Introduction

The Council approved an EAFM Guidance Document in 2016 which outlined a path forward to more fully incorporate ecosystem considerations into marine fisheries management[1], and revised the document in February 2019[2]. The Council's stated goal for EAFM is "to manage for ecologically sustainable utilization of living marine resources while maintaining ecosystem productivity, structure, and function." Ecologically sustainable utilization is further defined as "utilization that accommodates the needs of present and future generations, while maintaining the integrity, health, and diversity of the marine ecosystem." 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 [1]. Because there are so many possible ecosystem interactions to consider, a risk assessment was adopted as the first step to identify a subset of high priority interactions [2]. The risk elements included in the Council's initial assessment spanned biological, ecological, social and economic issues (Table 1) and risk criteria for the assessment were based on a range of indicators and expert knowledge (Table 2).

This document updates the Mid-Atlantic Council's initial EAFM risk assessment with indicators from the 2020 State of the Ecosystem report and with new analyses by Council Staff for the Management elements. The risk assessment was designed to help the Council decide where to focus limited resources to address ecosystem considerations by first clarifying priorities. Overall, the purpose of the EAFM risk assessment is to 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.

Many risk rankings are unchanged based on the updated indicators for 2020 and the Council's risk criteria. Below, we highlight only the elements where updated information has changed the perception of risk. In addition, we present new indicators based on Council feedback on the original risk analysis that the Council may wish to include in future updates to the EAFM risk assessment.

[1] http://www.mafmc.org/s/EAFM_Guidance-Doc_2017-02-07.pdf
[2] http://www.mafmc.org/s/EAFM-Doc-Revised-2019-02-08.pdf

Table 1: Risk Elements, Definitions, and Indicators Used

Element	Definition	Indicator
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		
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

Table 2: Risk Ranking Criteria used for each Risk Element

Element	Low	Low-Moderate	Moderate-High	High
Assessment performance	Assessment model(s) passed peer review, high data quality	Assessment passed peer review but some key data and/or reference points may be lacking	*This category not used*	Assessment failed peer review or no assessment, data-limited tools applied
F status	F < Fmsy	Unknown, but weight of evidence indicates low overfishing risk	Unknown status	F > Fmsy
B status	B > Bmsy	Bmsy > B > 0.5 Bmsy, or unknown, but weight of evidence indicates low risk	Unknown status	B < 0.5 Bmsy
Food web (MAFMC Predator)	Few interactions as predators of other MAFMC managed species, or predator of other managed species in aggregate but below 50% of diet	*This category not used*	*This category not used*	Managed species highly dependent on other MAFMC managed species as prey
Food web (MAFMC Prey)	Few interactions as prey of other MAFMC managed species, or prey of other managed species but below 50% of diet	Important prey with management consideration of interaction	*This category not used*	Managed species is sole prey and/or subject to high mortality due to other MAFMC managed species
Food web (Protected Species Prey)	Few interactions with any protected species	Important prey of 1-2 protected species, or important prey of 3 or more protected species with management consideration of interaction	Important prey of 3 or more protected species	Managed species is sole prey for a protected species
Ecosystem productivity	No trends in ecosystem productivity	Trend in ecosystem productivity (1-2 measures, increase or decrease)	Trend in ecosystem productivity (3+ measures, increase or decrease)	Decreasing trend in ecosystem productivity, all measures
Climate	Low climate vulnerability ranking	Moderate climate vulnerability ranking	High climate vulnerability ranking	Very high climate vulnerability ranking
Distribution shifts	Low potential for distribution shifts	Moderate potential for distribution shifts	High potential for distribution shifts	Very high potential for distribution shifts
Estuarine habitat	Not dependent on nearshore coastal or estuarine habitat	Estuarine dependent, estuarine condition stable	Estuarine dependent, estuarine condition fair	Estuarine dependent, estuarine condition poor
Offshore habitat	No change in offshore habitat quality or quantity	Increasing variability in habitat quality or quantity	Significant long term decrease in habitat quality or quantity	Significant recent decrease in habitat quality or quantity
Commercial Revenue	No trend and low variability in revenue	Increasing or high variability in revenue	Significant long term revenue decrease	Significant recent decrease in revenue
Recreational Angler Days/Trips	No trends in angler days/trips	Increasing or high variability in angler days/trips	Significant long term decreases in angler days/trips	Significant recent decreases in angler days/trips
Commercial Fishery Resilience (Revenue Diversity)	No trend in diversity measure	Increasing or high variability in diversity measure	Significant long term downward trend in diversity measure	Significant recent downward trend in diversity measure

