Northeast Habitat Climate Vulnerability Assessment

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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.

Scope: 52 marine, estuarine, riverine habitats; Cape Hatteras, NC to Maine/Canadian border

Assessment Framework

Sensitivity

- Habitat condition
- Habitat fragmentation
- Distribution/range
- Ability to spread or disperse
- Resilience
- Resistance
- Changes in abiotic factors
- Non-climate stressors
- Critical ecological linkages

Exposure

- Sea surface temperature
- Bottom temperature
- Air temperature
- Stream temperature
- Salinity (surface & bottom)
- pH
- Precipitation
- Streamflow
- Sea level rise

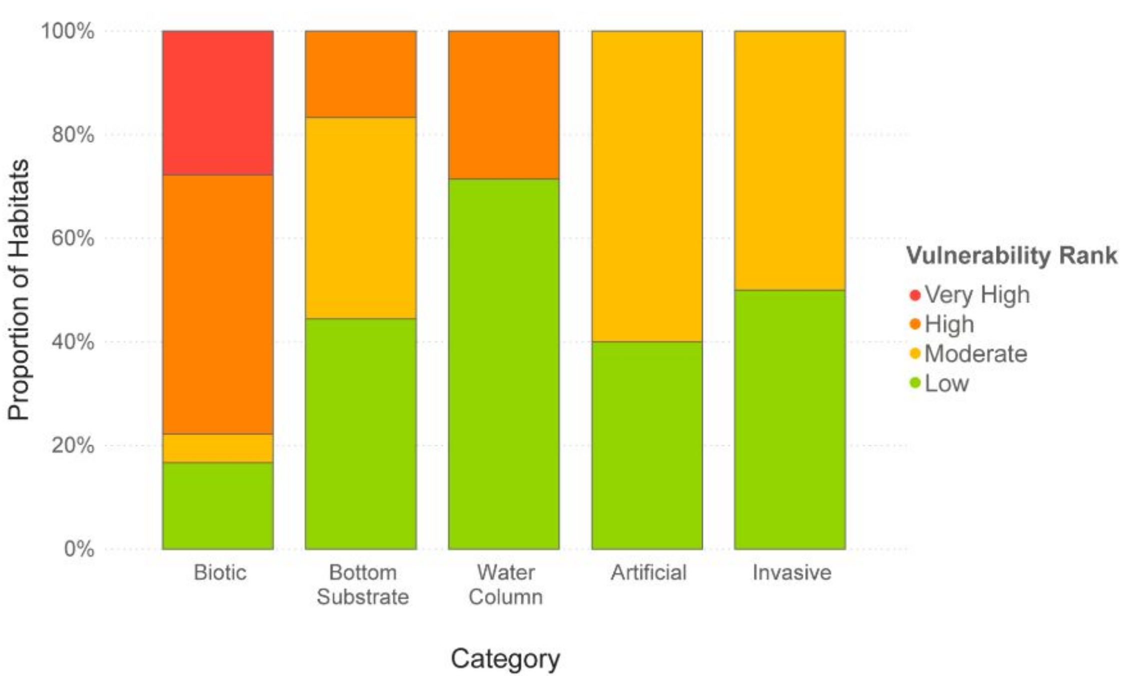
Habitat Vulnerability

Results: Vulnerability Ranks

Sensitivity \ Exposure	Low	Moderate	High	Very High
Very High		Deep Sea Coral & Sponge: Gulf of Maine	*Deep Sea Coral & Sponge: Seamounts and Canyons**	
High		**Riv. Tidal Native Wetland****	Mar. SAV Est. SAV Est. Kelp Est. Subtidal Shellfish Feef Mar. Subtidal Shellfish Reef Est. Water Column Mar. Kelp Riv. Non-tidal Native Wetland *Riv. SAV* *Riv. Water Column**	Est. Native Wetland: Mid-Atlantic Est. Native Wetland: New England Mar. Intertidal Shellfish Reef Est. Intertidal Shellfish Reef
Moderate		Mar. Rocky Bottom >200m	Mar. Shellfish Aquaculture Est. Subtidal Mud Bottom Est. Shellfish Aquaculture Riv. Mud Bottom Riv. Sand Bottom	Mar. Intertidal Mud Bottom Mar. Intertidal Rocky Bottom *Mar. Intertidal Sand Bottom*
Low	Mar. Slope Surface Water Column	Mar. Mud Bottom >200m Mar. Sand Bottom >200m Mar. Shelf Bottom Water Column Mar. Slope Bottom Water Column Riv. Tidal Invasive Wetland	**Riv. Rocky Bottom** **Est. Subtidal Rocky Bottom** **Mar. Rocky Bottom <200m** Mar. Mud Bottom <200m Mar. Shallow/Inner Shelf Water Column Est. Red, Green, Small-brown Algae Est. Subtidal Sand Bottom Est. Subtidal Manmade Structures Mar. Red, Green, Small-brown Algae Mar. Manmade Structures Mar. Sand Bottom <200m Mar. Shelf Surface Water Column Riv. Algae Riv. Non-Tidal Invasive Wetland	**Est. Intertidal Rocky Bottom**** **Est. Intertidal Mud Bottom** Est. Intertidal Sand Bottom Est. Invasive Wetland: Mid-Atlantic Est. Invasive Wetland: New England Est. Intertidal Manmade Structures

