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 [3] with indicators from the 2021 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 2021 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 2020: 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

Butterfish biomass (B) status has changed from low risk (B > Bmsy) to low-moderate risk (Bmsy > B > 0.5Bmsy) based on the new benchmark assessment (Table 3).

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, as reported in the 2020 SOE, the Chesapeake Bay experienced below average salinity in 2019, caused by the highest precipitation levels ever recorded for the watershed throughout 2018 and 2019.

In 2020, Chesapeake Bay experienced a warmer than average winter, followed by a cooler than average spring, with potential impacts to striped bass and blue crabs as noted in the 2021 SOE. Observations from the NOAA CBIBS buoys indicated higher-than-average salinity throughout 2020, particularly in the upper Chesapeake Bay (Gooses Reef), suggesting that the region experienced less precipitation than usual.

A dissolved oxygen model operated by the Virginia Institute of Marine Science (VIMS) and Anchor QEA (www.vims.edu/hypoxia) estimated that the overall severity and duration of hypoxia in the Chesapeake Bay was lower and shorter in 2020 compared to most recent years. A smaller-than-average spring freshet, which resulted in above-average salinity in the Bay, also might have decreased surface runoff and nutrient concentrations. Reduced nutrient inputs and cool spring temperatures likely contributed to reduced hypoxia in 2020. Information on submerged aquatic vegetation (SAV) collected in 2020 has not yet been processed, but may be included in upcoming SOE reports.

It is unclear how these annual updates in Chesapeake Bay temperature, salinity, dissolved oxygen, and SAV will affect the overall water quality indicator (which was not updated for the 2020 or 2021 report because it requires multiple years to update). The new information below suggests that high risk for estuarine-dependent species is still warranted. However, direct links between estuarine habitat conditions and population attributes for managed species (as reported for Chesapeake Bay striped bass and blue crabs) could be incorporated into future risk assessments as the science continues to develop.

Update on Climate risks

New information has been added to the SOE that could be used to update species-specific Climate risk rankings in the future. Risks to species productivity (and therefore to achieving OY) due to projected climate change in the Northeast US were evaluated in a comprehensive assessment [4]. 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.

Mid-Atlantic 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.

The 2021 SOE includes multiple climate indicators including surface and bottom water temperature, marine heat waves, cold pool area, and new information on ocean acidification measurements. Combined with species sensitivity information from lab work, these indicators could be used to further clarify climate risks to managed species.

For example, new glider-based observations revealed areas of low pH (7.8) during summer in Mid-Atlantic habitats occupied by Atlantic surfclams and sea scallops (Fig. 1) [5]. This seasonal pH minimum is associated with cold-pool subsurface and bottom water, which is cut off from mixing with surface water by strong stratification. However, seawater pH in shelf waters increased during the fall mixing period due to the influence of a slope water mass characterized by warm, salty, highly alkaline seawater. Lower pH in nearshore waters is likely associated with freshwater input.

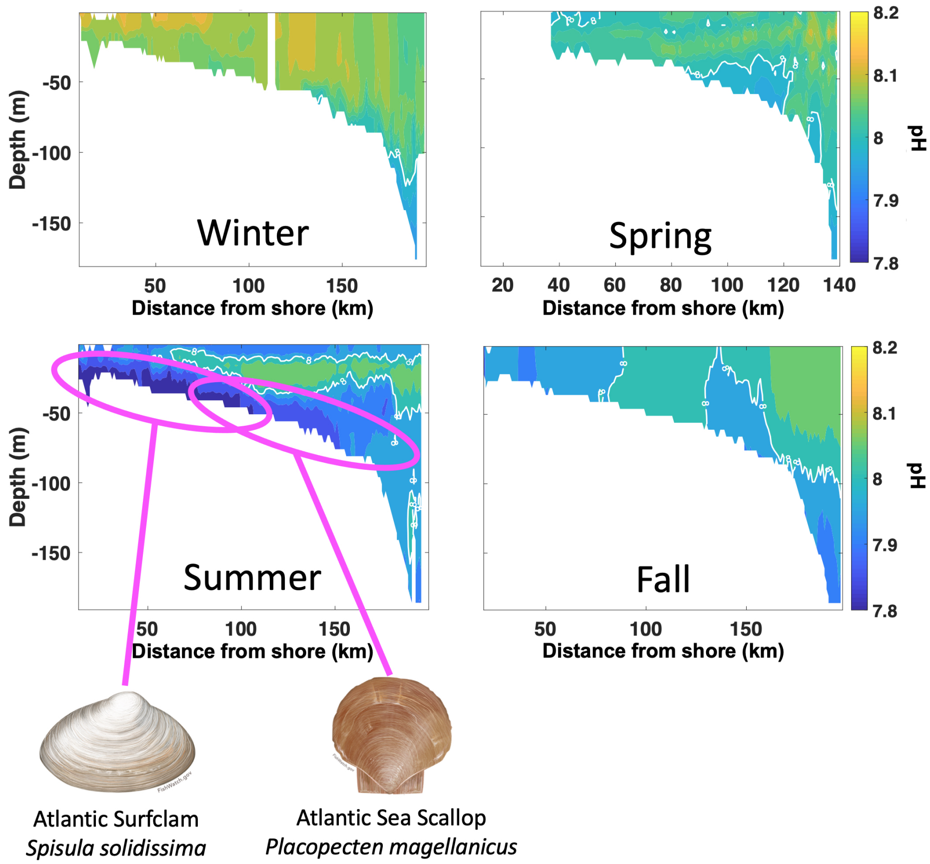

Figure 1: Seasonal glider-based pH observations on the Mid-Atlantic Bight shelf (New Jersey cross-shelf transect) in relation to Atlantic surfclam and Atlantic sea scallop habitats (modified from Wright-Fairbanks et al. 2020).

