EXAMPLE Georges Bank EBFM Risk Assessment Documentation and Results

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Introduction

The Mid-Atlantic Council approved an Ecosystem Approach to Fisheries Management (EAFM) Guidance Document in 2017 which outlined a path forward to more fully incorporate ecosystem considerations into marine fisheries management. Of particular interest to the Council was the development of tools to incorporate the effects of species, fleet, habitat and climate interactions into its management and science programs. To accomplish this, the Council agreed to adopt a structured framework to first prioritize ecosystem interactions, second to specify key questions regarding high priority interactions and third tailor appropriate analyses to address them. Because there are so many possible ecosystem interactions to consider, risk assessment was adopted as the first step to identify a subset of high priority interactions.

This report documents a potential use of ecosystem indicators for Georges Bank using the same framework as the Mid-Atlantic Council's EAFM initial risk assessment (reviewed in December 2017, available at http://www.mafmc.org/s/SOE_MAB_RiskAssess-6cgk.pdf). **This is intended as an example, not a finished assessment. To complete an actual assessment for Georges Bank and Gulf of Maine would require interation with the New England Council, its committees and advisors.**

A risk assessment could help the Council decide where to focus limited resources to address ecosystem considerations by first clarifying priorities. Overall, risk assessment tailored to the New England region could provide the Council with a proactive strategic planning tool for the sustainable management of marine resources under its jurisdiction, while taking interactions within the ecosystem into account.

The Mid-Atlantic Council defined a **Risk Element** as an aspect that may threaten achieving the biological, economic, or social objectives that the Council desires from a fishery. By that definition, some risk elements or risk rankings may change as conditions change or new information becomes available. Thus, an EBFM Risk Assessment can be a dynamic and evolving process that will be revisited and updated in future years.

The Mid-Atlantic Council selected a range of risk elements to be evaluated at either the managed species level, the species and sector level, or the ecosystem level. An overview of the risk elements with definitions and associated indicators as adopted by the MAFMC is presented in Table 1.

In the following sections, we describe each risk element in more detail along with MAFMC definitions of low, low-moderate, moderate-high, and high risk. Indicators are then shown for each risk element and a preliminary risk categorization based on the indicator is presented. **New England and or Georges Bank indicators have been substituted for the original Mid-Atlantic indicators where possible.** For trend-based risk definitions, a Mann-Kendall test for monotonic trends is used to test significance ($p<0.05$) of both long term and recent trends. Autocorrelation in the time series was addressed by prewhitening the data as suggested by (Yue et al. 2002).

At the end of the document, we summarize risk ranking results across elements in three tables.

Table 1: Risk element names, definitions, and indicators selected by the MAFMC.

Risk Element	Definition: Risk to what?	Indicators used
Ecological		
Assessment performance	Risk of not achieving OY due to analytical limitations	Current assessment method/data quality
F status	Risk of not achieving OY due to overfishing	Current F relative to reference F from assessment
B status	Risk of not achieving OY due to depleted stock	Current B relative to reference B from assessment
Food web (MAFMC Predator)	Risk of not achieving OY due to MAFMC managed species interactions	Diet composition, management measures
Food web (MAFMC Prey)	Risk of not achieving OY due to MAFMC managed species interactions	Diet composition, management measures
Food web (Protected Species Prey)	Risk of not achieving protected species objectives due to species interactions	Diet composition, management measures
Ecosystem productivity	Risk of not achieving OY due to changing system productivity	Four indicators, see text
Climate	Risk of not achieving OY due to climate vulnerability	Northeast Climate Vulnerability Assessment
Distribution shifts	Risk of not achieving OY due to climate-driven distribution shifts	Northeast Climate Vulnerability Assessment + 2 indicators
Estuarine habitat	Risk of not achieving OY due to threats to estuarine/nursery habitat	Enumerated threats + estuarine dependence
Offshore habitat	Risk of not achieving OY due to changing offshore habitat	Integrated habitat model index
Economic		
Commercial Revenue	Risk of not maximizing fishery value	Revenue in aggregate
Recreational Angler Days/Trips	Risk of not maximizing fishery value	Numbers of anglers and trips in aggregate
Commercial Fishery Resilience (Revenue Diversity)	Risk of reduced fishery business resilience	Species diversity of revenue
Commercial Fishery Resilience (Shoreside Support)	Risk of reduced fishery business resilience due to shoreside support infrastructure	Number of shoreside support businesses
Social		
Fleet Resilience	Risk of reduced fishery resilience	Number of fleets, fleet diversity
Social-Cultural	Risk of reduced community resilience	Community vulnerability, fishery engagement and reliance
Food Production		

Risk Element	Definition: Risk to what?	Indicators used
Commercial	Risk of not optimizing seafood production	Seafood landings in aggregate
Recreational	Risk of not maintaining personal food production	Recreational landings in aggregate
Management		
Control	Risk of not achieving OY due to inadequate control	Catch compared to allocation
Interactions	Risk of not achieving OY due to interactions with species managed by other entities	Number and type of interactions with protected or non-MAFMC managed species, co-management
Other ocean uses	Risk of not achieving OY due to other human uses	Fishery overlap with energy/mining areas
Regulatory complexity	Risk of not achieving compliance due to complexity	Number of regulations by species
Discards	Risk of not minimizing bycatch to extent practicable	Standardized Bycatch Reporting
Allocation	Risk of not achieving OY due to spatial mismatch of stocks and management	Distribution shifts + number of interests
Put Aside		
Population diversity	Risk of not achieving OY due to reduced diversity	Size composition, sex ratio, genetic diversity
Ecological diveristy	Risk of not achieving OY due to reduced diversity	Fishery independent species diversity
Fishery Resilience (2)	Risk of reduced fishery business resilience due to access to capital	No current indicator avilable
Fishery Resilience (3)	Risk of reduced fishery business resilience due to insurance availabilty	No current indicator available
Fishery Resilience (5)	Risk of reduced fishery business resilience due to access to emerging markets/opportunities	Needs clarification
Commercial Employment	Risk of not optimizing employment opportunities	EOP Committee unconfident in Fisheries of US employment inicator
Recreational Employment	Risk of not optimizing employment opportunities	EOP Committee unconfident in Fisheries of US employment indicator
Seafood safety	Risk of not maintaining market access, human health	Number of public advisories by species

Ecological Elements

Assessment Performance

This element is applied at the species level. The elements below describe risks according to our best understanding of stock status, but assessment methods and data quality shape our understanding. This risk element addresses risk to achieving OY due to scientific uncertainty based on analytical limitations.

Risk Level	Definition
Low	Assessment model(s) passed peer review, high data quality
Low-Moderate	Assessment passed peer review but some key data and/or reference points may be lacking
Moderate-High	*This category not used*
High	Assessment failed peer review or no assessment, data-limited tools applied

Members of the New England Council's Scientific and Statistical Committee would be most qualified to rank species for this risk element. This preliminary characterization is based on review of NE SSC minutes from late 2017.

Stocks with low risk due to assessment performance include sea scallops, Atlantic herring, GB haddock, American plaice (?), white hake (?) Stocks with low-moderate risk for this element include GB winter flounder (accepted assessment, troubling diagnostics), windowpane(?), Acadian redfish (accepted assessment, retrospective pattern), Stocks with high risk due to assessment performance include those where OFL could not be determined: GB yellowtail flounder, witch flounder, and Atlantic halbut. High risk was also assigned to stocks using empirical methods (due to rejected assessments or lack of information to complete standard assessments): GB cod, all 7 skate species, monkfish.

F status and B status

These elements are applied at the species level. Fishing mortality (F) rates and biomass (B) levels relative to established reference points from assessments indicate the level of risk to achieving OY. Risk level definitions for F and B are below.

Risk Level	Definition
Low	F < Fmsy
Low-Moderate	Unknown, but weight of evidence indicates low overfishing risk
Moderate-High	Unknown status
High	F > Fmsy

Risk Level	Definition
Low	B > Bmsy
Low-Moderate	Bmsy > B > 0.5 Bmsy, or unknown, but weight of evidence indicates low risk
Moderate-High	Unknown status
High	B < 0.5 Bmsy

Current assessment results for all NEFMC managed stocks are summarized below. Based on these results, F and B status are both in the low risk category for Atlantic herring, scallop, haddock, northern silver and red hakes, redfish, pollock, and southern windowpane. F and B status are also low risk for barndoor, clearnose, little, rosette, smooth, and winter skates according to the index based method. F is low risk but B is low-moderate risk for plaice, dogfish, white hake, southern silver hake, and GB winter flounder. F is low risk but B is high risk for thorny skates, wolffish, ocean pout, northern windowpane, and SNE winter flounder. F is moderate-high risk and B is high risk for GB cod, halibut, and witch flounder. F and B status are low-moderate risk for red crab, offshore hake, and both goosefish stocks, and moderate-high risk for GOM winter flounder. Finally, Both F and B status rank high risk for GOM cod, southern red hake, and all yellowtail flounder stocks (assessment-based status for GB yellowtail flounder is unknown, but NMFS-determined stock status is overfished with overfishing ocurring).

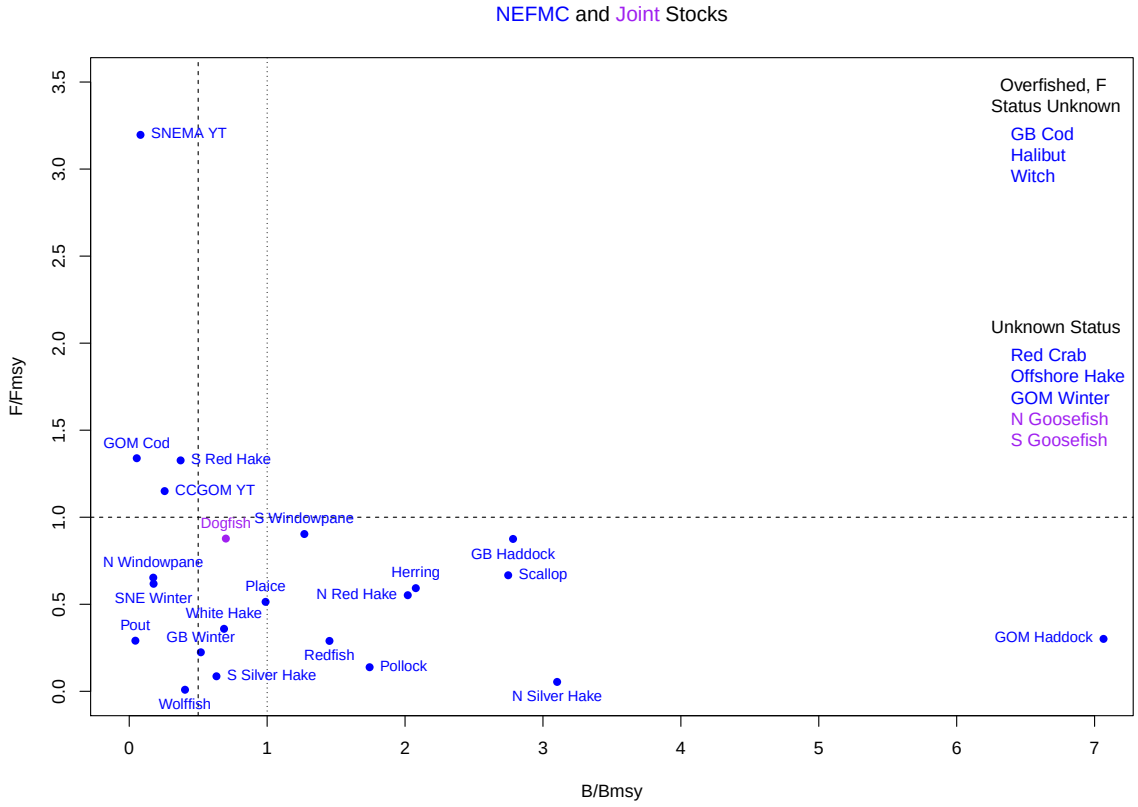

Figure 1: Summary of single species status for NEFMC stocks

Food Web (NEFMC Predators)

This element is applied at the species level. This element ranks the risks of not achieving OY due to predator interactions between NEFMC managed species. To rank these risks, the "importance" of each species as predator must be assessed. There are not clear standardized thresholds to define this. Diet information can be used to develop thresholds: an important predator of NEFMC managed species can be defined as having more than a threshold level of NEFMC managed species in the diet by weight. "Dependent" predators warranting a high risk ranking would have a majority (>50%) of diet from an individual NEFMC managed species.

