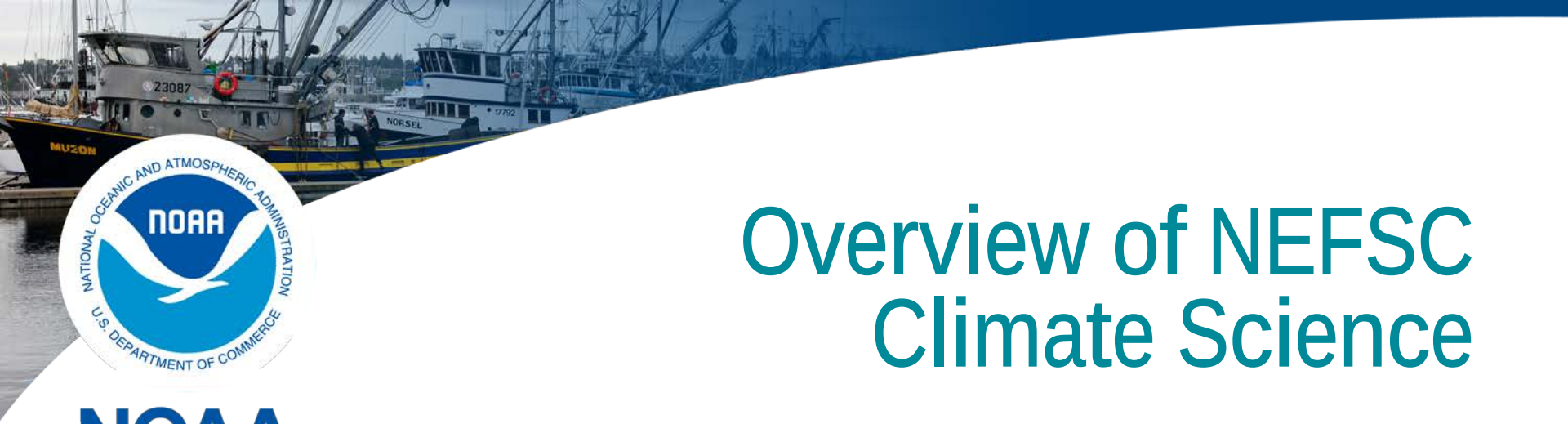



# Overview of NEFSC Climate Science

Jon Hare

NEFSC Ecosystem and Climate Science Program Review

Climate Research Session

June 6, 2016

# Climate & Northeast U.S. Shelf Ecosystem

- *“For many years Americans have commented on an apparent warming of their climate; older people have referred to the "old-fashioned winters" they once knew. Climatologists long shrugged off the idea as unfounded, but a melioration in climate is no longer confined to the popular mind: a decided trend toward warmer winters during the past, 50 years is now well-documented.”*

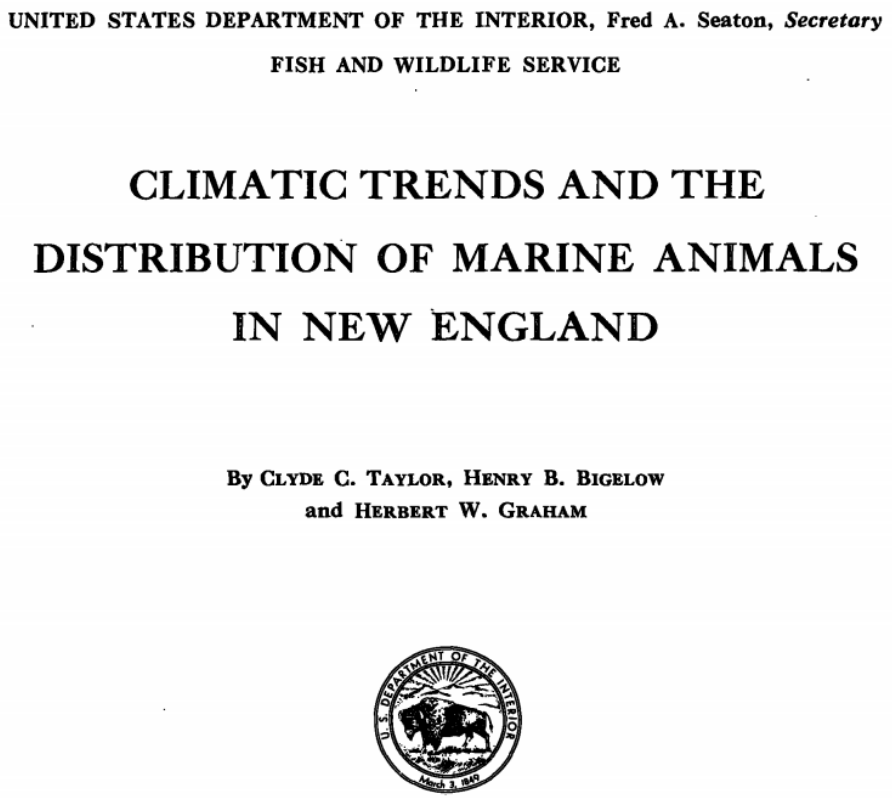
# Climate & Northeast U.S. Shelf Ecosystem

- *“For many years Americans have commented on an apparent warming of their climate; older people have referred to the "old-fashioned winters" they once knew. Climatologists long shrugged off the idea as unfounded, but a melioration in climate is no longer confined to the popular mind: a decided trend toward warmer winters during the past, 50 years is now well-documented.”*

Taylor, Bigelow and Graham (1957)
United States Fish and Wildlife Service. Woods Hole, MA

# Climate & Northeast U.S. Shelf Ecosystem

- Lobster and Silver Hake: increase in north; decrease in south
- Atlantic Menhaden: increase in north
- Yellowtail Flounder: increase in north, decrease in south
- Southern species in northern areas: Black Sea Bass, Great White Sharks



