Evaluating adaptation scenarios for fishing communities facing climate-driven species changes

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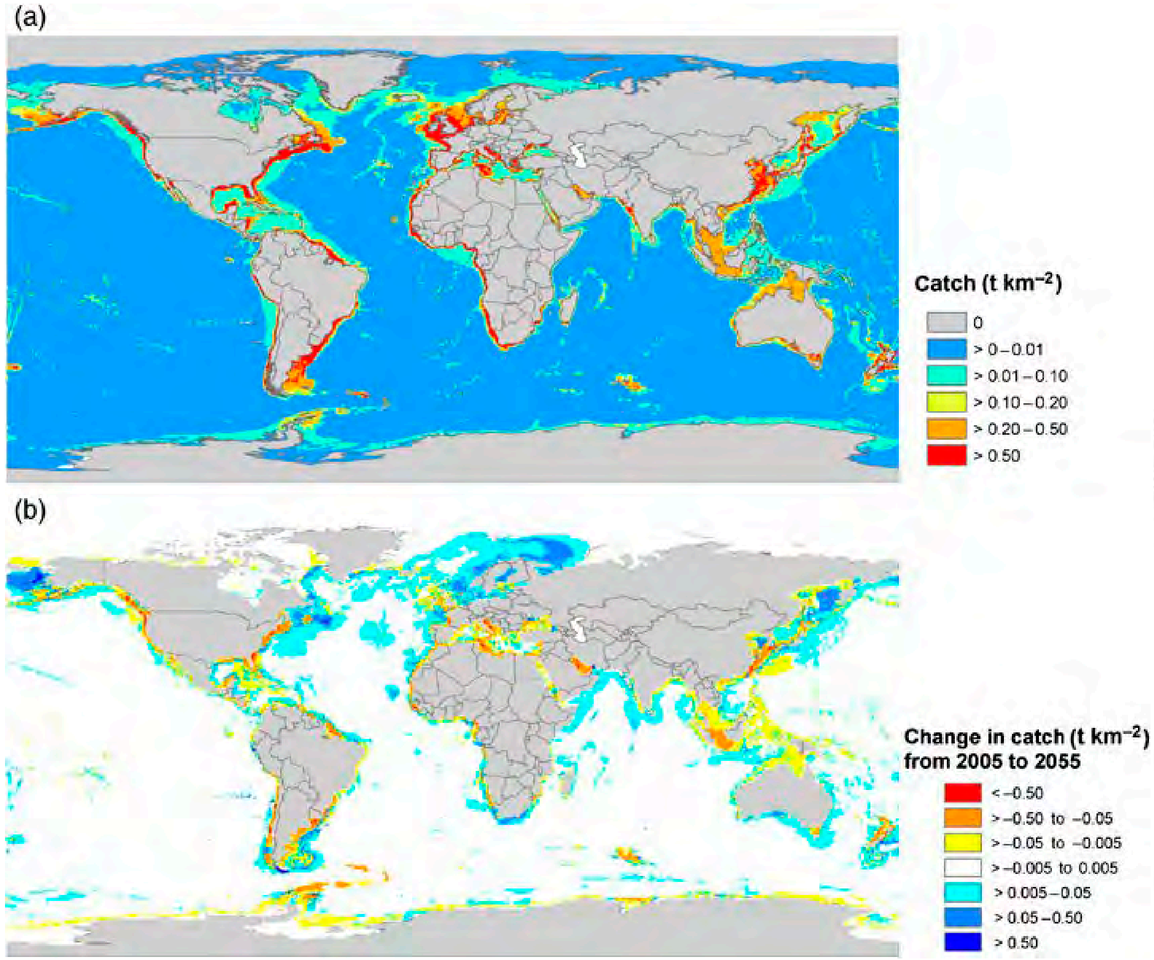
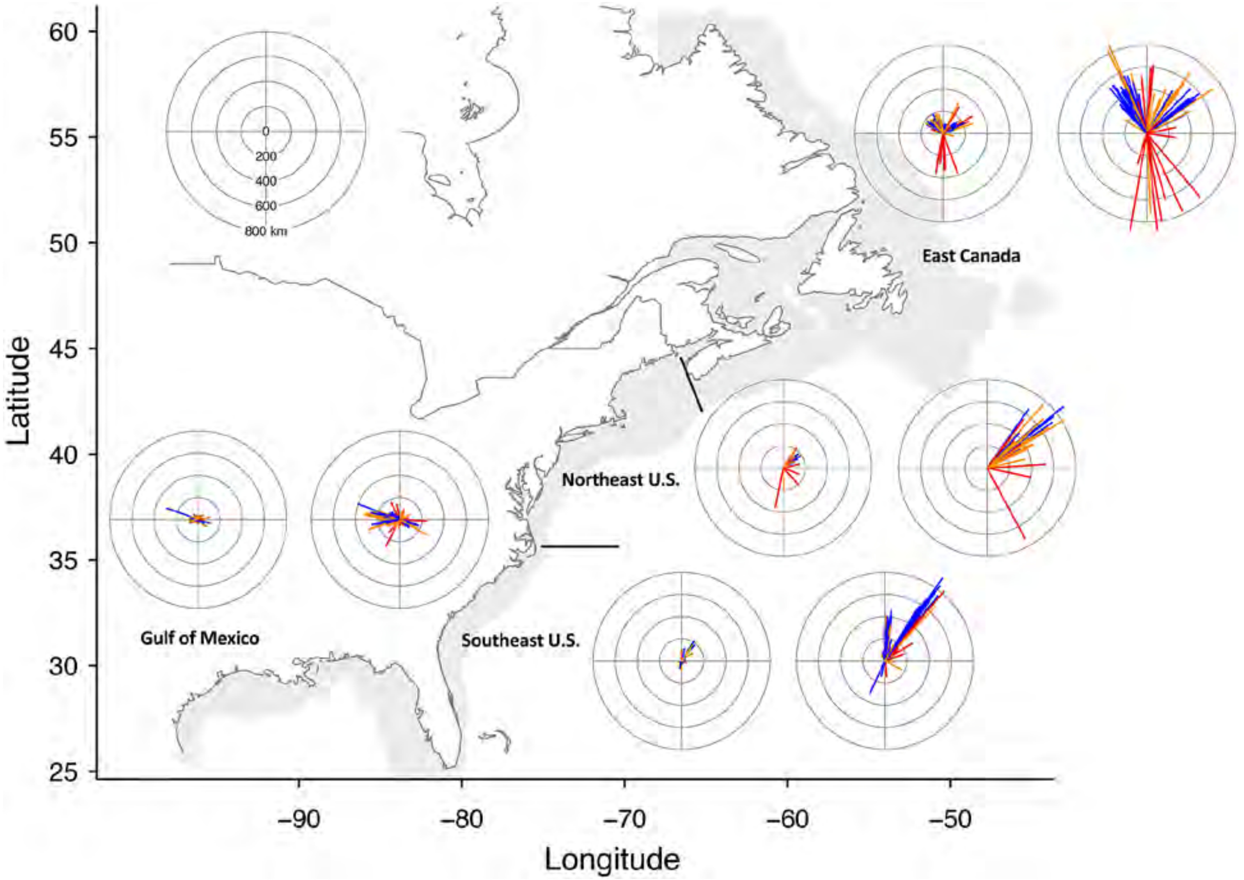
Science. Education. Community.

