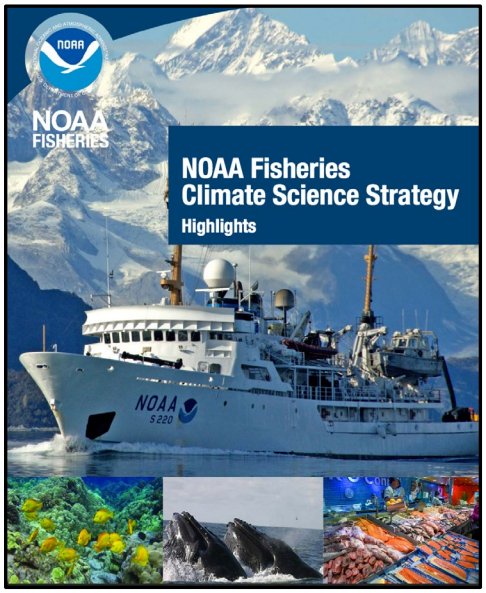
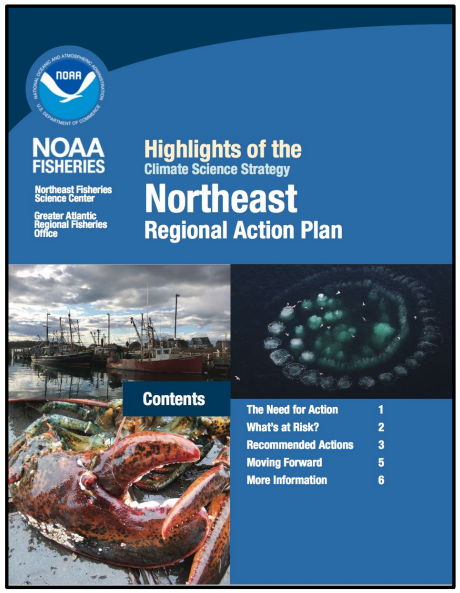
Northeast Regional Action Plan to Implement the NOAA Fisheries Climate Science Strategy in 2022 - 2024

Vincent Saba

NOAA Northeast Fisheries Science Center





Presentation Outline

1) Observed change in the U.S. Northeast Shelf.

2) National Climate Science Strategy and Northeast Regional Action Plan (NERAP 1.0).

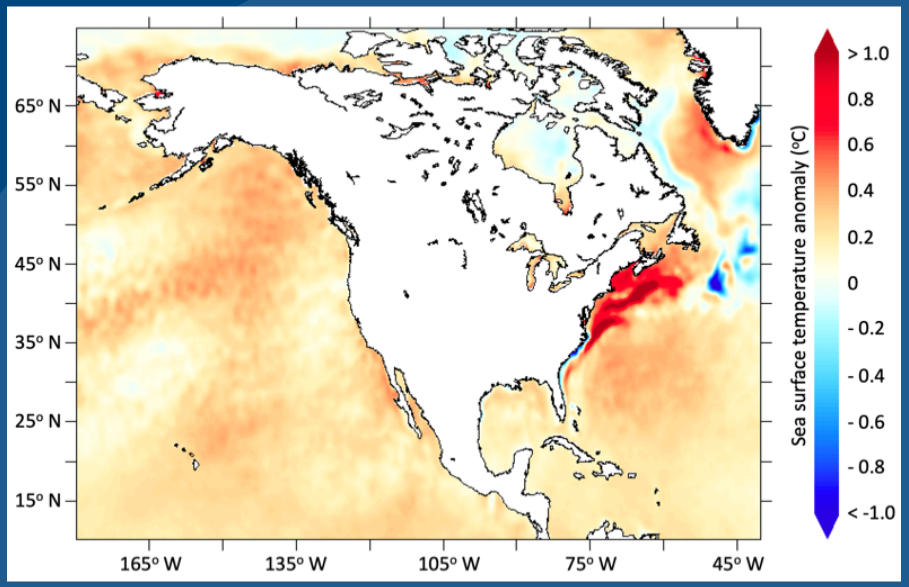
3) NERAP 1.0 accomplishments over the last five years.
   - Climate vulnerability assessments, scenario planning, laboratory studies, stock assessments, species distribution projections.

4) NERAP 2.0 (FY22-FY24).

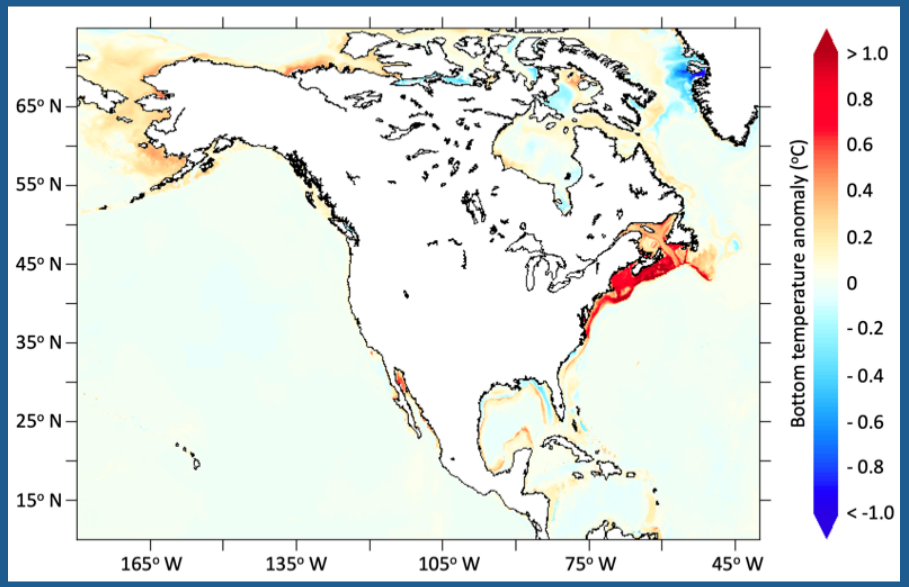
Northeast Regional Action Plan 2.0 contributors

Diane Borggaard, Joseph Caracappa, Patricia Clay, Lisa Colburn, Mathias Collins, Jonathan Deroba, Geret DePiper, Paula Fratantoni, Marianne Ferguson, Sean Hayes, Kimberly Hyde, Kristen Jabanoski, Michael Johnson, John Kocik, Ellen Keane, Dan Kircheis, Scott Large, Andrew Lipsky, Sean Lucey, Anna Mercer, Shannon Meseck, Timothy Miller, Christopher Orphanides, Julie Reichert, Ronald Vogel, Bruce Vogt, Gary Wikfors

U.S. Northeast Shelf - Warming



Sea surface temperature

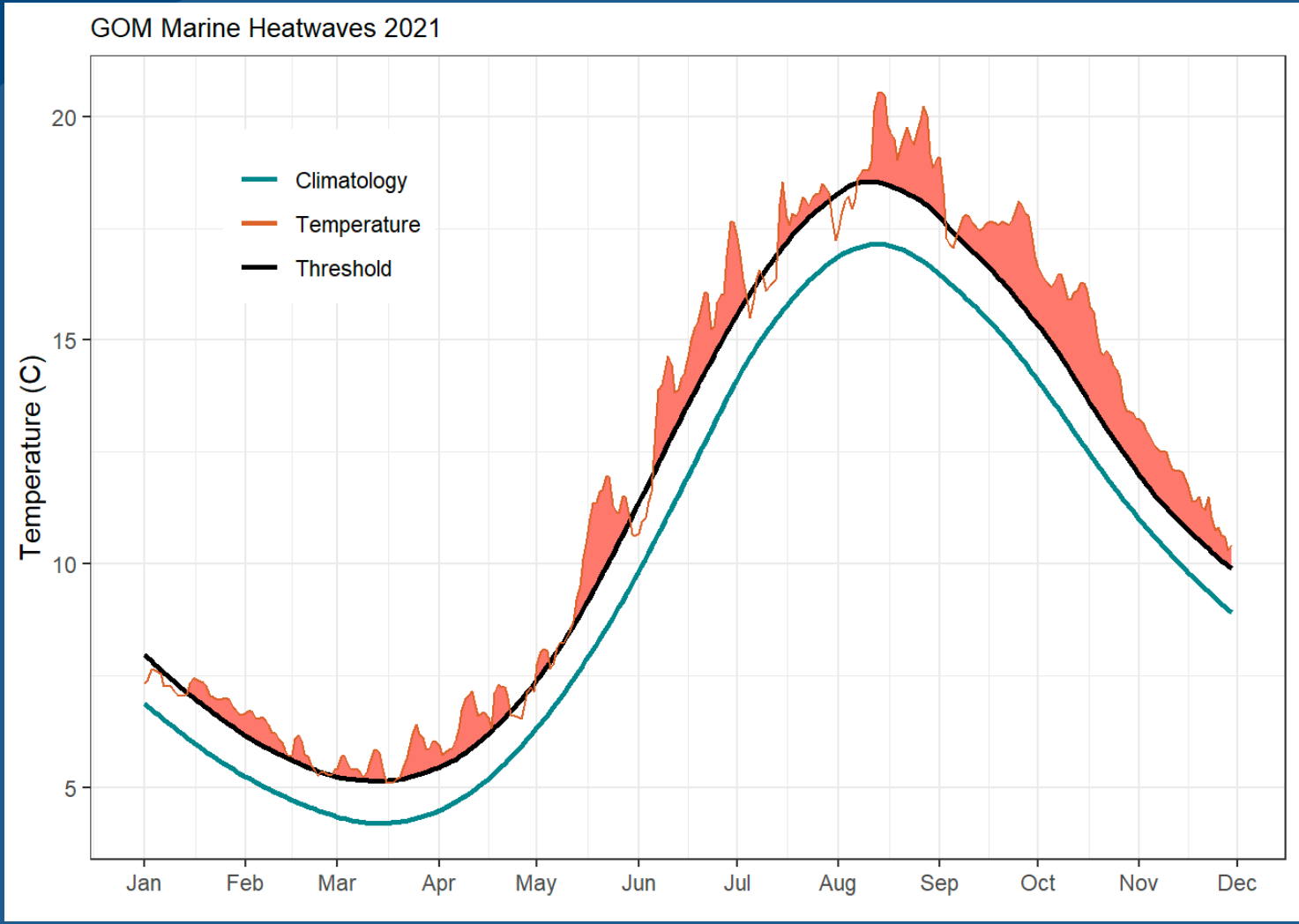


Ocean bottom temperature

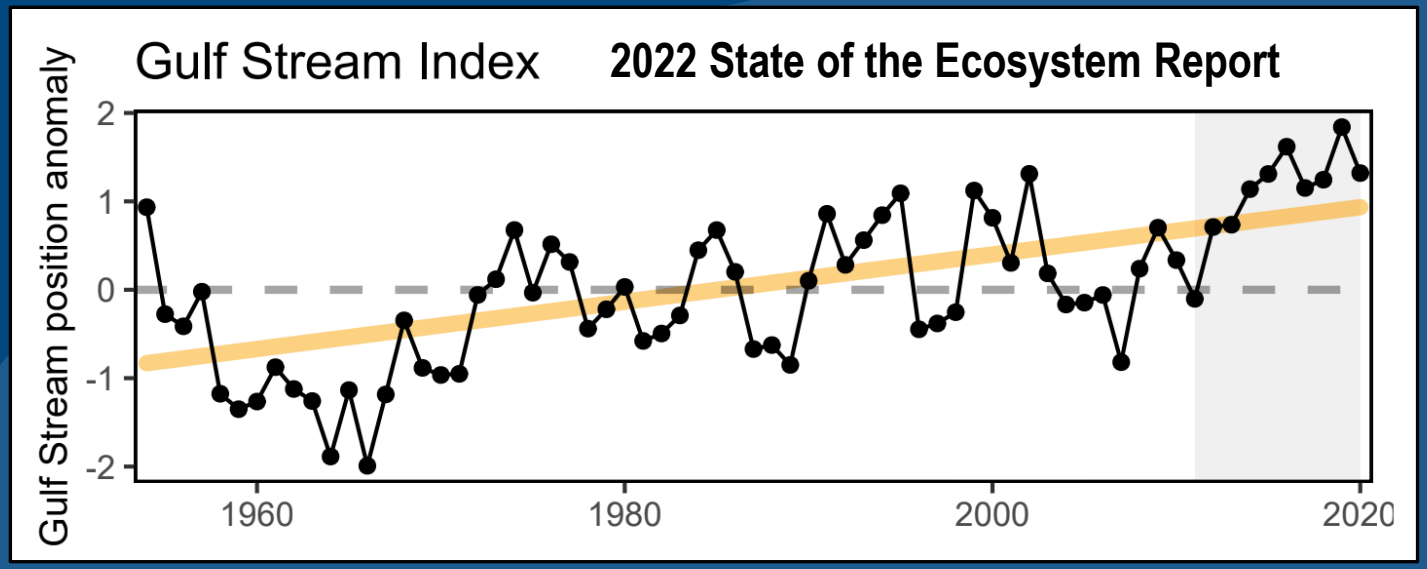
Anomaly is based on the average temperature from 2010-2019 relative to the historical climatology from 1993-2019.

