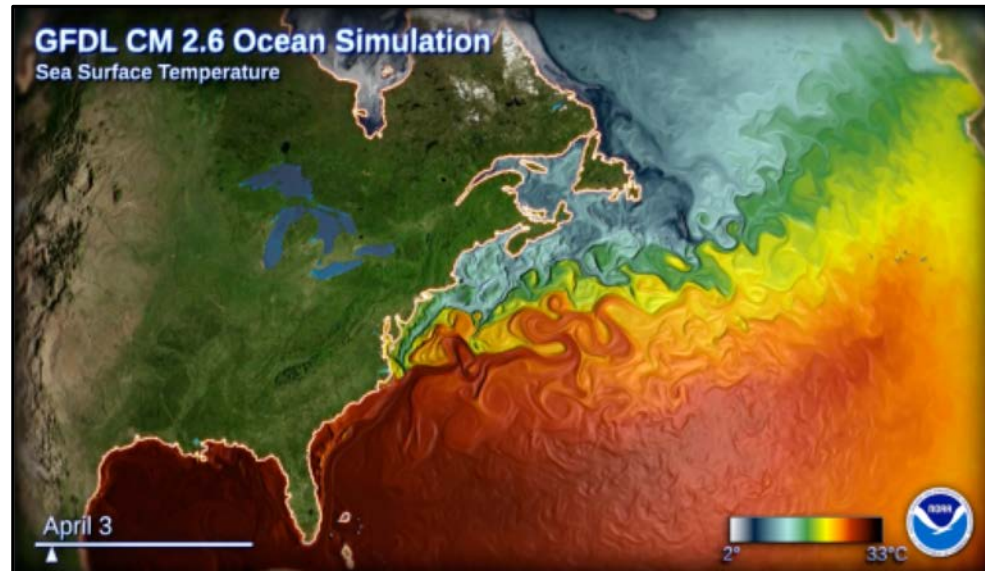




**NOAA
FISHERIES**

An Overview of NOAA Fisheries Species Distribution Research in the U.S. Northeast Shelf

Vincent Saba (with contributions from others)
NOAA Northeast Fisheries Science Center



NOAA FISHERIES



**NOAA
FISHERIES**

NOAA Fisheries Climate Science Strategy Highlights

“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.”

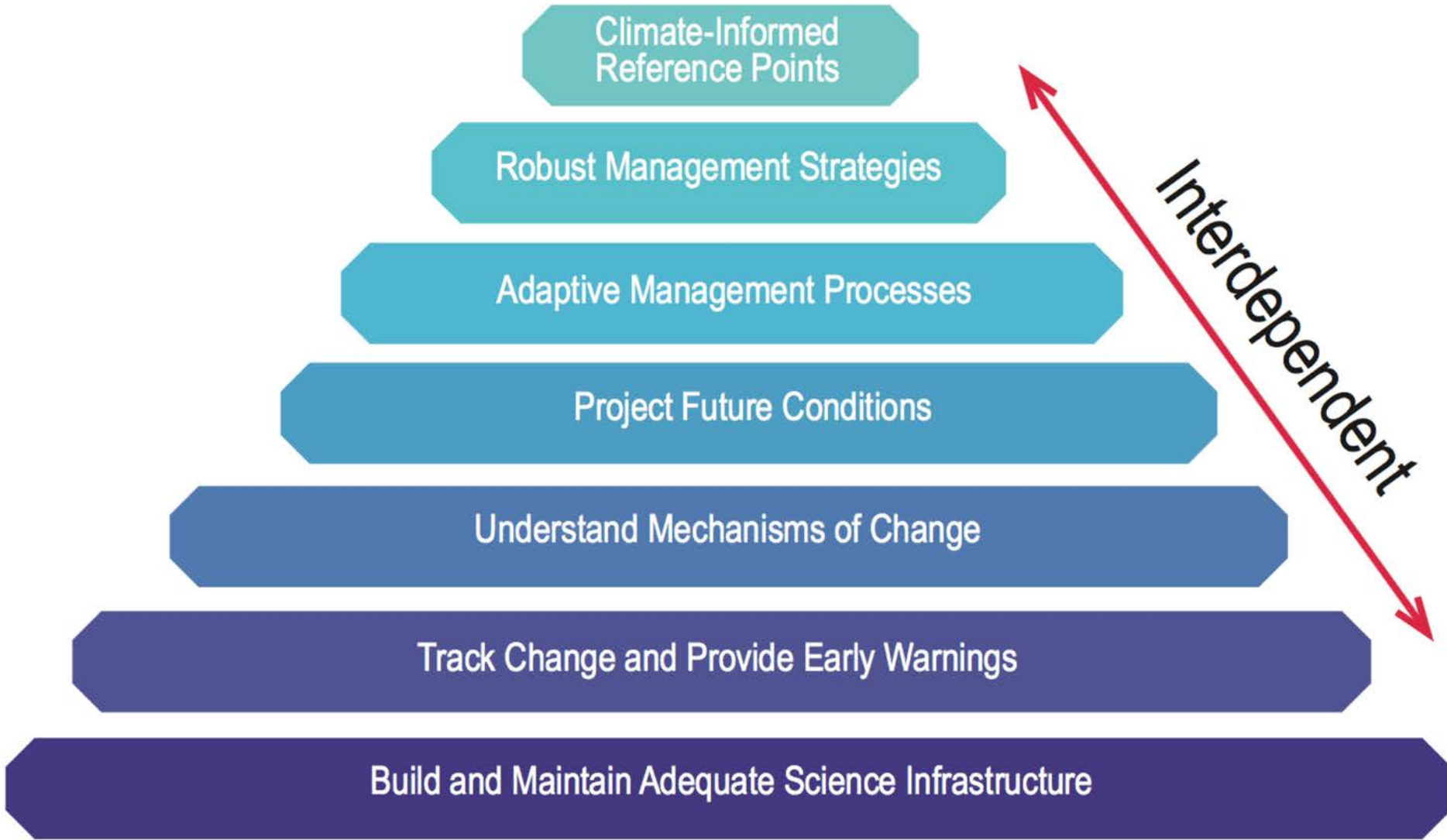
*- Eileen Sobeck
Former Fisheries
Assistant Administrator*

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



NOAA FISHERIES

Climate Science Strategy Objectives



Western
Region

NOAA Fisheries Climate Science Strategy Regional Action Plans

+

Northeast

Southeast

+

Alaska

Pacific Islands

+

Caribbean

Gulf of Mexico

Mouse over this icon
for more information

+



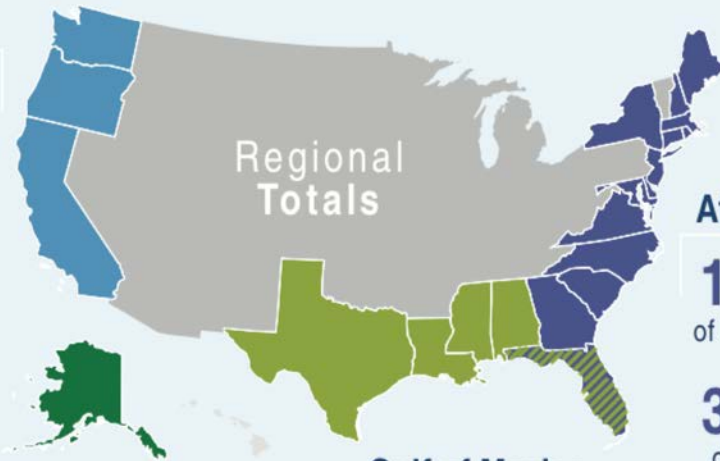
NOAA FISHERIES

U.S. Commercial Fishery Annual Value

Pacific

10%
of landings

13%
of value



Atlantic

13%
of landings

39%
of value

Gulf of Mexico

18%
of landings

16%
of value

Alaska

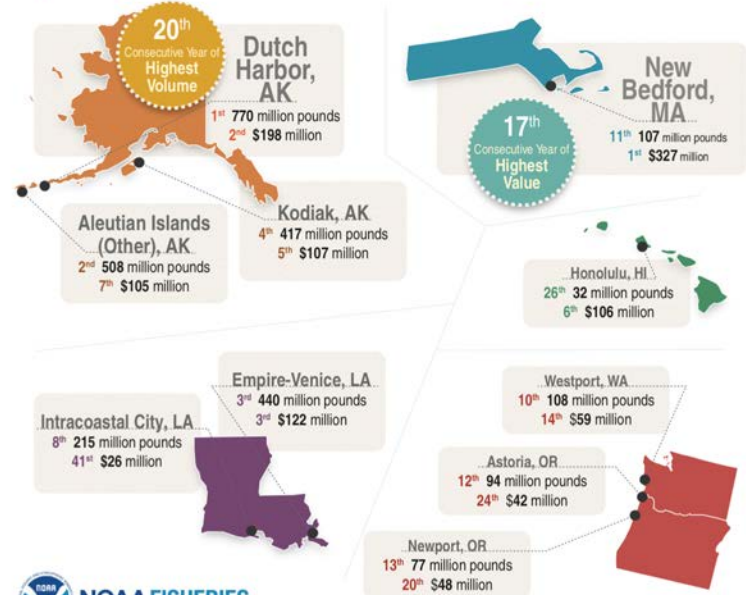
58%
of landings

29%
of value

*Hawaii contributed <1% of U.S. volume and 2% of U.S. landings value.
The Great Lakes contributed <1% of U.S. landings and landings value.

