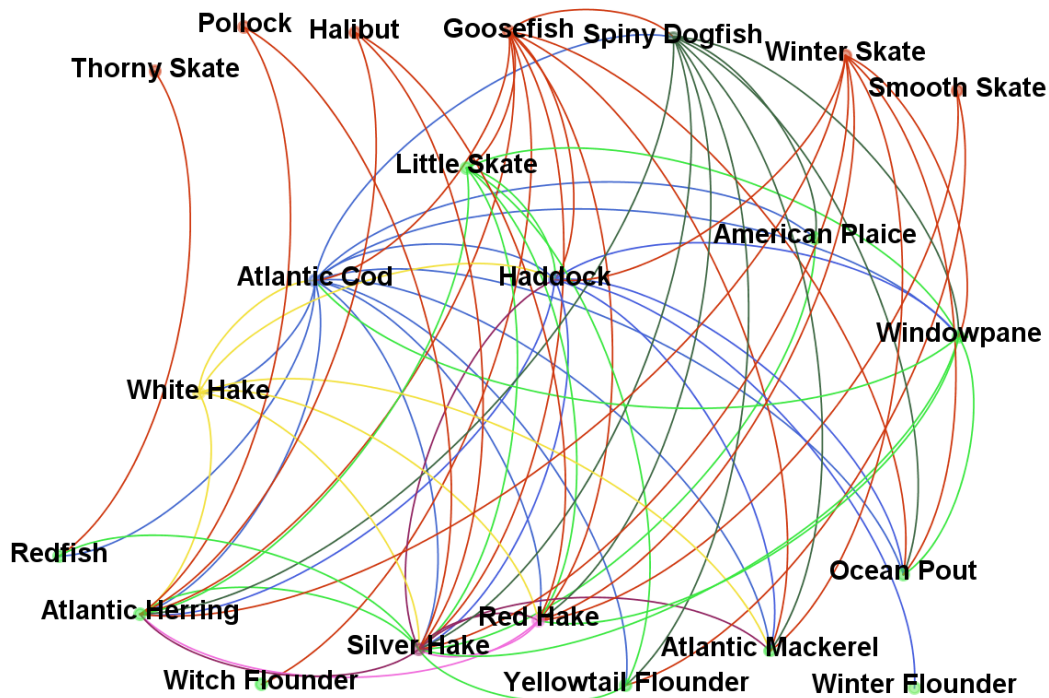


# NEW ENGLAND FISHERY MANAGEMENT COUNCIL

## A Framework for Providing Catch Advice For a Fishery Ecosystem Plan (FEP)

prepared by the

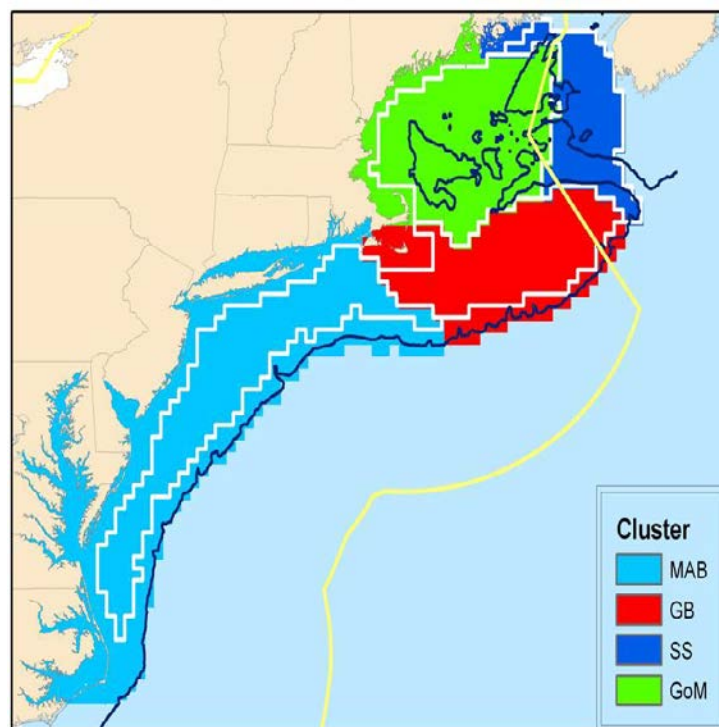
Ecosystem Based Fishery Management  
Plan Development Team



