



NOAA
FISHERIES

NEFMC Managed Species and Climate Change

Northeast Fisheries Climate Vulnerability Assessment

NEFMC Meeting

Mystic, Connecticut

April 2016

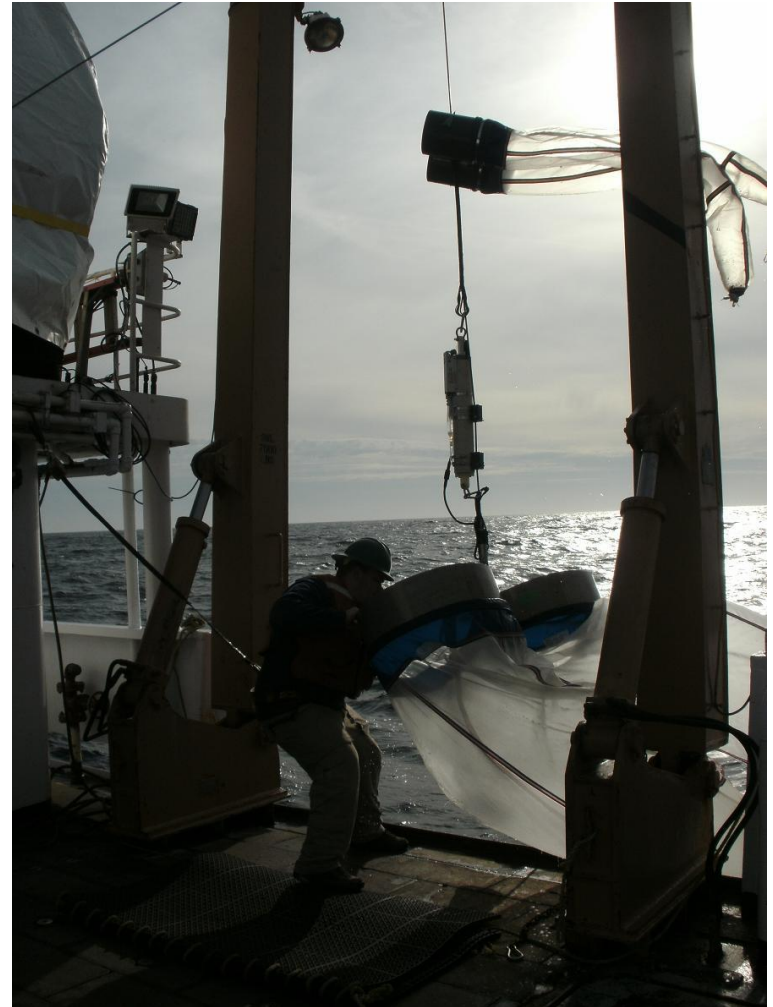
Northeast U.S. Climate Change and Variability

Climate change

- Long-term difference in the earth, atmosphere, and ocean conditions

Climate variability

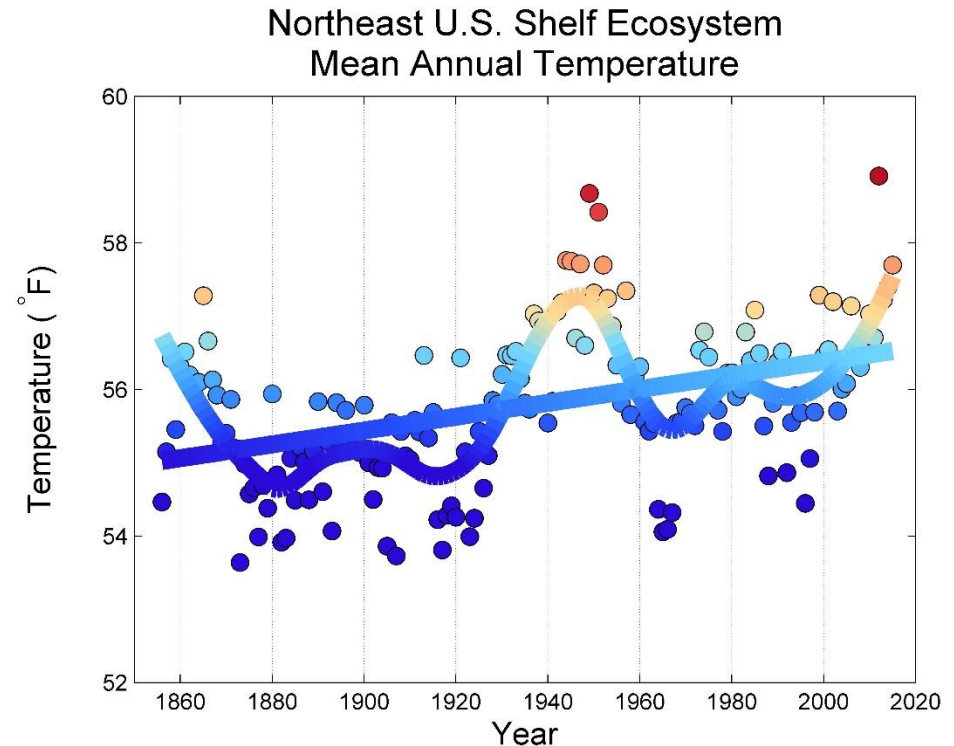
- Natural variability within the climate system (for example year-to-year)



