

Atlantic Highly Migratory Species Climate Vulnerability Assessment

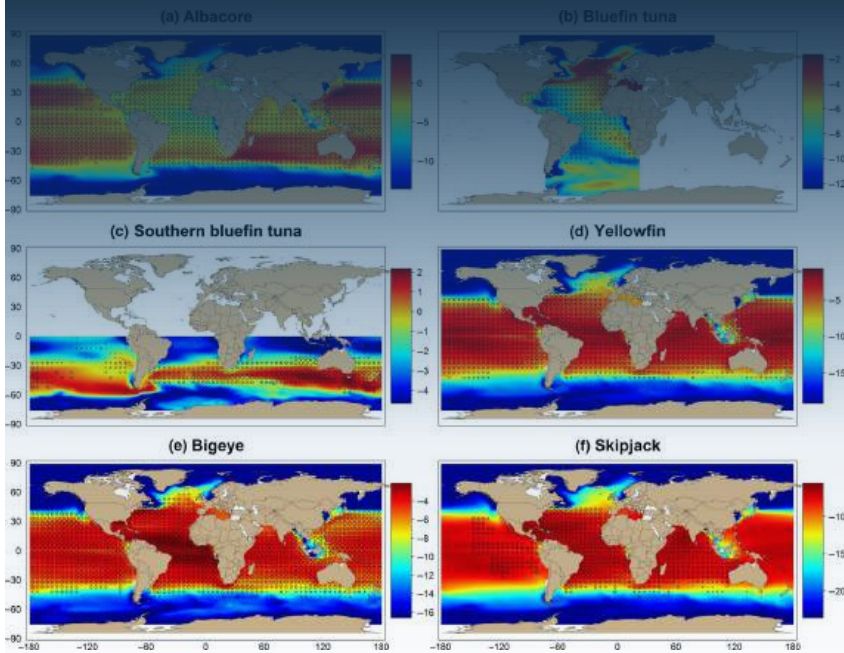
IATTC 2nd Climate Change Workshop
April 2026

Tyler Loughran *HMS Policy Analyst, Azura Consulting LLC in support of
Atlantic Highly Migratory Species Management Division, NOAA Fisheries*

Climate Impacts to HMS

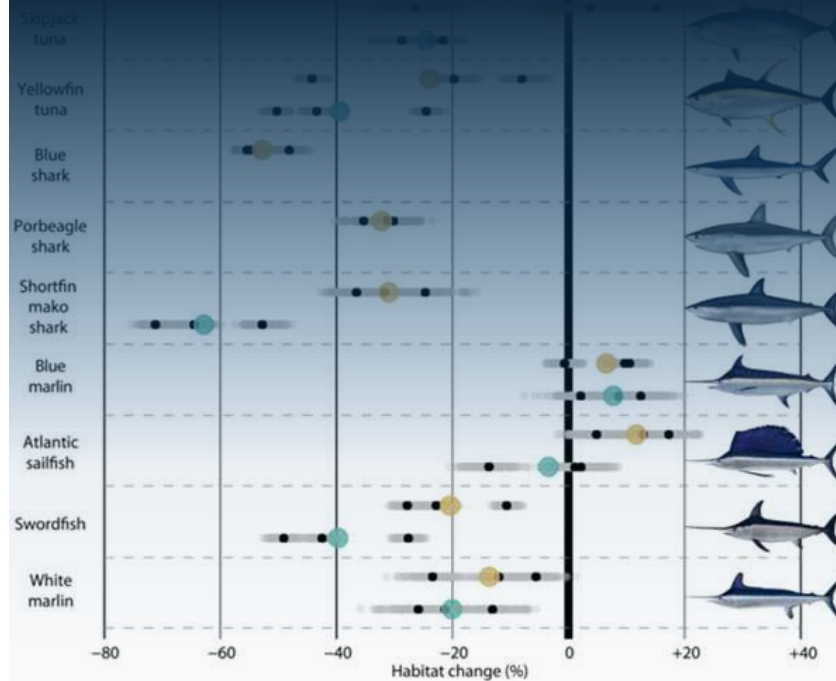
Species Distribution Modeling Erauskin-Extramiana et al. (2019)

- Poleward shifts predicted for 20 of 22 tuna stocks



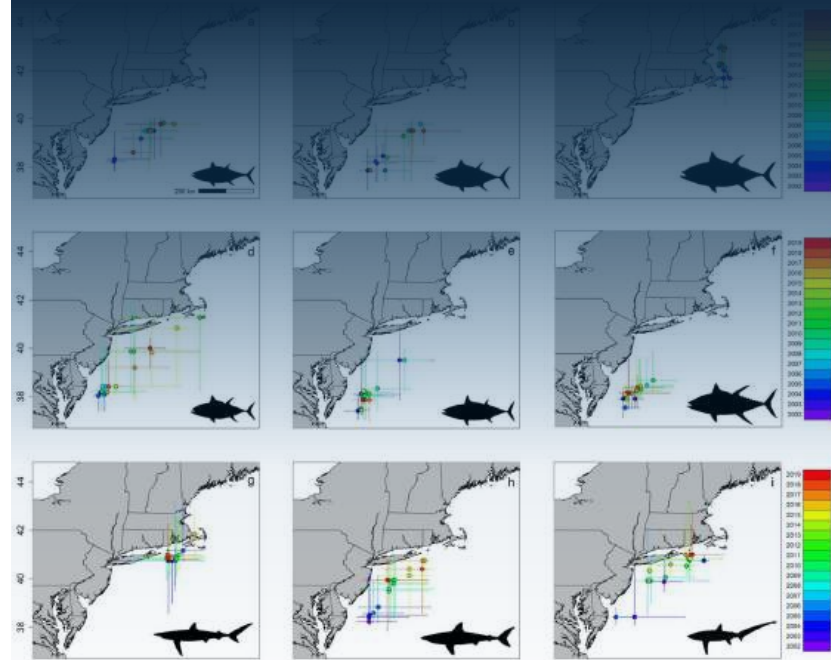
Suitable Habitat Modeling Braun et al. (2019)