UNITED STATES DEPARTMENT OF THE INTERIOR, Fred A. Seaton, *Secretary*

FISH AND WILDLIFE SERVICE

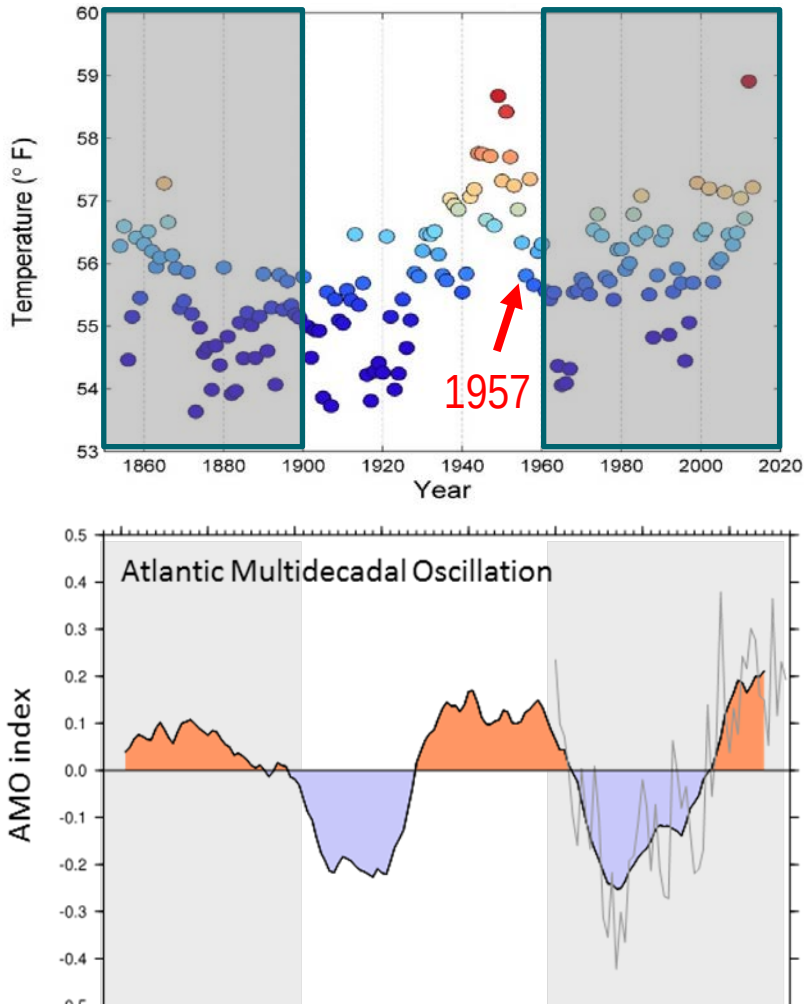
CLIMATIC TRENDS AND THE DISTRIBUTION OF MARINE ANIMALS IN NEW ENGLAND

By CLYDE C. TAYLOR, HENRY B. BIGELOW and HERBERT W. GRAHAM

Taylor et al (1957)

# Climate & Northeast U.S. Shelf Ecosystem

- Paper was written near previous peak in temperatures
- Atlantic Multidecadal Oscillation
- Temperatures cooled, and the interest in climate waned



# Climate & Northeast U.S. Shelf Ecosystem

- Inter-annual variation in temperature significantly related to mean latitude for 12 of 36 species
- Implication: species distribution change in response to climate change

TRANSACTIONS
OF THE AMERICAN FISHERIES SOCIETY

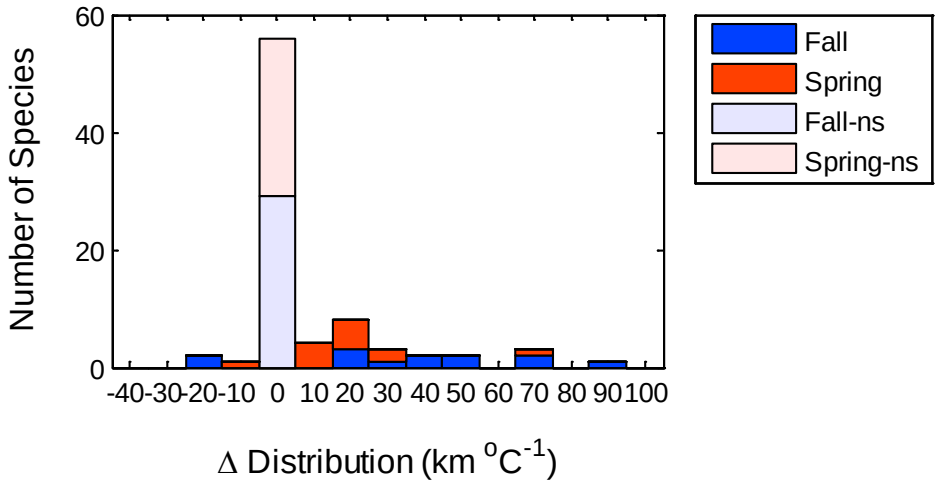
Volume 122 September 1993 Number 5

*Transactions of the American Fisheries Society* 122:647–658, 1993

**Climate Change and Marine Fish Distributions: Forecasting from Historical Analogy**

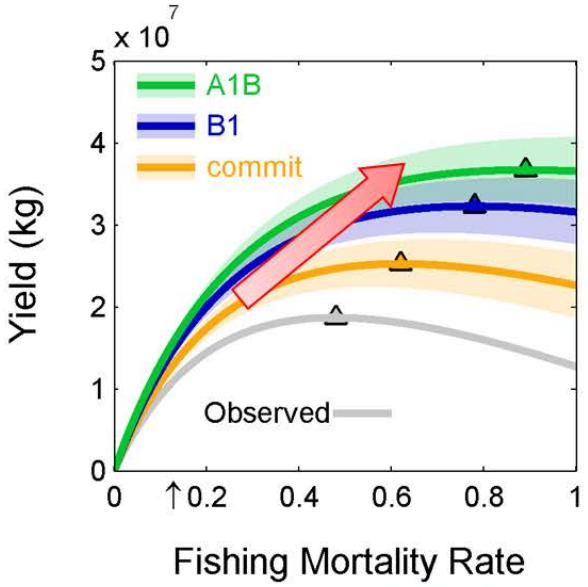
S. A. MURAWSKI

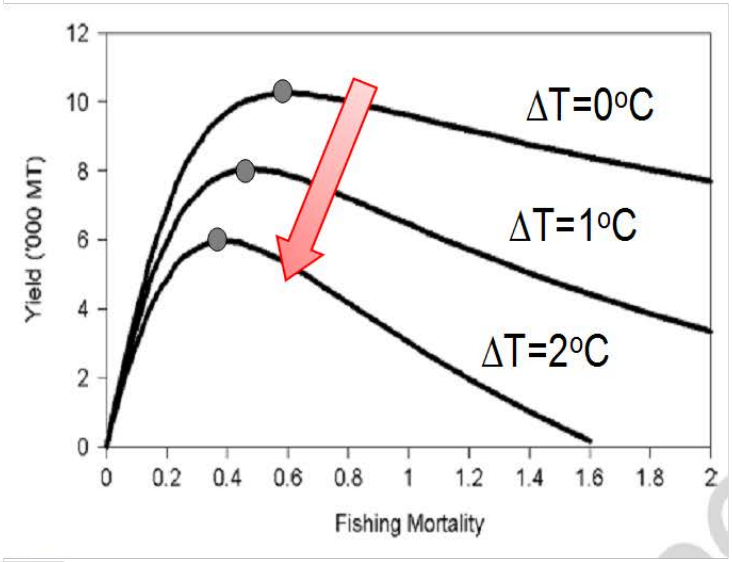
*National Marine Fisheries Service, Northeast Fisheries Science Center Woods Hole, Massachusetts 02543, USA*