Sensitivity (vertical axis); Exposure (horizontal axis)

Trends in Climate Vulnerability



- Biotic and coastal habitats most vulnerable
- Manmade and invasive habitats generally low vulnerability

Habitat Narratives

Estuarine Submerged Aquatic Vegetation

System: Estuarine

Subsystem: Subtidal & Intertidal

Class: Aquatic Bed

Sub-class: Rooted Vascular

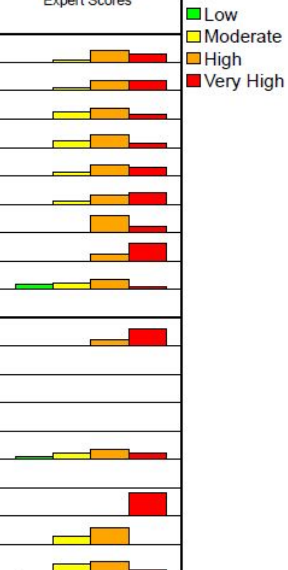
Geographic Area: Entire Area

Overall Vulnerability Rank = High

Habitat Sensitivity = High

Climate Exposure = High

	Estuarine Submerged Aquatic Vegetation	Attribute Mean	Data Quality	Distribution of Expert Scores
Sensitivity Attributes	Habitat condition	3.2	2.6	
	Habitat fragmentation	3.3	2.3	
	Distribution/Range	2.9	2.3	
	Mobility/Ability to spread or disperse	2.9	1.6	
	Resistance	3.2	2.4	
	Resilience	3.4	2.5	
	Sensitivity to changes in abiotic factors	3.3	2.5	
	Sensitivity and intensity of non−climate stressors	3.7	2.6	
	Dependency on critical ecological linkages	2.4	2.1	
	Sensitivity Component Score	High		
Exposure Factors	Sea surface temp	3.7	2.5	
	Bottom temp	n/a	n/a	
	Air temp	n/a	n/a	
	River temp	n/a	n/a	
	Surface salinity	2.8	2.1	
	Bottom salinity	n/a	n/a	
	pH	4	2	
	Sea level rise	2.7	2.2	
	Precipitation	2.7	2.1	
	Floods	n/a	n/a	
	Droughts	n/a	n/a	
	Exposure Component Score	High		
	Overall Vulnerability Rank	**High**		



__Habitat Description__: This sub-class includes rooted vascular beds occurring in the estuarine system of the study area from near full-salinity to brackish waters (≤30 ppt to >0.5 ppt). Eelgrass (*Zostera marina*) is the dominant rooted vascular plant found in the estuarine environment over its western Atlantic range from North Carolina to Canada (Thayer et al. 1984). Widgeon grass (*Ruppia maritima*) can be found in estuarine waters in discrete meadows or intermixed with eelgrass (Kantrud 1991). Widgeon grass has a broad geographic range spanning Florida to Canada (Kantrud 1991). Both species require sediments that allow for root penetration, thus sand and silt are the most common. However, eelgrass can colonize areas of gravel with underlying sand and in one instance was observed growing on a section of the seafloor that was Boston blue clay (Colarusso, pers obs). Due to the high light requirements for both species, they are generally restricted to shallow coastal waters (Thayer et al. 1984; Kantrud 1991).

