlantic EAFM Risk Assessment Documentation and Results; February 13, 2018; http://www.mafmc.org/s/SOE_MAB_RiskAssess-6cgk.pdf

Table 2 - Associated Milestones for the Northeast under Guiding Principle 2. The timing category explains when a milestone has been achieved (**complete**), is expected to be achieved within a year (**short**), is expected to be achieved in the next few years (**mid**), or milestones that may take some time to achieve (**long**). Milestones can also be labeled as **annual** if they are occurring each year.

Roadmap Number and Action Item	Associated Milestone (timing)
2a1. Advance resources to conduct EBFM	• Current investments are aligned with strategic plans; National strategic initiatives (NOAA Fisheries Climate Science Strategy, Stock Assessment Improvement Plan, etc.) are coordinated in the region (mid)
2a2. Develop capacity for NOAA Fisheries to conduct end-to-end ecosystem studies	• A suite of ecosystem models has been developed (mid)
2a4. Develop and maintain core data and information streams	• Surveys (bottom trawl, EcoMon, scallop, etc.) are conducted; Ecosystem information (food habits, oceanography, etc.) is collected on appropriate surveys (annual) • Finalize the Fishery-Dependent Data Initiative (mid)
2b2. Establish routine, regular, and dynamic reporting of ecosystem status reports for each large marine ecosystem	• State of the Ecosystem (SOE) reports for both Mid-Atlantic and New England Councils produced (annual) • Center Reference Document that details the methods for developing SOE indicators produced; NEFSC, GARFO, and Councils are engaged during the production process of the SOEs (short) • SOE report for ASMFC produced (mid) • Feedback process from the Councils established to ensure indicators are relevant and can be translated into management applications (mid)

Guiding Principle 3: Prioritize vulnerabilities and risk to ecosystems and their components

Identify ecosystem-level, cumulative risk (across LMRs, habitats, ecosystem functions, and associated fisheries communities) and vulnerability to human and natural pressures

Risk analysis allows managers to explore multiple drivers and pressures to better understand the cumulative effects on the ecosystem, including fisheries. The Northeast has been a pioneer in this type of research. Scientists from the region, in collaboration with NMFS HQ, were instrumental in developing the protocol[7] used by each NMFS region to conduct fisheries climate vulnerability assessments. The region was also the first to conduct a full assessment based on these protocols[8] with plans to re-evaluate the assessment on a regular schedule of five to ten years. The vulnerability of fishing communities to system shocks and changes in drivers including climate was also pioneered in the Northeast along with collaborators in the Southeast Regional Office[9], and is being adopted nationally. Components of both vulnerability assessments along with indicators presented in the SOE have been used by the Mid-Atlantic Council in its first iteration of an indicator-based risk assessment.[6] The New England Council is interested in conducting a similar analysis to the one completed by the Mid-Atlantic Council. NEFSC and GARFO have completed initial work on a habitat risk assessment[10] and will continue evaluating habitat on an ongoing basis while supporting Council-related activities focused on habitat.

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[7] Morrison, W.E., et al. 2015. Methodology for Assessing the Vulnerability of Marine Fish and Shellfish Species to a Changing Climate. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OSF-3, 48 p.

[8] Hare J.A., et al. 2016. A Vulnerability Assessment of Fish and Invertebrates to Climate Change on the Northeast U.S. Continental Shelf. PLoS ONE 11(2): e0146756. https://doi.org/10.1371/journal.pone.0146756

[9] Colburn, L.L., et al. 2016. Indicators of climate change and social vulnerability in fishing dependent communities along the Eastern and Gulf Coasts of the United States. Marine Policy. 74:323-333

Jepson, M and L.L. Colburn. 2013. Development of Social Indicators of Fishing Community Vulnerability and Resilience in the U.S. Southeast and Northeast Regions. U.S. Dept. of Commerce., NOAA Tech Memo. NMFS-F/SPO-129, 2013, 64 p

Colburn, L.L. and M. Jepson. 2012. Social Indicators of Gentrification Pressure in Fishing Communities: A Context for Social Impact Assessment. Coastal Management. 40:289-300.

[10] NMFS. 2015. Regional habitat assessment prioritization for northeastern stocks. Report of the Northeast Regional Habitat Assessment Prioritization Working Group. Internal report, NMFS White Paper. Office of Science and Technology, NMFS, NOAA. Silver Spring, MD. 31p.

