Assessing the Vulnerability of Fish Stocks to Climate Change

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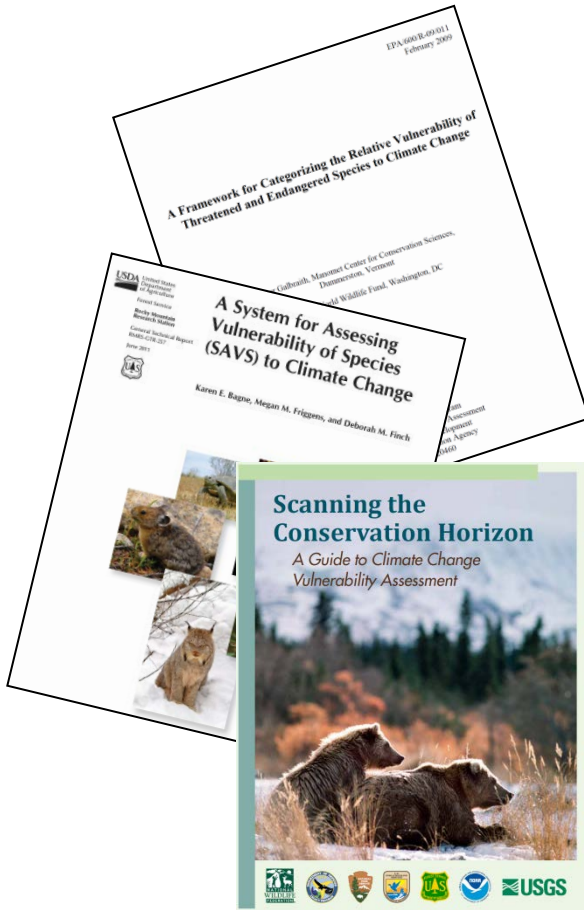
Project Goal and Objectives

Goal:

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

Objectives:

1. Develop relative vulnerability rank across species

2. Determine attributes/factors driving vulnerability rank

3. Identify data quality and data gaps

Vulnerability Assessments

Vulnerability assessments:

- Identify *which* species are likely to be most strongly affected by projected changes
- Increase our understanding of *why* these species are likely to be vulnerable

NWF 2011. Scanning the Conservation Horizon

What do we mean by vulnerability?

- This methodology was designed to identify stocks that may *decrease in abundance or productivity*.

- Stocks that possess the ability to adapt to climate change via distributional shifts are more likely to receive a "low vulnerability" rank.

- A subset of our sensitivity attributes could be used to identify stocks that possess the *ability to shift distributions*.

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Vulnerability Assessment Framework

Stock Vulnerability

Exposure

- Sea surface temperature
- Air temperature
- Salinity
- Ocean acidification (pH)
- Precipitation
- Currents
- Sea level rise
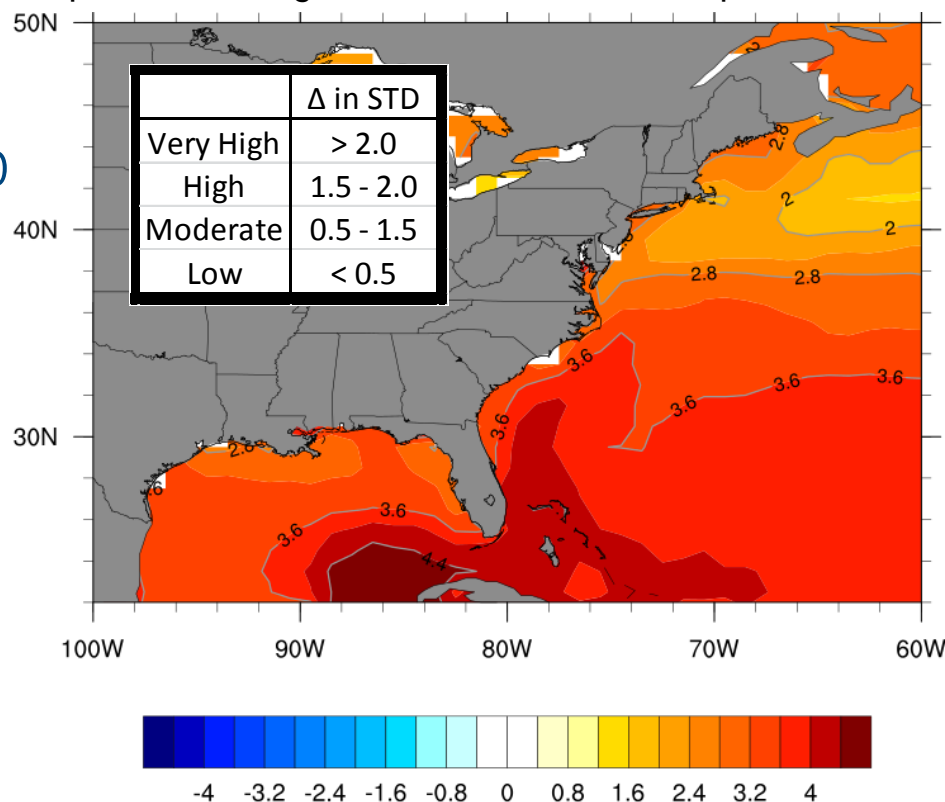
*** Exposure factors will vary depending on the region*