Retrieving equipment – J. Prezioso

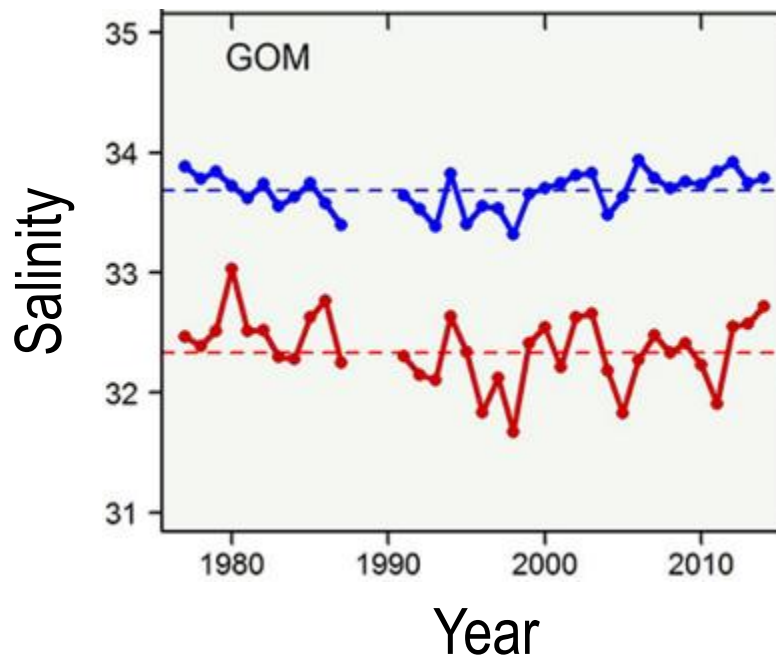
Northeast U.S. Climate Change and Variability

- Recent increase in ocean temperatures - a combination of climate change and decadal-scale variability



Northeast U.S. Climate Change and Variability

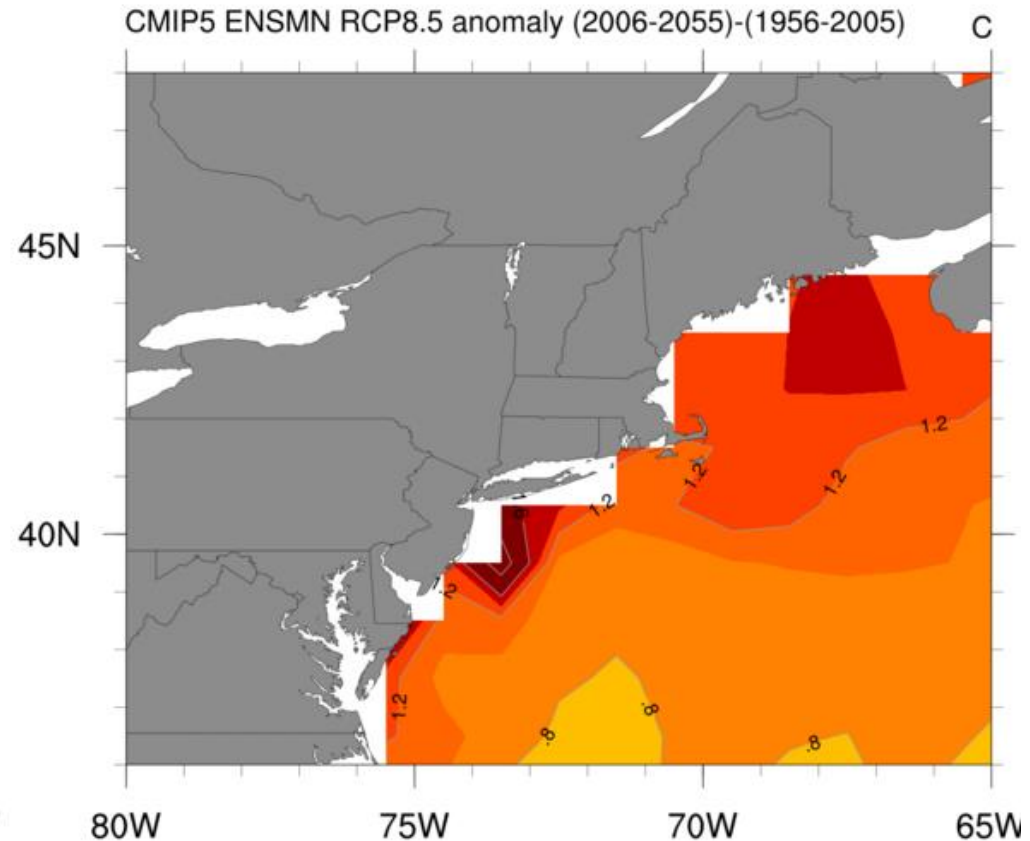
- Temperatures increasing
- Precipitation and streamflow changing
- Large-scale circulation changing
- pH decreasing (ocean acidification)
- Wind patterns changing
- Sea-level rising
- And more