- Predicted widespread loss of suitable habitat



Large Pelagics Survey Crear et al. (2023)

- HMS recreational fishery is shifting likely due to climate change



Highly Migratory Species

Climate Vulnerability Assessment

Large Coastal Sharks

Small Coastal Sharks

Pelagic Sharks

Tunas

Billfish / Swordfish

Sea Surface Temperature (°C)



NOAA Fisheries Climate Vulnerability Assessments

Methodology for Assessing the Vulnerability of Marine Fish and Shellfish Species to a Changing Climate

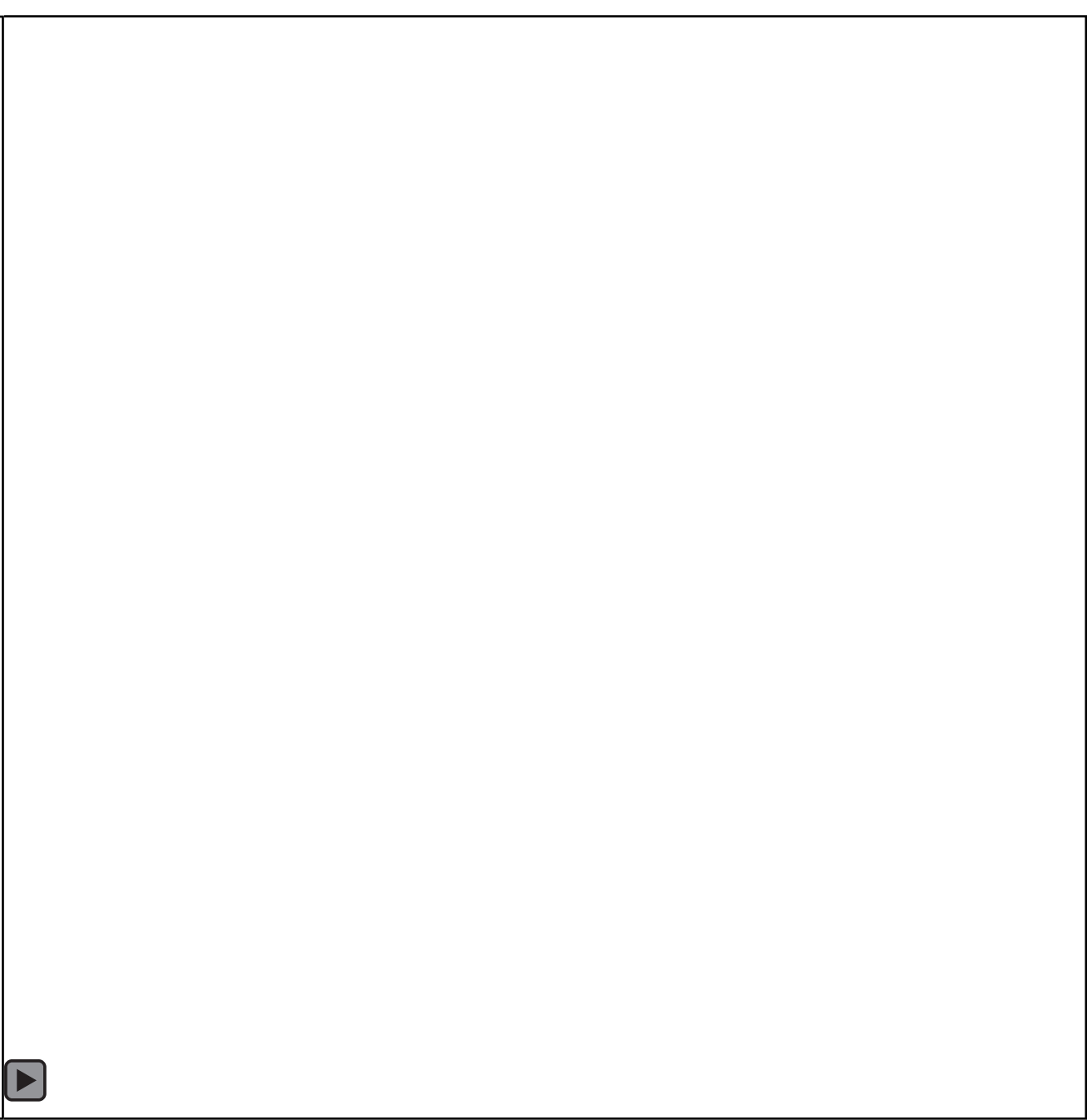
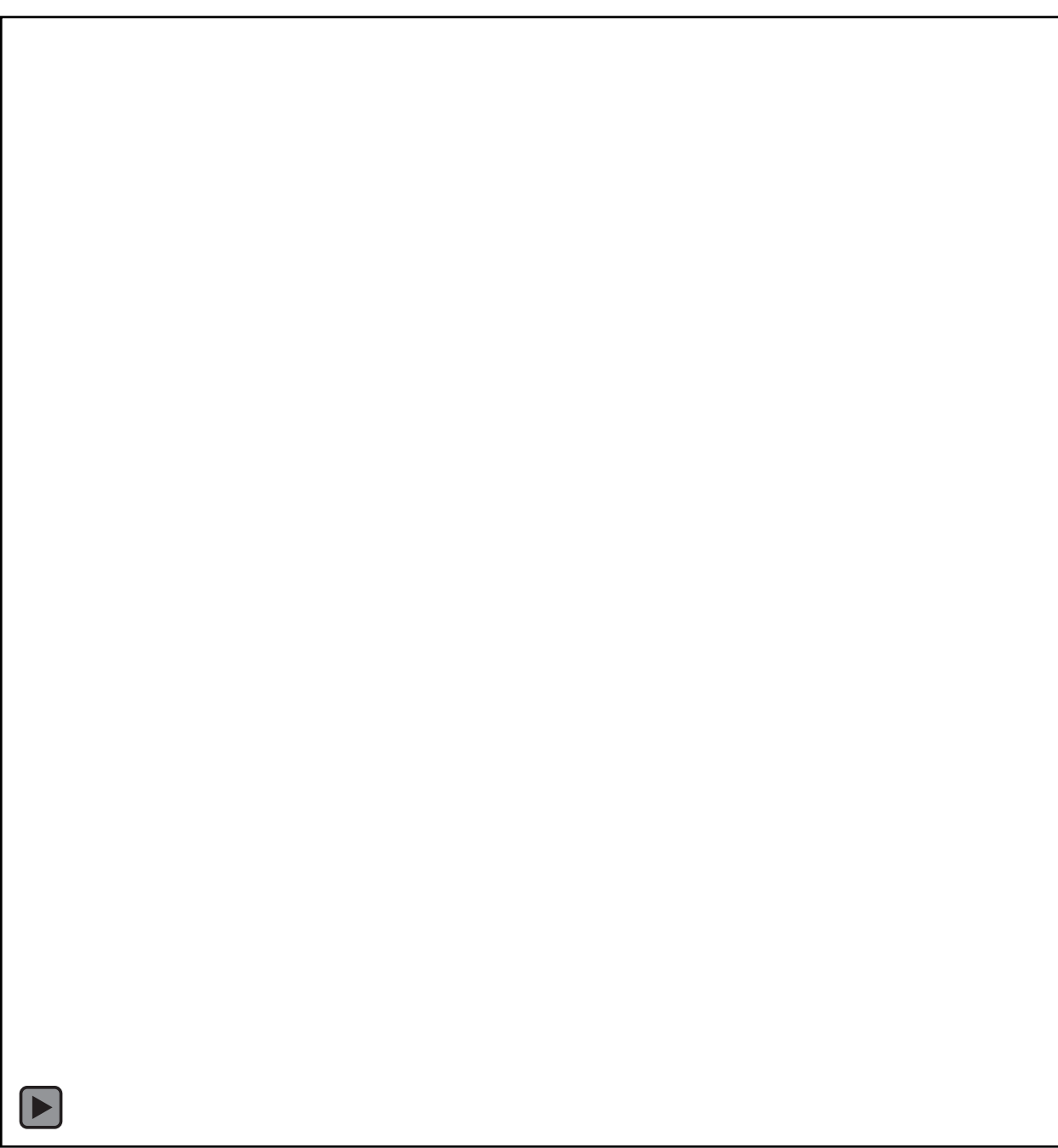
Wendy E. Morrison, Mark W. Nelson, Jennifer F. Howard, Eric J. Teeters, Jonathan A. Hare, Roger B. Griffis, James D. Scott, and Michael A. Alexander

