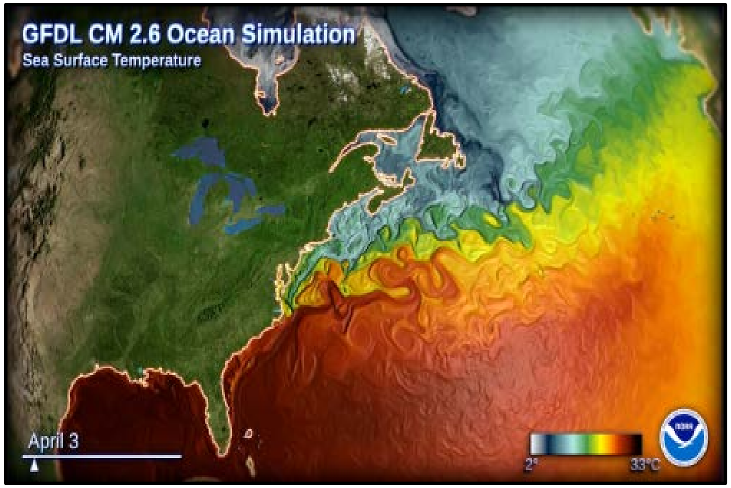
Overview of Climate Change Research within NOAA's Northeast Fisheries Science Center

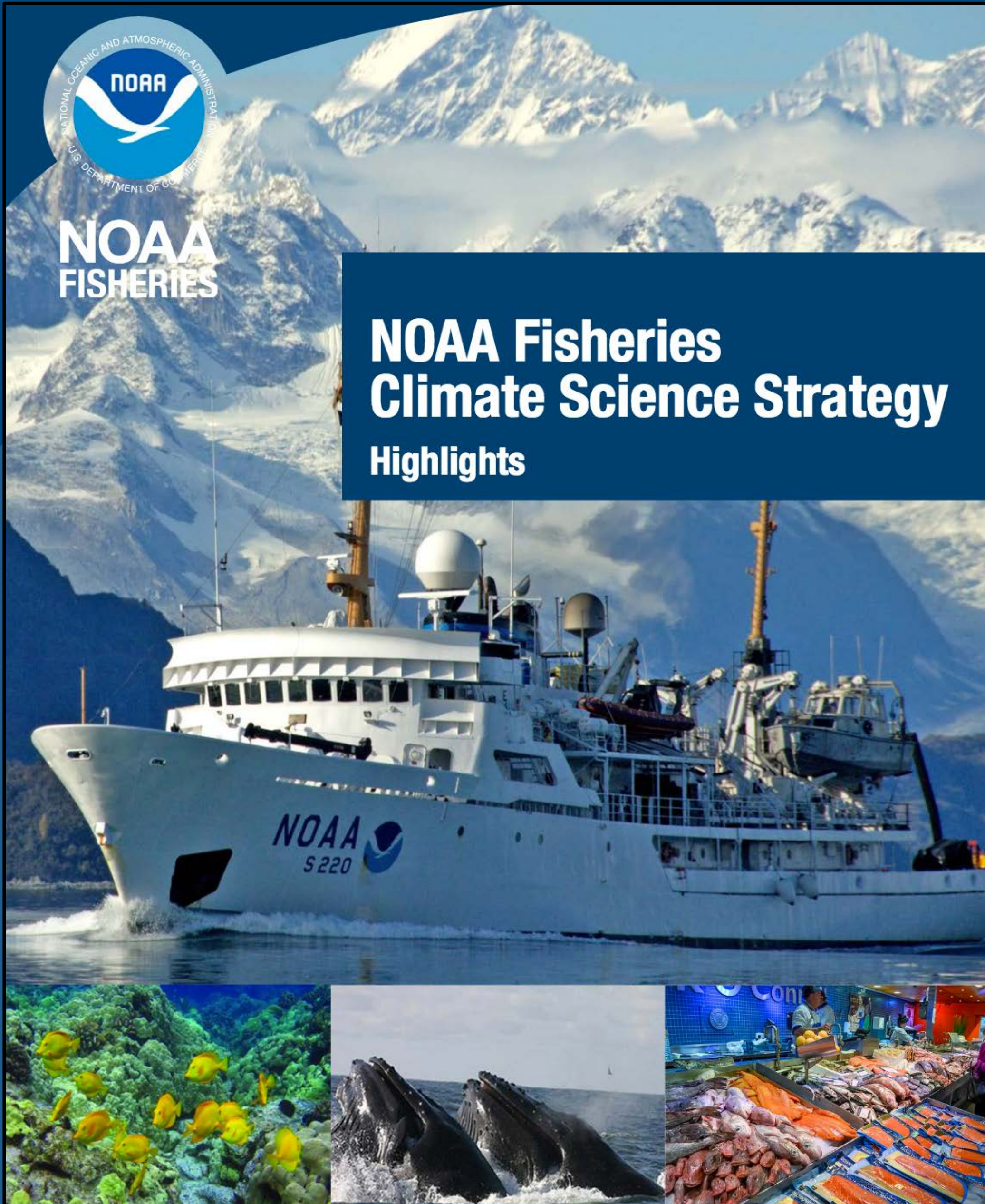
Vincent Saba

NOAA Northeast Fisheries Science Center

NOAA FISHERIES

Northeast Fisheries Science Center



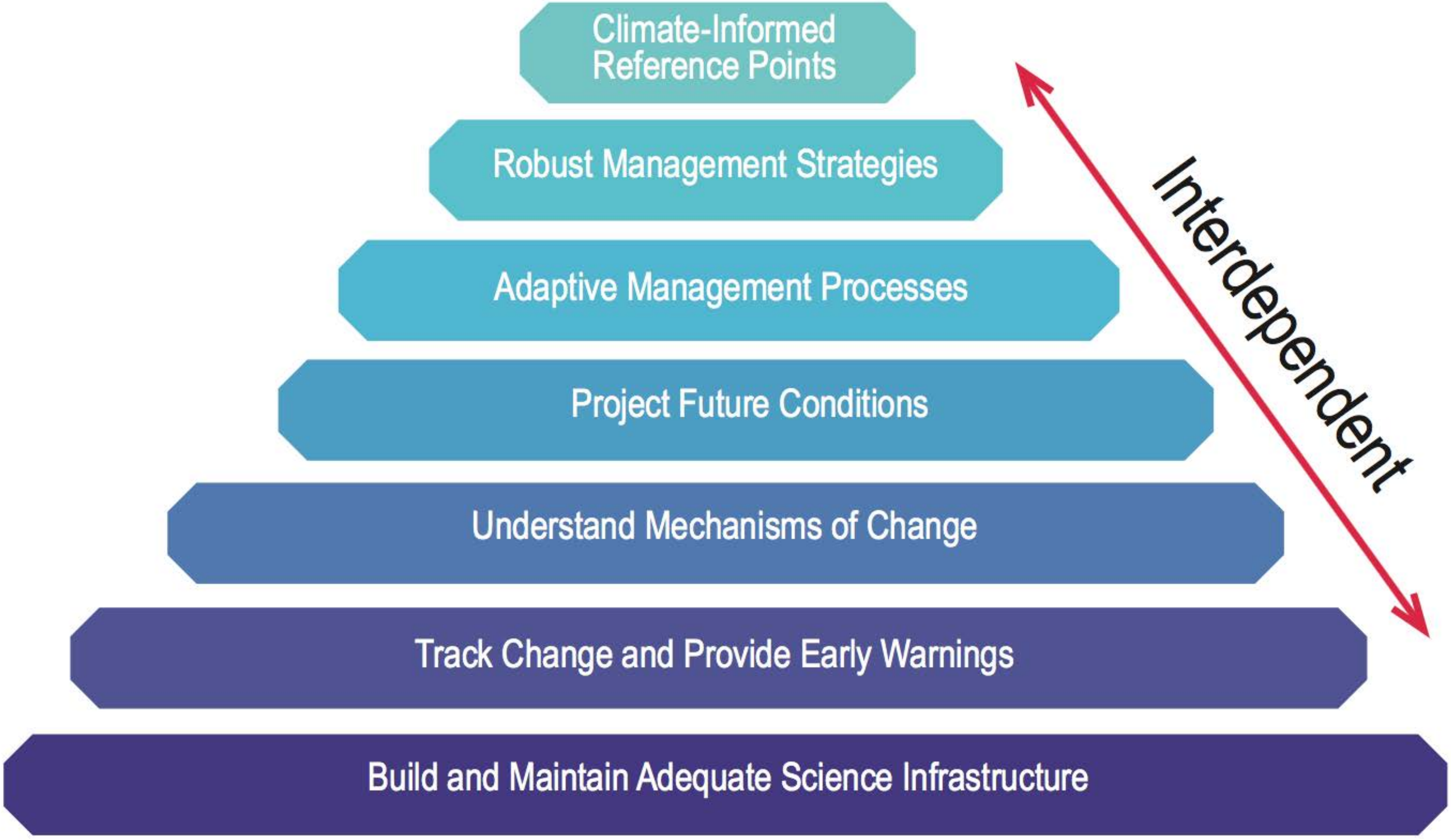


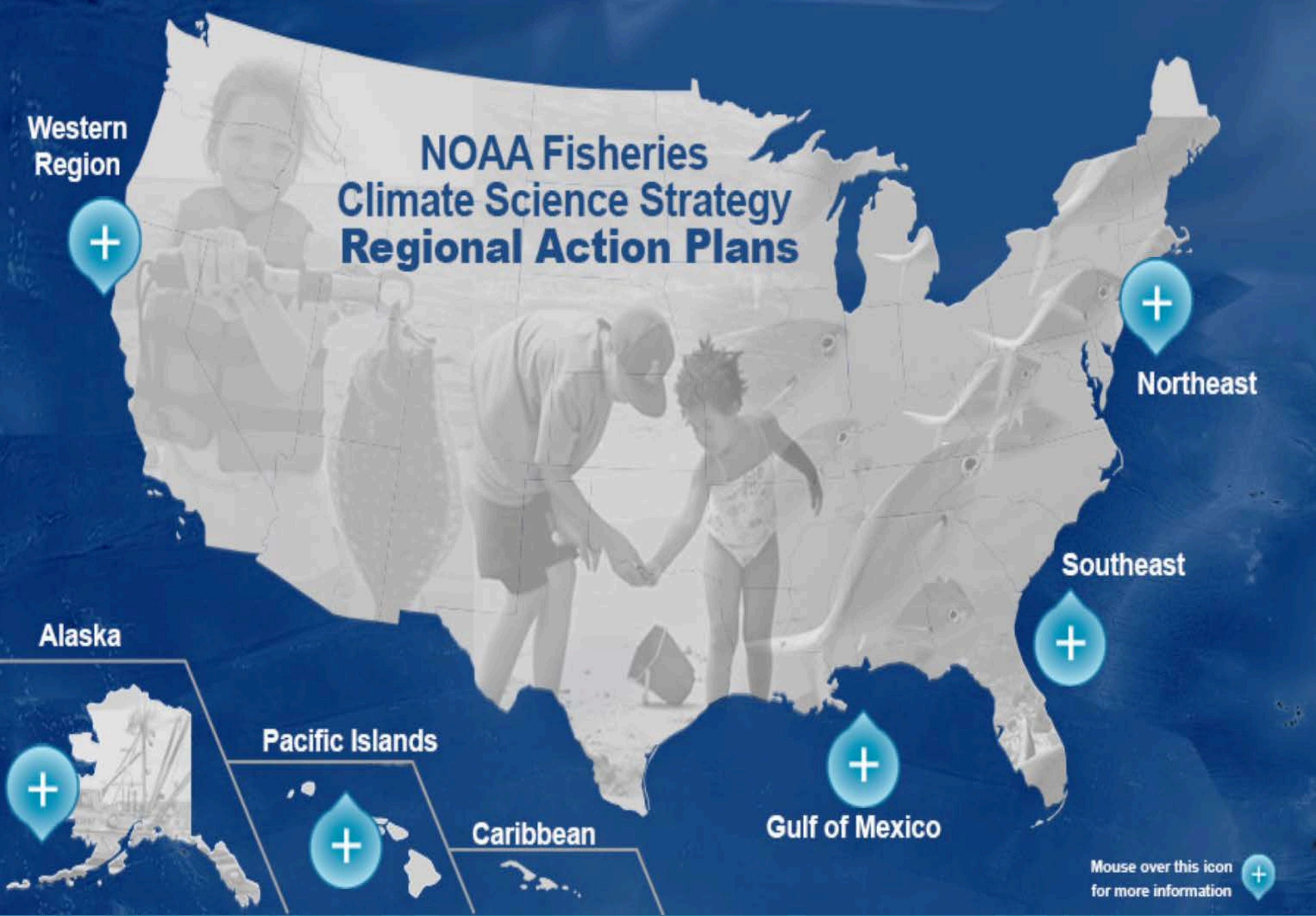
"The Strategy is part of a proactive approach to increase the production, delivery and use of climate-related information to fulfill NOAA Fisheries mandates in a changing climate. Implementing this Strategy will help reduce impacts and increase the resilience of our valuable living marine resources,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

