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Northeast Habitat Climate Vulnerability Assessment

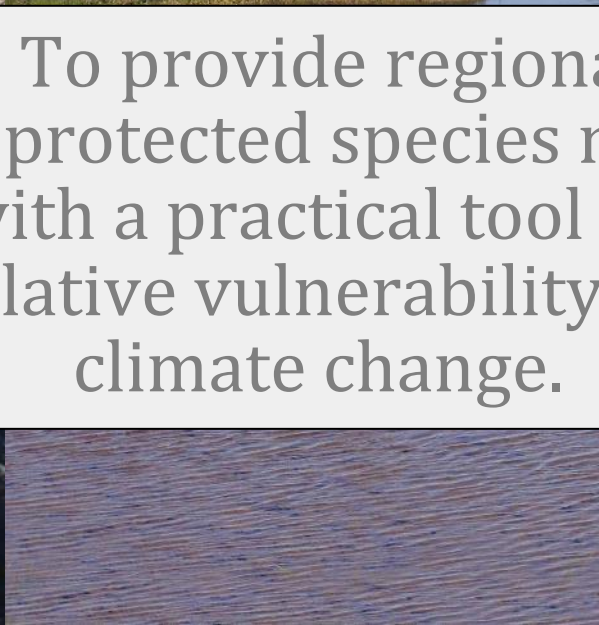
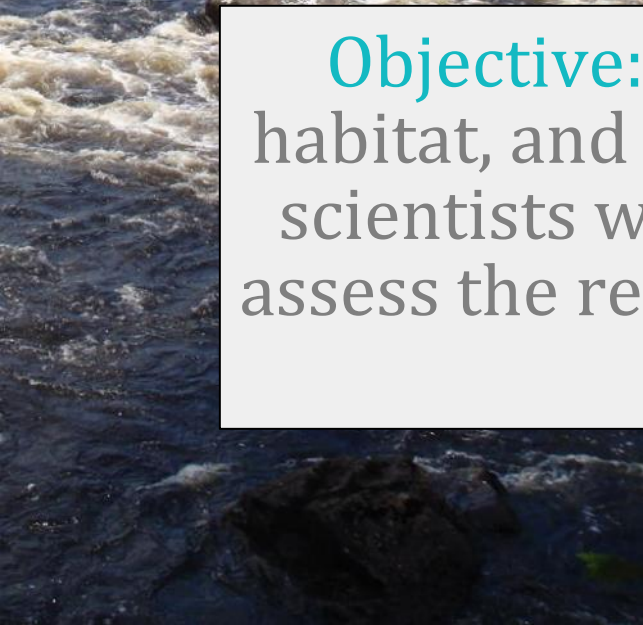
Emily Farr (NMFS Habitat Conservation)

Mark Nelson (NMFS Science & Technology)

Mike Johnson (NMFS GARFO)



Objective: To provide regional fisheries, habitat, and protected species managers and scientists with a practical tool to efficiently assess the relative vulnerability of habitats to climate change.

