EAFM Risk Elements with Few Changes

Ecosystem and Ocean Planning Committee and AP Discussion Document #2

2023-09-06

Below is a list of risk elements, grouped by category (Ecological, Socio-economic, and Management), along with the element description, definition, indicators, and proposed risk criteria. This information has been updated and refined to reflect the feedback and direction provided by the Committee and AP during previous meetings. Unless time allows, these risk elements will not be discussed during the September 13-14 Ecosystem and Ocean Planning (EOP) Committee and AP meeting.

This document focuses on those risk elements where there was greater agreement and/or fewer changes identified by the Committee and AP for those risk elements. There is a second discussion document that includes the remaining risk elements and will be the focus of the discussion at the September EOP meeting (found at the Sept 13-14 EOP meeting page: https://www.mafmc.org/council-events/2023/sept-13-14/eop-comm-ap). While we are not planning to go over these risk elements during the September meeting, Committee and AP members are strongly encouraged to provide feedback on any of the information in the document following the meeting.

Contents

Ecological Elements

Assessment Performance

Description:

Stock assessments provide the scientific basis for sustainable fishery management in this region. This risk element is applied at the species level, and addresses risk to achieving OY due to scientific uncertainty based on analytical and data limitations. The Council risk policy accounts for scientific uncertainty in assessments, with methods for determining scientific uncertainty currently being refined by the Council's Scientific and Statistical Committee (SSC).

Other assessment-related risk elements (F status and B status) describe risks according to our best understanding of stock status, but assessment methods and data quality shape that understanding.

Definition:

Risk of not achieving OY due to analytical limitations

Indicators:

The Council currently uses indicators from stock assessment review and a qualitative assessment of general assessment data quality. The EOP and Council can continue to use pass/fail criteria from independent stock assessment reviews, and more formally incorporate data quality indicators (including data quality impacts from any source of scientific survey constraint), assessment retrospective performance indicators, or other indicators of analytical limitations. The SSC OFL CV process already reviews many aspects of analytical assessment uncertainty, including data quality and retrospective performance, which may be incorporated in this EAFM risk assessment.

Proposed risk criteria:

Low risk for assessment performance was defined as stock assessment model(s) passing peer review, and stocks having high data quality. Low-Moderate risk was assessment passing peer review, but some key data and/or reference points are lacking. The Moderate-High risk category was not used for this element in the past, but could include consideration of major data gaps and or large retrospective patterns that require adjustment. High risk was the assessment failing peer review, and/or that considerable data shortcomings required the use of data-limited tools.

An alternative set of criteria could apply OFL CVs used by the SSC for establishing ABC, which represent overall assessment uncertainty. An OFL CV of 60% could represent the low risk category, 100% the low-moderate risk category, 150% the moderate-high risk category, and stocks without an assessment (where OFL CV is usually not applied) remaining in the high risk category. If applying these criteria, we could change the name of this to "Assessment uncertainty" to match what the SSC is evaluating.

Risk Level	*Definition*
Low	Assessment model(s) passed peer review, high data quality, small retrospective pattern
Low-Moderate	Assessment passed peer review but some data and/or reference points may be lacking
Moderate-High	Assessment passed peer review but with major data quality issue or large retrospective pattern
High	Assessment failed peer review or no assessment, data-limited tools applied

Risk discussion:

Stocks with low risk due to assessment performance include ocean quahog, surf clam, summer flounder, scup, black sea bass, Atlantic mackerel, butterfish, golden tilefish, and bluefish.

The 2022 spiny dogfish Research Track assessment put forward an analytical stock assessment model which passed peer review. This model is considered an improvement over the empirical method applied in the past, which was ranked low-moderate risk. Therefore, the risk ranking for assessment performance was decreased to low for 2023.

Longfin squid are assessed with index-based assessment methods which rank low-moderate risk due to incomplete survey coverage in some years, and reference points for squids are lacking.

The 2022 *Illex* Research Track assessment was unable to put any analytical method forward to evaluate stock status or trends. Therefore, the risk ranking for assessment performance was increased from low-moderate to high for 2023.

The monkfish 2016 operational assessment was unable to model growth or population status due to inaccurate ageing methods (Richards, 2016), so both northern and southern stocks rank high risk for this element. At present, blueline tilefish ranks as high risk for assessment type because it is assessed with the data limited methods toolkit [https://cran.r-project.org/web/packages/DLMtool/index.html; Carruthers et al. (2014)]. Chub mackerel have no formal assessment, so rank high risk for assessment type.

Unmanaged forage and deep sea corals are not currently assessed and not ranked for this element.

Fishing Mortality and Biomass Status

Description:

Managed fisheries are required to be prosecuted within fishing mortality limits and managed stocks are required to be maintained above minimum threshold biomass levels to preserve sustainable yield. These elements are applied at the species level. Because OY is the objective, and OY is at most MSY under U.S. law, fishing mortality (F) limit reference points are based on F_{MSY}, while the stock biomass (B) target is biomass at MSY (B_{MSY}). F and B status relative to established MSY-based target and limit reference points or proxies (Gabriel and Mace, 1999) from stock assessments therefore indicate the level of risk to achieving OY from either overfishing or stock depletion, respectively.

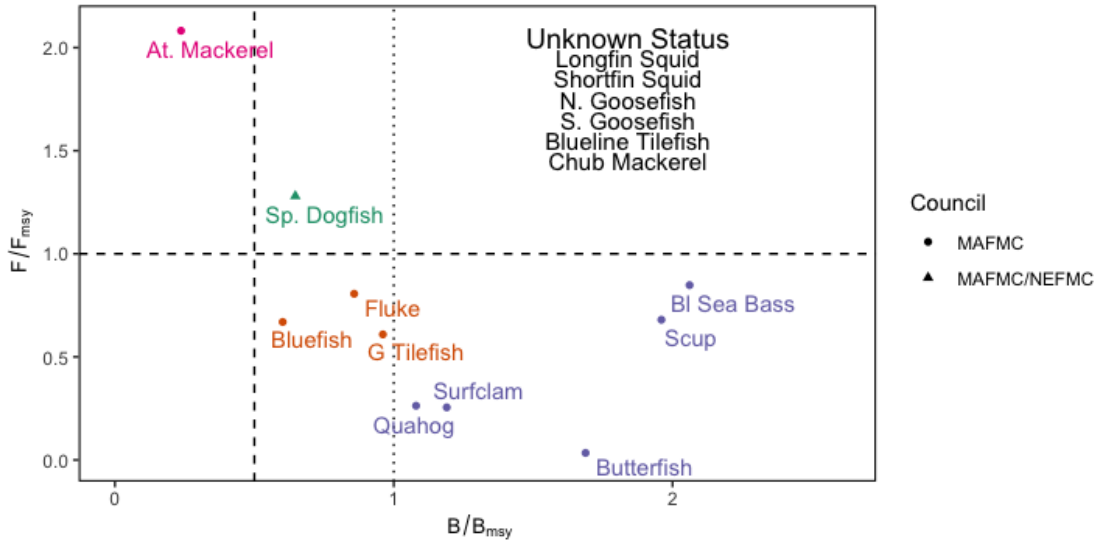
Definitions:

Fishing Mortality – F Status: Risk of not achieving OY due to overfishing

Stock Biomass – B Status: Risk of not achieving OY due to depleted stock

Indicators:

Stock assessments estimate both current F relative to the F reference point and current B relative to the B reference point and these indicators are used directly. When these quantities are not estimated due to analytical limitations, the SSC can evaluate the weight of evidence for risk of overfishing and overfished status based on evidence outside the stock assessment, and this evaluation is used in the EAFM risk assessment.