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

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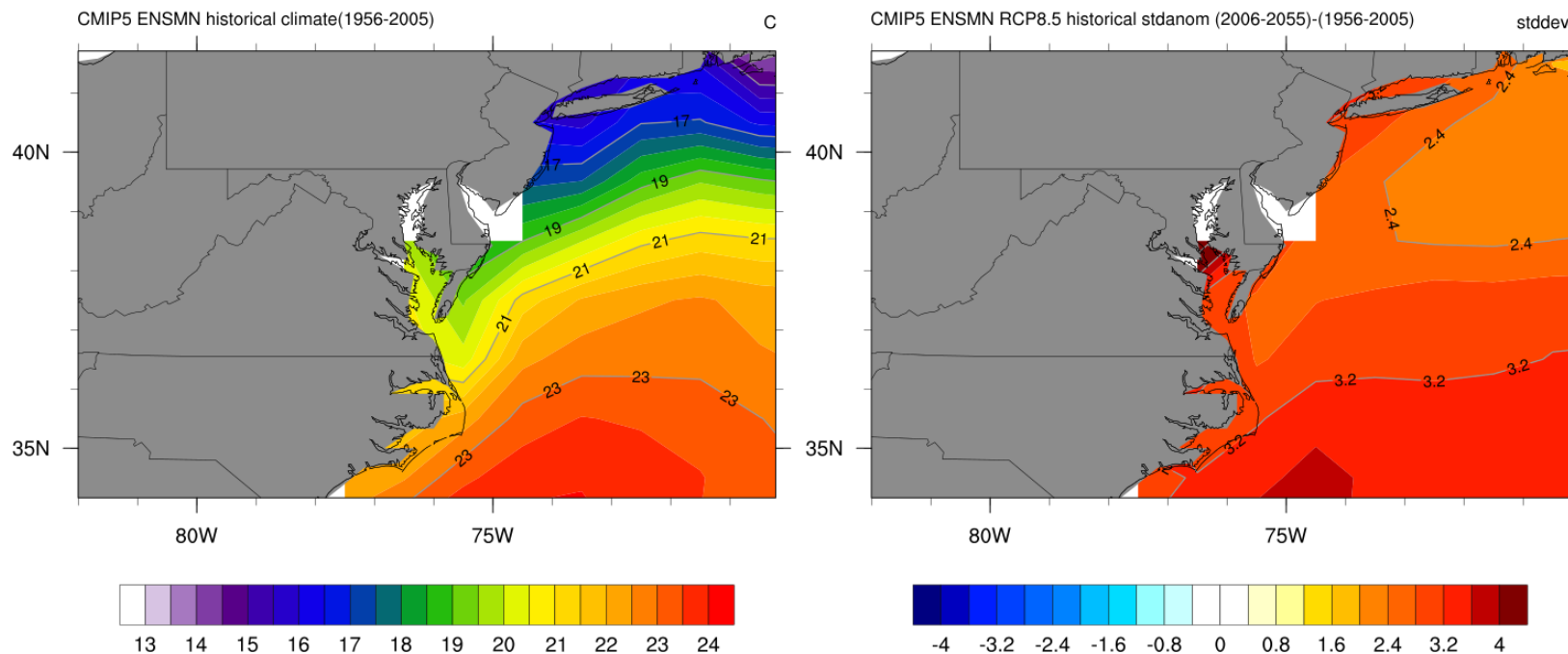
Exposure Factors

- <u>Definition</u>: a measure of how much a species is likely to experience a change in climate
- Quantified as the spatial overlap between a species' current distribution and the expected climate change
- Mean change is related to current variability (z-score)
- Changes in variability are measured with an F-test (future variability/current variability)

