

# The Northeast Regional Implementation Plan of NOAA Fisheries Ecosystem-Based Fisheries Management Roadmap

## Introduction

NOAA Fisheries recently codified its commitment to ecosystem-based fisheries management (EBFM) with the release of its EBFM policy<sup>1</sup> and subsequent EBFM Roadmap<sup>2</sup>. Beyond defining what EBFM means to the organization, the NOAA Fisheries EBFM Policy establishes a framework of guiding principles to “enhance and accelerate the implementation of EBFM within NOAA Fisheries, and in cooperation with NOAA Fisheries partners”. The policy recognizes that implementation of EBFM cannot be obtained in a single action, but rather will take many small actions to achieve comprehensive management of complex systems. The policy identifies six guiding principles:

- Implement ecosystem-level planning;
- Advance our understanding of ecosystem processes;
- Prioritize vulnerabilities and risks of ecosystems and their components;
- Explore and address trade-offs within an ecosystem;
- Incorporate ecosystem considerations into management advice; and
- Maintain resilient ecosystems.

The EBFM Road Map is meant to guide and enhance NOAA Fisheries’ efforts in implementing the EBFM Policy over the next 5 years. It further describes a national strategy for operationalizing the policy’s guiding principles. NOAA Fisheries wants to ensure that its various efforts are well coordinated among science centers, regional and headquarters offices, regional fishery management councils and other key stakeholders. The Roadmap calls for each region to develop a regional implementation plan based on their unique conditions, challenges, capabilities, and priorities. This document is the Northeast regional implementation plan of the NOAA Fisheries EBFM Roadmap. It contains specific actions and milestones to guide the region’s EBFM activities.

## Regional Context

For the purposes of this implementation plan, the Northeast Region is defined as the marine waters of 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

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<sup>1</sup> National Marine Fisheries Service (NMFS) Policy Directive 01-120; May 23, 2016

<sup>2</sup> NMFS Instruction 01-120-01; November 17, 2016

Center (NEFSC) and Greater Atlantic Regional Fisheries Office (GARFO), as well as three fishery management entities: The Mid-Atlantic and New England Fisheries 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.

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. 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.