Table 2: Risk Ranking Criteria used for each Risk Element *(continued)*

Element	Low	Low-Moderate	Moderate-High	High
Commercial Fishery Resilience (Shoreside Support)	No trend in shoreside support businesses	Increasing or high variability in shoreside support businesses	Significant recent decrease in one measure of shoreside support businesses	Significant recent decrease in multiple measures of shoreside support businesses
Fleet Resilience	No trend in diversity measure	Increasing or high variability in diversity measure	Significant long term downward trend in diversity measure	Significant recent downward trend in diversity measure
Social-Cultural	Few (<10%) vulnerable fishery dependent communities	10-25% of fishery dependent communities with >3 high vulnerability ratings	25-50% of fishery dependent communities with >3 high vulnerability ratings	Majority (>50%) of fishery dependent communities with >3 high vulnerability ratings
Commercial	No trend or increase in seafood landings	Increasing or high variability in seafood landings	Significant long term decrease in seafood landings	Significant recent decrease in seafood landings
Recreational	No trend or increase in recreational landings	Increasing or high variability in recreational landings	Significant long term decrease in recreational landings	Significant recent decrease in recreational landings
Control	No history of overages	Small overages, but infrequent	Routine overages, but small to moderate	Routine significant overages
Interactions	No interactions with non-MAFMC managed species	Interactions with non-MAFMC managed species but infrequent, Category II fishery under MMPA; or AMs not likely triggered	AMs in non-MAFMC managed species may be triggered; or Category I fishery under MMPA (but takes less than PBR)	AMs in non-MAFMC managed species triggered; or Category I fishery under MMPA and takes above PBR
Other ocean uses	No overlap; no impact on habitat	Low-moderate overlap; minor habitat impacts but transient	Moderate-high overlap; minor habitat impacts but persistent	High overlap; other uses could seriously disrupt fishery prosecution; major permanent habitat impacts
Regulatory complexity	Simple/few regulations; rarely if ever change	Low-moderate complexity; occasional changes	Moderate-high complexity; occasional changes	High complexity; frequently changed
Discards	No significant discards	Low or episodic discard	Regular discard but managed	High discard, difficult to manage
Allocation	No recent or ongoing Council discussion about allocation	*This category not used*	*This category not used*	Recent or ongoing Council discussion about allocation

Changes from 2019

Ecological risk elements

Decreased Risk: 0

No indicators for existing ecological elements have changed enough to warrant decreased risk rankings according to the Council risk critiera.

Increased Risk: 1

Bluefish biomass (B) status has changed from low-moderate risk (Bmsy > B > 0.5Bmsy) to high risk (B < 0.5Bmsy) based on the new benchmark assessment (Table 4).

Update on Chesapeake Bay water quality

Many important MAFMC managed species use estuarine habitats as nurseries or are considered estuarine and nearshore coastal-dependent (summer flounder, scup, black sea bass, and bluefish), and interact with other important estuarine-dependent species (e.g., striped bass and menhaden). In 2019, we reported on improving water quality in Chesapeake Bay, and suggested that the Council could reconsider high risk ratings for estuarine-dependent species if this trend continues. However, the Chesapeake Bay experienced below average salinity in 2019, caused by the highest precipitation levels ever recorded for the watershed throughout 2018 and 2019. It is unclear how this will affect the overall water quality indicator (which was not updated for the 2020 report because it requires multiple years to update). The new information below suggests that high risk for estuarine-dependent species is still warranted.

Low salinity levels recorded by NOAA Chesapeake Bay Office's Chesapeake Bay Interpretive Buoy System (CBIBS) at Stingray Point showed below-average levels starting in summer 2018 and continuing through spring of 2019 (Fig. 1).