Surclams were ranked high vulnerability in the Northeast Fish and Shellfish Climate Vulnerability Assessment (FCVA) completed in 2016 [4], therefore they rank moderate-high risk for the Climate element of the MAFMC EAFM risk assessment. Surfclam climate vulnerability was based on both sensitivity and exposure to ocean acidificaiton, exposure to ocean warming, and low adult mobility. Recent lab studies have found that surfclams exhibited metabolic depression in a pH range of 7.46-7.28 [6]. At pH of 7.51, short term experiments indicated that surfclams were selecting particles differently, which may have long term implications for growth [6]. Computer models would help in determining the long term implications of growth on surfclam populations. Data from about one year of observations (2018-2019) show that seasonal ocean pH has not yet reached the metabolic depression threshold observed for surfclams in lab studies so far; however, thresholds at different life stages, specifically larval stages that are typically more vulnerable to ocean acidification, have not yet been determined. Monitoring pH in surfclam habitats could be used to assess Climate risk in the future.

Potential new indicators

Habitat Climate Vulnerability

A Habitat Climate Vulnerability Assessment (HCVA; [7]) for habitat types in the Northeast US Large Marine Ecosystem was completed in 2020. To better understand which species depend on vulnerable habitats, the Atlantic Coastal Fish Habitat Partnership (ACFHP) habitat-species matrix [8] was used in conjunction with the results of the HCVA and the Northeast Fish and Shellfish Climate Vulnerability Assessment (FCVA) completed in 2016 [4]. The ACFHP matrix identified the importance of nearshore benthic habitats to each life stage of select fish species, which helps elucidate species that may be highly dependent on highly vulnerable habitats that were identified in the HCVA.

Several MAFMC managed species, including black sea bass, scup, and summer flounder, are dependent on several highly vulnerable nearshore habitats from salt marsh through shallow estuarine and marine reefs. Details on highly vulnerable habitats with linkages to a variety of species, including which life stages have different levels of dependence on a particular habitat, are available in a detailed table.[3]

Species highlighted here are those that are highly dependent on highly vulnerable habitats. A ranking matrix was created using the habitat vulnerability rankings compared to the habitat importance rankings to determine the criteria, and for the purposes of this submission, “high dependence on a highly vulnerable habitat” encompasses moderate use of very highly vulnerable habitats, high use of highly or very highly vulnerable habitats, or very high use of moderately, highly, or very highly vulnerable habitats.

Preliminary species narratives have been developed by Grace Roskar and Emily Farr (NMFS Office of Habitat Conservation), using information from the entire team that worked on the HCVA. We include two here so that the Council may provide feedback to improve their utility for management in general and for potentail future inclusion in the EAFM risk assessment.

Black Sea Bass *Summary:* Black sea bass have a high vulnerability to climate change, due to very high exposure related to surface and air temperature in both inshore and offshore waters, and moderate sensitivity of early life history requirements. Climate change is predicted to have a positive effect on black sea bass, due to warmer temperatures increasing spawning and therefore recruitment, and distribution of the species shifting farther north [4].

The habitats important to black sea bass, such as shellfish reefs, submerged aquatic vegetation, and subtidal rocky bottom habitats, are vulnerable to projected changes in sea surface temperature. Additionally, intertidal habitats such as shellfish reefs are also vulnerable to projected changes in air temperatures and sea level rise. Habitat condition and habitat fragmentation were also of concern for shellfish reefs and submerged aquatic vegetation. The species itself is also vulnerable to temperature changes, as mentioned above. The overlapping high importance of intertidal and subtidal shellfish reefs to black sea bass and the very high to high climate vulnerability of these habitats, respectively, show a potential critical nexus of climate vulnerability.

Mid-Atlantic *Summary:* Shellfish reef habitats are highly important for both juveniles/young-of-the-year and adults. These life stages utilize both marine and estuarine shellfish reefs, in both intertidal and subtidal zones, which are very highly vulnerable and highly vulnerable, respectively. Other important habitats for black sea bass include submerged aquatic vegetation, which is highly vulnerable, and subtidal sand and rocky bottom habitats, which have low vulnerability. More information is needed on use of intertidal benthic habitats by black sea bass. Juvenile occurrence on sandy intertidal flats or beaches is rare, according to [9], but additional information on the use and importance of intertidal rocky bottom or intertidal benthic habitat use by adults is lacking. According to [9], black sea bass eggs have been collected in the water column over the continental shelf, as has larvae. As water column habitats were not included in ACFHP’s assessment of habitat importance, finer-scale information on the importance of specific pelagic habitats is needed for the species.

Habitat importance by life stage:

- Juveniles/Young-of-the-year:

[3] https://noaa-edab.github.io/ecodata/Hab_table

  - Marine and estuarine intertidal shellfish reefs, which are very highly vulnerable to climate change, are of high importance.
  - Marine and estuarine submerged aquatic vegetation and subtidal shellfish reefs, which are highly vulnerable to climate change, are of high importance.
  - Marine intertidal rocky bottom habitats, which are highly vulnerable to climate change, are of high importance.
  - Marine (<200 m) and estuarine subtidal rocky bottom habitats, which have a low vulnerability to climate change, are also of high importance.
- Adults:
  - Marine and estuarine intertidal shellfish reefs, which are very highly vulnerable to climate change, are of high importance.
  - Marine and estuarine subtidal shellfish reefs, which are highly vulnerable to climate change, are of high importance.
  - Marine intertidal rocky bottom habitats, which are highly vulnerable to climate change, are of high importance.
  - Marine and estuarine submerged aquatic vegetation, which are highly vulnerable to climate change, are of moderate importance.
  - Marine (<200 m) and estuarine subtidal rocky bottom habitats, which have a low vulnerability to climate change, are also of high importance.
  - Marine (<200 m) and estuarine subtidal sand habitats, including sandy-shelly areas, which have a low vulnerability to climate change, are also of moderate importance.