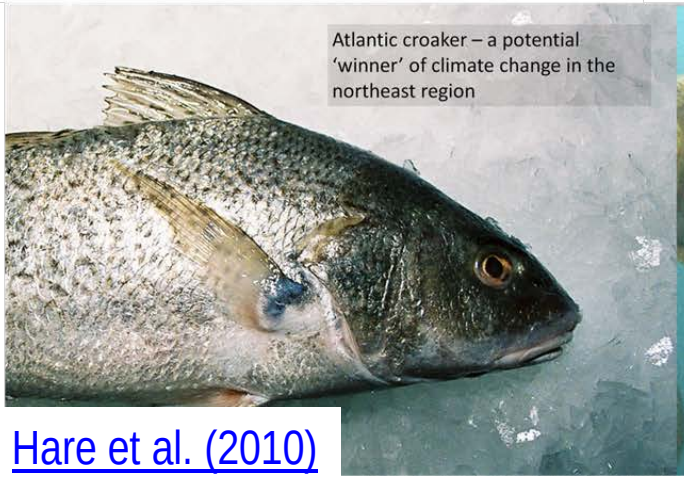


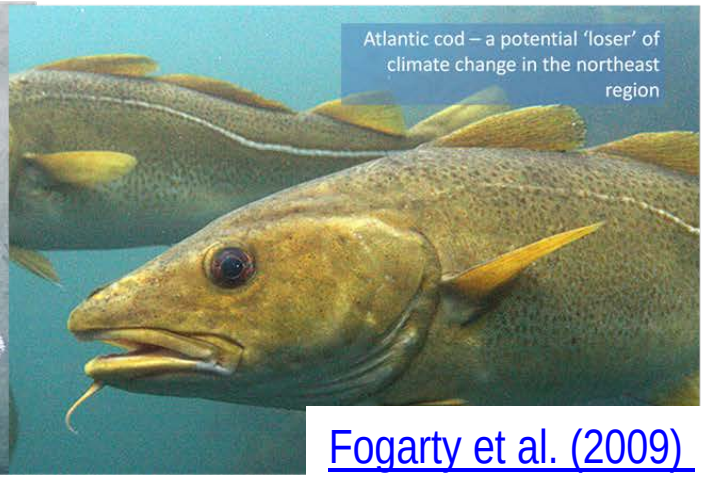

Murawski (1993)

# Climate & Northeast U.S. Shelf Ecosystem



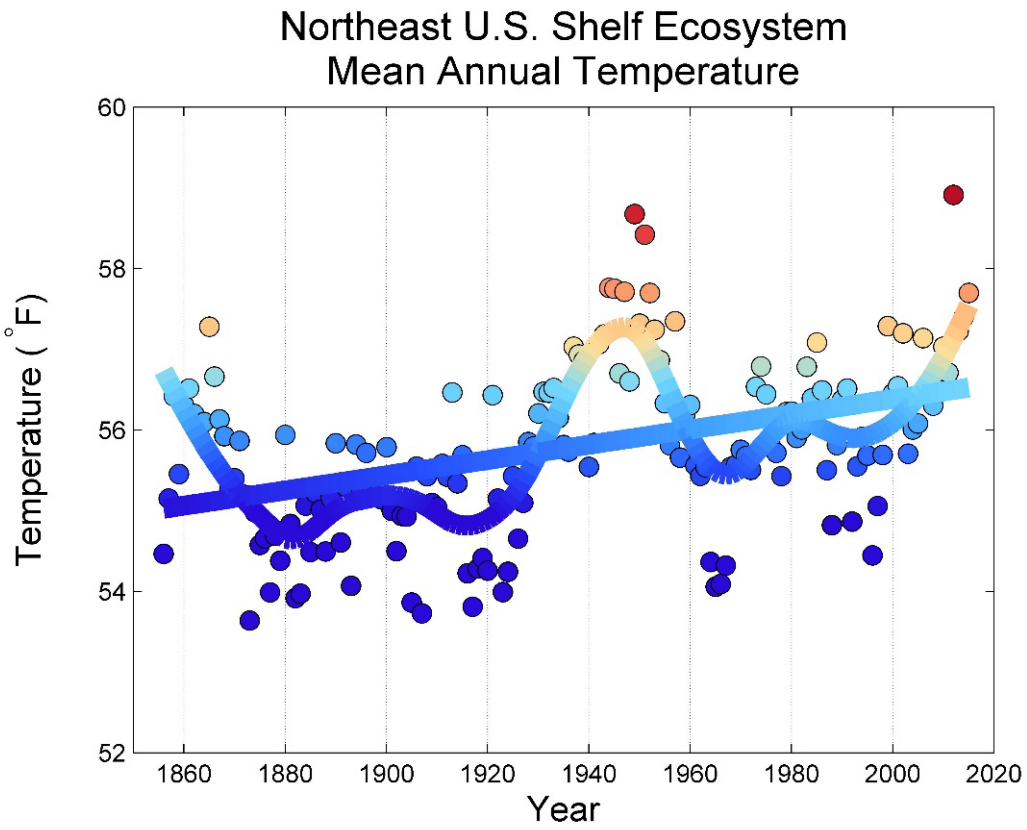




Hare et al. (2010)

Fogarty et al. (2009)

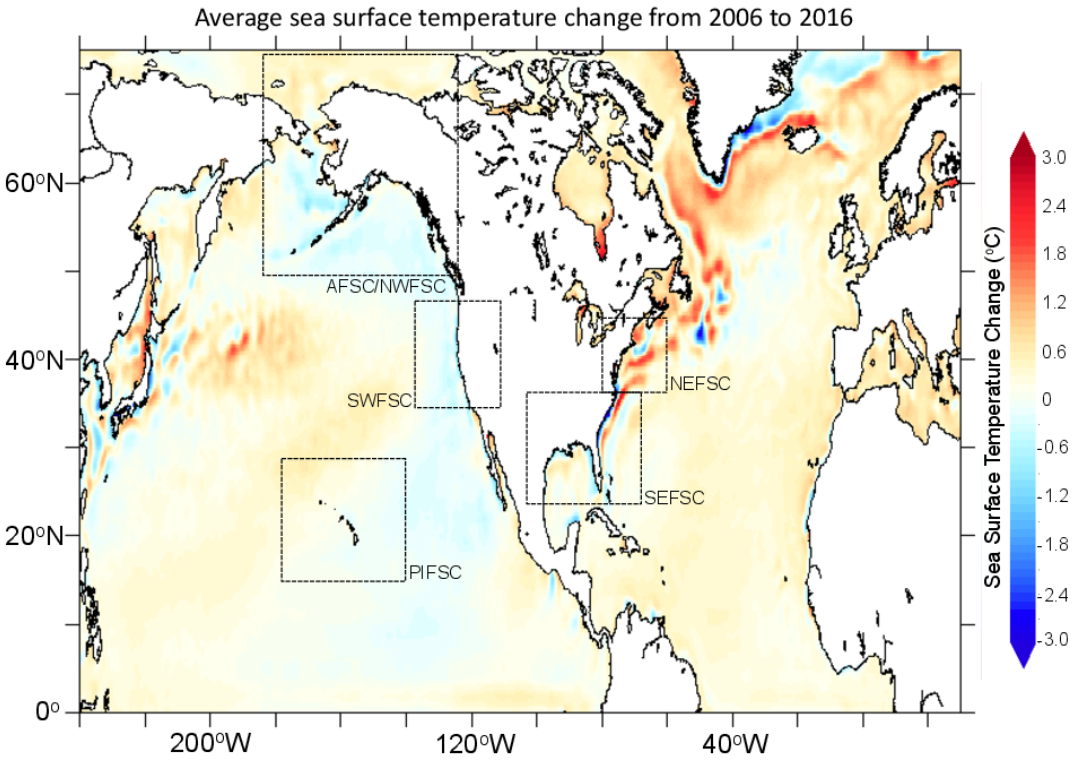
# Climate & Northeast U.S. Shelf Ecosystem

- Climate change and decadal-scale climate variability
- Impacts to living marine resources in the past, present, and future