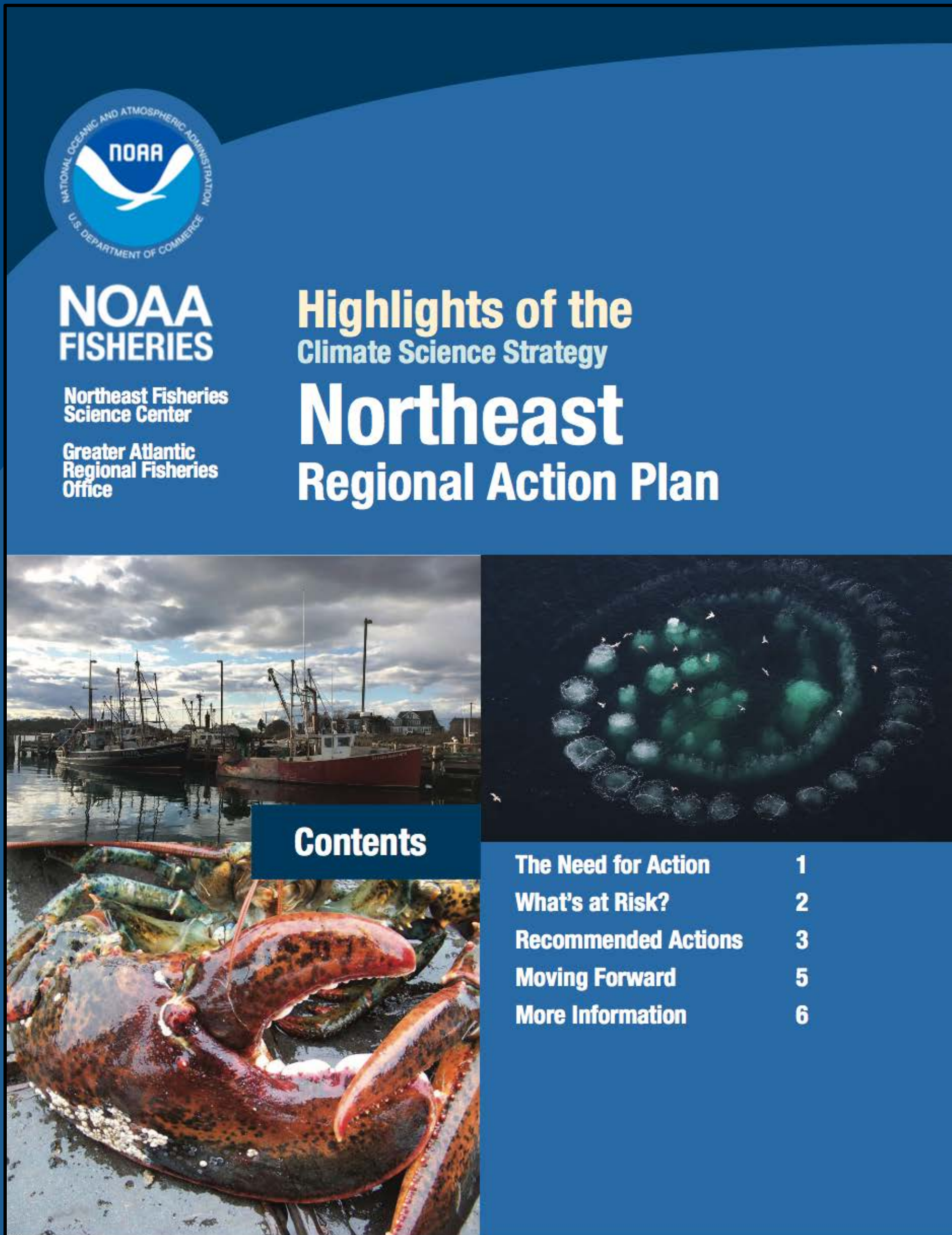
- Eileen Sobeck
Former Fisheries
Assistant Administrator

https://www.st.nmfs.noaa.gov/ecosystems/climate/national-climate-strategy

Climate Science Strategy Objectives

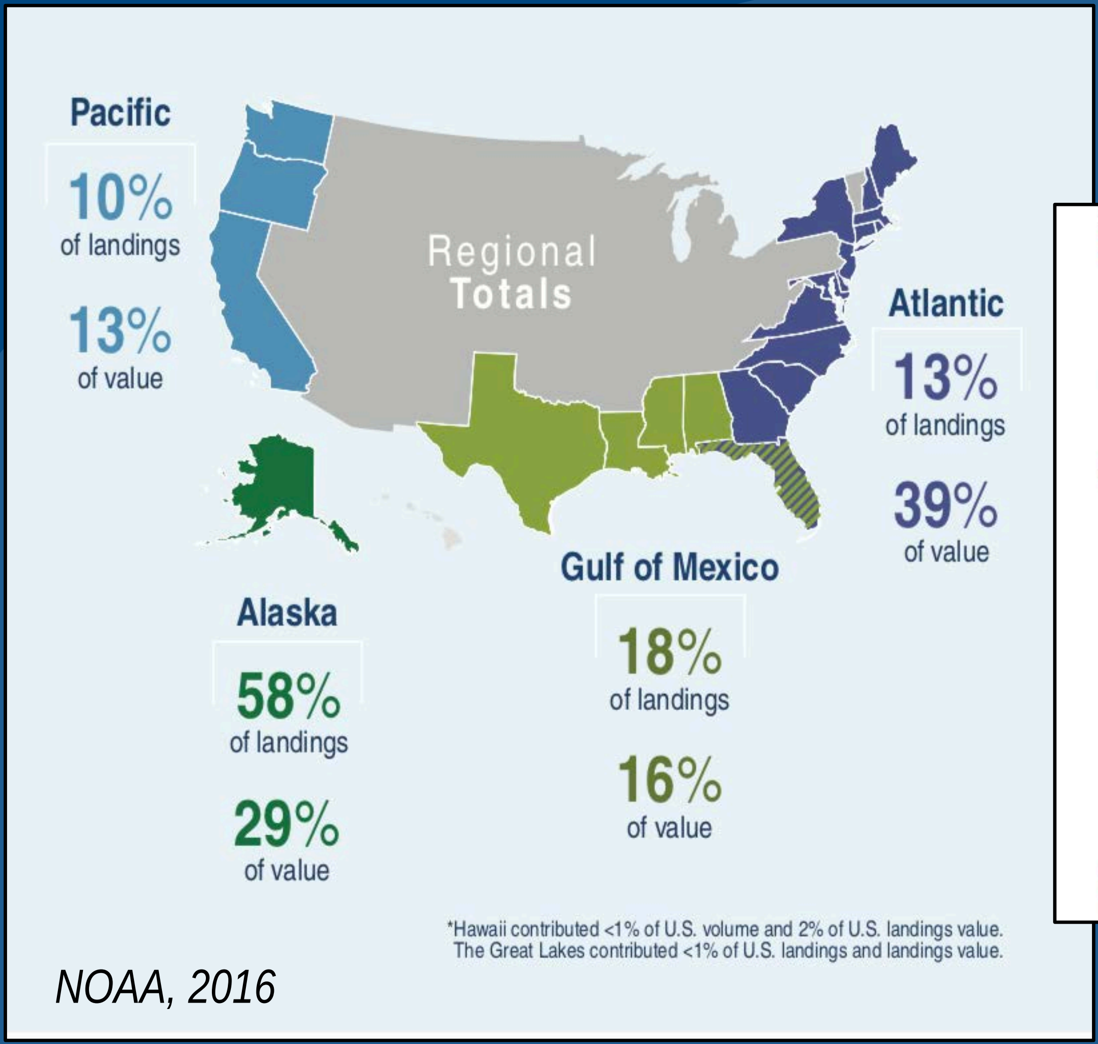



NOAA Fisheries
Climate Science Strategy
Regional Action Plans
Western Region
Northeast
Southeast
Alaska
Pacific Islands
Caribbean
Gulf of Mexico
Mouse over this icon
for more information

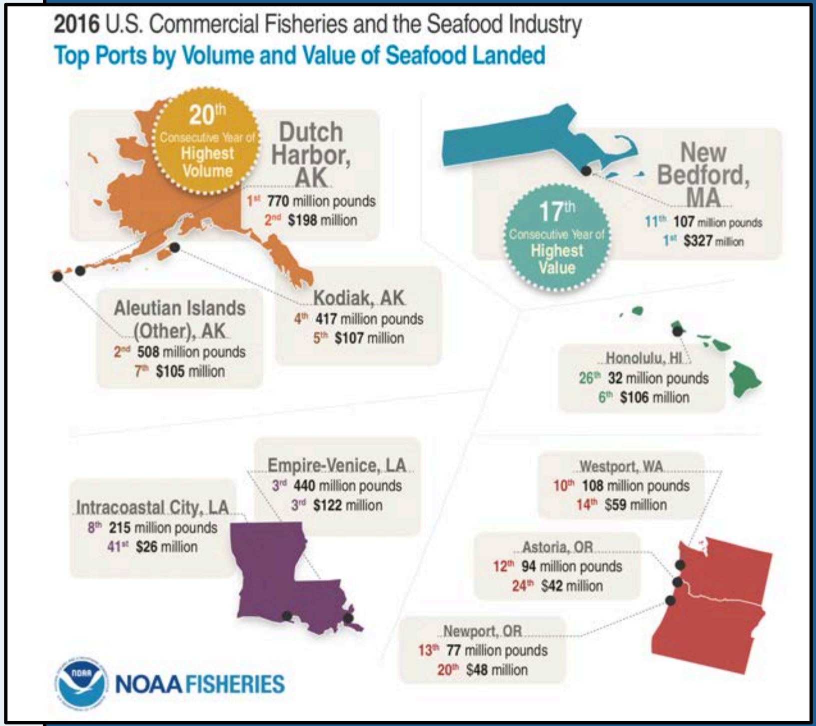


The Northeast Regional Action Plan identifies 15 NERAP Actions of highest priority. These actions are ordered by the objectives of the NOAA Fisheries Climate Science Strategy (e.g., NERAP Action 1 is associated with Objective 1 of the Strategy). Actions are prioritized for No New Resources and New Resources scenarios.

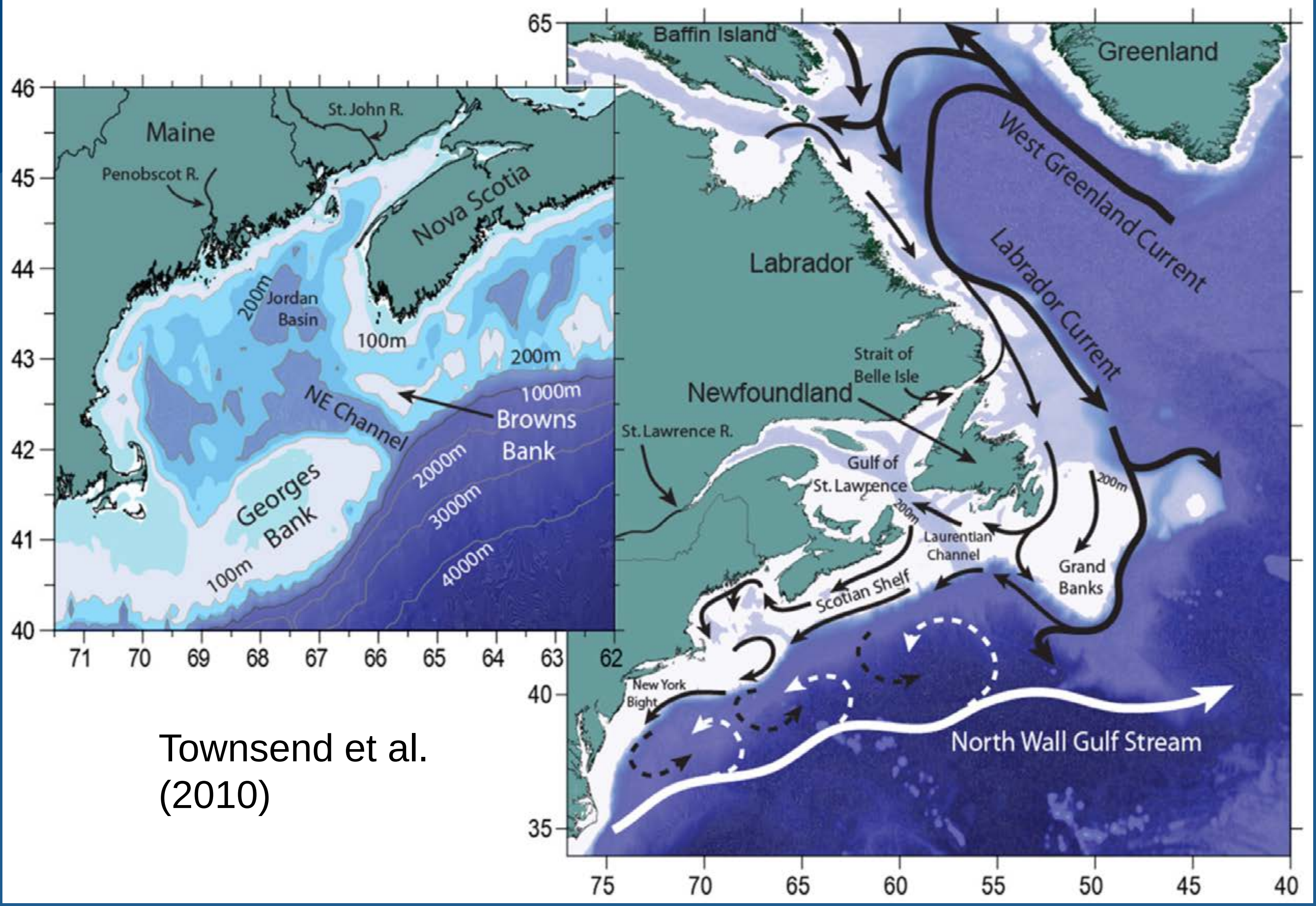
U.S. Commercial Fishery Annual Value



NOAA, 2016

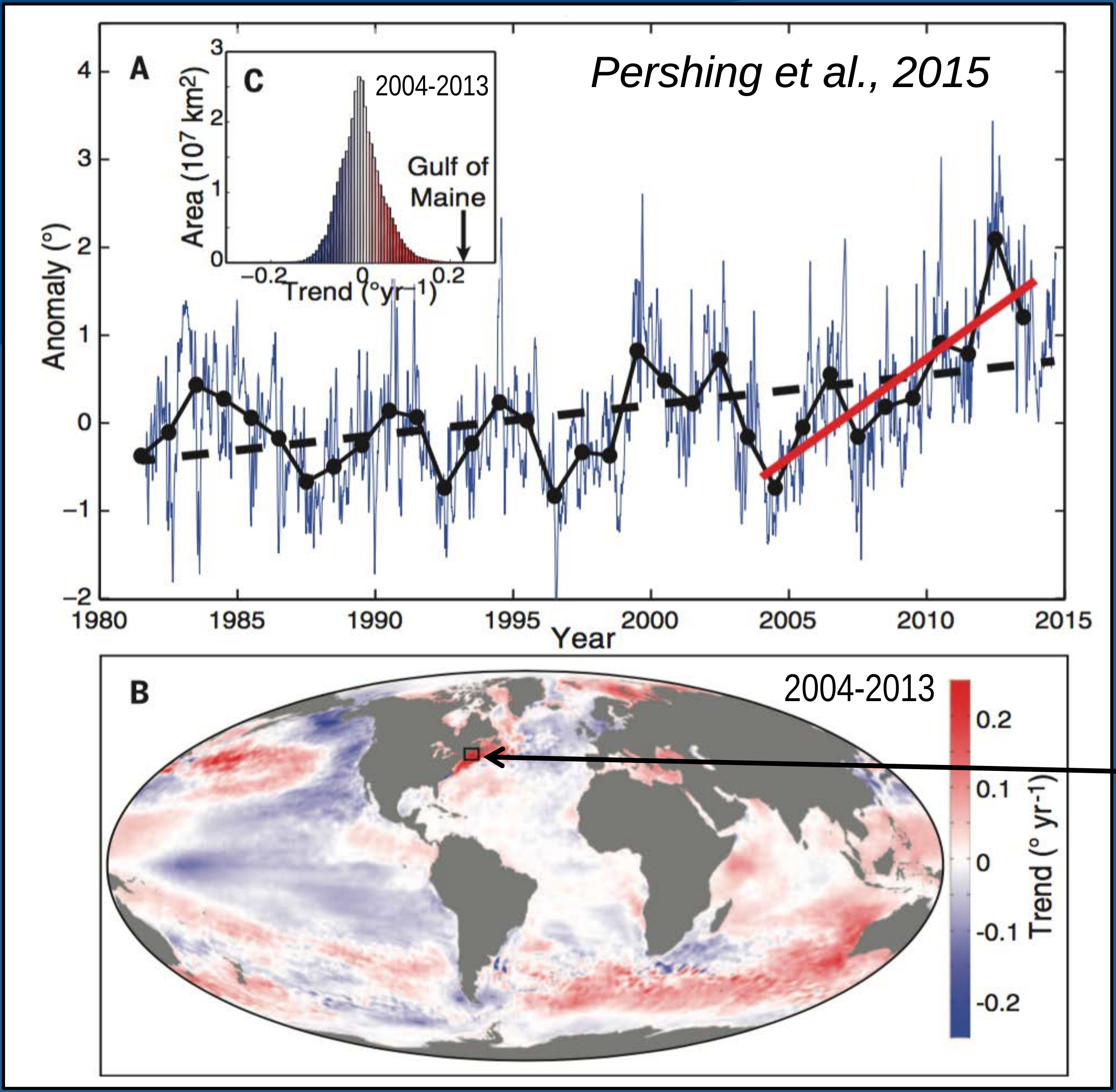


Northwest Atlantic Oceanography



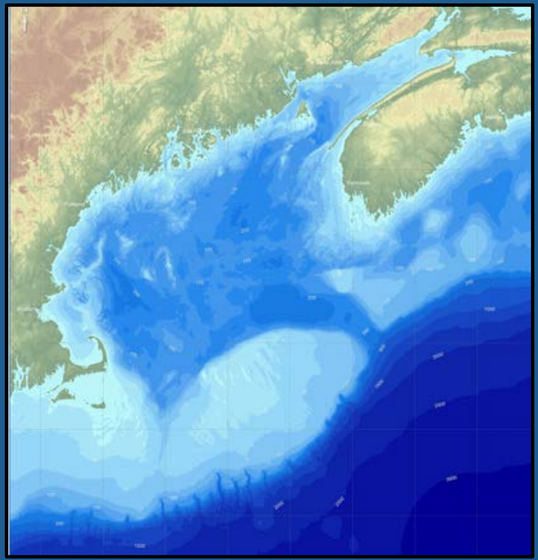
Townsend et al. (2010)