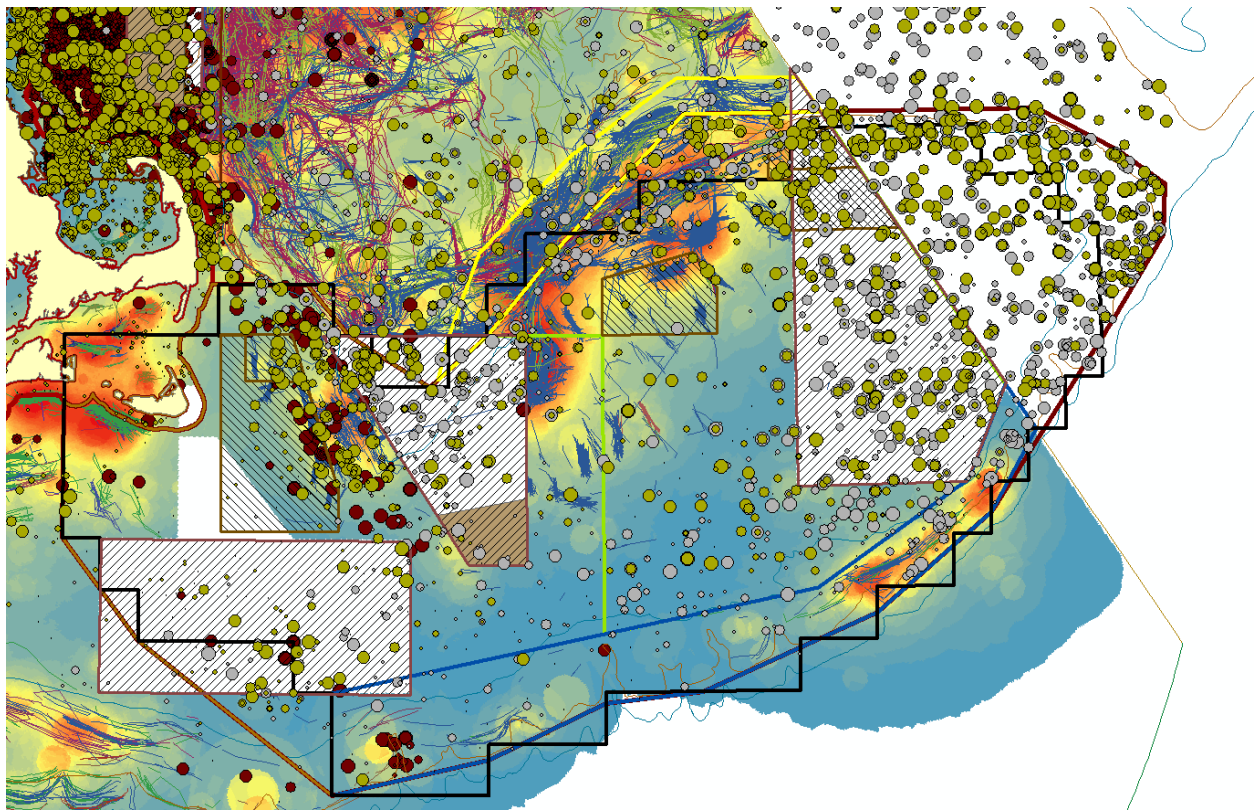


The goal of a Fishery Ecosystem Plan (FEP) is to provide catch advice that produces the optimal yield from fisheries conducted in a specified location, while taking into account all the components of the ecosystem. The catch advice will have a similar format as the current single-species advice, but will be supplied at the stock complex level, accounting for the living and non-living components of the environment, such as species interactions. The process starts with place based management coordinating the science and regulations in a defined geographic area (see PDT Discussion Document 2). The Northeast U.S. Continental Shelf was divided into four major ecological zones including (1) the Western-Central Gulf of Maine, (2) the Eastern Gulf of Maine-Scotian Shelf, (3) Georges Bank-Nantucket Shoals, and (4) the Mid-Atlantic Bight (Map 1) based on physiography, hydrography, and production at the base of the food web. For the example Fishery Ecosystem Plan (eFEP), the focus is on a Georges Bank EPU. The specific boundaries of the management area for the EPU can be further refined based on distribution of fishing activity and distributions of trophically-related species (Map 2).