# Climate & Northeast U.S. Shelf Ecosystem

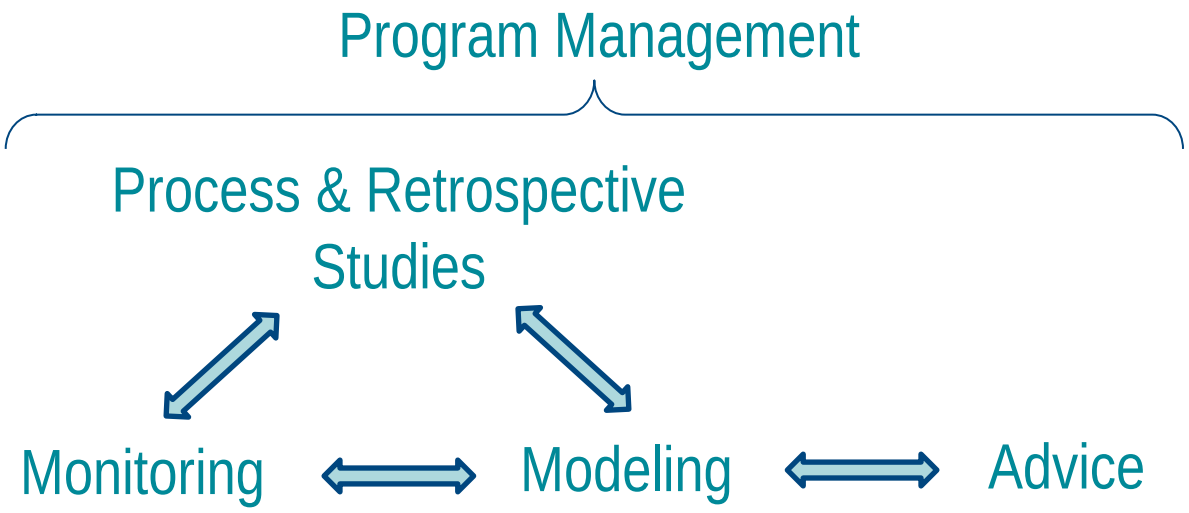
- Rate of temperature increase on Northeast U.S. Shelf among highest on planet
- Rate of sea-level rise also among highest
- Many other aspects of climate system are changing



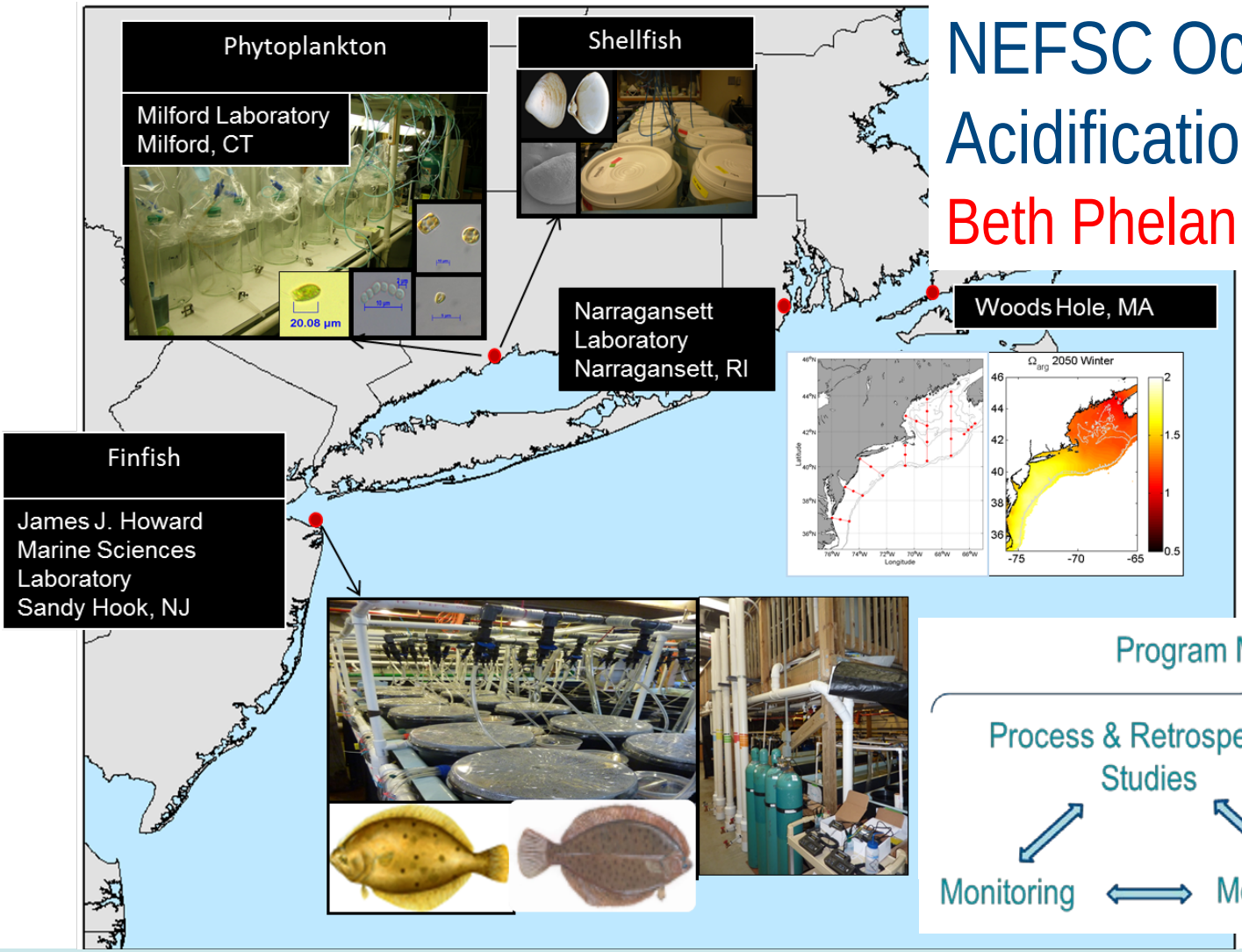

NEFSC Climate Change Website

# NEFSC Climate Science Program - 2009

- GLOBEC Model but with emphasis on advice
- Program did not receive support
- Activities supported through various sources
- But a spin-off Ocean Acidification Program



# NEFSC Climate Science Program - 2009




## NEFSC Ocean Acidification Program

Beth Phelan - Poster

# NEFSC Climate Science Program - 2009

- Monitoring
  - Ecosystem Indicators – Kevin Friedland - Talk
  - eMOLT – Jim Manning - Poster
  - EcoMon – Jerry Prezioso - Poster
  - CTD – Paula Fratantoni - Poster
  - EcoOp – Stace Beaulieu - Poster
  - Cooperative Research – John Hoey - Poster