The MAFMC EOP Committee agreed that high dependence on a single prey represented high risk to a predator, but could not come to agreement on thresholds for intermediate risk levels, so this risk ranking uses only low and high levels.

Risk Level	Definition
Low	Few interactions as predators of other NEFMC managed species, or predator of other managed species in aggregate but below 50% of diet
Low-Moderate	*This category not used*
Moderate-High	*This category not used*
High	Managed species highly dependent on other NEFMC managed species as prey

This information is gathered from the NEFSC food habits database and other sources (Johnson et al. 2008, Smith and Link 2010). Scallops are not predators of other NEFMC managed species, so they rank low risk for this element. Similarly, flatfish and skates eat primarily benthic invertebrates, and herring eat zooplankton. Atlantic cod, spiny dogfish, silver hake, and monkfish are predators of NEFMC managed species, but do not meet the threshold of >50% of diet. Cod prey on other NEFMC managed species, including herring, silver hake, and haddock (combined diet averages ~38%). Dogfish average ~27% of total diet from NEFMC managed species with herring representing the majority. Silver hake average ~34% of total diet from NEFMC managed species, with cod family (including cannibalism) representing the majority. Therefore, these three predators rank low risk for food web interactions with other NEFMC managed species.

Food Web (NEFMC Prey)

This element is applied at the species level. This element ranks the risks of not achieving OY due to prey interactions between NEFMC managed species. To rank these risks, the "importance" of each species as prey must be assessed. There are not clear standardized threshold to define this. Diet information and a food web model can be used to develop thresholds. An important prey of NEFMC managed species can be defined as individually comprising above a certain threshold of the predator's diet by weight. "Vulnerable" prey warranting a high risk ranking would comprise a majority (>50%) of diet or have a majority of mortality caused by an individual NEFMC managed species.

The EOP Committee agreed that a high proportion in diet represented high risk as a prey (and also to the predator), but could not come to agreement on thresholds for intermediate risk levels, so this risk ranking uses only low and high levels.

Risk Level	Definition
Low	Few interactions as prey of other NEFMC managed species, or prey of other managed species but below 50% of diet
Low-Moderate	Important prey with management consideration of interaction
Moderate-High	*This category not used*
High	Managed species is sole prey and/or subject to high mortality due to other NEFMC managed species

This information is gathered from the NEFSC food habits database and other sources (Johnson et al. 2008, Smith and Link 2010). Scallops are not major prey of other NEFMC managed species, so they rank low risk for this element. Similarly, skates, spiny dogfish, silver hake, cod, and flatfish do not show up individually as >10% of prey by weight in any NEFMC managed species diets, so they rank low risk. While some NEFMC managed species are prey of other managed species, none meet the defined risk threshold, so all are ranked low risk. Herring is a prey of spiny dogfish and cod (~19% and ~20%

of diet respectively, with high interannual variability), and cod family is prey of silver hake (~25% of diet including cod and hake species). Viewed from a mortality standpoint, the GB EMAX food web model (Link et al. 2008) suggests that commercial pelagics (mainly herring) have about 29% of their total mortality caused by demersal piscivoves on Georges Bank, with another 16% of total mortality caused by demersal omnivores and benthivores combined. These three categories represent all of the NEFMC managed fish combined, plus others, but still does not meet the threshold of 50% of mortality. Therefore, all species rank low risk for this element.

Food Web (Protected Species Prey)

This element is applied at the species level. This element ranks the risks of not achieving protected species objectives due to species interactions with MAFMC managed species. As above, a food web model and updated marine mammal diet information can be used to establish thresholds of "importance" for predators and prey. There are no MAFMC managed species that are important predators of protected species, so here we rank only risks where MAFMC managed species represent prey of protected species. An important prey of protected species is defined here as individually comprising >30% of the predator's diet by weight. "Dependent" predators and prey warranting a high risk ranking would have a majority (>50%) of diet or mortality caused by an individual protected species.

Risk Level	Definition
Low	Few interactions with any protected species
Low-Moderate	Important prey of 1-2 protected species, or important prey of 3 or more protected species with management consideration of interaction
Moderate-High	Important prey of 3 or more protected species
High	Managed species is sole prey for a protected species

Protected species include marine mammals (under the Marine Mammal Protection Act), Endangered and Threatened species (under the Endangered Species Act), and migratory birds (under the Migratory Bird Treaty Act). In the Northeast US, endangered/threatened species include Atlantic salmon, Atlantic and shortnose sturgeon, all sea turtle species, and 5 baleen whales. NEFMC managed species are not important predators of protected species (Smith and Link 2010), even though monkfish occasionally ingest seabirds (Perry et al. 2013). Atlantic salmon, both species of sturgeon, and sea turtles are not major predators of NEFMC managed species, as reviewed in the MAFMC Forage Fish white paper (Shoop and Kenney 1992, Burke et al. 1993, 1994, Johnson et al. 1997, McClellan and Read 2007, Savoy 2007, Seney and Musick 2007). Information sources for marine mammal diets in the Northeast US (Smith et al. 2015), and seabird diets (Powers 1983, Powers and Backus 1987, Powers and Brown 1987, Schneider and Heinemann 1996, Barrett et al. 2007, Bowser et al. 2013) were reviewed.

Diet information for protected species tends to be more uncertain than for fished species, so we consider diet at the family level for these rankings because diet compositions are not reported to the species level. Clupeids (which include Atlantic herring) comprise 30% of minke whale diet in the Northeast US (Smith et al. 2015). Small gadids (all hakes) comprise 32% of harbor porpoise diets (Smith et al. 2015). Therefore we rank herring and hake species low-moderate risk for this element. Fish were identified as important prey for pelagic seabirds in the Northeast US (Powers and Backus 1987), but the primary species listed were sandlance and saury, with butterfish and silver hake also mentioned. Nesting common terns in the Gulf of Maine fed chicks juvenile herring and hakes in many colonies, reinforcing the low-moderate ranking for these species.

Ecosystem Productivity

This element is applied at the ecosystem level. This element ranks the risk of not achieving OY due to changes in ecosystem productivity at the base of the food web. Four indicators are used together to assess risk of changing ecosystem productivity. We examine trends in total primary production, zooplankton abundance for a key Mid-Atlantic species, and two aggregate fish productivity measures: condition factor (weight divided by length of individual fish) and a survey based "recruitment" (small fish to large fish) index. Because many MAFMC managed species rely on benthic crustaceans as forage, a benthic production indicator is also desirable, *but not yet available.*

Risk Level	Definition
Low	No trends in ecosystem productivity
Low-Moderate	Trend in ecosystem productivity (1-2 measures, increase or decrease)
Moderate-High	Trend in ecosystem productivity (3+ measures, increase or decrease)
High	Decreasing trend in ecosystem productivity, all measures

For primary production and fish productivity, the spatial scale of analysis is the Georges Bank Ecosystem Production Unit, as indicated in Figure 2.

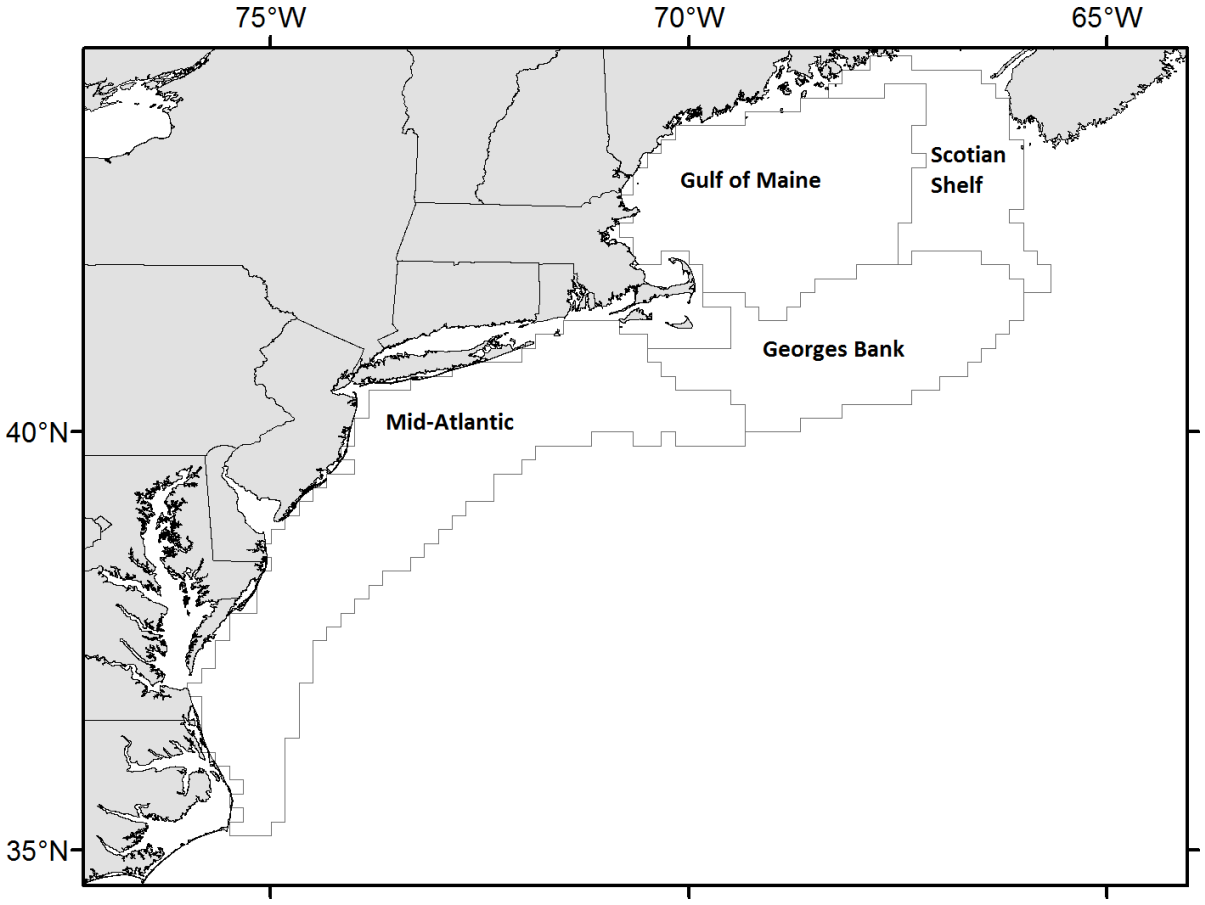

Figure 2: Northeast US Ecosystem Production units.

Primary production

Primary production has fluctuated recently with current conditions near average.

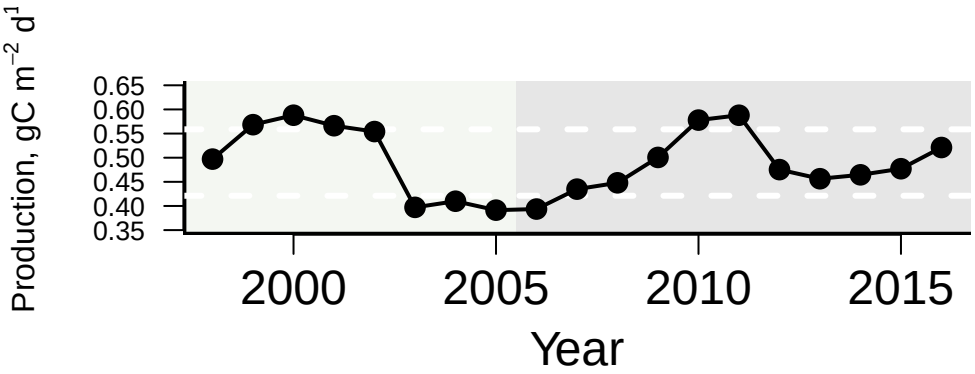

Figure 3: Primary production–Georges Bank

Zooplankton

Zooplankton surveys have been conducted since the 1970s and have been most consistently executed in the spring and fall seasons coinciding with the NEFSC bottom trawl survey. The time series of zooplankton biovolume suggest that overall zooplankton production has not changed over time. However, the zooplankton *Calanus finmarchicus* shows no spring trends, but a short-term decline in the fall on Georges Bank over the past decade. Adult *Calanus* are the principal prey of North Atlantic right whales; reductions in *Calanus* populations potentially impact the most vulnerable protected species in our region as well as key forage fish that feed on them, with implications throughout the food web..