New England *Summary:* All habitats in New England for black sea bass were ranked as moderately important, likely indicating that the species uses a diverse range of habitats rather than high dependence on a specific habitat type. Shellfish reef habitats are moderately important for both juveniles/young-of-the-year and adults. These life stages utilize both marine and estuarine shellfish reefs, in both intertidal and subtidal zones, which are very highly vulnerable and highly vulnerable, respectively. Juveniles/young-of-the-year are also moderately dependent on native salt marsh habitats, which are highly vulnerable to climate change. Other moderately important habitats for black sea bass include submerged aquatic vegetation, which is highly vulnerable, and subtidal sand and rocky bottom habitats, which have low vulnerability. More information is needed on use of intertidal benthic habitats by black sea bass. Juvenile occurrence on sandy intertidal flats or beaches is rare, according to [9], but additional information on the use and importance of intertidal rocky bottom or intertidal benthic habitat use by adults is lacking.

Habitat importance by life stage:

- Juveniles/Young-of-the-year:
  - Marine and estuarine submerged aquatic vegetation and subtidal shellfish reefs, which are all highly vulnerable to climate change, are of moderate importance.
  - Marine and estuarine intertidal shellfish reefs, which are very highly vulnerable to climate change, are of moderate importance.
  - Native salt marshes, which are very highly vulnerable to climate change, are of moderate importance. Marine (<200 m) and estuarine subtidal rocky bottom habitats, which have a low vulnerability to climate change, are of moderate importance.
- Adults:
  - Marine and estuarine submerged aquatic vegetation and subtidal shellfish reefs, which are all highly

vulnerable to climate change, are of moderate importance.

- Marine and estuarine intertidal shellfish reefs, which are very highly vulnerable to climate change, are of moderate importance.

- Marine (<200 m) and estuarine subtidal rocky bottom habitats, which have a low vulnerability to climate change, are of moderate importance.

- Structured sand habitats in marine (<200 m) and estuarine subtidal areas, which have a low vulnerability to climate change, and marine intertidal areas, which are highly vulnerable, are of moderate importance.

Summer Flounder *Summary:* Summer flounder were ranked moderately vulnerable to climate change due to very high exposure to both ocean surface and air temperature, but low sensitivity to all examined attributes. Broad dispersal of eggs and larvae and seasonal north-south migrations by adults lend the species a high potential for distribution shifts. However, climate change is expected to have a neutral effect on the species, although there is high uncertainty surrounding this. The dispersal of eggs and larvae and the broad use of both estuarine and marine habitats could result in climate change having a positive effect, but uncertainty remains [4].

The habitats important to summer flounder, such as intertidal benthic habitats, submerged aquatic vegetation, and native salt marsh habitats, are vulnerable to projected changes in temperature as well as sea level rise. Subtidal benthic habitats are vulnerable to changes in sea surface temperature. The species itself is also vulnerable to such factors, as they are exposed to changes in conditions in both inshore and offshore habitats. The overlapping high importance of native salt marsh and submerged aquatic vegetation habitats to the species and the very high and high climate vulnerability of these habitats, respectively, show a potential critical nexus of climate vulnerability.

Mid-Atlantic *Summary:* Marine and estuarine sand and mud habitats are highly important to juvenile and adult summer flounder, and these habitats range in their vulnerability to climate change. For example, marine intertidal sand is highly vulnerable, whereas subtidal mud and sand habitats have low vulnerability. In addition to these fine bottom benthic habitats, native salt marshes are highly important to juveniles and moderately important to adults, yet these habitats are very highly vulnerable to climate change. Eggs and larvae utilize pelagic continental shelf habitats; however, water column habitats were not included in ACFHP's assessment of habitat importance. Finer-scale information on the importance of specific pelagic habitats is needed for the species.

Habitat importance by life stage:

- Juveniles/Young-of-the-year:
  - Marine and estuarine intertidal shellfish reefs, which are very highly vulnerable to climate change, are of moderate importance.
  - Marine and estuarine subtidal shellfish reefs, which are highly vulnerable to climate change, are of moderate importance.
  - Marine and estuarine submerged aquatic vegetation, which are highly vulnerable habitats, are of high importance.
  - Native salt marsh habitats, which are very highly vulnerable to climate change, are of high importance.
  - Marine and estuarine subtidal and intertidal sand and mud bottom habitats are of high importance. These habitats range in climate vulnerability, from high vulnerability of marine intertidal sand to low vulnerability of marine subtidal sand and mud (<200 m) and estuarine subtidal sand.
- Adults:
  - Marine and estuarine submerged aquatic vegetation, which are highly vulnerable habitats, are of moderate importance.

  - Native salt marsh habitats, which are very highly vulnerable to climate change, are of moderate importance.
  - Marine and estuarine subtidal and intertidal sand and mud bottom habitats are of high importance. These habitats range in climate vulnerability, from high vulnerability of marine intertidal sand to low vulnerability of marine subtidal sand and mud (<200 m) and estuarine subtidal sand.
- Spawning Adults:
  - Marine subtidal (<200 m) sand habitats, which have a low vulnerability to climate change, are of high importance.

We seek Council feedback on how best to include information on habitat climate vulnerability for managed species in future EAFM risk assessments.

Changes from 2020: 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.

Potential new indicators

Social vulnerability in commercial and recreational fishing communities

Social vulnerability measures social factors that shape a community's ability to adapt to change and does not consider gentrification pressure (see detailed definitions). Communities that ranked medium-high or above for one or more of the following indicators: poverty, population composition, personal disruption, or labor force structure, are highlighted in red.