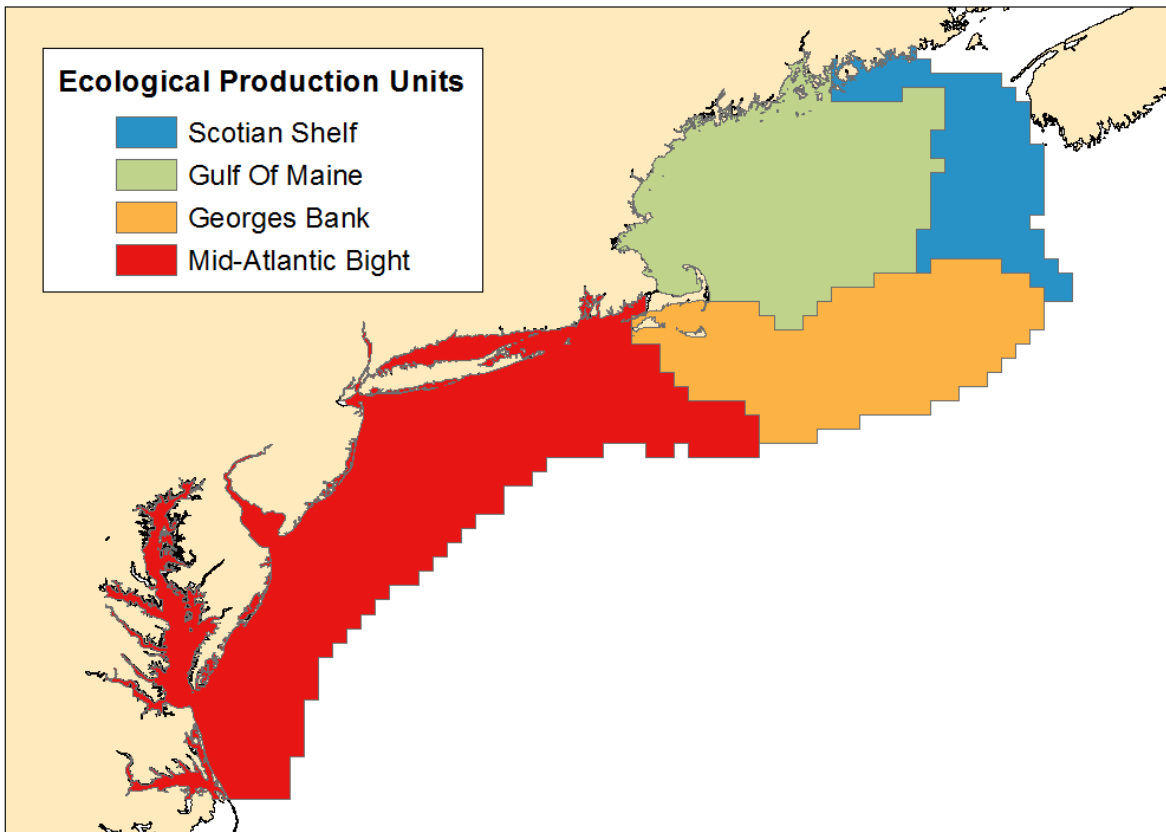


Figure 1 – The Northeast U.S. Continental Shelf divided into four Ecological Production Units (EPUs).

The two federal Fishery Management Councils are approaching EBFM differently. The Mid-Atlantic Council has adopted an incremental approach via its Ecosystem Approach to Fisheries Management (EAFM) guidance document<sup>3</sup>. 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<sup>4</sup> 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 Council ecosystem teams.

GARFO's strategic plan<sup>5</sup> identifies 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. This cross-cutting goal pairs well with many of the EBFM roadmap objectives by seeking to enhance both fishing community and working waterfront (social, economic, and cultural) and living marine resource community (ecological) resiliency. Both new strategic initiatives and ongoing programs within several divisions are expected to support the development of EBFM capacity within GARFO.

As EBFM moves forward within the Councils, GARFO will provide regional coordination of the policy and 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 is currently developing 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 roadmap activities and milestones, primarily through an EBFM Fishery Policy Analyst expected to be hired in 2018. GARFO's Habitat Conservation Division (HCD) has been actively involved with both Councils' EBFM initiatives as well as engaged in habitat vulnerability assessments.

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<sup>3</sup> Mid-Atlantic Fishery Management Council; Mid-Atlantic Fishery Management Council Ecosystem Approach to Fisheries Management Guidance Document; August 8, 2016.

<sup>4</sup> <https://www.nefsc.noaa.gov/mission.html>

<sup>5</sup> 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 EBFM principles in the management process within the region has been slow. EBFM is 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.

## 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 Roadmap 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.

To further enhance the development of a regional engagement strategy, GARFO will be hiring an Ecosystem Fishery Policy Analyst in 2018 that will serve as its primary POC for EBFM-related activities. The majority of interactions between the Management 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 to blend the two approaches being taken by the Councils and incorporate states' needs, especially with respect to any place-based

strategies that use the EPU as the basis for management. Discussions with ASMFC will begin in earnest once the regional working group is formed.

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<sup>3</sup> 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 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 leading an effort to catalog how ecosystem considerations are incorporated in current management efforts in the region.