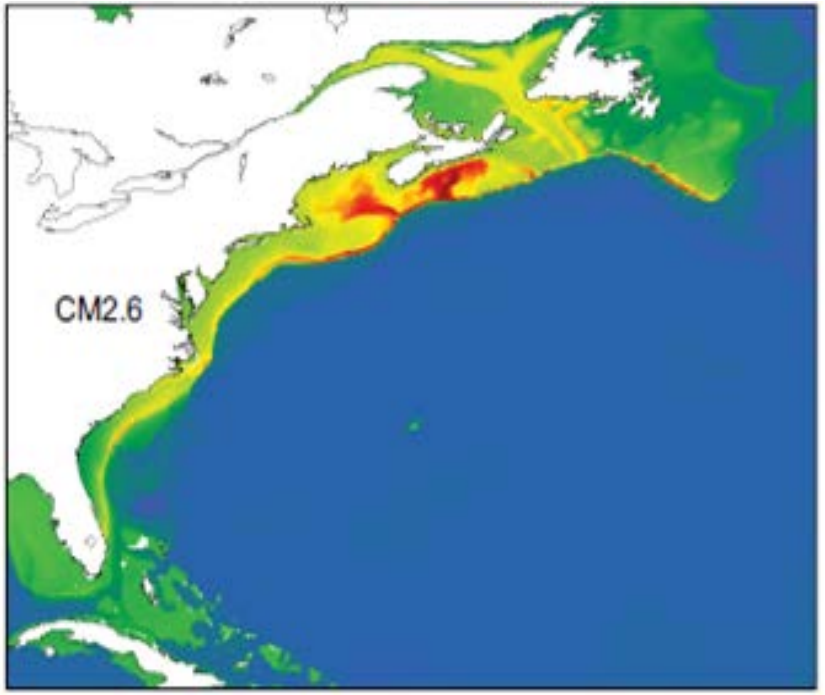
# NEFSC Climate Science Program - 2009

- Modeling
  - Climate Modeling

    Vince Saba – Talk
  - Species Distribution Modeling

    John Manderson - Talk
  - Bio-economic Modeling

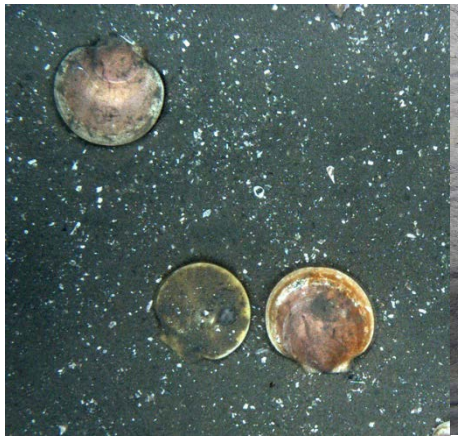
    Sarah Cooley - Poster



# NEFSC Climate Science Program - 2009

- Process & Retrospective Studies
  - Change in productivity (e.g., recruitment)
  - Shifts in distribution (e.g., movement, migration)

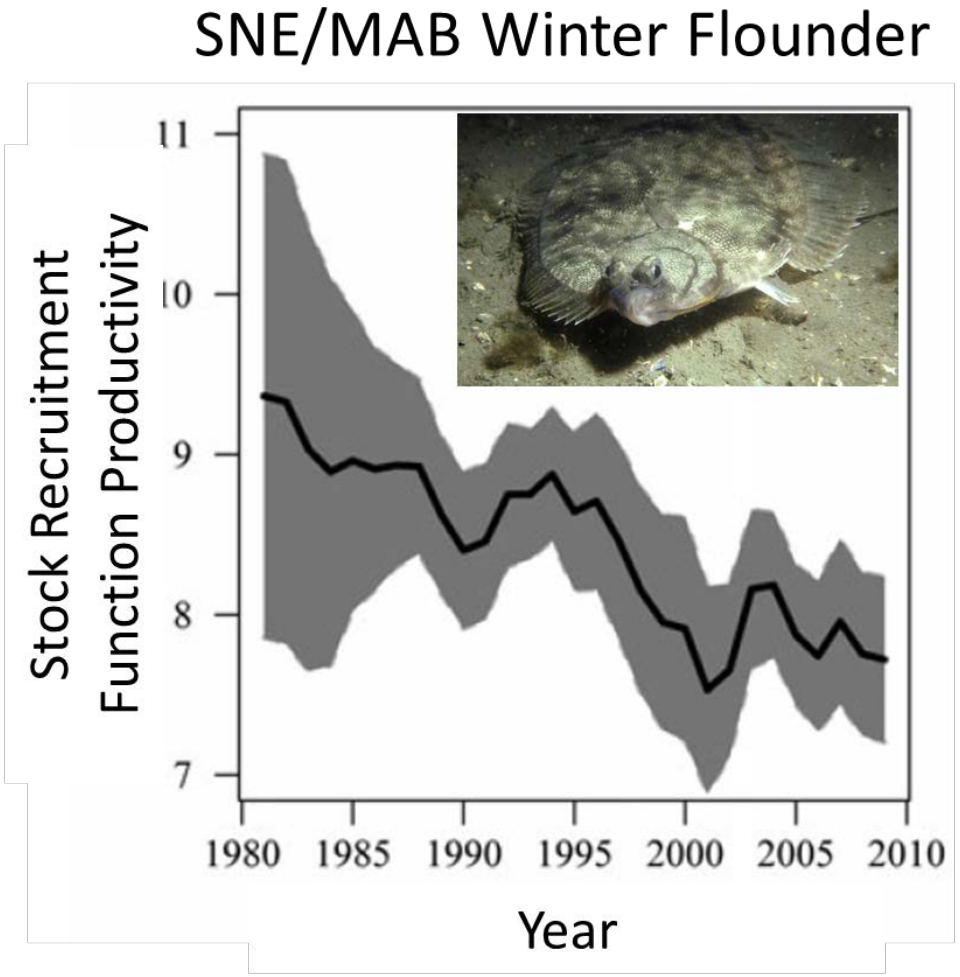
Kristen Kleisner - Talk



# NEFSC Climate Science Program - 2009

- Process & Retrospective Studies
  - Winter flounder productivity decreasing as temperature increasing

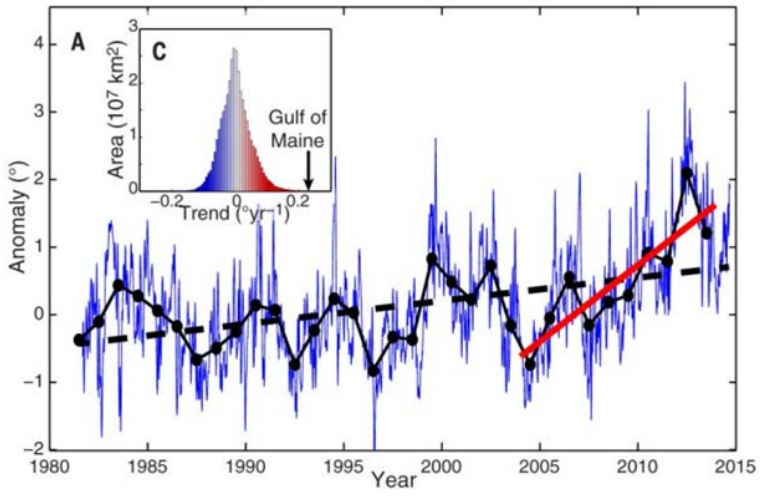
COCA Project lead by Jeremy Collie



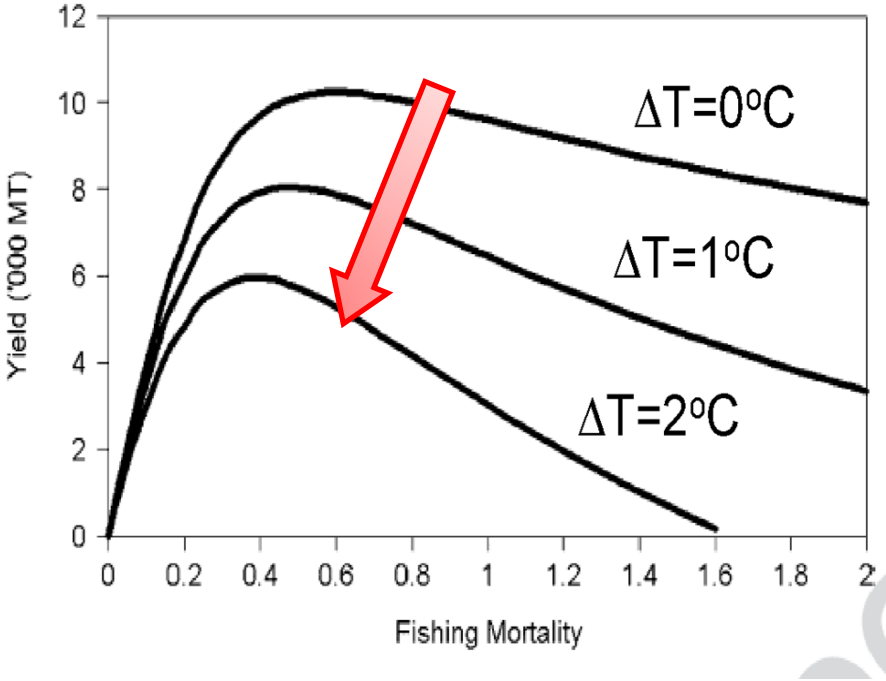

Bell et al. (2014)