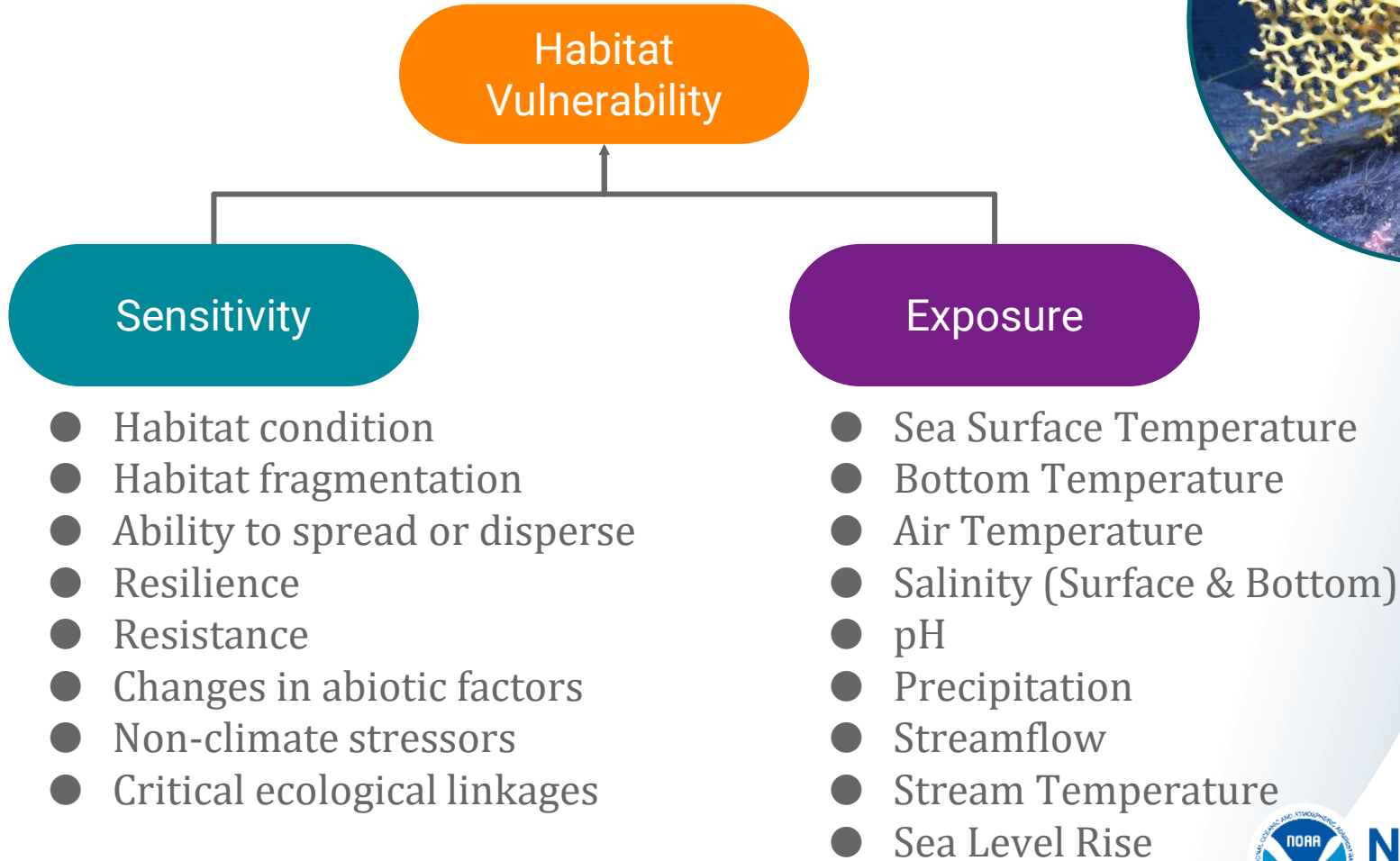


Habitats Assessed (52)

Marine (23 sub-classes)		Estuarine (19 sub-classes)		Riverine (10 sub-classes)	
Rocky Bottom	subtidal, offshore	Emergent Wetland	Mid-Atlantic, native	Unconsolidated Streambed/ Bank	Sand, tidal and non-tidal
	subtidal, nearshore		Mid-Atlantic, non-native		Mud, tidal and non-tidal
	subtidal, intertidal		New England, native	Emergent Wetland	Native, tidal
	artificial		New England, non-native		Native, non-tidal
Aquatic Bed	kelp algal bed	Reef (Mollusk)	Mollusk reef, subtidal	Water Column	Non-native, tidal
	non-kelp algal bed		Mollusk reef, intertidal		Non-native, non-tidal
	rooted vascular		Cultured mollusk reef		
...



Our Approach



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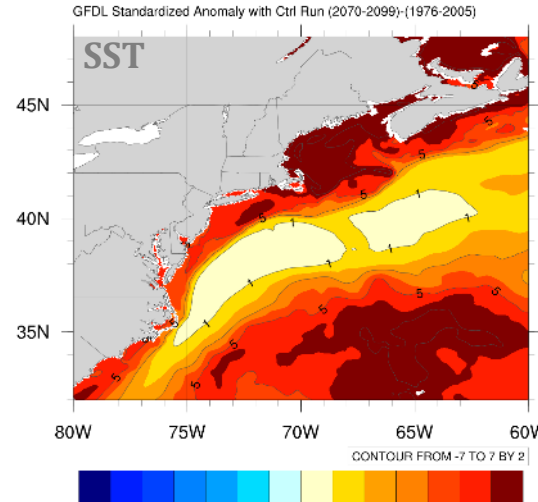
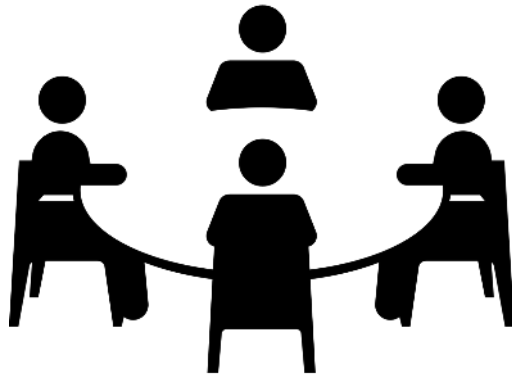
Our Approach