Summary of single species status for MAFMC and jointly federally managed stocks (Spiny dogfish and both Goosefish). The dotted vertical line is the target biomass reference point of Bmsy. The dashed lines are the management thresholds of one half Bmsy (vertical) or Fmsy (horizontal). Stocks in red are below the biomass threshold (overfished) and have fishing mortality above the limit (subject to overfishing), stocks in green are above the biomass threshold but have fishing mortality above the limit. Remaining stocks have fishing mortality

within limits: stocks in orange are above the biomass threshold but below the biomass target, and stocks in purple are above the biomass target.

Proposed risk criteria:

We applied low and high risk criteria for these elements as defined in U.S. law. Low risk criteria are $F<F_{MSY}$ and $B>B_{MSY}$ for an individual stock. High risk criteria are $F>F_{MSY}$ and $B < 0.5\ B_{MSY}$ for an individual stock. The Council established the intermediate risk categories to address stocks with unknown status. Moderate-high risk was defined as unknown status in the absence of other information for both F and B. Low-moderate risk was defined as unknown status, but with a weight of evidence indicating low overfishing risk for F. Similarly, low-moderate risk for B was either $0.5\ B_{MSY} < B < B_{MSY}$ or unknown status, but with a weight of evidence indicating low risk that the population is depleted.

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

Risk discussion:

Single species management objectives (1. maintaining biomass above minimum thresholds and (2. maintaining fishing mortality below overfishing limits) are being met for all but one MAFMC managed species, though the status of six stocks is unknown . In addition, the status of Spiny dogfish and bluefish are based on 2022 research track assessments and are thus waiting for a management track update to finalize stock status.

Based on these results, F and B status are both in the low risk category for surfclams, ocean quahogs, scup, black sea bass, and butterfish. Bluefish, golden tilefish, and summer flounder F status is in the low risk category, and B risk is in the low-moderate risk category. Spiny dogfish F status is in the high risk category and B status is in the low-moderate risk category. F and B status for northern and southern monkfish stocks were formerly in the low risk categories, but a recent assessment update was unable to determine status, so they were provisionally ranked low-moderate risk (unknown but weight of evidence supports lower risk). Longfin squid B is above the established B threshold, and both squid stocks

have unknown F status, but F is difficult to estimate because it is very low relative to natural mortality, so they were also ranked low-moderate risk. Blueline tilefish are high risk for F status and have unknown B status and little auxiliary information in the Mid-Atlantic region, and so rank moderate-high risk for B status. Finally, Atlantic mackerel has high risk for both F and B status.

Climate

Description:

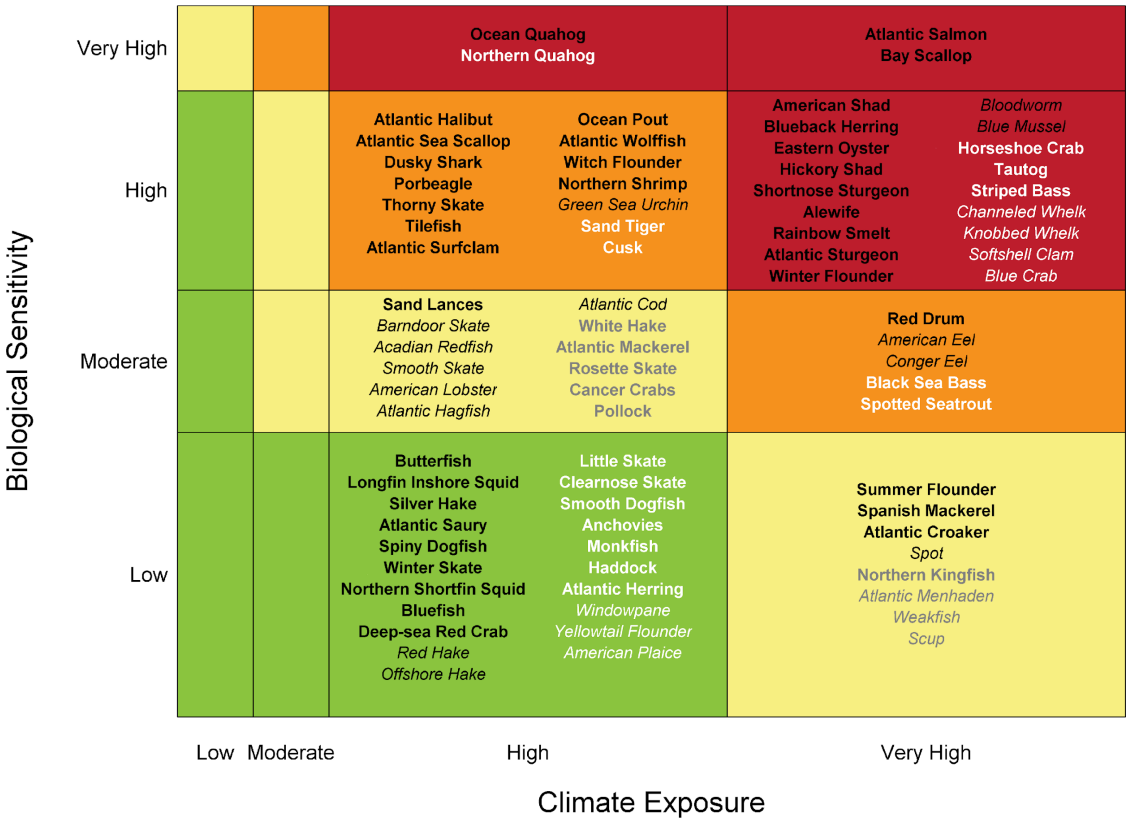
Climate change is expected to alter environmental conditions for managed fish in the Northeast US. This element is applied at the species level, and evaluates risks to species productivity (and therefore to achieving OY) due to projected climate change factors in the region using a comprehensive assessment (Hare et al., 2016) and other climate indicators (e.g., Mid-Atlantic ocean acidification).

Definition:

Risk of not achieving OY due to projected climate change or ocean acidification impacts on species productivity.