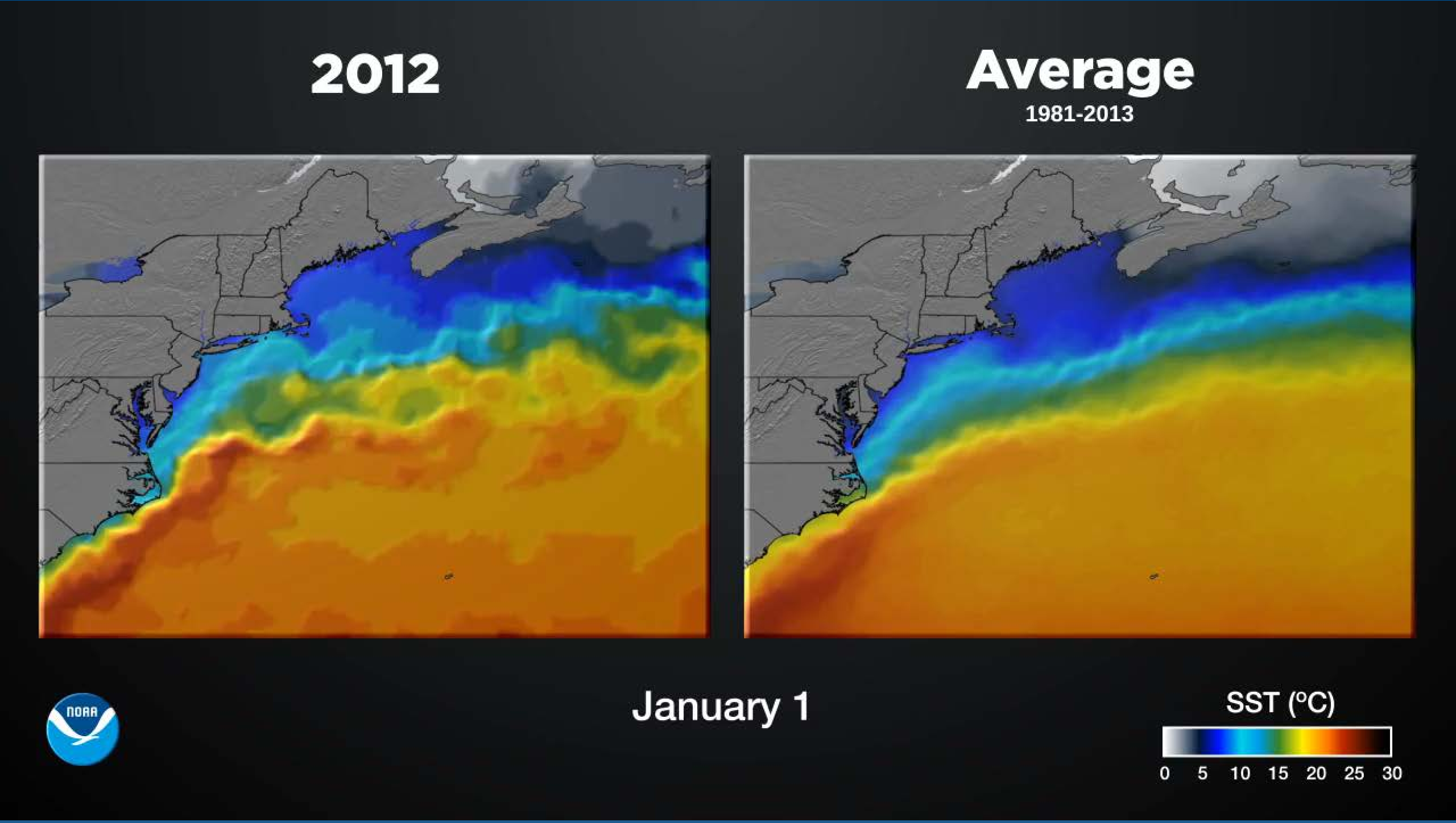
U.S. Northeast Shelf - Warming



Gulf of Maine

Ocean surface temperature has warmed faster than 99% of the global ocean (*Pershing et al. 2015*).

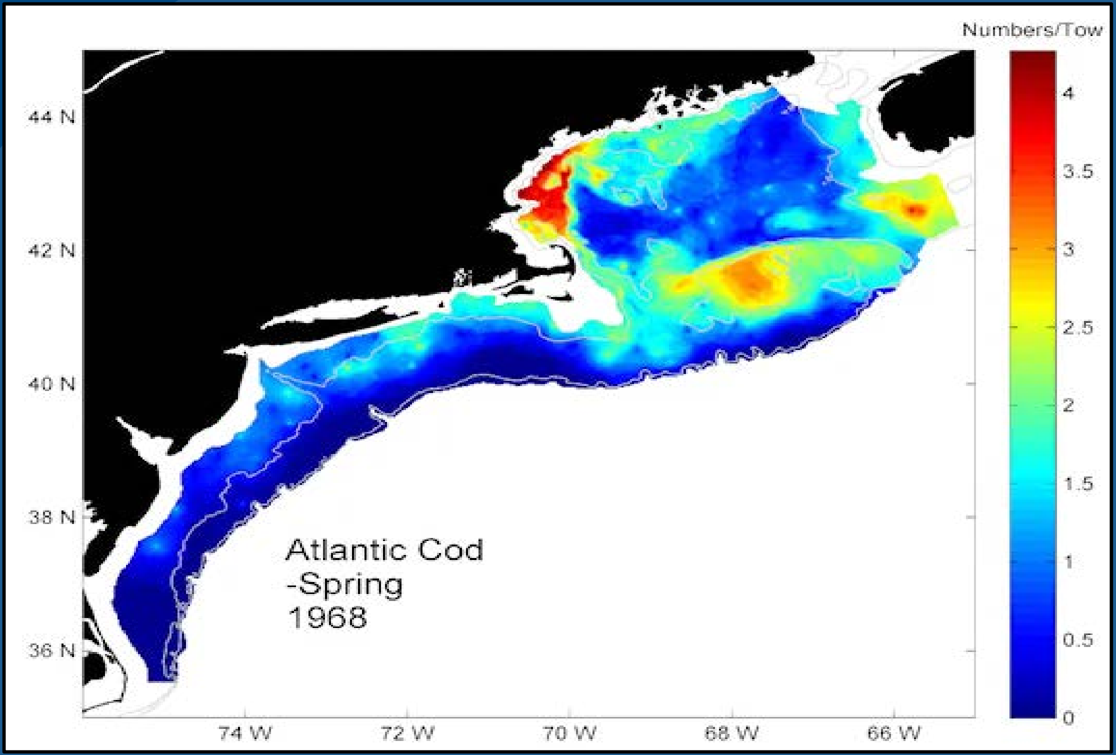




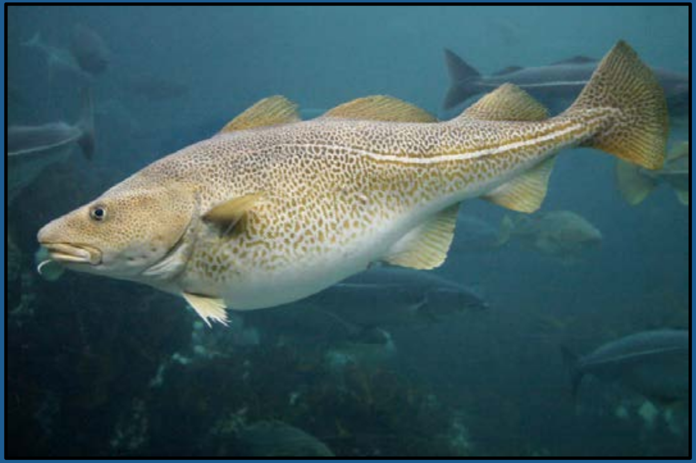
NOAA Reynolds Daily SST 25-km resolution
Data analysis: Vincent Saba (NOAA NMFS)
Animation: Remik Ziemlinski (NOAA OAR)