High flows during the winter and spring of Water Year (WY) 2019 came during a critical time of year when the nutrients delivered to the Bay fuel algal blooms, which can cause low dissolved oxygen in the summer. Low dissolved oxygen levels less than 2.0 mg/l (or hypoxia) are harmful to oysters, crabs and fish. The high flows, and associated nutrient loads, during WY 2019 contributed to summer dissolved-oxygen levels in the Bay that were the 3rd lowest recorded in Maryland waters, according to the Maryland Department of Natural Resources[3].

In Maryland, the Spatfall Intensity Index, a measure of oyster recruitment success and potential increase in the population, was 15.0 spat/bu, well below the 34-year median value of 39.8. Blue catfish, an invasive species in the Chesapeake, spread over the last two summers due to the lower salinity levels.

[3] https://www.usgs.gov/center-news/september-hypoxia-report

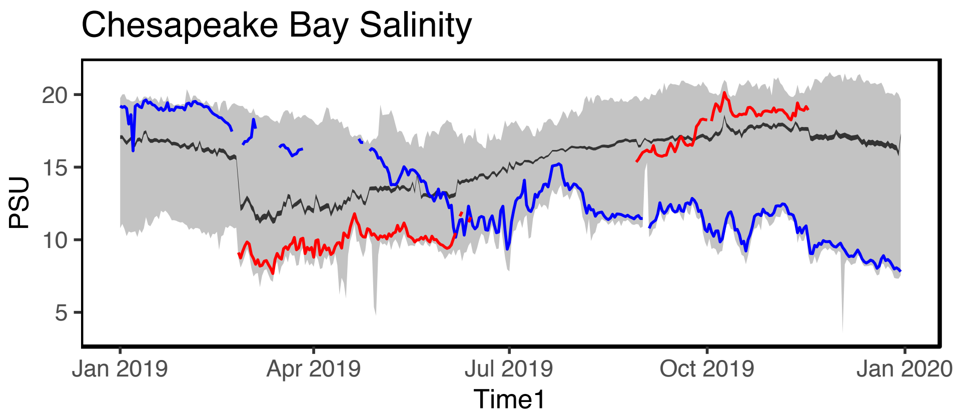

Figure 1: Salinity in Chesapeake Bay throughout 2018 (blue) and 2019 (red) as well as the daily average 2008-2019 (black) and the full observed range 2008-2019 (gray shading).

Economic, Social, and Food production risk elements

Decreased Risk: 0

No indicators for existing economic, social, and food production elements have changed enough to warrant decreased risk rankings according to the Council risk critiera.

Increased Risk: 0

No indicators for existing economic, social, and food production elements have changed enough to warrant increased risk rankings according to the Council risk critiera.

Update on recreational seafood production

Although the risk ranking for recreational seafood production remains at moderate-high based on the continued long term downward trend in this indicator, the most recent data is notable. 2018 recreational seafood landings were the lowest observed since 1982, with a 47% drop year over year (Fig. 2). This drop involved multiple species, including black sea bass, scup, spot, and bluefish, among others and though accompanied by lower recreational effort in 2018, is not fully explained by changes in effort alone. The survey methodology behind these numbers was updated in 2018, and additional years worth of data is needed to understand whether these declines are driven by changes in the precision or other statistical properties of the data.

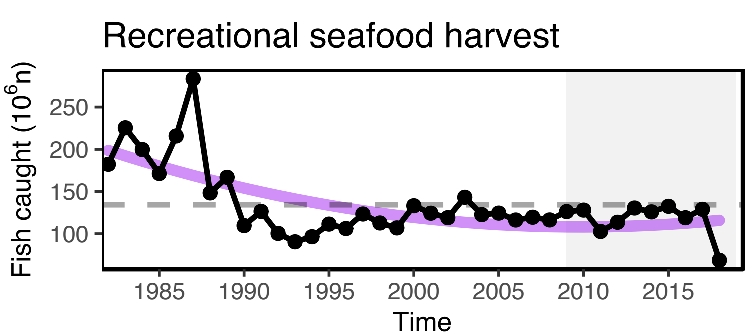

Figure 2: Total recreational seafood harvest in the Mid-Atlantic region.