Change & Natural Variability

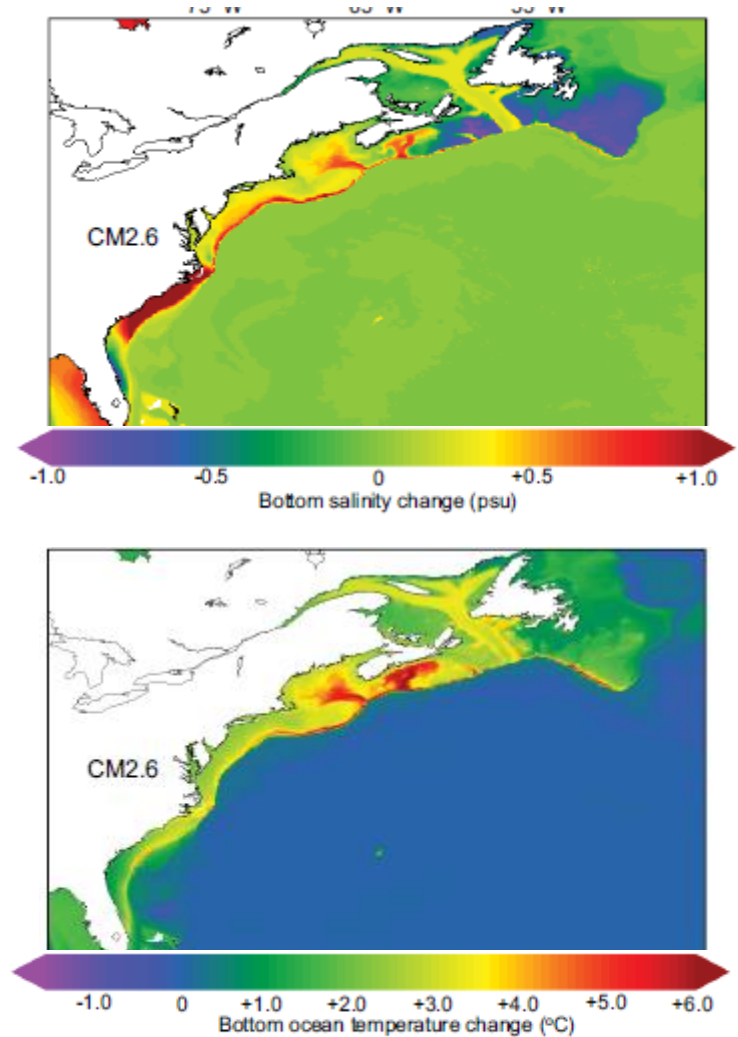
Northeast U.S. Climate Change and Variability

- IPCC AR5 Class Models
- Relatively coarse $\sim 1^\circ$ latitude/longitude
- Change 1956-2005 to 2006-2055
- Ocean temperatures increase



