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# What's at Risk? Assessing Vulnerability of Fish Stocks in a Changing Climate

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**NOAA FISHERIES**

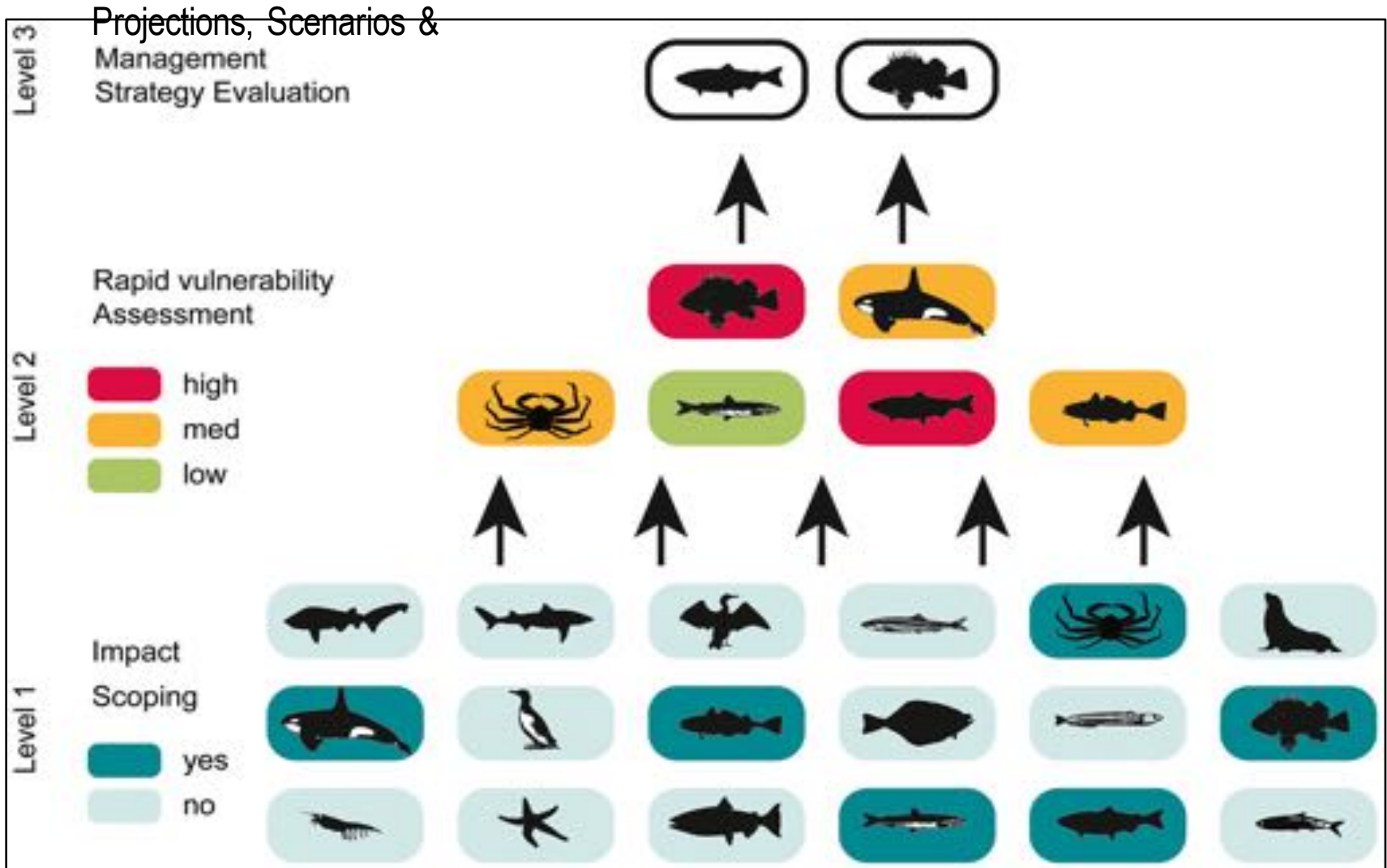
# What's at risk?