# NEFSC Climate Science Program - 2009

- Process & Retrospective Studies
  - 2.3°C increase in temperature
  - 50% decrease in MSY




## Atlantic Cod

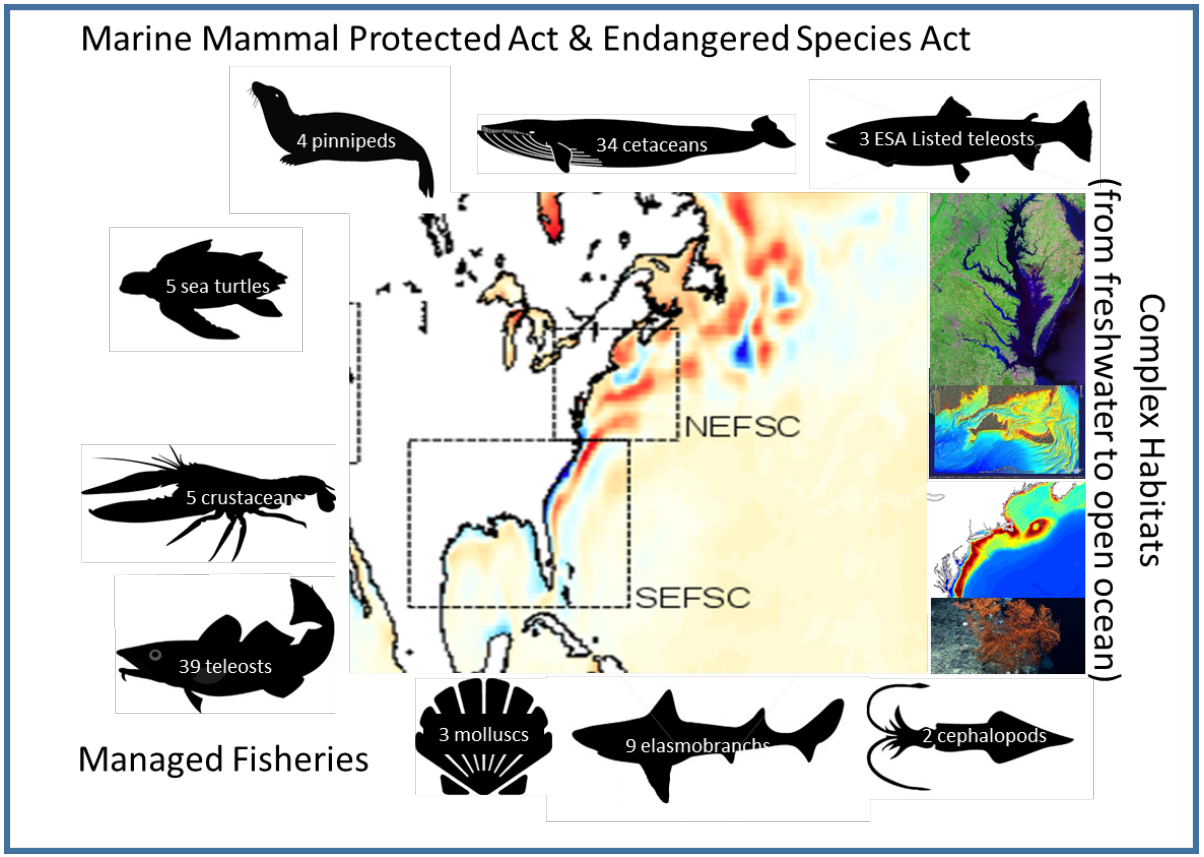



Fogarty et al. (2009)

Pershing et al. (2015)

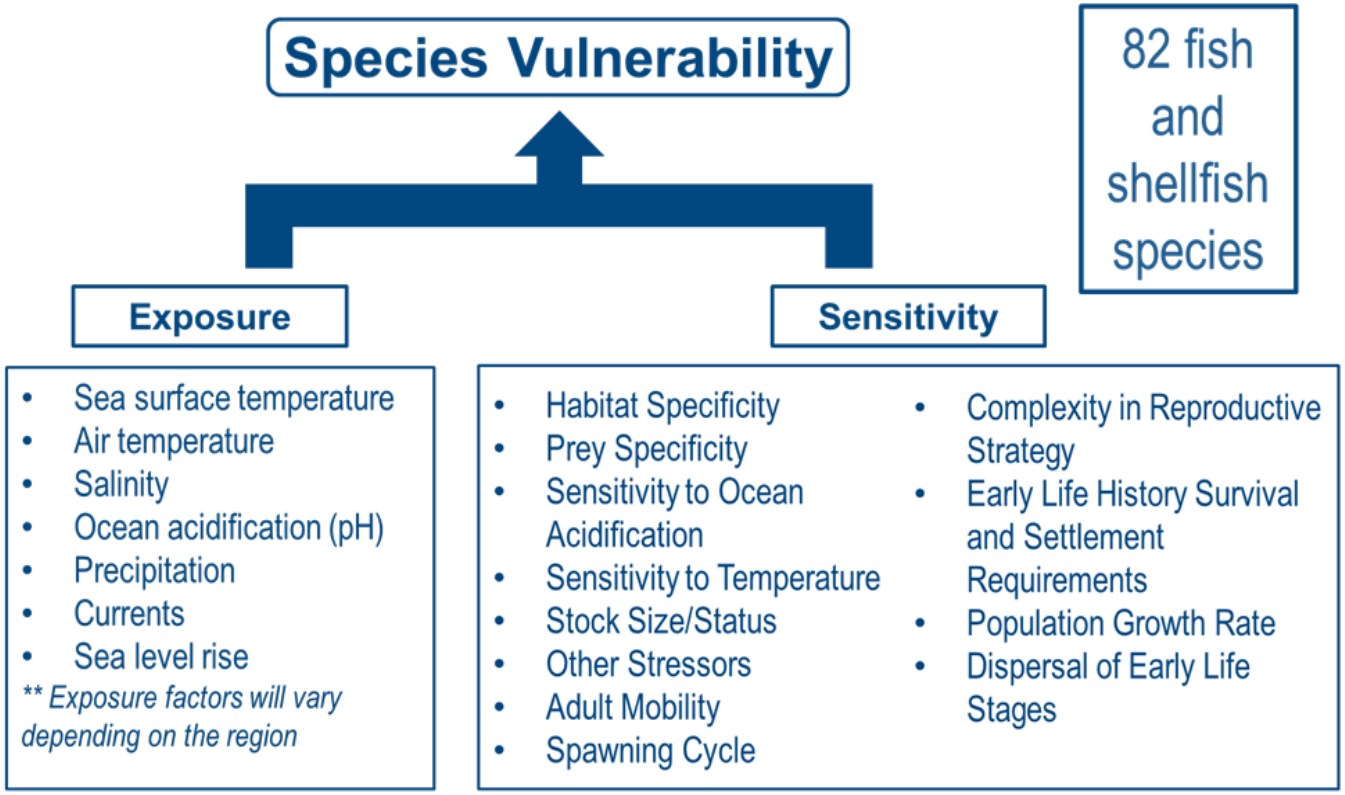
# NEFSC Climate Science

- Most living marine resources will be affected (negatively or positively)