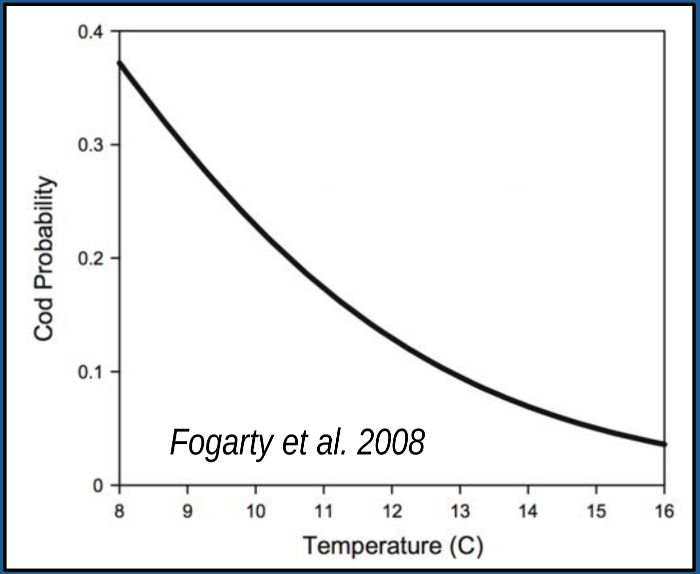
Warming ocean, fish on the move

Atlantic cod



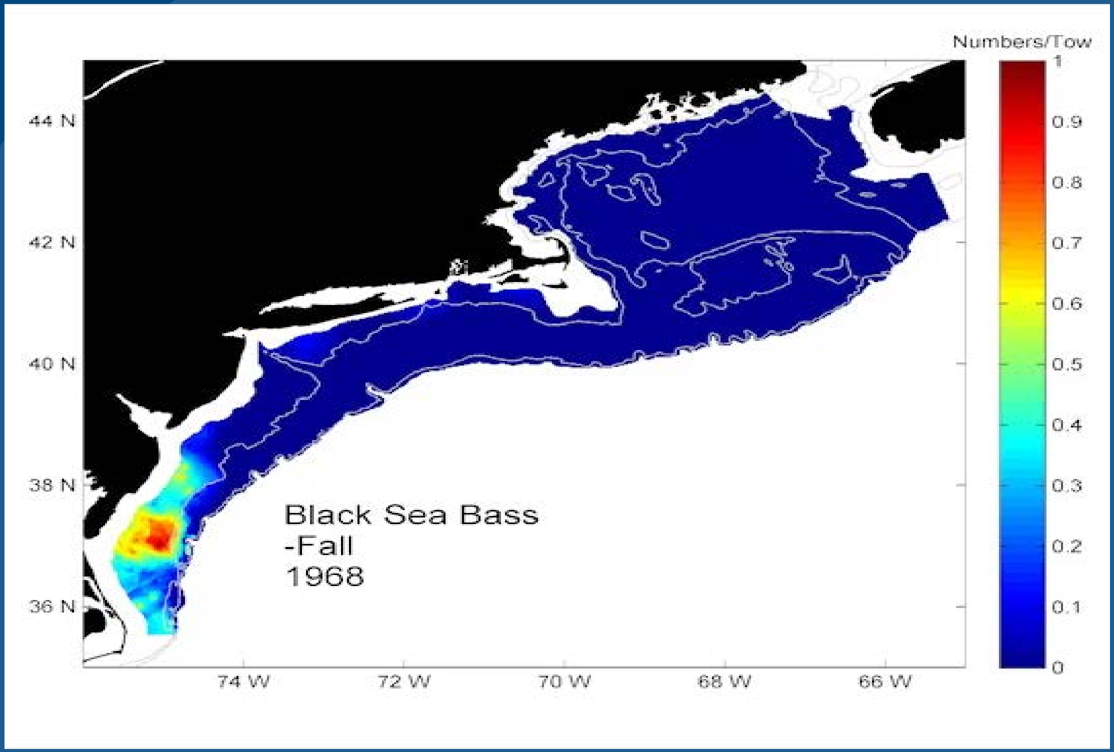
NOAA Survey Data



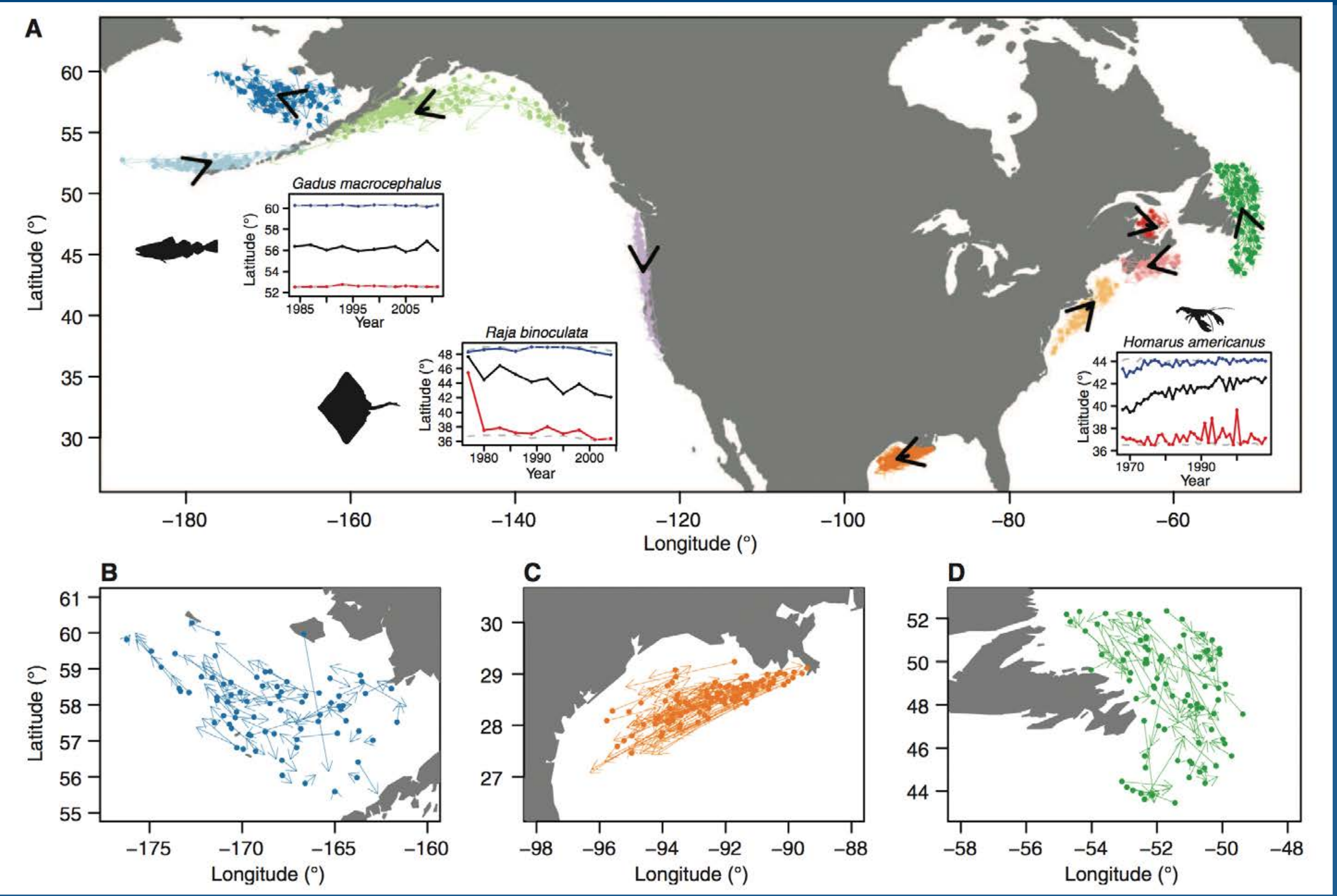


Warming ocean, fish on the move

Black sea bass



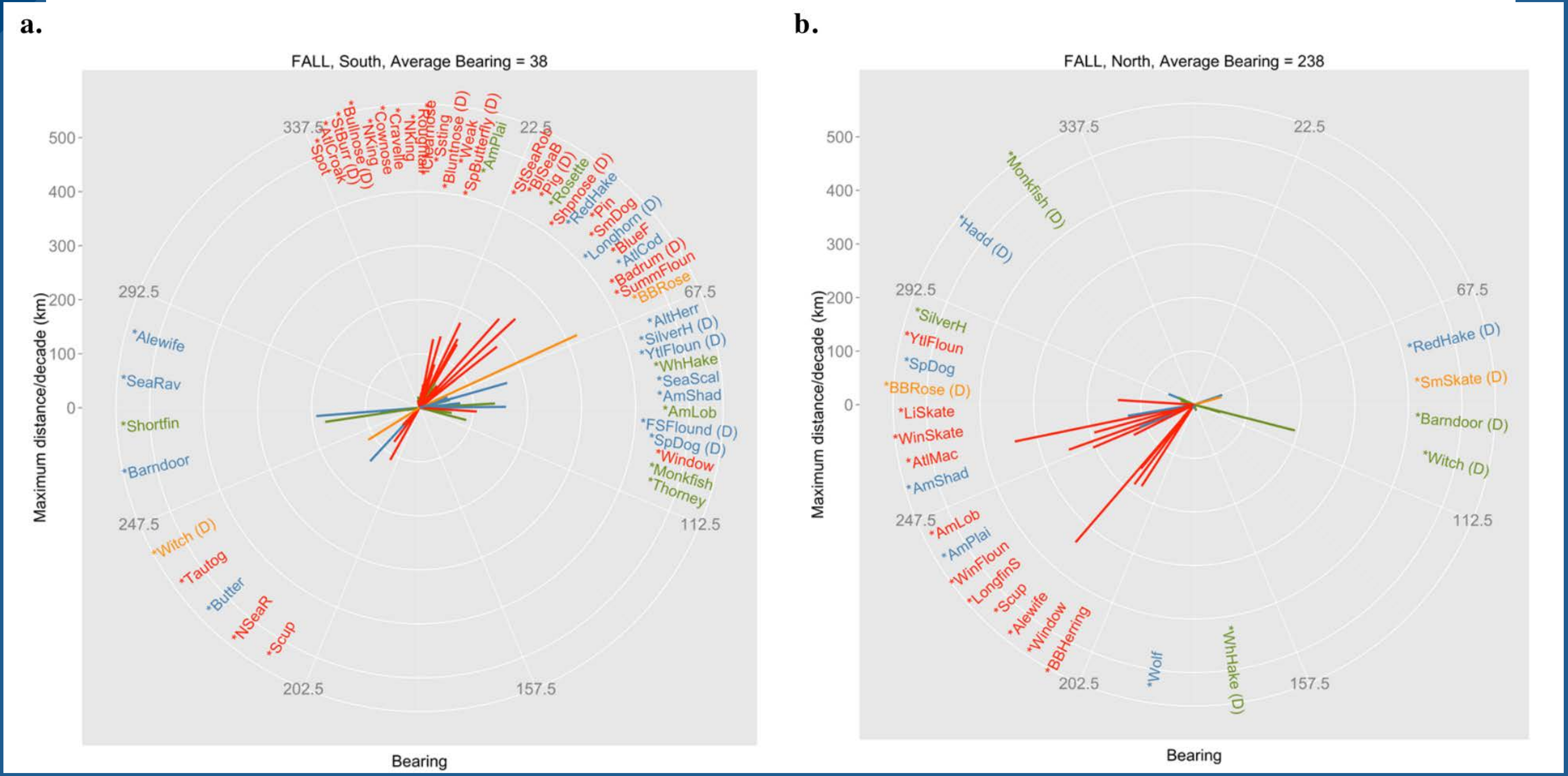
NOAA Survey Data



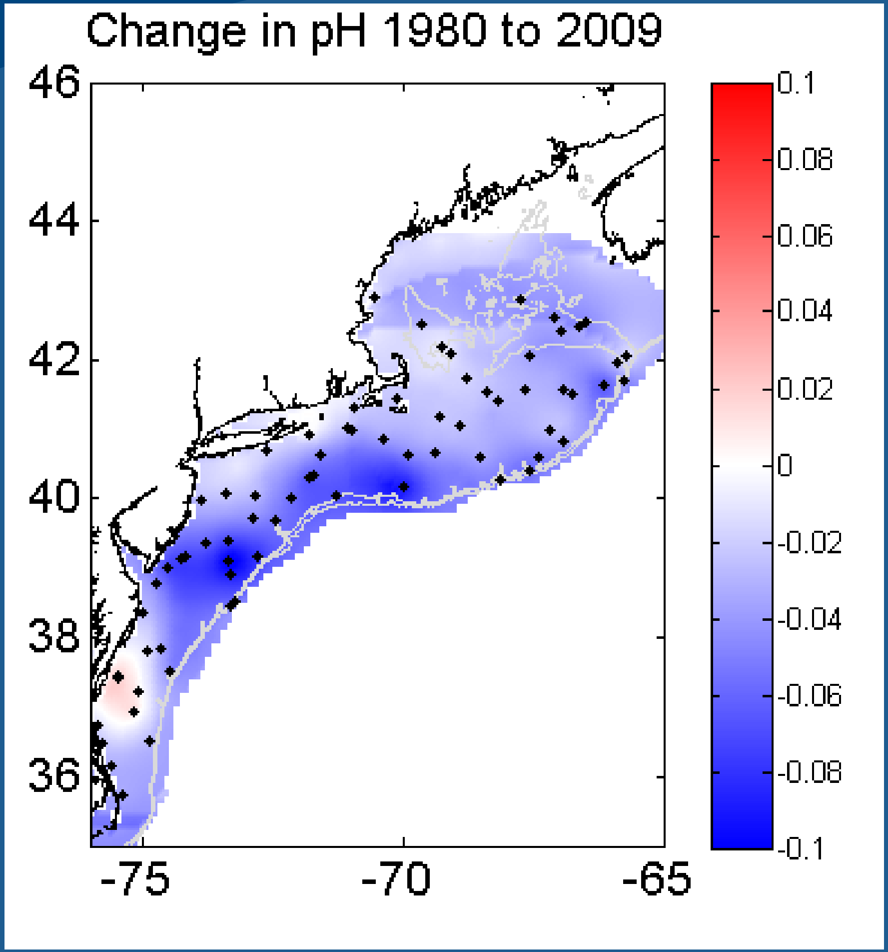
Pinsky et al., 2013

The effects of sub-regional climate velocity on the distribution and spatial extent of marine species assemblages

Kristin M. Kleisner[1*], Michael J. Fogarty[1], Sally McGee[2], Analie Barnett[2], Paula Fratantoni[1], Jennifer Greene[2], Jonathan A. Hare[3], Sean Lucey[1], Christopher McGuire[2], Jay Odell[2], Vincent S. Saba[4], Laurel Smith[1], Katherine J. Weaver[2], Malin L. Pinsky[5]



Surface pH – U.S. NES

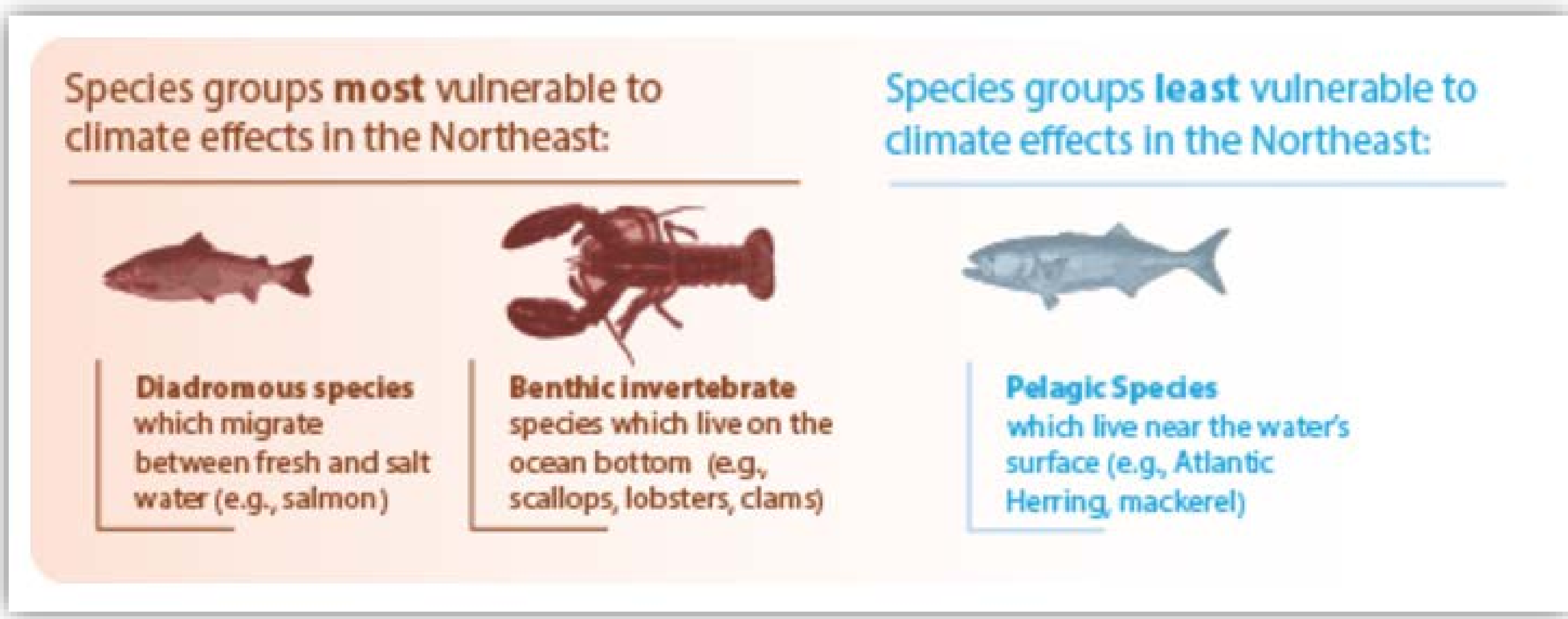


Average pH change -0.036 over 29 years
(Rebuck et al. unpublished)

Climate Vulnerability Assessment (CVA) Northeastern US

Overall Climate Vulnerability Ranking for 82 Species

Low 23%	Med 23%	High 23%	Very High 30%



NOAA FISHERIES

Based on Hare et. al., 2016* and Morrison et al., 2015.