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)
<b>1a1.</b> Establish EBFM Point of Contacts	<ul style="list-style-type: none"> <li>• Regional POCs identified; Regional management councils' POCs identified; DFO/NOAA EBFM WG established (complete)</li> <li>• ASMFC POC identified; Northeast/Southeast WG established (short)</li> <li>• Plan for incorporating estuarine and freshwater habitats into Northeast Regional ecosystem considerations developed (mid)</li> </ul>
<b>1a2.</b> Develop Regional engagement strategies	<ul style="list-style-type: none"> <li>• NEFSC and GARFO participate in National EBFM working group (complete)</li> <li>• Regular engagement between NEFSC, GARFO, Mid-Atlantic and New England Councils, and ASMFC established (short)</li> </ul>
<b>1a3.</b> Develop best practices where there are overlapping jurisdictions	<ul style="list-style-type: none"> <li>• Plan for coordination between Councils and states relative to EPU developed (long)</li> </ul>
<b>1a5.</b> NOAA Fisheries supports any Ecosystem Plan Development Teams, Ecosystem Committees (or equivalent groups) that Councils establish	<ul style="list-style-type: none"> <li>• NEFSC and GARFO participate in the New England Council EBFM PDT; NEFSC and GARFO participate in the Mid-Atlantic Council EAFM working group (annual)</li> <li>• NEFSC and GARFO participate in ASMFC ecosystem-related working groups (short)</li> </ul>
<b>1b1.</b> Establish Fishery Ecosystem Plan Coordinator/Analyst for each NOAA Fisheries Regional Office	<ul style="list-style-type: none"> <li>• GARFO SFD hire EBFM Fishery Policy Analyst (short)</li> </ul>
<b>1b2.</b> Review and develop inventory of existing Fishery Ecosystem Plans and Ecosystem Considerations in fishery management plans, documenting best practices	<ul style="list-style-type: none"> <li>• Ecosystem considerations which are currently included in any Northeast region fishery management plans or assessment are cataloged by GARFO (short)</li> </ul>
<b>1b3.</b> Assist Councils, Commission, regional fisheries management organizations, and other bodies as requested, in their development of new, or revision of existing, Fishery Ecosystem Plans	<ul style="list-style-type: none"> <li>• See 1a5 (annual)</li> </ul>

## 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, 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 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 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. With the anticipated hire of a new Ecosystem Fishery Analyst, GARFO will become more involved in the process.

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)
<b>2a1.</b> Advance resources to conduct EBFM	<ul style="list-style-type: none"> <li>• 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)</li> </ul>
<b>2a2.</b> Develop capacity for NOAA Fisheries to conduct end-to-end ecosystem studies	<ul style="list-style-type: none"> <li>• A suite of ecosystem models has been developed (mid)</li> </ul>
<b>2a4.</b> Develop and maintain core data and information streams	<ul style="list-style-type: none"> <li>• Surveys (bottom trawl, EcoMon, scallop, etc.) are conducted; Ecosystem information (food habits, oceanography, etc.) is collected on appropriate surveys (annual)</li> <li>• Finalize the Fishery-Dependent Data Visioning project (short)</li> </ul>
<b>2b2.</b> Establish routine, regular, and dynamic reporting of ecosystem status reports for each large marine ecosystem	<ul style="list-style-type: none"> <li>• State of the Ecosystem (SOE) reports for both Mid-Atlantic and New England Councils produced (annual)</li> <li>• 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)</li> <li>• SOE report for ASMFC produced (mid)</li> </ul>



### 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<sup>6</sup> 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<sup>7</sup> 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<sup>8</sup>, 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.<sup>9</sup> The NEFMC 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<sup>10</sup> and will continue evaluating habitat on an ongoing basis while supporting Council-related activities focused on habitat.

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<sup>6</sup> 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.

<sup>7</sup> 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>

<sup>8</sup> 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.

<sup>9</sup> Gaichas, S. et al. Mid-Atlantic EAFM Risk Assessment Documentation and Results; February 13, 2018; [http://www.mafmc.org/s/SOE\\_MAB\\_RiskAssess-6cjk.pdf](http://www.mafmc.org/s/SOE_MAB_RiskAssess-6cjk.pdf)

<sup>10</sup> 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. 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 has convened a workshop on New England fishing community resiliency and plan on holding a similar workshop for the Mid-Atlantic in June 2018.