Map 1. Ecological subunits of the Northeast Continental Shelf including (1) Western-Central Gulf of Maine (GoM) (2) Eastern Gulf of Maine-Scotian Shelf (SS), (3) Georges Bank-Nantucket Shoals (GB) and (4) Middle-Atlantic Bight (MAB). White lines indicate boundaries between areas, including the designation of special areas at the edge of the continental shelf and in the immediate nearshore areas of the Middle-Atlantic Bight and the Gulf of Maine.



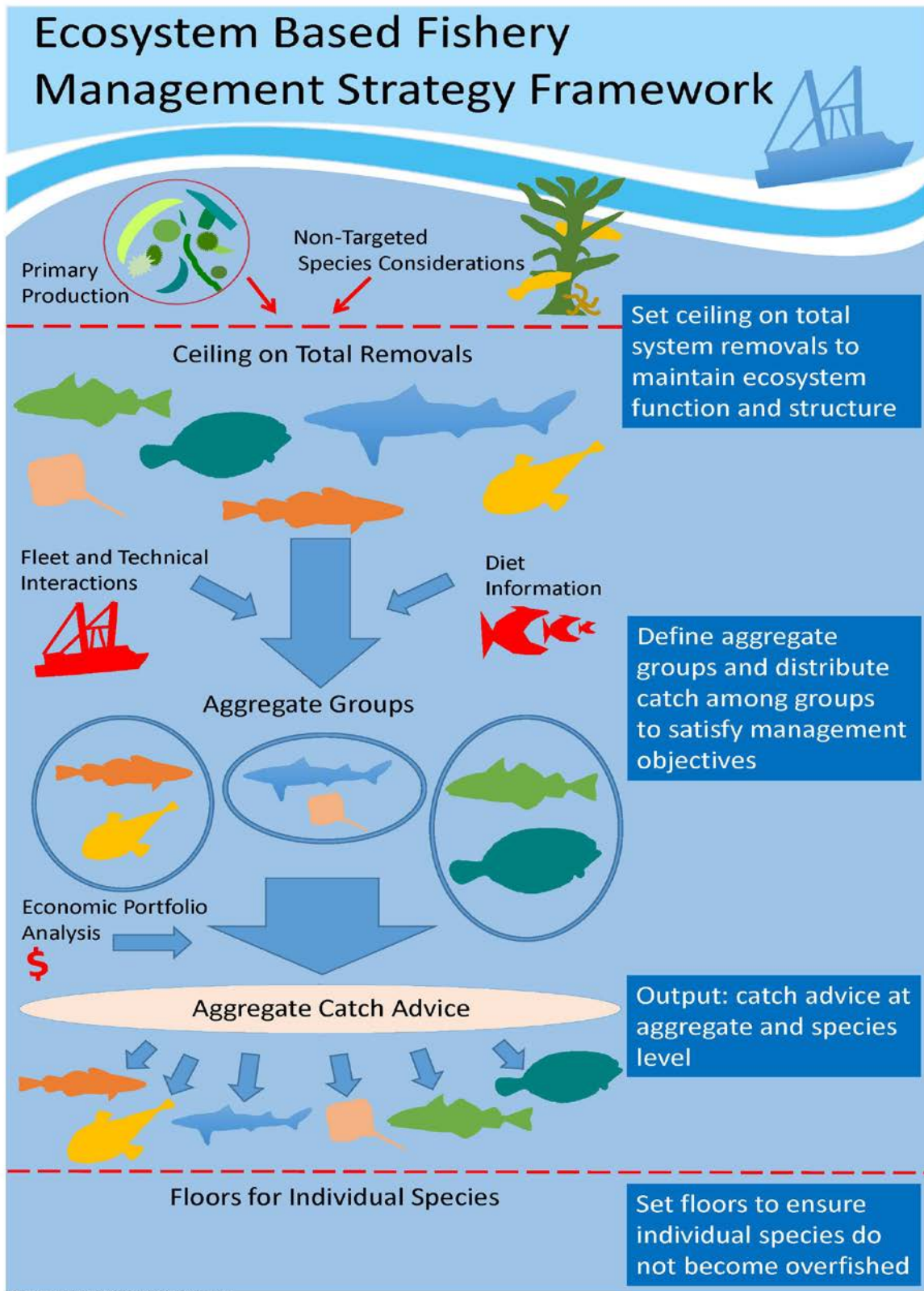
Map 2. 2014 bottom trawl, recreational cod (red), survey cod (duck green) and haddock (grey) distributions overlaid on estimated bottom trawl revenue (blue=low; red=high)



The recommended framework for providing EPU catch advice would begin with a total system catch cap to ensure that only a sustainable amount of biomass is removed and ecosystem function and structure are maintained. This total system catch cap would be derived from estimates of primary productivity, the productivity at the base of the food web, which regulates the total amount of energy available to higher trophic levels; i.e. harvestable fish and invertebrates.