Trait-based
& expert elicitation
(scoring)

Habitat
Vulnerability

Sensitivity

Exposure



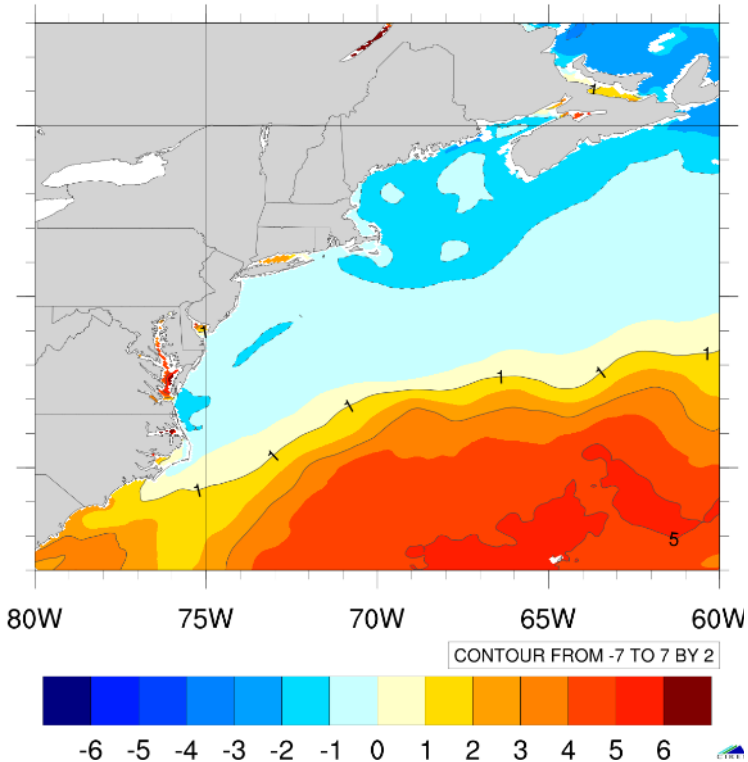
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Climate Exposure

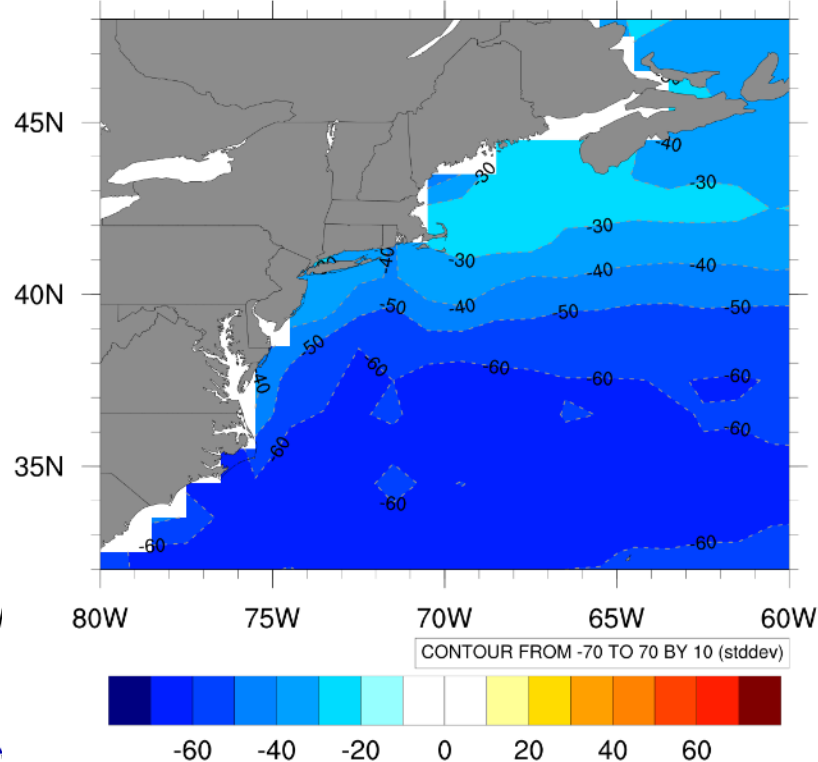
sea surface salinity (ROMS-NWA)

pH (CMIP5)