**What species are most vulnerable?**

**What fisheries/fishing communities are at risk?**

**Where focus science and management efforts reduce risks and increase resilience?**

# Range of tools....



# General Vulnerability Assessments

## 1. Highly Vulnerable

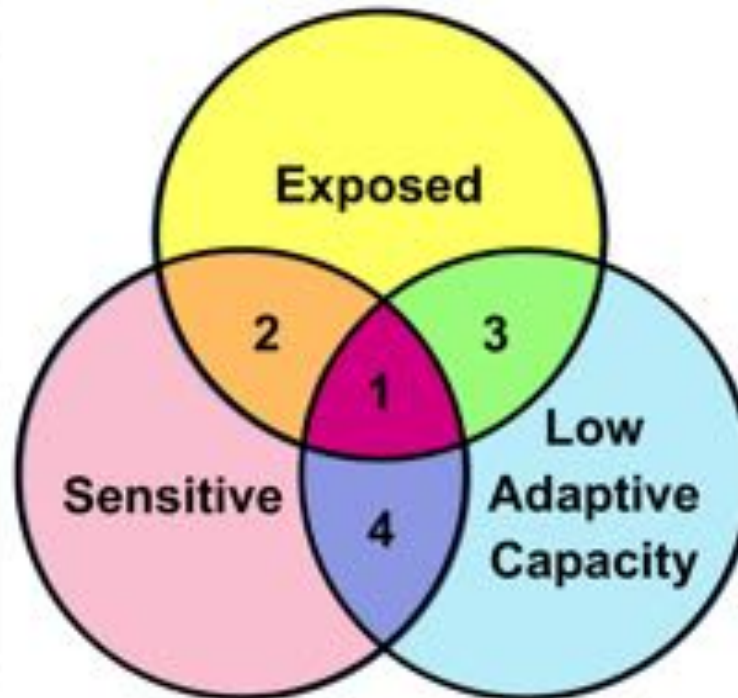
**At greatest risk**

- Specific research needed
- Interventions generally needed

## 2. Potential Adapters

**May be at risk**

- Monitor and support adaptive responses



## 3. Potential Persisters

**May not be at risk**

- Monitor population trends

## 4. High Latent Risk

**Not currently at risk**

- Monitor environment

Foden et al. 2013

# Vulnerability Assessment Framework

## Stock Vulnerability

### Exposure

- Sea surface temperature
- Sea surface salinity
- Air temperature
- Ocean acidification (pH)
- Precipitation
- Currents
- Phenology of Upwelling
- Sea level rise
- Subsurface Oxygen

### 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

# Vulnerability Assessment Process

## Scoping and Planning

- Identify leaders and stakeholders
- Define scope and study area

## Assessment Preparation

- Species profiles
- Climate projections
- Species distributions

## Scoring

- Train scorers
- Preliminary scoring (individual)
- Final scoring (workshop)

## Results

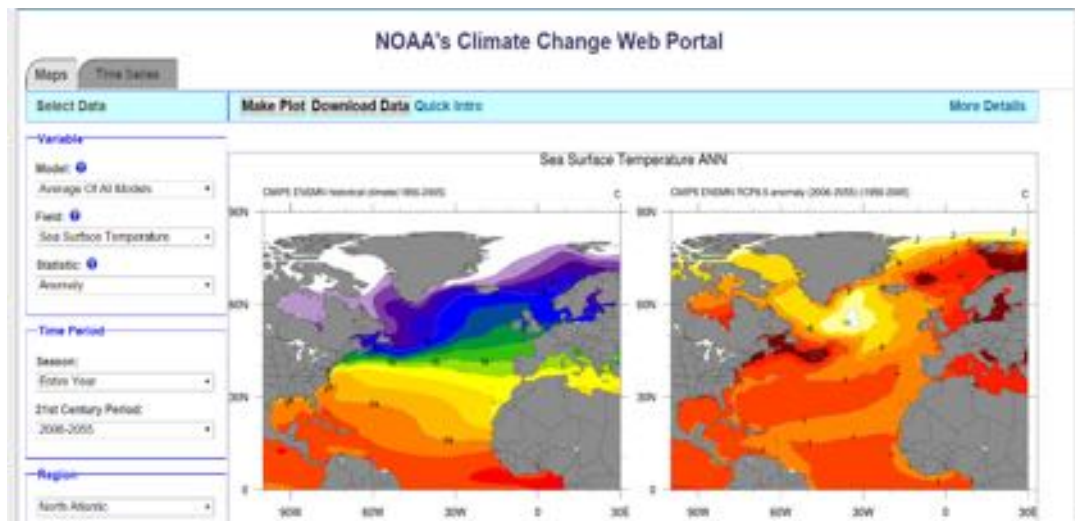
- Tables and figures
- Species narratives
- Peer reviewed article