Species Distribution Models

Cheung et al. (2009)



Morley et al. (2018)



Economic Questions

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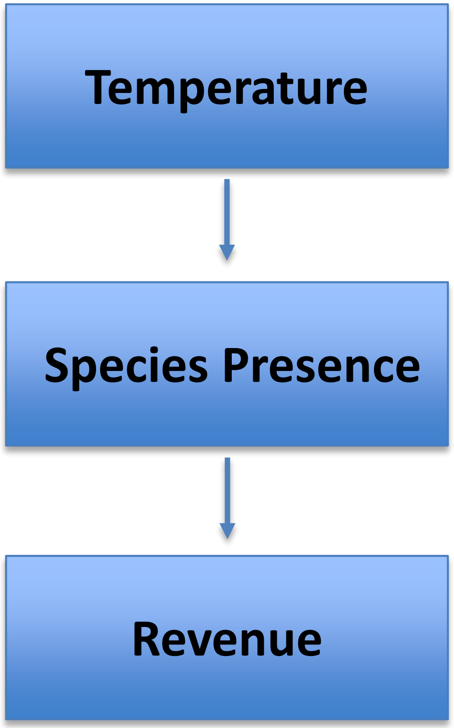
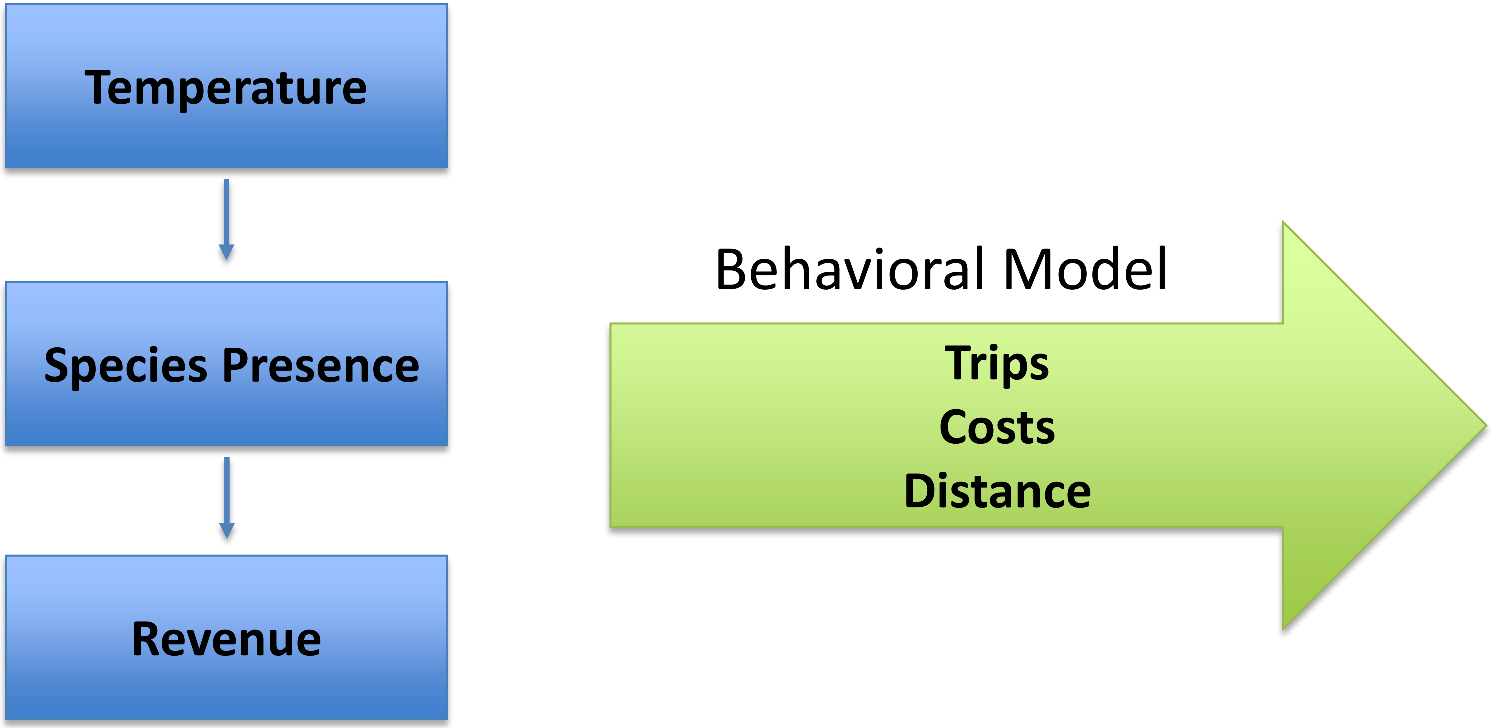
- What are the potential economic costs of climate-driven changes in distribution of fish species?
- To what degree can adaptation offset these costs/add benefits?
- How can fisheries management facilitate adaptation?