NOAA, 2016

2016 U.S. Commercial Fisheries and the Seafood Industry Top Ports by Volume and Value of Seafood Landed



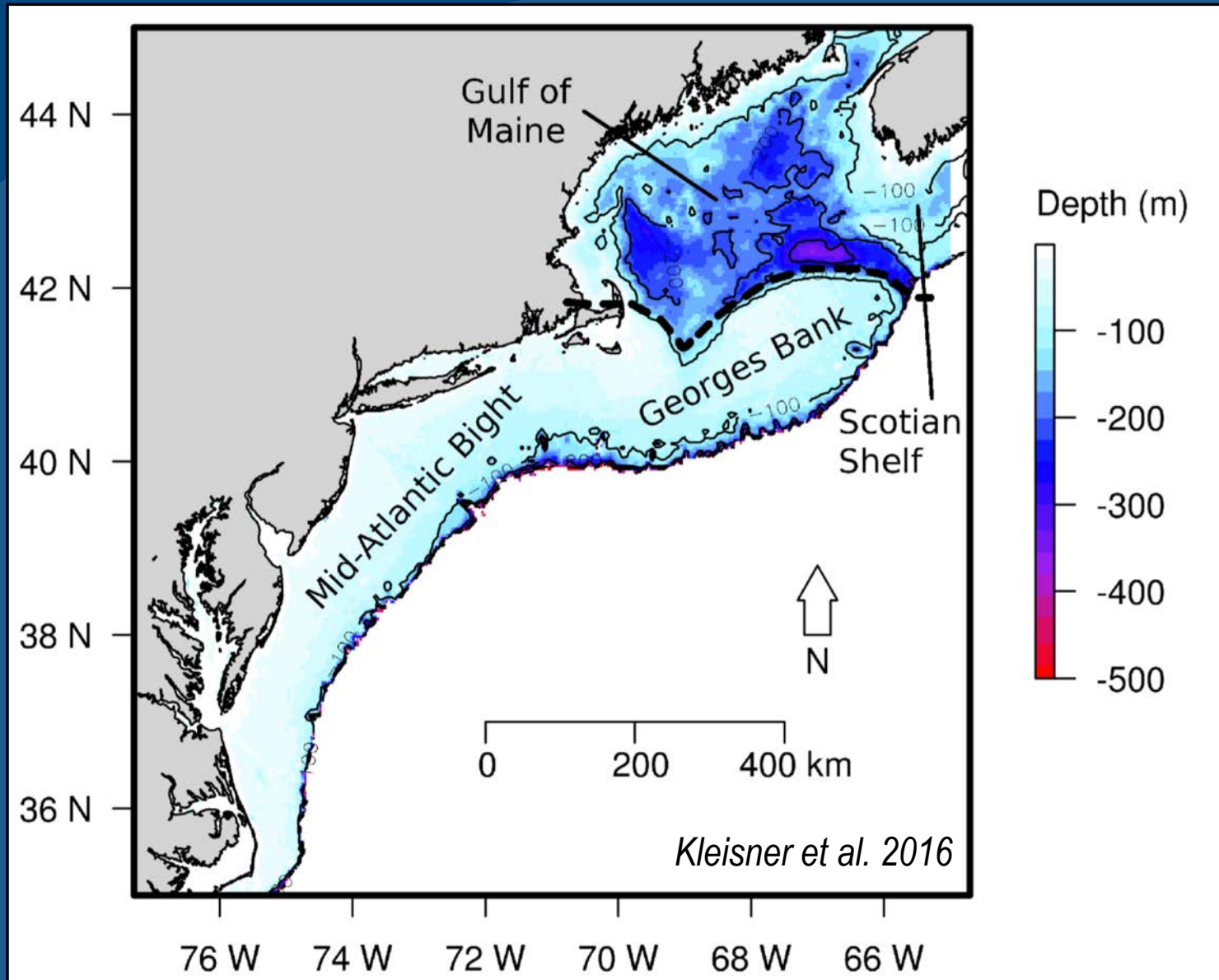
NW Atlantic - Outline

- 1) Observed change in the Northeast U.S. Shelf Ecosystem
- 2) Vulnerability analyses
- 3) Projected change (thermal habitat)
- 4) Process studies (laboratory research)

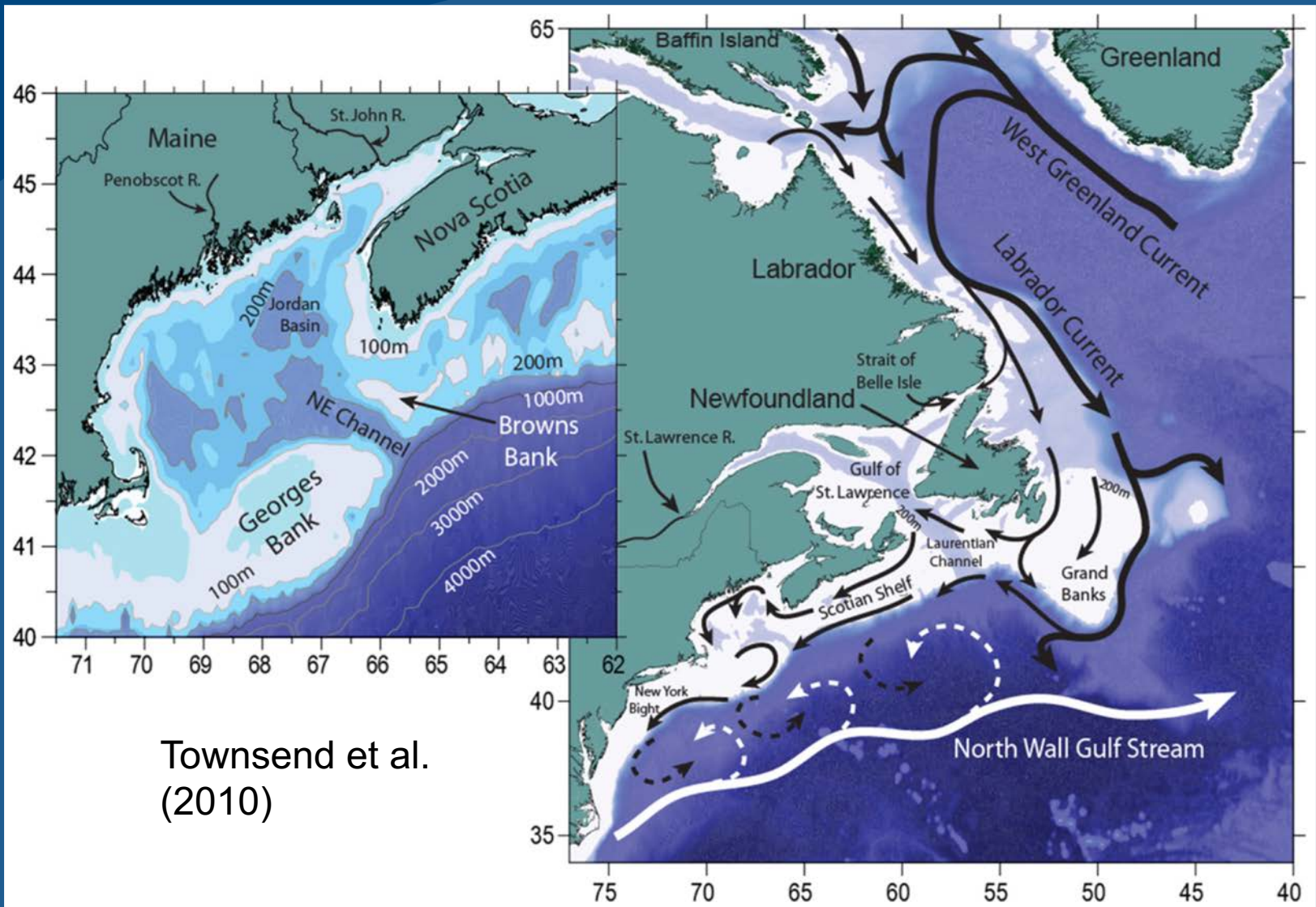
NEFSC Climate Change Website

<https://www.nefsc.noaa.gov/ecosys/climate-change>

U.S. Northeast Continental Shelf

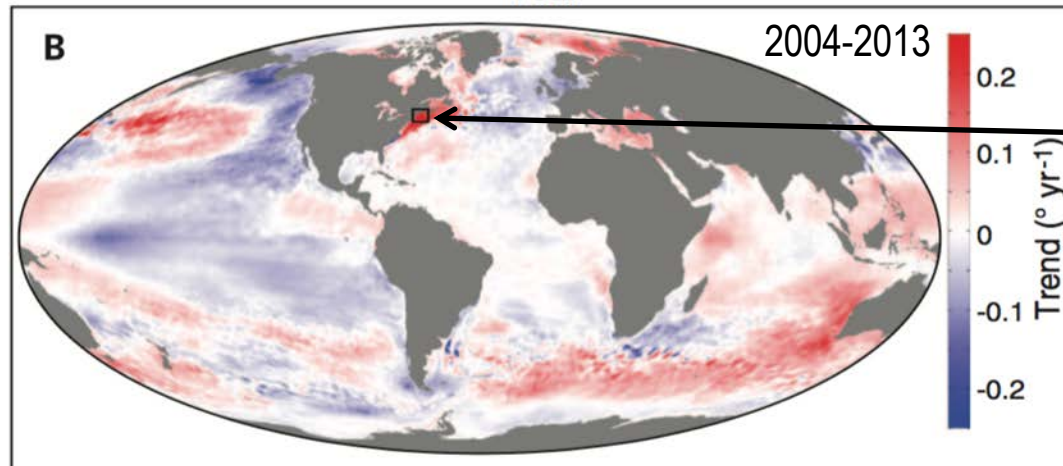
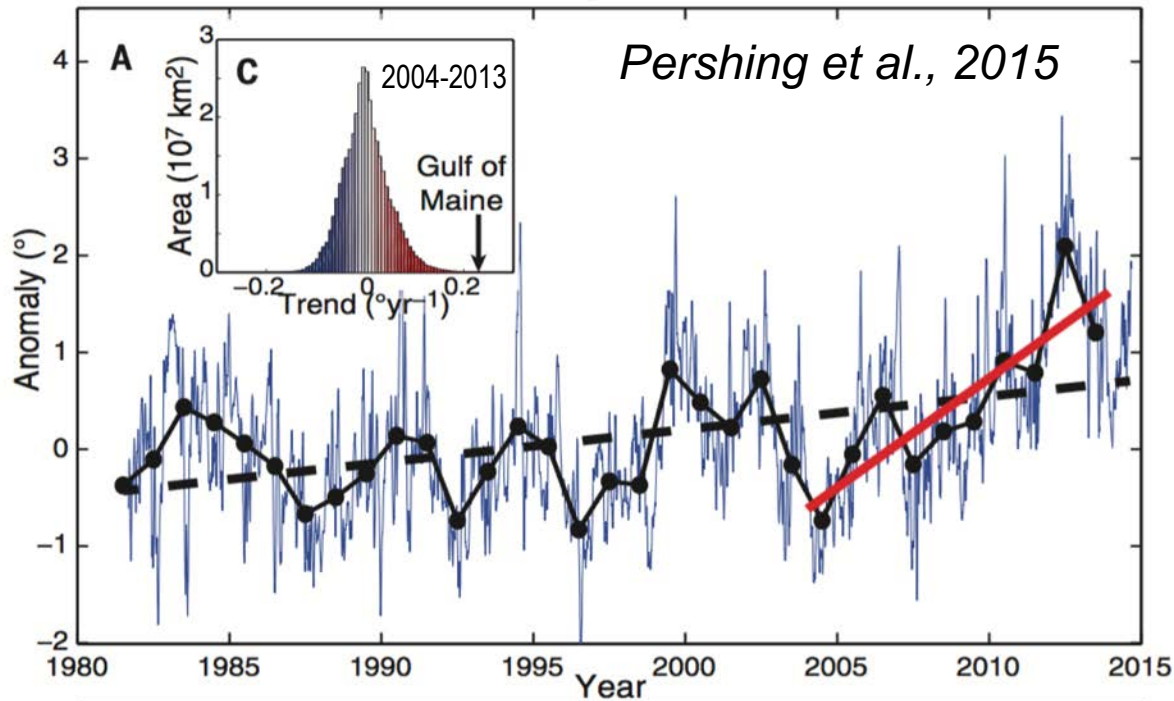