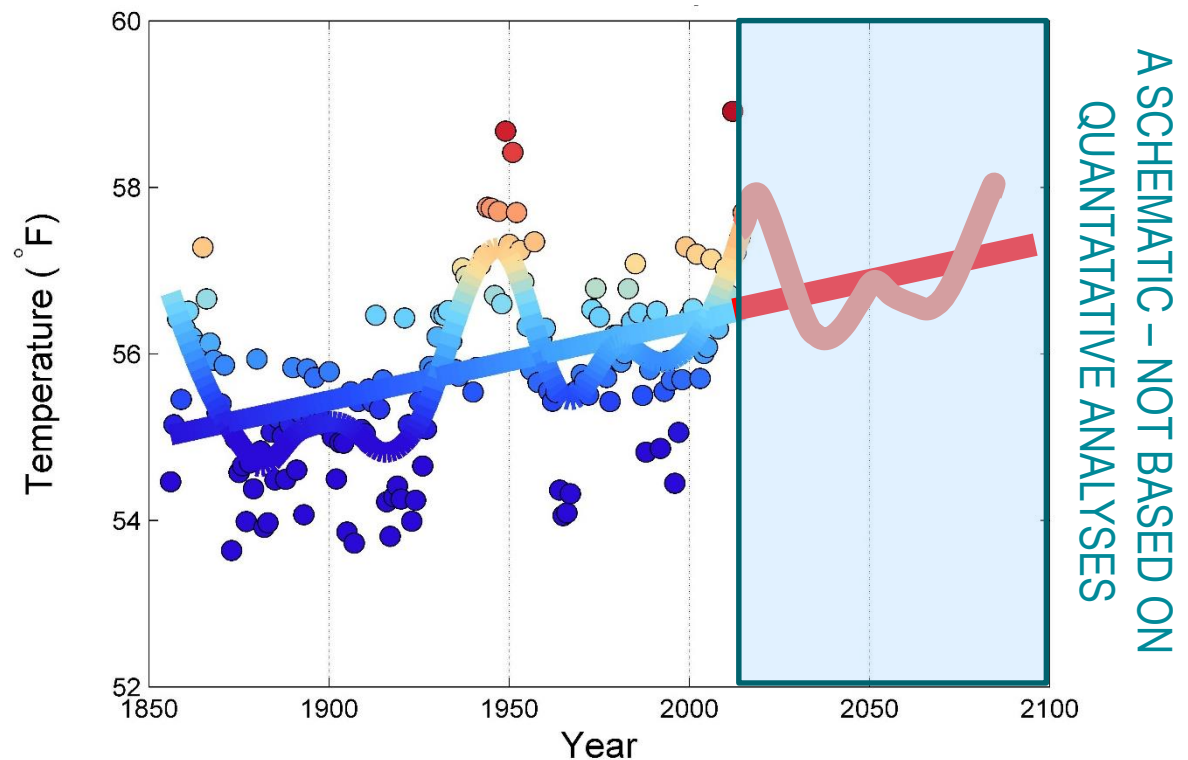
Northeast U.S. Climate Change and Variability

- Higher resolution model
- Regional-scale oceanography changes
- Warming and salinity increase in Gulf of Maine greater than IPCC AR5
- Warming and water mass replacement



Northeast U.S. Climate Change and Variability

- Interplay between decadal-scale variability and change over next 10-20 years is major uncertainty
- Long-term change signal is strong (30-100 years)
- Change will persist for foreseeable future



Need

Climate Change is a long-term change in part of the land-atmosphere-ocean system

Already observing impacts of climate change on variety fish stocks.

Expected Changes:

- Changes in stock **productivity**
- Changes in **distribution**
- Changes in species **interactions**

Quantitative approach for all species
*not possible at this time: limited by
resources and understanding*



Goal and Objectives



Goal:

Produce a practical and efficient tool for assessing the vulnerability of a wide range of fish stocks to a changing climate

Objectives:

1. Develop relative vulnerability rankings across species
2. Determine attributes/factors driving vulnerability
3. Identify data quality and data gaps

What do we mean by vulnerability?

- Vulnerability = risk of ***changes in stock abundance or productivity in a changing climate***
- Stocks with ability to shift distributions in a changing climate may receive a “low vulnerability” ranking
- Subset of the attributes may be useful in identifying stocks that possess the ***ability to shift distributions***



Methodology

Stock Vulnerability

Exposure

- Sea surface temperature
- Air temperature
- Salinity
- Ocean acidification (pH)
- Precipitation
- Currents
- Sea level rise