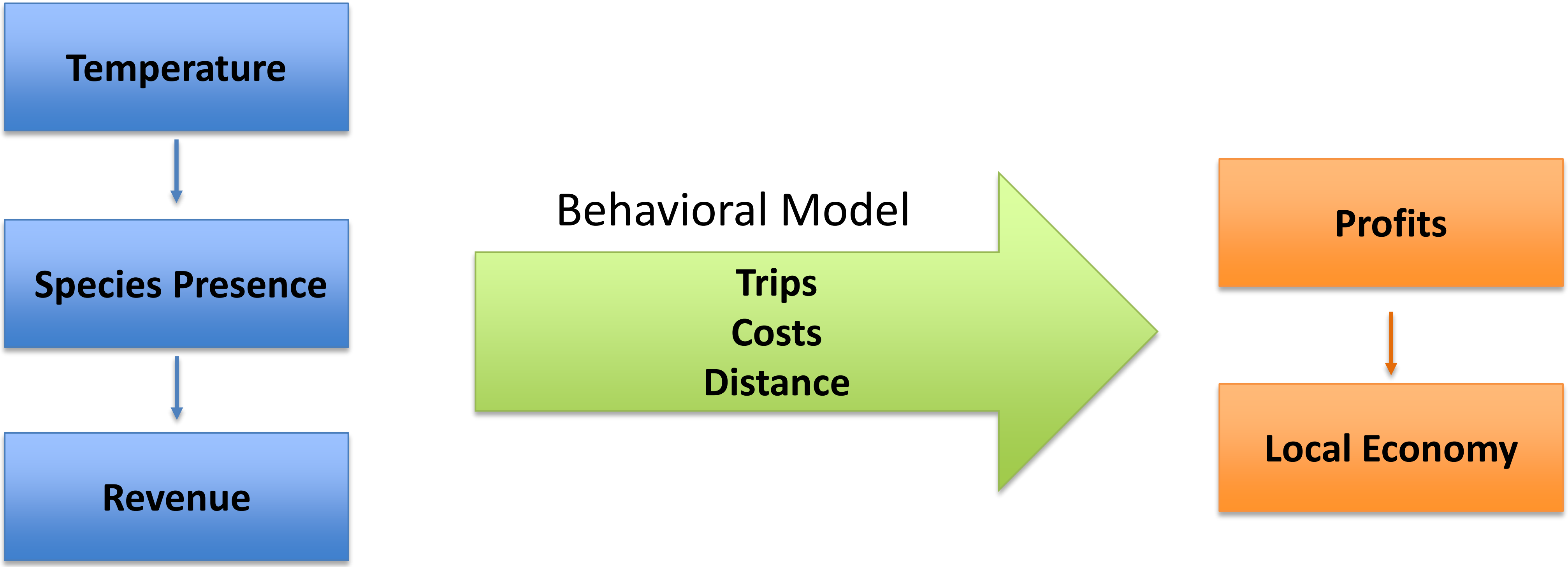
Adding economics to species distribution change



Adding economics to species distribution change



Adding economics to species distribution change



Integrated Modeling Framework: Port-Level Economics

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- Goal: Develop a framework that accounts for adaptation at the port level and estimates changes in industry profits, community impacts
- Local analysis
  - Multiple activities
  - Fishing patterns
  - Resources available
  - Adaptation strategies