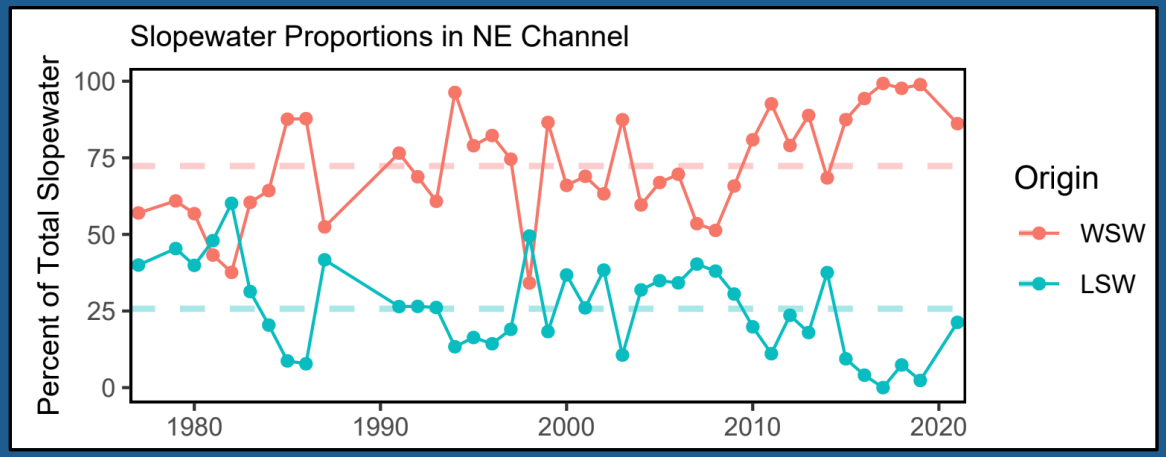
U.S. Northeast Shelf – Marine Heatwaves

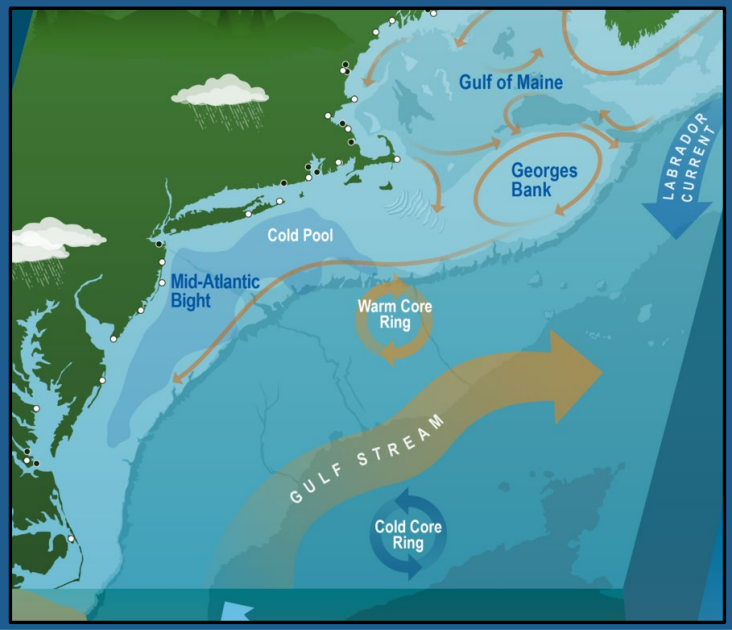
2022 State of the Ecosystem Report



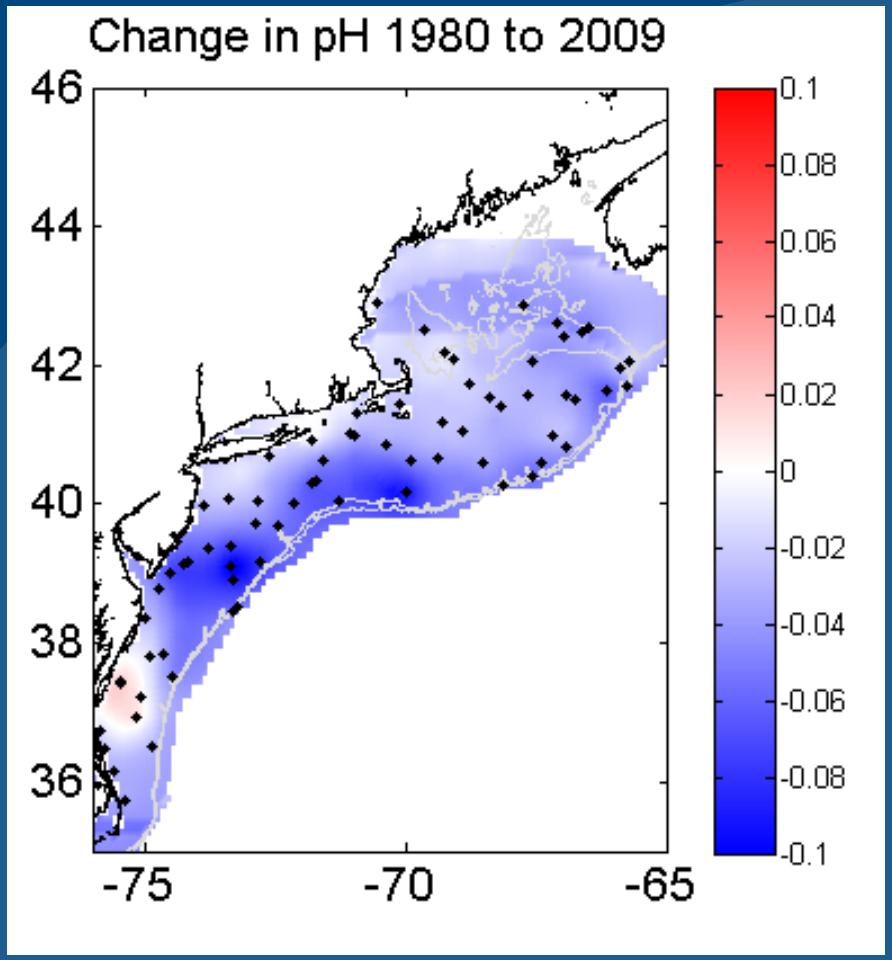
Gulf Stream Index, Slope Waters

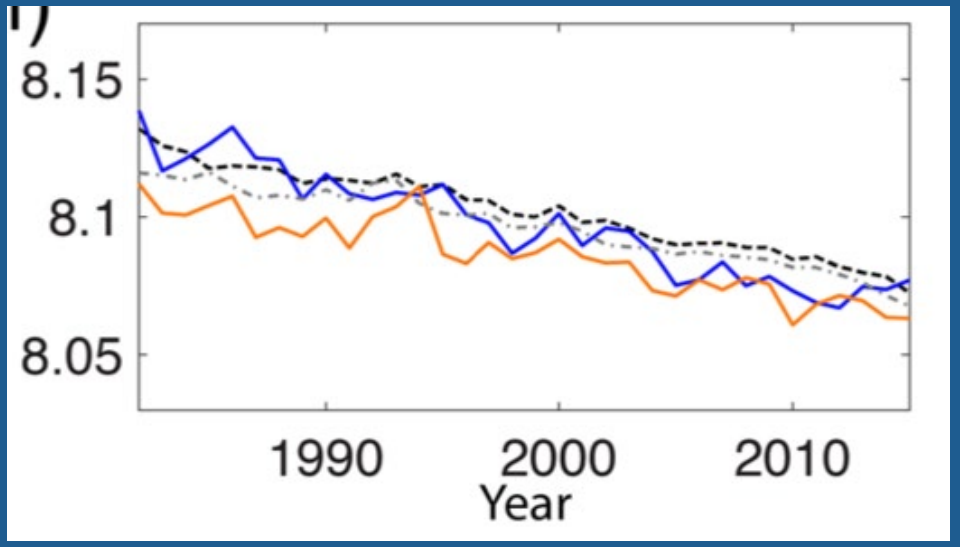






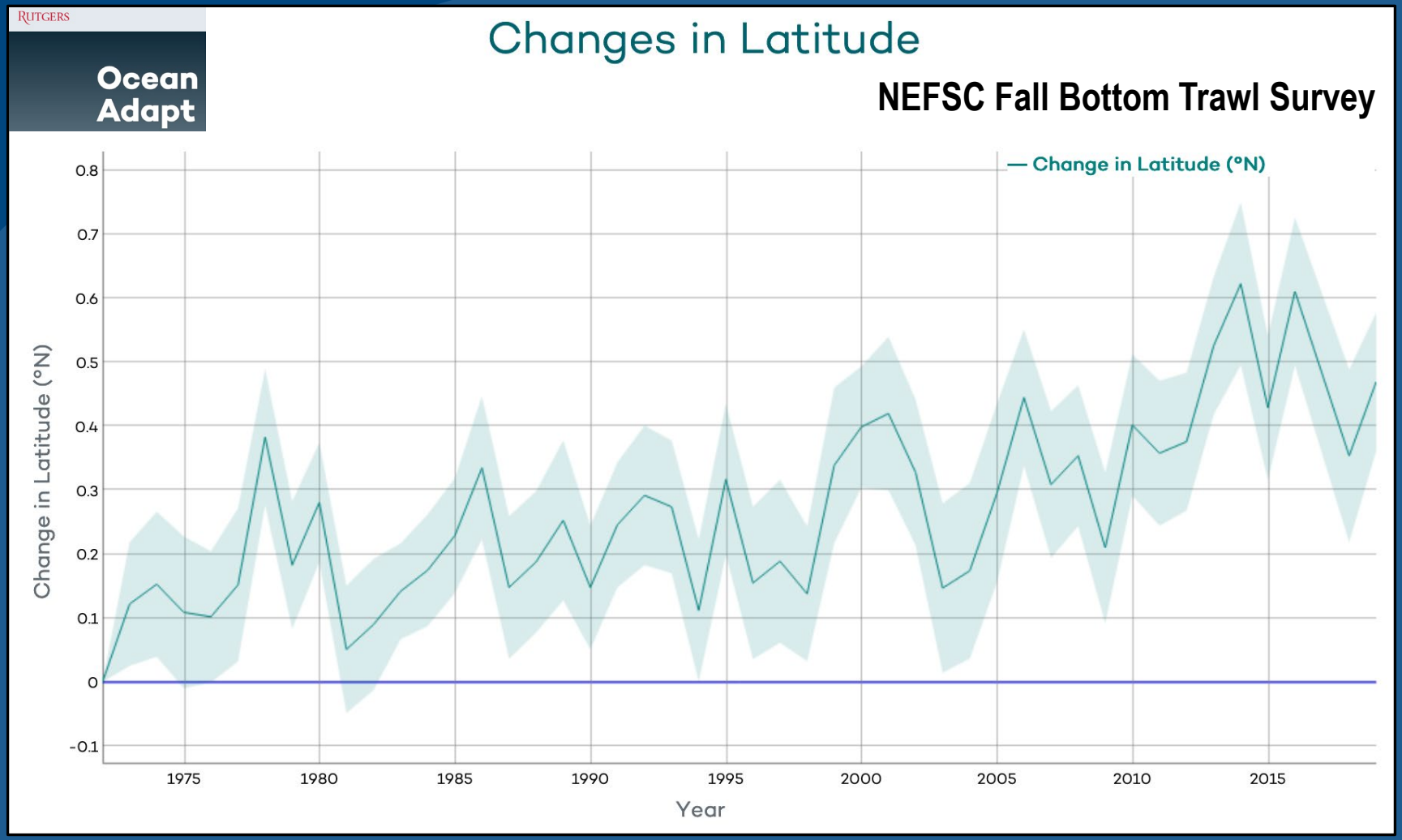
Surface pH – U.S. NES



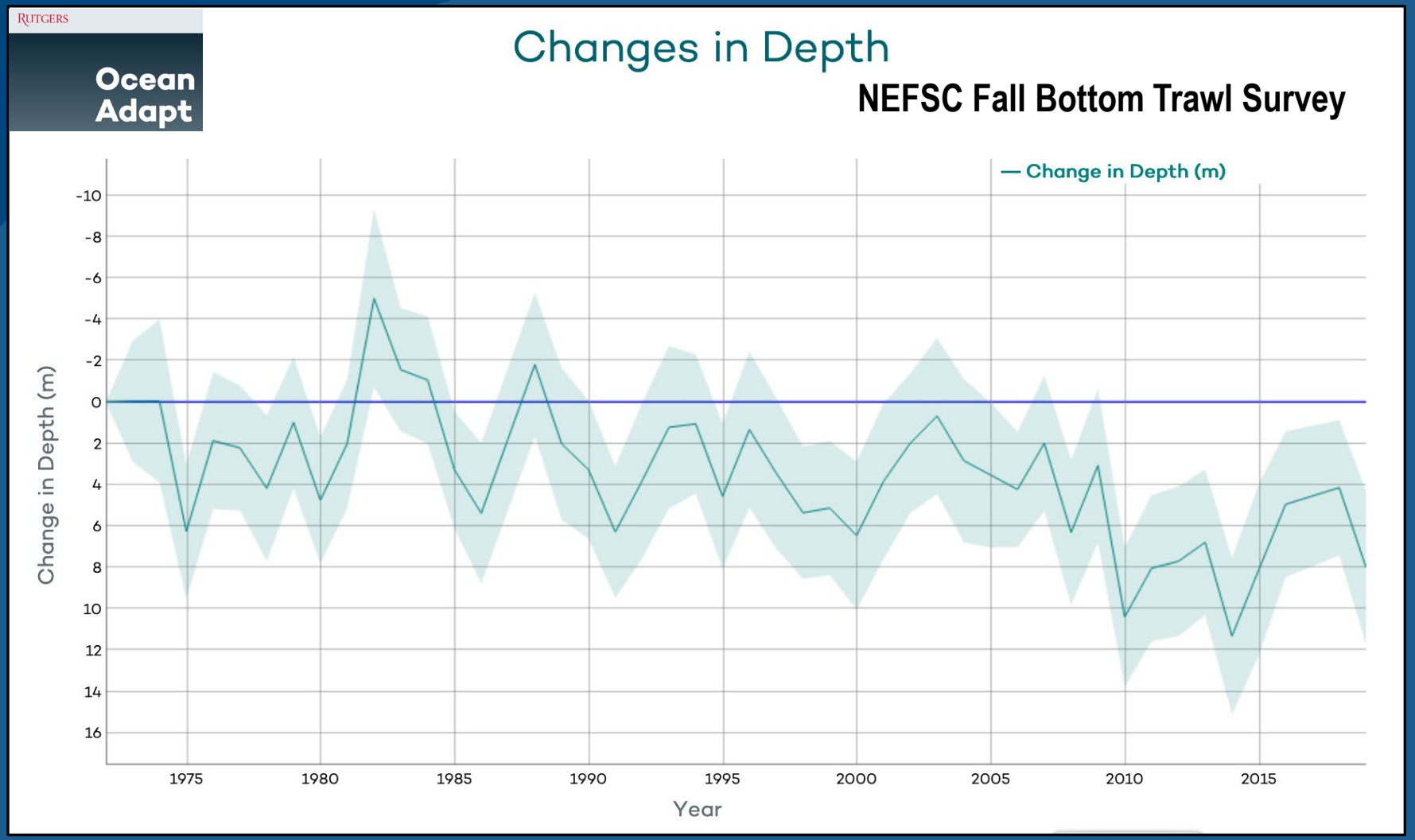


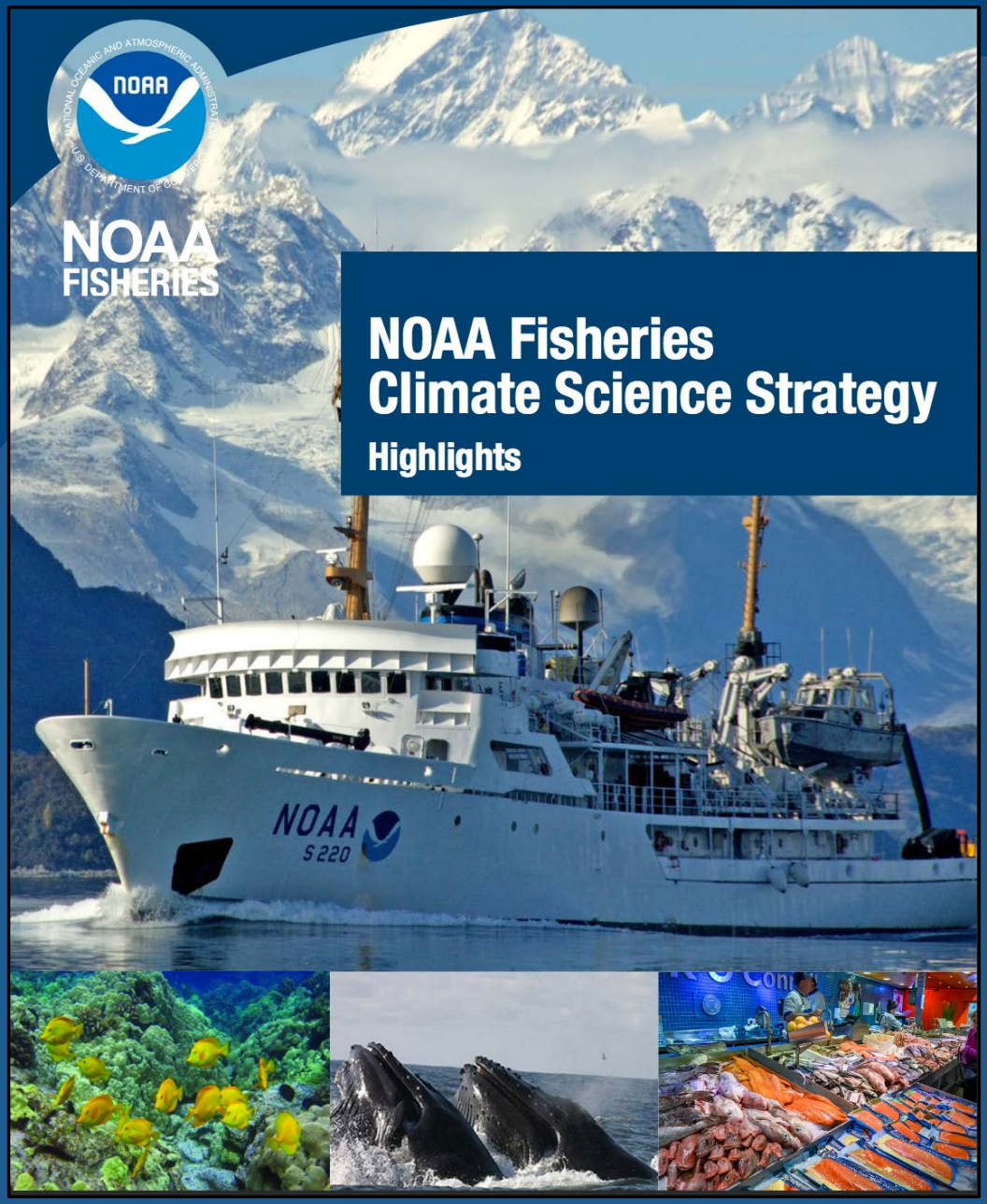
Xu et al. 2020

Warming ocean, fish on the move



Warming ocean, fish on the move