Identify the individual and cumulative pressures that pose the most risk to vulnerable resources and dependent communities

Once ecosystem-level risk assessments have been performed, it is important to translate the findings into management decisions. The best way to accomplish this is to ensure that ecosystem-related ToRs are being considered during the assessment process and setting of ABC control rules. It is important to note that ecosystem considerations are not a one-size-fits-all criteria and will need to be developed on an assessment by assessment basis. There are plans within GARFO to catalog what ecosystem-related control rules or processes have been used in management. Since EBFM is cutting edge in the United States, these studies and catalogs will be published so other regions can follow. There are also several studies underway in the region looking at individual and cumulative pressures on marine resources and coastal communities. Work is ongoing with respect to the effects of oceanographic conditions on fish stocks, as well as temperature impacts on protected species. Other ecosystem-related effects are explored as part of the section 7 consultation of the Endangered Species Act (ESA). GARFO convened a workshop on New England fishing community resiliency in Gloucester, MA, in June 2017. A similar workshop for the Mid-Atlantic was held in Cape May, NJ, in June 2018. Summaries from these meetings can be found on the GARFO community resiliency website: https://www.greateratlantic.fisheries.noaa.gov/sed/community/workshops/june2017/index.html.

Table 3 - Associated Milestones for the Northeast under Guiding Principle 3. The timing category explains when a milestone has been achieved (**complete**), is expected to be achieved within a year (**short**), is expected to be achieved in the next few years (**mid**), or milestones that may take some time to achieve (**long**). Milestones can also be labeled as **annual** if they are occurring each year.

Roadmap Action Item	Associated Milestone
3a1. Conduct Systematic Risk Assessments for relevant NOAA regional ecosystems	● Northeast Climate Vulnerability Assessment completed[6]; Index-based risk assessment for the Mid-Atlantic Council completed[8]; Community vulnerability Assessment completed[7] (complete) ● Index-based risk assessment for the New England Council completed; Index-based risk assessment for the Mid-Atlantic Council is reevaluated and improved (mid)
3a2. Explore protocols for conducting regional habitat risk assessments for those areas known to serve important ecological functions for multiple species groups or will be especially vulnerable or important in the face of climate change	● Habitat Risk Assessment completed[9] (complete) ● Council activities related to habitat are supported (annual)
3b1. Ensure that factors which impact 800+ US managed species are being considered	● Proper ecosystem-related ToRs are considered for assessments and ABC control rules; Ecosystem-related control rules/processes that have been considered in management decisions are cataloged; Effects of climate change on marine/estuarine habitat has been evaluated; Ecosystem-level impacts on protected resources through section 7 consultations (ESA) have been evaluated (mid)
3b2. Conduct Habitat Assessment Prioritization for all NOAA Fisheries regions	● Habitat Assessment Prioritization completed[9] (complete)
3b3. Conduct Fishing Community vulnerability assessments for all NOAA Fisheries regions	● New England community resiliency workshop held (complete) ● Mid-Atlantic community resiliency workshop held (complete)

Guiding Principle 4: Explore and address trade-offs within an ecosystem

Analyze trade-offs for optimizing benefits from all fisheries within each ecosystem or jurisdiction, taking into account ecosystem-specific policy goals and objectives, cognizant that ecosystems are composed of interconnected components

Sufficient modeling capacity to analyze trade-offs is important for EBFM. There are many different objectives and data sources that need to be synthesized. Work is ongoing in the region to develop a broad portfolio of models from simple qualitative network models to length-based multispecies models to full-system models. The NEFSC Ecosystem Dynamics and Assessment Branch has partnered with the NEFSC Social Sciences Branch to link economic and social models with both multispecies production models and full ecosystem models. Other bio-economic models and approaches have been developed in the region and further evaluation of all ecosystem models in the region needs to be conducted. The recent peer-review of the West coast Atlantis model should serve as a template of the best way to evaluate ecosystem models. In addition, researchers from the NEFSC routinely interact with the ICES working group on Multi-species Assessment Methods (WGSAM). This is a good venue for evaluating ecosystem models and determining key-runs, so that they can later be used for management. Due to the number of models in the Northeast and the identified need for a multi-model inference (MMI), there has been some work on developing methods for incorporating a MMI but more research is required.

Develop Management Strategy Evaluation capabilities to better conduct ecosystem-level analyses to provide ecosystem-wide management advice

Management Strategy Evaluations (MSE) are a stakeholder-driven process for testing various management strategies using simulation models. NMFS has been building MSE capacity by hiring an FTE at each science center who is responsible for MSE projects. At NEFSC, that position is currently split between two FTEs, one an ecosystem modeler and the other a stock assessment scientist. The two FTEs are supported by an interdisciplinary team of scientists with relevant expertise. For example, the Northeast recently completed an extensive MSE for Atlantic herring[11]. This MSE, coordinated by the New England Council, successfully incorporated stakeholders in the process. NOAA Fisheries is also supporting MSE activities in the region through a joint Climate Program Office – NOAA Fisheries grant to Gulf of Maine Research Institute.