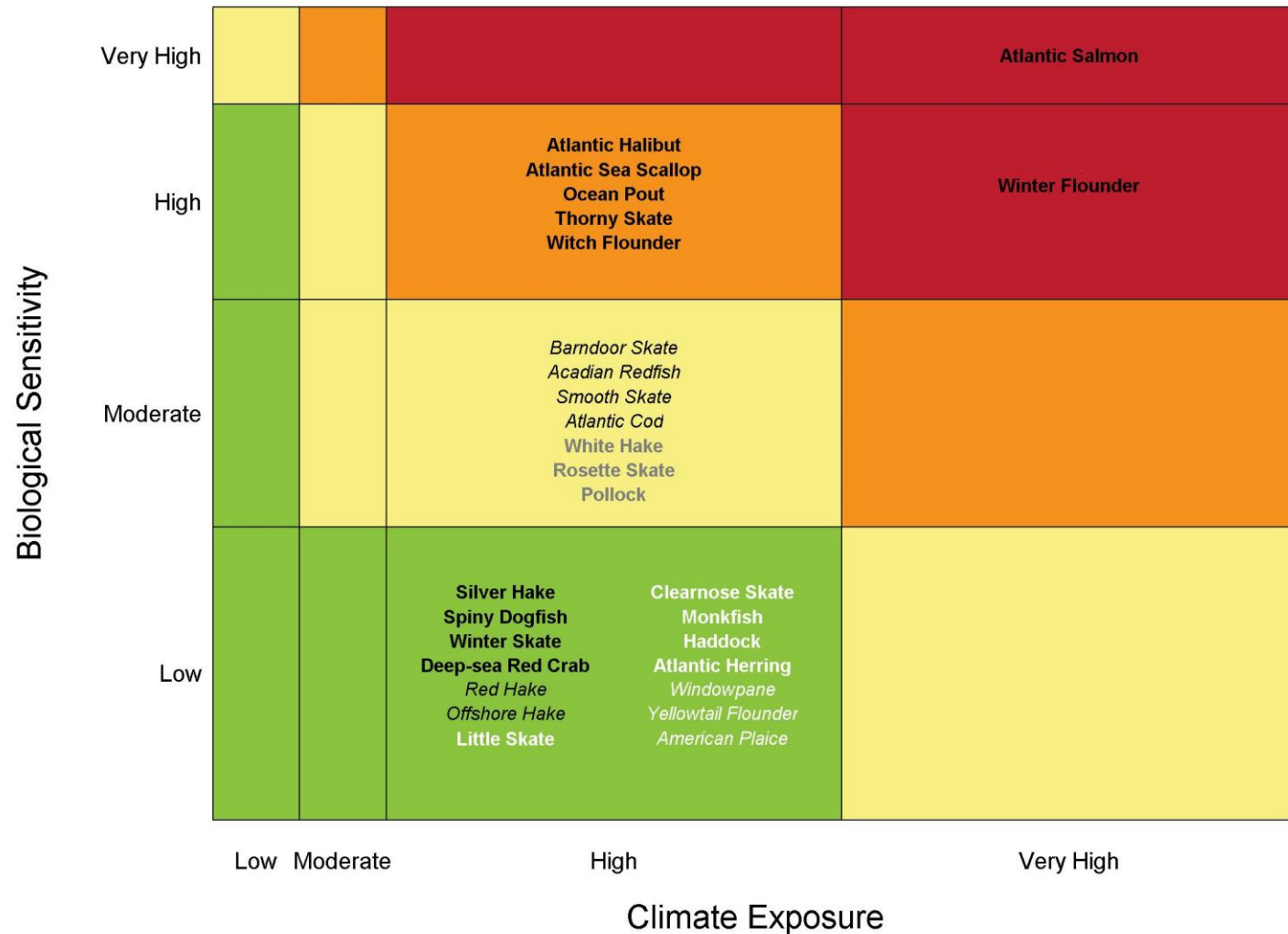
*** Exposure factors will vary depending on the region*