GMRI Integrated Modeling Framework

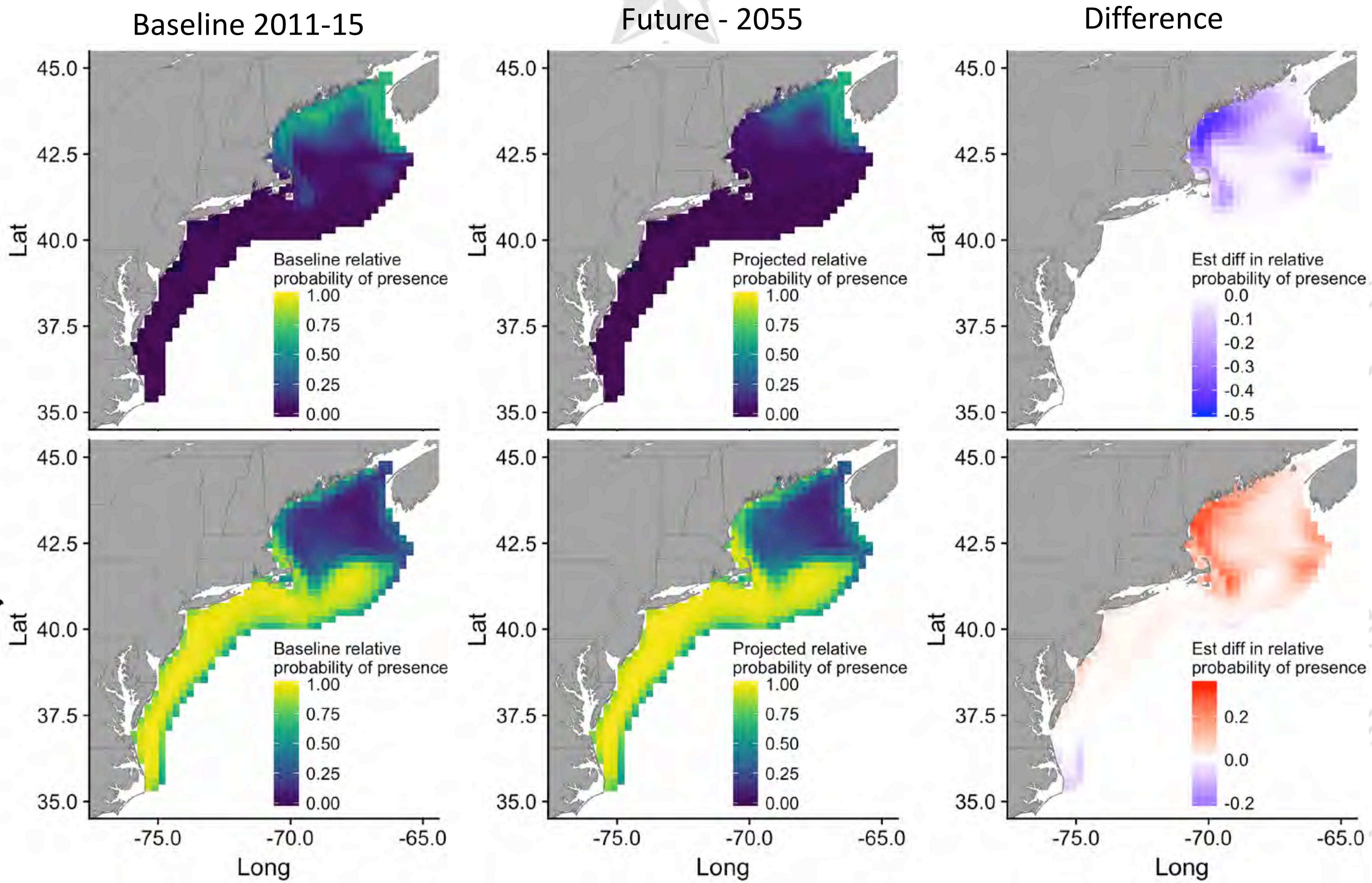
Species Distribution Model: Details

- Northeast U.S. Continental Shelf LME
- CMIP 5 Climate Ensemble RCP 8.5 scenario
- 54 species modeled