## Communication

- Disseminate results
- Publish results online
- Engage w/ stakeholders
- Work with end users of the results

# What Information is Produced?

1. Overall vulnerability to changes in productivity
2. Propensity for changes in distribution
3. Overall Directional Score (+, -)
4. Species Vulnerability Narratives (2-3 pages per species)
5. Regional climate/ocean projections



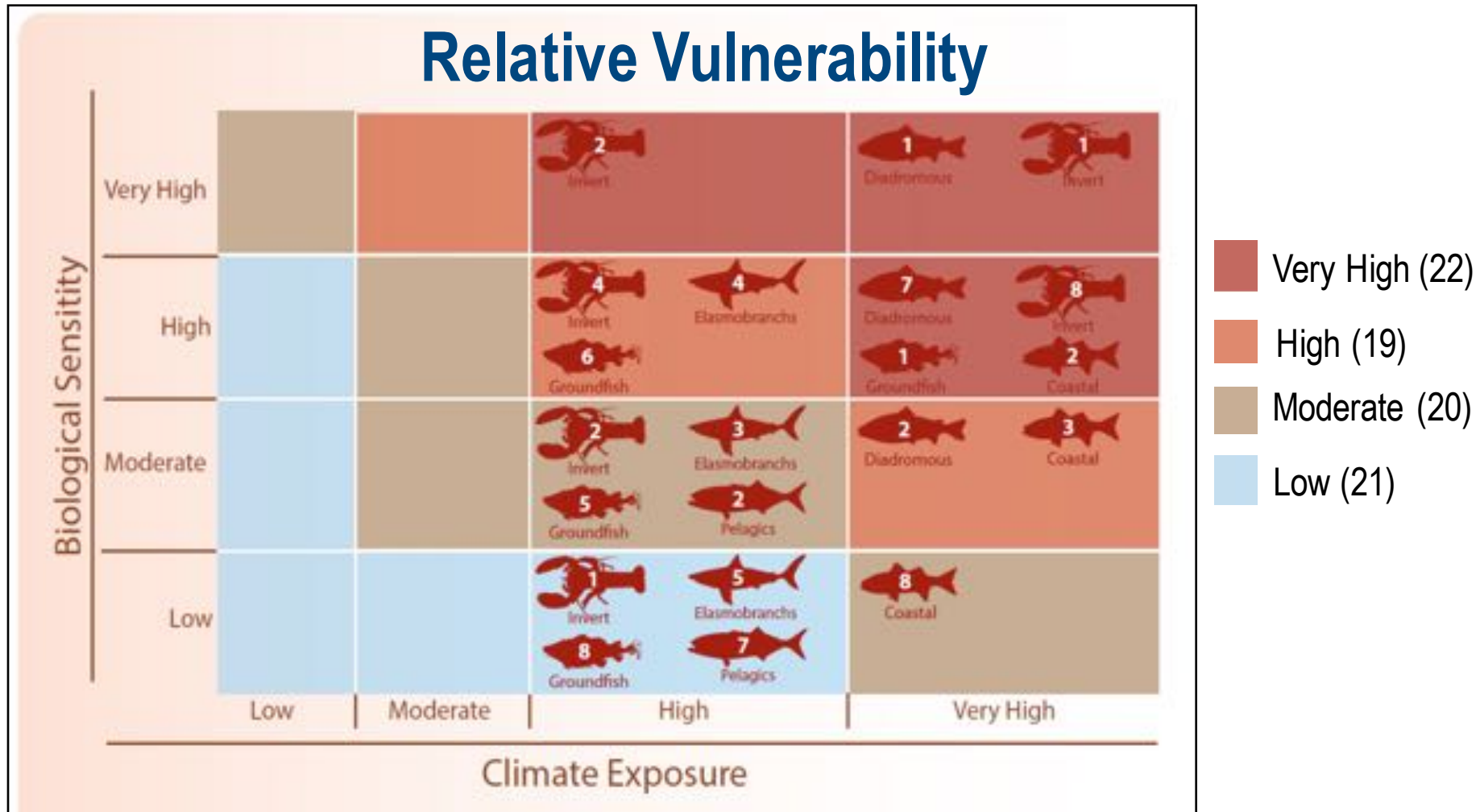


# Where are the Assessments Being Done?





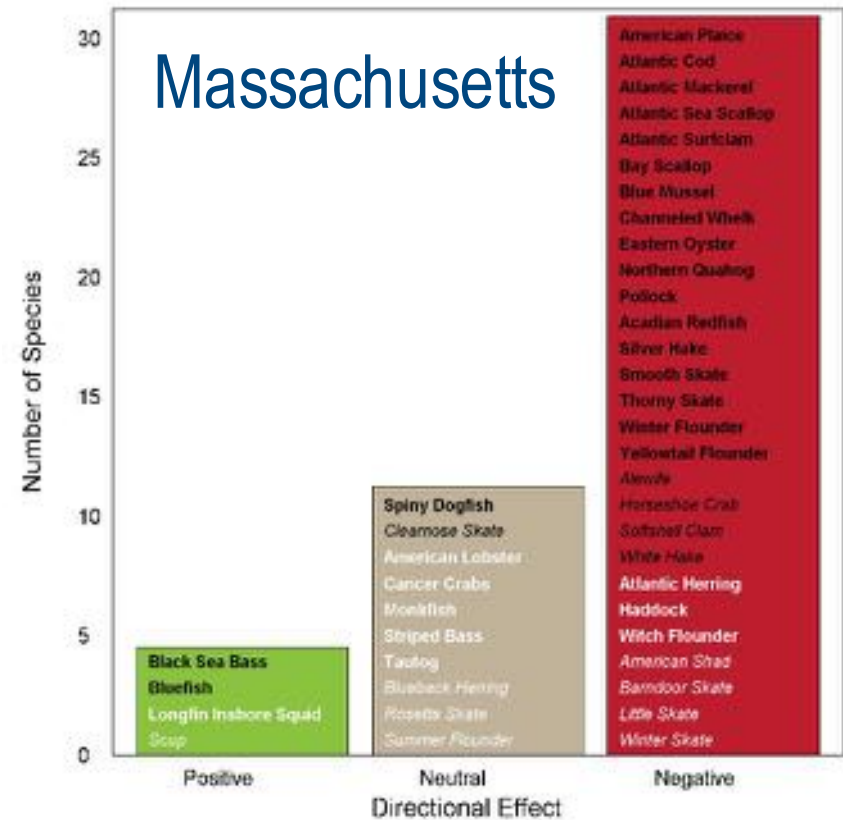
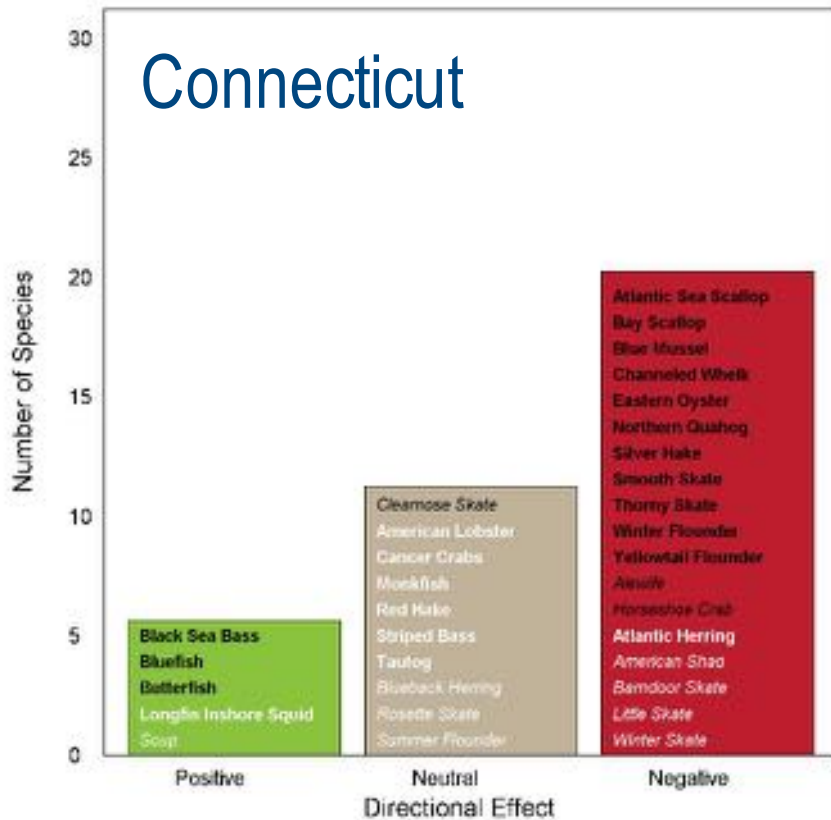
# What Are the Results?