Potential new indicators

Social-Cultural: Commerical Fishery Engagement

The trend in the number of Mid-Atlantic fishing communities that were highly engaged (red bar) in commercial fishing has shown a decrease since 2004 (Fig. 3). Some of the communities that were highly engaged have moved into the moderate (blue bar) or medium-high (green bar) category, and thus the number of moderately to medium-highly engaged communities have increased. Significant changes in engagement scores have also been observed in medium-highly engaged communities. The average engagement score has decreased since 2004. These changes may be driven by the decline in value landed by primary species such as sea scallops in this group of communities.

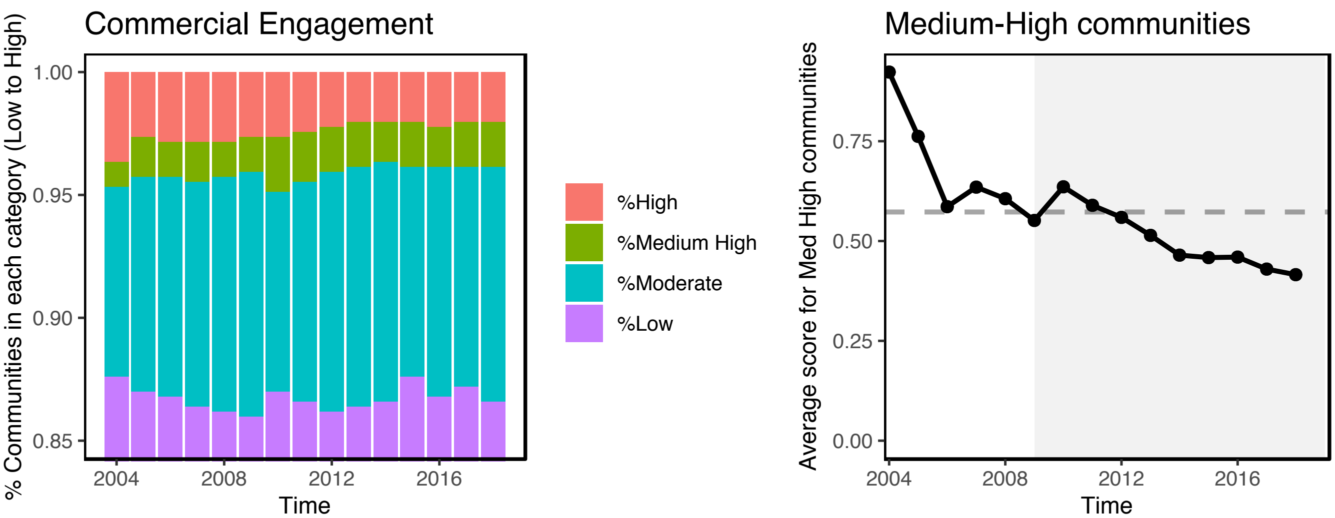

Figure 3: Commercial engagement scores (total pounds landed, value landed, commercial permits, and commercial dealers in a community) for Mid-Atlantic fishing communities, 2004-2018.

Recreational Diversity

Indicators for the diversity of recreational effort (i.e. access to recreational opportunities) by mode (party/charter boats, private boats, shore-based), and diversity of catch (NEFMC, MAFMC, SAFMC, and ASMFC managed species) show different trends. The downward effort diversity trend is driven by party/charter contraction (from a high of 24% of angler trips to 7% currently), with a shift towards shorebased angling. Effort in private boats remained stable between 36-37% of angler trips across the entire series. The long-term decrease in species catch diversity in the Mid-Atlantic states reported last year resulted from aggregation of SAFMC and ASMFC managed species into a single group. With SAFMC and ASMFC species considered individually, there is no long term trend in recreational catch diversity. This implies that recent increases in catch of SAFMC and/or ASMFC managed species is helping to maintain diversity in the same range that MAFMC and NEFMC species supported in the 1990s (Fig. 4).