*http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0146756

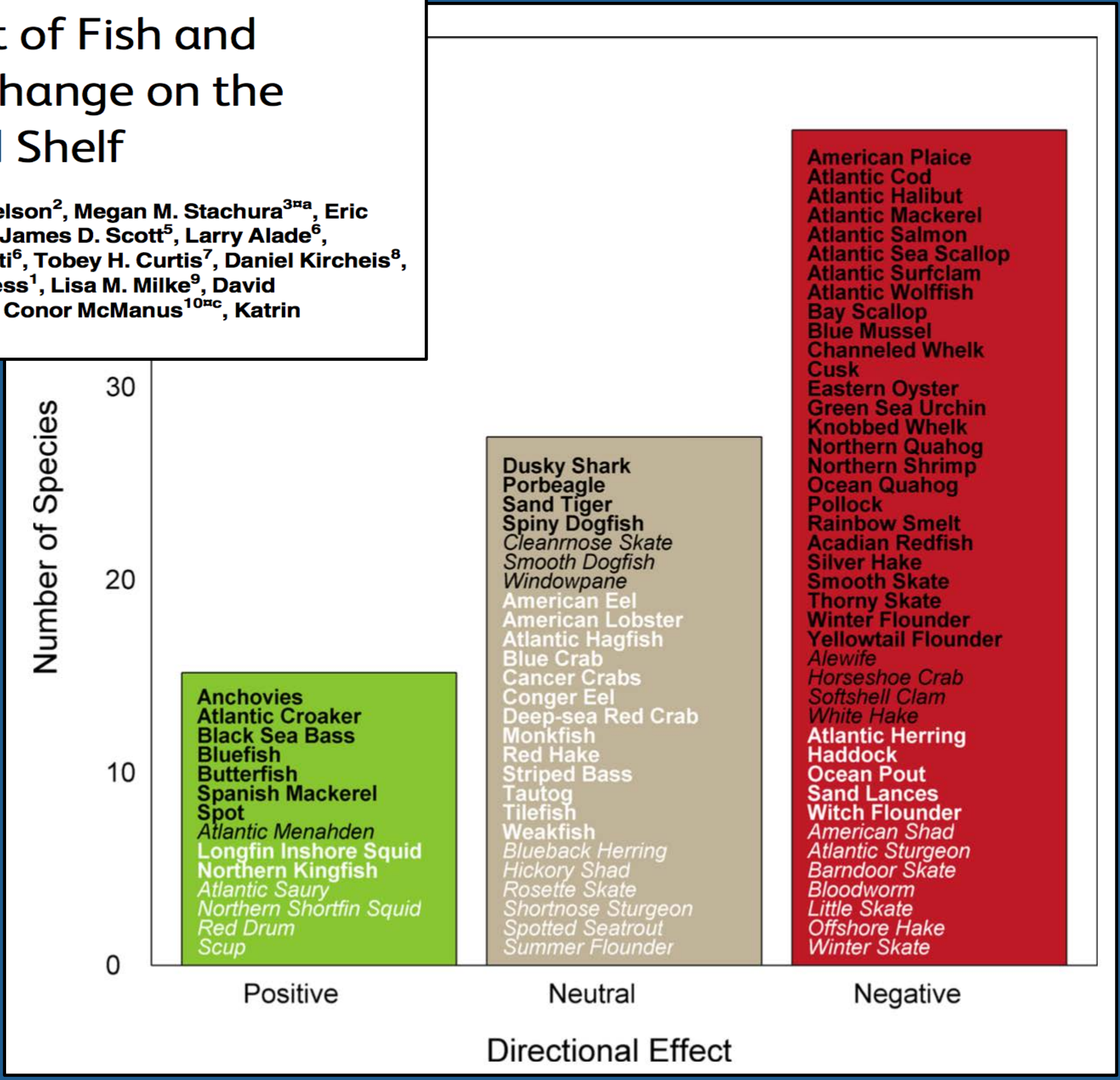
Climate vulnerability

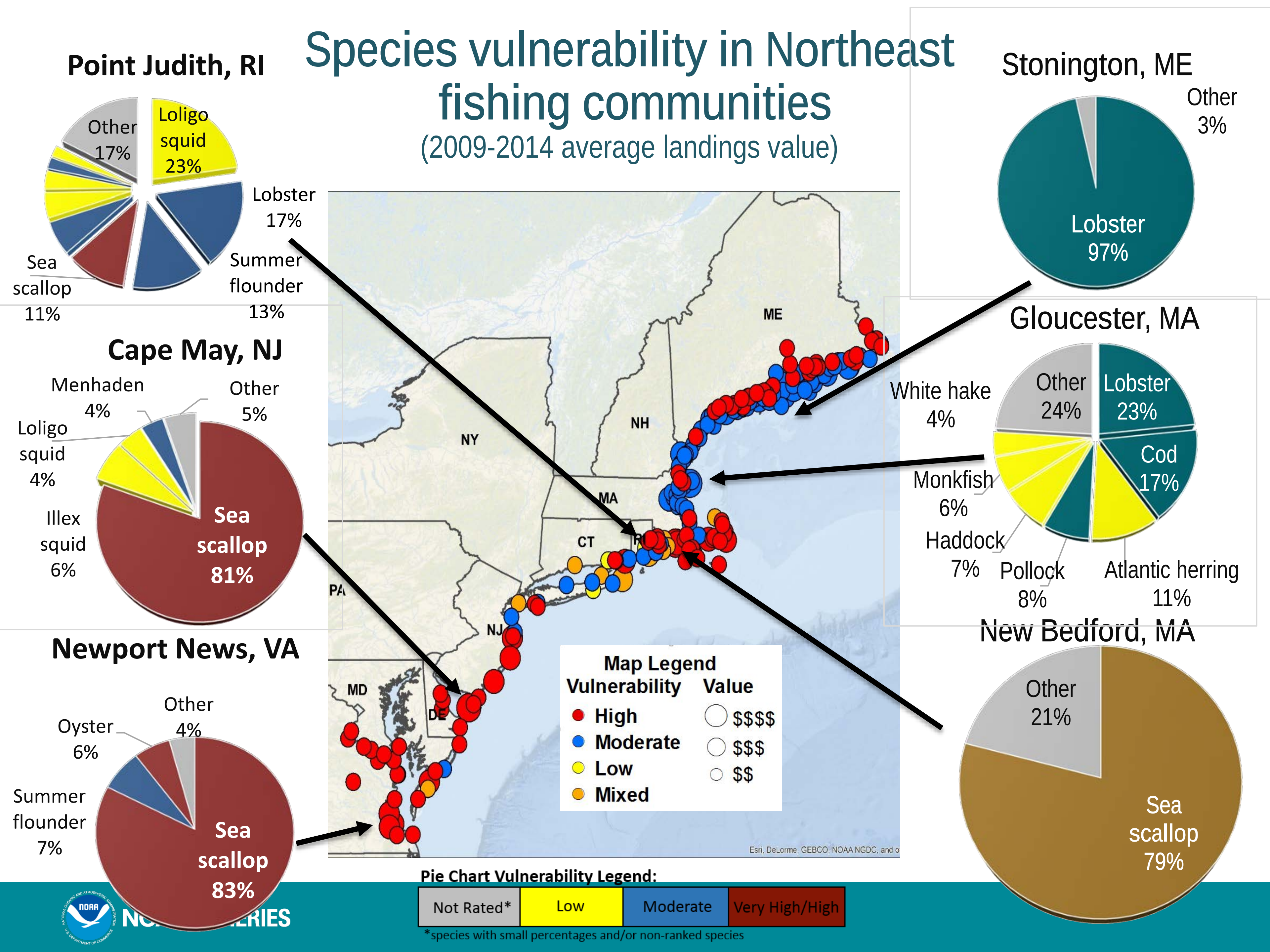
RESEARCH ARTICLE

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]

Sea turtle and marine mammal vulnerability assessment (*Lettrich et al. in prep.*)

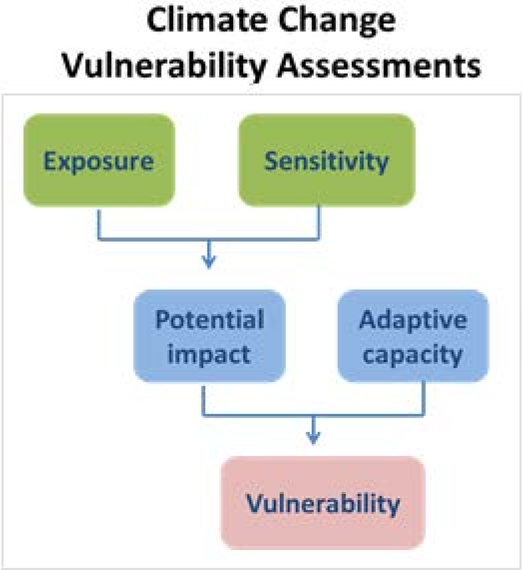



Species vulnerability in Northeast fishing communities
(2009-2014 average landings value)
Point Judith, RI
Other 17%
Loligo squid 23%
Lobster 17%
Summer flounder 13%
Sea scallop 11%
Cape May, NJ
Menhaden 4%
Other 5%
Loligo squid 4%
Illex squid 6%
Sea scallop 81%
Newport News, VA
Other 4%
Oyster 6%
Summer flounder 7%
Sea scallop 83%
Stonington, ME
Other 3%
Lobster 97%
Gloucester, MA
White hake 4%
Other 24%
Lobster 23%
Cod 17%
Monkfish 6%
Haddock 7%
Pollock 8%
Atlantic herring 11%
New Bedford, MA
Other 21%
Sea scallop 79%
ME
NH
NY
MA
CT
RI
PA
NJ
MD
DE
Map Legend
Vulnerability
High
Moderate
Low
Mixed
Value
$$$$
$$$
$$
Esri, DeLorme, GEBCO, NOAA NGDC, and o
Pie Chart Vulnerability Legend:
Not Rated*
Low
Moderate
Very High/High
*species with small percentages and/or non-ranked species

Habitat Climate Vulnerability Assessment

Develop a habitat vulnerability assessment that can provide broader consideration of habitat in future vulnerability assessments and can be used directly in management applications

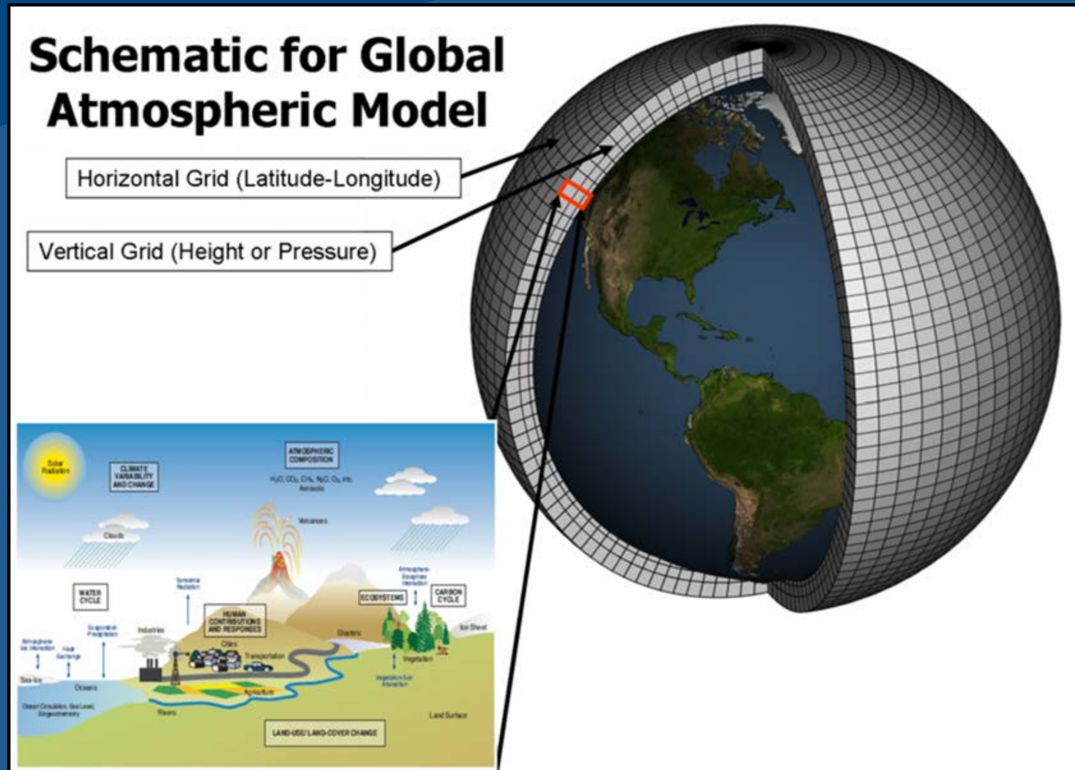
1. Review existing methods
2. Develop draft method
3. Implement draft method in Northeast U.S.
4. Review method and Northeast U.S. implementation

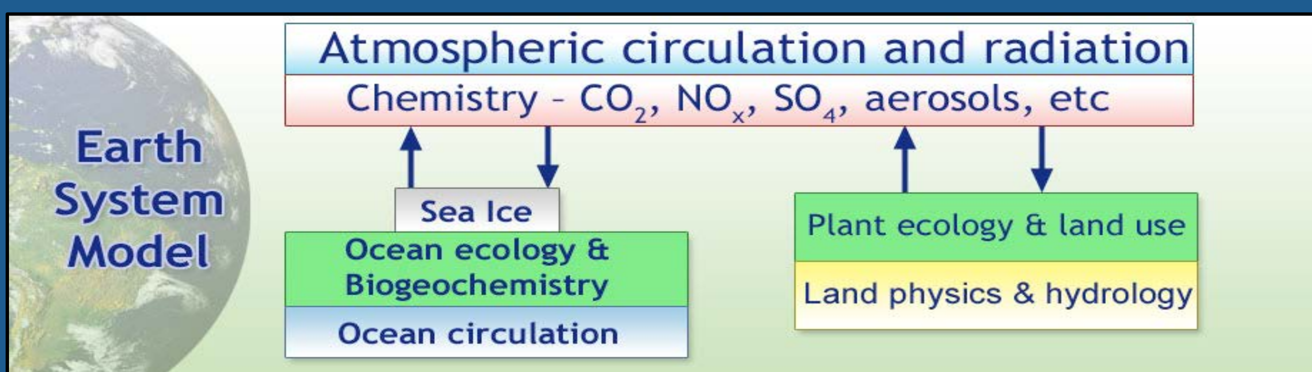


Habitat is defined as:

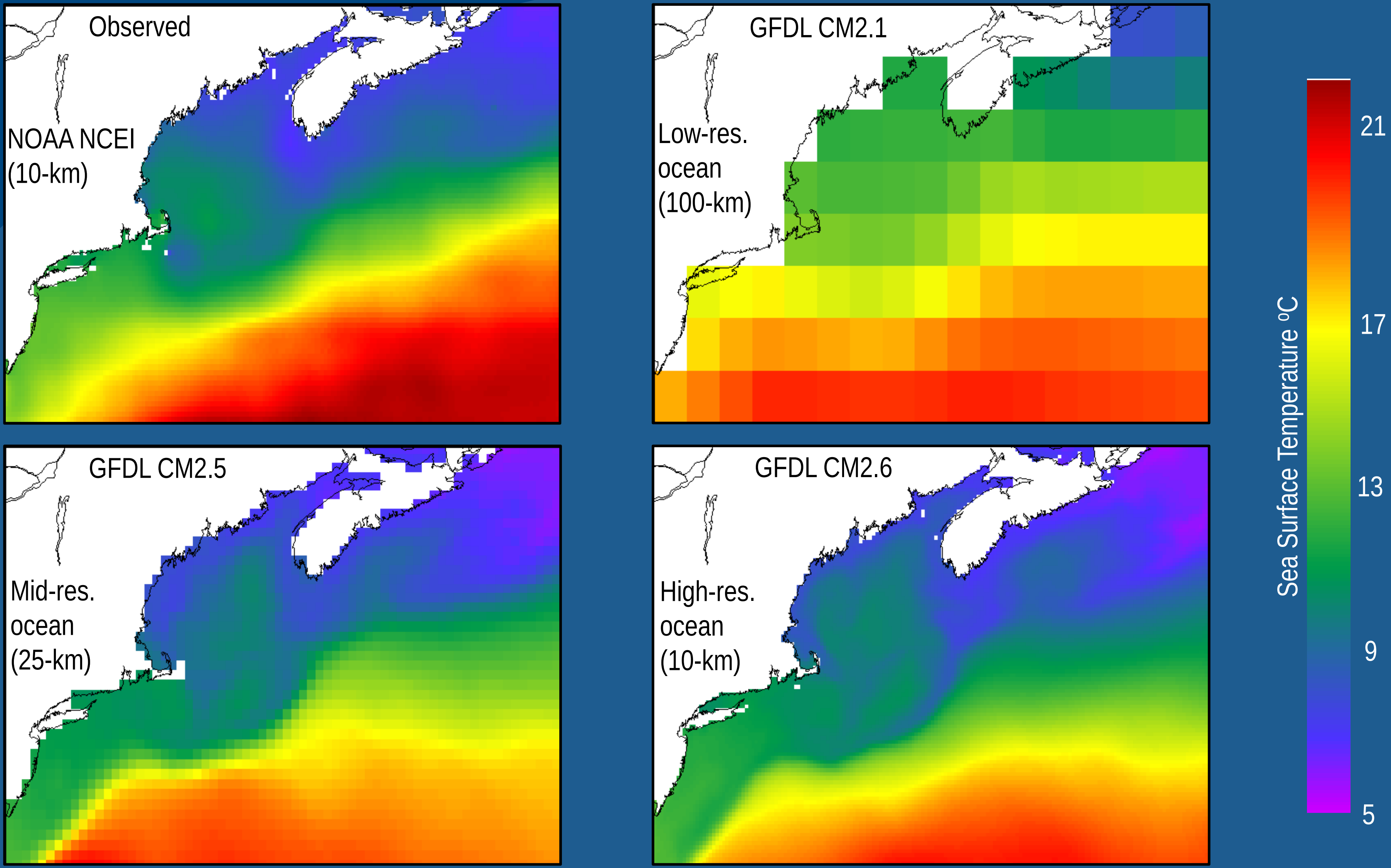
- coastal rivers and watersheds, estuaries, and marine waters;
- bottom zones through the water column;
- an area's physical, geological, chemical, and biological components