82 fish and invertebrate species – U.S. Northeast Shelf Ecosystem

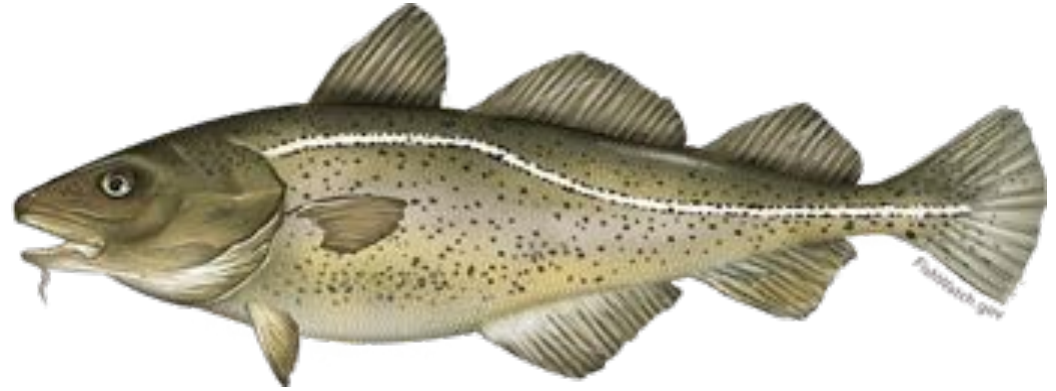
# What Are the Results?

- Variety of species at risk
- Possible positive and negative effects



# Species Specific Results

## Atlantic Cod:



1. Vulnerability to changes in productivity: **Moderate**
2. Propensity for changes in distribution: **High**
3. Overall Directional Change Score: **Negative**
4. Species Narrative: **2-4 pgs**