Northwest Atlantic Oceanography



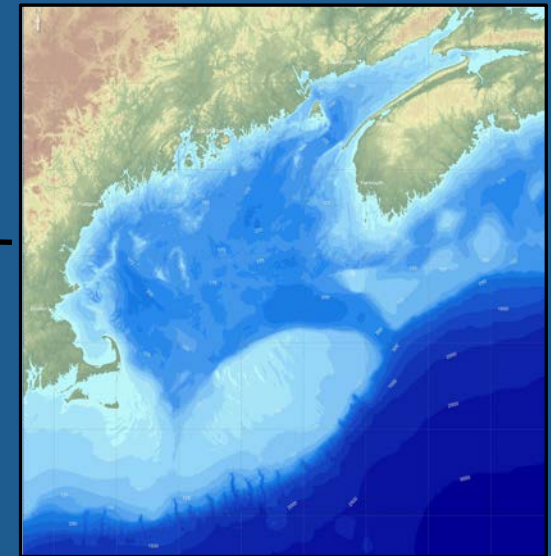
Townsend et al.
(2010)

U.S. Northeast Shelf - Warming



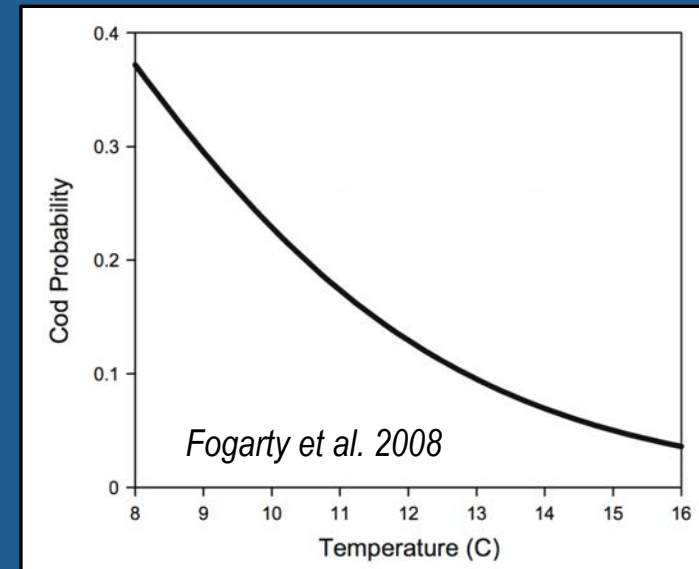
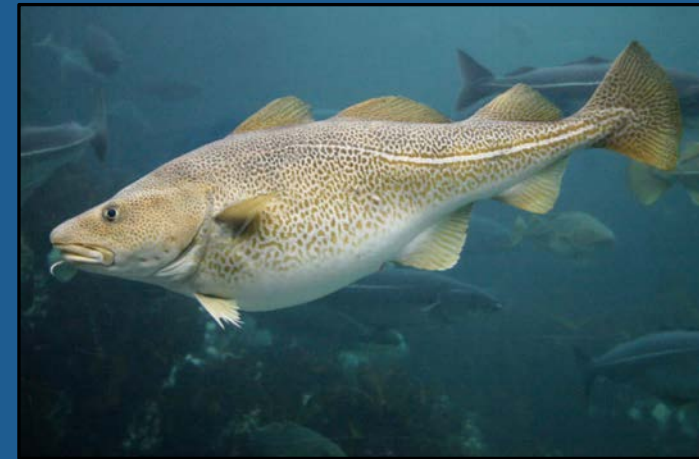
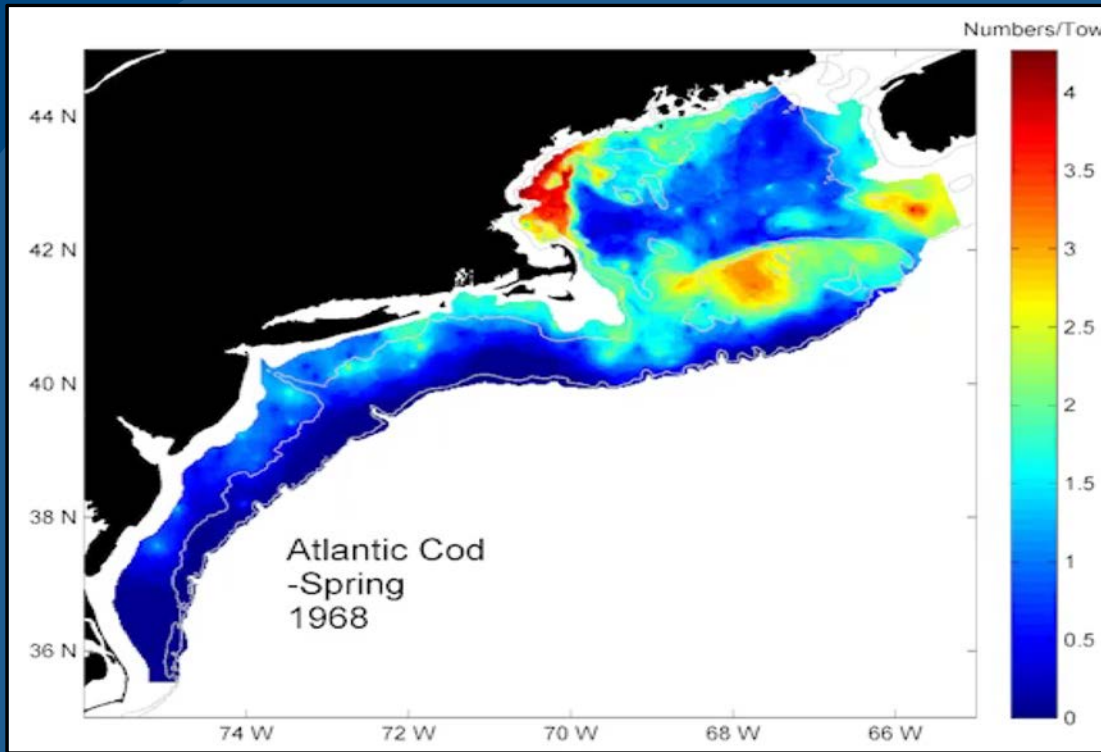
Gulf of Maine

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



Warming ocean, fish on the move

Atlantic cod

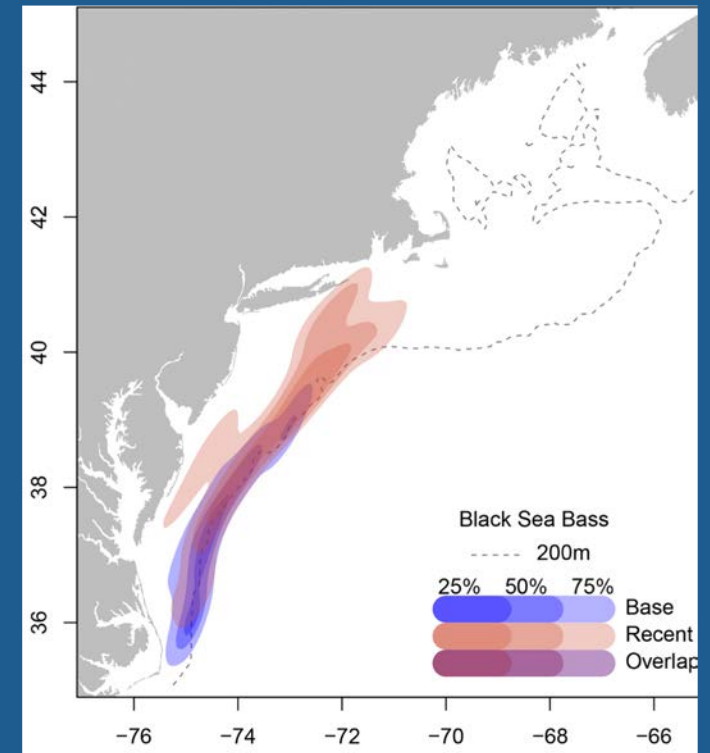
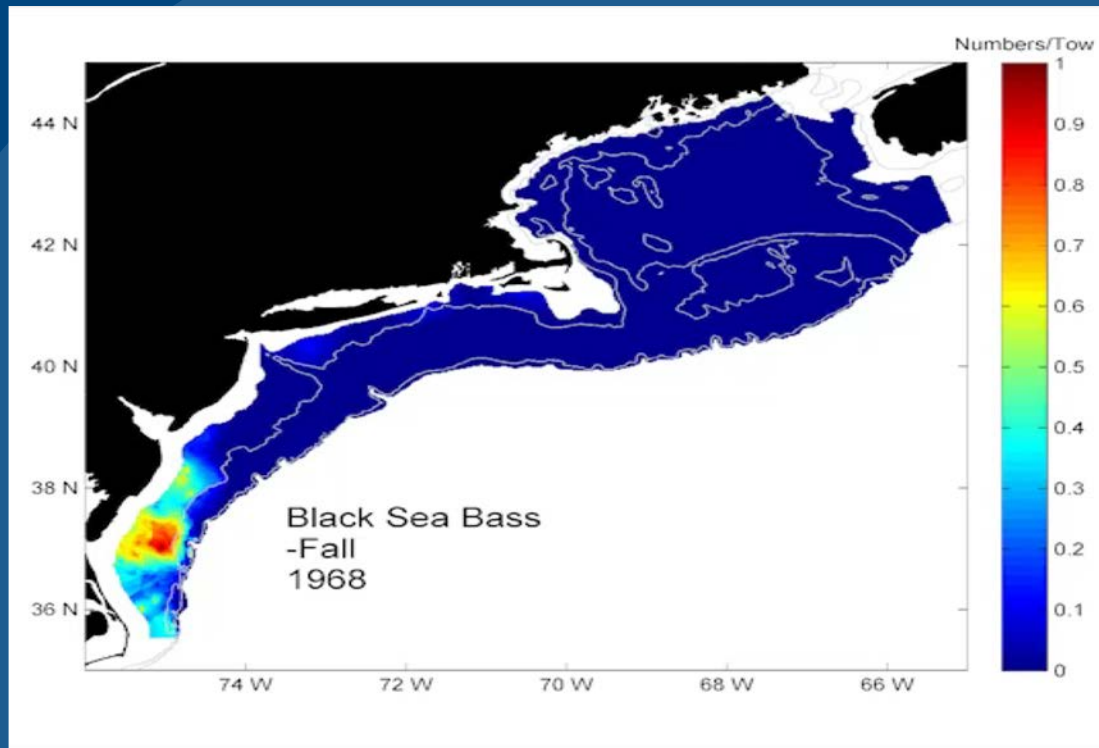