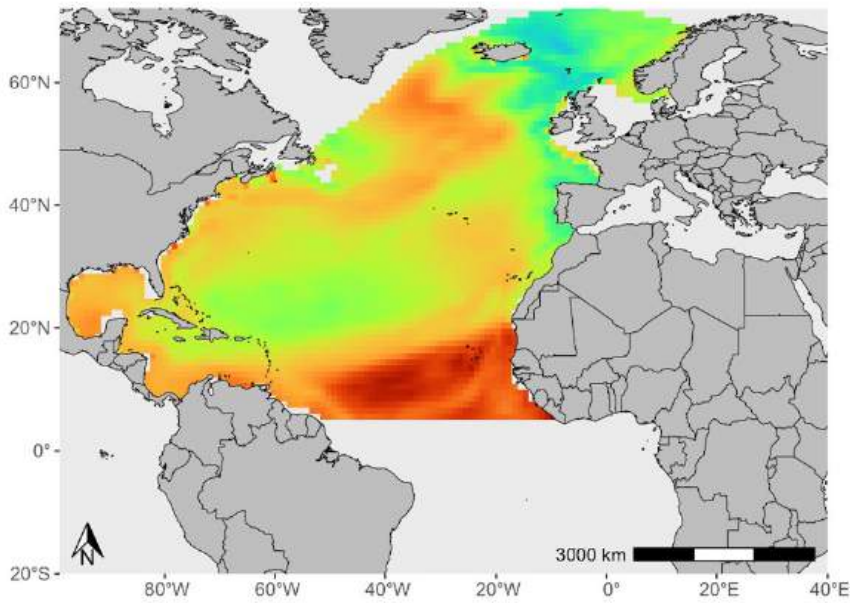


U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

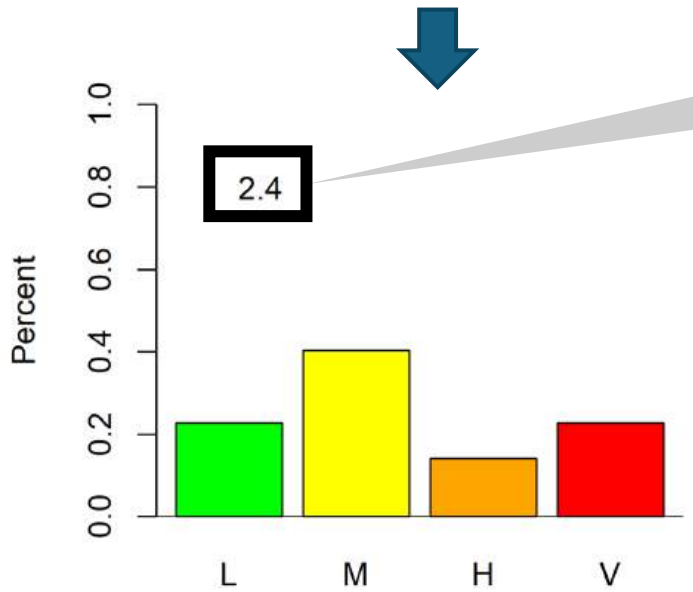
NOAA Technical Memorandum NMFS-OSF-3
October 2015