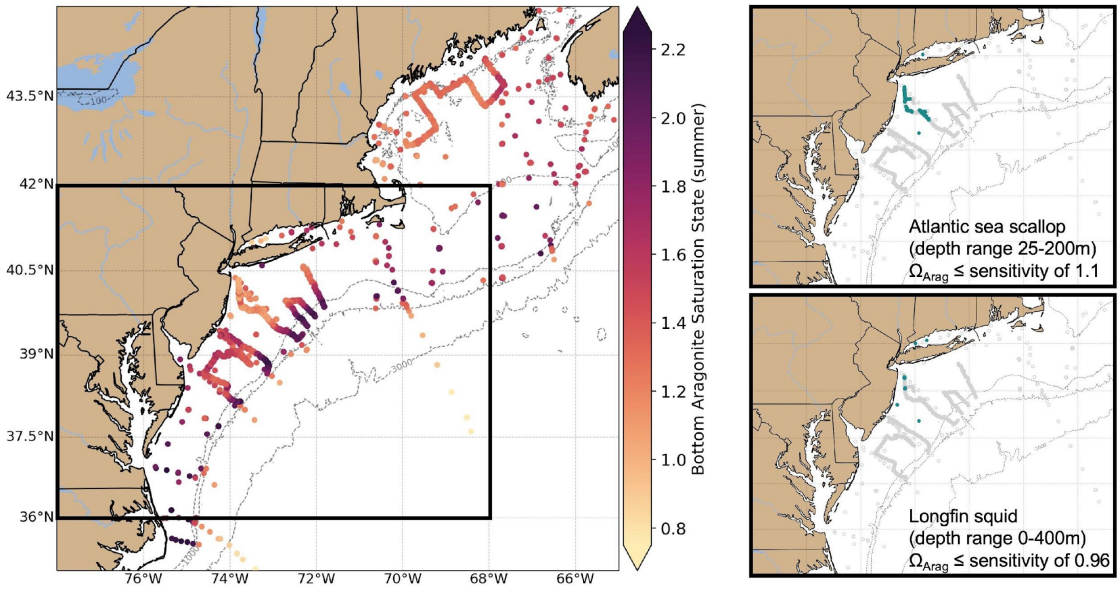
Indicators:

Indicators for climate productivity risk were taken from a climate vulnerability assessment (Hare et al., 2016) that 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. Additional indicators linking temperature and ocean acidification to individual stocks are presented in the State of the Ecosystem reports.



Hare et al., 2016 Climate vulnerability by species, Northeast US

Indicator: Mid Atlantic Ocean acidification



Proposed risk criteria:

Risk Level	*Definition*
Low	Low climate vulnerability ranking

Risk Level	*Definition*
Low-Moderate	Moderate climate vulnerability ranking
Moderate-High	High climate vulnerability ranking, climate indicators impacting the stock increasing (worsening)
High	Very high climate vulnerability ranking, climate indicators impacting the stock increasing (worsening)

Low risk ranking was defined as a low climate vulnerability ranking. Low-Moderate risk was a moderate climate vulnerability ranking. Moderate-High risk was a high climate vulnerability ranking. High risk was a very high climate vulnerability ranking.

Previous risk discussion:

At the July 7, 2023 meeting, EOP comments note that some climate impacts on stock productivity are positive, and that there may be opportunities from emerging fisheries under climate change. While positive productivity impacts have been ranked low risk in the current assessment, the EOP and Council may want to consider a separate risk element to evaluate emerging fisheries.

All Council-managed species were either highly or very highly exposed to climate risk, and range from low to very high sensitivity to expected climate change. The combination of exposure and sensitivity results in the overall vulnerability ranking. We applied those climate vulnerability rankings directly here as risk ranking criteria.

While this risk assessment focuses on overall vulnerability to impacts of climate, not all impacts will be negative. Some Council managed species, including black sea bass, bluefish, butterfish, longfin squid, and shortfin squid, may benefit from projected future climate conditions (Hare et al., 2016).

Distribution Shifts

Description:

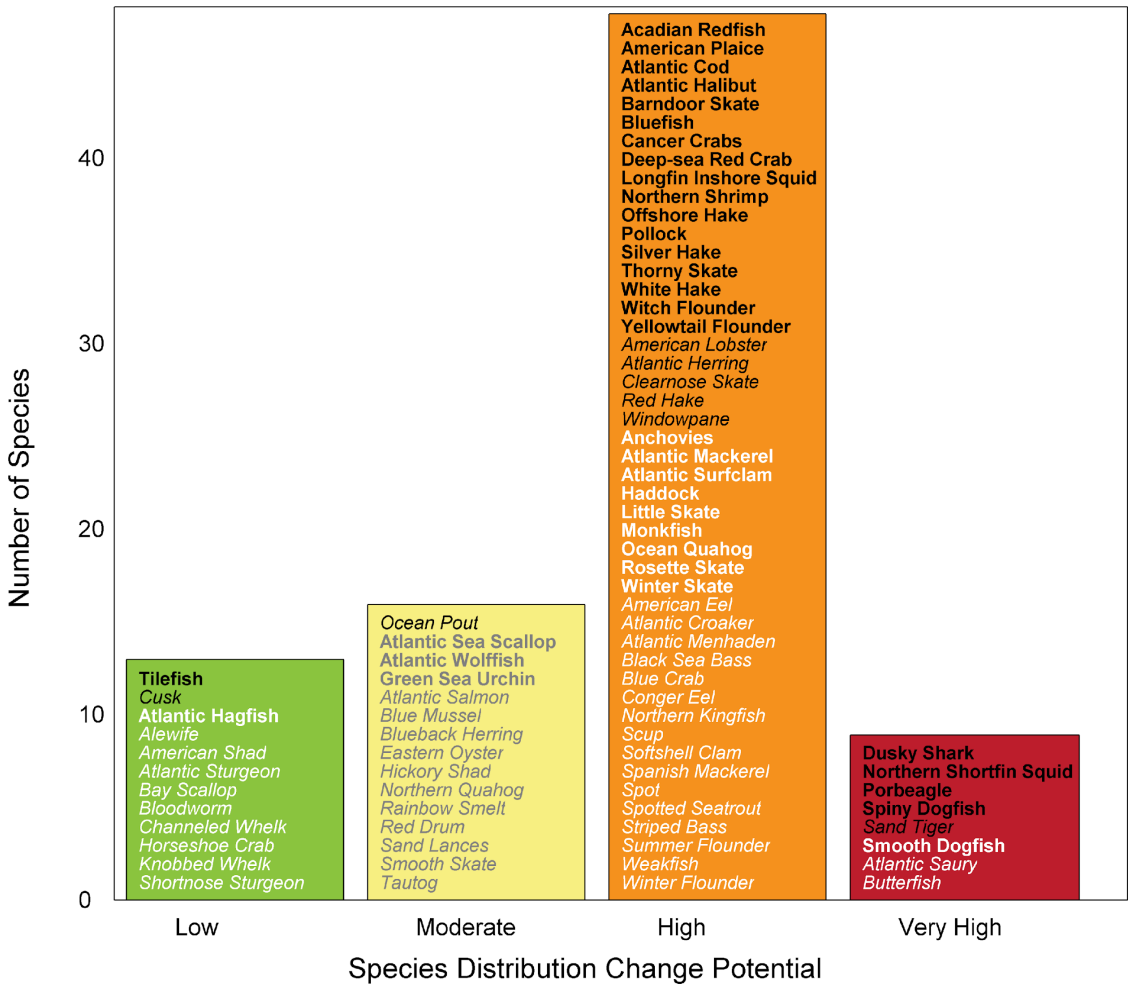
Climate change is expected to drive changes in spatial distribution for managed fish in the Northeast US as environmental conditions become more or less favorable for each stock throughout its range. Species distribution shifts in turn can increase risks of ineffective spatial catch allocation; if catch allocation is greatly mismatched with species distribution OY may not be achieved. This element is applied at the species level, and evaluates risks of species distribution shifts due to projected climate change in the Northeast US.

Definition:

Risk of not achieving OY due to spatial mismatch of stocks and management as a result of climate-driven distribution shifts.

Indicators:

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 in the risk assessment.