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
<p><b>3a1.</b> Conduct Systematic Risk Assessments for relevant NOAA regional ecosystems</p>	<ul style="list-style-type: none"> <li>• Northeast Climate Vulnerability Assessment completed<sup>6</sup>; Index-based risk assessment for the Mid-Atlantic Council completed<sup>8</sup>; Community vulnerability Assessment completed<sup>7</sup> (complete)</li> <li>• Index-based risk assessment for the New England Council completed (mid)</li> </ul>
<p><b>3a2.</b> 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</p>	<ul style="list-style-type: none"> <li>• Habitat Risk Assessment completed<sup>9</sup> (complete)</li> <li>• Council activities related to habitat are supported (annual)</li> </ul>
<p><b>3b1.</b> Ensure that factors which impact 800+ US managed species are being considered</p>	<ul style="list-style-type: none"> <li>• 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)</li> </ul>

Roadmap Action Item	Associated Milestone
<b>3b2.</b> Conduct Habitat Assessment Prioritization for all NOAA Fisheries regions	<ul style="list-style-type: none"> <li>Habitat Assessment Prioritization completed<sup>9</sup> (complete)</li> </ul>
<b>3b3.</b> Conduct Fishing Community vulnerability assessments for all NOAA Fisheries regions	<ul style="list-style-type: none"> <li>New England community resiliency workshop held (complete)</li> <li>Mid-Atlantic community resiliency workshop held (short)</li> </ul>

#### 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<sup>11</sup>. This MSE, coordinated by the NEFMC, 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.

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<sup>8</sup>. 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.

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)
<b>4a3.</b> Encourage and expand the use of multi-model inference	<ul style="list-style-type: none"> <li>Simulation testing of multi-model inference using models of varying degrees of complexity completed (mid)</li> </ul>
<b>4a4.</b> Establish suitable review venues and deliberative bodies for ecosystem models and associated information in each fishery science center region	<ul style="list-style-type: none"> <li>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)</li> </ul>
<b>4b1.</b> Develop functional system-level management strategy evaluations	<ul style="list-style-type: none"> <li>Atlantic Herring MSE completed (complete)</li> <li>MSE based on results of the Mid-Atlantic risk assessment for the Mid-Atlantic Council completed (mid)</li> <li>Integration of MSE activities conducted by academic partners (mid)</li> <li>Ecosystem-based procedures MSE for New England Council completed (long)</li> </ul>
<b>4b2.</b> Explore novel Harvest Control Rules (HCRs) and develop associated guidelines, as appropriate and consistent with National Standards,	<ul style="list-style-type: none"> <li>HCRs that implement the proposed ecosystem-based management procedure for the NEFMC developed and tested (short)</li> <li>More novel HCRs with respect to place-based management developed and tested (long)</li> </ul>

<sup>11</sup> Deroba, JJ, et al. In Review. 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.

Feeney, R., et al. In Review. Blending Management Strategy Evaluation into the US federal fisheries management process: lessons from a stakeholder driven MSE for Northeast US Atlantic herring. Can. J Fish. Aquat. Sci.

Roadmap Action Number and Item	Associated Milestone (timing)
especially to test & explore robust Ecosystem Level strategies	

## 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.

### *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 recent groundfish operational assessment also included an ecosystem considerations section based on the indicators from the SOE. 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. 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)
<b>5a1.</b> 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	<ul style="list-style-type: none"> <li>Ecosystem-based procedures MSE for New England Council completed (long)</li> </ul>
<b>5a2.</b> Explore best measures of cross-pressure, cumulative impacts in an ecosystem in conjunction with principle 3	<ul style="list-style-type: none"> <li>Ecosystem-related control rules/processes that have been considered in management decisions are cataloged (short)</li> </ul>
<b>5b1.</b> Develop and track fishery stock status indices that denote when ecosystem considerations are used	<ul style="list-style-type: none"> <li>Method of tracking ecosystem considerations used in management developed (mid)</li> </ul>
<b>5b2.</b> Support consistent and effective implementation of the NS1 guidelines, which includes guidance on incorporating ecosystem information into stock management	<ul style="list-style-type: none"> <li>Proper ecosystem-related ToRs are considered for assessments and ABC control rules (mid)</li> </ul>
<b>5b3.</b> Identify best practices for incorporating ecosystem considerations into management decisions	<ul style="list-style-type: none"> <li>Participation in national working groups (EBFM, ESR, etc.) is maintained (annual)</li> </ul>
<b>5b4.</b> 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	<ul style="list-style-type: none"> <li>Proper ecosystem-related ToRs are considered for assessments and ABC control rules (mid)</li> </ul>
<b>5c1.</b> Explore protocols for considering ecosystem-level information in	<ul style="list-style-type: none"> <li>Council activities related to habitat are supported (annual)</li> </ul>