- Widely used in terrestrial systems, but until recently only a few examples from marine systems
- Use currently existing knowledge and scientific opinion
- Use quantitative data when available, and qualitative information when data are lacking



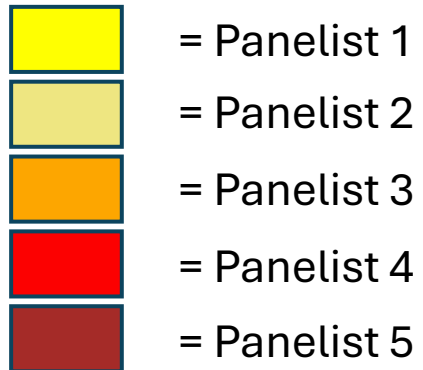
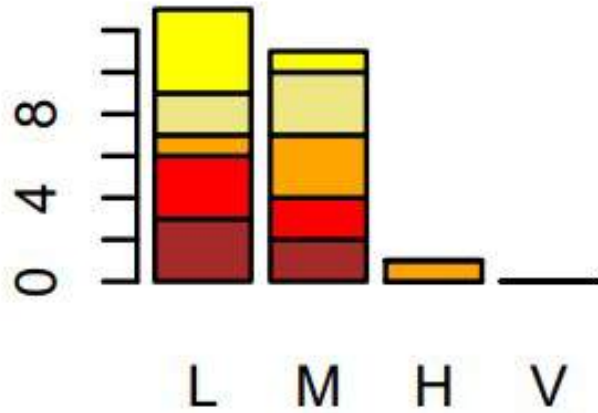


Exposure Factors	Weighted Averages
Mixed layer depth	1.62
Primary production	1.41
pH	4.00
Oxygen at 200m	2.40
Sea surface oxygen	3.29
Sea surface salinity	2.57
Sea surface temperature	3.30
Magnitude of sea surface temp gradient	1.45



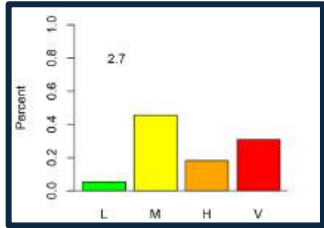
Habitat Specificity

m= 1.5



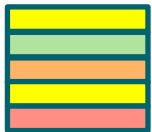
Sensitivity Attributes	Weighted Averages
Adult Mobility	1.28
Habitat Specificity	1.50
Mobility and Dispersal of Early Life Stages	2.00
Other Stressors	1.84
Population Growth Rate	3.24
Prey Specificity	1.56
Reproductive Cycle	2.84
Reproductive Strategy Sensitivity	2.56
Sensitivity to OA	1.60
Sensitivity to Temperature	1.72
Site Fidelity	2.08
Specificity in Early Life History Reqs	2.68
Stock Size / Status	2.56

HMS CVA Process



Exposure Analysis

CMIP6
Species Distributions



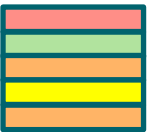
Exposure Rankings

Sensitivity Analysis

Species Profiles
Expert Scoring



Sensitivity Rankings



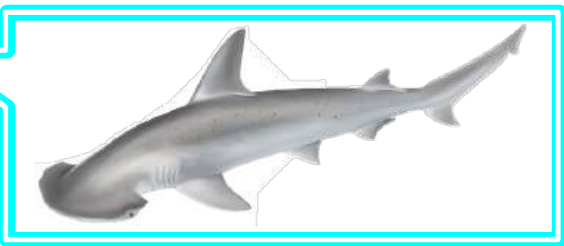
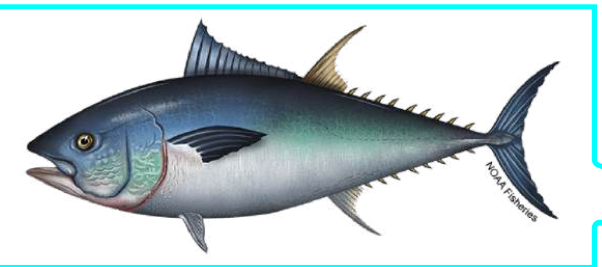
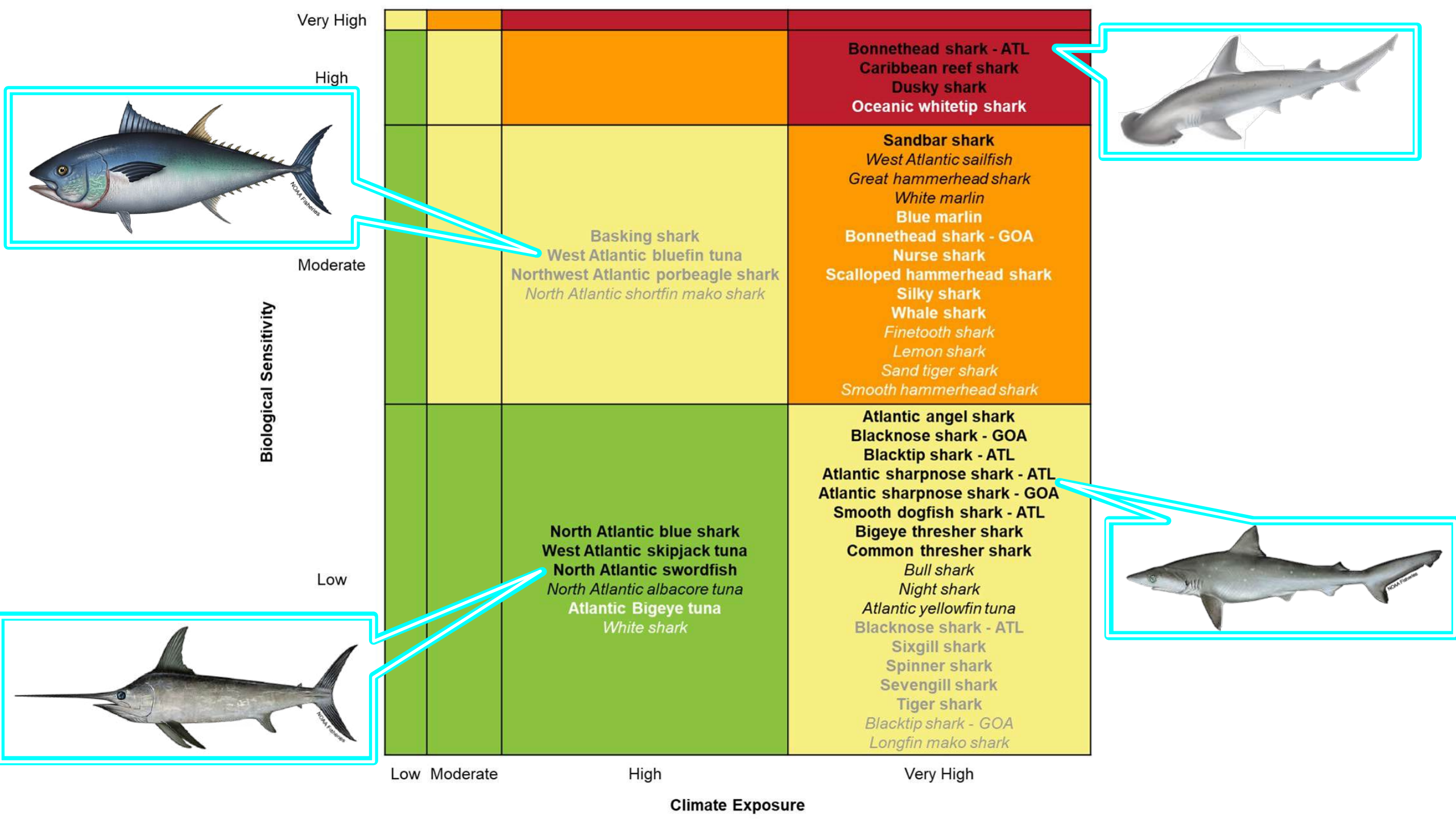
Final Vulnerability Rankings