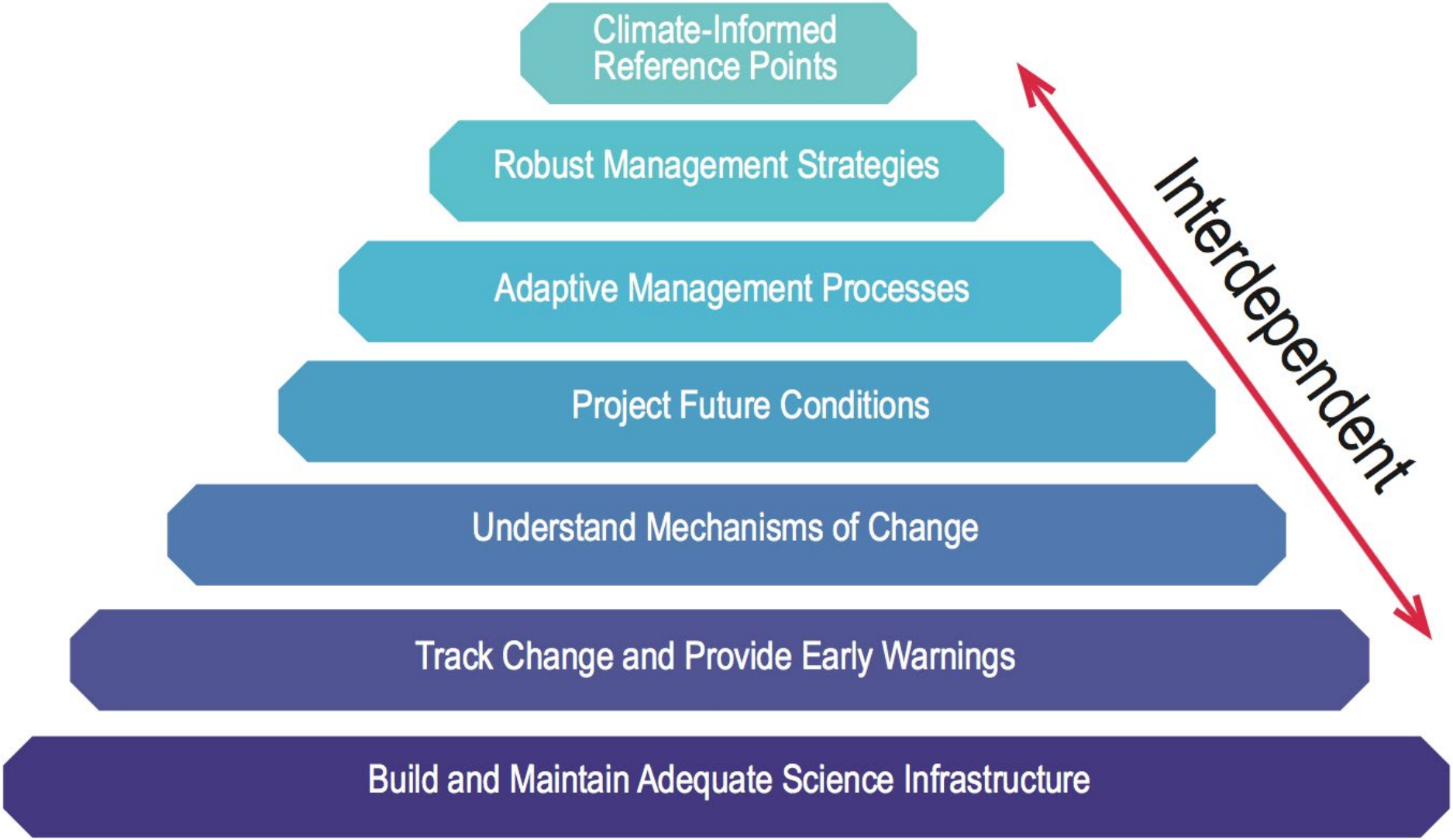


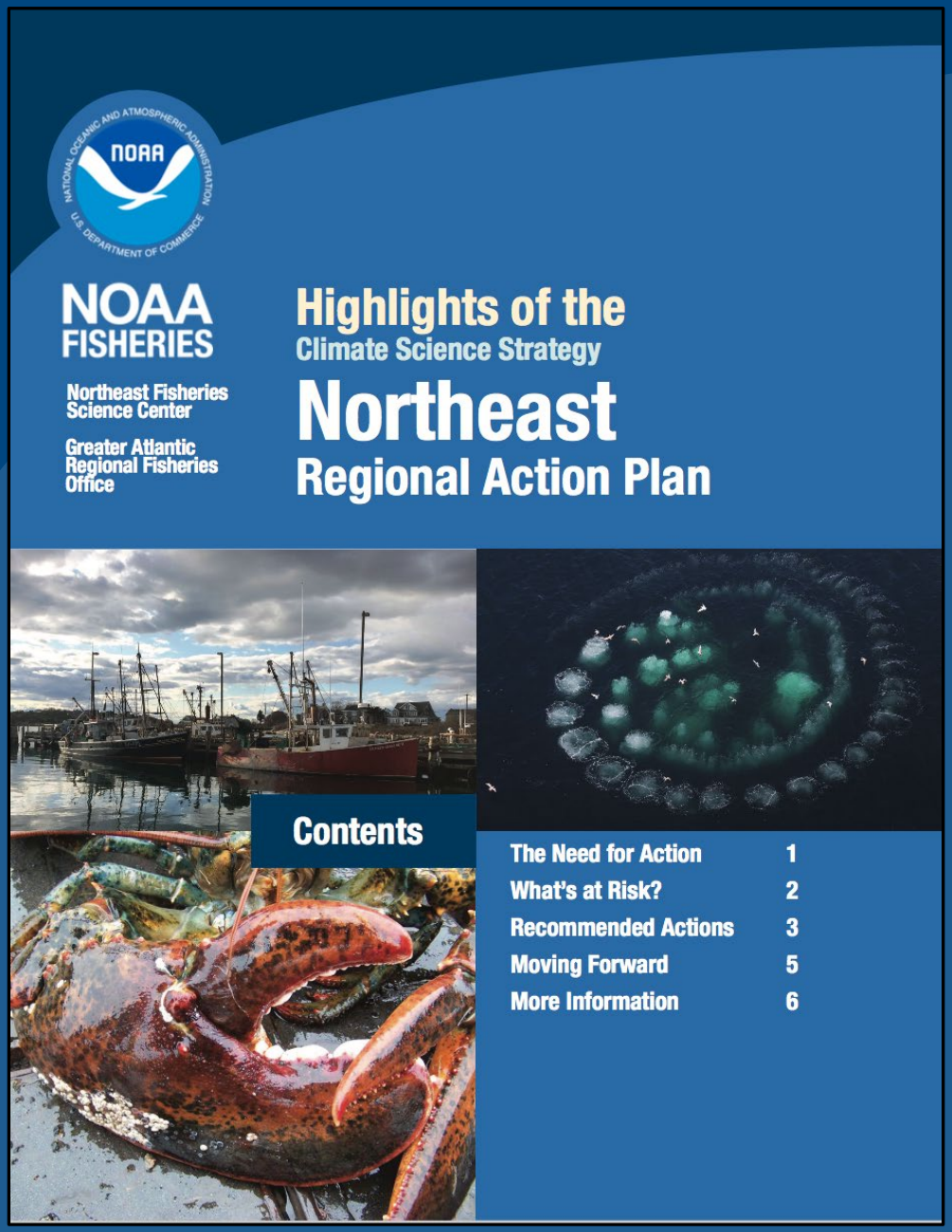
"The Strategy is part of a proactive approach to increase the production, delivery and use of climate-related information to fulfill NOAA Fisheries mandates in a changing climate. Implementing this Strategy will help reduce impacts and increase the resilience of our valuable living marine resources, and the people, businesses, and communities that depend on them."

- Eileen Sobeck
Former Fisheries
Assistant Administrator

(Link et al. 2015)

Climate Science Strategy Objectives