**Summary of results and information on climate impacts on Cod**

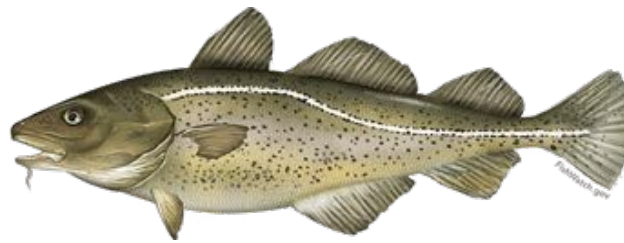
Atlantic Cod – *Gadus morhua*

Overall Vulnerability Rank = Moderate

Biological Sensitivity = Moderate

Climate Exposure = High

Data Quality = 92% of scores  $\geq 2$



# Vulnerability Narratives

<i>Gadus morhua</i>		Expert Scores	Data Quality	Expert Scores Plots (Portion by Category)
Sensitivity attributes	Stock Status	3.9	3.0	
	Other Stressors	2.0	2.5	
	Population Growth Rate	2.8	2.8	
	Spawning Cycle	2.0	3.0	
	Complexity in Reproduction	2.4	2.9	
	Early Life History Requirements	2.8	2.8	
	Sensitivity to Ocean Acidification	1.3	2.0	
	Prey Specialization	1.2	3.0	
	Habitat Specialization	1.8	3.0	
	Sensitivity to Temperature	2.0	3.0	
	Adult Mobility	2.2	2.8	
	Dispersal & Early Life History	1.4	2.8	
	<b>Sensitivity Score</b>	<b>Moderate</b>		
Exposure variables	Sea Surface Temperature	3.9	3.0	
	Variability in Sea Surface Temperature	1.0	3.0	
	Salinity	1.4	3.0	
	Variability Salinity	1.2	3.0	
	Air Temperature	1.0	3.0	
	Variability Air Temperature	1.0	3.0	
	Precipitation	1.0	3.0	
	Variability in Precipitation	1.0	3.0	
	Ocean Acidification	4.0	2.0	
	Variability in Ocean Acidification	1.0	2.2	
	Currents	2.1	1.0	
	Sea Level Rise	1.6	1.5	
	<b>Exposure Score</b>	<b>High</b>		
<b>Overall Vulnerability Rank</b>	<b>Moderate</b>			

Biological Sensitivity:  
High

Climate Exposure:  
Very High

Alewife - *Alosa pseudoharengus*

Overall Vulnerability Rank = Very High ■

Biological Sensitivity = High ■

Climate Exposure = Very High ■

Data Quality = 79% of scores  $\geq 2$



# Vulnerability Narratives

<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	
Dispensal & Early Life History	2.8	2.6	
<b>Sensitivity Score</b>	<b>High</b>		
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	
<b>Exposure Score</b>	<b>Very High</b>		
<b>Overall Vulnerability Rank</b>	<b>Very High</b>		