Hare et al., 2016 Distribution shift risk by species, Northeast US

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.

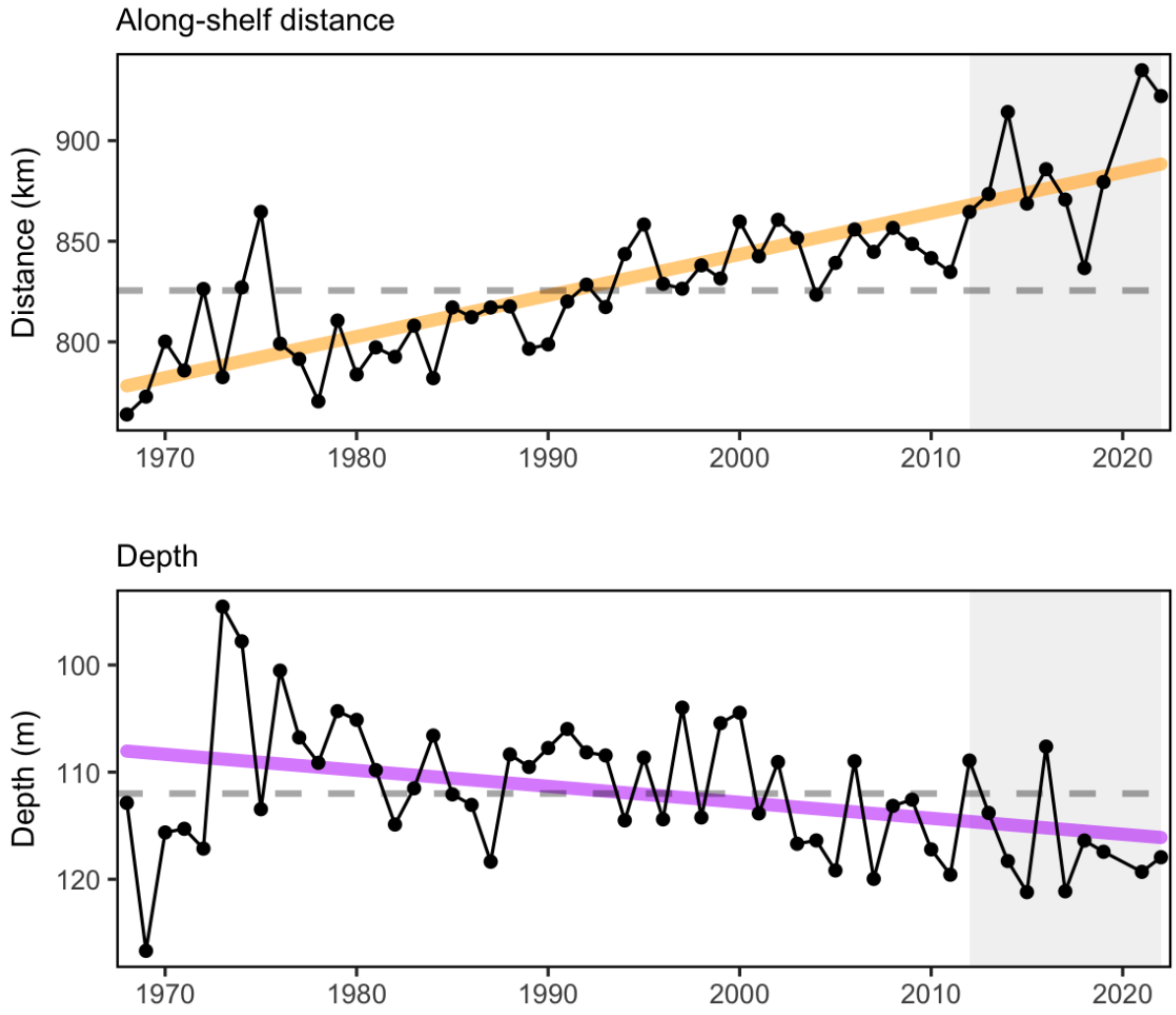
Historical vs. current distribution

Spatial distribution has changed over time for some species more than for others. The distribution of black sea bass, as measured by NEFSC surveys, has shifted northward relative to historical distributions. In contrast, the distribution of longfin squid in the Mid-Atlantic has remained relatively stable.

Species distribution models incorporating habitat variables show where distributions have increased or decreased over time: https://www.fisheries.noaa.gov/new-england-mid-atlantic/ecosystems/fisheries-habitat-northeast-us-shelf-ecosystem

Changes in along shelf position

The annual centroid of a species' distribution 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 km, which relates to positions along the axis from the origin in the southwest to the northeast. All species combined show a shift to the northeast and into deeper water. Individual Council managed species distribution centeroids, aside from squids, also showed this trend to the northeast along the shelf in previous analysis.



Aggregate species shifts from the 2023 SOE

Proposed risk criteria:

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, observed distribution shifts
High	Very high potential for distribution shifts, observed distribution shifts

Previous risk discussion:

All Council-managed species, with the exception of golden tilefish, had either high or very high risk of distribution shifts in the Northeast US.

Estuarine and Coastal Habitat

Description:

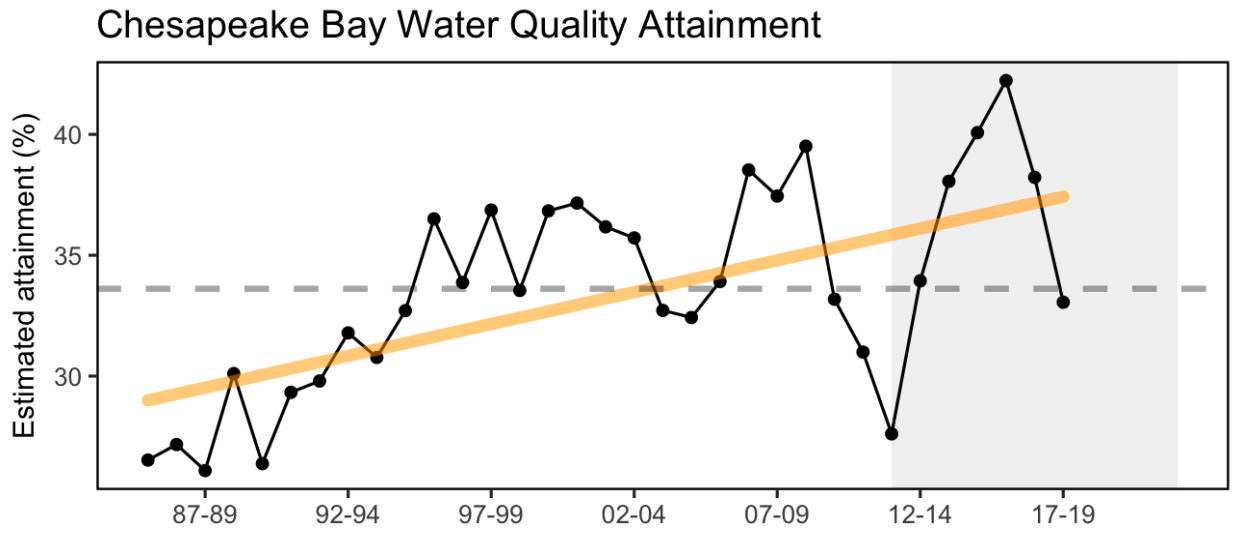
Estuarine and coastal habitat provides important nursery grounds for Council managed species, and is changing in quality and quantity due to multiple stressors from climate, land use, and coastal development. This element is applied at the species level, and evaluates risk of not achieving OY due to threats to estuarine and nearshore coastal habitat/nursery grounds.