Commercial fishery engagement measures the number of permits, dealers, and landings in a community, while reliance expresses these numbers based on the level of fishing activity relative to the total population of a community. In 2020, we reported that the number of highly engaged Mid-Atlantic commercial fishing communities had declined over time, and engagement scores had also declined in medium-highly engaged communities. Here we focus on the top ten most engaged, and top ten most reliant commercial fishing communities and their associated social vulnerability (Fig. 2). Barnegat Light and Cape May, NJ, and Reedville, VA are highly engaged and reliant with medium-high to high social vulnerability.

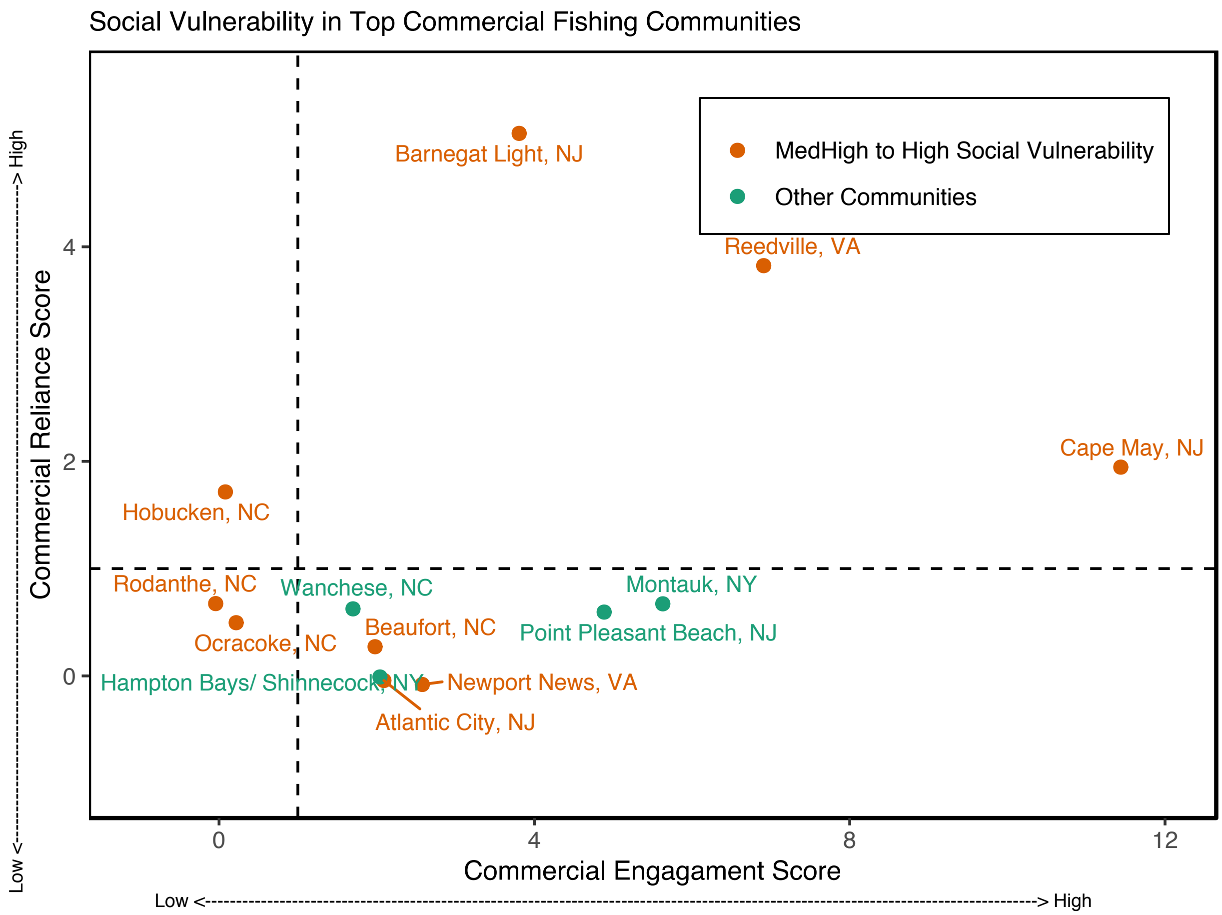

Figure 2: Commercial engagement, reliance, and social vulnerability for the top commercial fishing communities in the Mid-Atlantic.

Recreational fishery engagement measures shore, private vessel, and for-hire fishing activity while reliance expresses these numbers based on fishing effort relative to the population of a community. Of the nine recreational communities that are most engaged and reliant, Avon, Ocracoke and Hatteras, NC and Barnegat Light and Cape May, NJ scored medium-high or above for social vulnerability (Fig. 3).

Both commercial and recreational fishing are important activities in Montauk, NY; Barnegat Light, Cape May, and Point Pleasant Beach, NJ; and Ocracoke and Rodanthe, NC, meaning some of these communities may be impacted simultaneously by commercial and recreational regulatory changes. Of these communities, three scored medium-high or above for social vulnerability.