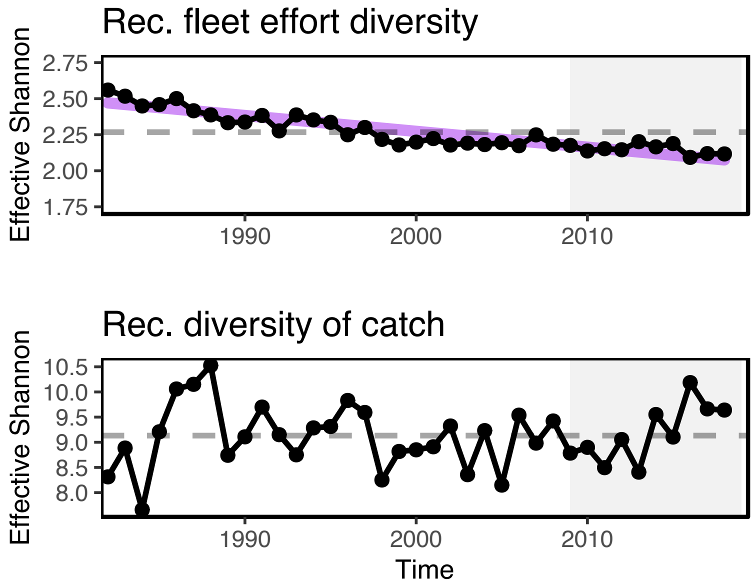

Figure 4: Recreational effort diversity and diversity of recreational catch in the Mid-Atlantic.

We seek Council feedback on whether to include commericial engagement and recreational diversity as an indicators for the EAFM risk assessment, and if so, what risk criteria should be applied to these indicators.

Management risk elements

Management risk elements have not been updated since the original risk assessment was conducted in 2017. Management risk elements contain a mixture of quantitatively (Fishing Mortality Control, Technical Interactions, Discards, and Allocation) and qualitatively (Other Ocean Uses and Regulatory Complexity) calculated rankings. The updated management risk element rankings were conducted by the Council staff lead for a particular species (Table 6).

New rankings for chub mackerel and unmanaged forage

In 2019, the Council approved adding chub mackerel to the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan; therefore, an evaluation of chub mackerel management risk has been included for the first time. The rankings for chub mackerel can be found in Table 6 and the justification for each ranking is provided below:

- **Management Control:** first annual landings limit implemented September 2017 and has not been exceeded. Proposed ABC expected to be implemented in 2020 and would represent a liberalization compared to measures implemented in 2017.
- **Technical Interactions:** some marine mammal interactions.
- **Other Ocean Use:** potential loss of access, particularly for mobile gear, due to offshore energy development (wind, gas, oil) in some fishing areas but most fishing far offshore.
- **Regulatory Stability:** simpler regulations than some other species (e.g., commercial possession limit only after ACL is close to being exceeded, no minimum fish size limit, no gear restrictions, no recreational management measures except for permit requirement). Management measures first implemented in 2017, will be revised in 2020.
- **Discards:** the first ABC and ACL are expected to be implemented in 2020 and are not expected to be exceeded based on recent trends in the fisheries. Discards generally make up 6% or less of total catch.
- **Allocation:** the stock is not allocated and there are currently no allocation concerns.

When the first risk assessment was completed in 2017, regulations pertaining to unmanaged forage were just implemented and therefore no rankings were provided for the various management risk elements. Rankings for unmanaged forage species are included for the first time (Table 6) and the justification for each ranking is provided below:

- **Management Control:** no stock assessments or ABCs. Only restriction on catch is a possession limit which was first implemented in Sept 2017. Dealer data for 2018-2019 show no trips exceeding that possession limit.
- **Technical Interactions:** forage ecosystem component (EC) species are not managed with OY and they largely do not have notable directed fisheries; therefore, although interactions with other fishery regulations are possible, these interactions likely have minimal impacts.
- **Other Ocean Use:** potential loss or degradation of habitat due to a variety of other uses, especially in nearshore areas used by many forage species.
- **Regulatory Stability:** only regulations are permit and reporting requirement, possession limit, and transit provisions. First implemented in September 2017 and have remained unchanged.
- **Discards:** forage EC species are not managed with ACLs; therefore, discards do not cause closures or trigger AMs. Targeting of these forage species is small-scale.
- **Allocation**: stocks are not allocated and there are currently no allocation concerns.