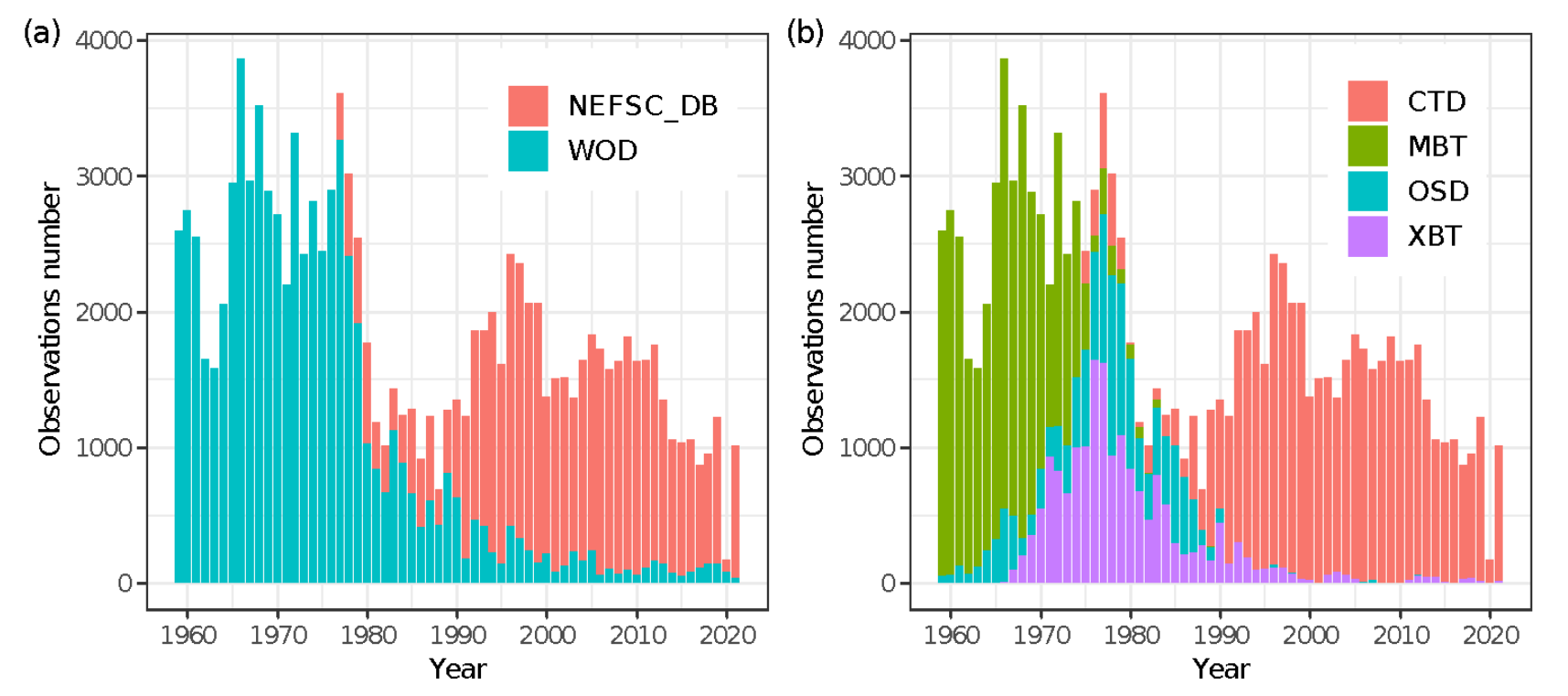




The Northeast Regional Action Plan (Hare et al. 2016) identifies 15 NERAP Actions of highest priority.

NERAP 2.0 (Saba et al.) is in public review.

NERAP 2.0 identifies 10 priority actions over the next 3 years (FY22-FY24).

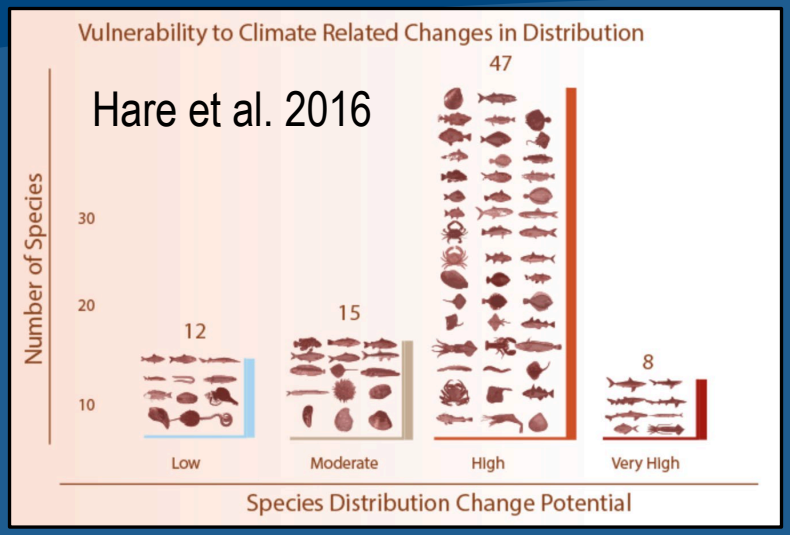

(a)
Observations number
4000
3000
2000
1000
0
1960
1970
1980
1990
2000
2010
2020
Year
NEFSC_DB
WOD
(b)
Observations number
4000
3000
2000
1000
0
1960
1970
1980
1990
2000
2010
2020
Year
CTD
MBT
OSD
XBT