Eelgrass has been observed rooted at 44 feet mean low water offshore of Rhode Island (Short, pers. comm.), but 25 feet mean low water is generally a maximum depth for New England (Colarusso, pers. obs.). Widgeon grass grows in shallow water with maximum depth limits of less than 10 feet mean low water (Kantrud 1991). Both species can persist in the intertidal, but only at higher latitudes (generally Maine/NH border northward) due to their sensitivity to desiccation (Thayer et al. 1984; Kantrud 1991). In addition, wild celery (*Vallisneria americana*) is a freshwater plant that can tolerate limited salinity levels to 18 ppt., although the limit of salt tolerance is in question (Doering et al. 2001). Other rooted vascular plants in estuaries include pondweed species (e.g., sago pondweed *Stuckenia pectinatus* and redhead grass *Potamogton perfoliatus*), which although have some tolerance to salinity are generally restricted to less than 10 ppt. (Moore 2009).

__Overall Climate Vulnerability Rank__: **High** (97% certainty from the bootstrap analysis)

__Climate Exposure__: **High.** The overall High exposure score was influenced by two Very High attribute means: Sea surface temperature (3.7) and pH (4.0). Salinity and Precipitation also received Very High and high scores (2.8 and 2.7, respectively). Sea level rise is expected to be significant throughout the entire study area, but the greatest relative rise is projected in the Mid-Atlantic. The change in sea surface temperature is projected to be greater inshore than offshore and slightly greater in New England than the Mid-Atlantic.

__Habitat Sensitivity__: **High.** All nine sensitivity attributes received some High and Very High scores. Six of the nine sensitivity attributes means were > 3.0, while the other attributes had scores between 2.4 and 2.9. The highest sensitivity attribute mean was for Sensitivity and intensity of non-climate stressors (3.7). Habitat condition (3.2), Habitat fragmentation (3.3), Resistance (3.2), Resilience (3.4) and Sensitivity to abiotic factors (3.3) all scored above 3.

__Data Quality & Gaps__: The data quality scores for four of the five climate exposure factors (pH, Precipitation, Surface salinity and Sea level rise) were scored relatively Low to Moderate (≤2.2). The highest score was for Sea surface temperature (2.5). Data quality is believed to be lower for estuarine

Linking with Species Vulnerability

Habitat Name (Vulnerability Rank)	Species	Importance of habitat by life stage (ACFHP)				Species Vulnerability Rank (FCVA)
		Eggs/Larva	Juvenile/YOY	Adult	Spawning Adult	
Mid-Atlantic native salt marsh (Very High)	Blueback herring		Moderate			Very high
	Blue crab		High	High		Very high
	Summer flounder		High	Moderate		Moderate
	Winter flounder	High	Moderate		High	Very high
Marine/estuarine intertidal shellfish reef (Very High)	Black sea bass		High	High		High
	Blue crab	Moderate	Moderate	Moderate		Very high
	Summer flounder		Moderate			Moderate
	Winter flounder		Moderate			Very high
Marine/estuarine subtidal shellfish reef (High)	Black sea bass		High	High		High
	Blue crab	Moderate	Moderate	Moderate		Very high
	Summer flounder		Moderate			Moderate
Marine/estuarine submerged aquatic vegetation (High)	Alewife	Very high	Very high		Very high	Very high
	Black sea bass		High			High
	Blue crab	Very high	Very high			Very high
	Summer flounder		High	Moderate		Moderate

How can the results be used?

- Prioritize habitat conservation & restoration
- Essential Fish Habitat and Endangered Species Act consultations & EFH designations
- Ecosystem context for fisheries management decisions
- Context for coastal & marine planning (e.g., siting of wind/aquaculture)
- Framework replicated in other regions (or scales)

Areas for Future Research

- Climate models with nearshore & estuarine resolution
- More comprehensive habitat distribution data; link climate vulnerability with habitats spatially
- Assess rivers under a different framework than marine & estuarine habitats
- Finer-scale assessments

Questions?

Project Leads: Emily Farr, Mike Johnson, Mark Nelson, Jon Hare

Project Participants: Vince Guida, Ursula Howson, Douglas Christel, Matthew Lettrich, Rory Saunders, David Stevenson, Brian Grieve, Wendy Morrison, Thomas Noji, Vince Saba, Roger Griffis, Peg Brady, Tony Marshak, Lou Chiarella, Kenric Osgood, Bruce Vogt, Mark Monaco, Donna Johnson, Michael Alexander, Diane Borgaard, Peter Auster, Jon Grabowski, Dave Packer, Damian Brady, Renee Mercaldo-Allen, Phil Colarusso, Mathias Collins, Christopher Meaney, Frank Borsuk, Matthew Cashman, James Hawkes, Grace Roskar