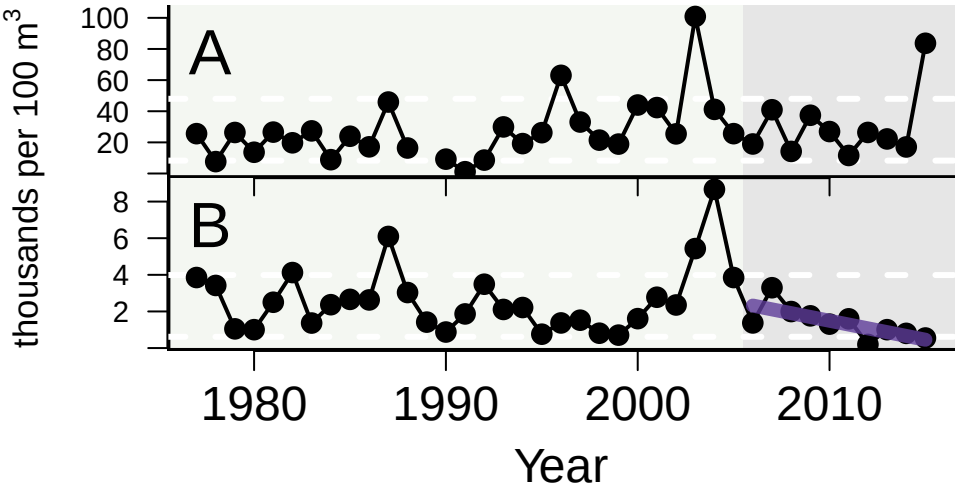

Figure 4: A: GB Calanus finmarchicus spring, B: GB Calanus finmarchicus fall

Fish condition

Fish condition is measured as the weight per length–a measure of "fatness". This information is from NEFSC bottom trawl surveys and shows a change in condition across all species at around 2000. Around 2010-2013 many species started to have better condition, while GB yellowtail flounder remain thinner for

their length on average.

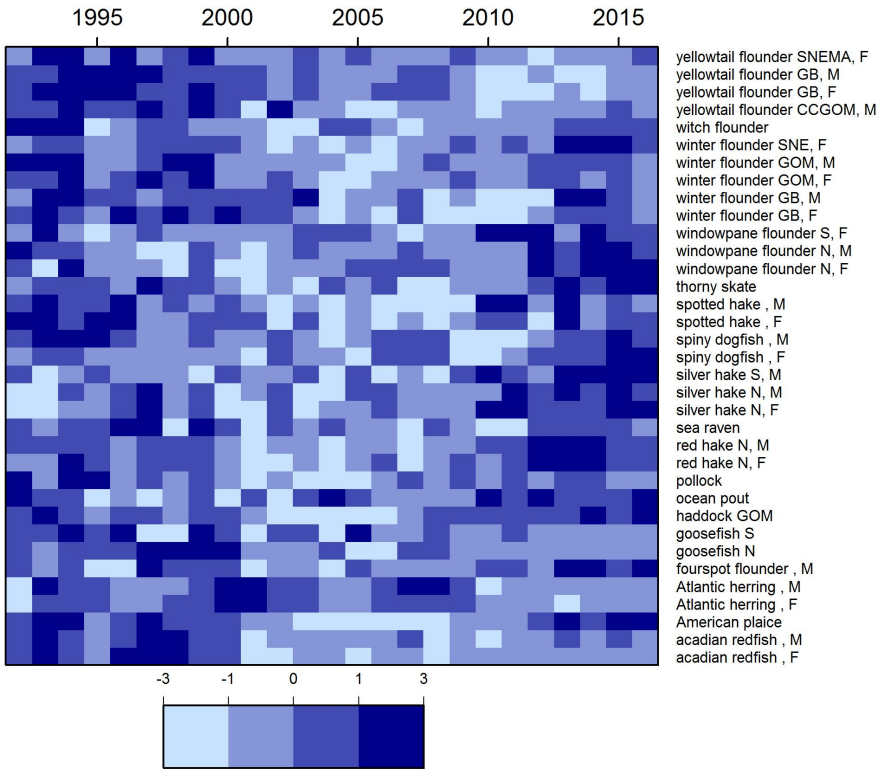

Figure 5: Fish Condition (weight/length)

Fish productivity

The number of small fish relative to the biomass of larger fish of the same species from the NEFSC survey is a simple measure of productivity, intended to complement model-based stock assessment estimates of recruitment for commercial species. There is a no clear trend in this indicator when aggregated across managed and unmanaged species on Georges Bank.

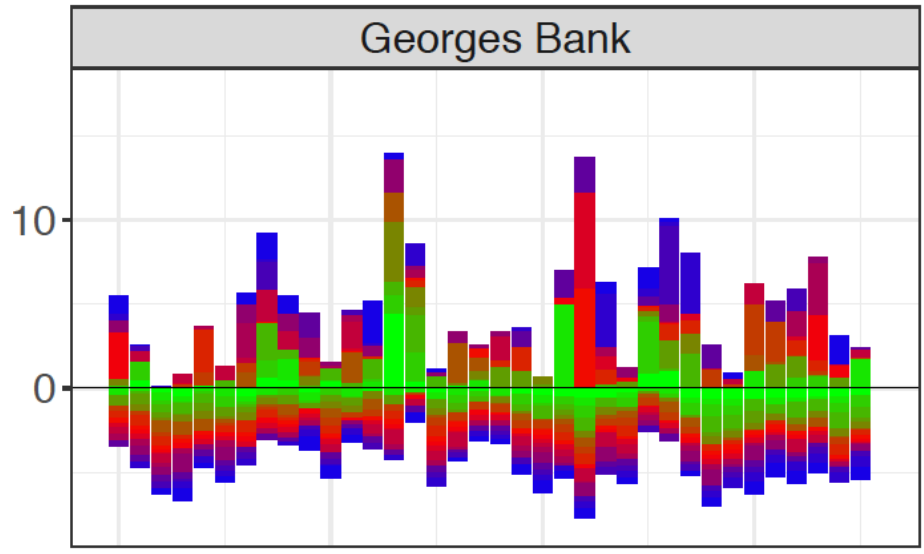

Figure 6: Fish productivity: Anomalies of recruit abundance per spawner biomass for species in the MAB. Annual anomalies shown are the average of spring and fall anomalies.

To summarize, primary production shows no trend. Similarly, there are no trends in overall zooplankton abundance, but an important New England species shows a recent decline during fall. Fish condition showed a drop across all species in the early 2000s, but most species appear to have recovered. There is no trend in aggregate numbers of small fish per large fish. The one clear trend in Calanus biovolume (combined with poor condition for GB yellowtail) suggests a low-moderate risk of changing ecosystem productivity in the Georges Bank region.

Climate

This element is applied at the species level. Risks to species productivity (and therefore to achieving OY) due to projected climate change in the Northeast US were evaluated in a comprehensive assessment (Hare et al. 2016). This assessment evaluated exposure of each species to multiple climate threats, including ocean and air temperature, ocean acidification, ocean salinity, ocean currents, precipitation, and sea level rise. The assessment also evaluated the sensitivity (*not extinction risk*) of each species based on habitat and prey specificity, sensitivity to temperature and ocean acidification, multiple life history factors, and number of non-climate stressors. This assessment is intended to be conducted iteratively, so these results can be updated in the future.

Risk Level	Definition
Low	Low climate vulnerability ranking
Low-Moderate	Moderate climate vulnerability ranking
Moderate-High	High climate vulnerability ranking
High	Very high climate vulnerability ranking

New England species were all either highly or very highly exposed to climate risk in this region, and ranged from low to very high sensitivity to expected climate change in the Northeast US. The combination of exposure and sensitivity results in the overall vulnerability ranking. We applied those climate vulnerability rankings directly here (Fig. 7).

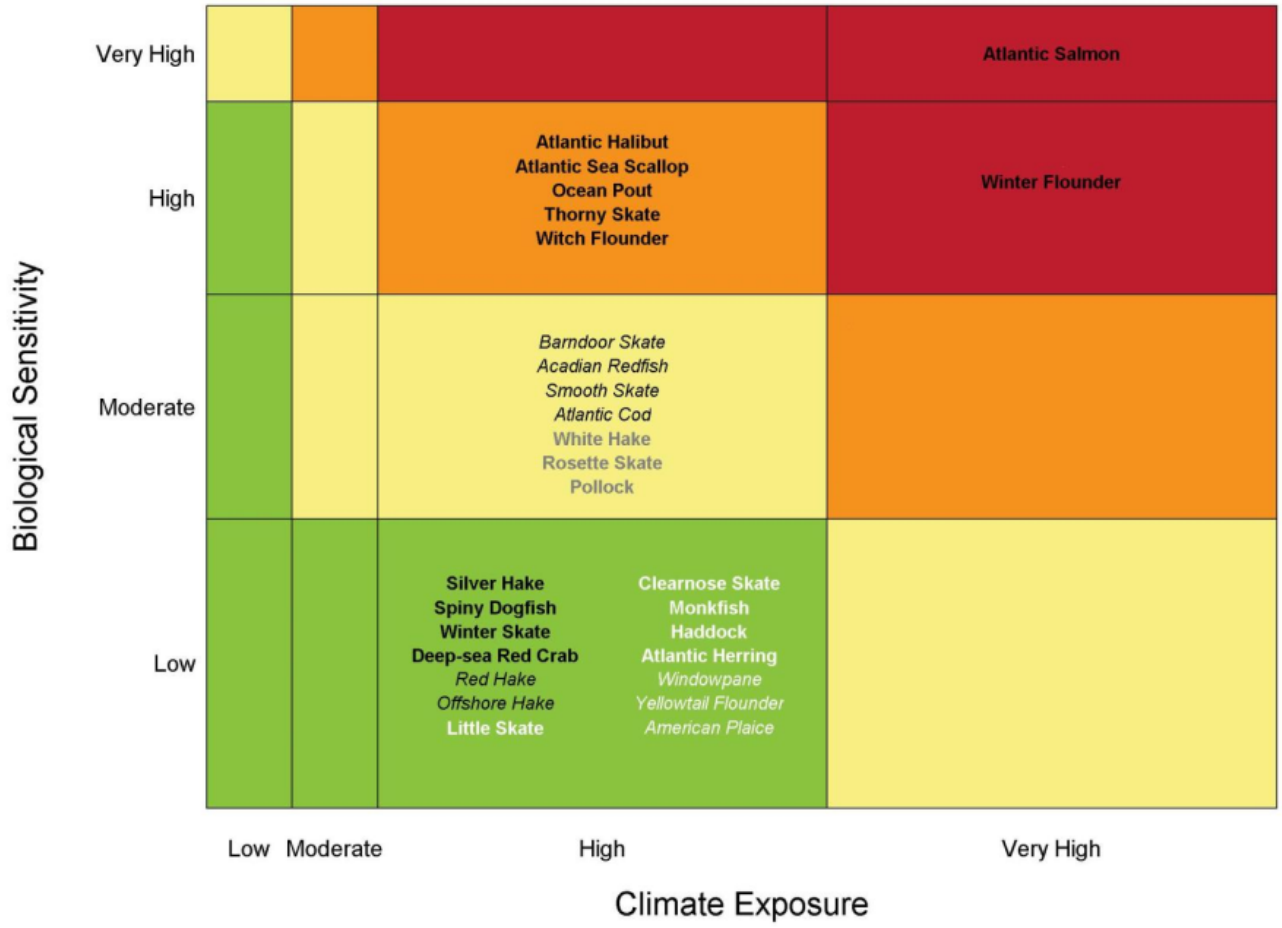

Figure 7: Results of Northeast Climate Vulnerability Analysis (Hare et al. 2016) for Mid-Atlantic species

While this risk assessment focuses on overall vulnerability to impacts of climate, not all impacts will be negative. Some MAFMC managed species may benefit from projected future climate conditions, including black sea bass, bluefish, butterfish, longfin squid, and shortfin squid (Hare et al. 2016). However, all NEFMC managed species were expected to have either neutral or negative directional effects from expected climate change (Hare et al. 2016).