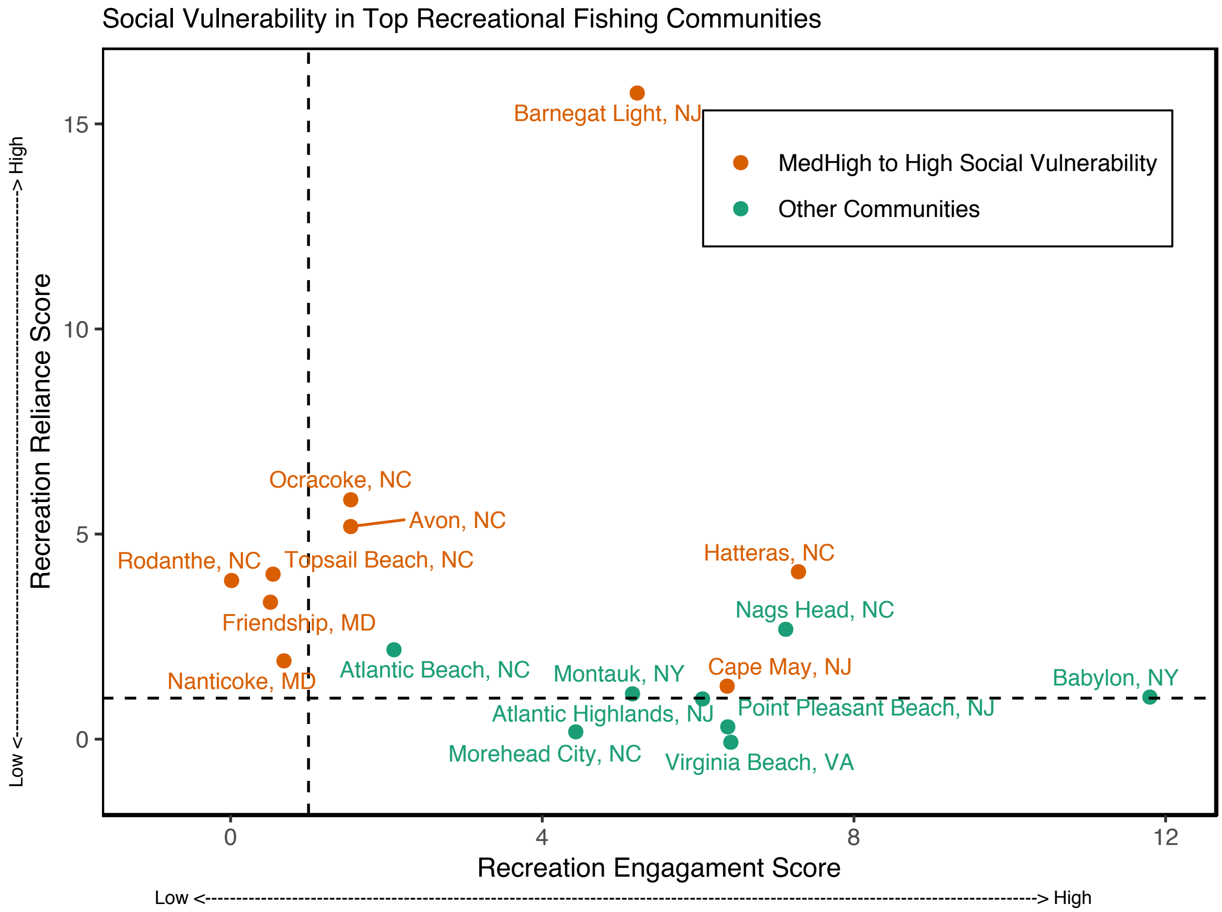

Figure 3: Recreational engagement, reliance, and social vulnerability for the top recreational fishing communities in the Mid-Atlantic.

These plots provide a snapshot of the relationship between social vulnerability and the most highly engaged and most highly reliant commercial and recreational fishing communities in the Mid-Atlantic. Similar plots are used to inform the annual California Current Ecosystem Status Report. These communities may be vulnerable to changes in fishing patterns due to regulations and/or climate change. When any of these communities are also experiencing social vulnerability, they may have lower ability to successfully respond to change. These indicators may also point to communities that are vulnerable to environmental justice issues. Additional analysis related to ecosystem shifts and National Standard 8 of the Magnuson-Stevens Act is ongoing.

Recreational Fleet 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) have been included in the SOE and may be useful to parallel commercial diversity metrics in the EAFM risk assessment. Recreational fleet diversity has declined over the long term (Fig. 4).

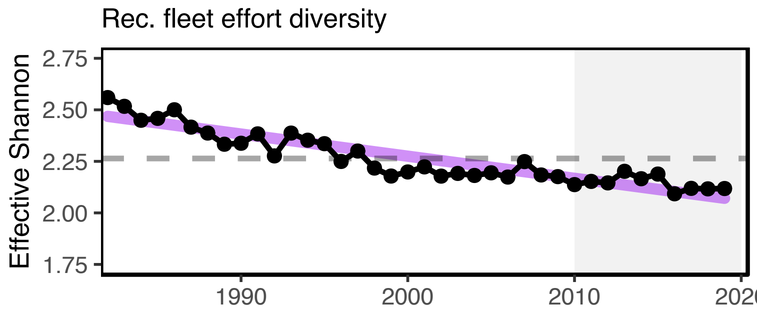

Figure 4: Recreational fleet effort diversity in the Mid-Atlantic.

The absence of a long-term trend in recreational effort suggests relative stability in the overall number of recreational opportunities in the MAB. However, the decline in recreational fleet diversity suggests a potentially reduced range of opportunities.

The downward effort diversity trend is driven by party/charter contraction (from a high of 24% of angler trips to 7% currently), and a shift toward shorebased angling. Effort in private boats remained stable between 36-37% of angler trips across the entire series.

Changes in recreational fleet diversity can be considered when managers seek options to maintain recreational opportunities. Shore anglers will have access to different species than vessel-based anglers, and when the same species, typically smaller fish. Many states have developed shore-based regulations where the minimum size is lower than in other areas and sectors to maintain opportunities in the shore angling sector.

We seek Council feedback on whether to include fishing community vulnerability and recreational diversity indicators within the EAFM risk assessment, and if so, what risk criteria should be applied to these indicators.