Decreased Risk: 5

Summer flounder recreational regulatory complexity risk dropped slightly moving from high to medium-high risk. Frequent changes in size, season and possession limits, significant differences between some states remain, but regulatory stability and year to year consistency has improved somewhat since 2014.

Technical interaction risk within the commercial scup fishery decreased from medium-high to low-medium. No accountability measures (AMs) have been triggered due to other fisheries and the commercial scup fishery is considered a category II fishery.

The recreational Atlantic mackerel allocation risk decreased from high to low. There have been no recent Council discussions regarding potential changes to the recreational Atlantic mackerel allocation and the Council recently changed to a simple deduction of expected recreational catch instead of a set recreational allocation.

The longfin squid allocation risk deceased from high to low. There were some allocation discussions during the development and completion of Amendment 20 in 2018, but the Council is currently not considering any allocation changes.

The commercial spiny dogfish allocation risk dropped from high to low. There are no current discussions to modify the commercial allocation and the ASMFC recently completed an action that has added flexibility to transfer regional quotas and match annual variability and reduced the need for allocation changes.

Increased Risk: 14

Discards in the ocean quahog and surfclam fisheries moved from low risk to medium-high risk. While the ocean quahog and surfclam fisheries are allocated minimal coverage under SBRM as a result of discards comprising a low percent of total catch, the comingling of surfclams and quahogs (trips can not be mixed) has resulted in increased discarding of one species is occurring frequently enough to be raised as a concern.

Commercial summer flounder discard risk increased from medium-high to high. Dead discards as a percentage of commercial catch have increased slightly in recent years due to lower quotas and caused ACLs to be exceeded in some years. Discards can be difficult to control given various reasons for discarding, and some uncertainty and variability in discard estimates remain.

The risk to recreational scup management control increased slightly from low to low-moderate. Recreational scup ACL and RHL underages each year since 2011; however, in 2017 the ACL was exceeded by 1% due to recreational discards.

Recreational and commercial scup allocation risk element changed from low to high. In 2019, the Council and ASMFC initiated an amendment to consider changes to the current 78% commercial/22% recreational split of the total allowable catch.

Risks from other ocean uses to the commercial scup fishery increased from low-medium to medium-high due to the potential for habitat impacts and the loss of access from offshore energy development.

Recreational black sea bass discard risk increased from medium-high to high. There is a high recreational discard rate and ACL overages have occurred for at least the past 4 years due to higher discards than assumed during specifications setting process (considering pre-calibration MRIP estimates).

The risk to commercial black sea bass management control rose appreciably from low-medium to high. Commercial landings are generally very close to quota, but the ACL has been exceeded every year from 2015 to 2018 (likely during earlier years as well) due to higher discards than assumed during specifications setting.

These ACL overages due to higher than projected discards resulted in greater risk from commercial black sea bass discards, with the ranking changing from low-medium to high.

The risk to recreational Atlantic mackerel management control increased slightly from low to low-medium. There have been no ACL overages last 5 years using the appropriate MRIP data and the current recreational measures in place should avoid overages generally. However, the recreational sector has been exceeding its assumed harvest, but the commercial management uncertainty buffer has accommodated these overages.

The risk to shortfin squid (*Illex*) management control increased slightly from low to low-medium. There are no ACL's for this fishery; however, there was a 5% ABC overage in 2018. The current management measures that are in place should generally avoid overages.

Illex allocation risk changed from low to high. The Council is currently considering modifications to the *Illex* permitting system which may have allocation implications amongst participants in the fishery.

The recreational bluefish regulatory complexity risk increased slightly from low to low-medium. Regulations recently changed to ensure the reduced RHL is not exceeded as result of the newly determined overfished status. As the rebuilding plan is implemented, future regulatory changes may also be needed.