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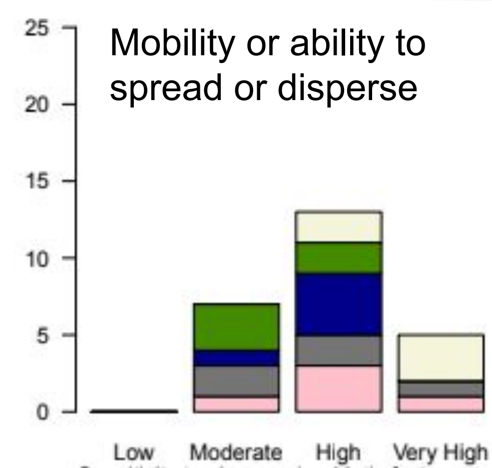
Sensitivity Scoring

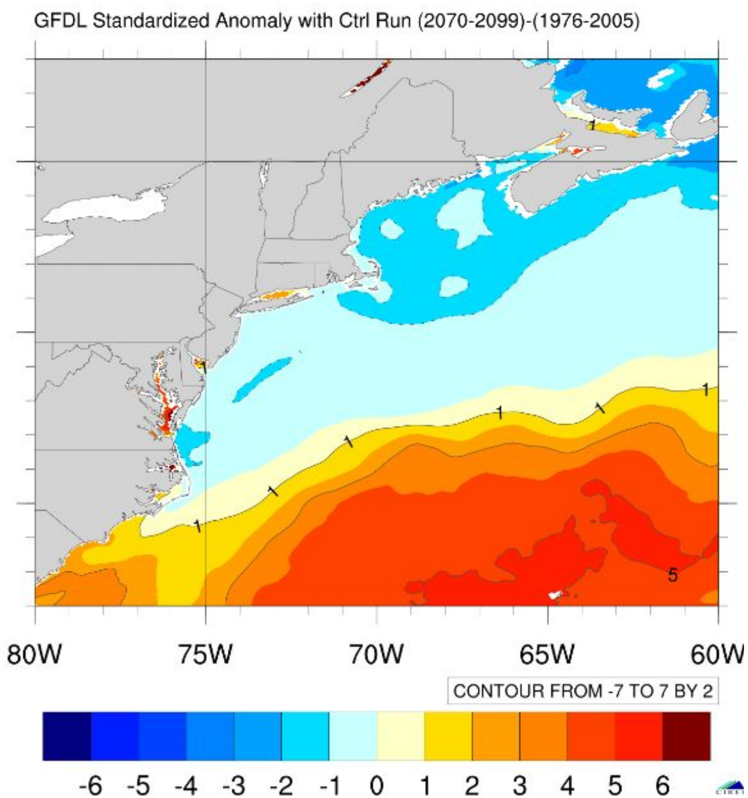
Scoring Bins
Low
Moderate
High
Very High



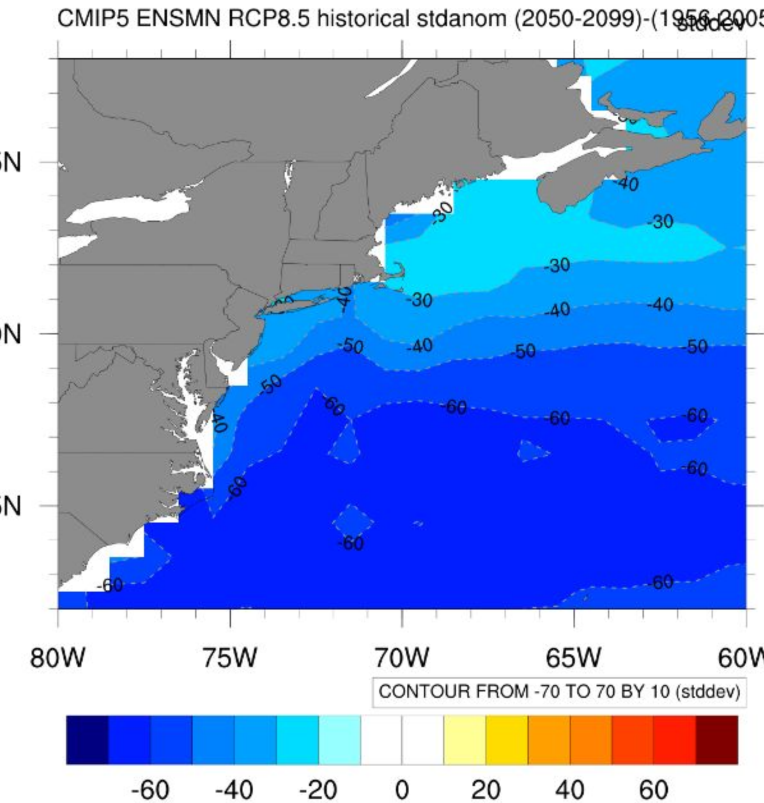
- Expert elicitation: 15 habitat experts, 5 per system
- In-person workshop to leverage collective knowledge of the group