Definition:

Risk of not achieving OY due to threats to estuarine/nursery habitat.

Indicators:

Risk was determined by first evaluating the estuarine dependence of species, and then by enumerating threats to the estuarine habitat required by these species. An assessment of national coastal and estuarine condition was used in this assessment. Water and habitat quality assessments produced for Chesapeake Bay, Delaware Bay, Long Island Sound, and other coastal estuaries have been developed and can be considered in the future. The 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. State of the Ecosystem reports now include up to date indicators of Chesapeake Bay habitat conditions which could be included as indicators.



Improvement in overall Chesapeake Bay water quality, from 2022 SOE

Species specific habitat use indicators for Chesapeake Bay are in development. As reported in the 2023 SOE, Chesapeake Bay suitable habitat for juvenile summer flounder growth has declined by 50% or more. Climate change is expected to continue impacting habitat function and use for multiple species. Habitat is improving in some areas (tidal fresh SAV,

oyster reefs), but eelgrass is declining. Similar information from multiple East Coast estuaries could be integrated into the risk assessment as it becomes available.

Proposed risk criteria:

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

Species were defined as low risk if not dependent on nearshore coastal or estuarine habitat. Low-Moderate risk were estuarine dependent species with a stable estuarine condition. Moderate-High risk were estuarine dependent species with a fair estuarine condition. High risk were estuarine dependent species with a poor estuarine condition.

Previous risk discussion:

The 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. Coastal waters in the Mid-Atlantic region 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 2003-2006 nearshore and estuarine summer sampling. Although the overall coastal condition was rated fair for the entire region, this includes offshore conditions which the Council intended to address separately. Therefore, estuarine dependent species (summer flounder, scup, black sea bass, and bluefish, (Able, 2005)) were ranked high risk based on overall poor estuarine condition, and all others were ranked low risk due to lower dependence on this habitat type.

Economic Elements

Marine Recreational Angler Days/Trips

Description:

Providing recreational opportunities is a stated goal of optimal fishery management under the legal definition of "benefits to the nation". Recreational fishing is important in the Mid-Atlantic region with the economic and social aspects of many coastal communities being highly dependent on recreational fishing.

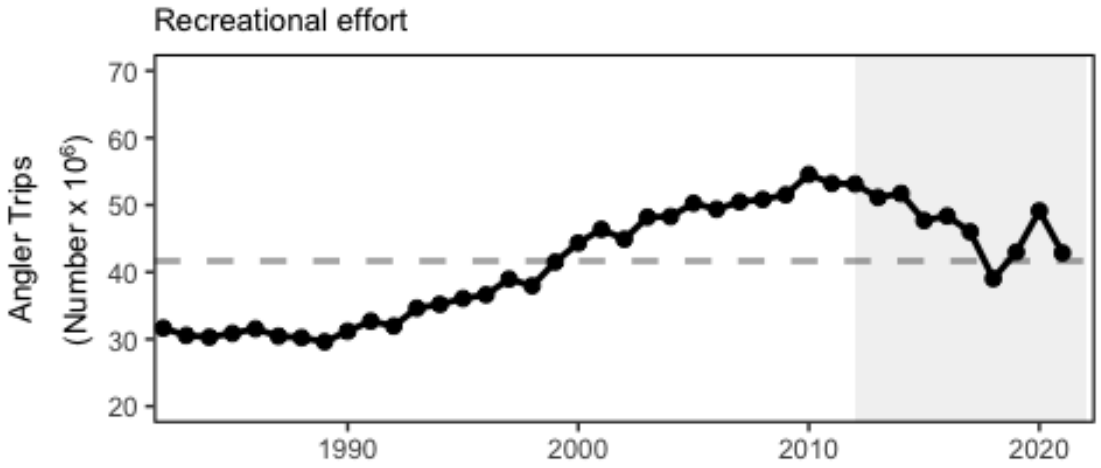
This element is assessed at the ecosystem level where it applies equally to all recreationally fished species. Providing recreational opportunities is a stated goal of optimal fishery management under the legal definition of "benefits to the nation". Recreational fishing is important in the Mid-Atlantic region with the economic and social aspects of many coastal communities being highly dependent on recreational fishing.

Definition:

Risk of not maximizing recreational fishery value and opportunities

Indicators:

Currently, angler days and trips are the proxy indicators for the value generated from recreational fishing. Although willingness to pay would better capture the economic concept of recreational value, this information is not gathered systematically in the region. Potentially, multiple indicators could be used to better proxy for recreational fishery value.



Proposed risk criteria:

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

Risk Level	*Definition*
High	Significant recent decreases in angler days/trips

Angler days and trips are the proxy indicators for the value generated from recreational fishing. Low risk was defined as no trend and low variability in angler days/trips. Low-Moderate risk was increasing variability or overall high variability in angler days/trips. Moderate-High risk was significant long-term decreases in angler days/trips. High risk was significant recent decreases in angler days/trips.

Previous risk discussion:

Both trends and interannual variability in recreational participation are affected by economic drivers including human population growth, changes in disposable income and generational shifts in leisure time preferences, management actions such as species bag limits, fish population availability, and a host of other issues that affect how people choose to spend their time. Although there is an overall long-term trend of increasing recreational fishery participation in terms of number of angler days, the most recent 10 years has shown a striking decline in both recreation indices (Fig. , Lower left). These significant recent decreases in number of anglers and number of trips indicate high risk to recreational value generated from the species with substantial recreational fisheries (summer flounder, scup, black sea bass, bluefish).

Social-Cultural Elements

Commercial Fleet Diversity

Description:

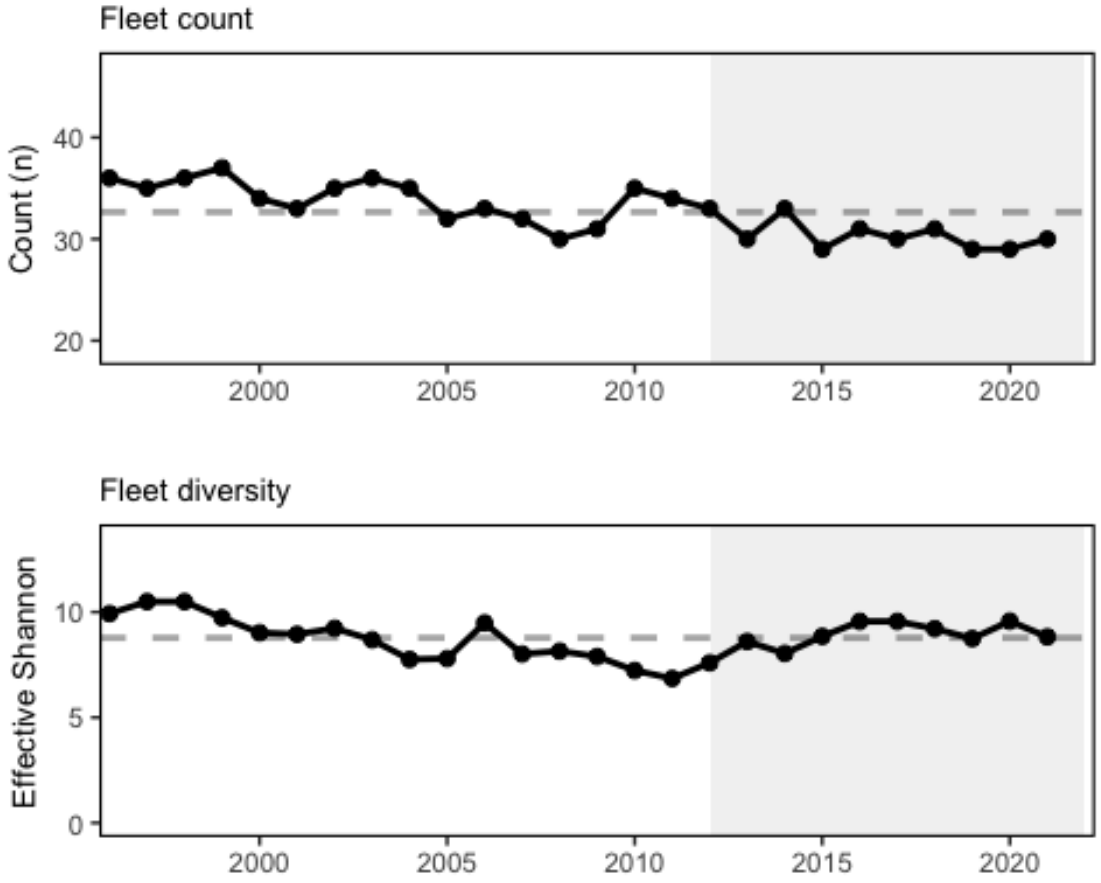
This element is applied at the ecosystem level, and ranks the risk to maintaining equity in access to fishery resources. Beyond equity concerns, maintaining diversity can provide the capacity to adapt to change at the ecosystem level for dependent fishing communities, and can address objectives related to stability.

Definition:

Risk of reduced fishery resilience (number and diversity of fleets).

Indicators:

Currently the diversity in revenue generated by different fleet segments, as well as a count of the number of active fleets, at the ecosystem level. A fleet is defined here as the combination of gear (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). The effective Shannon index is used to calculate the diversity of revenue across these fleets. Although the exact value of the effective Shannon index is relatively uninformative in this context, the relative value identifies changes in diversity.



Other metrics for diversity exist. The Simpson index is a common measure of biodiversity, but has the undesirable attribute of being asymmetric and weighing more common types more heavily than the less common types. Although the Shannon index provides a measure proportional to each type's relative frequency, the effective Shannon index has the added benefit of converting diversity measures onto a common scale. As such, the effective Shannon index was selected as the preferred index of fishing diversity, consistent with the literature and ensuring no differential treatment between large and small fleets (Thunberg & Correia 2015).

Potential risk criteria:

Low risk was defined as no trend and low variability in the diversity measure. Low-Moderate risk was increasing variability or overall high variability in the diversity measure. Moderate-High risk was a significant long-term decrease in the diversity measure. High risk was a significant recent decrease in the diversity measure.

Risk Level	*Definition*
Low	No trend in diversity measure
Low-Moderate	Increasing or high variability in diversity measure

Risk Level	*Definition*
Moderate-High	Significant long term downward trend in diversity measure
High	Significant recent downward trend in diversity measure

Previous risk discussion:

A declining trend in diversity indicates a less diverse fleet is currently active in Council-managed fisheries. However, it cannot distinguish whether specialization (by choice), or alternatively stove piping (constrained choices), is occurring, rather merely that the fleet composition is changing, which might warrant additional scrutiny. There is a long term decrease in the fleet count metric (Fig. , top panel). Therefore, this element ranks moderate-high risk. The number of fleets in the Mid-Atlantic seems to be negatively correlated to the revenue diversity metric in the most recent five years, which indicates that the latter results are being dominated by changes in the distribution of revenue across fleets, as opposed to the number of active fleets.

Community Vulnerability

Description:

This element ranks 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. Vulnerability metrics can help assess the relative impact of system changes on human communities dependent on and engaged in fishing activities.

This element is applied at the ecosystem level.

Definition:

Risk of reduced community resilience (vulnerability, reliance, engagement).

Indicators:

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.

Proposed risk criteria:

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 vulnerability category based on the NOAA social indicator study (Colburn et al., 2016; Jepson and Colburn, 2013):

- **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.

Here, we define gentrification in fishing communities as described by Colburn and Jepson (2012), where coastal population growth combined with an influx of higher-income people seeking waterfront property can increase property values and displace working-class residents engaged in resource-dependent activities. "Three common elements of gentrification are reuse of waterfront structures, construction of new housing, and growth within the services sector (Colburn and Jepson, 2012)."

Communities are ranked as high, medium high, moderate, or low relative to the respective indicator. Community dependence on commercial and recreational fishing is mixed, with notably more communities in the Mid-Atlantic dependent on recreational fishing. While communities with high to medium high risk for social vulnerability are broadly distributed in suburban and rural areas of the Mid-Atlantic region, communities with high to medium high gentrification pressure are concentrated in beachfront communities near urban areas in New York and New Jersey.

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.). 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.

While the maps provide an overview of the social and climate indicator results for the Mid-Atlantic coastal communities, Table identifies Mid-Atlantic communities that are most highly dependent on both commercial and recreational fishing. 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.

To estimate "high" vulnerability across all current indicators (which are ranked on different scales), we tallied rankings from Table of MedHigh or High 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. We considered a majority (3 or more out 5) to represent high risk to a community overall because with only 5 indicators, this means that a majority (60-100%) of the individual indicators were high risk. Low risk ranking was defined as few (<10%) vulnerable fishery dependent communities with 3 or more high vulnerability rating. Low-Moderate risk was 10-25% of fishery dependent communities with 3 or more high vulnerability ratings. Moderate-High risk was 25-50% of fishery dependent communities with 3 or more high vulnerability ratings. High risk was a majority (>50%) of fishery dependent communities with 3 or more high vulnerability ratings.

Previous risk discussion:

Four 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: https://apps-nefsc.fisheries.noaa.gov/read/socialsci/communitySnapshots.php

Management Elements

Fishing Mortality Control

Description:

This element is applied at the species and sector (commercial and recreational) level, and addresses the level of management control in terms of catch estimation 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.

The ability to control total catch within the specified Acceptable Biological Catch (ABC) is necessary to prevent overfishing, which is a fundamental requirement of US fisheries law. Chronic or persistent overfishing can lead to stock depletion and ultimately to a stock being declared as overfished and requiring a stock rebuilding plan. The ability to constrain catch is a function of the efficacy of the catch monitoring program for each species and sector which relies on both proactive (in -season closure) and reactive (pay backs for overages in subsequent years) accountability measures (AMs). 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.