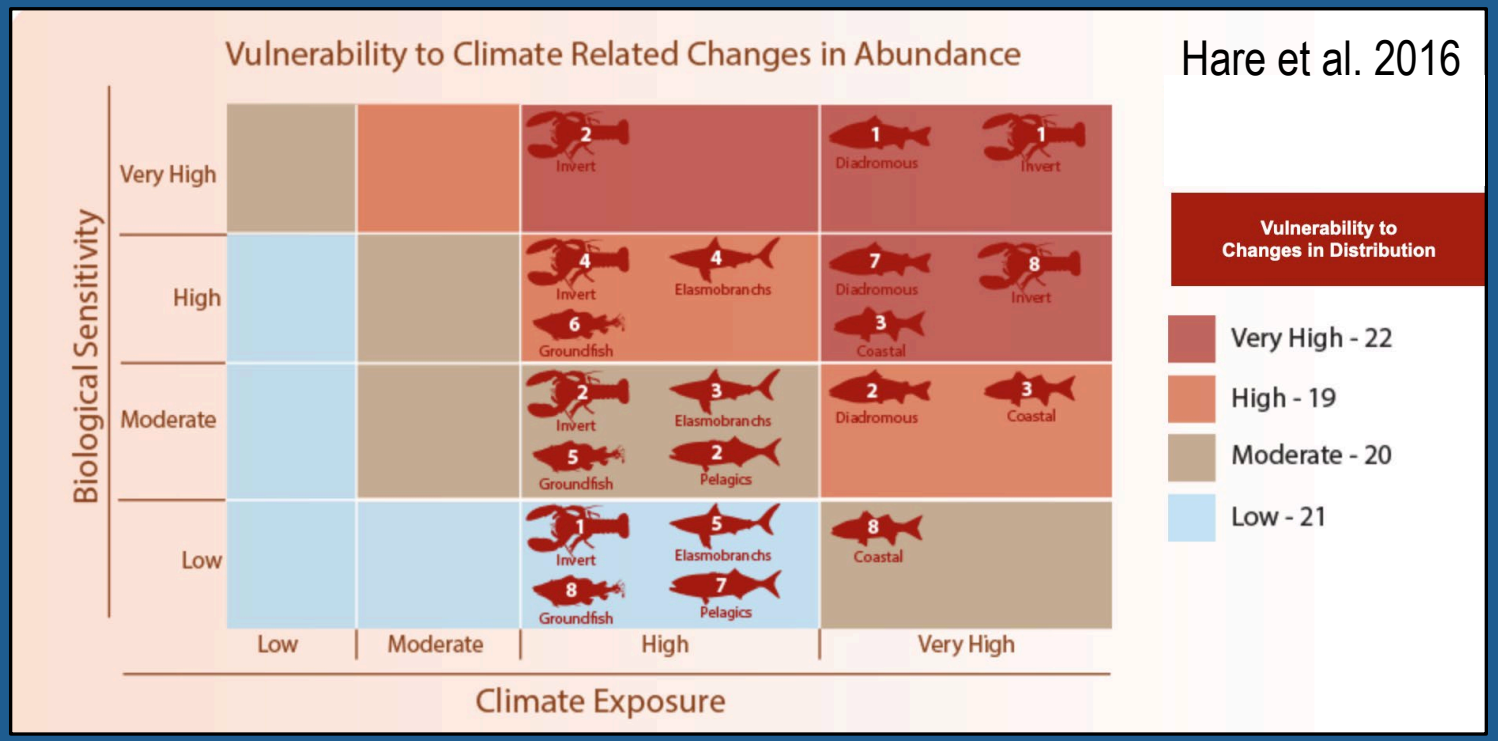
Climate vulnerability

RESEARCH ARTICLE

A Vulnerability Assessment of Fish and Invertebrates to Climate Change on the Northeast U.S. Continental Shelf

Jonathan A. Hare[1]*, Wendy E. Morrison[2], Mark W. Nelson[2], Megan M. Stachura[3¤a], Eric J. Teeters[2], Roger B. Griffis[4], Michael A. Alexander[5], James D. Scott[5], Larry Alade[6], Richard J. Bell[1¤b], Antonie S. Chute[6], Kiersten L. Curti[6], Tobey H. Curtis[7], Daniel Kircheis[8], John F. Kocik[8], Sean M. Lucey[6], Camilla T. McCandless[1], Lisa M. Milke[9], David E. Richardson[1], Eric Robillard[6], Harvey J. Walsh[1], M. Conor McManus[10¤c], Katrin E. Marancik[10], Carolyn A. Griswold[1]





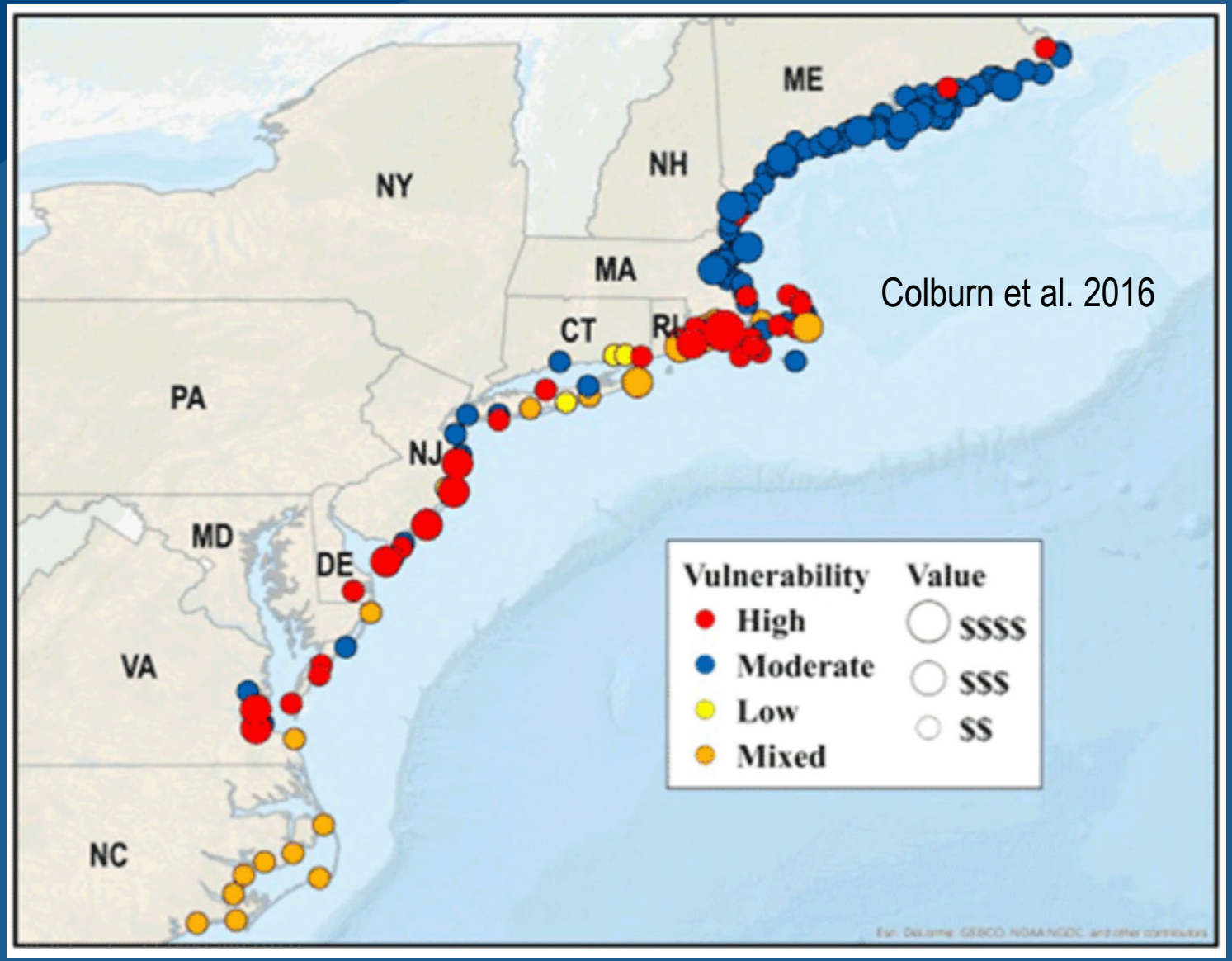
Climate vulnerability

RESEARCH ARTICLE

An assessment of marine, estuarine, and riverine habitat vulnerability to climate change in the Northeast U.S.

Emily R. Farr[1]*, Michael R. Johnson[2], Mark W. Nelson[3], Jonathan A. Hare[4], Wendy E. Morrison[5], Matthew D. Lettrich[3], Bruce Vogt[6], Christopher Meaney[7], Ursula A. Howson[8], Peter J. Auster[9], Frank A. Borsuk[10], Damian C. Brady[11], Matthew J. Cashman[12], Phil Colarusso[13], Jonathan H. Grabowski[14], James P. Hawkes[15], Renee Mercaldo-Allen[16], David B. Packer[17], David K. Stevenson[2]

Climate vulnerability



Scenario Planning – Atlantic Salmon and NA Right Whales

Scenario Planning

- Helps manage risk & prioritize management actions
- Identifies data gaps & science priorities
- Outcomes contribute to data modeling/ management strategy evaluations

Pilot Purpose

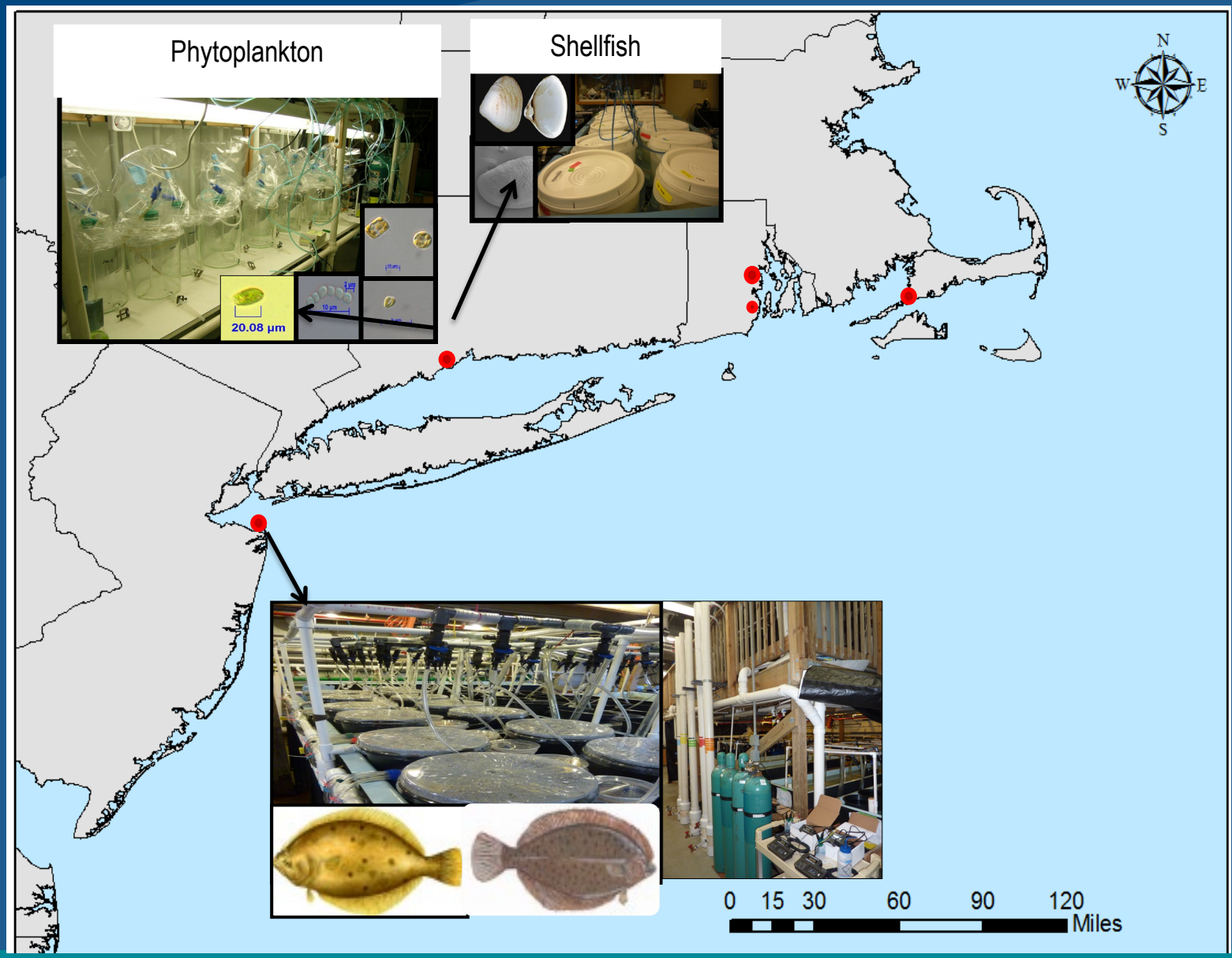
- Apply scenario planning within NMFS
- Explore what NMFS can do to improve species resilience in the face of climate change.