GFDL Standardized Anomaly with Ctrl Run (2070-2099)-(1976-2005)



CMIP5 ENSMN RCP8.5 historical stananom (2050-2099)-(1956-2005)



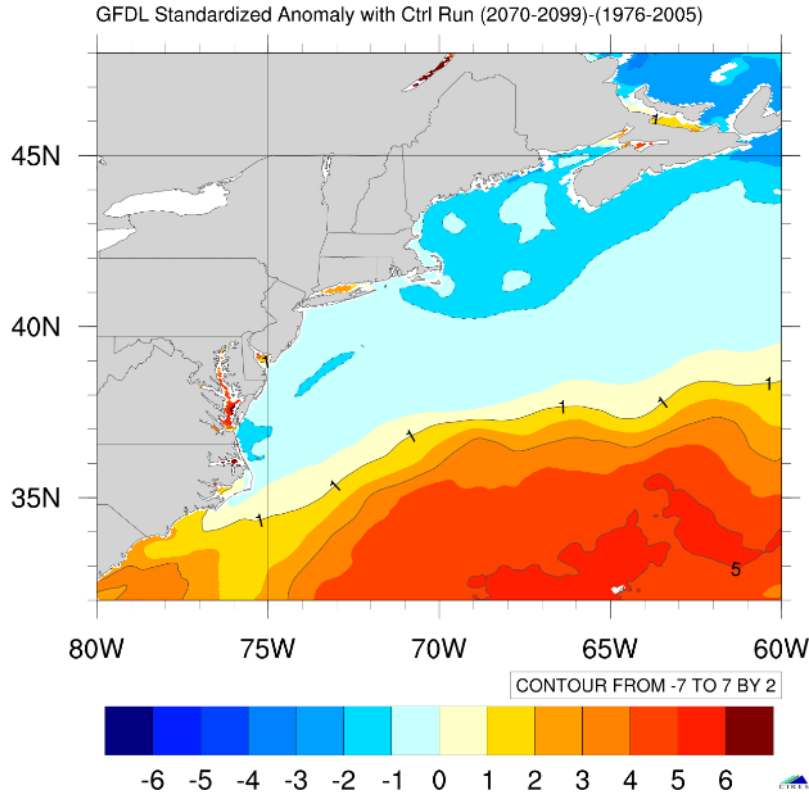
Scoring Bins	
Low	0-1.5
Moderate	1.5-4
High	4-5.5
Very High	5.5+



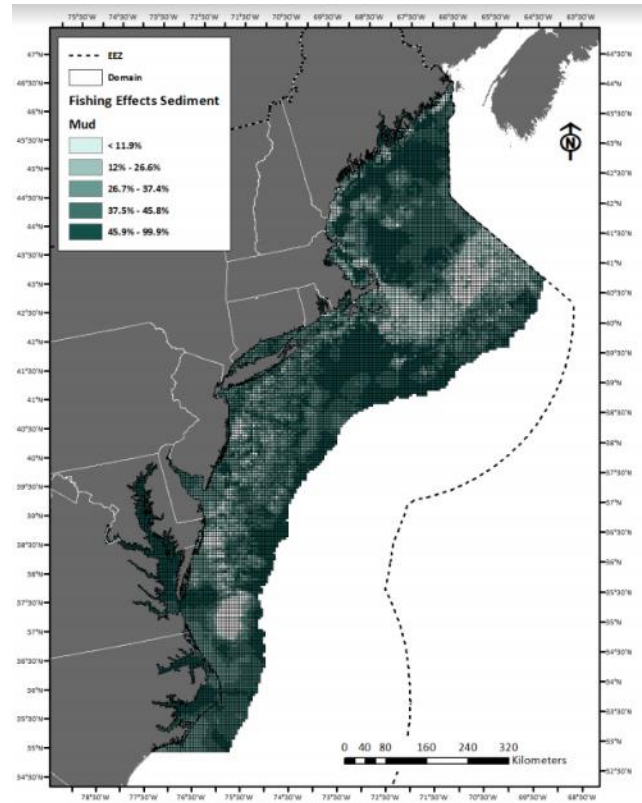
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Climate Exposure

sea surface salinity (ROMS-NWA)