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[11] Deroba, JJ, et al. In Press. The dream and the reality: meeting decision-making time frames while incorporating ecosystem and economic models into management strategy evaluation. Can. J Fish. Aquat. Sci. http://dx.doi.org/10.1139/cjfas-2018-0125

Feeney, R., et al. In Press. Integrating Management Strategy Evaluation into fisheries management: advancing best practices for stakeholder inclusion based on an MSE for Northeast US Atlantic herring. Can. J Fish. Aquat. Sci. http://dx.doi.org/10.1139/cjfas-2018-0125

Both Councils have pending needs for ecosystem-level MSEs. The New England Council EBFM PDT is developing ecosystem-based management procedures that will warrant further exploration via an MSE process. The Mid-Atlantic Council has recently concluded its indicator-based risk assessment[6]. The plan is to use the risk assessment to identify a critical area of need and conduct an MSE. Both processes will involve large commitments from NEFSC, GARFO, and Council staff.

There has been a clear need to develop flexible responses in adaptation to increased utilization of ecosystem-related information in fisheries decision making. Where MSE is expected to provide a robust mechanism to evaluate trade offs when crafting ecosystem-related policy and management decisions, another avenue that can be pursued is scenario planning. Scenario planning can incorporate assumptions about the vulnerability of specific components within the ecosystem and, as such, help provide another means to evaluate risk tolerance for management decision making. This effort is expected to require commitments from NEFSC, GARFO, and Council staff and be coordinated by the GARFO ecosystem fishery policy analyst.

Table 4 - Associated Milestones for the Northeast under Guiding Principle 4. The timing category explains when a milestone has been achieved (**complete**), is expected to be achieved within a year (**short**), is expected to be achieved in the next few years (**mid**), or milestones that may take some time to achieve (**long**). Milestones can also be labeled as **annual** if they are occurring each year.

Roadmap Action Number and Item	Associated Milestone (timing)
4a3. Encourage and expand the use of multi-model inference	• Simulation testing of multi-model inference using models of varying degrees of complexity completed (mid)
4a4. Establish suitable review venues and deliberative bodies for ecosystem models and associated information in each fishery science center region	• Key runs endorsed by the International Council for the Exploration of the Sea working group on multi-species stock assessment methods; Peer-review of ecosystem models completed (mid)
4b1. Develop functional system-level management strategy evaluations	• Atlantic Herring MSE completed (complete) • MSE based on results of the Mid-Atlantic risk assessment for the Mid-Atlantic Council completed (mid) • Integration of MSE activities conducted by academic partners (mid) • Ecosystem-based procedures MSE for New England Council completed (long) • Capabilities to conduct scenario planning are established in the region (long)
4b2. Explore novel Harvest Control Rules (HCRs) and develop associated guidelines, as appropriate and consistent with National Standards, especially to test & explore robust Ecosystem Level strategies	• HCRs that implement the proposed ecosystem-based management procedure for the NEFMC developed and tested (short) • More novel HCRs with respect to place-based management developed and tested (long)

Guiding Principle 5: Incorporate ecosystem considerations into management advice

Develop and monitor Ecosystem-Level Reference Points

Ecosystem-level reference points and thresholds will be necessary for proper implementation of EBFM. They should reflect emergent ecosystem priorities or major ecosystem-wide issues that impact many species. The New England Council EBFM PDT is exploring a system-level cap on total removals as well as individual species' biomass floors. The management procedure will be reviewed in the near future but further testing will be required. NEFSC and GARFO in coordination with NMFS HQ will investigate the permissibility of ecosystem reference points and the proposed management procedure within current legislation. Ultimately, a broad range of ecosystem-related control rules should be tested. GARFO will catalog the ways that ecosystem-level control rules have been implemented throughout the country. The objective of this work will be to develop a compendium of ecosystem control rule 'best practices'.