CVA Methodologies Comparison

Project Element	HMS CVA	NE CVA	SE CVA	GOA CVA
Climate Model	CMIP6	CMIP5	CMIP5	CMIP5
Species Distribution	Atlantic Distribution (multiple regions, federal & international waters)	Regional	Regional	Regional
Functional Groups	All HMS	Fish, invertebrates	Fish, invertebrates	Fish, invertebrates
Sensitivity Analysis	Panel Scoring	Panel Scoring	Panel Scoring	Panel Scoring
Exposure Analysis	Quantitative Analysis	Panel Scoring	Panel Scoring	Panel Scoring



Final Vulnerability Rankings



Atlantic & Gulf of America Bonnethead

Atlantic

Species	Sensitivity Attributes
Population Growth Rate	Moderate
Prey Specificity	High
Site Fidelity	High

×

3

= 12

Species	Exposure Factors
pH	Very High
Sea surface oxygen	Very High
Bottom salinity	Very High
Bottom temperature	Very High

4

Gulf of America

Species	Sensitivity Attributes
Habitat Specificity	Moderate
Prey Specificity	High
Sensitivity to OA	Moderate
Site Fidelity	Moderate

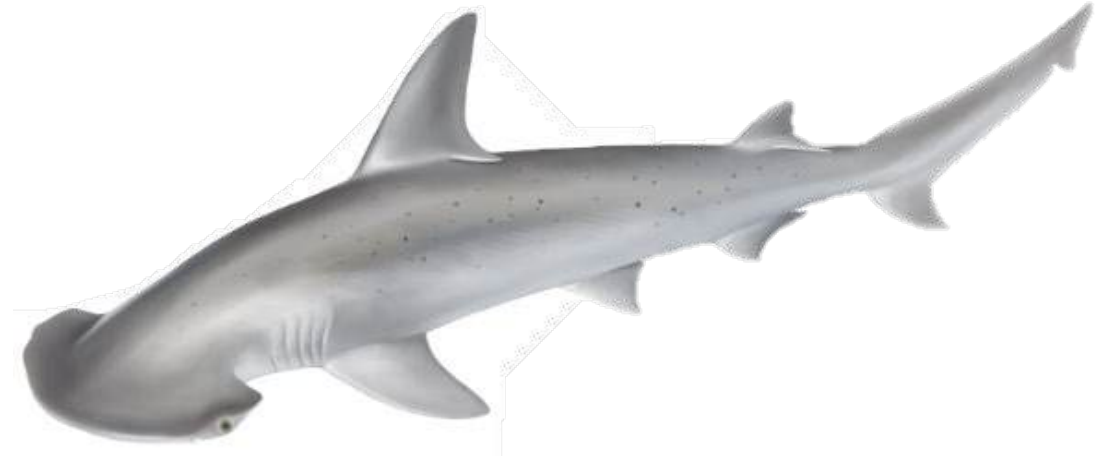
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2

= 8

Species	Exposure Factors
pH	Very High
Sea surface oxygen	Very High
Bottom salinity	Moderate
Bottom temperature	Very High