Changes from 2020: Management risk elements

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. In general, the management indicators evaluate a particular risk over several years; therefore, the rankings should remain fairly consistent on an annual basis unless something changed in the fishery or if a management action occurred. A comprehensive evaluation and update of all management risk elements was conducted by Council staff in 2020. In 2021, Council staff reviewed the 2020 rankings and associated justifications to determine if any significant fishery or management changes would result in a change in a risk element ranking. The updated management risk element rankings can be found in Table 5 and the justification for any ranking change can be found below.

Updated Justifications

The **Other Ocean Use** risk ranking (moderate-high) for recreational black sea bass did not change from 2020 to 2021; however, the justification for the ranking was modified to be more reflective of current considerations. The justification now states: "potential habitat impacts primarily from offshore energy (wind, gas, oil) development. Offshore wind turbine foundations may create new structured habitat (reef effect) and create new recreational fishing opportunities."

The 2020 risk assessment report included chub mackerel for the first time but was not yet a managed species within the Mackerel, Squid, and Butterfish Fishery Management Plan (FMP). Chub mackerel was formally added to the FMP in 2020 and, therefore, some of the language for the ranking justifications were updated. None of the rankings changed from 2020 (Table 5) and the revised justifications are provided below:

- **Management Control:** first annual landings limit implemented September 2017 and has not been exceeded. First ABC implemented in Sept 2020, represents a liberalization compared to previous measures.
- **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, revised in 2020.
- **Discards:** the first ABC and ACL were implemented in 2020 and were not exceeded. Discards generally make up 6% or less of total catch.
- **Allocation:** the stock is not allocated and there are currently no allocation concerns.

Decreased Risk: 5

The **Allocation** risk ranking for *Illex* squid decreased from high to low. The Council took final action on the *Illex* permitting amendment in 2020 and no additional allocation related actions are under consideration.

The **Regulatory Complexity** risk ranking for recreational black sea bass decreased from high to moderate-high. Changes to recreational management measures have become less frequent and more stable since 2018.

The **Allocation** risk rankings for longfin squid, commercial spiny dogfish, and recreational Atlantic mackerel decreased from high to low. This change corrects an error for these rankings in the 2020 risk assessment table. As per the Council risk criteria, allocation is either scored as low (no recent or ongoing Council discussion) or high (recent or ongoing Council discussion); however, the 2020 risk assessment ranked the allocation indicator for these species as either low-medium or medium-high. After reviewing the justification and rationale for allocation ranking, it was determined the low ranking was most appropriate.

Increased Risk: 0

No indicators for the management risk elements changed enough to warrant increased risk rankings according to the Council risk criteria.

Potential new indicators

Other ocean uses: Offshore wind development metrics

More than 20 offshore wind development projects are proposed for construction over the next decade in the Northeast (projects & construction timelines based on Table E-4 of South Fork Wind Farm Draft Environmental Impact Statement). Offshore wind areas may cover more than 1.7 million acres by 2030 (Fig. 5). Just over 1,900 foundations and more than 3,000 miles of inter-array and offshore export cables are proposed to date. Each proposed project has a two-year construction timeline [10]. Based on current timelines, the areas affected would be spread out such that it is unlikely that any one particular area would experience full development at one time.