Roadmap Action Number and Item	Associated Milestone (timing)
essential fish habitat reviews, identifying ecosystem-level habitat areas of particular concern, and setting habitat conservation objectives and/or indicators	<ul style="list-style-type: none"> <li>• Critical habitat for protected resources (based on the Endangered Species Act, Marine Mammal Protection Act, etc.) is designated (long)</li> </ul>
<b>5c2.</b> Finalize and implement National Bycatch Reduction Strategy	<ul style="list-style-type: none"> <li>• Staff from NEFSC and GARFO participated in the implementation of the National Bycatch Reduction Strategy (short)</li> </ul>
<b>5c3.</b> Evaluate ecosystem effects of offshore aquaculture	<ul style="list-style-type: none"> <li>• Research on offshore aquaculture and its ecosystem effects is completed (long)</li> </ul>
<b>5c5.</b> 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	<ul style="list-style-type: none"> <li>• Interdisciplinary team from NEFSC Ecosystem Dynamics and Assessment Branch, NEFSC Protected Species Branch, and GARFO Protected Resources Division created (long)</li> </ul>

## 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 tracks 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. But it's not a guarantee that societal preferences will not change.

### *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 has conducted a community resilience workshop for the New England Council and plans on conducting a similar workshop for the Mid-Atlantic in 2018. 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)
<b>6a1.</b> Evaluate and Track Ecosystem-level reference point to assess changes in ecosystem-level resilience	<ul style="list-style-type: none"> <li>State of the Ecosystem (SOE) reports for both Mid-Atlantic and New England Councils produced (annual)</li> <li>SOE report for ASMFC produced (mid)</li> <li>Research on ecosystem thresholds and resilience completed (long)</li> </ul>
<b>6a2.</b> Evaluate, conduct and track ecosystem goods and services valuation methods and best practices	<ul style="list-style-type: none"> <li>State of the Ecosystem (SOE) reports for both Mid-Atlantic and New England Councils produced (annual)</li> <li>SOE report for ASMFC produced (mid)</li> </ul>
<b>6b1.</b> Explore community health and well-being socio-economic metrics	<ul style="list-style-type: none"> <li>Community socio-economic indicators calculated (annual)</li> </ul>
<b>6b2.</b> Adopt community vulnerability analyses to a broader range of cumulative factors	<ul style="list-style-type: none"> <li>Assessment of community climate vulnerability completed (complete)</li> </ul>
<b>6b3.</b> Track community health, well-being and vulnerability socio-economic metrics	<ul style="list-style-type: none"> <li>State of the Ecosystem (SOE) reports for both Mid-Atlantic and New England Councils produced (annual)</li> <li>SOE report for ASMFC produced (mid)</li> </ul>

## Engagement Strategy

To enhance the coordination between NEFSC, GARFO, and stakeholders, GARFO and the NEFSC will work directly with elements of NOAA Fisheries, other NOAA Line Offices, other federal agencies, the states, the Councils, the Atlantic States Marine Fisheries Commission, other regional partners, and the general public, to understand and make use of the regional EBFM strategy actions and milestones. EBFM and the implementation roadmap will garner consideration within the annual work plan for the Region and strategic planning goals.