Incorporate ecosystem considerations into appropriate LMR assessments, control rules, and management decisions

Ecosystem considerations are a term of reference for each stock assessment conducted in the region. They are, however, only rarely included in the final control rule or management decision. A couple of notable exceptions are the most recent assessment for butterfish and yellowtail flounder. For butterfish, a thermal niche model was used to modify the availability of the stock to the survey and ultimately improve the estimation of catchability. For yellowtail flounder, a change in productivity was used as a rationale to split the time series and recalculate reference points. The last groundfish operational assessment included an ecosystem considerations section based on the indicators from the SOE. This idea was expanded for the recent summer flounder assessment where indicators from the SOE as well as additional information were included as an ECSA report. Plans are to make ECSAs a regular part of the assessment process. It will be important to track when ecosystem considerations are taken into account within the assessment process. NEFSC and GARFO in conjunction with the National working group will need to develop an effective means of tracking ecosystem considerations. Coordination of ecosystem considerations will be strengthened by the addition of the new Ecosystem Fishery Policy Analyst.

Provide integrated advice for other management considerations, particularly applied across multiple species within an ecosystem

While NMFS's primary focus is to prevent overfishing and rebuild overfished stocks, there are many other species and ecosystem services that can benefit from the inclusion of an ecosystem approach. Both Councils have and continue to evaluate and preserve habitat both as Essential Fish Habitat and for conservation of unique biota such as deep-sea corals. Ecosystem-related information may play a role in evaluating habitat and providing insight into impact mitigation. Given the mandate to minimize bycatch to the extent practicable, ecosystem-related analyses may be explored for bycatch evaluation and reduction, with emphasis on exploring control rules that consider importance of forage species., Designation of critical habitat under the Endangered Species Act as well as recovery efforts for species like North Atlantic right whales will entail comprehensive evaluation of ecosystem considerations across multiple species. Ecosystem information can also contribute to a number of state initiatives; NOAA Fisheries will work with ASMFC to strengthen the necessary links.

Table 5 - Associated Milestones for the Northeast under Guiding Principle 5. The timing category explains when a milestone has been achieved (**complete**), is expected to be achieved within a year (**short**), is expected to be achieved in the next few years (**mid**), or milestones that may take some time to achieve (**long**). Milestones can also be labeled as **annual** if they are occurring each year.

Roadmap Action Number and Item	Associated Milestone (timing)
5a1. Delineate, evaluate, and explore best practices for estimating and using system-wide or aggregate group harvest limits, eco production measures, and other ecosystem level reference points, to inform management decisions	• Ecosystem-based procedures MSE for New England Council completed (long)
5a2. Explore best measures of cross-pressure, cumulative impacts in an ecosystem in conjunction with principle 3	• Ecosystem-related control rules/processes that have been considered in management decisions are cataloged (short)
5b1. Develop and track fishery stock status indices that denote when ecosystem considerations are used	• Method of tracking ecosystem considerations used in management developed (mid)
5b2. Support consistent and effective implementation of the NS1 guidelines, which includes guidance on incorporating ecosystem information into stock management	• Proper ecosystem-related ToRs are considered for assessments and ABC control rules (mid)
5b3. Identify best practices for incorporating ecosystem considerations into management decisions	• Participation in national working groups (EBFM, ESR, etc.) is maintained (annual) • Development of comprehensive existing ecosystem-based management control rules and catalog of ecosystem best practices (short)
5b4. Establish ecosystem-related Terms of References (ToR) for stock assessments, stock assessment reviews, and support ecosystem-related terms of reference for status review groups, harvest control rules, and science and statistical committee review processes	• Proper ecosystem-related ToRs are considered for assessments and ABC control rules (mid)

5c1. Explore protocols for considering ecosystem-level information in essential fish habitat reviews, identifying ecosystem-level habitat areas of particular concern, and setting habitat conservation objectives and/or indicators	● Council activities related to habitat are supported (annual) ● Critical habitat for protected resources (based on the Endangered Species Act, Marine Mammal Protection Act, etc.) is designated (long)
5c2. Finalize and implement National Bycatch Reduction Strategy	● Staff from NEFSC and GARFO participated in the implementation of the National Bycatch Reduction Strategy (short)
5c3. Evaluate ecosystem effects of offshore aquaculture	● Research on offshore aquaculture and its ecosystem effects is completed (long)
5c5. Review long-term protected species recovery and rebuilding plans to ensure they account for the potential effects of near-term and long-term climate change, particularly relating to alterations to food web structure	● Interdisciplinary team from NEFSC Ecosystem Dynamics and Assessment Branch, NEFSC Protected Species Branch, and GARFO Protected Resources Division created (long)

Guiding Principle 6: Maintain resilient ecosystems

Evaluate ecosystem-level measures of resilience

The marine ecosystem provides a variety of services that humans rely on such as food, cultural value, employment, etc. It is therefore imperative that the resilience of the ecosystem is tracked over time. The SOE reports annually track the status and trend of multiple ecosystem indicators to best understand the trends and changes in these services and considers how they might impact human communities. Further work will need to be conducted to establish thresholds to determine ecosystem resilience, though for social and economic indicators there is rarely a threshold as these are set by societal preference rather than ecological constraints. In general, we can look at historical trends plus a standard deviation or two on either side as a way to capture apparent societal preference. Although this does not guarantee that societal preferences will not change over time. The Mid-Atlantic Council's EAFM guidance document and ecosystem risk assessment initiative are attempting to develop region/council specific social and economic targets and thresholds.