NOAA Survey Data

<https://www.nefsc.noaa.gov/ecosys>

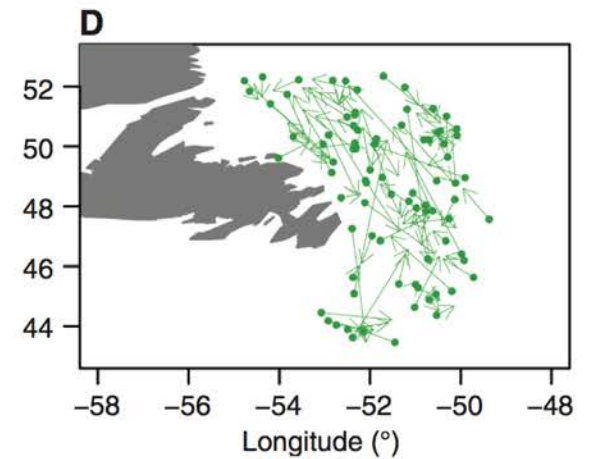
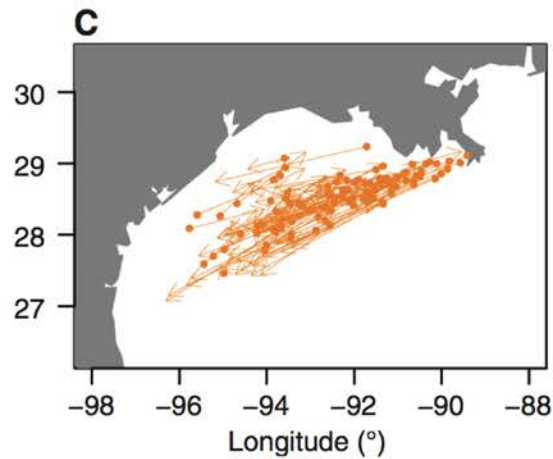
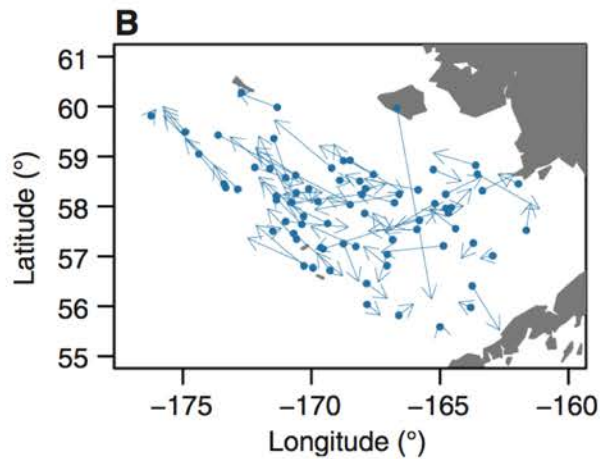
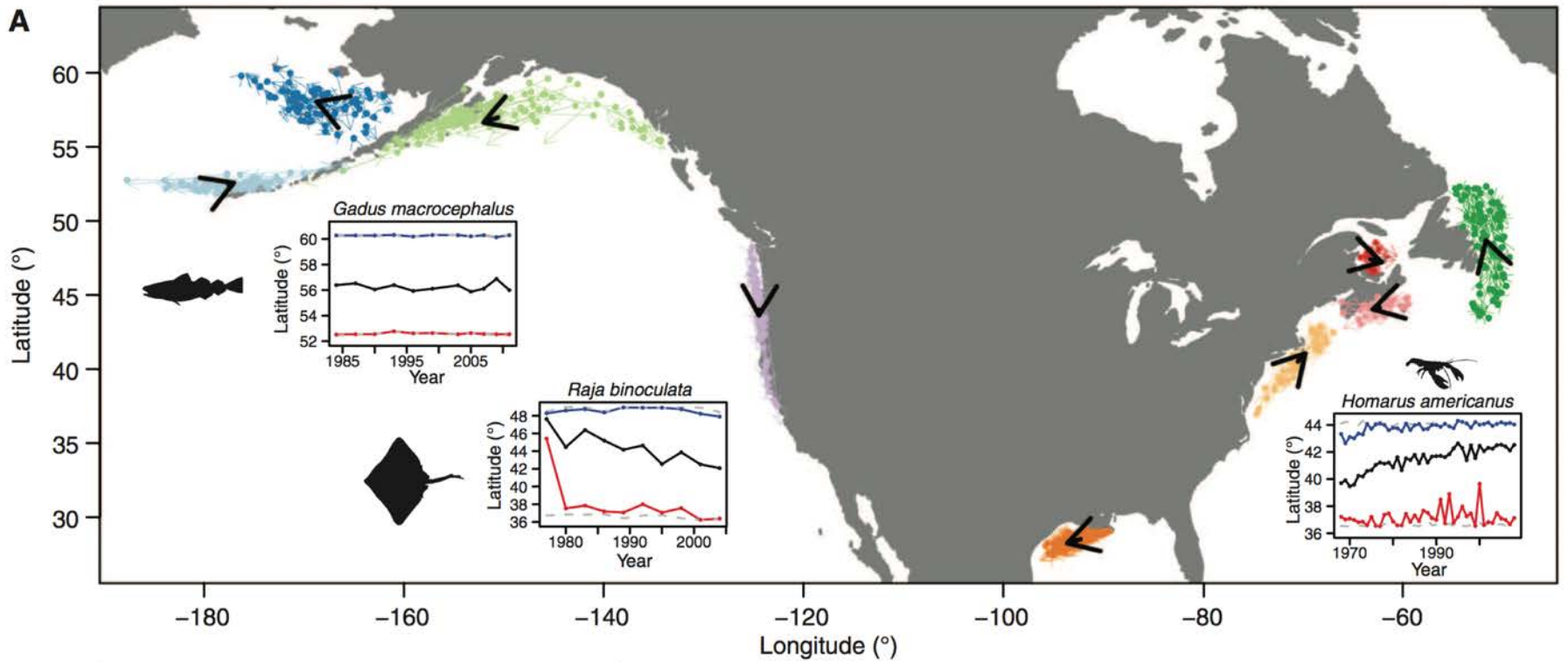
Warming ocean, fish on the move