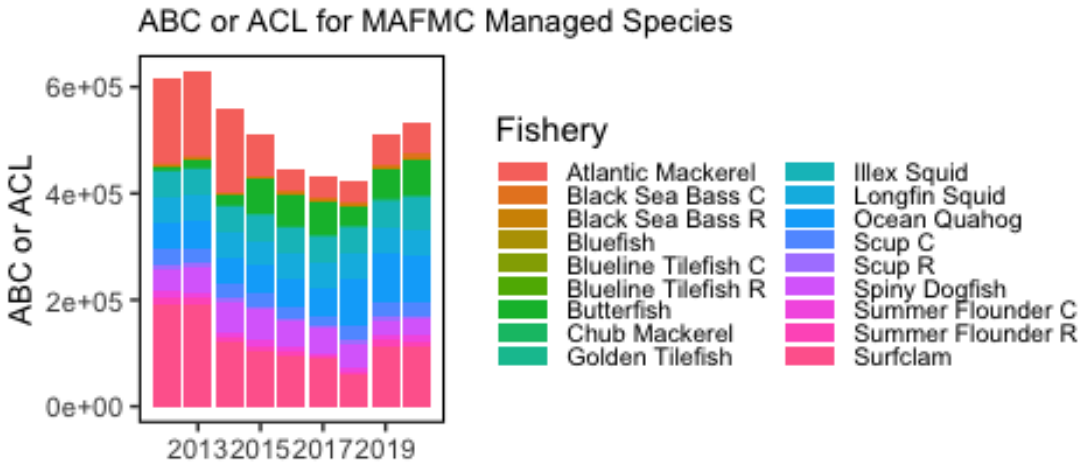
Definition:

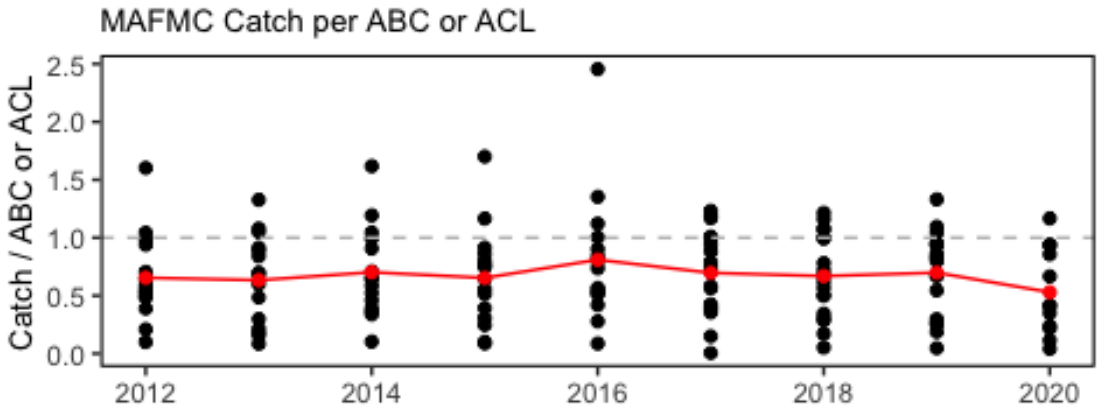
Risk of not achieving OY due to a mismatch of projected effects of management controls with harvest/catch targets.

Indicators:

Total catch at the fishery sector level compared to the appropriate catch limit (ABC or Annual Catch Limit, ACL). For the commercial fishery, NMFS dealer data in conjunction with estimates of dead discards from the most recent stock assessment are used to compare the annual catch limit to actual annual catch. For the recreational sector, Marine Recreational Information Program (MRIP) estimates of recreational landings and dead discards in conjunction with stock assessment estimates of recreational discards in weight are used to compare the annual catch limit to actual annual catch estimates.

Landings only information could potentially be considered if underfishing appears to be more important or if discards are low for a fishery sector. Discards are also addressed under a separate risk element. However, the current risk element is "Fishing Mortality Control" which would include both landings and discards. The Mid-Atlantic State of the Ecosystem report now includes an indicator that looks at total catch divided by total ABC or ACL across all Mid-Atlantic species if a broader look across managed species is preferred.





Proposed risk criteria:

Risk Level	Definition
Low	No recent history (last 5 years) of overages
Low-Moderate	Small recent overages, but infrequent
Moderate-High	Routine recent overages, but small to moderate
High	Routine recent significant overages

Previous risk discussion:

Both surfclam and ocean quahog were low risk because they are well within recent quotas and are managed as ITQ fisheries. Recreational fisheries for scup, Atlantic mackerel, blueline tilefish, and spiny dogfish and commercial fisheries for scup, mackerel, butterfish, longfin squid, shortfin squid, golden and blueline tilefish, bluefish, and spiny dogfish were also low risk with no overages for the past 5 years and generally sufficient measures are in place to avoid overages. Recreational golden tilefish was unranked because there are no catch and landings limits associated with the recreational fishery and appear to be a minor component of total removals. Recreational bluefish and commercial summer flounder and black sea bass fisheries were low-moderate risk with catches always within <2% of quota

and limits exceeded by <5% twice in the past 5 years. Recreational summer flounder ranked moderate-high risk with highly variable performance relative to catch limits with two minor overages of the RHL between 2012-2016. Recreational black sea bass was ranked high risk because catch limits were exceeded substantially in all of the past 5 years.

Technical Interactions

Description:

This element is applied at the species and sector (commercial and recreational) level and considerers potential interactions with non-Council-managed species, including protected species, on Council-managed fisheries. Here the risk is caused by negative consequences from fishing activity regulated under Council FMPs which interacts with species managed by other agencies, including bycatch of protected species. For example, interactions with species protected under the U.S. Marine Mammal Protection Act (MMPA) could result in greater restrictions in Council managed fisheries, increasing the risk that OY would not be achieved in those fisheries.

Definition:

Risk of not achieving OY due to interactions with non-Council managed species, including protected species.

Indicators:

The current indicator used is the MMPA category fishery level (Category I - frequent incidental mortality or injury; Category II - occasional incidental mortality or injury; Category III, remote likelihood of incidental mortality or injury) assigned to the dominant gear type associated with the fishery sector. This indicator is relatively static over time and may not appropriately track risk associated with these technical interactions.

Could look at the total number of protected species "takes" by a fishery sector by year or five year period. Could also consider regulatory changes that were considered and/or implemented to reduce technical interactions in Mid-Atlantic fisheries.

Proposed risk criteria:

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

Evaluation of this risk element requires quantification of the likelihood that non-Council AMs would be triggered and impact fishing activities for Council managed species. In addition, NMFS manages incidental mortality of mammals through take reductions plans which could negatively impact a fishery. Low risk were defined as no interactions with species managed by another agency. Low-Moderate risk were infrequent interactions with non-Council managed species,, equivalent to a Category II fishery under MMPA, or non-

Council AMs not likely triggered. Moderate-High risk was that AMs in non-Council managed species may be triggered by Council-managed fishing activity, or a Category I fishery under MMPA but takes less than potential biological removal (PBR) threshold. High risk were triggered AMs in non-Council managed species, or a Category I fishery under MMPA and takes above PBR.

Previous risk discussion:

All recreational sector fisheries and commercial fisheries for surfclams, ocean quahogs, bluefish, golden and blueline tilefish were ranked low risk as there are no known interactions with protected resources or AMs in other fisheries. Black sea bass, Atlantic mackerel, butterfish, and shortfin squid commercial fisheries were low-moderate risk as Category II fisheries and/or having infrequent interactions with marine mammals or river herring and shad. Moderate-high risk rankings included commercial sector summer flounder and scup (Category II fisheries with potential to trigger AMs for windowpane flounder, a New England managed species), longfin squid (marine mammal interactions and turtle takes) and spiny dogfish (marine mammal interactions and sturgeon takes).