Sensitivity

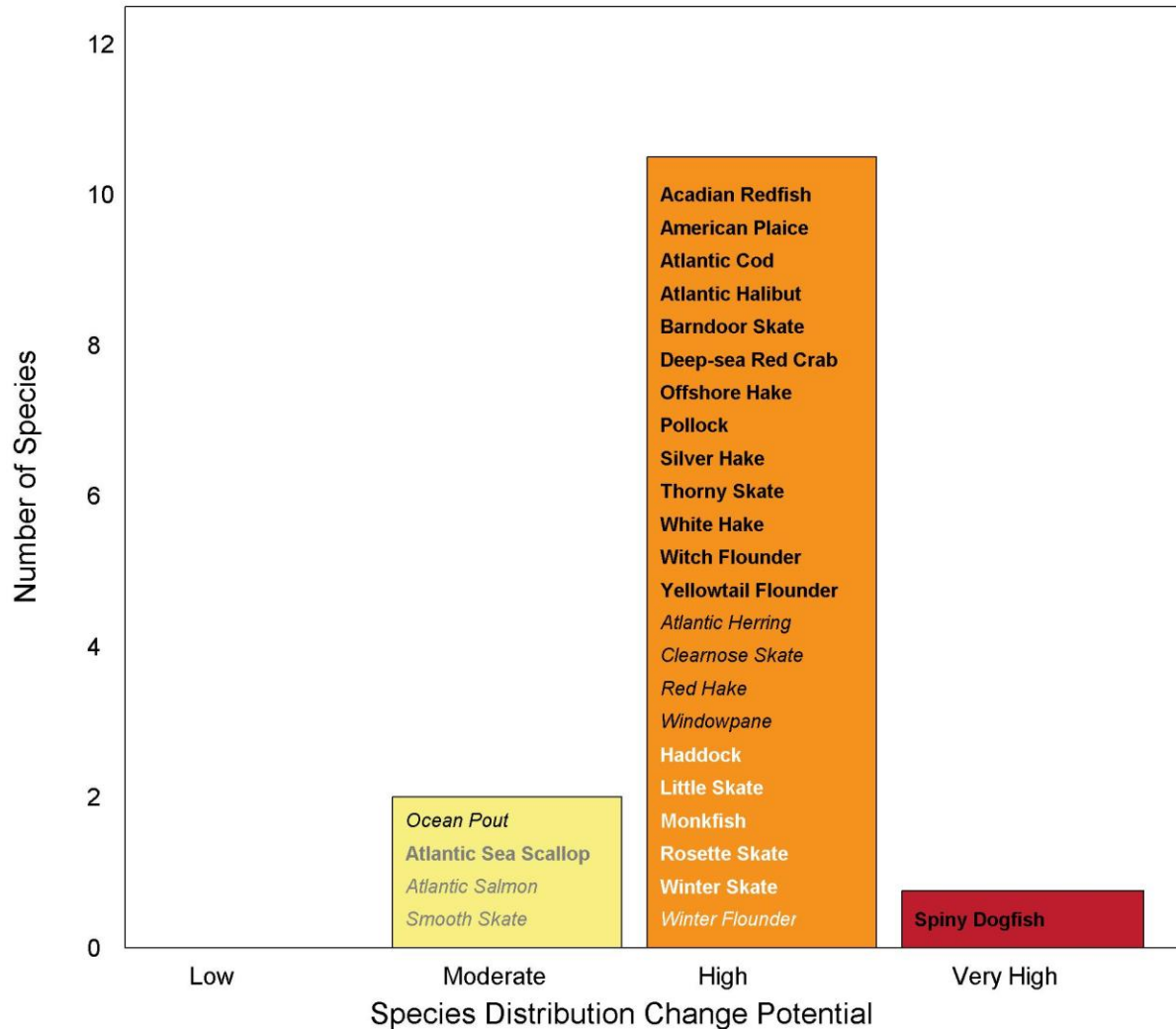
- Habitat Specificity
- Prey Specificity
- Sensitivity to Ocean Acidification
- Sensitivity to Temperature
- Stock Size/Status
- Other Stressors
- Adult Mobility
- Spawning Cycle
- Complexity in Reproductive Strategy
- Early Life History Survival and Settlement Requirements
- Population Growth Rate
- Dispersal of Early Life Stages