Studies show that roughly 27% of primary production ( $88 \text{ gC/m}^2/\text{yr}$ ,  $\sim 5.5$  million mt C/y) is considered new production (microplankton) and is available to higher trophic levels on Georges Bank. The remaining primary productivity largely cycles through a microbial loop that does not contribute to the higher trophic levels. A potential appropriate limit exploitation reference point for the system as a whole therefore, could be 27% of primary productivity. To ensure that the food requirements of all the components of the ecosystem, including fish and protected species such as marine mammals, sea turtles, and sea birds are met, a target level of exploitation of two thirds to three quarters of the limiting level should be established (18-20%,  $\sim 3.8$  million mt C/y). Primary productivity is continuously measured by satellite and the percentage of microplankton production in the EPU (27%) is calculated seasonal by multiple institutions, including the NEFSC.

Figure 1. EBFM catch advice diagram, prepared by Amanda Hart, UMass Dartmouth.



Amanda Hart UMass Dartmouth

Given the multispecies nature of various fisheries, particularly the groundfish fishery, catch advice would be provided at both the multispecies/stock complex level and at the species level within an EPU. Stock complexes for this process are defined as groups of species that share similar diet and habitat niches and are often caught together in a specific fishery. As fish are typically caught in this multispecies fashion, the primary catch advice will be provided at the stock complex level. For example, specifications (ABCs) would apply to piscivores in the trawl fishery, or benthivores in the gill net fishery, as opposed to individual species or stocks. To ensure that individual species within a stock complex do not become depleted, biomass thresholds (floors) will be established for all species considering potential ecosystem effects and other factors. Species that are below the threshold or at risk could be managed through its own catch limit, or by taking measures that reduce mortality on the species until it recovers.

The biomass for the stock complexes will be developed from multiple multispecies/multi-functional group assessment models or directly from survey data. The multispecies assessment models (such as Kraken, a multispecies/multi-functional group surplus production models, and multispecies statistical catch-at-age models) take the same data inputs as single species assessment models (trawl survey data, catch data, age-at-maturity data), but explicitly include interactions in the estimates of biomass by incorporating decades of diet data into the analysis. Multiple assessment models will be run and the results compiled similar to hurricane modelling to derive the biomass levels.

Empirical indicators, such as current survey biomass compared to historical survey biomass, proportion of the stock in different age/length bins, risk to the ecosystem, or risk of not fulfilling FEP objectives, as well as other methods could be used to evaluate stock status. The trawl survey index is currently being used to determine the status of many New England stocks and could be used to set the threshold floors for many species. Estimates of total biomass could also be derived based on estimates of catchability in the survey for each species combined with state-space models to quantify true trends in the survey indices. A range of other techniques could also be used to ensure specific species do not become depleted.

Catch advice for stock complexes (ceilings) will be developed to achieve FEP goals, such as stabilizing the variation in catch, maximizing yield, minimizing depleted stocks, maximizing gross or net revenue, optimizing employment and/or community resilience such that the total catch cap cannot be exceeded and that individual species are not driven below their floors. Portfolio analysis is one method to objectively provide catch advice subject to the constraints of the FEP goals. Apex predators and protected species are typically not part of these multispecies models because the data on them are limited. Output from the assessment models as well as data on apex predators and protected species will be combined in food web models such as Ecopath/Ecosim to evaluate catch levels that will be sustainable across all the components of the ecosystem.

Prior to implementation in an FEP, all these methods would be tested in a computer simulated ecosystem to determine what harvest techniques are robust and would lead to the objectives desired by stakeholders. The output of the assessment process would be very similar to the existing single species process except the catch advice would be generated at the stock complex level, subject to a total catch cap for the ecological production unit with insurances for individual species.