Climate Projections - Global Climate & Earth System



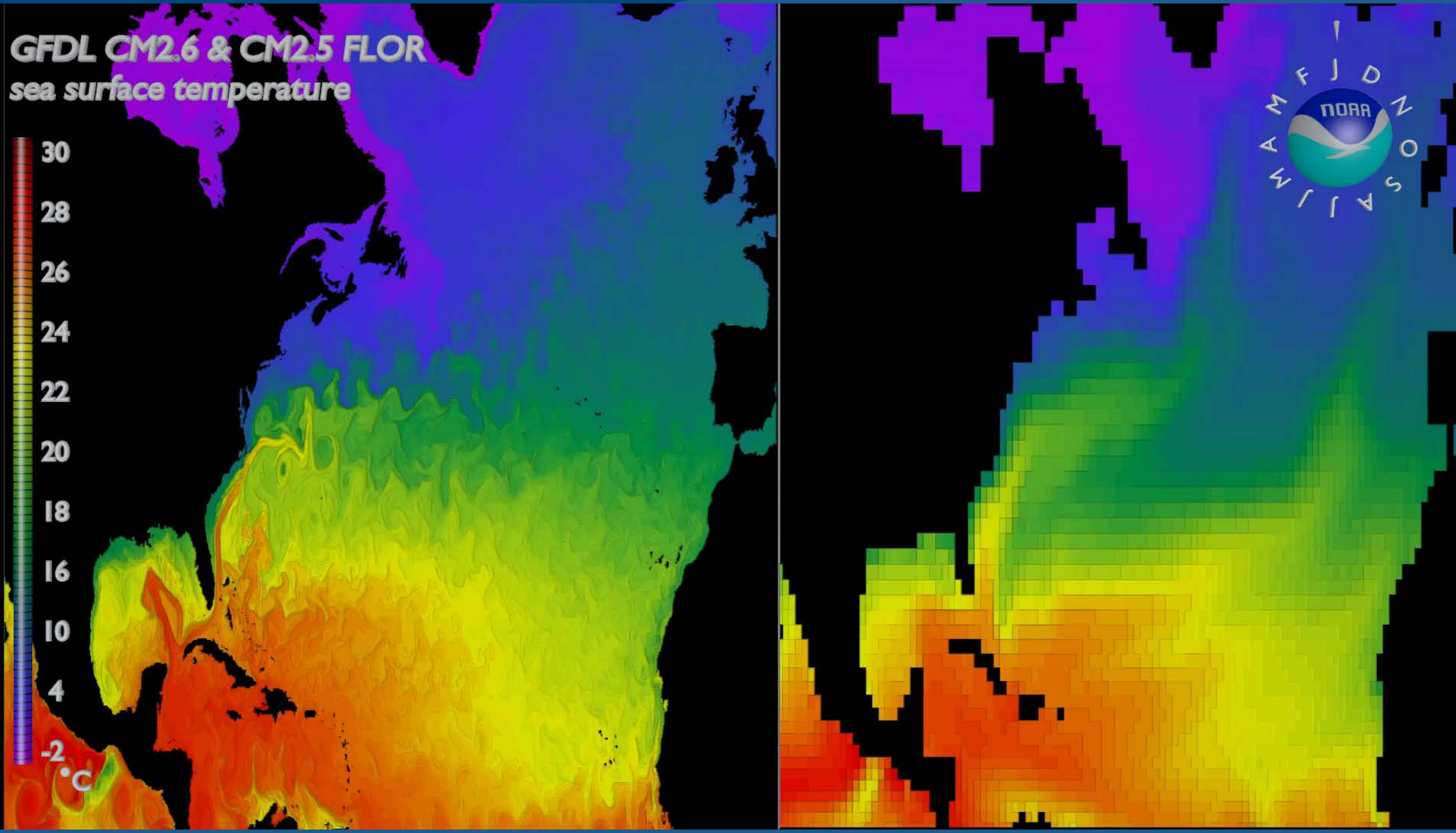


NOAA GFDL Climate Models: U.S. Northeast Shelf



Saba et al. 2016

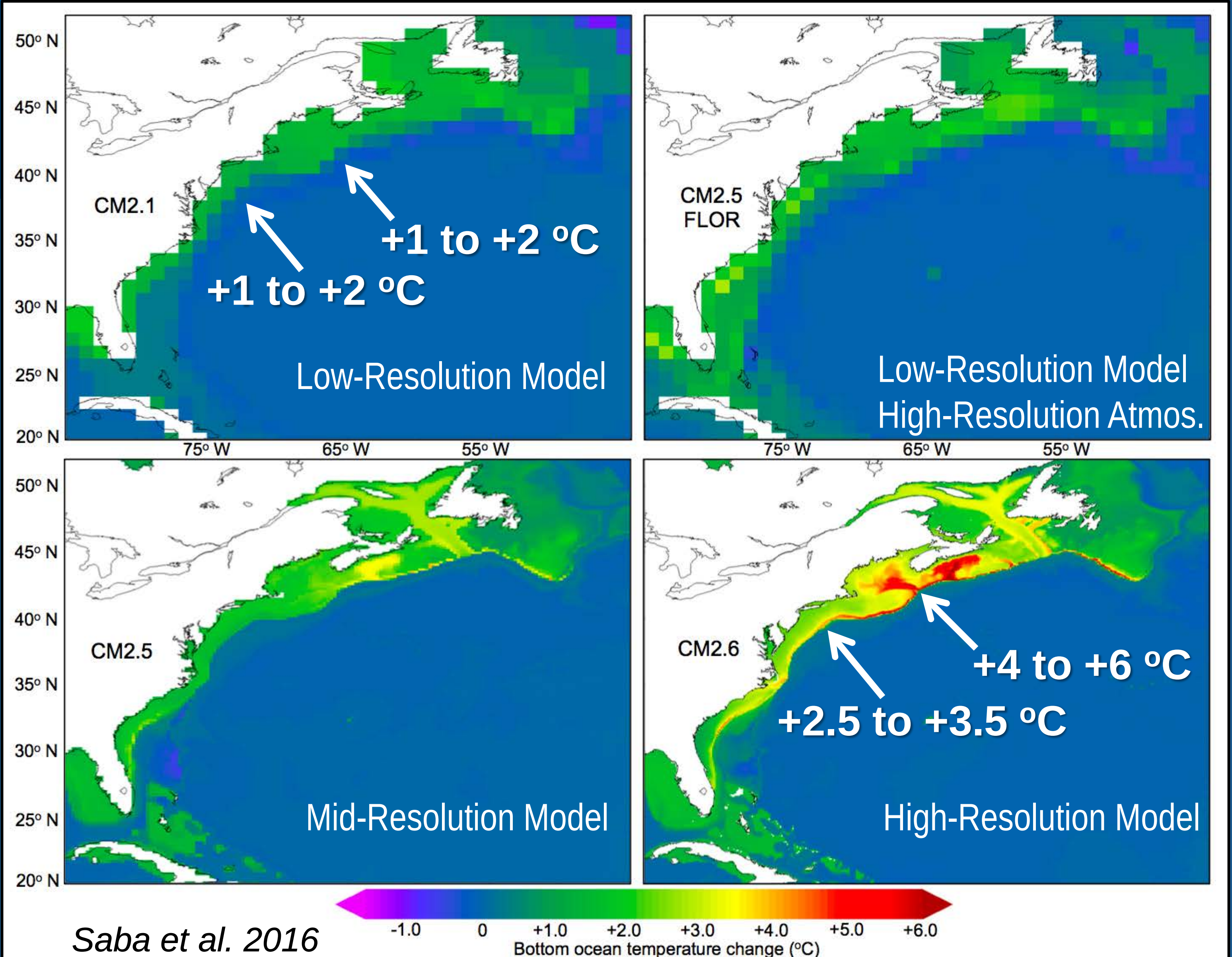
Global Climate Models: Resolution



High-Resolution Ocean (10-km)

Low-Resolution Ocean (100-km)

Northwest Atlantic – Projected ocean warming



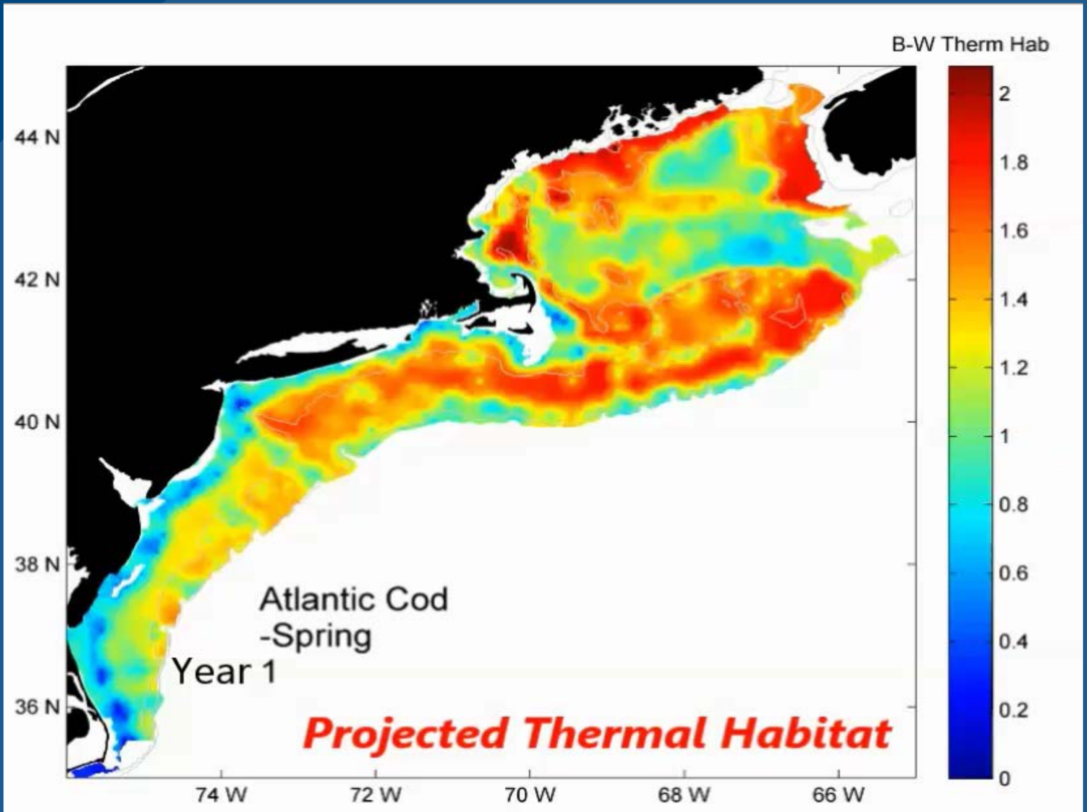
Saba et al. 2016

Northwest Atlantic 2xCO_2 Projection

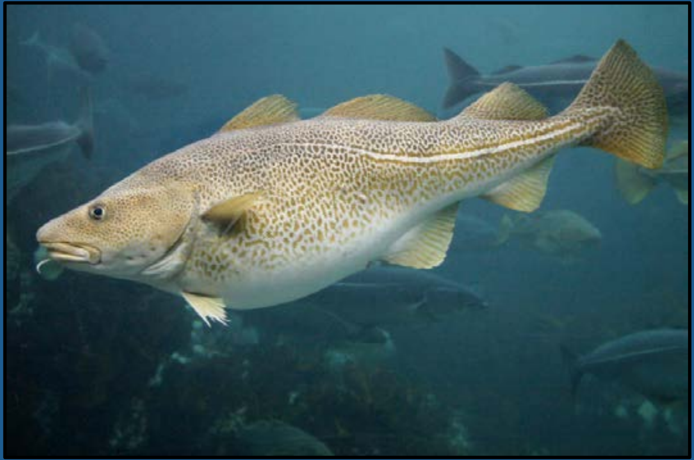
Saba et al. 2016

Atlantic cod thermal habitat projection based on NOAA GFDL's high-res. climate model

Atlantic cod



Kleisner et al. 2017

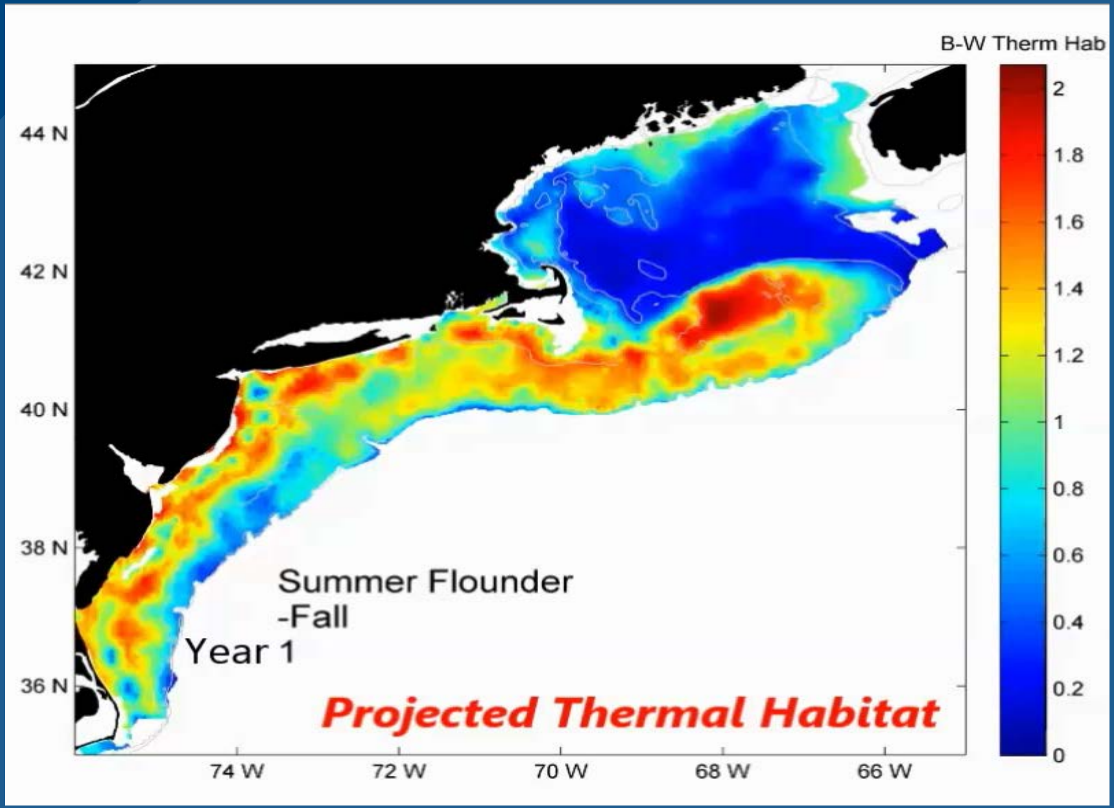


Value of Landings

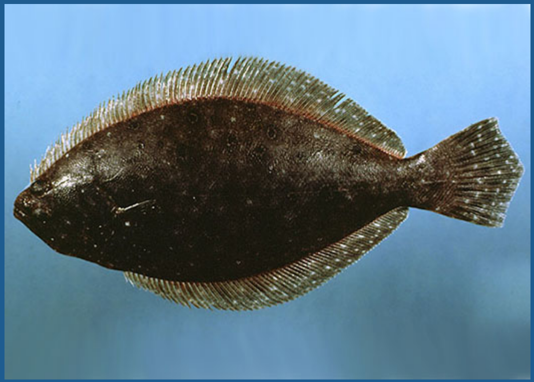
Rank	Species	Thousand Dollars
1	Lobsters	679,214
2	Crabs	678,727
3	Shrimp	488,384
4	Salmon	460,166
5	Pollock	449,198
6	Scallops	440,496
7	Cod	264,191
8	Flatfish	263,615
9	Oysters	213,773
10	Clams	206,299