Successful Outcome Examples

- Identification of high priority actions
- NMFS considering additional training & applications of scenario planning

- East Coast Climate Change Scenario Planning underway

Laboratory Studies



Incorporating climate information into assessment variables

- Progress on climate-enhanced stock assessment variables (e.g. demographics, recruitment, population growth) has been moving forward on key commercial and recreational species including southern New England yellowtail flounder (Miller et al. 2016a, Xu et al. 2018), summer flounder (O'Leary et al. 2019, O'Leary et al. 2020), winter flounder (Bell et al. 2018), northern shrimp (Cao et al. 2017), Atlantic cod (Miller et al. 2018), surf clam (Hennen et al. 2018), and black sea bass (Miller et al. 2016b).

- The Woods Hole Assessment Model (WHAM) was developed by scientists at the NEFSC and it can be used to support climate-enhanced stock assessments via the incorporation of time-varying processes with links to environmental covariates (Stock and Miller, 2021).

- A framework has been developed for incorporating climate and habitat information into fisheries management using risk assessment and management strategy evaluation (Gaichas et al. 2016). Support was provided to the Mid-Atlantic Fisheries Management Council risk assessment (Gaichas et al. 2018), which included the results from the climate vulnerability analysis and habitat shifts into a conceptual model for high risk summer flounder fisheries in 2019 (DePiper et al. 2021).

Northeast Climate Integrated Modeling (NCLIM)

Climate-Ocean Models

Ecosystem and Population Models

Human Dimension models

NCLIM Synthesis and Coordination

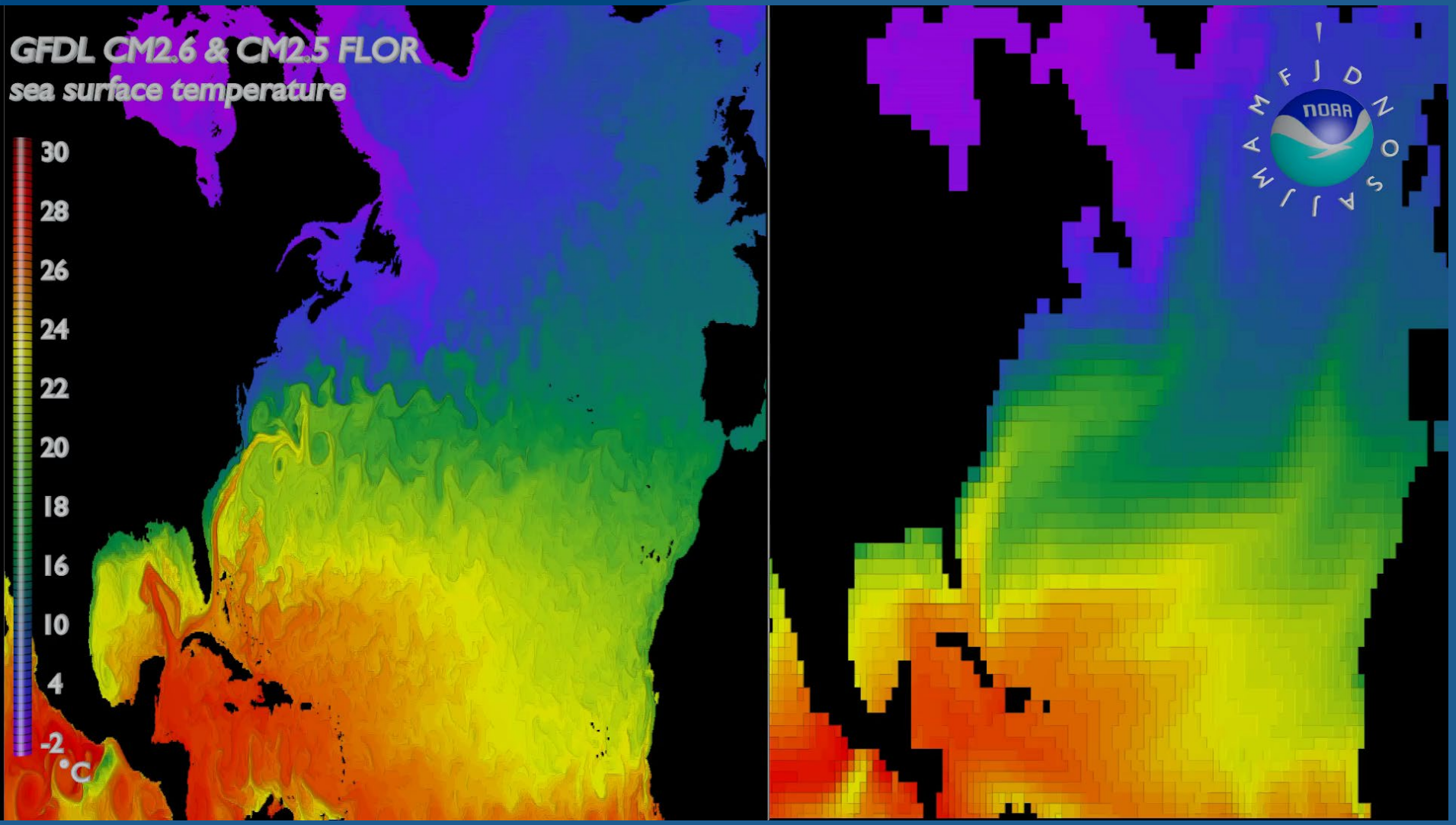
Management Process

Stakeholder Engagement

Tactical decision-making

Long term management strategies

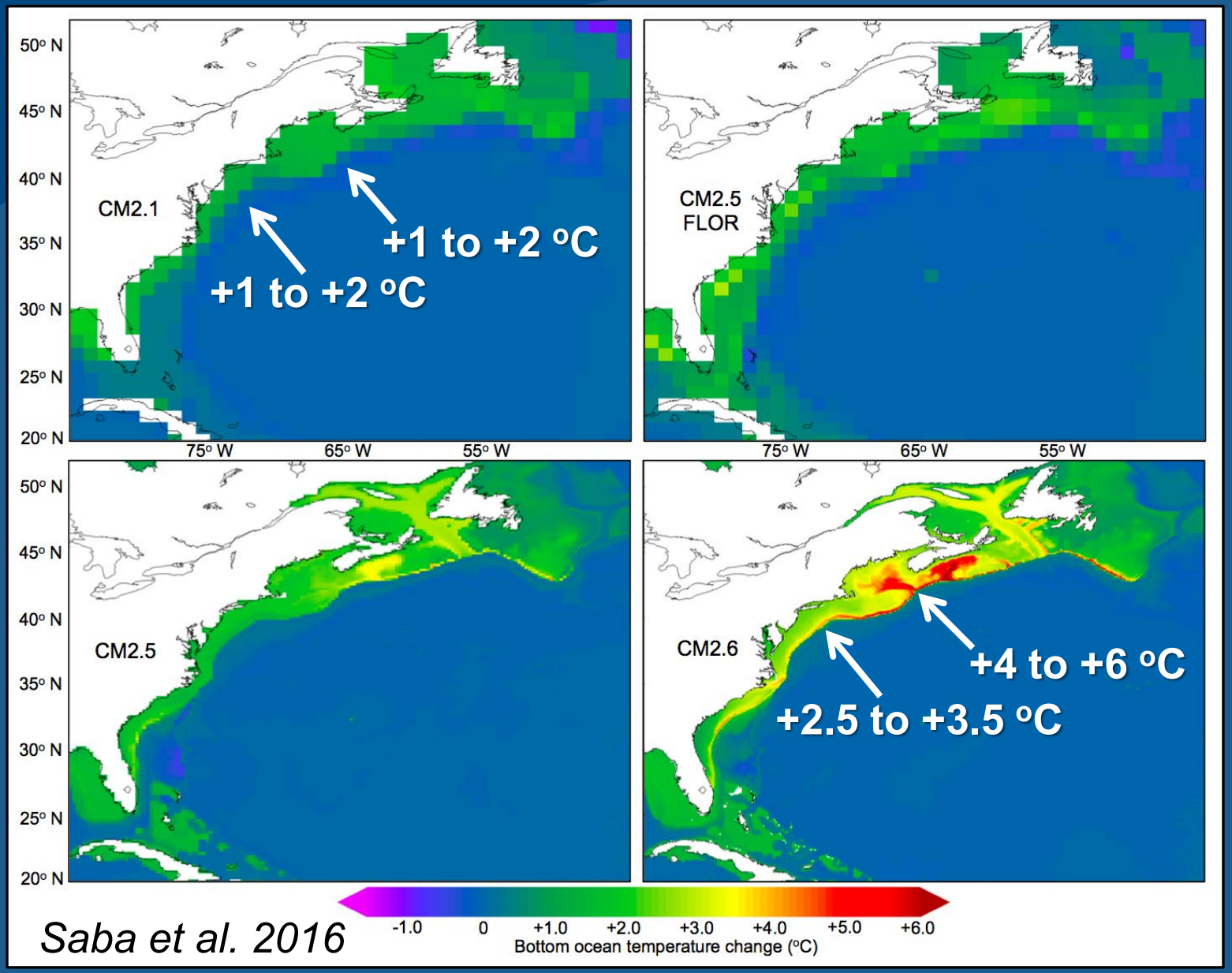
Global Climate Models: Resolution



High-Resolution Ocean (10-km)

Low-Resolution Ocean (100-km)

Northwest Atlantic – Projected ocean warming ($2xCO_2$)