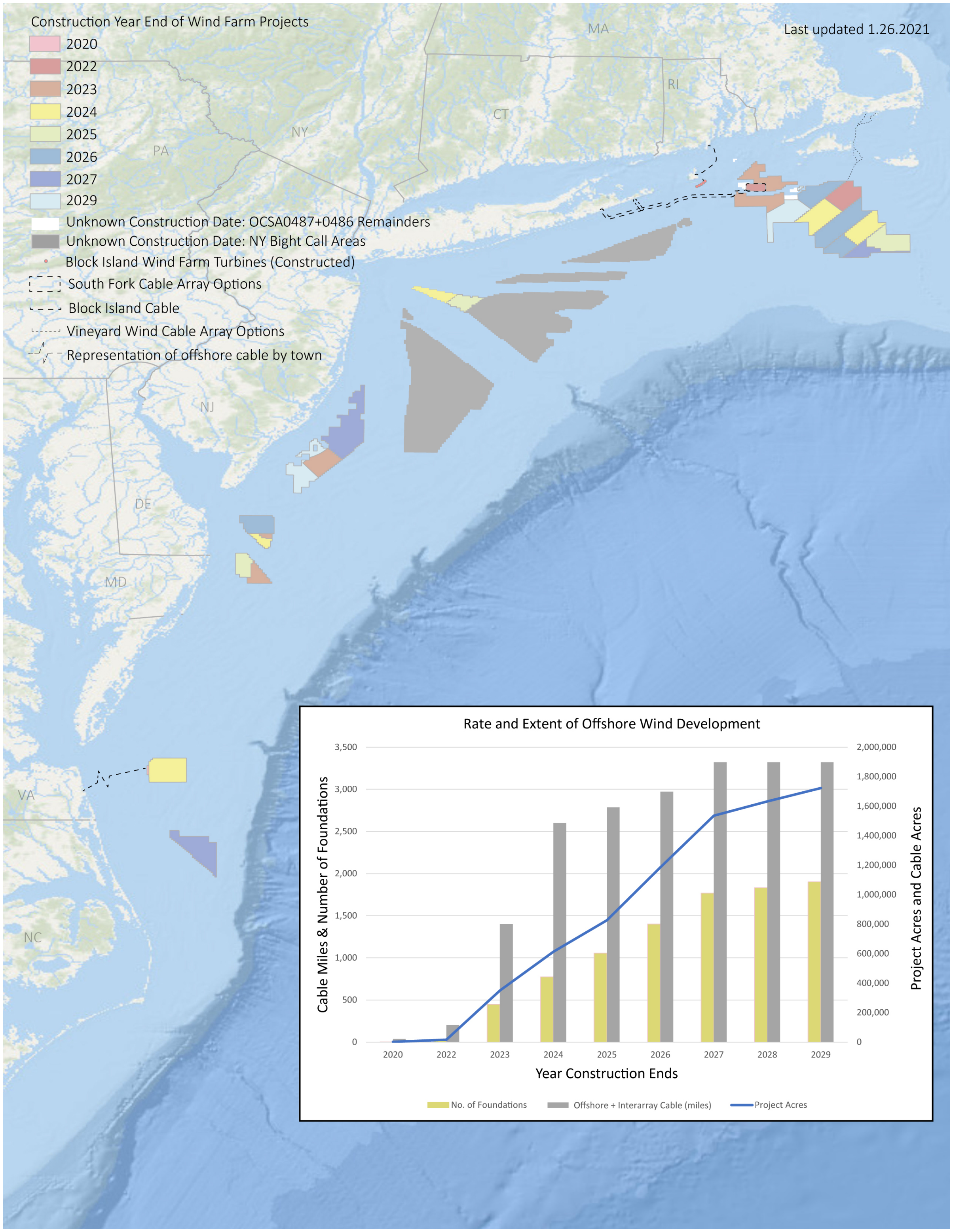

Figure 5: All Northeast Project areas by year construction ends (each project has 2 year construction period). Data for cumulative project areas, number of foundations, offshore cable area (acres) and offshore cable and interarray cable (mile) are displayed in the graph.

Other ocean uses: Commercial fishey revenue in lease areas

Based on vessel logbook data, average commercial fishery revenue from trips in the proposed offshore wind lease areas and the New York Bight Call Areas represented 2-24% of the total average revenue for each MAFMC managed fishery from 2008-2018 (Fig. 6).

The surfclam/ocean quahog fishery was the most affected fishery, with a maximum of 31% of annual fishery revenue occurring within potential wind lease areas during this period. The golden and blueline tilefish fisheries and spiny dogfish fishery were the least affected, at 3-4% maximum annual revenue affected, respectively. A maximum of 11% of the annual monkfish revenues were affected by these areas, with similar effects for the bluefish (10%), summer flounder/scup/black sea bass (9%), and mackerel/squid/butterfish (8%) fisheries. The New York Bight Call Areas represented only 1-5% of total average fishery revenue from any fishery during 2008-2018, with the surfclam/ocean quahog fishery most affected.

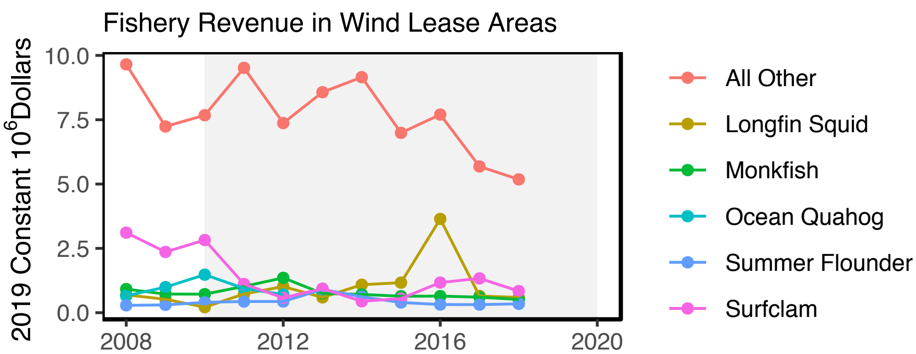

Figure 6: Wind energy revenue in the Mid-Atlantic

Other ocean uses: Wind lease area overlap with scientific surveys

Proposed wind energy project areas and NY Bight Call Areas interact with the region's federal scientific surveys (Fig. 7). The total survey area overlap ranges from 1-14% across ecosystem, shellfish, fish, shark, and protected species surveys. For example, the sea scallop survey will have significant overlap (up to 96% of individual strata) while the bottom trawl survey will have up to 60% overlap. Additionally, up to 50% of the southern New England North Atlantic right whale survey's area overlaps with proposed project areas.

Figure 7: Interaction of Greater Atlantic Fisheries Scientific Surveys and Offshore Wind Development

Implications of offshore wind indicators

Current plans for rapid buildout of offshore wind in a patchwork of areas spreads the impacts differentially throughout the region (Fig. 8).