Summer flounder thermal habitat projection based on NOAA GFDL's high-res. climate model

Summer flounder



Kleisner et al. 2017



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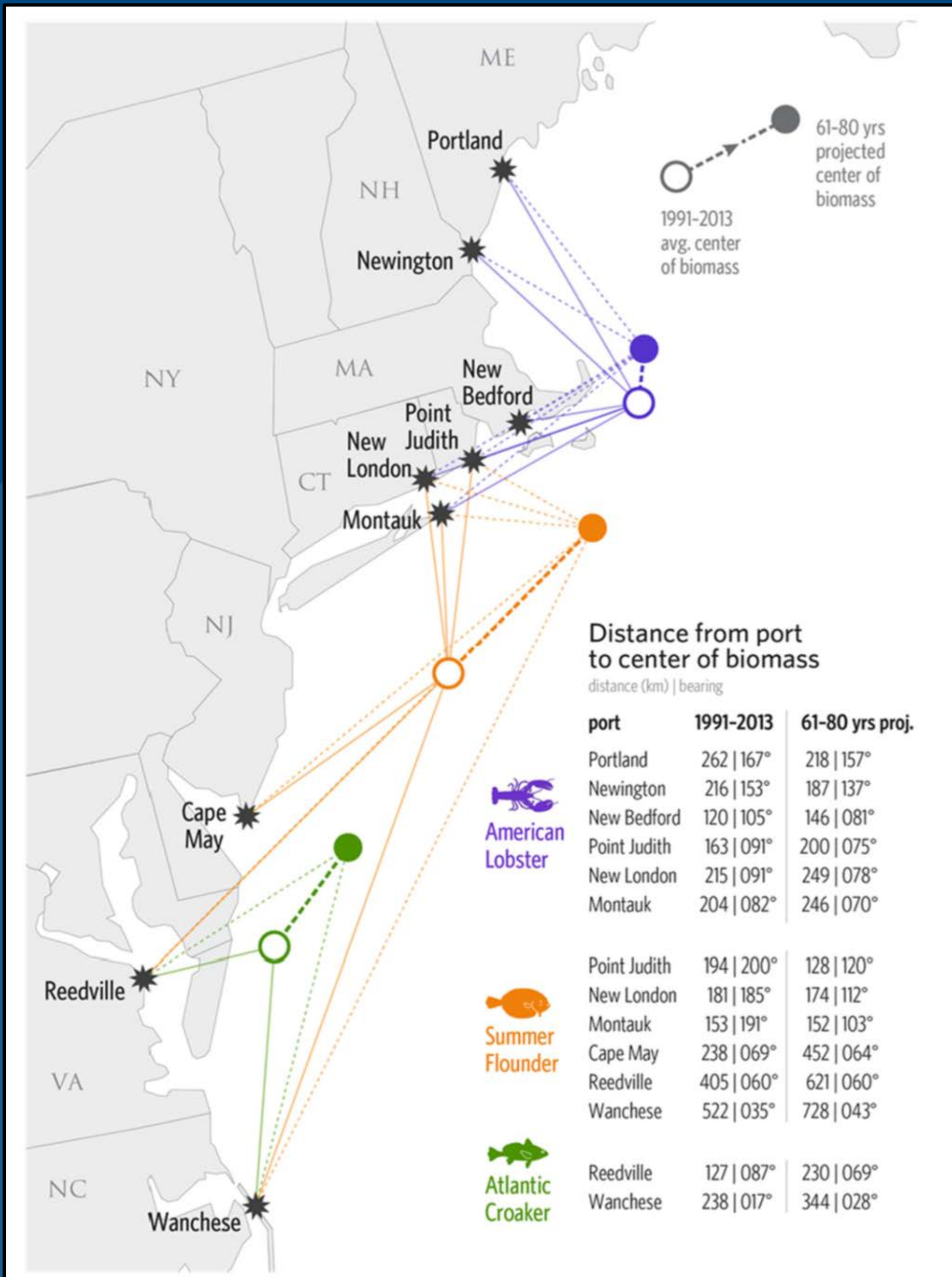


Distance from port to fishing areas

Distance to port under continued ocean warming.

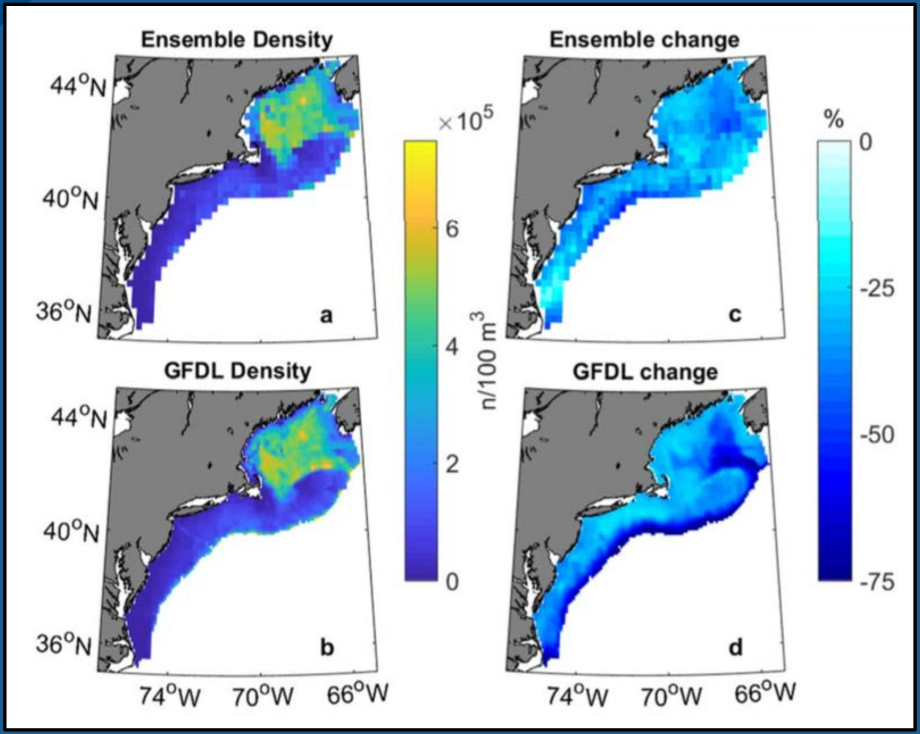
Does not account for:

- Fishing mortality change.
- Species interactions.

Kleisner et al. 2017

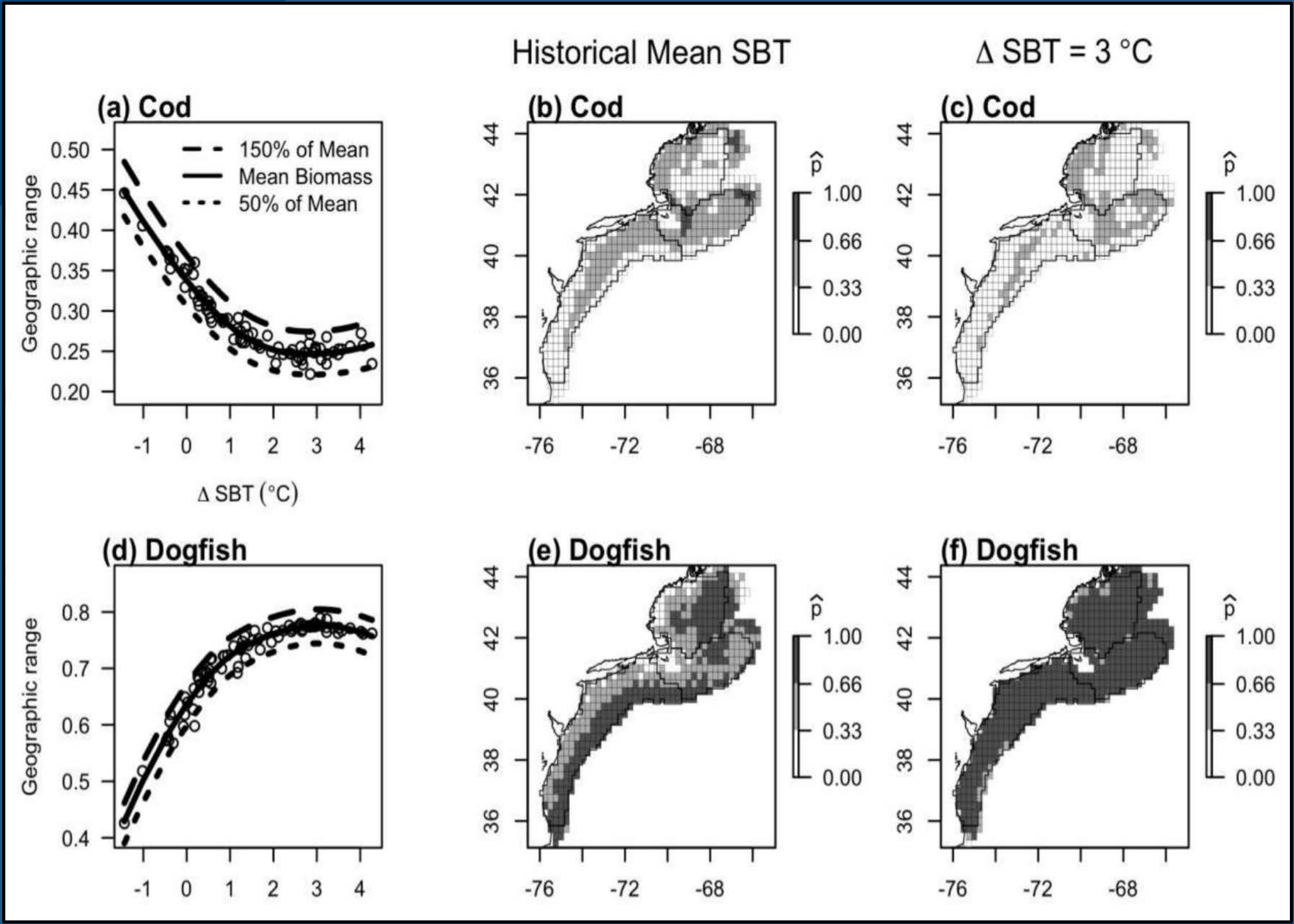
Calanus finmarchicus projection based on NOAA GFDL's high-res. climate model

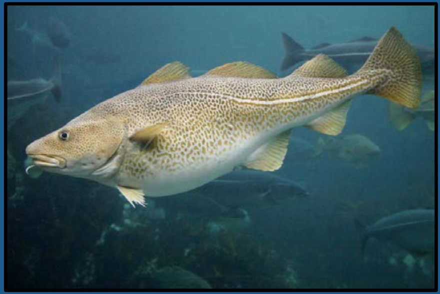
Calanus finmarchicus habitat climate change projection based on NOAA GFDL's high-res. CM2.6.



Grieve et al. 2017

Piscivore overlap projections based on NOAA GFDL's high-res. climate model

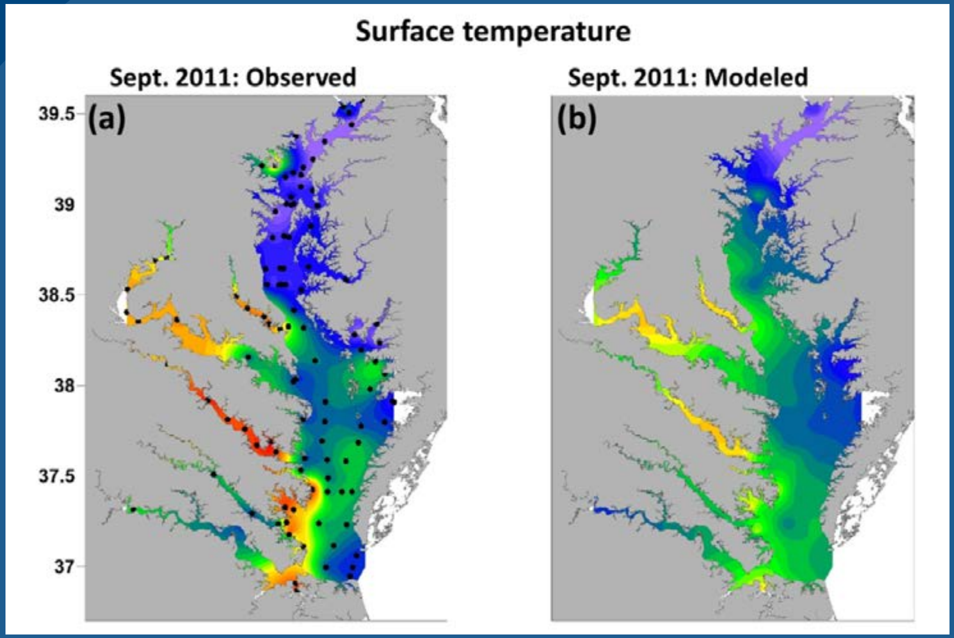




Selden et al. 2017

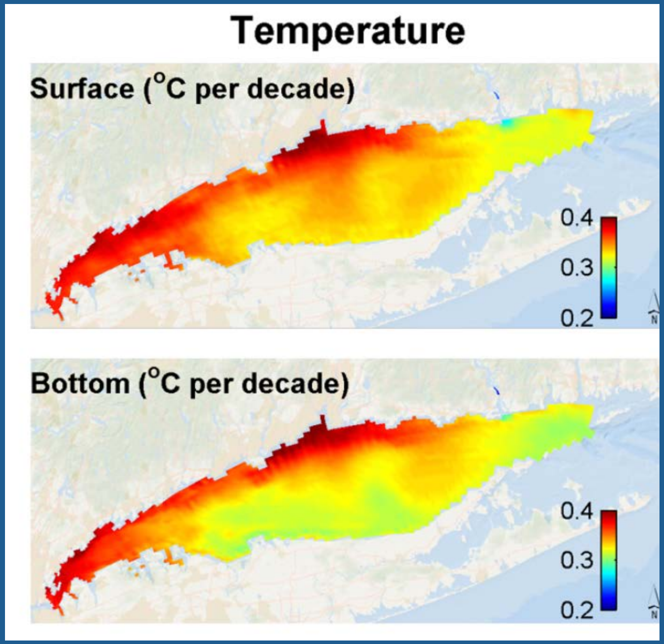
Climate Model Downscaling - Northeast U.S. Estuaries