Saba et al. 2016

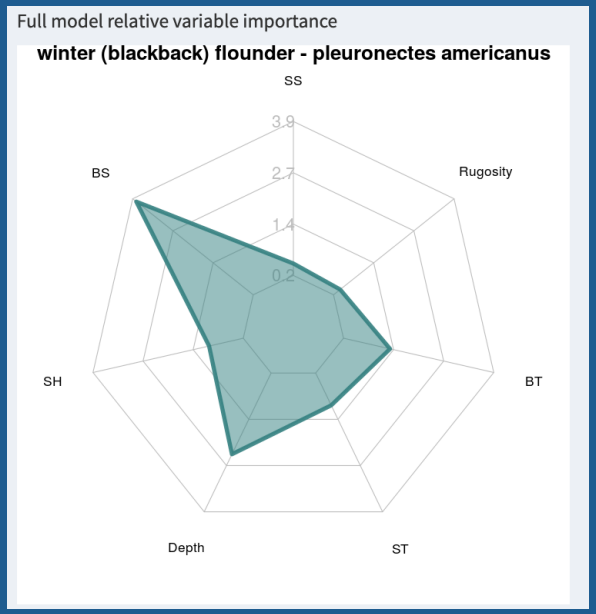
Projected impacts of ocean warming

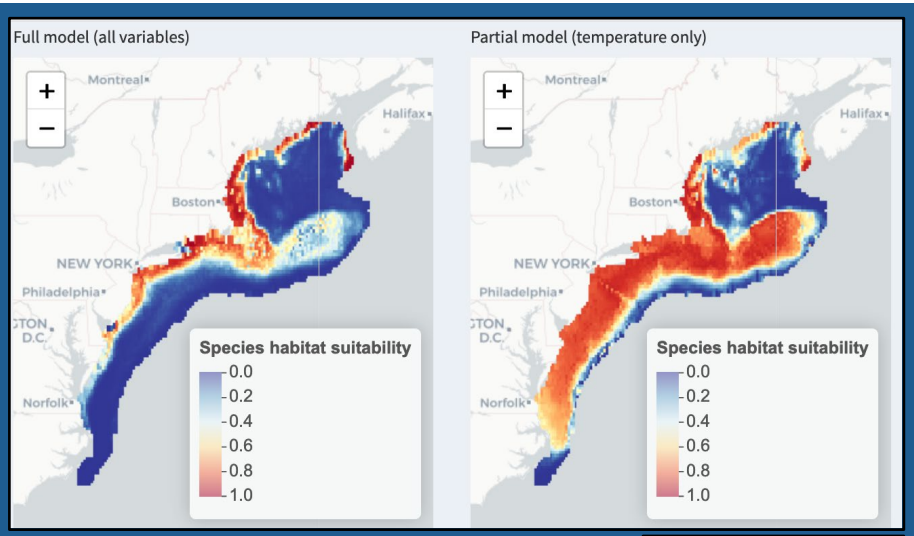
PRIMARY RESEARCH ARTICLE

Global Change Biology WILEY

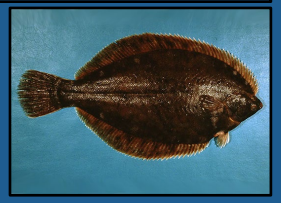
Projecting marine species range shifts from only temperature can mask climate vulnerability

Jennifer McHenry[1] | Heather Welch[2,3] | Sarah E. Lester[1] | Vincent Saba[4]





McHenry et al. 2019, Glob. Ch. Bio.



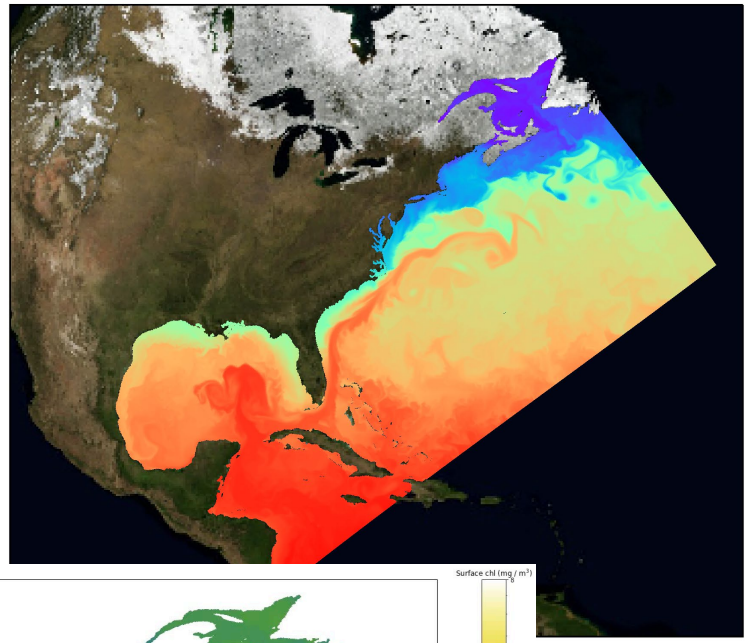
Single species studies:

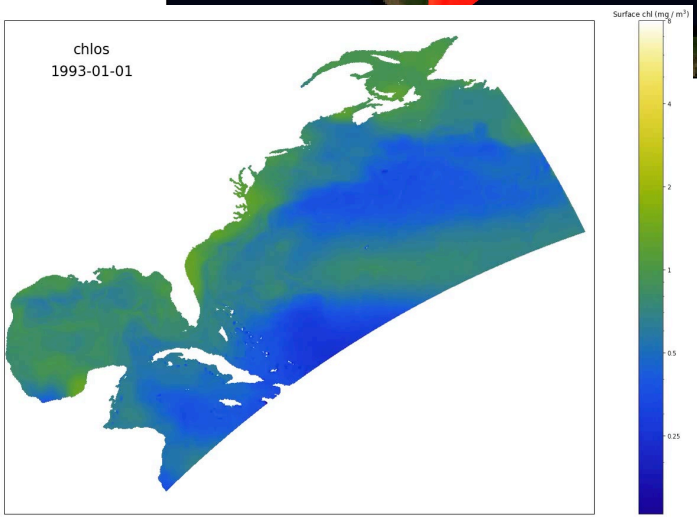
Lobster
Scallop
Cobia
Cal. fin.
Loggerhead
Black sea bass
Coastal sharks
Cod/Haddock

https://heatherwelch.shinyapps.io/beyond_temperature/

- Regional hindcasts, forecasts, and projections using NOAA GFDL's state-of-the-art ocean model MOM6. Physics and biogeochemistry.

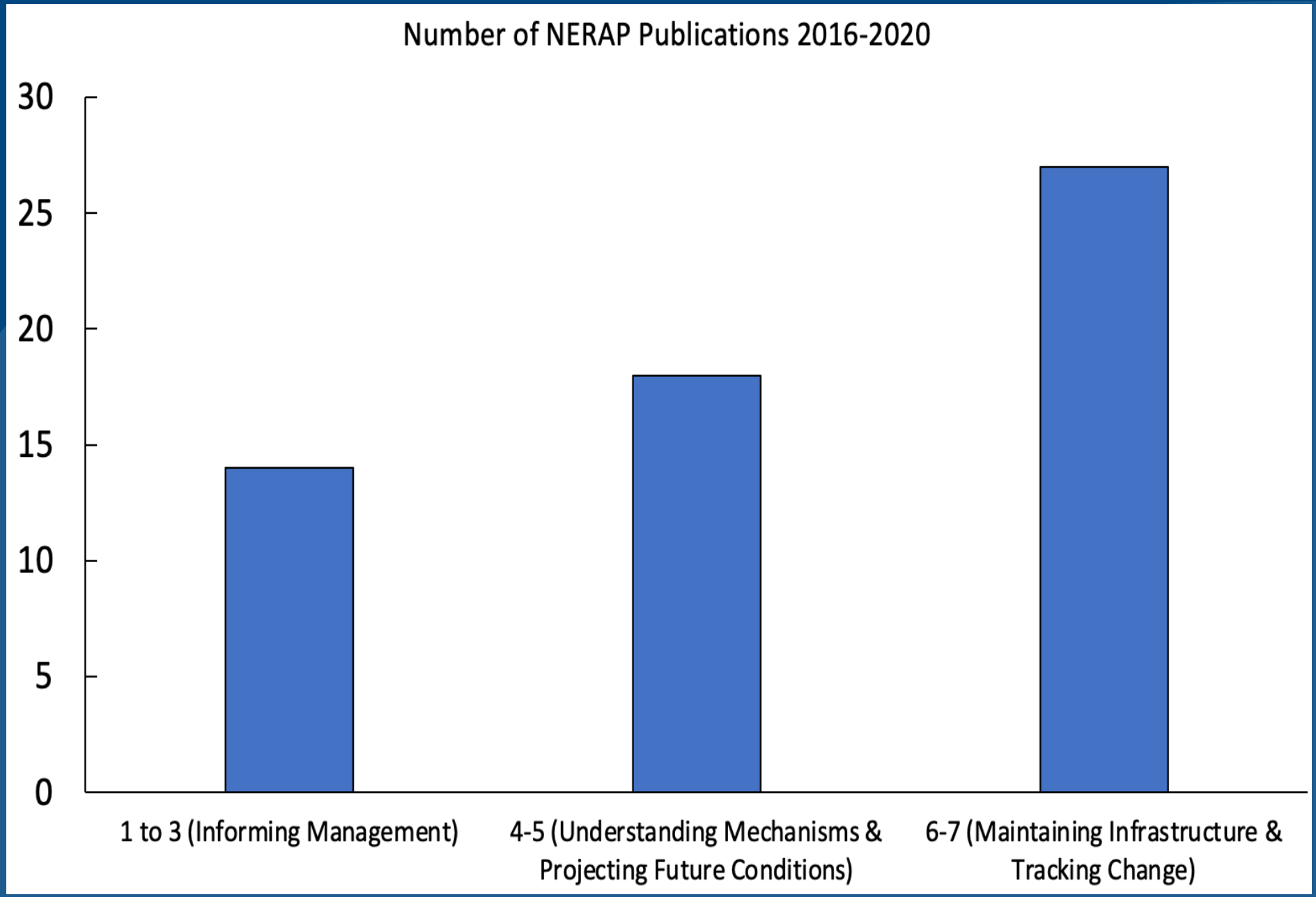
- New ocean bottom temp time-series 1959-2019 using ocean models (du Pontavice et al. in prep).