Black sea bass



NOAA Survey Data

<https://www.nefsc.noaa.gov/ecosys>



Pinsky et al., 2013

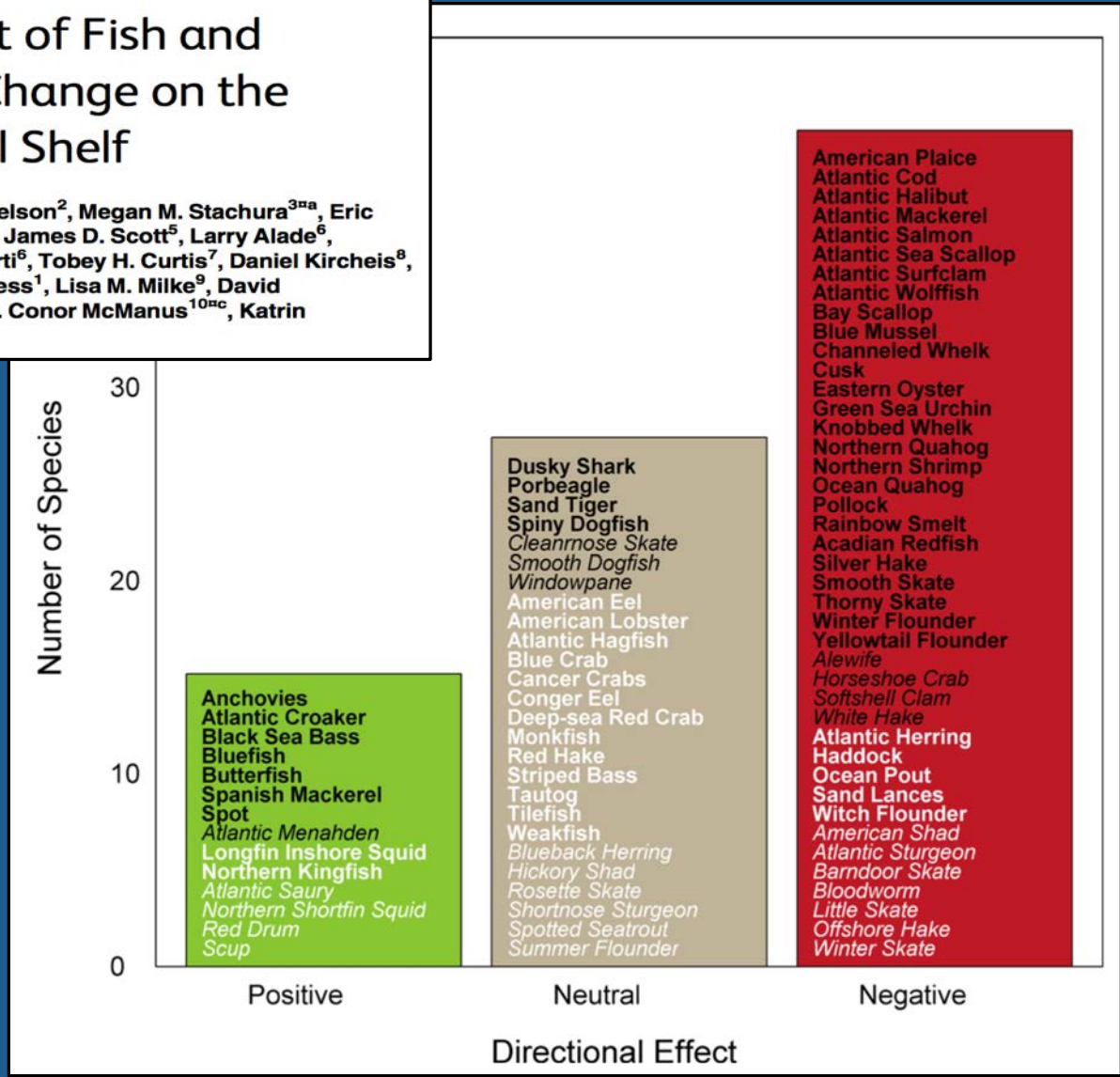
Climate vulnerability

RESEARCH ARTICLE

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

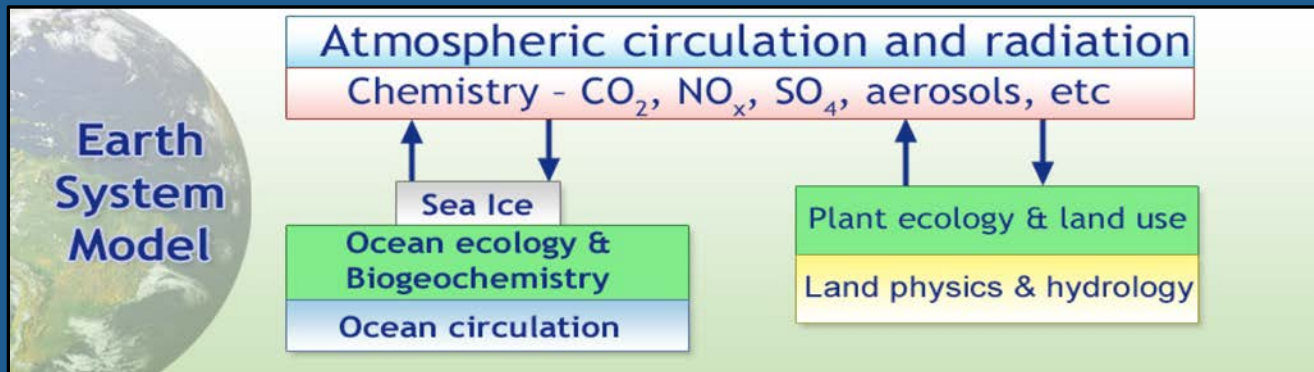
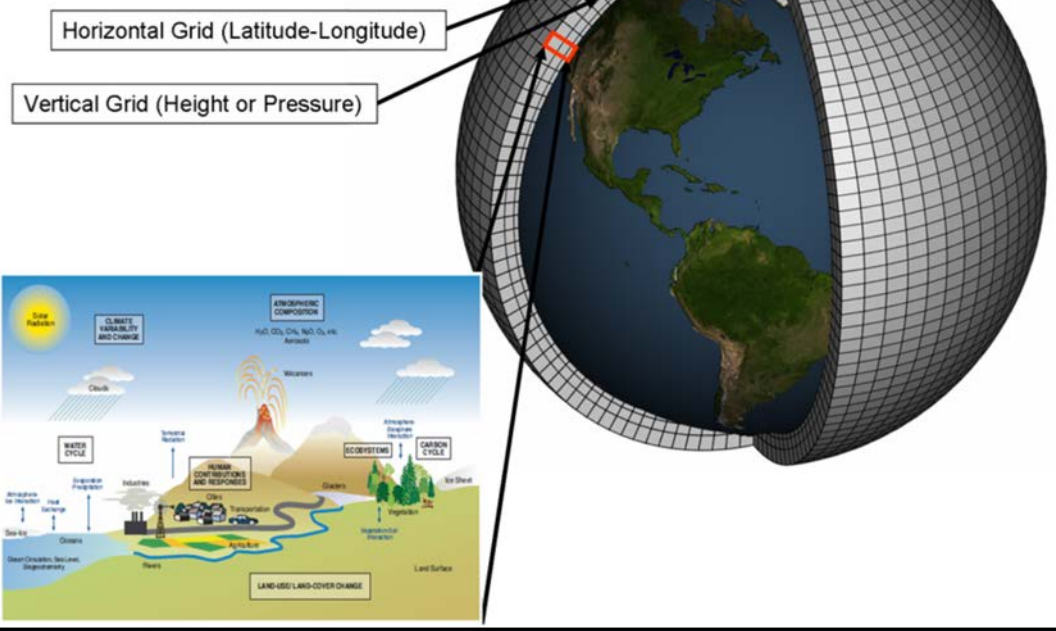
Jonathan A. Hare^{1*}, Wendy E. Morrison², Mark W. Nelson², Megan M. Stachura^{3aa}, Eric J. Teeters², Roger B. Griffis⁴, Michael A. Alexander⁵, James D. Scott⁵, Larry Alade⁶, Richard J. Bell^{1ab}, Antonie S. Chute⁶, Kiersten L. Curti⁶, Tobey H. Curtis⁷, Daniel Kircheis⁸, John F. Kocik⁸, Sean M. Lucey⁶, Camilla T. McCandless¹, Lisa M. Milke⁹, David E. Richardson¹, Eric Robillard⁶, Harvey J. Walsh¹, M. Conor McManus^{10ac}, Katrin E. Marancik¹⁰, Carolyn A. Griswold¹

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

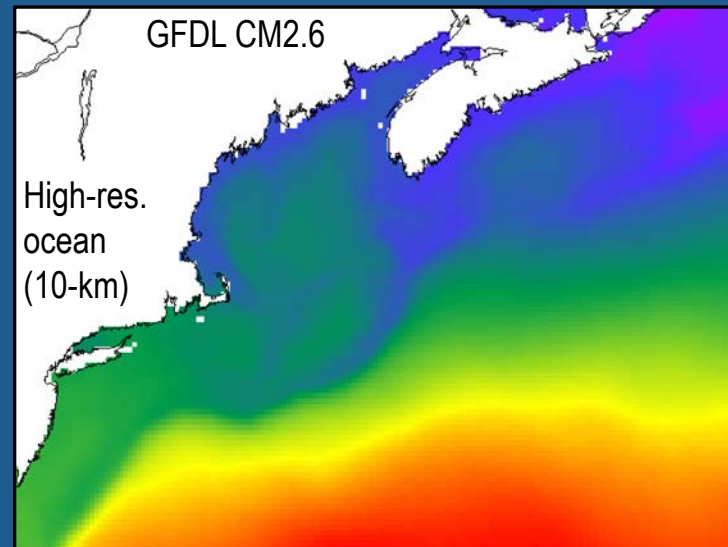
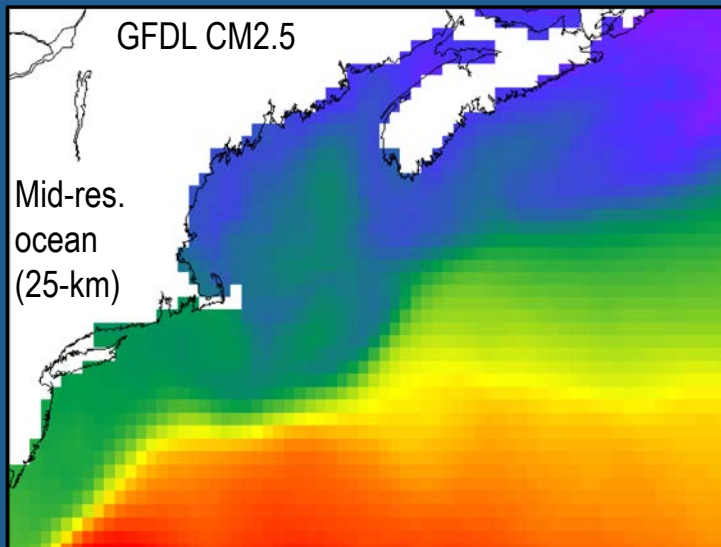
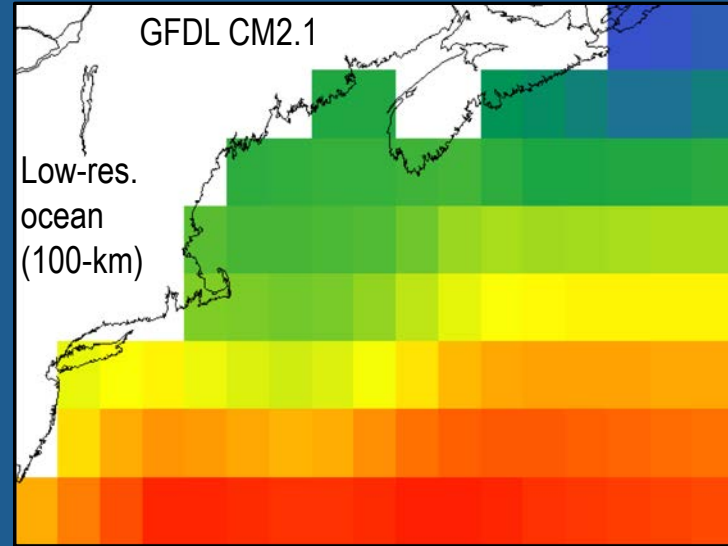
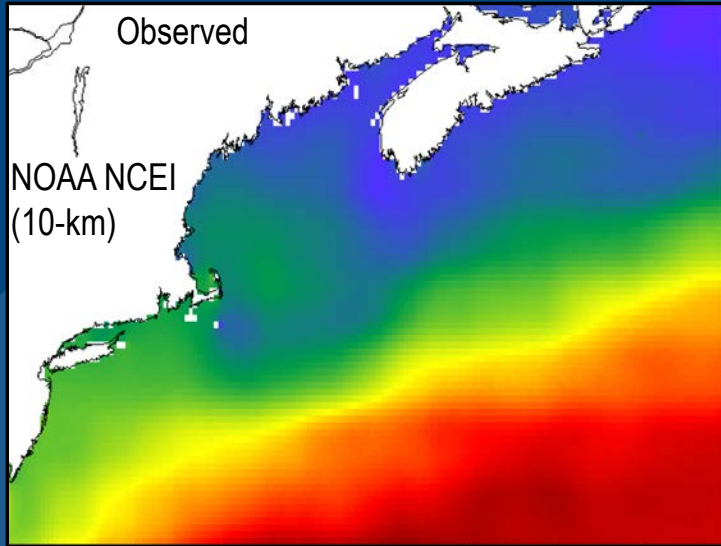