Evaluate community well-being

Ultimately fisheries management looks to sustainably derive benefits for human communities. The Northeast has studied a number of factors that contribute to community well-being. GARFO conducted a community resilience workshop in New England in June 2017 and a similar workshop for the Mid-Atlantic in 2018. GARFO is compiling a final report for these two workshops and is maintaining a web portal for community resiliency-related information. It is expected that the final report will outline next steps for regional community resiliency efforts. NEFSC has developed indicators of human community vulnerability, including a joint assessment with the outputs from the Northeast Climate Vulnerability Assessment. These data have been expanded to examine the engagement and reliance on vulnerable species by port, indicators of species dependence at the permit level, as well as indicators tracking the diversity of fleets. Many of these factors are reported in the annual State of the Ecosystem report.

Table 6 - Associated Milestones for the Northeast under Guiding Principle 6. The timing category explains when a milestone has been achieved (**complete**), is expected to be achieved within a year (**short**), is expected to be achieved in the next few years (**mid**), or milestones that may take some time to achieve (**long**). Milestones can also be labeled as **annual** if they are occurring each year.

Roadmap Number and Action Item	**Associated Milestone (timing)**
6a1. Evaluate and Track Ecosystem-level reference point to assess changes in ecosystem-level resilience	• State of the Ecosystem (SOE) reports for both Mid-Atlantic and New England Councils produced (annual) • SOE report for ASMFC produced (mid) • Research on ecosystem thresholds and resilience completed (long)
6a2. Evaluate, conduct and track ecosystem goods and services valuation methods and best practices	• State of the Ecosystem (SOE) reports for both Mid-Atlantic and New England Councils produced (annual) • SOE report for ASMFC produced (mid)
6b1. Explore community health and well-being socio-economic metrics	• Community socio-economic indicators calculated (annual)
6b2. Adopt community vulnerability analyses to a broader range of cumulative factors	• Assessment of community climate vulnerability completed (complete)
6b3. Track community health, well-being and vulnerability socio-economic metrics	• State of the Ecosystem (SOE) reports for both Mid-Atlantic and New England Councils produced (annual) • SOE report for ASMFC produced (mid)

Section 3: Engagement Strategy

This Engagement Strategy outlines approaches and strategies to enhance coordination, collaboration, and communication practices with external NMFS partners. To be successful, an engagement strategy requires the long-term commitment of multiple partners and involves a spectrum of approaches and methods that are effective in advancing EBFM.

The Northeast engagement strategy will employ the following approaches:

- **INFORM** - provide balanced and objective information with respect to the EBFM process, objectives, obstacles, alternatives, opportunities and/or solutions. Ensure effective communication and collaboration by employing useful tools.
- **CONSULT** - ask science and management partners for feedback throughout the process to identify informational needs, ensure products and approaches address their needs, and clarify and resolve obstacles.
- **PARTNER** - work with new and current science and management partners in each phase of EBFM implementation, including the recognition of issues, identification of solutions, and leveraging of resources to enhance EBFM implementation.

Key partners in the region include the Regional Fishery Management Councils along with their Science and Statistical Committees (SSC), states, interstate commissions, other NOAA Line Offices, and other government agencies. Northeast staff also coordinate and collaborate with other external partners and stakeholders, including interagency workgroups, NMFS advisory committees and regional bodies, academic and research organizations, non-governmental organizations, and interested stakeholder groups.

Strategies to facilitate participation by external partners and stakeholders in the implementation of the plan include:

- Seek out and share information with collaborators, within and external to NOAA, that will enable synergistic partnerships to achieve EBFM actions.
- Provide policy information to advance EBFM actions undertaken by management partners.
- Partner with organizations that have technologies and approaches that will advance EBFM.
- Deliver scientific advances, products, and new information to users to support management decisions.
- Employ a variety of communication efforts to ensure constructive dialogue and feedback with management partners.