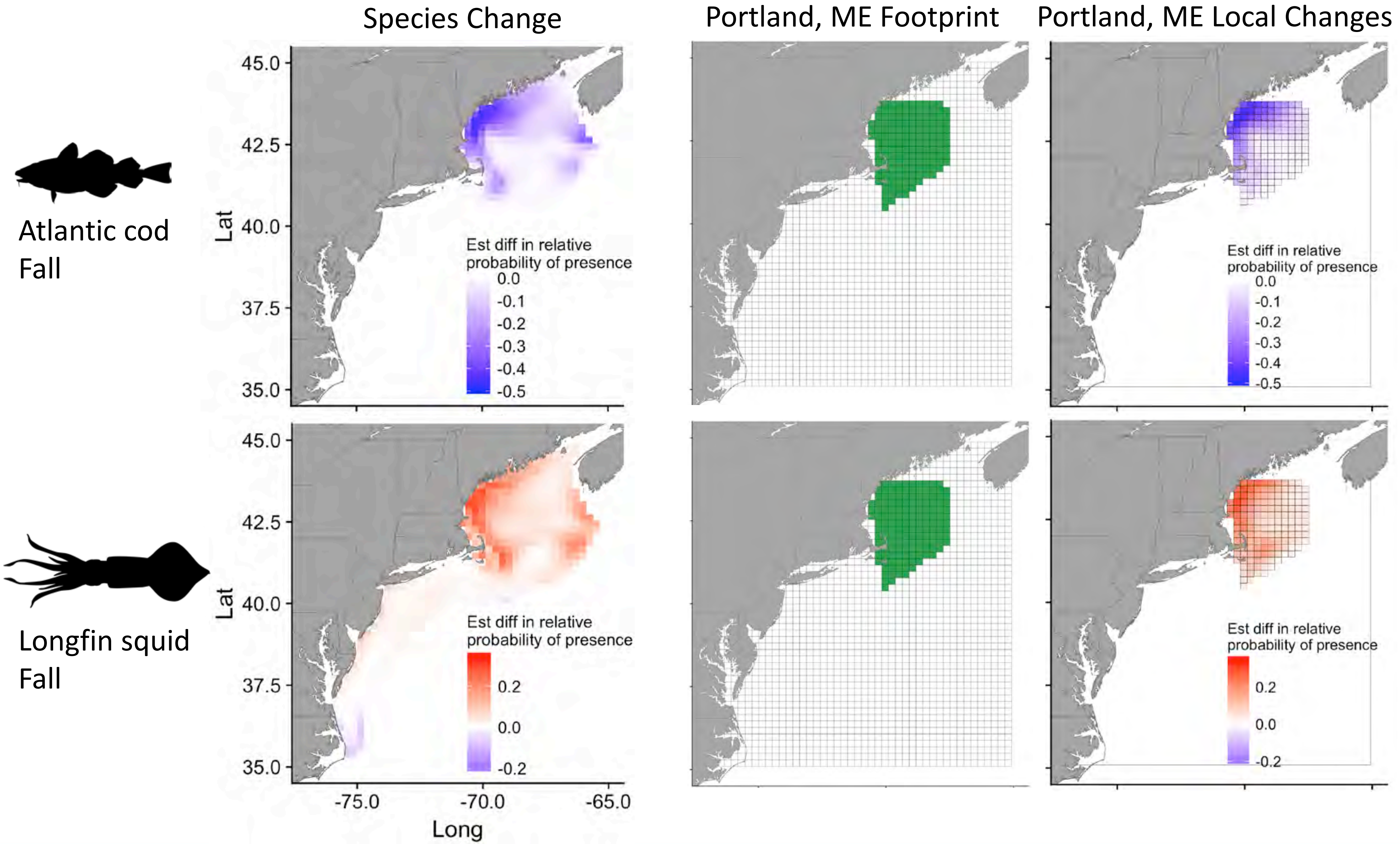
Species distribution projections for selected species