Climate Projections - Global Climate & Earth System

Schematic for Global Atmospheric Model

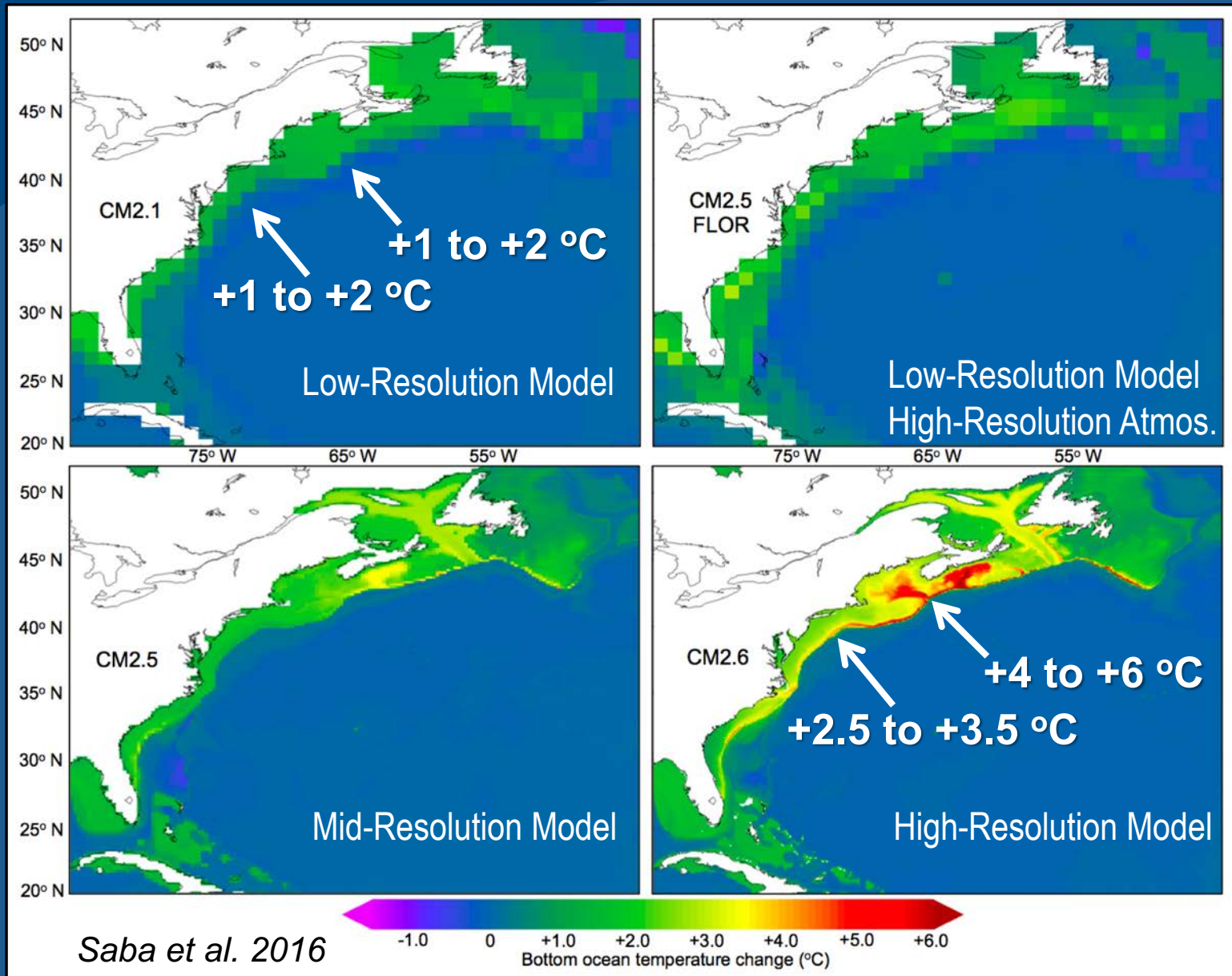


NOAA GFDL Climate Models: U.S. Northeast Shelf

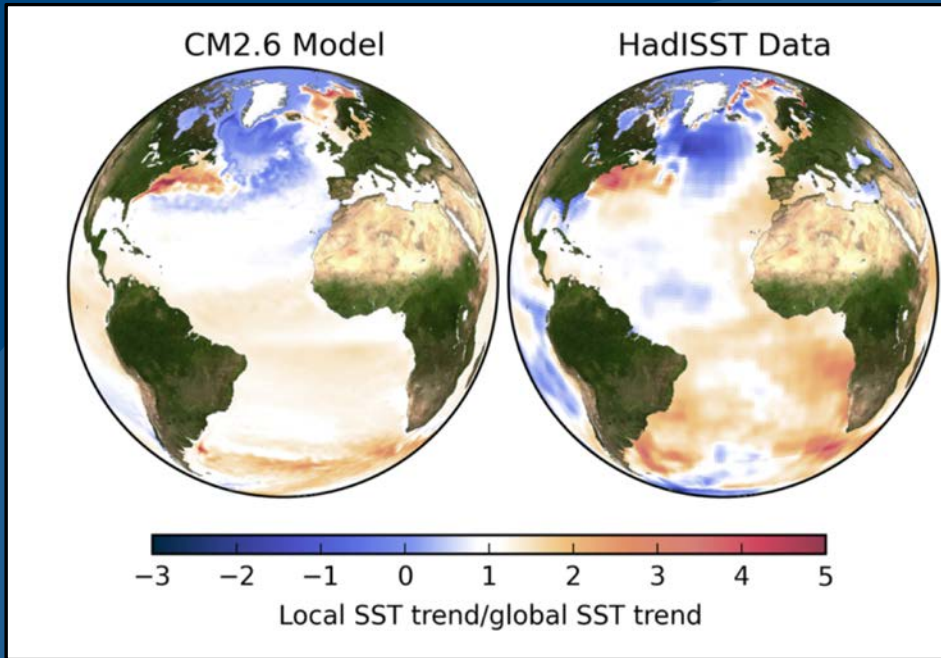


Saba et al. 2016

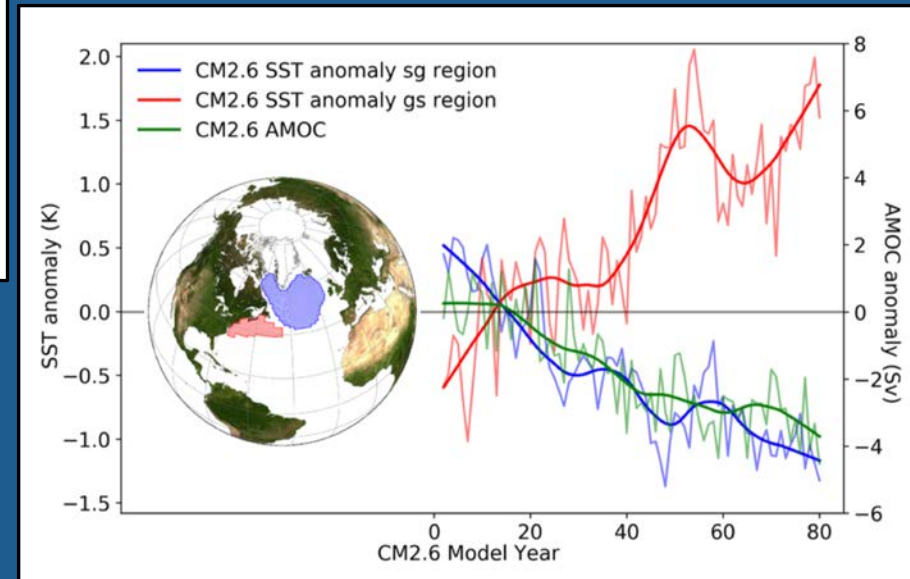
Northwest Atlantic – Projected ocean warming



Enhanced Warming linked to AMOC

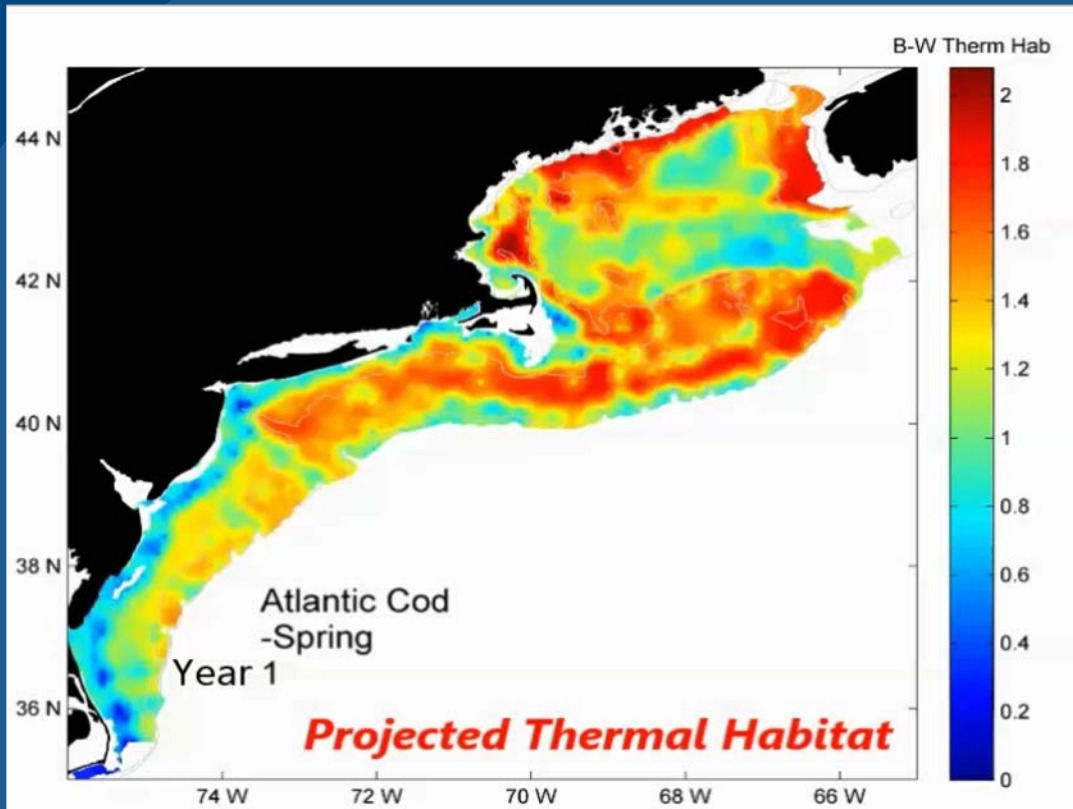
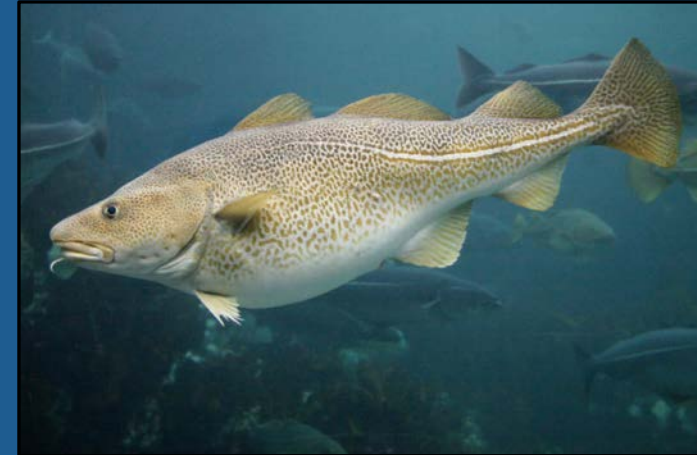