Distribution Shifts

This element is applied at the species level. Species distribution shifts can increase risks of ineffective spatial catch allocation; if catch distribution is greatly mismatched with species distribution OY may not be achieved. Risks of species distribution shifts due to projected climate change in the Northeast US were assessed in a comprehensive assessment (Hare et al. 2016). We applied those distribution shift risk rankings directly here. In addition, changes in species distribution are monitored using fisheries independent bottom trawl surveys. Two distribution shift indicators are derived from these surveys: kernel density plots of recent distribution compared with 1970s distribution, and time series of the along shelf position of the center of distribution.

Risk Level	Definition
Low	Low potential for distribution shifts

Risk Level	Definition
Low-Moderate	Moderate potential for distribution shifts
Moderate-High	High potential for distribution shifts
High	Very high potential for distribution shifts

Most New England species had either high or very high risk of distribution shifts in the Northeast US. Sea scallops, ocean pout, Atlantic salmon, and smooth skate were predicted to have moderate risk of distribution change (Hare et al. 2016).

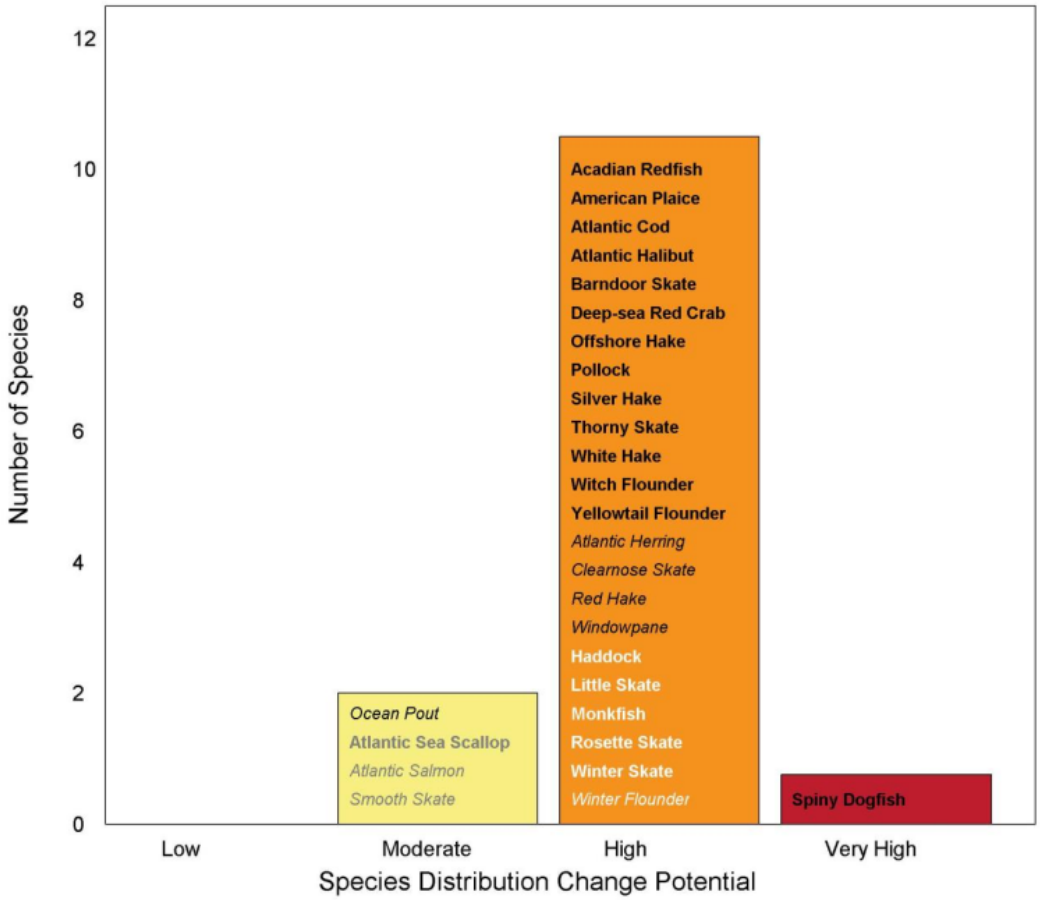

Figure 8: Results of Northeast Climate Vulnerability Analysis (Hare et al. 2016) for Mid-Atlantic species distribution shift risk

Historical vs. Current Distribution Maps

Spatial distribution has changed over time for some species more than for others. Yellowtail flounder distributions measured by NEFSC surveys have shifted northward relative to historical distributions. In contrast, redfish distributions have remained relatively stable.

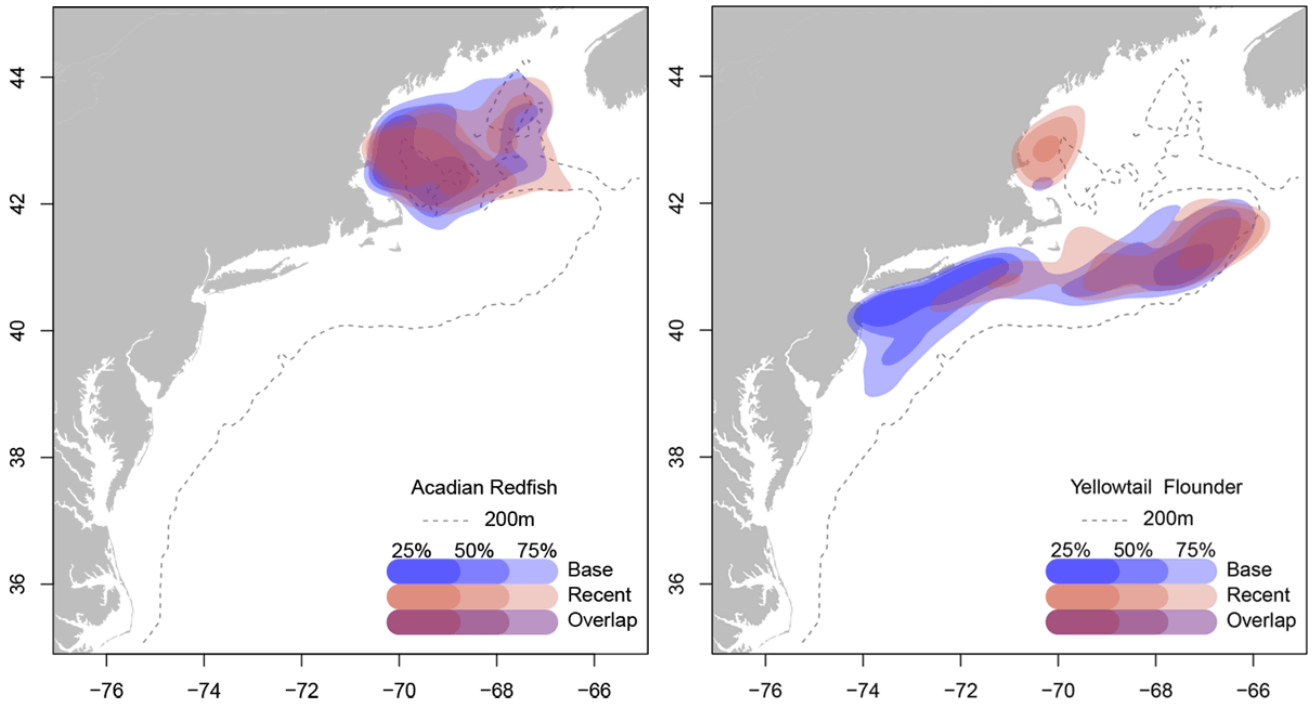

Figure 9: Shifts in species distribution, 1970s (blue), recent (red) and overlap (purple)

A full suite of these maps is available at http://www.nefsc.noaa.gov/ecosys/current-conditions/kernel-density.html.

Changes in Along Shelf Position

Species distribution on the NE Shelf can be characterized by the position in the ecosystem along an axis oriented from the southwest to the northeast, referred to as the along shelf distance, and by depth. Along shelf distances range from 0 to 1360, which relates to positions along the axis from the origin in the southwest to the northeast in kilometer units. The mean along shelf distance for several NEFMC species by year is shown below; many are consistent with the predictions of NEVA and show a significant northeastward change in distribution. Mean depth has also changed for some of these species. Information for more species is available at http://www.nefsc.noaa.gov/ecosys/current-conditions/species-dist.html.

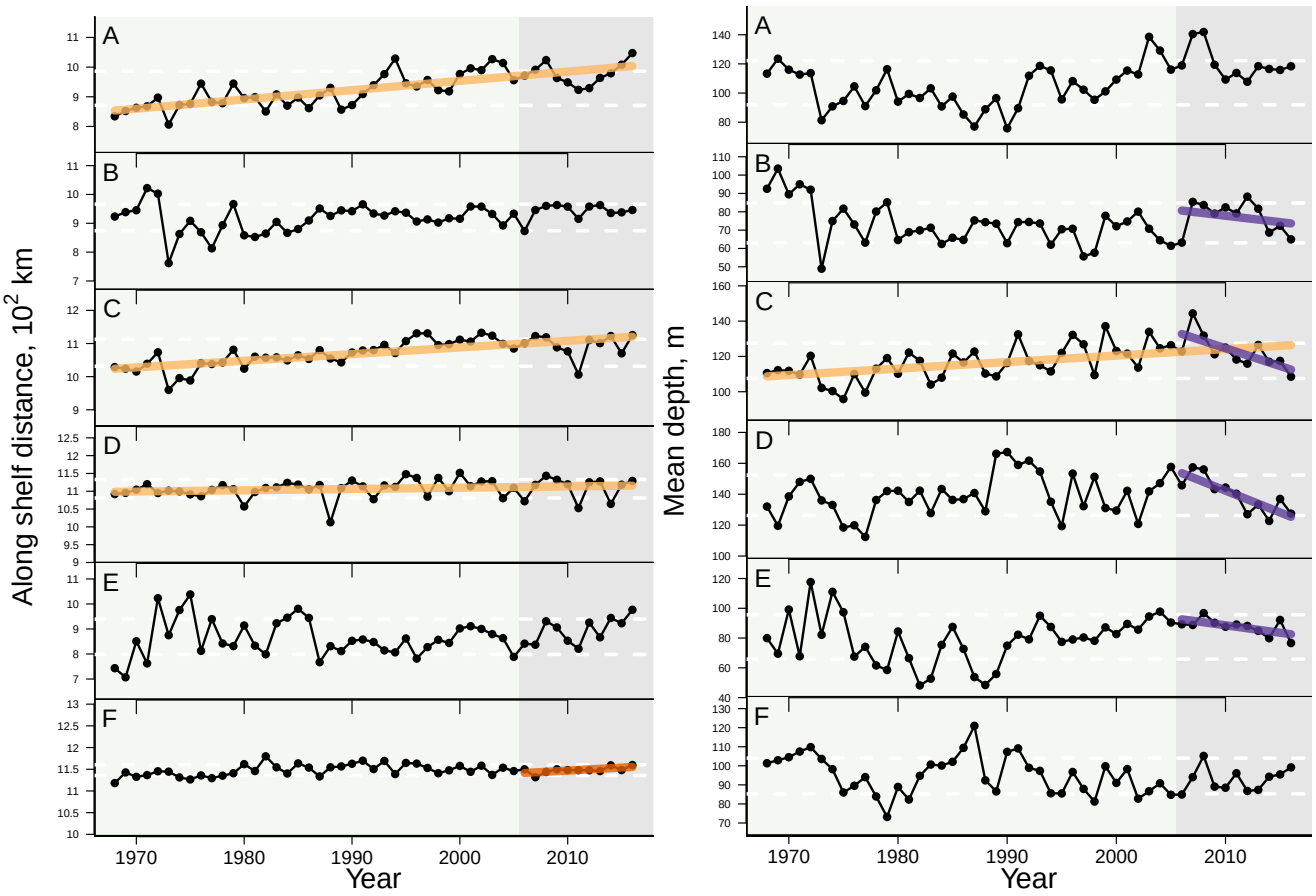

Figure 10: Shifts in species distribution over time; A: Yellowtail flounder, B: Winter flounder, C: Cod, D: Haddock, E: Atlantic herring, F: Acadian redfish

Estuarine and Coastal Habitat

This element is applied at the species level. Risk of not achieving OY due to threats to estuarine and nearshore coastal habitat/nursery grounds was determined by first evaluating the estuarine dependence of species, and then by enumerating threats to the estuarine habitat required by these species. Here, we include estuarine and nearshore coastal habitat in the term "estuarine" below. Water and habitat quality assessments produced for coastal estuaries within the Northeast region can be considered in the future.