Marine/Estuarine
Unconsolidated Bottom: Mud



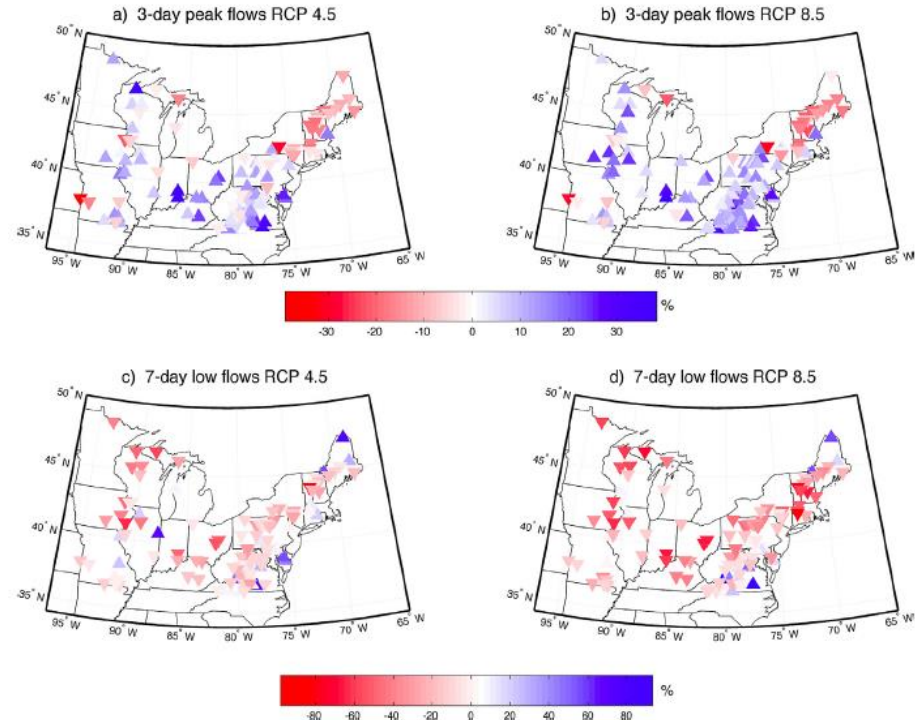
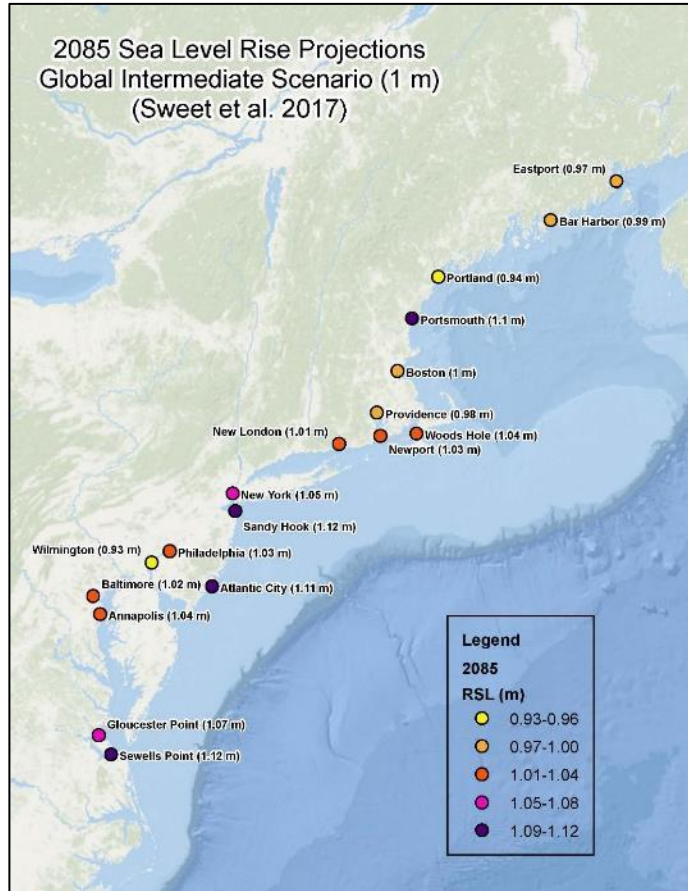
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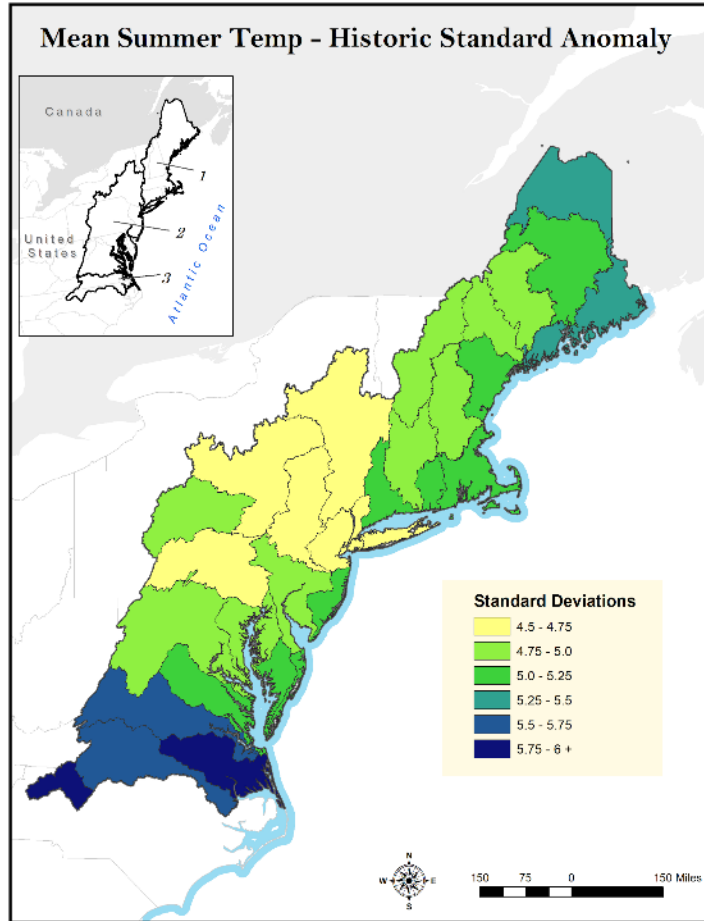
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Climate Exposure