4



Atlantic: Very High Ranking

Gulf of America: High Ranking

Sensitivity Attribute: Site Fidelity

RESEARCH ARTICLE

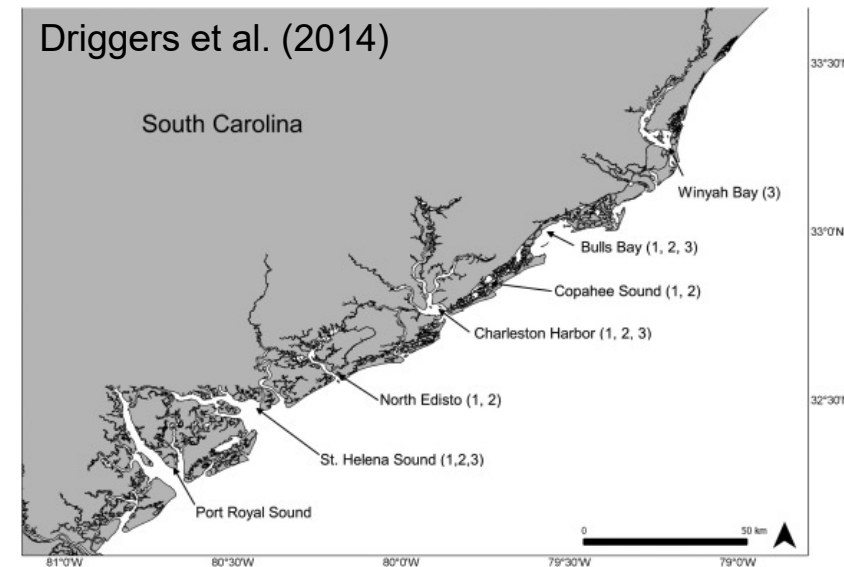
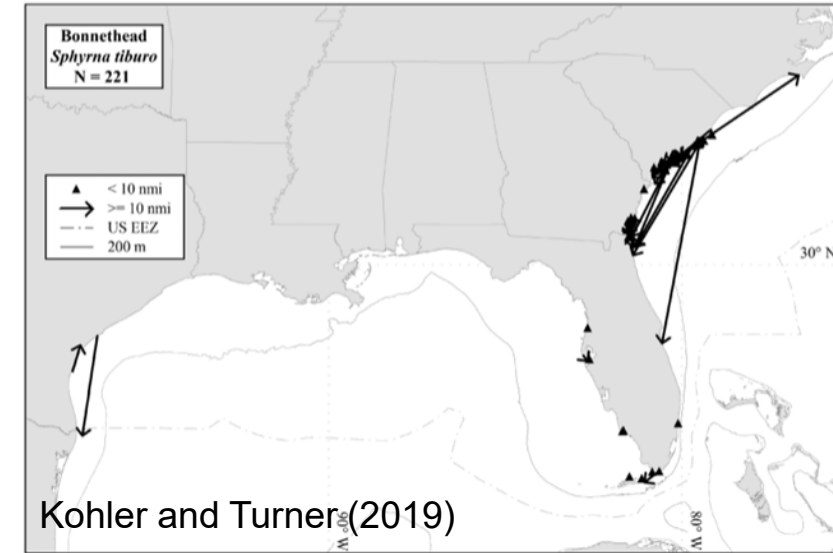
Vulnerability to climate change of United States marine mammal stocks in the western North Atlantic, Gulf of Mexico, and Caribbean



Gulf of America

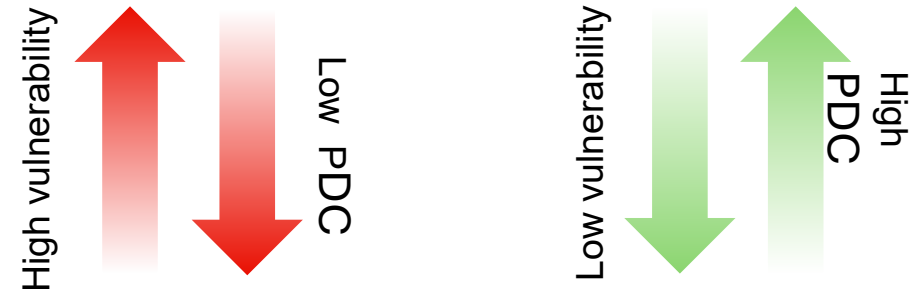


Atlantic

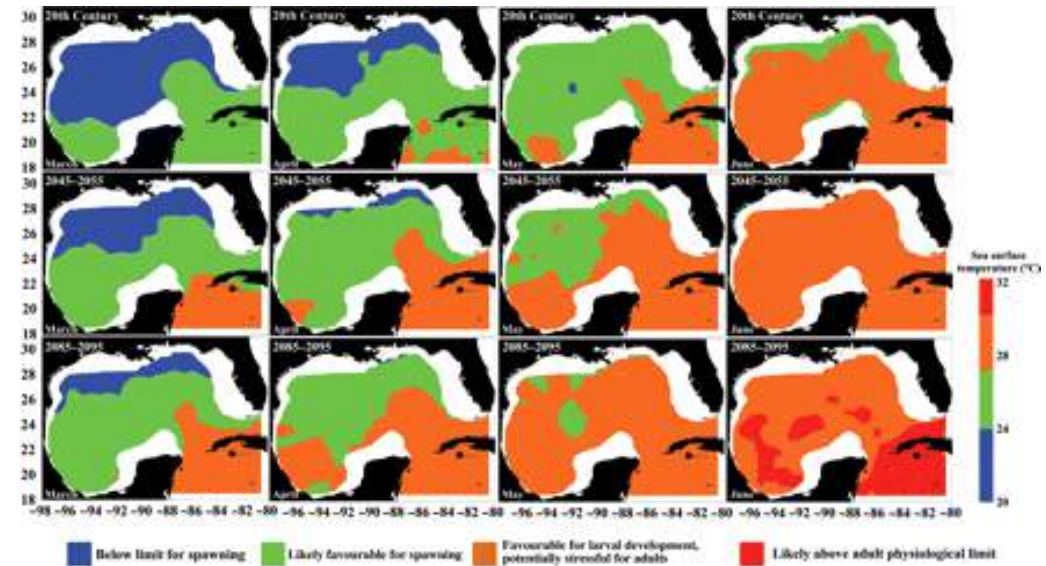
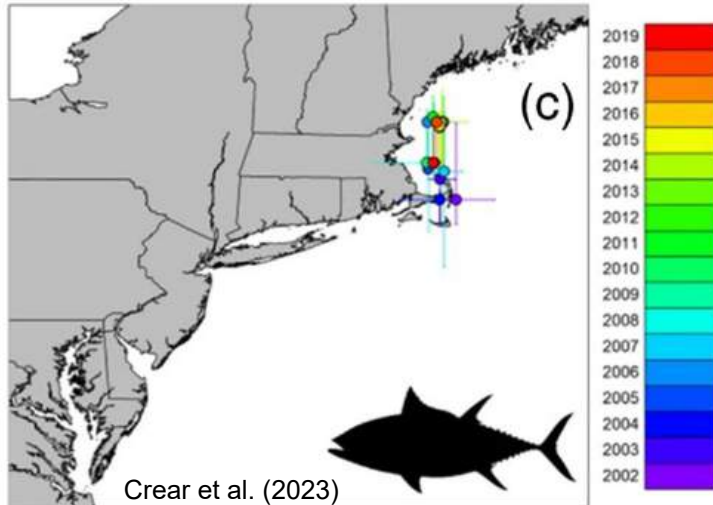


