New England Fishery Management Council
50 WATER STREET | NEWBURYPORT, MASSACHUSETTS 01950 | PHONE 978 465 0492 | FAX 978 465 3116
John F. Quinn, J.D., Ph.D., *Chairman* | Thomas A. Nies, *Executive Director*

MEMORANDUM

DATE: April 15, 2019

TO: EBFM Committee

FROM: Andrew Applegate, EBFM PDT chair

SUBJECT: Discussion document 9: Spatial management measures for habitat, spawning, and endangered/threatened species protection

Spatial processes and species demographics are important considerations in the health of the ecosystem, improving productivity, and achieving the goals of a fishery ecosystem plan (FEP). Although many of the linkages between habitat quality, spatial processes, and productivity are uncertain, reasonable estimates can be made and systems can be simulated to evaluate how catch allocations amongst fishery functional groups affect the distribution of fishing effort and the ecosystem.

The attached document (Discussion Document 9 on the eFEP task list) discusses four spatial management strategies that could achieve an ecosystem management goal of sustaining and improving productivity of managed and protected species through sustaining and restoring habitat quality, resulting in increased survival of new recruits and optimal conditions for feeding, survival and growth, and reproduction. This eFEP component is not intended to duplicate or replace the Omnibus Habitat Amendment 2 measures, but instead broaden the scope of considering spatial effects of fishing as they relate to ecosysem function, including effects on juvenile survival and growth, energy flow through the system, and abundance and availability of prey for apex predators and protected species.

The four strategies in this document include:

1. Assessing spatial distribution of effort by gear type and fishery functional group to evaluate patterns of impact and recovery to habitat, spawning, and protected species within each EPU.
2. Evaluate allocations of catch to fishery functional groups to achieve management objectives for habitat, spawning, and protected species within each EPU.
3. Estimate effort and gear impacts to habitat for each managed species (or complex/functional group) regarding variation in productivity (growth, survival, reproduction) to evaluate performance of management to meet habitat, spawning, and protected species management objectives.
4. Effects of spatial variation in demographics of prey species for managed and protected species.

As an example of these strategies, the document gives a summary of recent research on yellowtail flounder habitat use and research by Pereira et al. (2012) that links research survey data to identify areas that make significant contributions to its productivity.

Discussion Document 9

Spatial Management Measures for Habitat, Spawning, and Endangered/Threatened Species Protection

prepared by the

Ecosystem-Based Fishery Management

Plan Development Team

This document describes some strategies to achieve an ecosystem management goal of sustaining and improving productivity of managed and protected species through sustaining and restoring habitat quality, resulting in increased survival of new recruits and optimal conditions for feeding and reproduction.

This eFEP management strategy component is not intended to duplicate or replace the Omnibus Habitat Amendment 2 measures, but instead broaden the scope of considering spatial effects of fishing as they relate to ecosystem function, including effects on juvenile survival and growth, energy flow through the system, and abundance and availability of prey for apex predators and protected species. The intent is to focus on the role of spatial processes on ecosystem function and health, as well as the benefits accrued from taking these processes into account in order to minimize risk to managed populations. A recent example where such processes were explicitly addressed was in Amendment 8 to the Herring FMP. In Amendment 8, several spatial alternatives and their potential effects were considered to reduce the effects of fishing in coastal populations of herring, an important prey species.

Listed below are four management strategies that would focus on the role that quality habitat has to improve ecosystem productivity and broaden the scope of consideration about the role of quality habitat in the ecosystem. These strategies focus on issues that are fundamentally different however from protecting mainly habitat that is vulnerable to adverse effects of various types of fishing effort or that take a relatively long time to recover from such disturbance caused by fishing. Instead, the issues recognize the importance and scale of spatial processes and demographic characteristics of fish in the “local” environment, i.e. how species interact on smaller spatial scales. Broadly speaking, these ecological “assets” include quality habitat for juvenile fish survival and growth, maintenance and enhancement of spawning potential (not just the amount of spawning biomass, but consideration of where and how spawning takes place), and quality habitat and forage fish availability to marine mammals and other apex predators.

Potential spatial management approaches to address management objectives for habitat, spawning and protected species include:

1. Assessing spatial distribution of effort by gear type and fishery functional group to evaluate patterns of impact and recovery to habitat, spawning, and protected species within each EPU.

Rationale and general approach: Quantifying spatial and temporal variation in fishing effort by gear type, linked to spatial variation of habitat types within EPUs. The output could be used to assess effects of fishing on vulnerable attributes of habitat and the potential for interactions within and between fishery functional groups and protected species. Geospatial data products, based on the SASI model framework, can be used to assess spatial variation of habitat impacts in regard to recovery rates, timing of gear effects, and co-occurrence with managed and protected species.