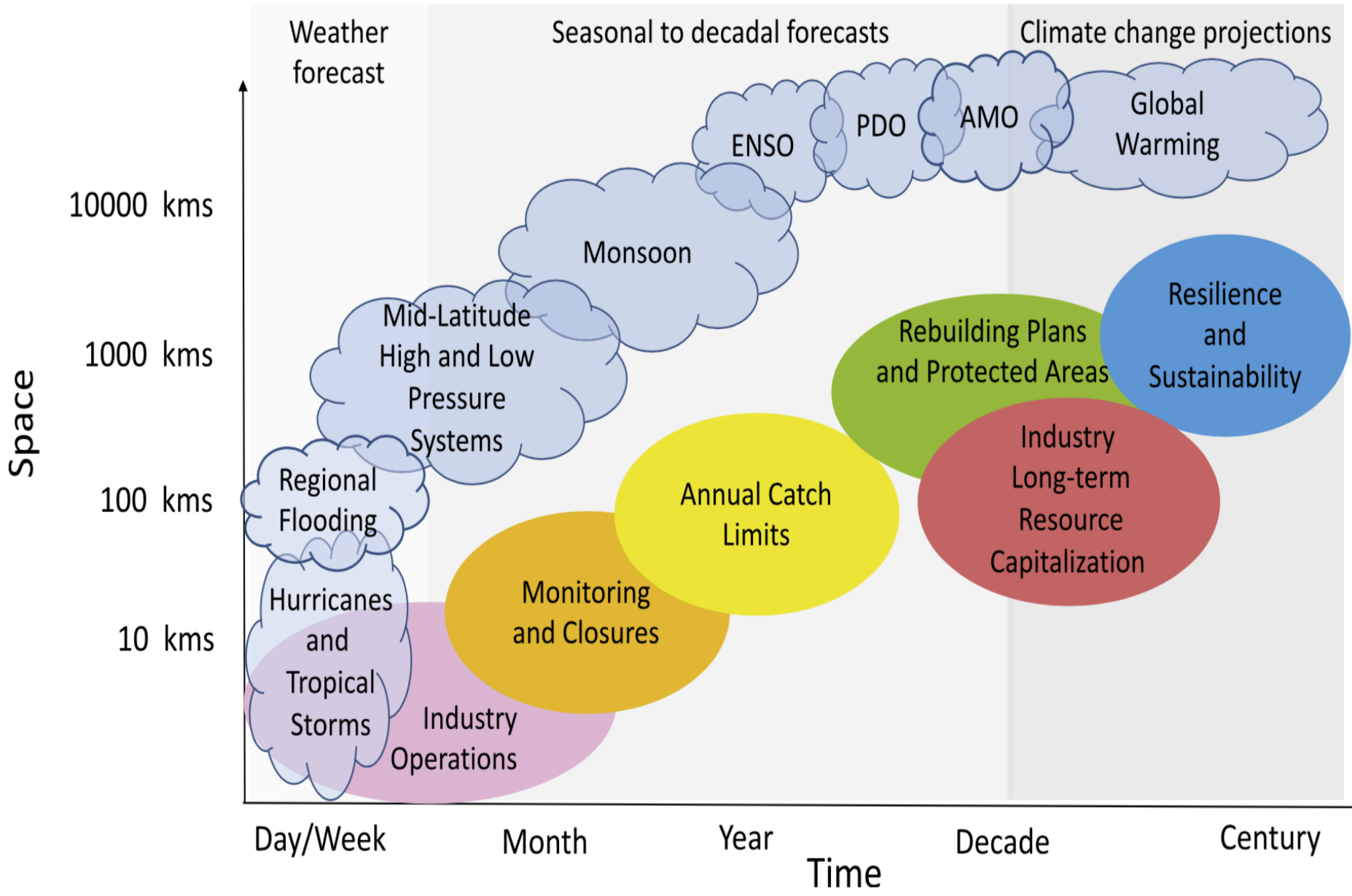




Ross et al. in prep.

Animation and figure courtesy of Andrew Ross (GFDL).


Number of NERAP Publications 2016-2020
30
25
20
15
10
5
0
1 to 3 (Informing Management)
4-5 (Understanding Mechanisms & Projecting Future Conditions)
6-7 (Maintaining Infrastructure & Tracking Change)


Weather forecast
Seasonal to decadal forecasts
Climate change projections
ENSO
PDO
AMO
Global Warming
Monsoon
Mid-Latitude High and Low Pressure Systems
Regional Flooding
Hurricanes and Tropical Storms
Industry Operations
Monitoring and Closures
Annual Catch Limits
Rebuilding Plans and Protected Areas
Resilience and Sustainability
Industry Long-term Resource Capitalization
10000 kms
1000 kms
100 kms
10 kms
Space
Day/Week
Month
Year
Decade
Century
Time

NERAP 2.0 Priority Actions (FY22-FY24)

- Maintaining Infrastructure (NCSS Objective 7)

- NERAP Priority Action 1: Maintain ecosystem survey and data collection efforts in the Northeast U.S. Continental Shelf ecosystem including the Bottom Trawl Survey, Ecosystem Monitoring Program, Sea Scallop Survey, Northern Shrimp Survey, Clam Survey, and Protected Species Surveys and expand where possible (e.g., Gulf of Maine longline survey, data poor species, right whale prey sampling, ocean acidification monitoring).

- NERAP Priority Action 2: Coordinate with other NOAA Programs, Line Offices, and partners to link living marine resource data, science, and management to climate science and research activities. This is critical for funding new research.

- NERAP Priority Action 3: Continue to build industry-based fisheries and ocean observing capabilities.

NERAP 2.0 Priority Actions (FY22-FY24)

- Tracking and projecting change, understanding mechanisms (NCSS Objectives 4-6)

- NERAP Priority Action 4: Continue production of the NEFSC State of the Ecosystem reports and other related products that include climate relevant information that is useful to management.

- NERAP Priority Action 5: Conduct laboratory and field research on the mechanistic effects of multiple climate factors (e.g. temperature, ocean acidification, dissolved oxygen) on living marine resources with the goal of informing process-based models for single species, multi-species, and the ecosystem.

- NERAP Priority Action 6: Work with NOAA Oceanic and Atmospheric Research, National Weather Service, National Ocean Service, and academic partners to develop and improve regional hindcasts, forecasts, and projections of ocean and estuarine/river physics and biogeochemistry.

NERAP 2.0 Priority Actions (FY22-FY24)

- Informing Management (NCSS Objectives 1-3)

- NERAP Priority Action 7: Improve spatial management of living marine resources through an increased utility of spatial and temporal distributions, abundance, productivity, migration, and phenology in management decisions.

- NERAP Priority Action 8: Develop and use Vulnerability Analyses, Scenario Planning, and Management Strategy Evaluations to examine the effect of different management strategies under various climate change scenarios.

- NERAP Priority Action 9: Increase social, economic, and ecosystem scientist involvement in climate change research through multidisciplinary work, including the Northeast Integrated Ecosystem Assessment, that examines relationships between various ecosystem components with the goal of enhancing ecosystem-based management with climate information.

- NERAP Priority Action 10: Development of stock assessment models (e.g. WHAM) that include environmental terms (e.g., temperature, ocean acidification) with a priority for stocks that have upcoming research track assessments.

- https://www.fisheries.noaa.gov/national/climate/climate-science-strategy-regional-action-plans (Public comment closes July 29th)

NERAP 2.0 Priority Actions (FY22-FY24)

Species	Research Track Assessment Year	Environmental variables linked to life history	References
American lobster	2025	Ocean acidfication, temperature, dissolved oxygen	Harrington et al. 2019,2020, Niemisto et al. 2021, Lopez-Anido et al. 2021, Klymasz-Swartz et al. 2019, Haarr et al. 2020, Bayer et al. 1998
American plaice	2022	NA	NA
Atlantic cod	2023	Ocean acidfication, temperature	Leo et al. 2017, Pershing et al. 2015
Atlantic herring	2025	Ocean acidfication, temperature, salinity	Leo et al. 2018, Sswat et al. 2018, Berg et al. 2020, Maravelias et al. 2000
Black sea bass	2023	Ocean acidification, temperature, dissolved oxygen, salinity	Meseck et al. 2022, Slesinger et al. 2019, Miller et al. 2016b
Bluefish	2022	Ocean temperature	Taylor et al. 2007
Butterfish	2022	Ocean temperature	Adams, 2017
Golden tilefish	2024	NA	NA
Haddock	2022	Ocean temperature, chlorophyll concentration	Norin et al. 2019, Friedland et al. 2015
Longfin inshore squid	2026	Ocean temperature	Nichols et al. 2019
Sea scallop	2024	Ocean acidfication, temperature	Meseck et al. unpublished, Barbeau and Scheibling, 1994, Coleman et al. 2021
Shortfin squid	2022	Ocean temperature	Dor and Dawe, 2013
Spiny dogfish	2022	Ocean temperature	Taylor and Gallucci, 2009, Andres et al. in review
Winter flounder	2026	Winter surface air temperature in estuaries	Manderson et al. 2008, Bell et al. 2014, 2018
Yellowtail flounder	2024	Summer/fall ocean temperature, Gulf Stream indices, Cold pool indices	Miller et al. 2016a, Xu et al. 2018, du Pontavice et al. 2022

Incorporating climate information into stock assessments

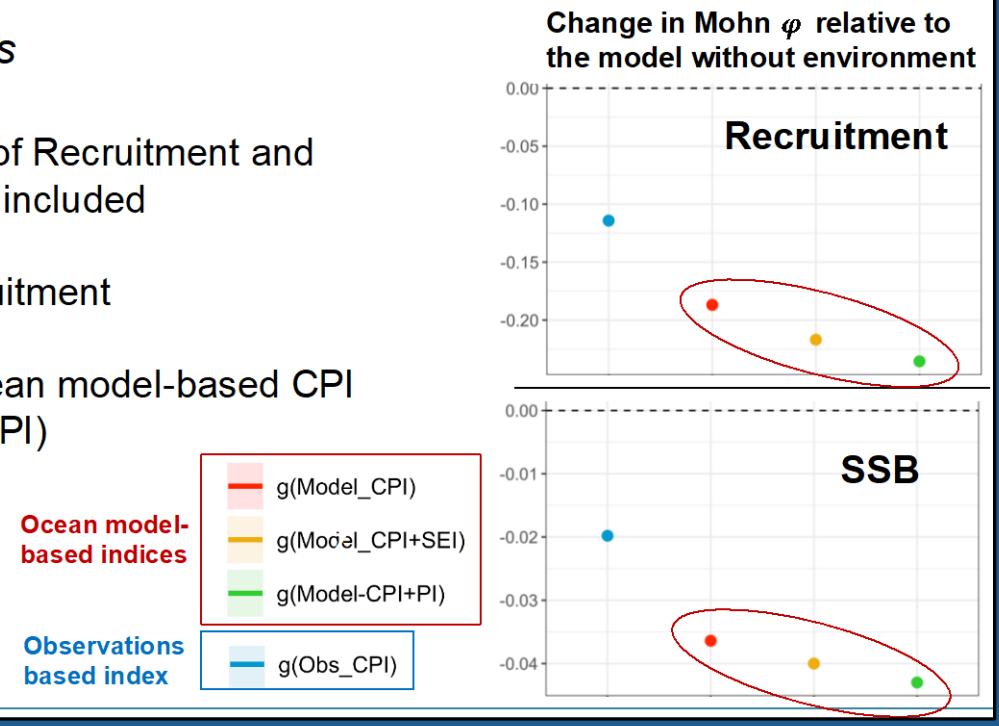
3. Performance of models including ocean model-based Cold Pool indices

A. Cold Pool effects within the stock assessment model

Retrospective patterns analysis

- Reduction of retrospective patterns of Recruitment and SSB when the Cold Pool effects are included
- More pronounced reduction for recruitment
- More pronounced reduction with ocean model-based CPI (than with the observations-based CPI)

Mohn φ : retrospective pattern metric



du Pontavice et al. 2022 (SNE-MA yellowtail flounder)

U.S. Northeast Climate Fisheries Seminar Series

Date	Speaker	Title
1/27/2022	Hubert du Pontavice	Incorporating environmental effects from ocean models improves a marine fishery stock assessment.
2/24/2022	Rich Bell	Climate induced habitat changes in commercial fish stocks.
3/31/2022	Joe Caracappa	Advancements in the Northeast United States Atlantis ecosystem model.
4/28/2022	Chris Chambers	Biological consequences of a changing climate on pre-recruit life-stages of northeast U.S. finfish: effects of CO2 and thermal environments.
5/26/2022	John Kocik	Charting a RAD-ical Future for Salmon Ecosystems with RAD (Resist, Accept, Direct) frameworks.
6/30/2022	Sally Dowd	Assessing the vulnerability of coastal communities to marine heatwaves: a comparison of the U.S. and Australia.
7/28/2022	Kathy Mills / Andrew Allyn	Shifting species and climate adaptation pathways for U.S. Northeast fishing communities.
8/25/2022	Andrew Ross	Seasonal forecasts of ocean physics and biogeochemistry in the Northeast U.S. with Regional MOM6.
9/29/2022	Sean Lucey	East coast climate change scenario planning.
10/27/2022	Vincent Saba	Surface and demersal marine heatwaves in the Northeast U.S.
11/17/2022	Mike Johnson	An assessment of marine, estuarine, and riverine habitat vulnerability to climate change in the Northeast U.S.
12/15/2022	Amanda Hart	Integrating climate impacts on stock dynamics into a groundfish stock assessment.