*Caesar, Saba et al. in press,
Nature*



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

Atlantic cod

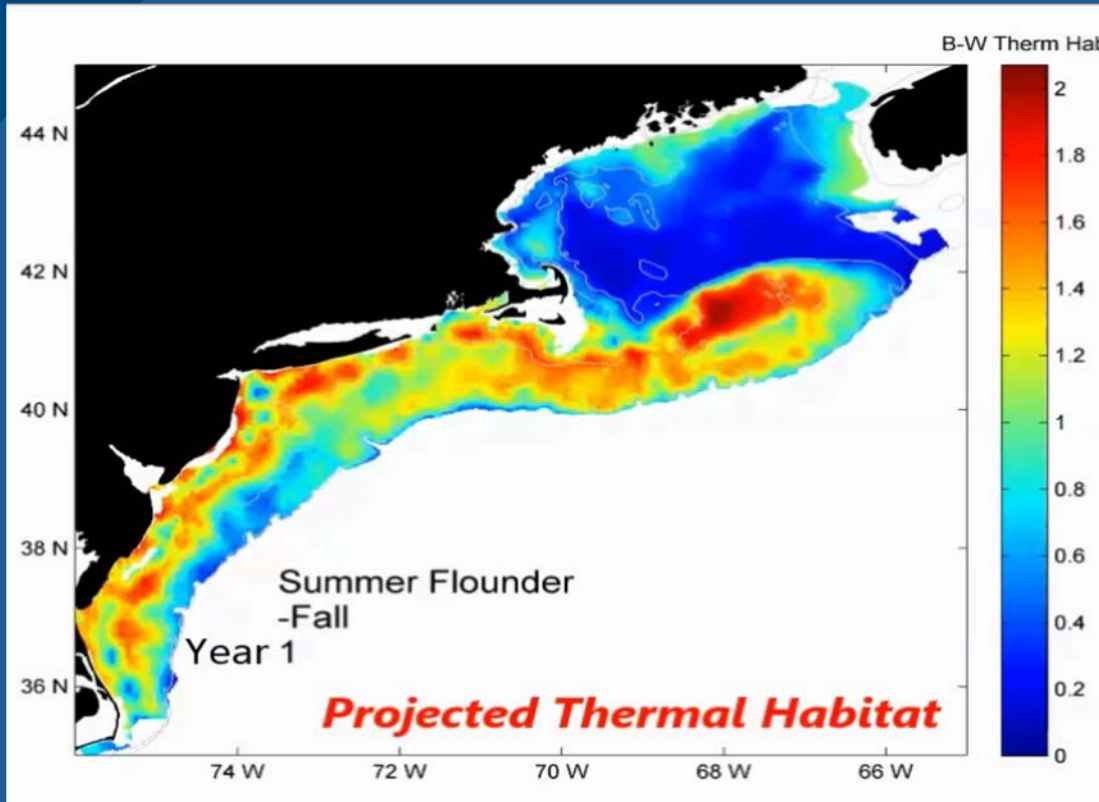
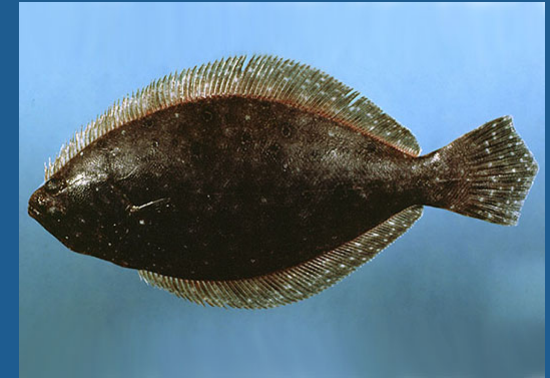


Kleisner et al. 2017

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

Value of Landings		
Rank	Species	Thousand Dollars
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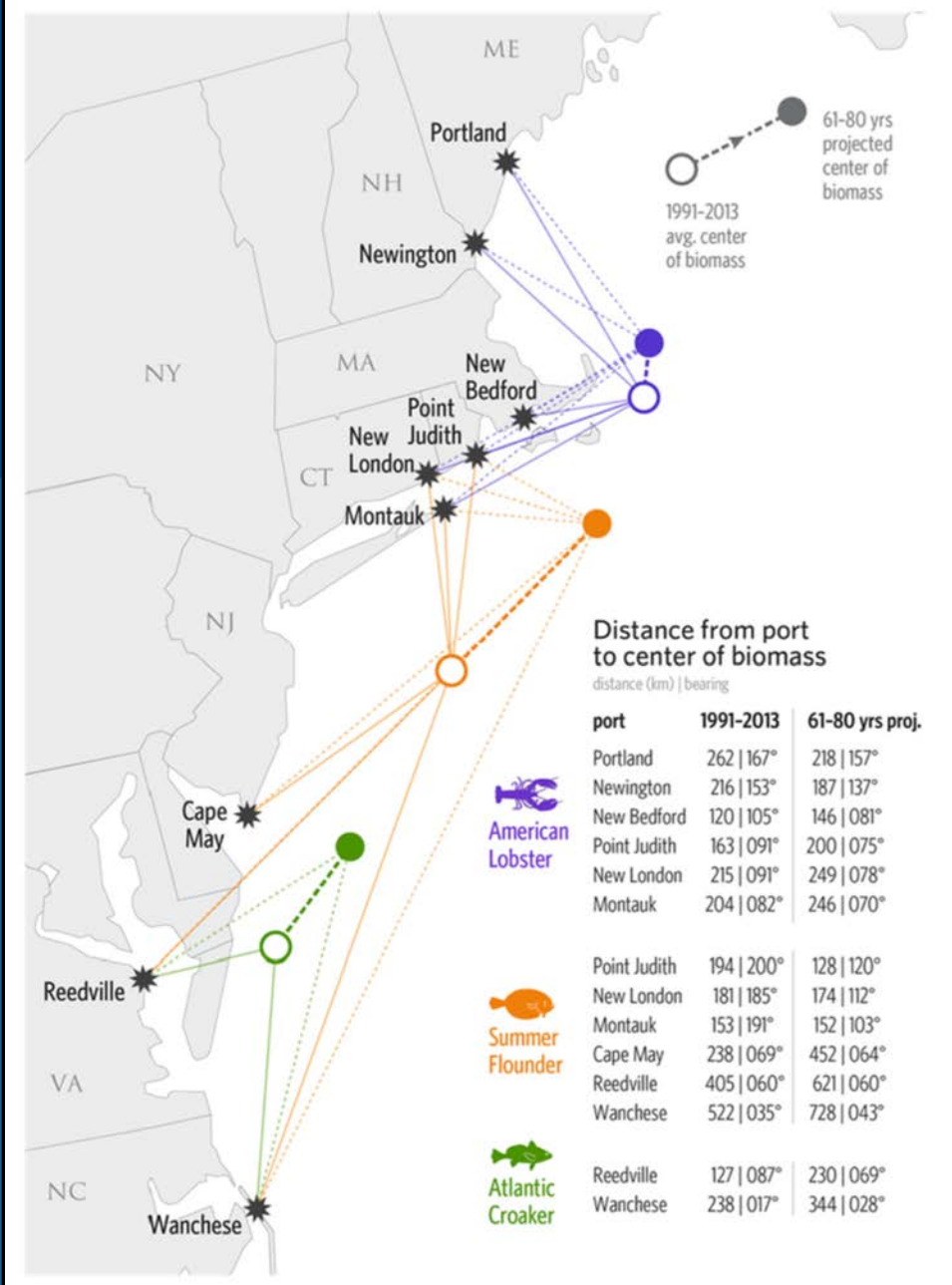
Distance from port to fishing areas

Distance to port under continued ocean warming.

Does not account for:

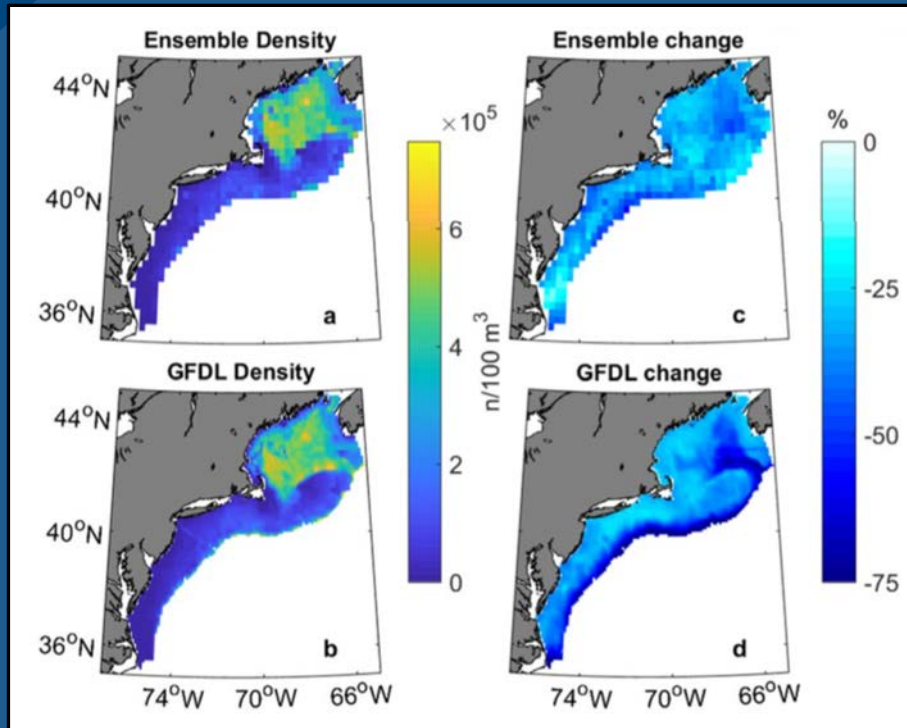
- Fishing mortality change.
- Species interactions.