Potential new indicators

Other ocean uses: Fish habitat overlap with offshore wind lease areas

Habitat modeling [3] indicates that summer flounder, butterfish, longfin squid, and spiny dogfish are among fish species highly likely to occupy wind energy lease areas (Fig. 5). Habitat conditions for many of these species have become more favorable over time within wind lease areas (increasing trend in probability of occupancy). Table 3 lists the top 5 species in each season most likely to occupy the wind lease areas in the northern, central, and southern portions of the MAB, along with observed trends in probability of occupancy.

Table 3: Species with highest probability of occupancy species each season and area, with observed trends

	Existing - North		Proposed - North		Existing - Mid		Proposed - Mid		Existing - South	
Season	Species	Trend	Species	Trend	Species	Trend	Species	Trend	Species	Trend
Spring	Little Skate	↗	Atlantic Herring		Little Skate	↗	Spiny Dogfish	↗	Spiny Dogfish	↗
Spring	Atlantic Herring	↘	Little Skate	↗	Atlantic Herring	↘	Atlantic Herring	↘	Longfin Squid	↗
Spring	Windowpane	↗	Longhorn Sculpin	↗	Spiny Dogfish	↗	Little Skate	↗	Summer Flounder	↗
Spring	Winter Skate	↗	Windowpane	↗	Windowpane	↗	Alewife	↘	Clearnose Skate	↗
Spring	Longhorn Sculpin	↗	Alewife	↘	Winter Skate	↗	Silver Hake	↗	Spotted Hake	↗
Fall	Butterfish	↗	Butterfish	↗	Summer Flounder	↗	Longhorn Sculpin	↗	Longfin Squid	↘
Fall	Longfin Squid	↗	Fourspot Flounder		Longfin Squid	↗	Little Skate	↗	Northern Searobin	↗
Fall	Summer Flounder	↗	Longhorn Sculpin	↘	Butterfish	↗	Butterfish	↗	Clearnose Skate	↗
Fall	Winter Flounder	↘	Summer Flounder	↗	Smooth Dogfish	↗	Sea Scallop	↗	Butterfish	↗
Fall	Spiny Dogfish	↘	Spiny Dogfish	↘	Windowpane	↗	Fourspot Flounder	↗	Spiny Dogfish/Spotted Hake	↗

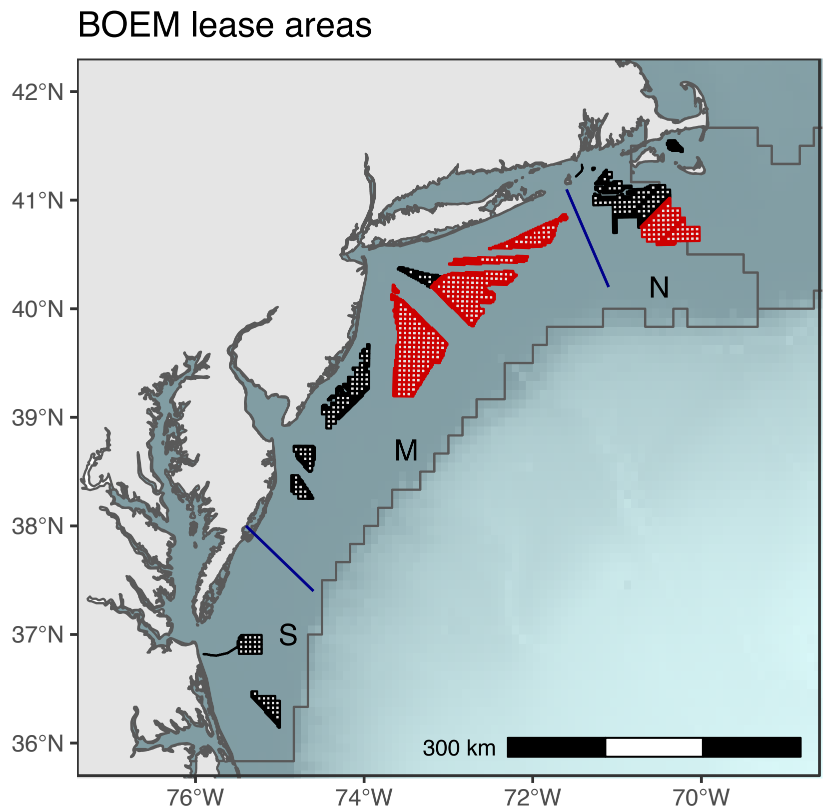

Figure 5: Map of BOEM existing (black) and proposed (red) lease areas as of February 2019.