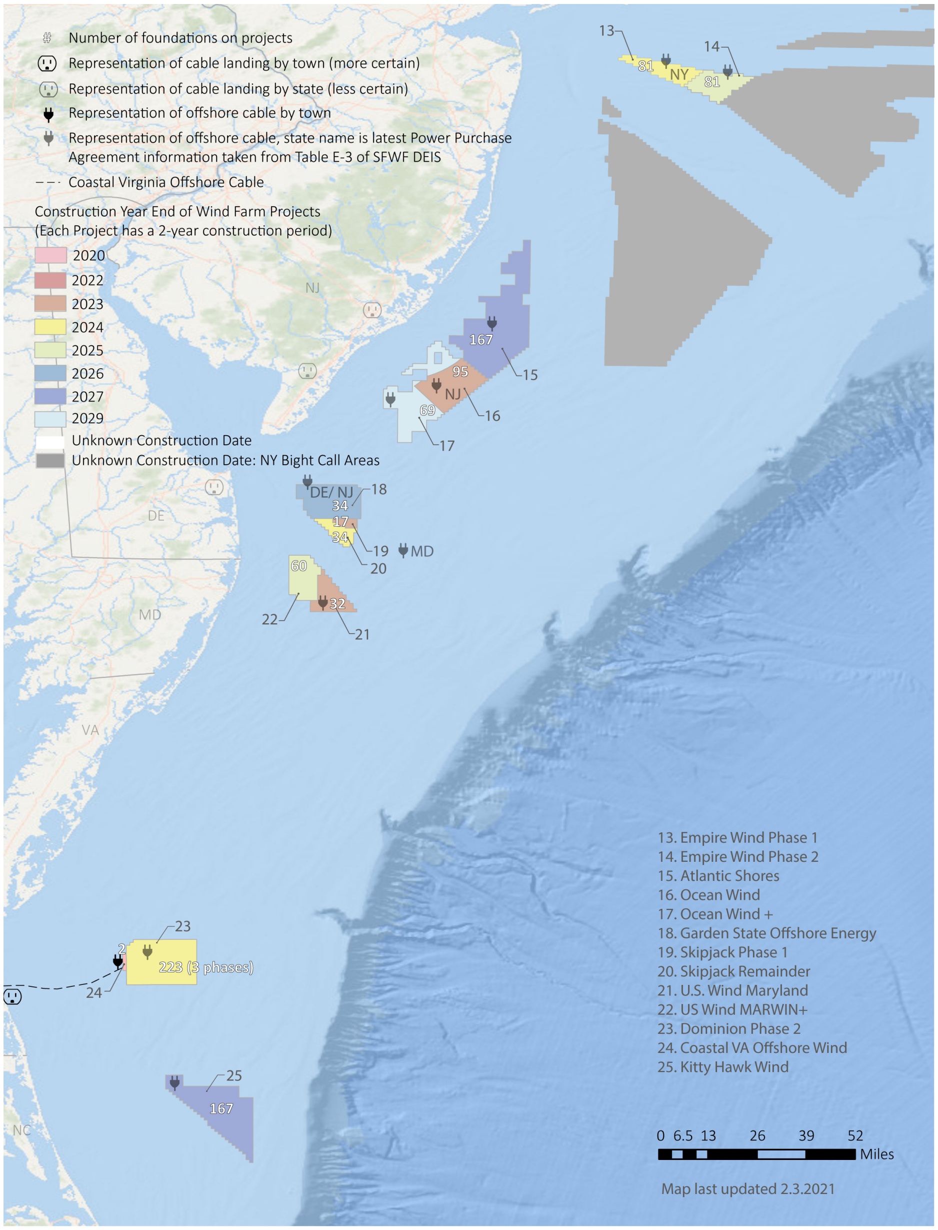

Figure 8: Zoomed in areas with name of Project, number of foundations within each project area and the states that have declared power purchase agreements.

2-24% of total average revenue for major Mid-Atlantic commerical species in lease areas could be displaced if all sites are developed. Displaced fishing effort can alter fishing methods, which can in turn change habitat, species (managed and protected), and fleet interactions.

Right whales may be displaced, and altered local oceanography could affect distribution of their zooplankton prey.

Scientific data collection surveys for ocean and ecosystem conditions, fish, and protected species will be altered, potentially increasing uncertainty for management decision making.

We seek Council feedback on whether to include offshore wind development and related indicators within the EAFM risk assessment, and if so, what risk criteria should be applied to these indicators.

2021 EAFM Risk Tables

Table 3: 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	lm	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 4: 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 5: 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	mh	h	h
Black sea bass-C	h	lm	h	mh	h	h
Atl. mackerel-R	lm	l	l	l	l	l
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	l
Shortfin squid-C	lm	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	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	l
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. Gaichas SK, DePiper GS, Seagraves RJ, Muffley BW, Sabo M, Colburn LL, et al. Implementing Ecosystem Approaches to Fishery Management: Risk Assessment in the US Mid-Atlantic. Frontiers in Marine Science. 2018;5. doi:10.3389/fmars.2018.00442

4. Hare JA, Morrison WE, Nelson MW, Stachura MM, Teeters EJ, Griffis RB, et al. A Vulnerability Assessment of Fish and Invertebrates to Climate Change on the Northeast U.S. Continental Shelf. PLOS ONE. 2016;11: e0146756. doi:10.1371/journal.pone.0146756

5. Wright-Fairbanks EK, Miles TN, Cai W-J, Chen B, Saba GK. Autonomous Observation of Seasonal Carbonate Chemistry Dynamics in the Mid-Atlantic Bight. Journal of Geophysical Research: Oceans. 2020;125: e2020JC016505. doi:https://doi.org/10.1029/2020JC016505

6. Pousse E, Poach ME, Redman DH, Sennefelder G, White LE, Lindsay JM, et al. Energetic response of Atlantic surfclam Spisula solidissima to ocean acidification. Marine Pollution Bulletin. 2020;161: 111740. doi:10.1016/j.marpolbul.2020.111740

7. Johnson M, Farr E, Nelson M, et a. In Prep. A Vulnerability Assessment of Habitats to Climate Change in the Northeast U.S.

8. Kritzer JP, DeLucia M-B, Greene E, Shumway C, Topolski MF, Thomas-Blate J, et al. The Importance of

Benthic Habitats for Coastal Fisheries. BioScience. 2016;66: 274–284. doi:10.1093/biosci/biw014

9. Drohan AF, Manderson JP, Packer DB. Essential fish habitat source document. Black sea bass, Centropristis striata, life history and habitat characteristics. NOAA Technical Memorandum NMFS-NE-200 [Internet]. 2007. Available: https://repository.library.noaa.gov/view/noaa/4038

10. BOEM. Bureau of Ocean Energy Management (BOEM). South Fork Wind Farm and South Fork Export Cable Project Draft Environmental Impact Statement. OCS EIS/EA BOEM 2020-057. [Internet]. 2021. Available: https://www.boem.gov/sites/default/files/documents/renewable-energy/SFWF-DEIS_0.pdf