# NEFSC Climate Science

- Fisheries Climate Vulnerability Assessment



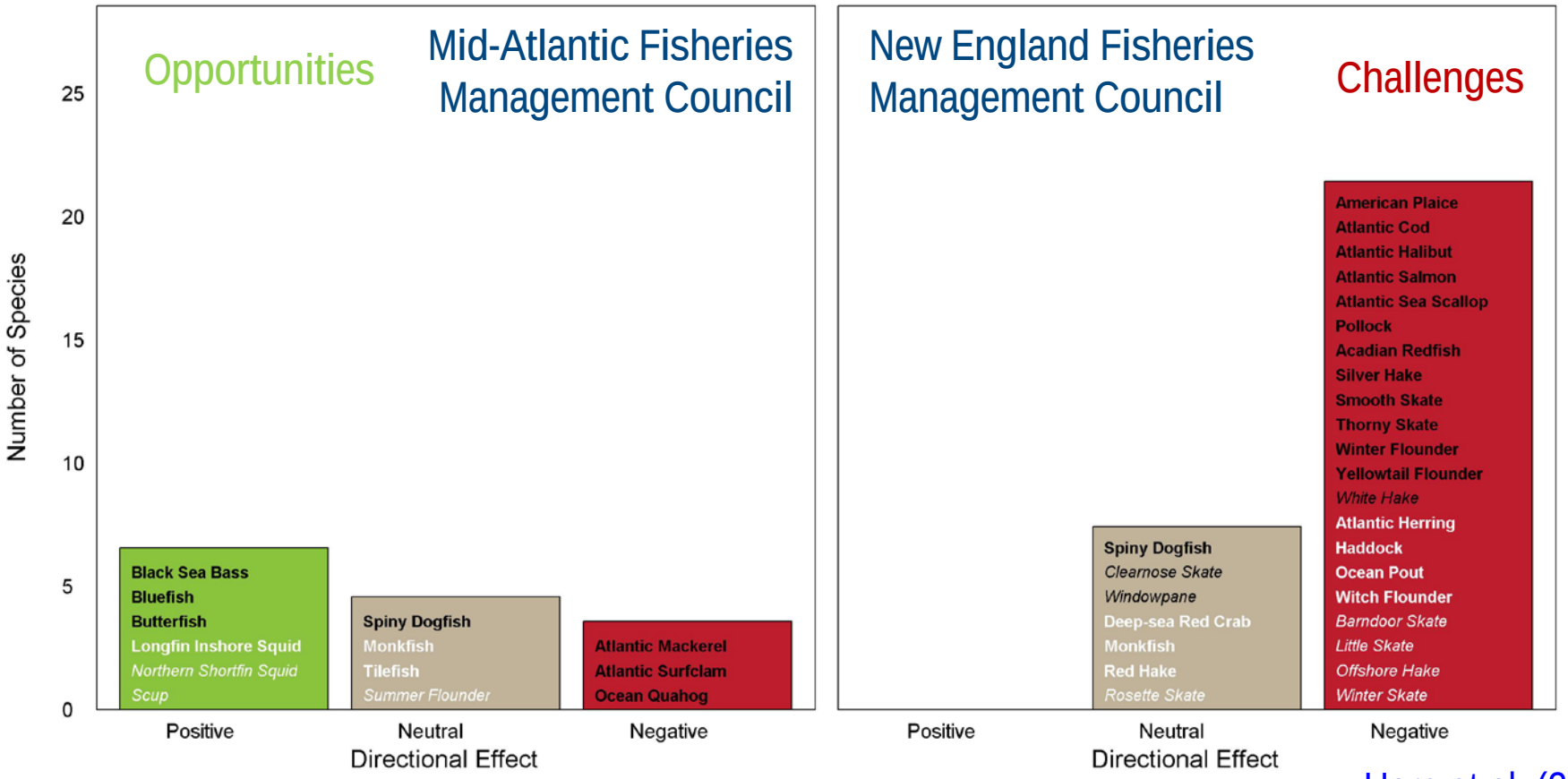

Morrison et al. (2016)

# NEFSC Climate Science

- Fisheries Climate Vulnerability Assessment
  - Vulnerability to a change in productivity
  - Potential for a shift in distribution
  - Effect of climate change on species in region
  - NMFS SF and ST lead methodology development
  - NEFSC lead first implementation
  - CIE Method and NE Peer-Review Oct 2014

# NEFSC Climate Science

- Fisheries Climate Vulnerability Assessment




Hare et al. (2016)

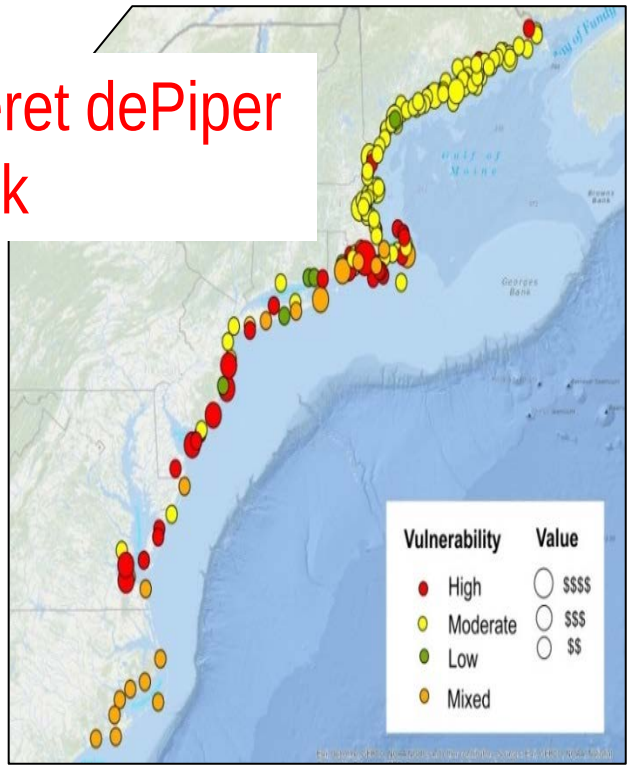
# NEFSC Climate Science

- Fisheries Climate Vulnerability Assessment
  - Dusky Shark & Thorny Skate Status Review
  - Link to social indicators


McCandless et al. (2014)