Exposure Scoring

sea surface salinity (ROMS-NWA)



pH (CMIP5)



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

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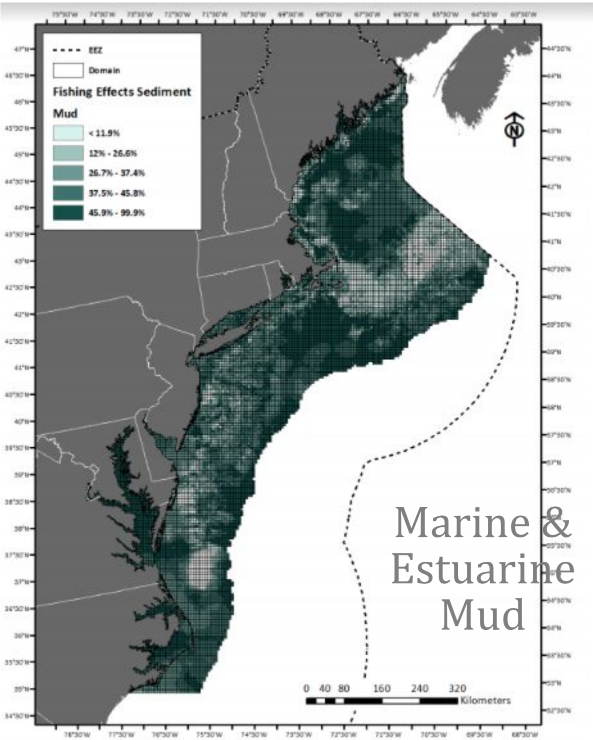
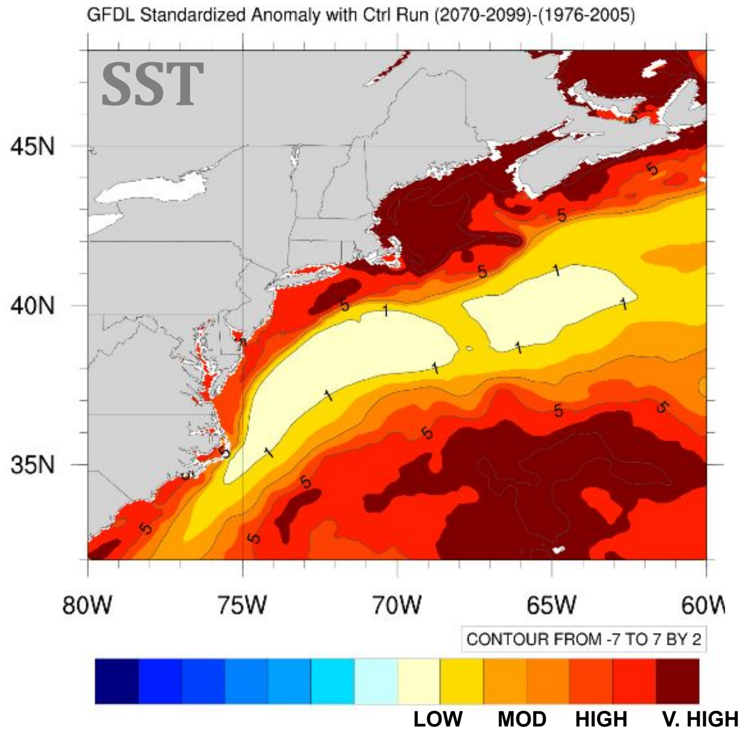
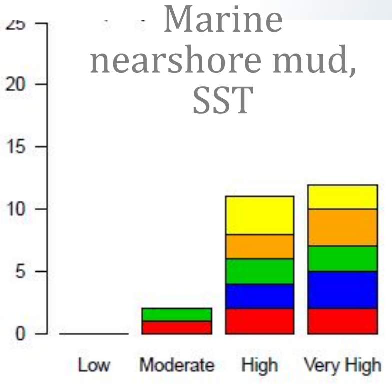
Exposure Scoring







- Compare habitat distribution and climate projections (RCP 8.5, end of century)

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