Biological Sensitivity:  
High

Climate Exposure:  
Very High



# How are the results being used?

## ***Science:***

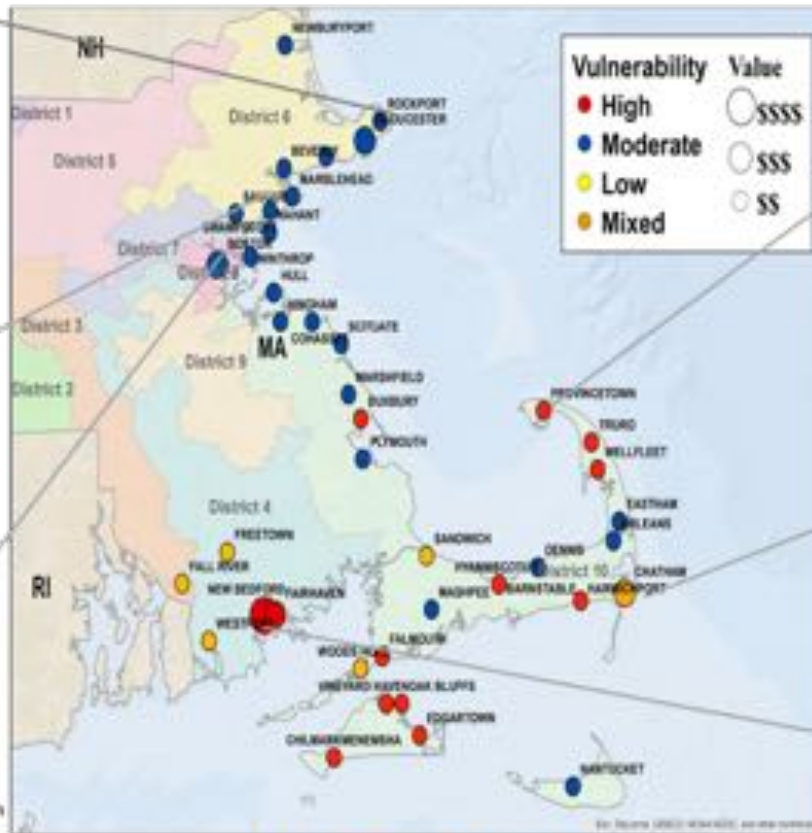
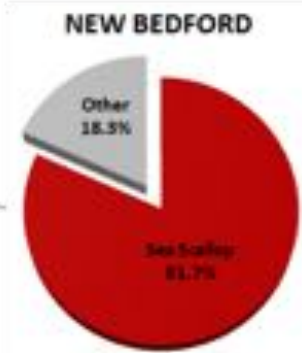
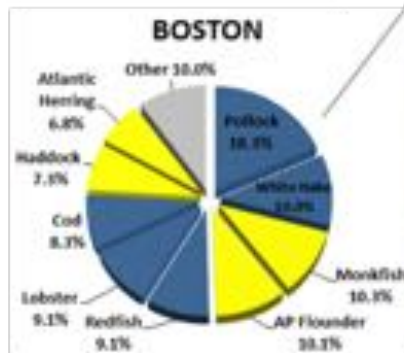
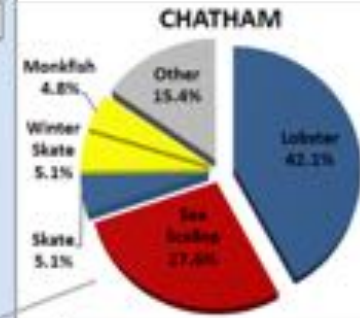
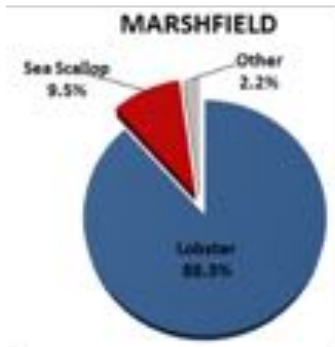
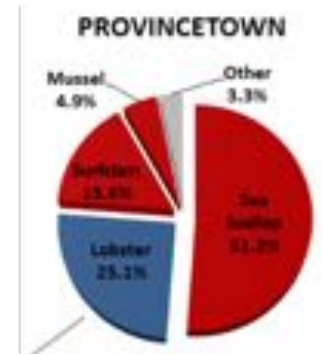
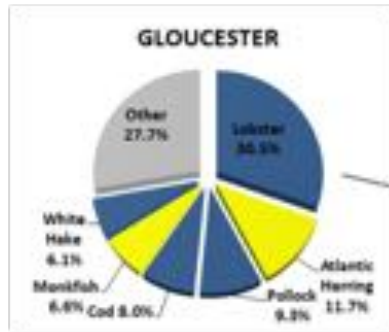
- Identify stocks & fisheries that could benefit from increased research, monitoring and environmental modeling.
- Identify important unknowns in species biology and ecology.
- Identify key environmental drivers impacting species.

## ***Management:***

- Provide context for fisheries management decisions and supporting documents (FMPs, EISs, BiOps, ACL Frameworks, Rebuilding Plans, Allocation, etc.).
- Help identify future scenarios and potential management actions to increase stock resilience in a changing climate.
- Support resilient fishing communities.

# What does this mean for MA fishing communities?

## Species vulnerability in MA fishing communities (2013 landings value)



Lisa Colburn - NEFSC



# Results - West Coast Stocks

Sensitivity	Very High			1 Salmon 1 Other Anadramous 1 Puget Sound Rockfish	
	High			4 salmon 2 Puget Sound Rockfish 5 Rockfish 1 HMS 1 Elasmobranch	
	Moderate		1 Other Groundfish 1 Elasmobranch	15 Rockfish 4 HMS 3 Other Groundfish 1 Other Anadramous 2 CPS 1 Flatfish	
	Low		2 Flatfish 1 Other Groundfish	1 Rockfish 5 HMS 4 Flatfish 5 CPS 2 Other Groundfish 1 Elasmobranch	
		Low	Moderate	High	Very High
		Exposure			

# West Coast – Salmon Specific Assessment

Sensitivity

Very High			4 Chinook 1 Coho 1 Sockeye	
High			5 Chinook 4 Coho 1 Chum 6 Steelhead	1 Chinook
Moderate		2 Chum	1 Chinook 1 Sockeye 5 Steelhead	
Low		1 Pink		
	Low	Moderate	High	Very High

Exposure

# Summary

## Vulnerability assessments:

- Provide rapid information on species vulnerability to changing climate
- Identify key sources of vulnerability
- Identify key information gaps
- Can help prioritize research and management actions.

# Thank You

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