Percentage changes in the magnitude of the 100-year return period 3-day peak flow (top panels) and 7-day low flows (bottom panels). (Demaria et al. 2015)

Climate Exposure



USGS SHEDS Stream Temperature Model (Letcher et al. 2016)



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Vulnerability Score

Table 3. Logic rule for calculating overall species' climate exposure and biological sensitivity. The scoring rubric is based on a logic model where a certain number of individual scores above a certain threshold are used to determine the overall climate exposure and overall biological sensitivity.

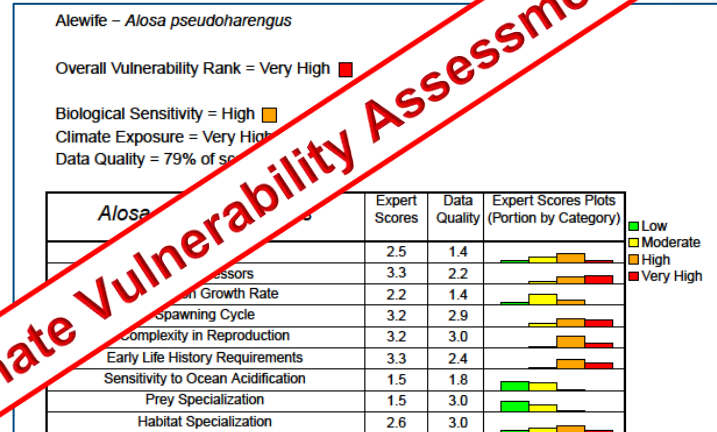
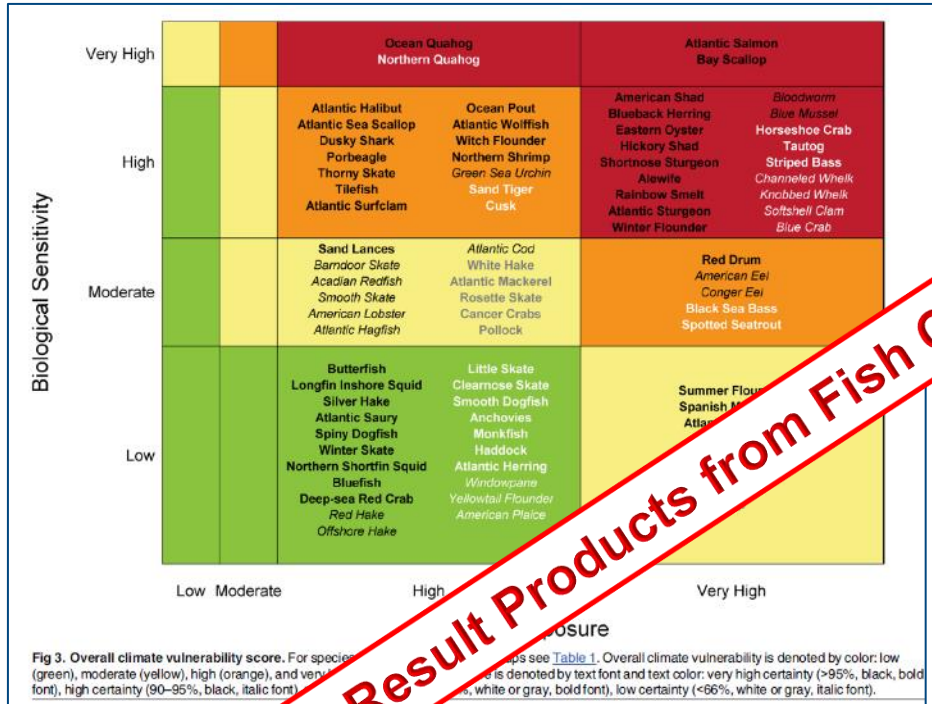
Overall Sensitivity or Exposure Score	Numeric Score	Logic Rule
Very High	4	3 of more attributes or factors mean ≥ 3.5
High	3	2 of more attributes or factors mean ≥ 3.0
Moderate	2	2 of more attributes or factors mean ≥ 2.5
Low	1	All other scores