We seek Council feedback on whether to include information on probability of occupancy in wind lease areas as an indicators for the EAFM risk assessment, and if so, what specific indicators would be most useful and what risk criteria should be applied to these indicators.

Table 4: Species level risk analysis results; l=low risk (green), lm= low-moderate risk (yellow), mh=moderate to high risk (orange), h=high risk (red)

Species	Assess	Fstatus	Bstatus	FW1Pred	FW1Prey	FW2Prey	Climate	DistShift	EstHabitat
Ocean Quahog	l	l	l	l	l	l	h	mh	l
Surfclam	l	l	l	l	l	l	mh	mh	l
Summer flounder	l	l	lm	l	l	l	lm	mh	h
Scup	l	l	l	l	l	l	lm	mh	h
Black sea bass	l	l	l	l	l	l	mh	mh	h
Atl. mackerel	l	h	h	l	l	l	lm	mh	l
Butterfish	l	l	l	l	l	l	l	h	l
Longfin squid	lm	lm	lm	l	l	lm	l	mh	l
Shortfin squid	lm	lm	lm	l	l	lm	l	h	l
Golden tilefish	l	l	lm	l	l	l	mh	l	l
Blueline tilefish	h	h	mh	l	l	l	mh	l	l
Bluefish	l	l	h	l	l	l	l	mh	h
Spiny dogfish	lm	l	lm	l	l	l	l	h	l
Monkfish	h	lm	lm	l	l	l	l	mh	l
Unmanaged forage	na	na	na	l	lm	lm	na	na	na
Deepsea corals	na	na	na	l	l	l	na	na	na

Table 5: Ecosystem level risk analysis results; l=low risk (green), lm= low-moderate risk (yellow), mh=moderate to high risk (orange), h=high risk (red)

System	EcoProd	CommRev	RecVal	FishRes1	FishRes4	FleetDiv	Social	ComFood	RecFood
Mid-Atlantic	lm	mh	h	l	mh	l	lm	h	mh

Table 6: Species and sector level risk analysis results; l=low risk (green), lm= low-moderate risk (yellow), mh=moderate to high risk (orange), h=high risk (red)

Species	MgtControl	TecInteract	OceanUse	RegComplex	Discards	Allocation
Ocean Quahog-C	l	l	lm	l	mh	l
Surfclam-C	l	l	lm	l	mh	l
Summer flounder-R	mh	l	lm	mh	h	h
Summer flounder-C	lm	mh	lm	mh	mh	h
Scup-R	lm	l	lm	mh	mh	h
Scup-C	l	lm	mh	mh	mh	h
Black sea bass-R	h	l	mh	h	h	h
Black sea bass-C	h	lm	h	mh	h	h
Atl. mackerel-R	lm	l	l	l	l	lm
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	lm
Shortfin squid-C	lm	lm	lm	lm	l	h
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	lm	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	mh
Chub mackerel-C	l	lm	lm	lm	l	l
Unmanaged forage	l	l	mh	l	l	l
Deepsea corals	na	na	mh	na	na	na

References

1. Gaichas S, Seagraves R, Coakley J, DePiper G, Guida V, Hare J, et al. A Framework for Incorporating Species, Fleet, Habitat, and Climate Interactions into Fishery Management. Frontiers in Marine Science. 2016;3. doi:10.3389/fmars.2016.00105

2. Holsman K, Samhouri J, Cook G, Hazen E, Olsen E, Dillard M, et al. An ecosystem-based approach to marine risk assessment. Ecosystem Health and Sustainability. 2017;3: e01256. doi:10.1002/ehs2.1256

3. Friedland KD, Langan JA, Large SI, Selden RL, Link JS, Watson RA, et al. Changes in higher trophic level productivity, diversity and niche space in a rapidly warming continental shelf ecosystem. Science of The Total Environment. 2020;704: 135270. doi:10.1016/j.scitotenv.2019.135270