Risk Level	Definition
Low	Not dependent on nearshore coastal or estuarine habitat
Low-Moderate	Estuarine dependent, estuarine condition stable
Moderate-High	Estuarine dependent, estuarine condition fair
High	Estuarine dependent, estuarine condition poor

As a start, the US EPA National Coastal Condition Assessment for the Northeast US (US EPA 2012) was used to evaluate estuarine and coastal condition. This report lists water, sediment, benthic, and coastal habitat quality as well as fish contamination. Northeast US coastal waters rated fair to poor for water quality, fair for sediment quality, poor for benthic quality, good to fair for coastal habitat, and fair to poor for fish contamination. These ratings were based on nearshore and estuarine summer sampling

2003-2006. The overall coastal condition was rated fair for the entire region, but this includes offshore conditions which we address in the next element. Therefore, estuarine and nearshore coastal habitat dependent species (winter flounder (obligate), pollock (obligate?), and white and red hake (facultative), (Able 2005)) were ranked high risk based on overall poor estuarine condition for this element, and all others were ranked low risk due to lower dependence on this habitat type.

Offshore Habitat *need access to model output for NE species if ranking*

This element is applied at the species level. The risk of achieving OY due to changes in offshore habitat quality and quantity can be assessed using trends derived from experimental species-specific habitat modeling. *In addition, the number of threats from other human uses can be enumerated; at present this is addressed under "Other Ocean Uses" in the Management section below.*

Risk Level	Definition
Low	No change in offshore habitat quality or quantity
Low-Moderate	Increasing variability in habitat quality or quantity
Moderate-High	Significant long term decrease in habitat quality or quantity
High	Significant recent decrease in habitat quality or quantity

Habitat models using both static and dynamics variables have been developed for many of the resource species on the Northeast Shelf. These models estimate spring and fall habitat for the time series 1992 to 2016 reflecting the use of the ecosystem based on the NEFSC bottom trawl survey. The variables evaluated for use in these models included station salinity, station temperature, benthic complexity, satellite derived chlorophyll concentration and sea surface temperature, the gradient magnitude (front structure) of the satellite data, and zooplankton bio-volume and taxa abundance with station depth included in all models. The random forest approach differentiates variables with strong predictive power and was used to reduce the variable set to 11 variables for each species. The models were used to estimate fall habitat scores over the entire shelf over the time series.

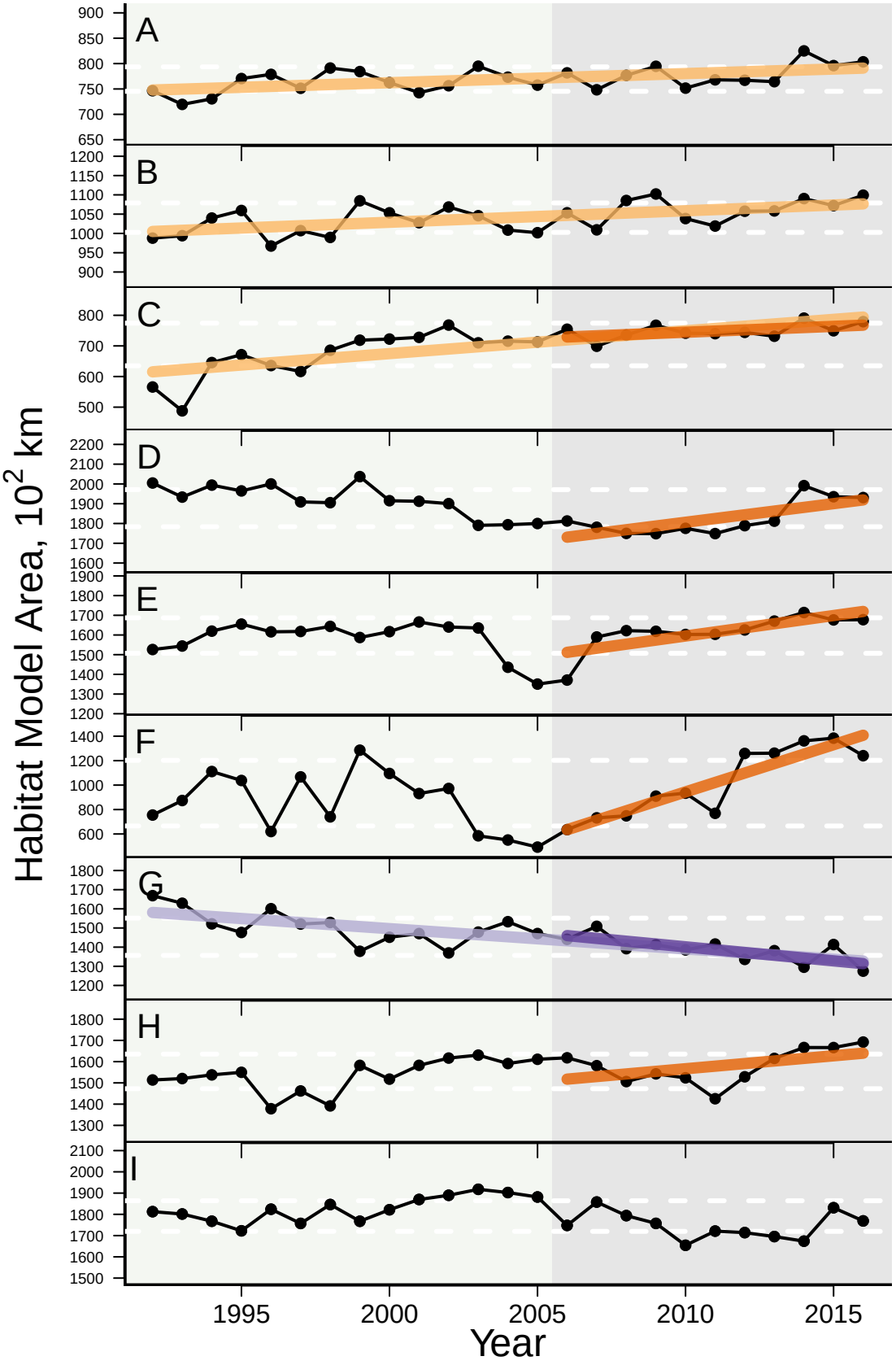

Figure 11: Shifts in modeled species fall habitat area over time; A: Black sea bass, B: Summer flounder, C: Scup, D: Butterfish, E: Atlantic mackerel, F: Longfin squid, G: Shortfin squid, H: Dogfish, I: Goosefish

This experimental habitat index is still being studied and improved, so habitat risk rankings based on this are considered preliminary by the EOP.

Overall, black sea bass, summer flounder, and scup have long term increasing trends in fall offshore habitat, and dogfish, butterfish, Atlantic mackerel and longfin squid have short term increasing trends. Goosefish has no significant trend in fall offshore habitat. Therefore, these species rank low risk for this element. However, shortfin squid has a long term and a short term decreasing trend in offshore habitat. Therefore, shortfin squid ranks high risk for this element.

Ocean quahogs, surfclams, tilefish, and bluefish are not adequately sampled by the bottom trawl survey and were not included in this analysis, similar to unmanaged forage and deepsea corals. Sessile species in particular may be highly vulnerable to habitat changes, so assessments of their habitat are particularly important to develop.

Economic Elements

Commercial Revenue

This element is applied at the ecosystem level, and addresses the risk of not maximizing fishery value. Revenue serves as a proxy for commercial profits, which is the component of a fishery's value that this element is ultimately attempting to assess risk towards.

Risk Level	Definition
Low	No trend and low variability in revenue
Low-Moderate	Increasing or high variability in revenue
Moderate-High	Significant long term revenue decrease
High	Significant recent decrease in revenue

This is aggregate commercial revenue for NEFMC managed species. There is a long term significant decrease in revenue for GB, indicating moderate-high risk to commercial fishery profit. This trend is consistent with the trend first shown in the EAFM Interactions white paper and published in Gaichas et al. (2016) (Figs 2-3).

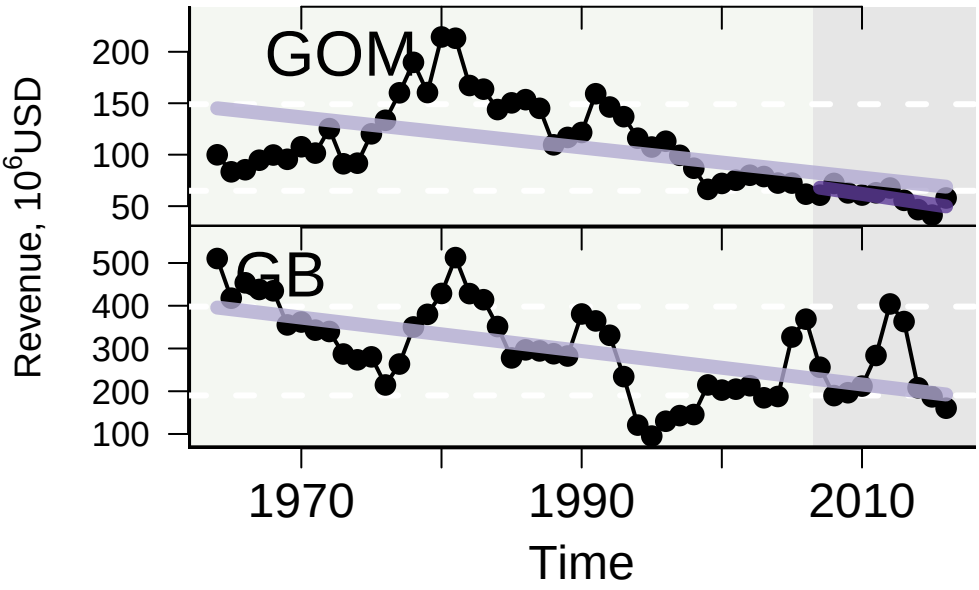

Figure 12: Aggregate New England managed species revenue

Marine Recreational Angler Days/Trips

This element is applied at both the fleet level and at the ecosystem level where it would apply equally to all recreationally fished species. Angler days and trips are proxies for the welfare (value) generated from recreational fishing. Risk of not maximizing fishery value is evaluated using the number of marine recreational fishing angler-days and number of marine recreational trips, in aggregate.

Risk Level	Definition
Low	No trends in angler days/trips
Low-Moderate	Increasing or high variability in angler days/trips
Moderate-High	Significant long term decreases in angler days/trips
High	Significant recent decreases in angler days/trips

Providing recreational opportunities is a stated goal of optimal fishery management as part of the definition of "benefits to the nation" under MSA. Recreational fishing is important in the Northeast region with many coastal communities having high recreational dependence. Although there is an overall trend of increasing recreational fishery participation in terms of number of anglers, the most recent 10 years has shown a striking decline in both recreation indices.

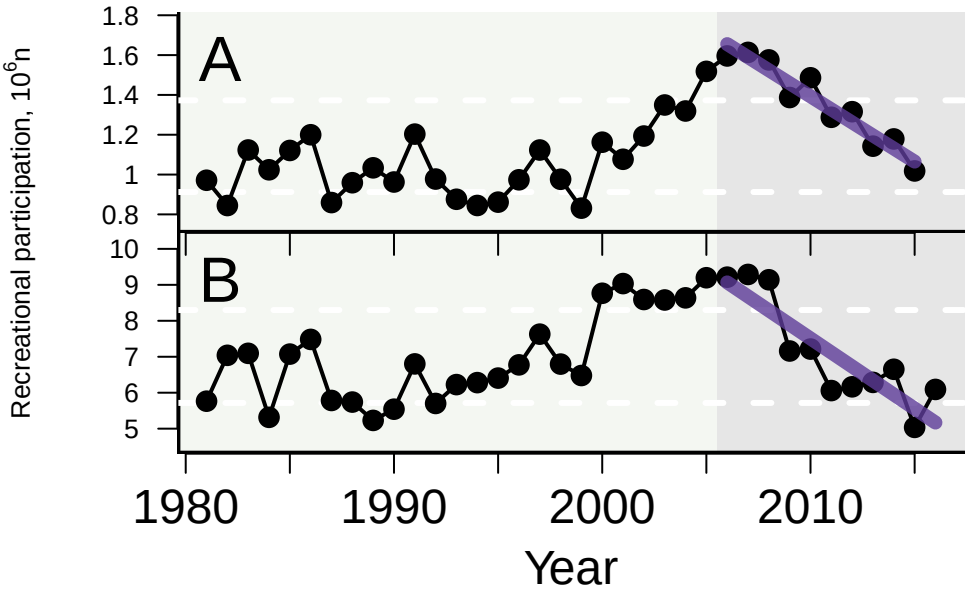

Figure 13: A: number of anglers, B: number of trips

These significant recent decreases in numbers of anglers and numbers of trips alone suggest high risk to recreational value generated from the species with substantial recreational fisheries. This is a national trend likely due to shifting demographics and general economic dynamics, among other issues.