$$\begin{array}{l} \text{Sensitivity} \\ \text{Component} \\ \text{Score} \end{array} \times \begin{array}{l} \text{Exposure} \\ \text{Component} \\ \text{Score} \end{array} = \begin{array}{l} \text{Overall} \\ \text{Vulnerability} \\ \text{Rank} \end{array}$$



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Presentation of Results



Alewife (*Alosa pseudoharengus*)

Overall Climate Vulnerability Rank: Very High (100% certainty from bootstrap analysis).

Climate Exposure: Very High. Three exposure factors contributed to this score: Ocean Surface Temperature (4.0), Ocean Acidification (4.0) and Air Temperature (4.0). Alewife are anadromous, spawning in freshwater, developing in freshwater and estuarine habitats, feeding as adults in marine habitats.

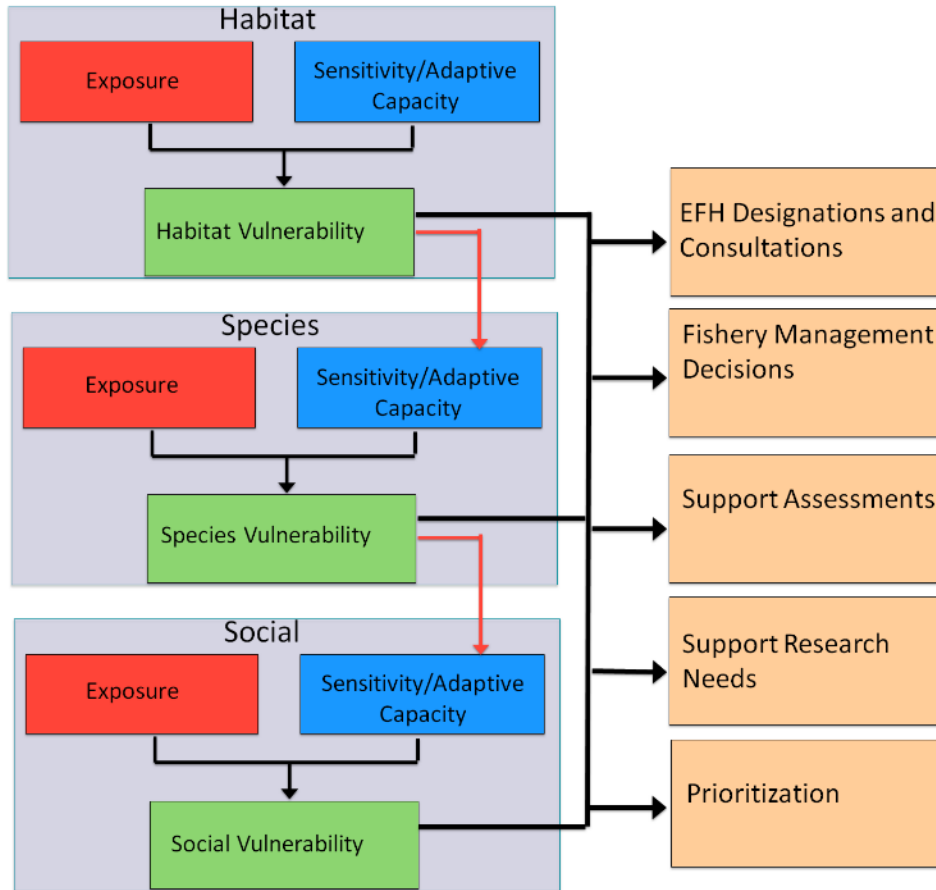
Biological Sensitivity: High. Four sensitivity attributes scored above 3.0: Other Stressors (3.3), Early Life History Requirements (3.3), Spawning Cycle (3.2), Complexity in Reproduction (3.2). Alewife are anadromous and exposed to a number of other stressors including habitat destruction, blockage to spawning habitats, and contaminants (Limburg and Waldman, 2009). Spawning time varies latitudinally and is linked to spring warming (Monroe, 2002). Eggs and larvae inhabit freshwaters and then juveniles move to estuarine and ocean waters.