Expected Change in SST 2006-2055 depicted as STD

	Δ in STD
Very High	> 2.0
High	1.5 - 2.0
Moderate	0.5 - 1.5
Low	< 0.5

OAR website on expected climate change

Sea Surface Temperature ANN

http://www.esrl.noaa.gov/psd/ipcc/ocn/ccwp.html

Sensitivity Attributes

Definition: Biological attributes believed to be indicative of the stock's response to climate change. They include the stock's resilience and its adaptive capacity.[1]

12 attributes relate to current life history characteristics:

- 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

[1] Williams et al. 2008

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Scoring Details

- Based on currently existing knowledge and expert opinion
- Uses quantitative data when available, and qualitative information when data is lacking
- 4 point scale (Low, Moderate, High, Very High)
- 2 step expert elicitation scoring process:
  - Preliminary Round
    - Experts provide individually scores
  - Final Round
    - Group workshop to discuss results and allow adjustments to scores

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Expected Products

- An index of relative vulnerability across stocks.

- Information on the key attributes behind the vulnerability score of each stock.

- Identification of the major data gaps.

- Completed stock profiles and climate projections available for other projects.

- Species Vulnerability Narratives

Species	Vulnerability
Sleepyfish	Very High
Plantfish	
Alligatorfish	
Popfish	
Spotfish	High
Pencilfish	
Orangefish	
Hiddenfish	
Rightfish	
Spiderfish	
Chocolatefish	Moderate
Flowerfish	
Lemonfish	
Lightfish	
Wrongfish	Low
Greenfish	
Ostrichfish	
Candyfish	
Picklefish	
Redtoefish	

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NE/MA Assessment

- In March, 2014, an assessment was completed on 79 Federal and State managed species off the Northeast US coast

- Results should be ready for publication by summer 2014

- Taking steps to expand methodology to other regions

NE Results – Vulnerability Matrix

SENSITIVITY

	Low	Moderate	High	Very High
Very High	0 species	0 species	2 species	2 species
High	0 species	0 species	14 species	18 species
Moderate	0 species	0 species	11 species	5 species
Low	0 species	0 species	19 species	8 species

EXPOSURE

Vulnerability Rank	# species
Very High	22
High	19
Moderate	19
Low	19

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Expected Results - Vulnerability Narratives

Anguilla rostrata	Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Stock Status (Status)	2.7	1.0	
Other Stressors (Other)	2.8	1.7	
Population Growth Rate (Pop Growth)	2.8	1.8	
Spawning Cycle (Spawning)	2.5	2.2	
Complexity in Reproduction (Repr Complx)	2.7	1.9	
Early Life History Requirements (ELH)	2.6	1.2	
Sensitivity to Ocean Acidification (OA)	1.1	2.0	
Prey Specialization (Prey)	1.1	3.0	
Habitat Specialization (Hab)	2.6	3.0	
Sensitivity to Temperature (Sens Temp)	1.3	3.0	
Adult Mobility (Adult Mobil)	1.2	3.0	
Dispersal & Early Life History (Dispersal)	1.1	2.6	
Sensitivity Score	Moderate		
Sea Surface Temperature (SST)	4.0		
Var. in Sea Surface Temperature (Var SST)		3.0	
Salinity (Salinity)	1.1	3.0	
Var. Salinity (Var Sal)	1.2	3.0	
Air Temperature (Air Temp)	4.0	3.0	
Var. Air Temperature (Var Air Temp)	1.0	3.0	
Precipitation (Precip)	1.3	3.0	
Var. in Precipitation (Var Precip)	1.4	3.0	
Ocean Acidification (OA)	4.0	2.0	
Var. in OA (Var OA)	1.0	2.2	
Currents (Currents)	2.4	1.0	
Sea Level Rise (Sea Level)	0.0	0.0	
Exposure Score	Very High		
Overall Vulnerability Rank	High		

Legend: ■ Low ■ Moderate ■ High ■ Very High

NOT FINAL DATA – FOR EXAMPLE ONLY

American eel:
Because this species is a generalist and can adjust easily to a variety of habitats and prey, it could be more resilient to the climate changes. However, since the entire species spawns in the Sargasso sea, and larvae drift and eat with the currents for months, climate change impacts on these life stages are not well understood.
In addition, stressors on the species are high. Much of the eel's habitat is impacted by freshwater dams, and an introduced parasite has become prevalent in most populations…

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Potential Uses

Science:

- Identify stocks that can benefit from incorporating environmental variability into stock assessments

- Identify gaps in information for use in shaping research priorities

- Identify stocks that could benefit from increased monitoring to better quantify when expected climate impacts occur

Management:

- Inform management decisions about catch amounts, and rebuilding plans

- Provide information for use in EIS's, BiOps and other decision making documents

- Identify potential management actions that might reduce vulnerability and increase stock resilience in a changing climate

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Questions?