Commercial Fishery Resilience (Revenue Diversity)

This element is applied at the ecosystem level. This element addresses the risk of reduced commercial fishery business resilience by evaluating species diversity of revenue at the permit level.

Risk Level	Definition
Low	No trend in diversity measure
Low-Moderate	Increasing or high variability in diversity measure
Moderate-High	Significant long term downward trend in diversity measure
High	Significant recent downward trend in diversity measure

This diversity index is the average effective Shannon index for species revenue at the permit level, for all permits landing any amount of NEFMC FMP species within a year (including both Monkfish and Spiny Dogfish). Although the exact value of the effective Shannon index is relatively uninformative, the major change in diversity seems to have occurred in the late 1990's, with much of the recent index relatively stable.

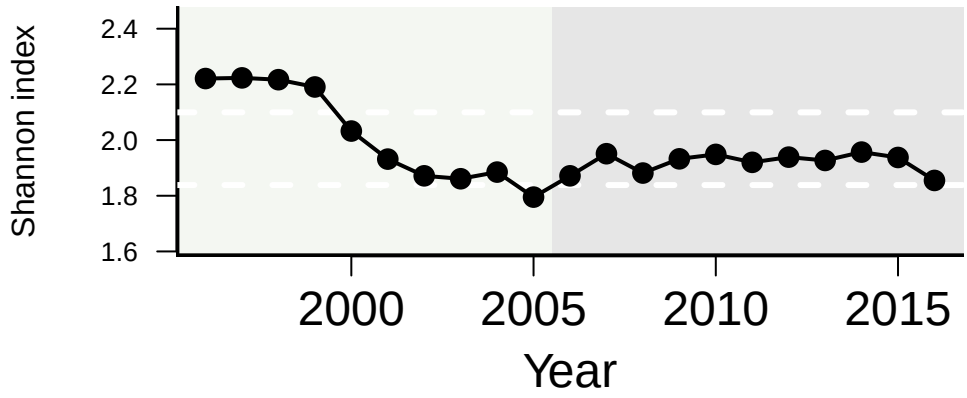

Figure 14: Diversity in species revenue

This index shows no significant trend, which would suggest a low risk to fishery business resilience based on diversity in species revenue.

Commercial Fishery Resilience (Shoreside Support) *need access to state data for New England if ranking*

This element is applied at the ecosystem level. This element ranks the risk of reduced fishery business resilience due to shoreside support infrastructure by examining the number of shoreside support businesses.

Risk Level	Definition
Low	No trend in shoreside support businesses
Low-Moderate	Increasing or high variability in shoreside support businesses
Moderate-High	Significant recent decrease in one measure of shoreside support businesses
High	Significant recent decrease in multiple measures of shoreside support businesses

The number of shoreside support businesses were tallied for all Mid-Atlantic states in two categories: number of companies (Quarterly Census of Employment and Wages. Obtained September 27, 2017. US Department of Labor, Bureau of Labor Statistics. https://www.bls.gov/cew/home.htm) and number of non-employer entities Nonemployer Statistics." Obtained September 28, 2017. U.S. Census Bureau. https://www.census.gov/programs-surveys/nonemployer-statistics.html), which we consider separately. Nonemployer entities are businesses that have no paid employees (i.e. the owner is the workforce), while the shoreside support companies include all businesses with paid employees. Some state level data was not included due to confidentiality.

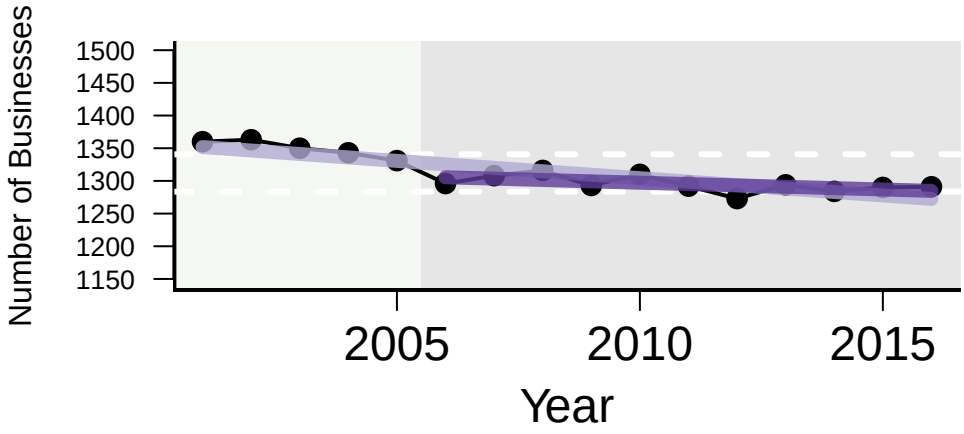

Figure 15: Shoreside support businesses: Number of Companies

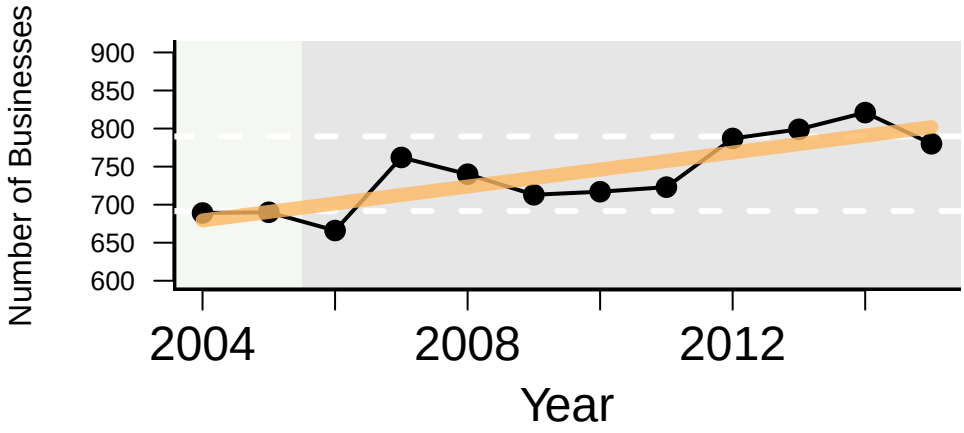

Figure 16: Shoreside support businesses: Number of Nonemployer entities

The number of shoreside support companies that include seafood merchant wholesalers, seafood product preparation and packaging, and seafood markets across all Mid-Atlantic states shows a significant long term and short term decrease, which on its own represents moderate-high risk to fishery resilience. However, the number of non-employer entities which include seafood preparation and packaging and seafood markets shows a long term increase. Trends in other shoreside fishery supporting businesses such as gear manufacturers and welding companies are not included here due to aggregation of the statistics.

Commercial Employment *need state level data for NE if ranking*

This element is applied at the state level. This element ranks the risk of not optimizing employment opportunities in the commercial sector. Risks were assessed by examining time series of employment information from Fisheries Economics of the U.S. (NMFS 2017). A full description of the model generating employment estimates can be found here: http://www.st.nmfs.noaa.gov/documents/commercial_seafood_impacts_2007-2009.pdf

Risk Level	Definition
Low	No trend in employment
Low-Moderate	Increasing or high variability in employment
Moderate-High	Significant recent decrease in employment for one state

Risk Level	Definition
High	Significant recent decrease in employment for multiple states

The EOP Committee lacked confidence in the available employment indicator data, so this element remains unranked at this time.

Recreational Employment *need state level data for NE if ranking*

This element is applied at the state level. This element ranks the risk of not optimizing employment opportunities in the recreational sector. Risks were assessed by examining time series of employment information from Fisheries Economics of the U.S. (NMFS 2017).

Risk Level	Definition
Low	No trend in employment
Low-Moderate	Increasing or high variability in employment
Moderate-High	Significant recent decrease in employment for one state
High	Significant recent decrease in employment for multiple states

The EOP Committee lacked confidence in the available employment indicator data, so this element remains unranked at this time.

Social-Cultural Elements

Fleet Diversity

This element is applied at the ecosystem level. This element ranks the risk to maintaining equity in access to fishery resources. Two indicators of commercial fleet diversity, including the number of distinct fleets and diversity of revenue across fleets are used in combination to evaluate current fleet resilience throughout the New England region.

Maintaining diversity can provide the capacity to adapt to change at the ecosystem level for dependent fishing communities, and can address objectives related to stability. Below are diversity estimates for fleets landing NEFMC-managed species. This measure identifies the diversity in revenue generated by different fleet segments. A fleet is defined here as the combination of gear code (Scallop Dredge, Other Dredge, Gillnet, Hand Gear, Longline, Bottom Trawl, Midwater Trawl, Pot, Purse Seine, or Clam Dredge) and vessel length category (Less than 30 ft, 30 to 50 ft, 50 to 75 feet, 75 ft and above).

Risk Level	Definition
Low	No trend in diversity measure
Low-Moderate	Increasing or high variability in diversity measure
Moderate-High	Significant long term downward trend in diversity measure
High	Significant recent downward trend in diversity measure

A declining trend in diversity indicates a less diverse fleet is currently active in NEFMC-managed fisheries.

However, it cannot distinguish whether specialization (by choice), or alternatively stovepiping (constrained choices), is occurring in the Northeastern Large Marine Ecosystem, rather merely that the fleet composition is changing, which might warrant additional scrutiny.

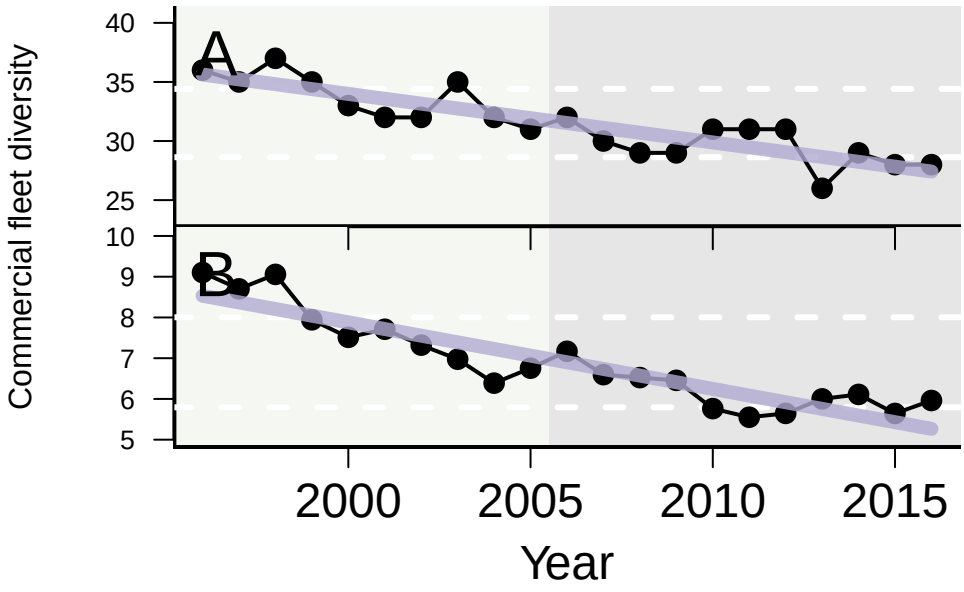

Figure 17: A: fleet count, B: average fleet diversity

There is a long term decrease in the fleet count metric. Therefore this element ranks moderate-high risk.

Community Vulnerability

The NOAA Fisheries Community Social Vulnerability Indicators (CSVIs; Jepson and Colburn (2013)) are statistical measures of the vulnerability of communities to events such as regulatory changes to fisheries, wind farms, and other ocean-based businesses, as well as to natural hazards, disasters, and climate change. The CSVIs currently serve as indicators of social vulnerability, gentrification pressure vulnerability, commercial and recreational fishing dependence (with dependence being a function of both reliance and engagement), sea level rise risk, species vulnerability to climate change, and catch composition diversity. We use a combination of these five indicators for the most fishery dependent communities to evaluate overall social risk levels.