Chesapeake Bay



Muhling et al. 2017a

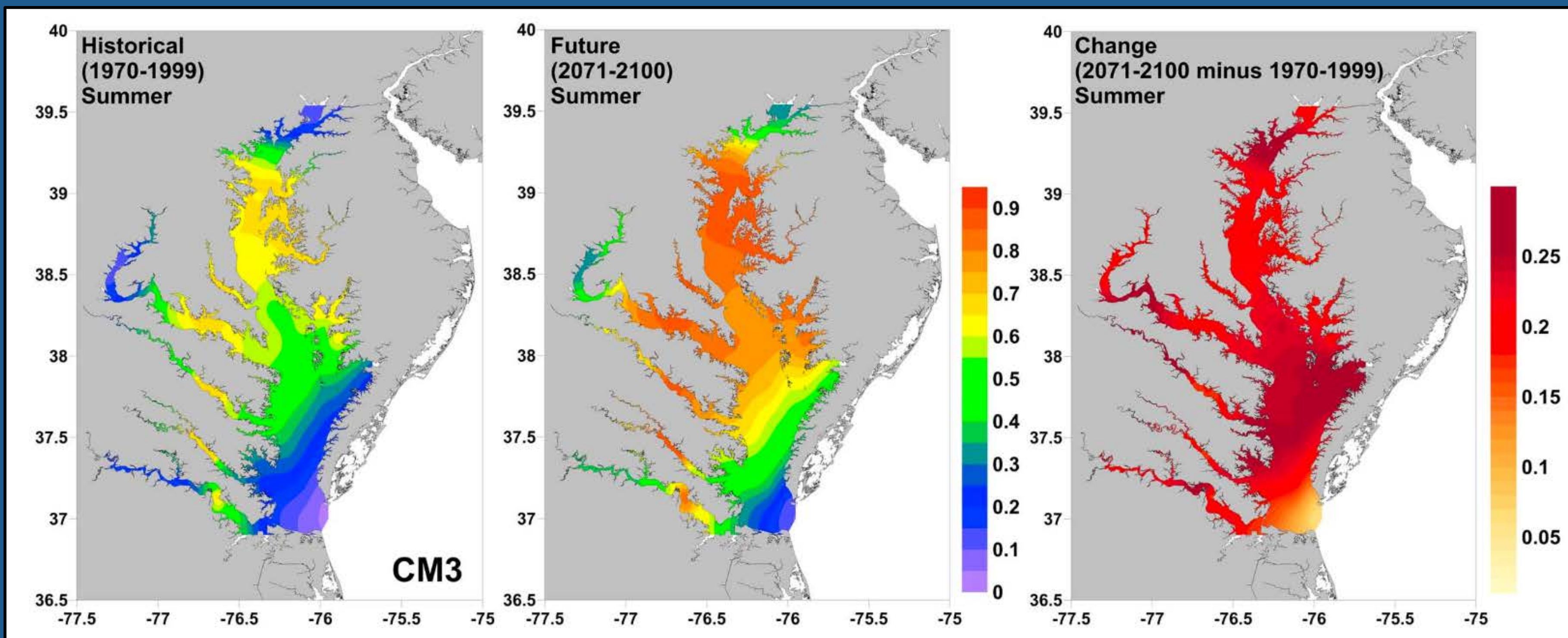
Long Island Sound



Shulte et al. 2017
Georgas et al. 2016

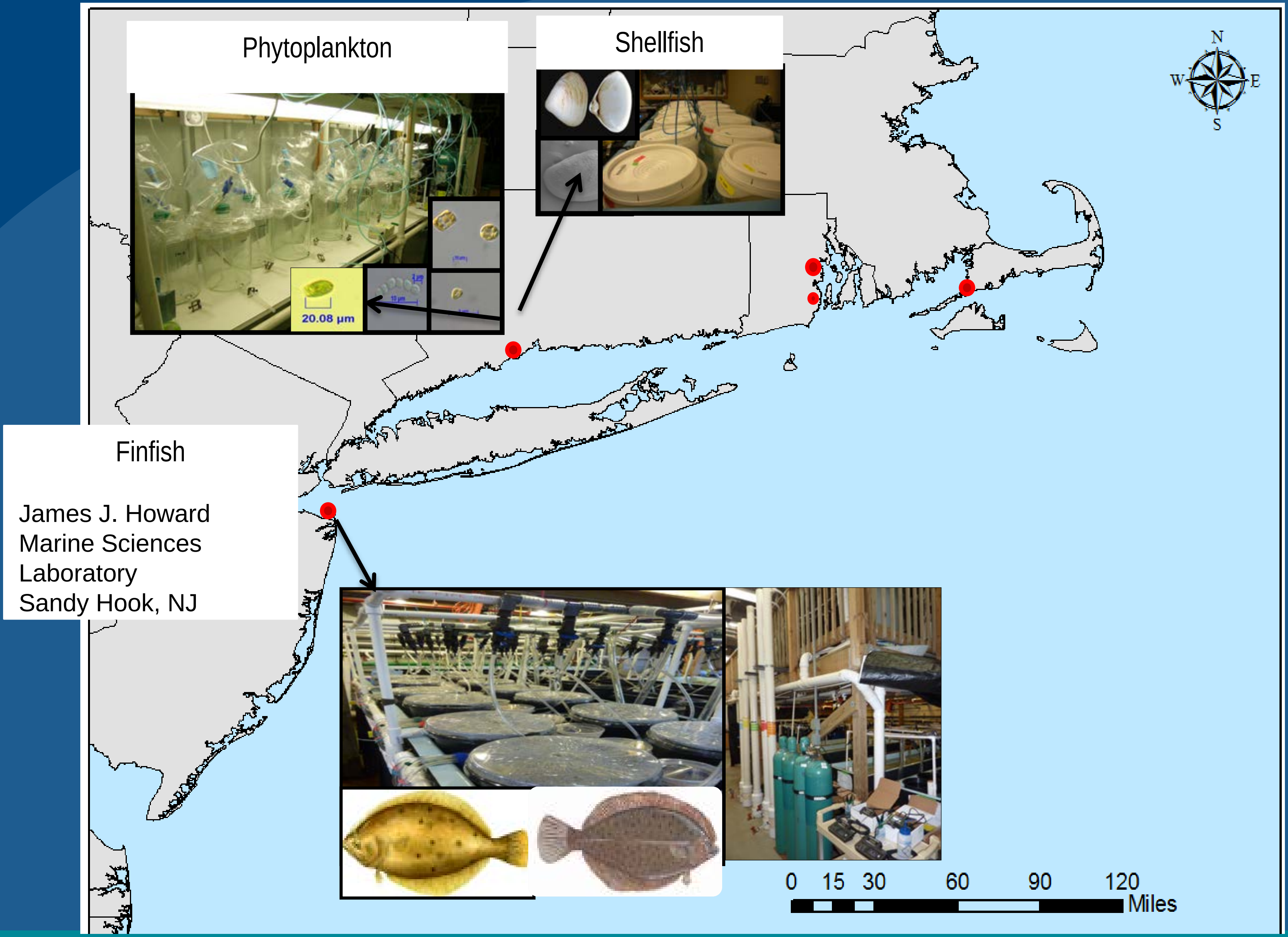
Projections of the future occurrence, distribution, and seasonality of three *Vibrio* species in the Chesapeake Bay under a high-emission climate change scenario

Barbara A. Muhling[1,2,3], John Jacobs[4], Charles A. Stock[2], Carlos F. Gaitan[5], and Vincent S. Saba[6]

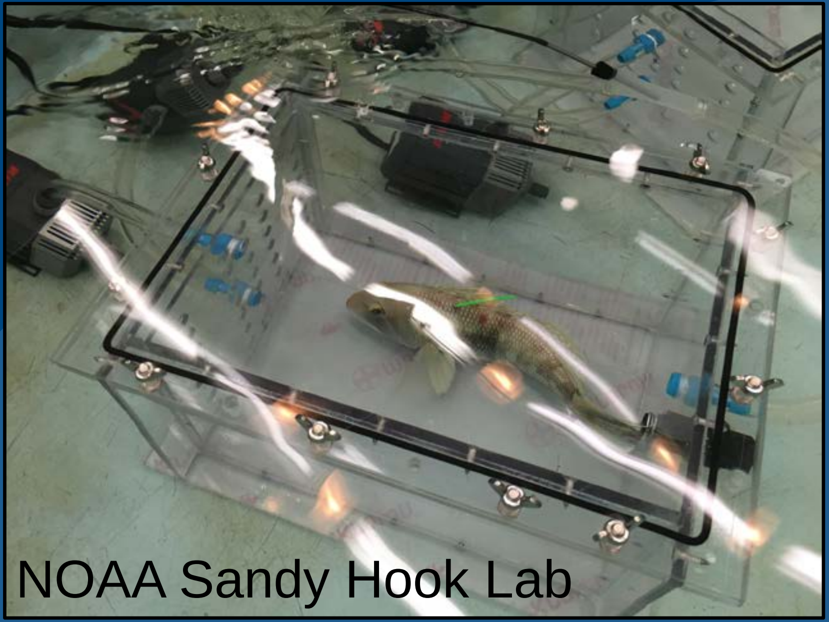


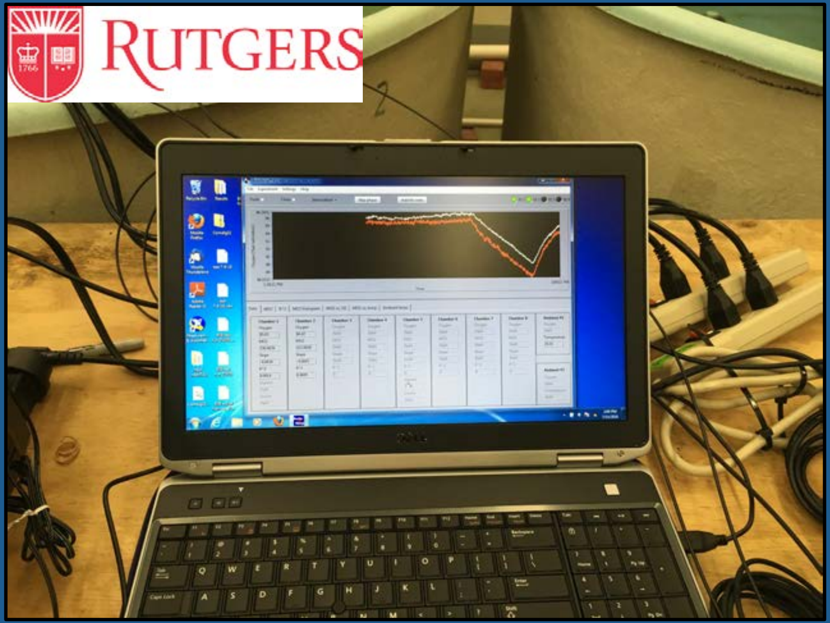
Muhling et al. 2017b

Laboratory Studies

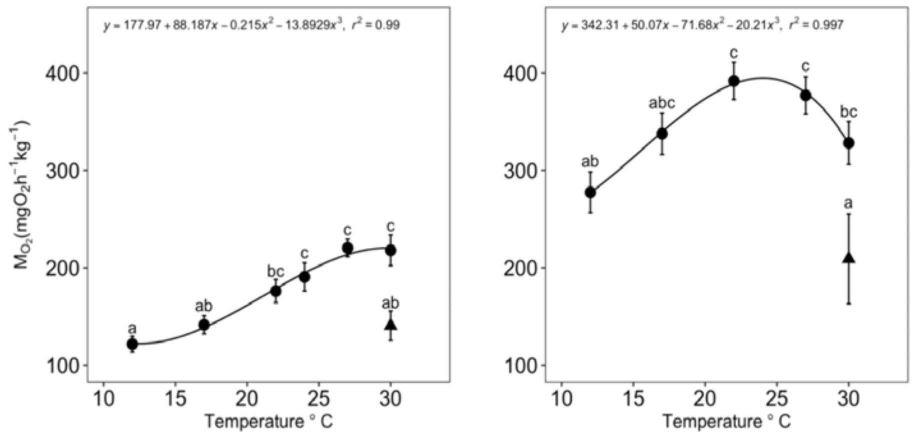


Laboratory Studies



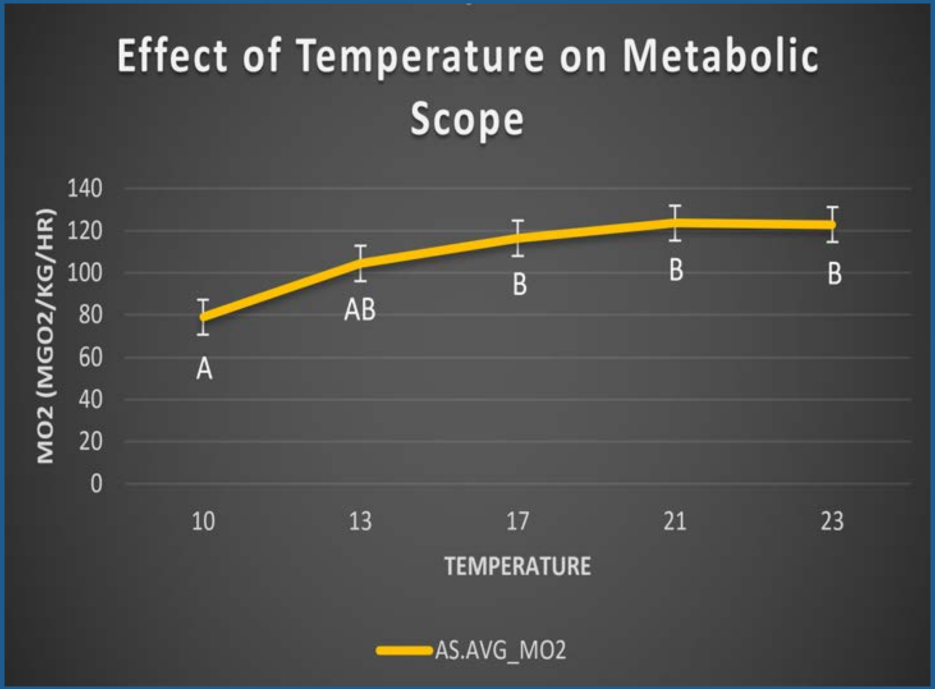


Slesinger et al. unpublished



Laboratory Studies

NOAA Sandy Hook Lab



Higher temperatures above 23-24C resulted in high mortality

Andres et al. unpublished

Other ongoing research

- Monitoring pH at shellfish hatcheries
- Fine-scale modeling of habitat
- Sea turtle nesting and habitat analyses
- Atlantic Salmon – climate scenario planning
- Beyond temperature: Habitat modeling using biological and physical variables
- Regional model projection – includes lower trophics (GFDL, Rutgers University). Many other academic collaborations.

Summary

- U.S. Northeast Shelf accounts for > 1/3 annual value of commercial fish.
- U.S. Northeast Shelf has warmed faster than most other coastal waters globally.
- NOAA GFDL's high-res. global climate model resolves the enhanced warming.
- Continued distribution shifts of valuable commercial species are highly likely under climate change.
- Need to move beyond temperature impacts. More laboratory process studies. Need to incorporate climate variables into ecosystem models. Assess uncertainty.
- Climate impacts research – inform assessments and management.
- Goal – climate ready fisheries management. Requires EBFM.