Distributional Vulnerability Rank: Low (62% certainty from bootstrap analysis). Alewife have a relatively high degree of spawning site fidelity, limiting the ability of the species to shift distribution.

Example Result Products from Fish Climate Vulnerability Assessment



How will the results be used?



- Prioritize conservation & restoration
- EFH consultations & 5-year reviews
- Ecosystem context for fisheries management decisions
- Framework replicated in other regions



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Other potential avenues

2020 State of the Ecosystem
Mid-Atlantic

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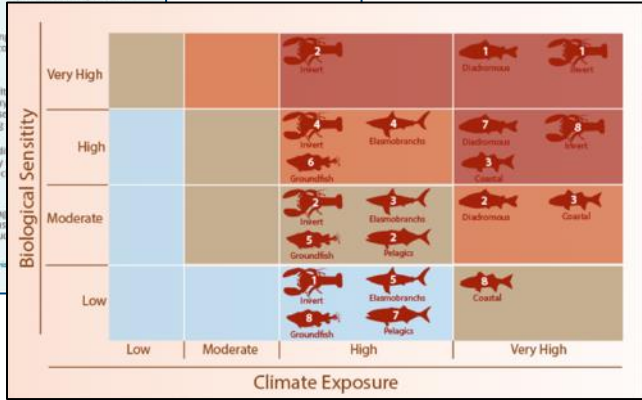
- Total commercial fishery landings were scaled to ecosystem productivity. Primary production required to support Mid-Atlantic commercial landings has been declining since 2004.
- Engagement in commercial fishing has declined since 2004 for medium to highly engaged Mid-Atlantic fishing communities. This may be related to the overall downward trend in commercial landings since 1986, and the decline in total revenue since 2004.
- 2018 retained recreational catch in the Mid-Atlantic was the lowest observed since 1982. There is also a similar, although less steep decline in recreational fishing effort. The party/charter sector is expected to continue to shrink. Recreational species catch diversity has been maintained by increased catch of South Atlantic and state managed species.
- Habitat modeling indicates that summer flounder, butterfish, longfin squid, and spiny dogfish are among fish species highly likely to occupy wind energy lease areas. Habitat conditions for many of these species have become more favorable over time within wind lease areas.
- There are no apparent trends in aggregate biomass of predators, forage fish, bottom feeders, and shellfish sampled by trawl surveys, implying a stable food web. However, we continue to see a northward shift in aggregate fish distribution along the Northeast US shelf, and a tendency towards distribution in deeper waters.
- Forage fish energy content is now being measured regularly, revealing variation in energy of these important prey species due to changing oceanic herring energy content is half what it was in the 1980-90s.
- Nearshore habitats are under stress. Heavy rains in 2018-2019 result in water and high nutrient flow into the Chesapeake Bay, driving low salinity, and spread of invasive catfish in this critical Mid-Atlantic estuarine altering coastal habitats in the Mid-Atlantic, driving declines in nesting.
- The Northeast US shelf ecosystem continued to experience warm conditions in ocean circulation affecting the shelf. The Gulf Stream is increasingly core rings resulting in higher likelihood of warm salty water and associated as shortfin squid coming onto the shelf.
- The intensity and duration of marine surface heatwaves are increasing both in the seasonal Mid-Atlantic cold pool and shelfwide are increasing increase nutrient remineralization and summer phytoplankton production.

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Risk Assessment Update 2020

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	h	l
Shortfin squid	lm	lm	lm	l	l	lm	l	h	l
Golden tilefish	l	l	l	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



Results: l=low risk (green), lm= low-moderate risk (yellow), mh=moderate to high risk (orange), h=high risk (red)

	RecVal	FishRes1	FishRes4	FleetDiv	Social	ComFood	RecFood
	h	l	mh	l	lm	h	mh



Questions?

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