2. Evaluate allocations of catch to fishery functional groups to achieve management objectives for habitat, spawning, and protected species within each EPU.

Rationale and general approach: Evaluate spatial distribution of catch based on gear-effort and fishery functional groups where: (1) impacts to habitat are highest and where recovery times longest, (2) highest effort coincides with important life-history stages of managed species (e.g., settlement), and (3) where fishing coincides with aggregations of protected species (e.g., based on patchiness of distributions). Evaluate management objectives and approaches to reduce effects through the allocation process. This should be an adaptive process to identify where interventions could enhance ecosystem objectives and where (collaborative) research could be implemented to test responses and refine assumptions. Interventions could include gear restrictions, time-area rotations or closures, or allocating catch/effort such that some areas are fully fished, some are moderately fished and some areas lightly fished or closed. The intention would be to ensure high quality habitat at all life stages to support productive fisheries and reduce technical interactions among protected species and the fleets.

While the effects of fishing are often measured as effort, i.e. hours and area of bottom contact with gear, the currency in the FEP that influences how much fishing effort occurs within the EPU is catch of fishery functional groups. To achieve EPU-wide objectives, decisions about catch allocations may take habitat, spawning, and protected species impacts into account, particularly when other more direct means of minimizing impacts and improving productivity through more direct measures like area restrictions and more selective gear are highly uncertain and variable.

3. Estimate effort and gear impacts to habitat for each managed species (or complex/functional group) regarding variation in productivity (growth, survival, reproduction) to evaluate performance of management to meet habitat, spawning, and protected species management objectives.

Rationale and general approach: The role of habitat is a primary but not exclusive factor mediating the demography of managed species. In order to develop alternatives for habitat management that conserve habitat and sustain or enhance managed species, a modeling approach that evaluates variation in habitat attributes and links to the life history of managed species is needed. The EcoPath-EcoSpace model platform, for example, can be used to predict population responses to variation in habitat attributes, that affect survival and energetics, based on implementation of foraging arena theory. Models can test multiple impact and intervention scenarios that can be used to further inform allocation decisions and research needs.

4. Effects of spatial variation in demographics of prey species for managed and protected species.

Rationale and general approach: The spatial variation in density, size, and patchiness of prey available to predators directly affects patterns of energy intake and subsequent patterns of survival, growth, and reproduction. Analysis of existing data sets (split-beam acoustic surveys, trawl survey and observer data) for spatial distribution of principal prey (e.g., Atlantic herring, sand lance, mackerel, pollock, decapod zooplankton) over seasonal periods with comparison to patterns of catch, and patterns of protected species, can inform development of spatial management alternatives related to protected species interactions with fisheries.

Research needs

As an initial examination into spatial variation, condition factor for managed species could be examined spatially with data from the NEFSC trawl survey (e.g., Pereira et al. 2012, 2014, Howell et al. 2016). Data could be analyzed to determine if there were consistent patterns in variation in condition across Georges Bank (Northeast Shelf) by season and over time and if the patterns in condition factor were correlated with habitat types (taking sex, size, and population level into account). The goal would be to identify productive areas or habitat types that could help define spatial regions that enhance fish productivity and could be examined in simulation testing and adaptive management actions. For example, Pereira et al. (2012) demonstrated that data collected during standard fisheries assessment surveys (size, sex, weight, abundance, location) could be used to quantify spatial patterns of habitat use for yellowtail flounder on Georges Bank and identify areas that make significant contributions to species productivity (Map 1).

Howell, P. T., Pereira, J. J., Schultz, E. T., & Auster, P. J. (2016). Habitat Use in a Depleted Population of Winter Flounder: Insights into Impediments to Population Recovery. Transactions of the American Fisheries Society, 145(6), 1208-1222.

Pereira, J. J., Schultz, E. T., & Auster, P. J. (2012). Geospatial analysis of habitat use in yellowtail flounder *Limanda ferruginea* on Georges Bank. Marine Ecology Progress Series, 468, 279-290.

Pereira, J. J., Schultz, E. T., & Auster, P. J. (2014). Geospatial analysis of habitat use by silver hake *Merluccius bilinearis* in the Gulf of Maine. Endangered Species Research, 23(3), 219-227.

Map 1. Example of a geospatial approach for identifying habitat areas that contribute significantly to productivity (from Pereira et al. 2012). The maps illustrate the distribution of yellowtail flounder population on Georges Bank during periods of (A) low and (B) high abundance. The cross-hatched area represents the area within which approximately 66% of the population occurred. The hatched area represents the distribution of an additional 33 % of the population. Together they account for 99% of the area occupied by the population. Analysis of spatial pattern revealed that the overall area occupied by flounder increased by a factor of 2 when abundance was high, and local density increased predominantly in high quality habitat, with quality based on variation in size-weight relationships.