Potential for Distributional Change Analysis

Adult Mobility • Habitat Specificity • Mobility and Dispersal of Early Life Stages

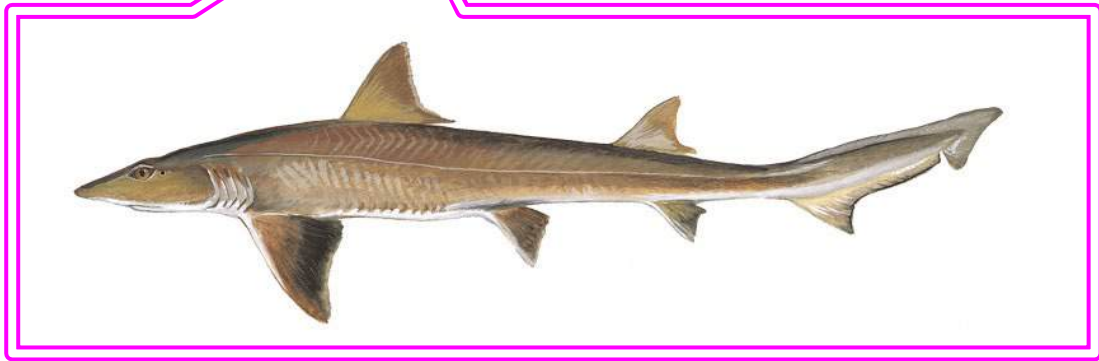


$3 \pm 1 \text{ km}^\circ\text{C}^{-1}$
80 days



Biological Sensitivity

Very High	
High	
Moderate	Bigeye sand tiger shark Galapagos shark Roundscale spearfish Smalltail shark
Low	Bigeye sixgill shark Bignose shark Caribbean sharpnose shark Florida smoothhound shark Gulf smoothhound shark Longbill spearfish Narrowtooth shark Smooth dogfish shark - GOA



Smooth Dogfish - Gulf of America

Sensitivity Attributes Scores

Species	Sensitivity Attributes
Habitat Specificity	Low
Prey Specificity	Low
Sensitivity to OA	Low
Reproductive Strategy Sensitivity	Low
Sensitivity to Temperature	Low
Specificity in Early Life History Reqs	Low
Stock Size/Status	Low
Other Stressors	Low
Population Growth Rate	Low
Mobility and Dispersal of Early Life Stages	Low
Adult Mobility	Low
Reproductive Cycle	Low
Site Fidelity	Low

1



Exposure Factors Scores

Species	Exposure Factors
Mixed layer depth	-
Magnitude of sea surface temp gradient	-
Oxygen at 200m	-
pH	-
Primary productivity	-
Sea surface oxygen	-
Sea surface salinity	-
Sea surface temperature	-



?

**Low Sensitivity
Smooth Dogfish
(Gulf of America Stock)**

CVA Vulnerability Ranking Comparisons

Species	HMS CVA	NE CVA	SE CVA	GOA CVA
Dusky	Very High	High	Very High	High
Great hammerhead	High	-	-	High
Scalloped hammerhead	High	-	-	High
Lemon	High	-	-	Moderate
Nurse	High	-	-	Low
Porbeagle	Moderate	High	-	-
Sand tiger	High	High	High	-
Sandbar	High	-	High	Moderate
Tiger	Moderate	-	-	Moderate
Smooth dogfish	Moderate	Low	-	-
Atlantic sharpnose	Moderate	-	High	Low
GOM Blacknose shark	Moderate	-	-	Low
GOM Blacktip shark	High	-	-	Low
Atlantic Bonnethead	Very High	-	High	
GOM Bonnethead	High			Low
Finetooth	High	-	-	Moderate



Where can I find HMS CVA results?

- Publication
- Species Narratives
- CVA Toolkit
- Website

Climate Vulnerability Assessment Tool

This tool displays measurements for how vulnerable different species are to the effects of a changing climate. Scores are derived by experts to determine how much a particular species is exposed to a changing environment, and how sensitive it is to these changes. This can help broaden our understanding, which can be helpful in making decisions about how to protect them.