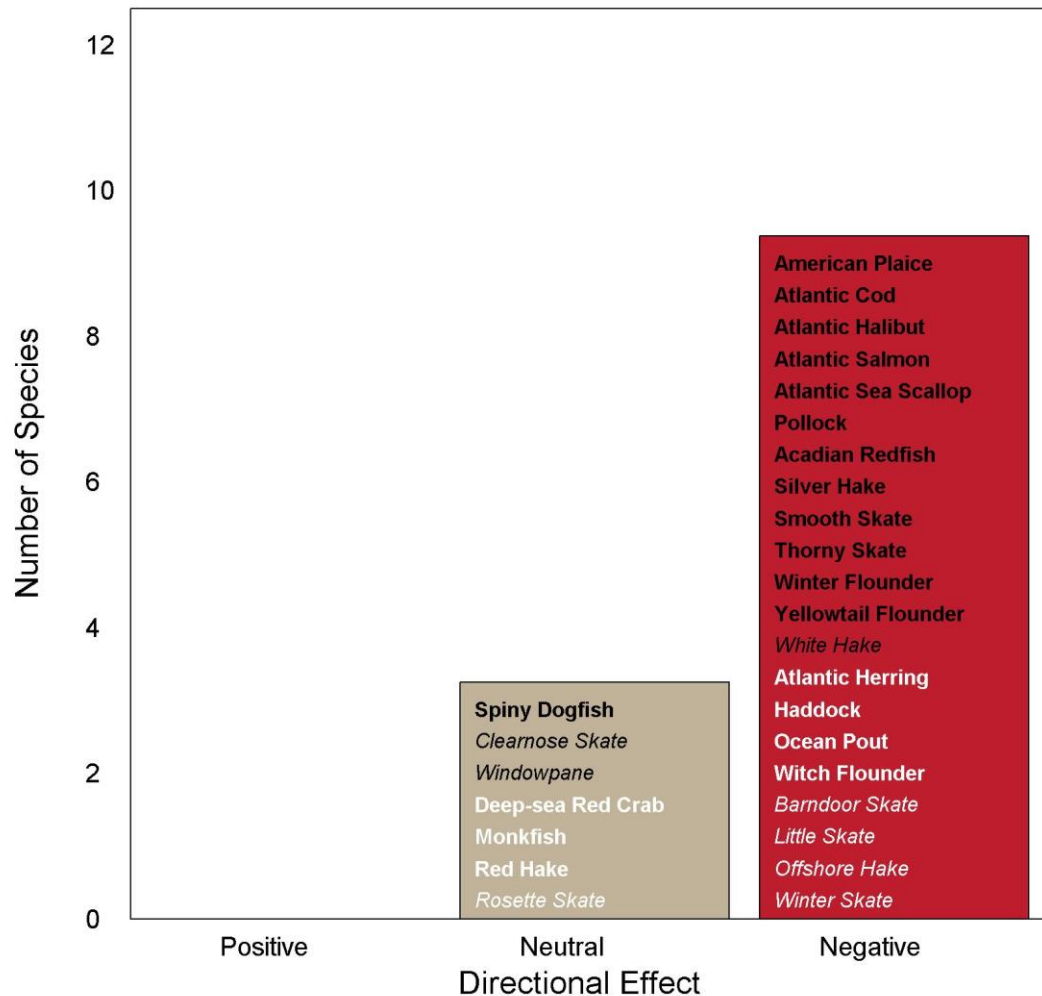
Results – Vulnerability Matrix



Results – Potential for Distribution Shift



Results – Directional Effect of Climate Change



Vulnerability Narratives

Alewife – *Alosa pseudoharengus*

Overall Vulnerability Rank = Very High ■

Biological Sensitivity = High ■

Climate Exposure = Very High ■

Data Quality = 79% of scores ≥ 2

<i>Alosa pseudoharengus</i>	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Stock Status	2.5	1.4	
Other Stressors	3.3	2.2	
Population Growth Rate	2.2	1.4	
Spawning Cycle	3.2	2.9	
Complexity in Reproduction	3.2	3.0	
Early Life History Requirements	3.3	2.4	
Sensitivity to Ocean Acidification	1.5	1.8	
Prey Specialization	1.5	3.0	
Habitat Specialization	2.6	3.0	
Sensitivity to Temperature	2.0	3.0	
Adult Mobility	1.6	2.8	
Dispersal & Early Life History	2.8	2.6	
Sensitivity Score	High		
Sea Surface Temperature	4.0	3.0	
Variability in Sea Surface Temperature	1.0	3.0	
Salinity	1.7	3.0	
Variability Salinity	1.2	3.0	
Air Temperature	4.0	3.0	
Variability Air Temperature	1.0	3.0	
Precipitation	1.3	3.0	
Variability in Precipitation	1.4	3.0	
Ocean Acidification	4.0	2.0	
Variability in Ocean Acidification	1.0	2.2	
Currents	2.0	1.0	
Sea Level Rise	2.8	1.5	
Exposure Score	Very High		
Overall Vulnerability Rank	Very High		