Kleisner et al. 2017



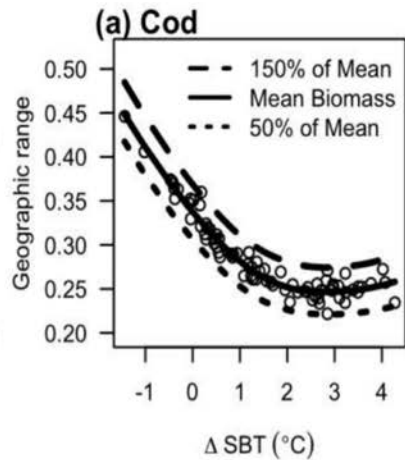
Calanus finmarchicus projection based on NOAA GFDL's high-res. climate model

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

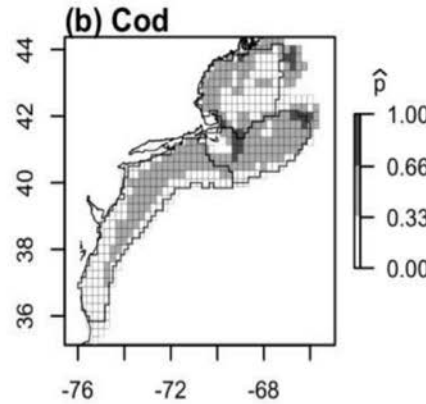


Grieve et al. 2017

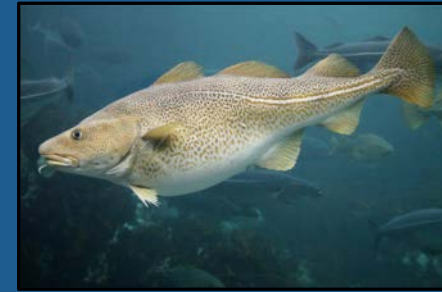
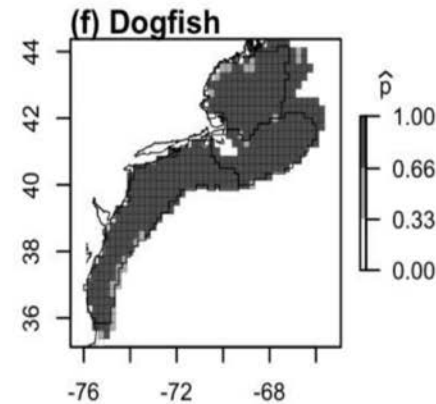
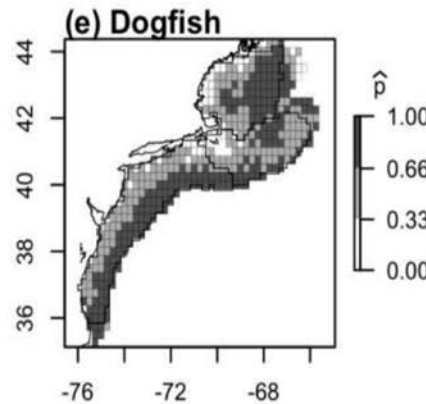
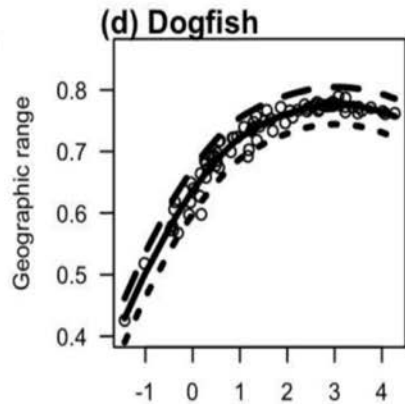
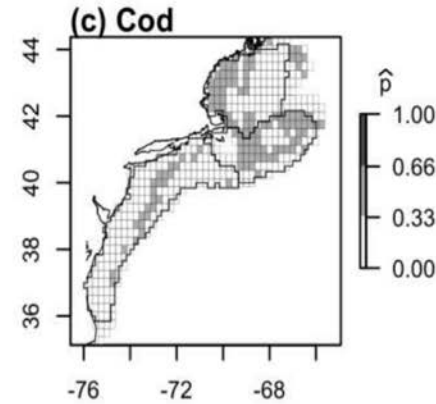
Piscivore overlap projections based on NOAA GFDL's high-res. climate model



Historical Mean SBT

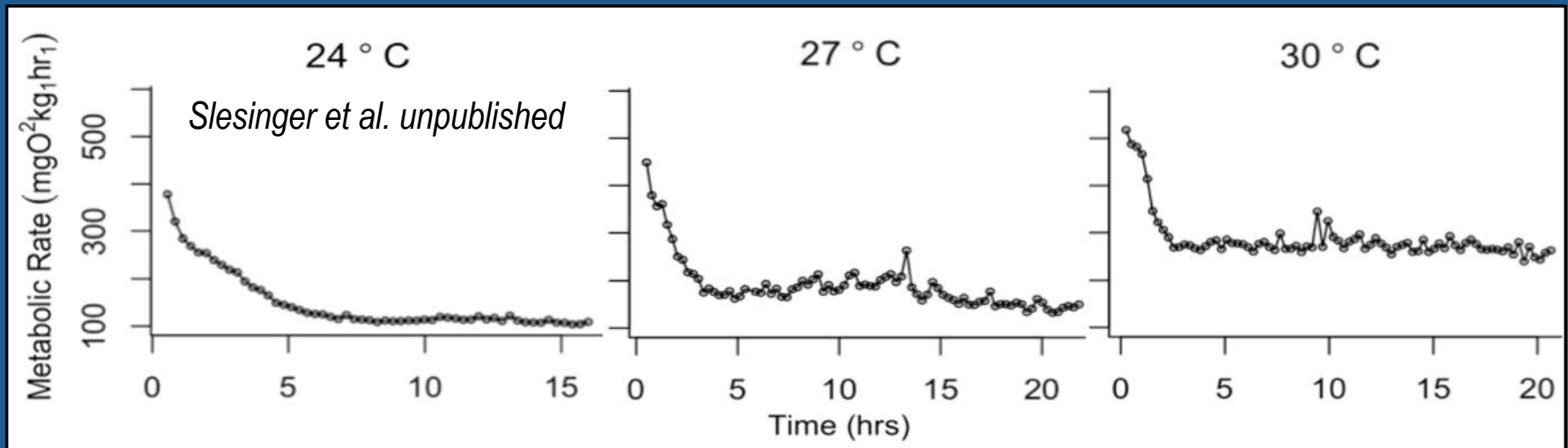
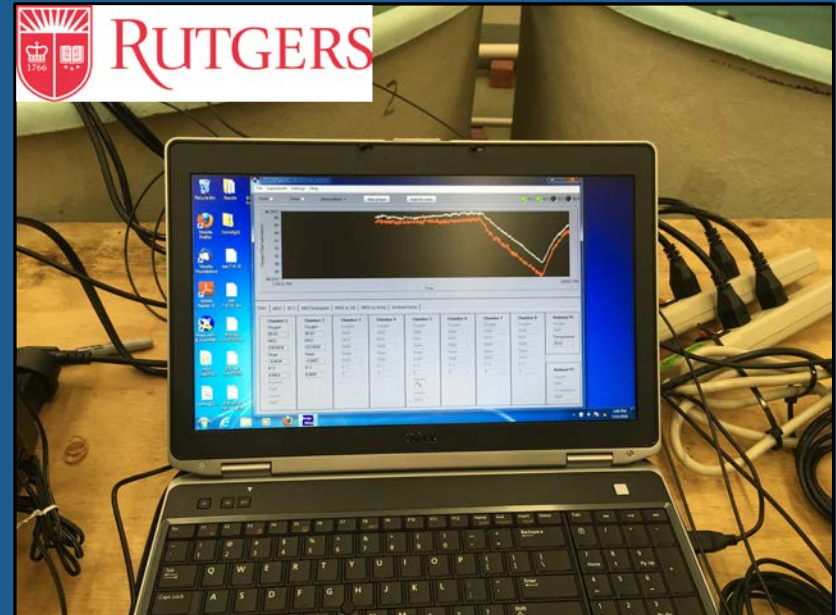


Δ SBT = 3 °C



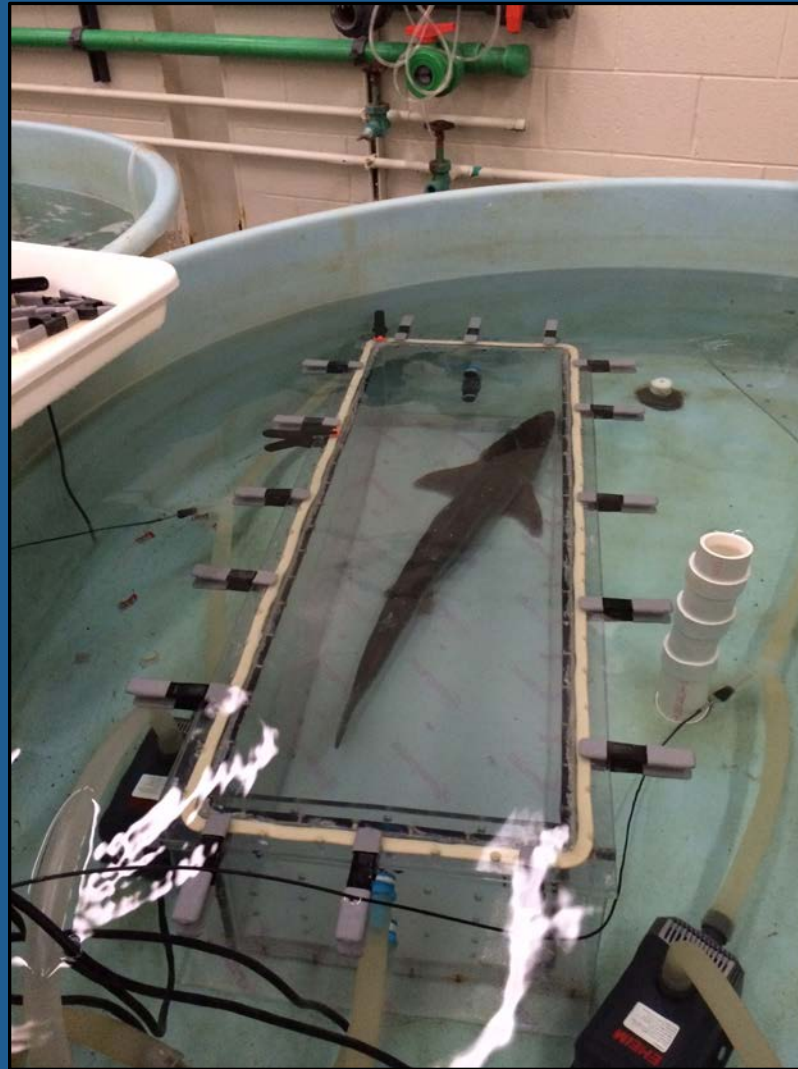
Selden et al. 2017

Laboratory Studies



Laboratory Studies

NOAA Sandy Hook Lab



Andres et al. unpublished



NOAA FISHERIES

Other ongoing research

- Habitat vulnerability analysis; Scenario Planning
- Fine-scale modeling of lobster and scallop habitat
- Sea turtle nesting and habitat analyses
- Beyond temperature: Habitat modeling using biological and physical variables

Contact: vincent.saba@noaa.gov

Summary

- U.S. Northeast Shelf > 1/3 U.S. annual value of commercial fish.
- Last decade: U.S. Northeast Shelf has warmed faster than most other coastal waters globally.
- Continued distribution shifts of valuable commercial and rec. species are highly likely under climate change.
- Need to move beyond temperature impacts. More laboratory process studies!
- Climate impacts research – inform assessments and management.
- Goal – climate ready fisheries management. Requires EBFM.