Dataset

Atlantic Highly Migra

Atlantic Highly Migratory Species Scores
Blue Marlin

Functional Group

Billfish and Swordfish

Common Name

Blue Marlin

Legend

Very High
High
Moderate
Low

Overall Vulnerability



Sensitivity



Exposure



Sensitivity Attributes

Other Stressors	1.8	1.9
Population Growth Rate	2.6	1.5
Prey Specificity	1.6	2.1
Reproductive Cycle	2.2	2.2
Reproductive Strategy Sensitivity	1.8	1.2
Sensitivity to Ocean Acidification	1.8	1.2
Sensitivity to Temperature	2.5	2.6
Site Fidelity	1.9	1.7
Specificity in Early Life History Requirements	2.1	1.2
Stock Size and Status	3.1	2.6

Mean

Data Quality

Expert Scores Plots



Low Medium High Very High

CVAs: Past, Present, and Future

- Atlantic HMS
- Pacific Islands
- Northeast
- South Atlantic
- Gulf of America
- Atlantic Marine Mammals
- Caribbean (In Progress)

Current FCVAs

- Pacific Salmon
- Bering Sea
- California Current
- Pacific Islands



Developments in CVA methodology

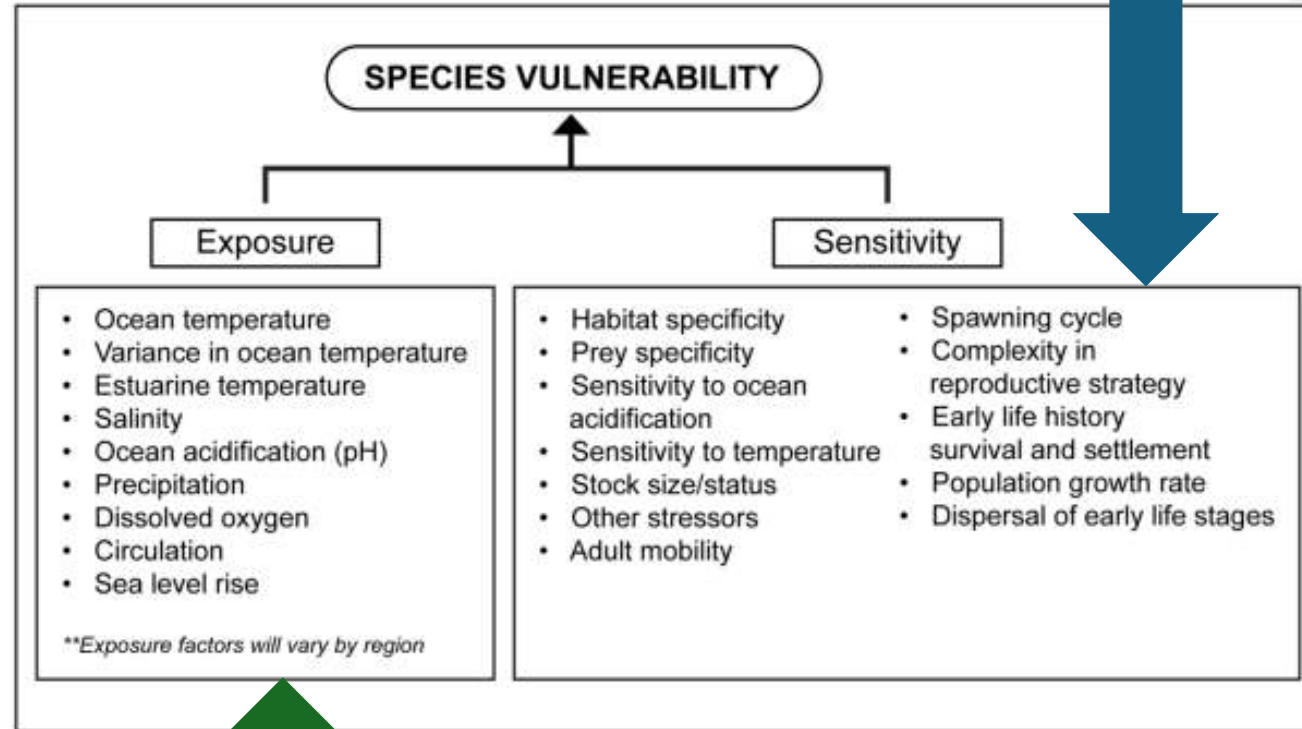
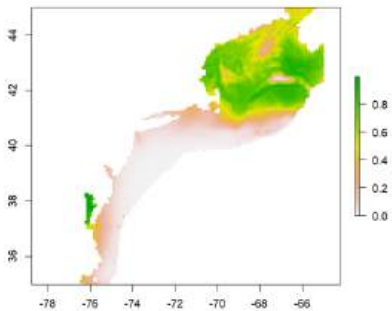
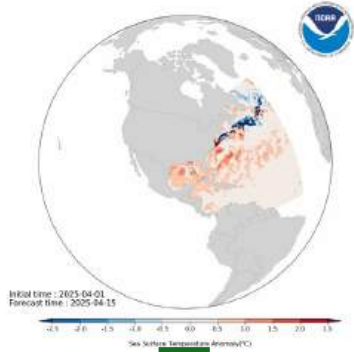
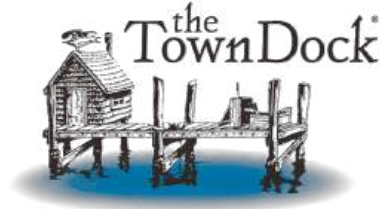
- NE CVA 2.0 (In Progress)
- CVA Retrospective & Framework (Farchadi et al. 2026; Braun et al. 2026)
- Adaptive capacity (Boyce et al. 2022)
- Decision trees and variable weighting (Champion et al. 2023)

Northeast CVA 2.0



NOAA
FISHERIES

VIMS | WILLIAM & MARY
VIRGINIA INSTITUTE OF MARINE SCIENCE



Questions?

Email: tyler.loughran@noaa.gov

A climate vulnerability assessment for U.S. highly migratory fishes in the Atlantic Ocean

TC Loughran*, JL Cudney*, DP Crear*, LM Crawford, BJ Curtis, EM Guitierrez, ER Hoffmayer, CT McCandless, ES Orbesen, BA Keller, DW Kerstetter, DJG Snodgrass, WE Morrison, JA Quinlan, RB Griffis, PW Cooper