Discards

Description:

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.

Definition:

Risk of not minimizing regulatory discards, bycatch mortality, and incidental catch to extent practicable.

Indicators:

NMFS provides estimates of discards by species based, in large part, on at-sea observations collected in the Northeast Fisheries Observer Program (NEFOP), for stock assessment purposes and quota monitoring. The observer program provides information on the reason for discarding during a commercial trip. In addition, the MRIP provides estimate of discards by species for the recreational fisheries. Discards and incidental catch will be evaluated for each species and fishery with a focus on identifying discards caused by regulations for each fishery sector. The ratio of regulatory discards to total discards for the target species could be applied or the ratio of discards to overall catch of the target species could be applied. A similar, or combined, approach could be applied for non-target species.

Discard mortality indicators might be more challenging, at least in terms of tracking improvements/declines over time. Discard mortality rates by species and gear type are not estimated annually, or even every 10 years, and are typically based on results developed from targeted research projects. Therefore, a static discard mortality rate by species and gear is applied to the discard estimate.

Proposed risk criteria:

Low risk was defined as no significant discards and incidental catch (<5%). Low-Moderate risk was low or episodic discarding and incidental catch (<20%). Moderate-High risk was regular discarding and incidental catch (20% or more) but managed at an acceptable level. High risk was high discarding and incidental catch (>40%) and difficulty in management. A similar approach could be applied to discard mortality risks: low - mortality <5% for dominant gear; low-moderate - mortality <25% for dominant gear; moderate-high - mortality <50% for dominant gear; mortality >50% for dominant gear.

Risk Level	*Definition*
Low	No significant discards or incidental catch; no significant discard mortality
Low-Moderate	Low or episodic discards and incidental catch; low discard mortality

Risk Level	*Definition*
Moderate-High	Regular discards and incidental catch but managed; moderate discard mortality
High	High discards and incidental catch, difficult to manage; high discard mortality.

Previous risk discussion:

Surfclams and ocean quahogs ranked low risk because discards are a small percentage of total catch; these fisheries are allocated minimal observer coverage as a result. Recreational spiny dogfish, recreational Atlantic mackerel, all tilefish, and shortfin squid fisheries were also determined to be of low risk because of low discards and/or low mortality associated with discards. Commercial fisheries for summer flounder, black sea bass, Atlantic mackerel, bluefish, and spiny dogfish ranked low-moderate risk due to relatively low (<20% of total catch) but consistent levels of overall discards. Moderate-high risk fisheries included scup (both sectors), commercial butterfish, recreational black sea bass, and recreational bluefish due to relatively high, regular discarding. Recreational summer flounder fishery was ranked high risk due to live discards making up over 85% of recreational catch; however these estimates can be uncertain and variable. Longfin squid fisheries ranked high risk due to high discards of both squid and butterfish.

Allocation

Description:

Many Mid-Atlantic fisheries have some allocation component and any adjustments/changes in allocation can be driven by a number of factors which can present a variety of management, biological, and fishery risks. This element is applied at the species and sector level, and 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.

Definition:

Risk of not achieving OY due to spatial mismatch of stocks and management or sub-optimal allocation by sector and/or area.

Indicators:

Currently, the Allocation indicator consists of whether or not the Council is considering or an ongoing management action that might have any sort of allocation outcome/implication (by sector, region, permit holder etc.). However, this indicator does not directly get at the actual risk associated with spatial mis-match or sub-optimal allocation.

Indicators quantifying the difficulty of allocation could include a combination of distribution shifts (see above) and the number of interests (sectors, states, etc.) requiring allocation. There are new analyses and tools available (Palacios-Abrentes et al 2023 - https://doi.org/10.1371/journal.pone.0279025) that could provide more insight on actual mismatch risks for some species and sectors.

Proposed risk criteria:

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

Currently, there are no definitions to specify intermediate levels of risk for this element, so only low and high risk criteria have been developed. A Low risk ranking was no recent or ongoing Council discussion about allocation. High risk was defined as recent or ongoing Council discussion about allocation.

References

Able, K. W. (2005). A re-examination of fish estuarine dependence: Evidence for connectivity between estuarine and ocean habitats. *Estuarine, Coastal and Shelf Science* 64, 5–17. doi:10.1016/j.ecss.2005.02.002.

Carruthers, T. R., Punt, A. E., Walters, C. J., MacCall, A., McAllister, M. K., Dick, E. J., et al. (2014). Evaluating methods for setting catch limits in data-limited fisheries. *Fisheries Research* 153, 48–68. doi:10.1016/j.fishres.2013.12.014.

Colburn, L. L., and Jepson, M. (2012). Social Indicators of Gentrification Pressure in Fishing Communities: A Context for Social Impact Assessment. *Coastal Management* 40, 289–300. doi:10.1080/08920753.2012.677635.

Colburn, L. L., Jepson, M., Weng, C., Seara, T., Weiss, J., and Hare, J. A. (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. doi:10.1016/j.marpol.2016.04.030.

Gabriel, W. L., and Mace, P. M. (1999). "A Review of Biological Reference Points in the Context of the Precautionary Approach," in *Proceedings of the Fifth National NMFS Stock Assessment Workshop: Providing Scientific Advice to Implement the Precautionary Approach Under the Magnuson-Stevens Fishery Conservation and Management Act. NOAA Tech. Memo. NMFS-F/SPO-40.*, ed. V. R. Restrepo (U.S. Dep. Commer.), 34–45. Available at: https://www.st.nmfs.noaa.gov/Assets/stock/documents/workshops/nsaw_5/gabriel_.pdf.

Hare, J. A., Morrison, W. E., Nelson, M. W., Stachura, M. M., Teeters, E. J., Griffis, R. B., et al. (2016). A Vulnerability Assessment of Fish and Invertebrates to Climate Change on the Northeast U.S. Continental Shelf. *PLOS ONE* 11, e0146756. doi:10.1371/journal.pone.0146756.

Jepson, M., and Colburn, L. L. (2013). *Development of Social Indicators of Fishing Community Vulnerability and Resilience in the US Southeast and Northeast Regions. NOAA Technical Memorandum NMFS-F/SPO-129 (US Dept Commerce, 2013)*. Available at: http://www.nmfs.noaa.gov/sfa/management/councils/training/2014/r_h3_fishing_community_vulnerability.pdf [Accessed September 25, 2015].

Palacios-Abrantes J, Crosson S, Dumas C, Fujita R, Levine A, Longo C, et al. (2023) Quantifying fish range shifts across poorly defined management boundaries. PLoS ONE 18(1): e0279025. https://doi.org/10.1371/journal.pone.0279025

Richards, R. A. (2016). 2016 Monkfish Operational Assessment. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 16-09. National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026 Available at: https://www.nefsc.noaa.gov/publications/crd/crd1609/crd1609.pdf [Accessed October 2, 2018].

US EPA (2012). National Coastal Condition Report IV, EPA-842-R-10-003. Washington, DC: United States Environmental Protection Agency, Office of Research; Development/Office of Water Available at: http://www.epa.gov/nccr.