Risk Level	Definition
Low	Few (<10%) vulnerable fishery dependent communities
Low-Moderate	10-25% of fishery dependent communities with >3 high vulnerability ratings
Moderate-High	25-50% of fishery dependent communities with >3 high vulnerability ratings
High	Majority (>50%) of fishery dependent communities with >3 high vulnerability ratings

Below is a brief description for each category based on the NOAA social indicator study (Jepson and Colburn 2013, Colburn et al. 2016):

- **Fishing dependence** indices portray the importance or level of dependence of commercial or recreational fishing to coastal communities.

- **Social vulnerability** indices represent social factors that can shape either an individual or community's ability to adapt to change. These factors exist within all communities regardless of the importance of fishing.
- **Gentrification pressure** indices characterize those factors that, over time may indicate a threat to commercial or recreational working waterfront, including infrastructure.

Communities are ranked as high, medium high, moderate, or low relative to the respective indicator (Table 21). Community dependence on commercial and recreational fishing is mixed, with notably more communities in the Mid-Atlantic dependent on recreational fishing than in New England.

	Low	Moderate	MedHigh	High
ME	109	20	9	34
NH	34	5	0	1
MA	124	21	4	4
RI	33	3	0	2
CT	72	3	0	0
NY	336	7	2	2
NJ	297	11	3	3
PA	40	1	0	0
DE	69	2	1	2
MD	239	4	0	2
VA	99	3	2	1
NC	113	6	3	4

	Low	Moderate	MedHigh	High
ME	159	11	1	1
NH	36	3	1	0
MA	129	10	7	7
RI	33	5	0	0
CT	69	5	1	0
NY	311	24	6	6
NJ	283	18	8	5
PA	41	0	0	0
DE	62	3	1	8
MD	218	14	6	7
VA	89	10	3	3
NC	85	13	8	20

Table 21: Number of communities at each level of commercial (left) and recreational (right) reliance

The social and economic impacts of climate change have been modeled through application of social indicators of fishing dependent communities (Jepson and Colburn 2013). Assessment of a range of social indicators has been applied in the Mid-Atlantic Region to predict vulnerability of communities to regulatory changes and disasters. More recently this methodology has been extended to include specific indicators of vulnerability to climate change and linked to species vulnerability assessments (Colburn et al. 2016, Hare et al. 2016). The tools developed through this approach are vital to an evaluation of the risks of climate change facing coastal communities dependent on fishing. Below is a description of the CSVIs related to climate change.

- **Sea Level Rise Index** is a measure of the overall risk of inundation from sea level rise based on community area lost from one to six foot level projections over the next ~90 years. A high rank indicates a community more vulnerable to sea level rise.
- **Species Vulnerability** is measured by the proportion of community fish landings that attributed to species vulnerable to climate change.
- **Catch Composition Diversity** is the relative abundance of species landed in a community. It is measured by Simpson's Reciprocal Index, and a higher index value indicates greater diversity. Communities with a diverse array of species landed may be less vulnerable to climate change.

Sea level rise is predicted to have variable impacts on coastal communities. The Mid-Atlantic region has a 3-4 times higher than global average sea level rise rate (Sallenger et al. 2012). Mid-Atlantic communities clustered around the Chesapeake Bay area and the New Jersey shore had especially high vulnerability to sea level rise (Fig. 18). These vulnerabilities include infrastructure (docks, marinas, bait shops, gear storage) and access to shore-based facilities due realignment of coastal communities.

Mid-Atlantic fishing communities with total landings value of $100,000 or more were mapped for their

dependence on species vulnerable to climate change and catch composition diversity (Simpson Reciprocal Index). A number of communities in southern New Jersey, Maryland and Virginia are highly dependent on species such as clams that are highly vulnerable to climate change while displaying low catch composition diversity. Communities with this situation are considered more vulnerable to climate change in general.

Assessment of the potential impacts of climate change on recreational and commercial fishermen and their communities has begun by linking social and economic indicators of community vulnerability and resilience to the climate vulnerability assessments of biological and ecological change expected to result from climate change and sea-level rise. Fishing communities in New England have generally moderate to low risks from sea level rise compared with communities in the Mid-Atlantic. However, there is moderate to high reliance on species vulnerable to climate in New England, and generally low catch diversity for communities in the Gulf of Maine, which may also increase risk.

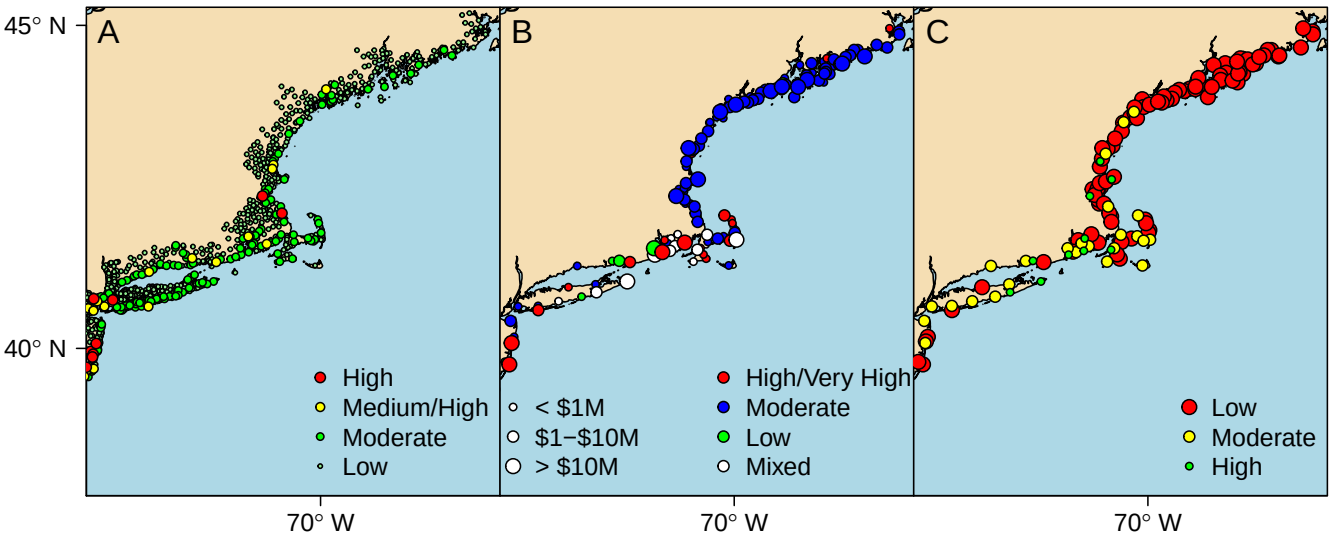

Figure 18: Risks from sea level rise (A), reliance on climate-vulnerable species (B), and catch diversity (C)

While the maps provides an overview of the social and climate indicator results for the New England coastal communities, Table 22 identifies Mid-Atlantic communities that are most highly dependent on both commercial and recreational fishing. *This analysis would need to be redone for New England communities if the New England Council wishes to use this element.* The varying vulnerability level to social factors, gentrification pressure, and climate change in these communities provide a more comprehensive profile and should be taken into account in the decision making process for fishery management.

As a preliminary risk assessment, rankings from Table 22 of MedHigh or High were tallied for social vulnerability and gentrification pressure, along with rankings of High risk from sea level rise, High/Very High species vulnerability, and rankings of Low catch composition diversity. Four of these communities (20%) have three or more of these high risk rankings, so we rank overall social-cultural risk as low-moderate for these Mid-Atlantic communities.

More information on Northeast coastal communities is available here: http://www.nefsc.noaa.gov/read/socialsci/communityProfiles.html

Table 22: Selected Mid-Atlantic Fishing Communities with Medium High to High Dependence on both Commercial and Recreational Fishing

Community	Commercial Fishing Dependence	Recreational Fishing Dependence	Social Vulnerability	Gentrification Pressure	Sea Level Rise Risk	Species Vulnerability	Catch Composition Diversity
Hampton Bays, NY	High	High	Low	MedHigh	Medium	Mixed	Moderate
Montauk, NY	High	High	Medium	MedHigh	Medium	Mixed	High
Barnegat Light, NJ	High	High	Medium	High	Low	High/Very High	Low
Cape May, NJ	High	High	Medium	MedHigh	Medium	High/Very High	Low
Beaufort, NC	High	High	MedHigh	Low	Low	Mixed	Low
Wanchese, NC	High	High	Medium	Low	Medium	Mixed	High
Point Lookout, NY	MedHigh	High	Low	MedHigh	Low	High/Very High	Low
Belmar, NJ	MedHigh	High	Medium	Medium	Low	Moderate	Low
Point Pleasant, NJ	MedHigh	High	Low	Medium	Medium	High/Very High	Moderate
Waretown, NJ	MedHigh	High	Low	Medium	Low	Low	Low
Ocean City, MD	MedHigh	High	Medium	Medium	Medium	Mixed	High
Aurora, NC	MedHigh	High	MedHigh	Medium	Low	N/A	N/A
Hatteras, NC	MedHigh	High	Medium	Low	N/A	Mixed	High
Oriental, NC	MedHigh	High	Medium	Medium	Low	Mixed	Low
Chincoteague, VA	MedHigh	High	Medium	Medium	High	Moderate	Moderate
Wachapreague, VA	MedHigh	High	Medium	Medium	Low	High/Very High	Moderate
Sea Isle City, NJ	MedHigh	MedHigh	Medium	MedHigh	Medium	Moderate	Low
Bowers, DE	MedHigh	MedHigh	Medium	Medium	Low	N/A	N/A
Hobucken, NC	MedHigh	MedHigh	Medium	Medium	N/A	Mixed	Low
Swan Quarter, NC	MedHigh	MedHigh	MedHigh	Low	N/A	Mixed	Low
Hampton, VA	MedHigh	MedHigh	MedHigh	Low	High	Moderate	Moderate
Newport News, VA	MedHigh	MedHigh	MedHigh	Low	High	High/Very High	Low

Food Production Elements

Commercial Seafood Provision

This element is applied at the ecosystem level. This element describes the risk of not optimizing domestic seafood production from MAFMC managed species. Commercial seafood landings (as opposed to total landings which include bait and industrial uses) were used to assess seafood provision.

Risk Level	Definition
Low	No trend or increase in seafood landings
Low-Moderate	Increasing or high variability in seafood landings
Moderate-High	Significant long term decrease in seafood landings
High	Significant recent decrease in seafood landings

Total commercial seafood landings from all species and from NEFMC managed species indicate total seafood production in the GOM and GB, which has declined over the long term.

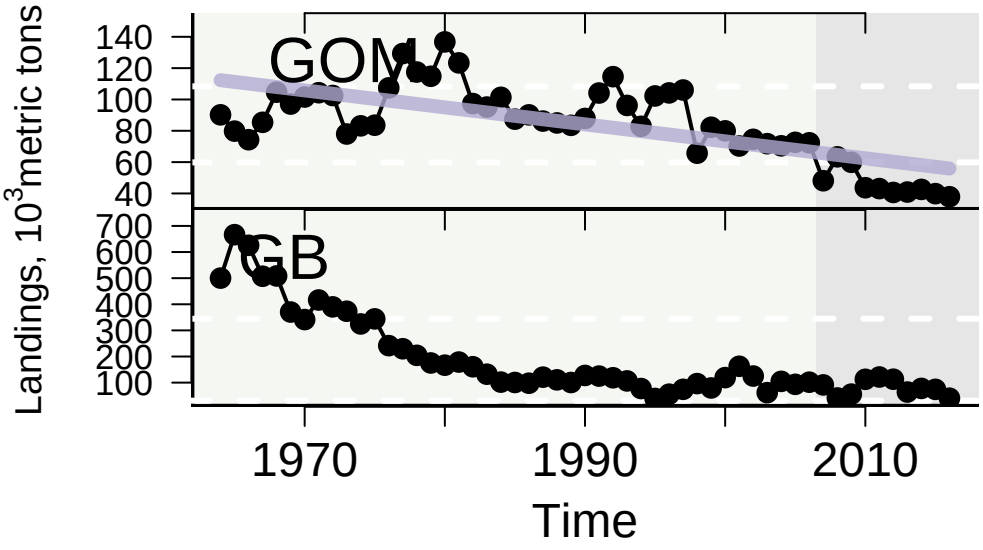

Figure 19: Total landings (black) and total landings managed by NEFMC (red) in Gulf of Maine (A) and Georges Bank (B).