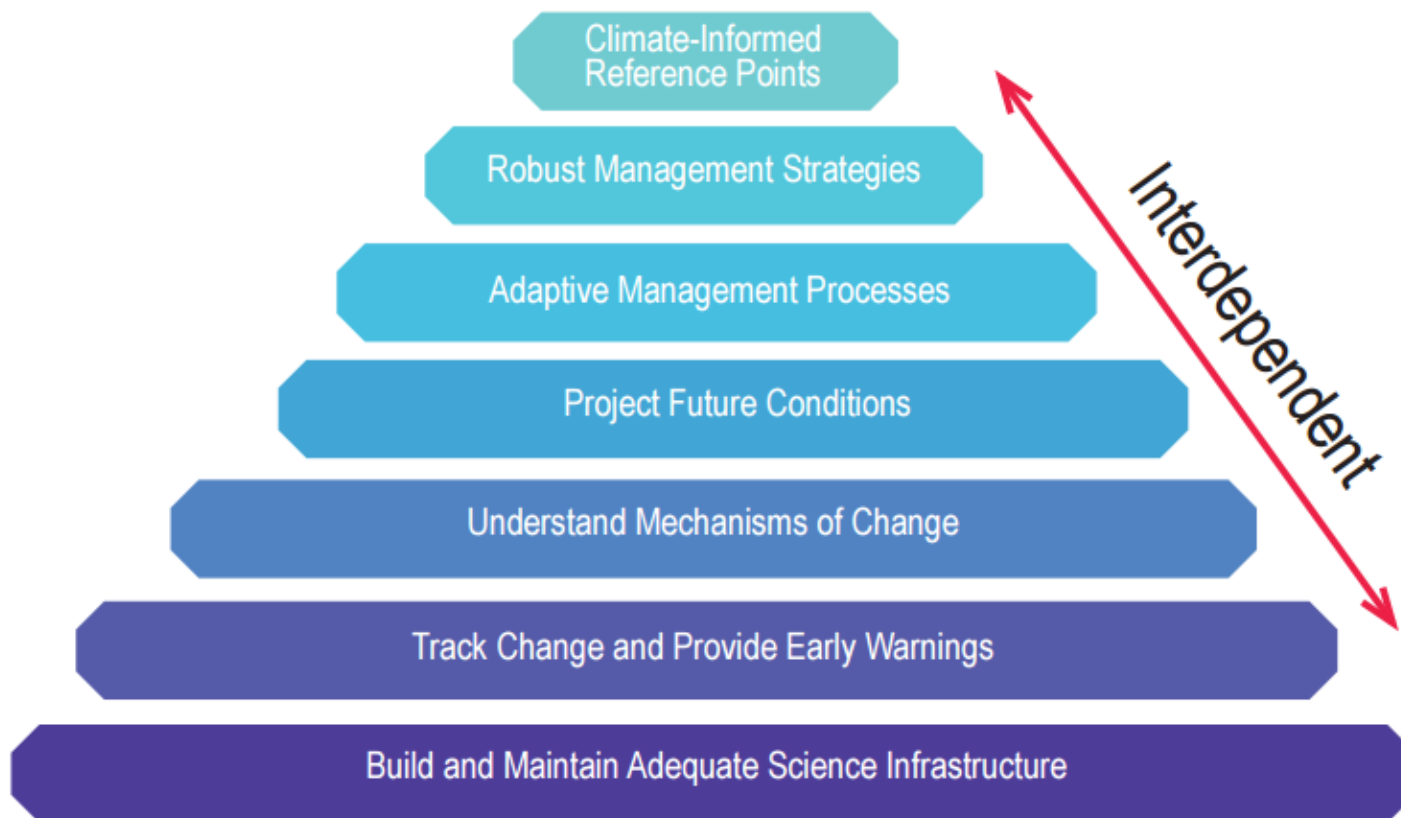


Climate Exposure: Very High. Three exposure factors contributed to this score: Ocean Surface Temperature (4.0), Ocean Acidification (4.0) and Air Temperature (4.0). Alewife are anadromous, spawning in freshwater, developing in freshwater and estuarine habitats, feeding as adults in marine habitats.

Biological Sensitivity: High. Four sensitivity attributes scored above 3.0: Other Stressors (3.3), Early Life History Requirements (3.3), Spawning Cycle (3.2), Complexity in Reproduction (3.2). Alewife are anadromous and exposed to a number of other stressors including habitat destruction, blockage to spawning habitats, and contaminants (Limburg and Waldman, 2009). Spawning time varies latitudinally and is linked to spring warming (Monroe 2002). Eggs and larvae inhabit freshwaters and then juveniles move to estuarine and ocean waters.

NOAA Fisheries Climate Science Strategy

Climate Science Strategy Objectives



NOAA Fisheries Climate Science Strategy

Immediate actions

- Conduct climate vulnerability analyses (Northeast Climate Vulnerability Assessment)
- Establish and strengthen ecosystem indicators and status reports (NEFSC Ecosystem Consideration)
- Develop capacity to conduct management strategy evaluations

Near-term actions

- Develop Regional Action Plan for Strategy
 - NEFMC staff input – Dec 2015
 - public comment period - summer 2016

NEFMC Food-for-Thought

- Many NEFMC managed species are likely to be negatively effected by climate change (decreased productivity, shift out of the region)
- Some of these impacts may already be occurring (e.g., Atlantic Cod - Pershing et al. 2015, Fogarty et al. 2008; Winter Flounder – Bell et al. 2014)
- Species interactions are likely to change



Questions??

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<http://www.savingseafood.org/news/regulations/nmfs-announces-approval-of-three-new-england-groundfish-rules-for-fishing-year-2015/>