Landings climate vulnerability

Geret dePiper Talk




Colburn et al. (in press) Marine Policy

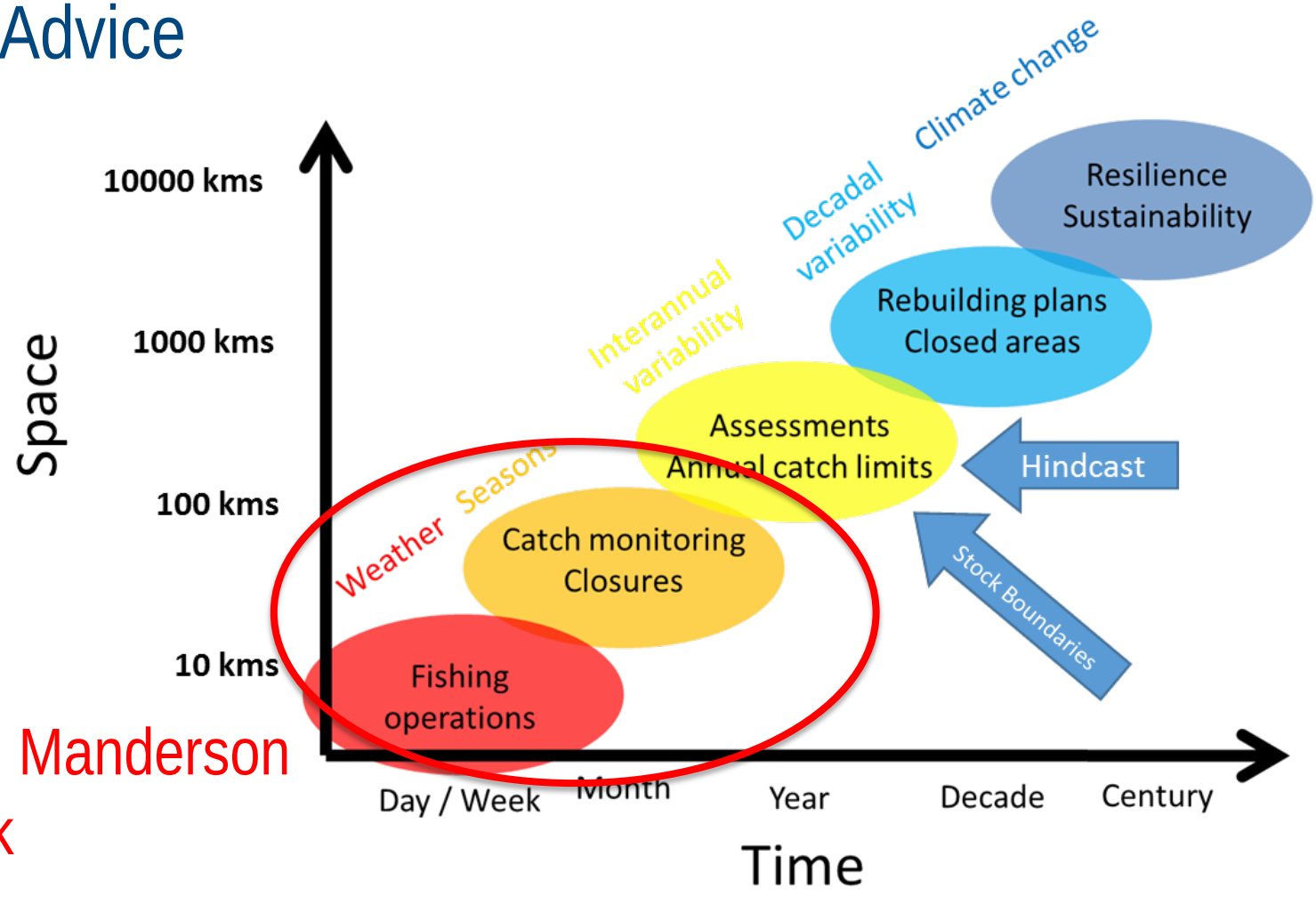
# NEFSC Climate Science

- Climate, Ecosystem, Habitat and Assessment Steering Group
  - provide structure and direction to apply C,E, & H research in assessments
  - provide guidance on the development and application of EBFM
  - upcoming discussion of climate change and the ESA

General guidelines

# NEFSC Climate Science

- Advice



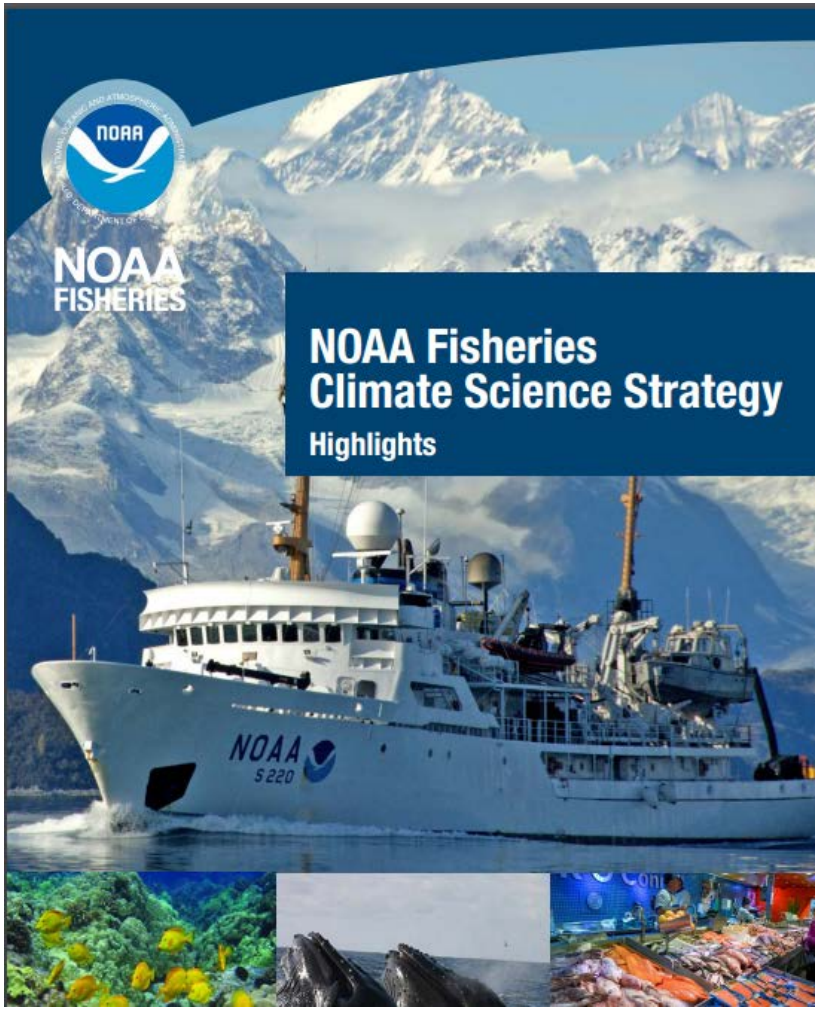

John Manderson - Talk

# NEFSC Climate Science

- Advice
  - State-space model with environment (Miller et al. 2016)
  - Rebuilding plans under climate change (Bell et al. 2015)
  - ESA critical habitat and climate change (Hare et al. 2012, Tommasi et al. 2014)
  - Right whale feeding habitats (Grieve et al. in prep)
  - Spatial allocation issues (ASMFC 2015)
  - Stock identification (Link et al 2012)
  - Scallop catch and bio-economics (Cooley et al. 2014)

# NEFSC Climate Science – Next Steps

- NOAA Fisheries Climate Science Strategy (Link et al. 2015)
- Northeast Regional Climate Action Plan (Hare et al. 2016)
- Work with MAFMC, NEFMC, and ASMFC



# Challenges and Opportunities

- Build Climate Science Enterprise for NOAA Fisheries