Recreational/Subsistence Food

This element is applied at the ecosystem level. This element describes the risk of not maintaining personal food production. Recreational seafood landings (as opposed to total landings which include catch and release that are captured under other risk elements/indicators) were used to assess food use of recreationally caught fish.

Risk Level	Definition
Low	No trend or increase in recreational landings
Low-Moderate	Increasing or high variability in recreational landings
Moderate-High	Significant long term decrease in recreational landings

Risk Level	Definition
High	Significant recent decrease in recreational landings

There is not much recreational harvest on Georges Bank; this is total recreational harvest (all species) in the Gulf of Maine region.

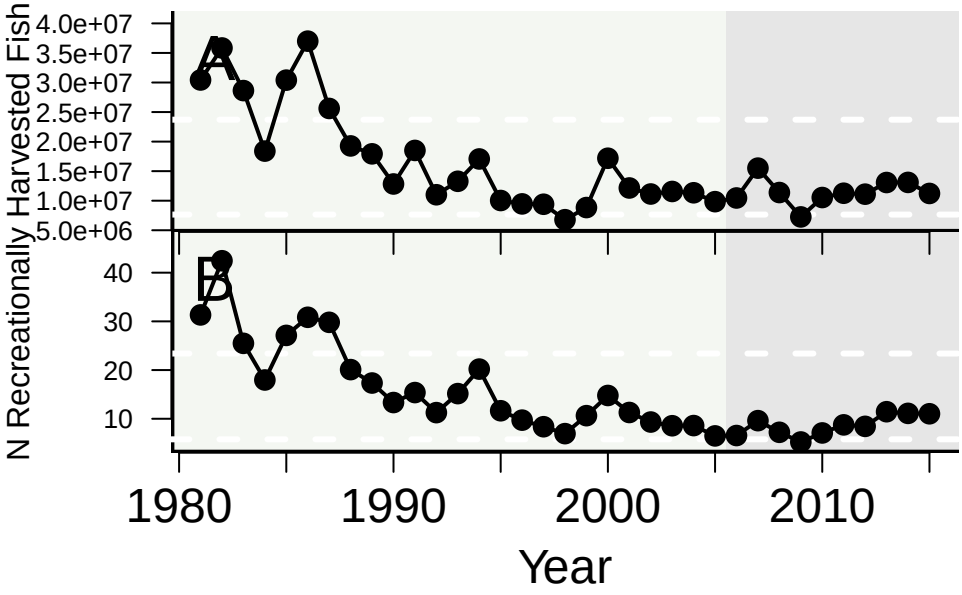

Figure 20: A: Total recreational harvest, B: Harvest per angler

There is no signficant trend in recreational landings and recreational landings per angler, which represents a low risk to food production.

Management Elements–*ALL FROM MAFMC staff, here as example only*

Fishing Mortality Control

This element is applied at the species and sector level. This element addresses the level of management control in terms of catch estimation (measurement) and monitoring to prevent overfishing. Adequate management control indicates a low risk of overfishing, while poor management control indicates a higher risk of overfishing and hence not achieving OY. Actual catch is compared with the specified ABC over the most recent five years of fishery history.

Risk Level	Definition
Low	No history of overages
Low-Moderate	Small overages, but infrequent
Moderate-High	Routine overages, but small to moderate
High	Routine significant overages

The ability to control total annual catch is necessary to prevent overfishing (i.e., defined to occur when total catch exceeds the overfishing level defined in the FMP), which is a fundamental requirement of MSA. Chronic or persistent overfishing can lead to stock depletion and ultimately to a stock being declared as overfished (thus requiring a stock rebuilding plan). The ability to constrain catch is a function of the efficacy of the catch monitoring program for each species which relies on both proactive (in -season closure) and reactive (pay backs for overages in subsequent years) accountability measures which were implemented post-MSA Reauthorization. Under certain circumstances, specification of management measures which are too strict could lead to "underfishing" (not achieving the desired quota) and hence not achieving OY. This element will be evaluated by fishery sector (commercial and recreational). For the commercial fishery, NMFS dealer data in conjunction with estimates of discards are used to compare target to actual annual catch. Small overages are defined as <5%, moderate as 5-10%, and significant overages as >10%. For the recreational sector, MRIP estimates of recreational catch are used to compare target to actual annual catch estimates.

Technical Interactions

This element is applied at the species and sector level. This element addresses the risk of not achieving OY due to interactions with non-MAFMC managed species, including protected species. Here the risk is caused by negative consequences from fishing activity regulated under MAFMC FMPs which interacts with species managed by other agencies, including bycatch of protected species. For example, windowpane flounder accountability measures (AMs) implemented by the New England Council have the potential to negatively impact a number MAFMC managed fisheries if they are triggered. Similarly, interactions with marine mammals protected under the MMPA could result in greater restrictions in MAFMC managed fisheries increasing the risk that OY would not be achieved in those fisheries. For example, the measures necessary for recovery of the critically endangered North Atlantic right whale population have the potential to seriously impact numerous fisheries in the NE US.

Risk Level	Definition
Low	No interactions with non-MAFMC managed species
Low-Moderate	Interactions with non-MAFMC managed species but infrequent, Category II fishery under MMPA; or AMs not likely triggered
Moderate-High	AMs in non-MAFMC managed species may be triggered; or Category I fishery under MMPA (but takes less than PBR)
High	AMs in non-MAFMC managed species triggered; or Category I fishery under MMPA and takes above PBR

Evaluation of this risk element requires quantification of the likelihood that AMs under other non-MAFMC FMPs would be triggered (thus impacting fishing activities for MAFMC managed species). In addition, NMFS manages marine mammal interactions with commercial fishing activity through take reductions plans. In cases where an MAMFC fishery interacts with marine mammals, conservation measures implemented through a take reduction plan could negatively impact that fishery.

Other Ocean Uses

This element is applied at the species and sector level. This element addresses the risk of fishery displacement or damage of a fishery resource and/or habitat that supports it as a result of non-fishing activities in the ocean. It also includes evaluation of risk to MAFMC fisheries from area based measures

outside of the control of the Council including area closures implemented by other Councils to protect sensitive habitats, spawning areas, etc. and/or through marine monument or other types of area based management designations.

Risk Level	Definition
Low	No overlap; no impact on habitat
Low-Moderate	Low-moderate overlap; minor habitat impacts but transient
Moderate-High	Moderate-high overlap; minor habitat impacts but persistent
High	High overlap; other uses could seriously disrupt fishery prosecution; major permanent habitat impacts

Non-fishing ocean activities (e.g., energy development/sand mining/other industrial, etc.) and/or designation of areas where fishing is prohibited (i.e., marine monument designations or establishment of habitat protected areas by other Councils) could potentially impact MAFMC fisheries because they overlap with historical fishing grounds (physical displacement) and/or through negative impacts on important habitats. This element can be evaluated through GIS analyses which quantify the degree of overlap and/or expert opinion relative impacts on habitat quality and function.

Regulatory Complexity and Stability

This element is applied at the species and sector level. Constituents have frequently raised concerns about the complexity of fishery regulations and the need to simplify them to improve their efficacy. Complex regulations may lead to non-compliance and/or impact other fisheries.

Risk Level	Definition
Low	Simple/few regulations; rarely if ever change
Low-Moderate	Low-moderate complexity; occasional changes
Moderate-High	Moderate-high complexity; occasional changes
High	High complexity; frequently changed

This element could be evaluated by quantifying the number of regulations and/or the frequency of regulatory changes (based on evaluation of the Code of federal regulations). In terms of recreational fisheries, the magnitude and frequency of change of management measures (size and bag limits, seasons, etc.) could also be evaluated/quantified.

Discards

This element is applied at the species and sector level. Stakeholders have identified the reduction of discards as a high priority in the Council management program, especially those caused by regulations since they represent biological and economic waste. Discards of either the target or non-target species in the fishery would be taken into consideration.

Risk Level	Definition
Low	No significant discards
Low-Moderate	Low or episodic discard

Risk Level	Definition
Moderate-High	Regular discard but managed
High	High discard, difficult to manage

NMFS provides estimates of discards by species based on at-sea observations collected in the Northeast Fisheries Observer Program for stock assessment purposes and quota monitoring. In addition, the MRIP provides estimate of discards by species for the recreational fisheries. Discards will be evaluated for each species and fishery with focus on identification of discards caused by regulations for each fishery sector (commercial and recreational).

Allocation

This element is applied at the species and sector level. This element addresses the risk of not achieving OY due to spatial mismatch of stocks and management allocations or because of sub-optimal allocation by sector and/or area. Indicators for difficulty of allocation include a combination of distribution shifts (see above) and the number of interests (sectors, states, etc.) requiring allocation.

Risk Level	Definition
Low	No recent or ongoing Council discussion about allocation
Low-Moderate	*This category not used*
Moderate-High	*This category not used*
High	Recent or ongoing Council discussion about allocation

Each species and sector will be evaluated relative to risk based on whether or not there is ongoing or recent (last three years) discussion by the Council concerning allocation.

Summary Tables: Risk Analysis Results

Species level

Species	Assess	Fstatus	Bstatus	FW1Pred	FW1Prey	FW2Prey	Climate	DistShift	EstHabitat
Scallop	l	l	l	l	l	l	mh	lm	l
Herring	l	l	l	l	l	lm	l	mh	l
GB Cod	h	mh	h	l	l	l	lm	mh	l
GB Yellowtail	h	h	h	l	l	l	l	mh	l
GB Winter	lm	l	lm	l	l	l	h	mh	h
N Windowpane	lm	l	h	l	l	l	l	mh	l
GB Haddock	l	l	l	l	l	l	l	mh	l
S Silver Hake	na	l	lm	l	l	lm	l	mh	l
S Red Hake	na	h	h	l	l	lm	l	mh	h
White hake	l	l	lm	l	l	lm	lm	mh	h
Pollock	na	l	l	l	l	l	lm	mh	h
Redfish	lm	l	l	l	l	l	lm	mh	l
Spiny dogfish	lm	l	lm	l	l	l	l	h	l
Monkfish	h	lm	lm	l	l	l	l	mh	l
6 Skates	h	l	l	l	l	l	lm	mh	l
Thorny skates	h	l	h	l	l	l	mh	mh	l
Wolffish	na	l	h	l	l	l	l	mh	l
Ocean pout	na	l	h	l	l	l	mh	lm	l

Species and Sector level *Mid Atlantic Rankings*

Species	MgtControl	TecInteract	OceanUse	RegComplex	Discards	Allocation
Ocean Quahog-C	l	l	lm	l	l	l
Surfclam-C	l	l	lm	l	l	l
Summer flounder-R	mh	l	lm	h	h	h
Summer flounder-C	lm	mh	lm	mh	lm	h
Scup-R	l	l	lm	mh	mh	l
Scup-C	l	mh	lm	mh	mh	l
Black sea bass-R	h	l	mh	h	mh	h
Black sea bass-C	lm	lm	h	mh	lm	h
Atl. mackerel-R	l	l	l	l	l	h
Atl. mackerel-C	l	lm	mh	h	lm	h
Butterfish-C	l	lm	mh	h	mh	l
Longfin squid-C	l	mh	h	h	h	h
Shortfin squid-C	l	lm	lm	lm	l	l
Golden tilefish-R	na	l	l	l	l	l
Golden tilefish-C	l	l	l	l	l	l
Blueline tilefish-R	l	l	l	mh	l	h
Blueline tilefish-C	l	l	l	mh	l	h
Bluefish-R	lm	l	l	l	mh	h
Bluefish-C	l	l	lm	lm	lm	h
Spiny dogfish-R	l	l	l	l	l	l
Spiny dogfish-C	l	mh	mh	mh	lm	h
Unmanaged forage	na	na	na	na	na	na
Deepsea corals	na	na	mh	na	na	na

Ecosystem level

System	EcoProd	CommProf	RecVal	FishRes1	FishRes4	FleetDiv	Social	ComFood	RecFood
New England	lm	mh	h	l	na	mh	na	mh	l

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