Atlantic cod
Fall

Longfin squid
Fall



Localizing change via fishing footprints



Catch

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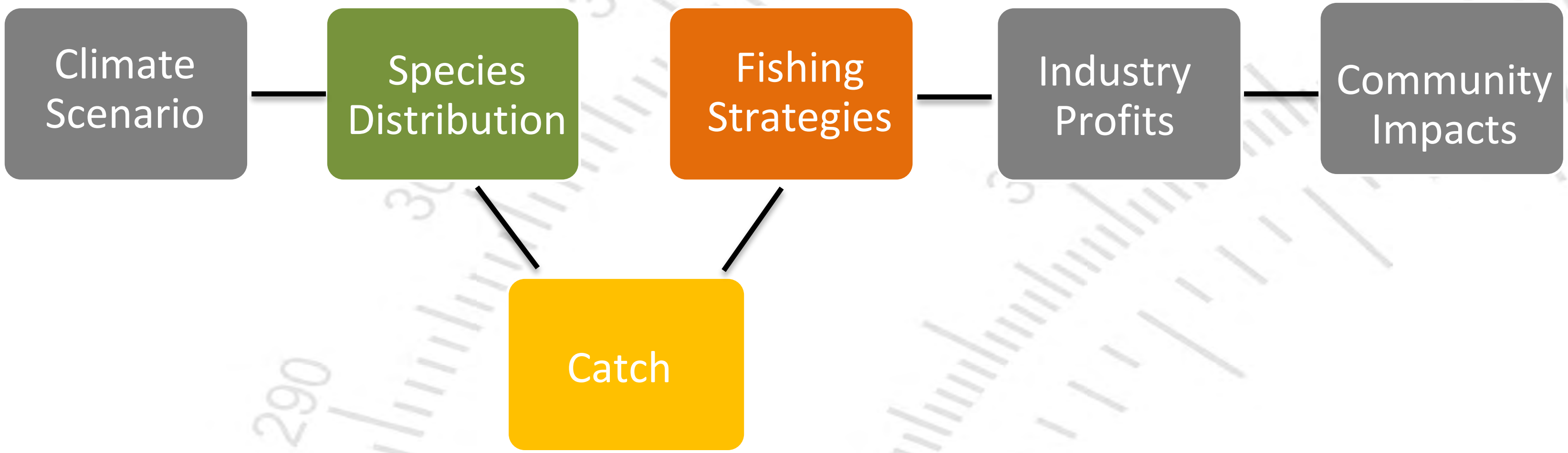
Problem: Economic model cannot directly use probability of presence.

How to relate presence to catch?

What should catch be for emerging species at a given port?



Relating Presence to Catch

One Answer:

$$C_t = (p_t / p_{t-1})^{\alpha} * C_{t-1}$$

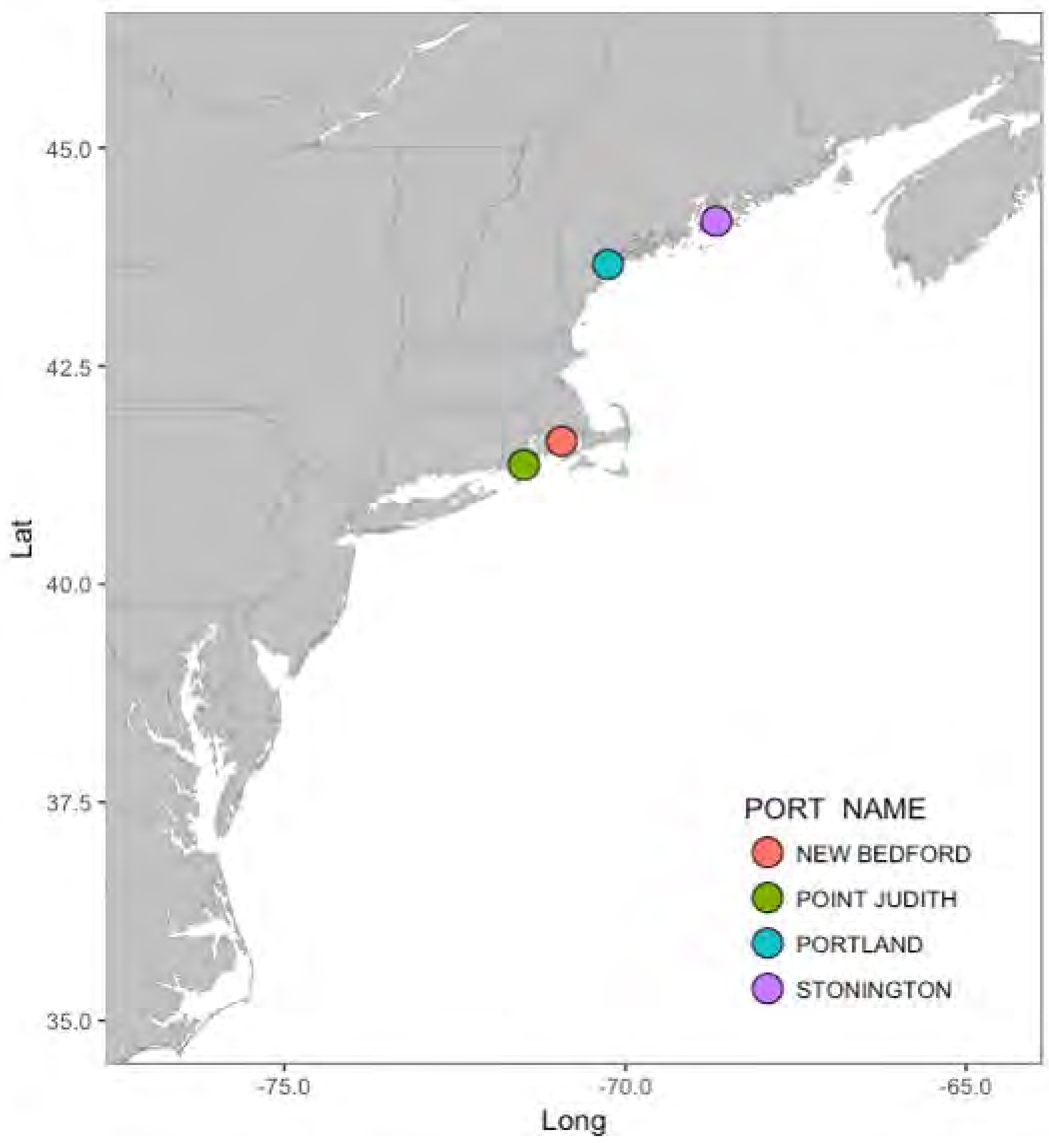
- C_t is Catch per trip
- p_t is probability of presence
- α in (0,2) reflects degree of sensitivity of catch to change in presence
- High alpha → high sensitivity

- If baseline presence or average catch = 0 (not available or not allowed)

$$C^{Port}_{t} = (p^{Port}_{t} / p^{Region}_{t-1})^{\alpha} * C^{Region}_{t-1}$$

Focal Ports

NEW BEDFORD			STONINGTON		
Species	$ M	% Value	Species	$ M	% Value
Sea Scallop	239.7	85%	Lobster	52	98%
POINT JUDITH			**PORTLAND**		
Species	$ M	% Value	Species	$ M	% Value
Loligo Squid	8.4	28%	Lobster	13	45%
Lobster	4.8	16%	Herring	7.5	26%
Sea Scallop	4.6	15%	Pollock	2.2	8%
Summer Flounder	4.2	14%	White Hake	2.1	7%
Scup	2.3	8%	Hagfish	1	4%



Defining Fishing Activities

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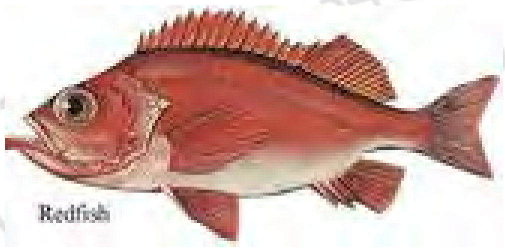
Organization Scheme

Port Gear Type * Species Targeted*

Key Variables

-# Trips
-Landings
-Variable Costs
- Profits



Sample Fishing Activity Matrix: Volume (1,000 lbs) landed

Species

Gear /Fishing Activity	*Cod*	*Hagfish*	*White Hake*	*Lobster*	*Pollock*	*Redfish*	**Totals**
Gillnet	182		398		1,605	74	2,259
Pot/Trap		81		431			512
Totals	182	81	398	431	1,605	74	

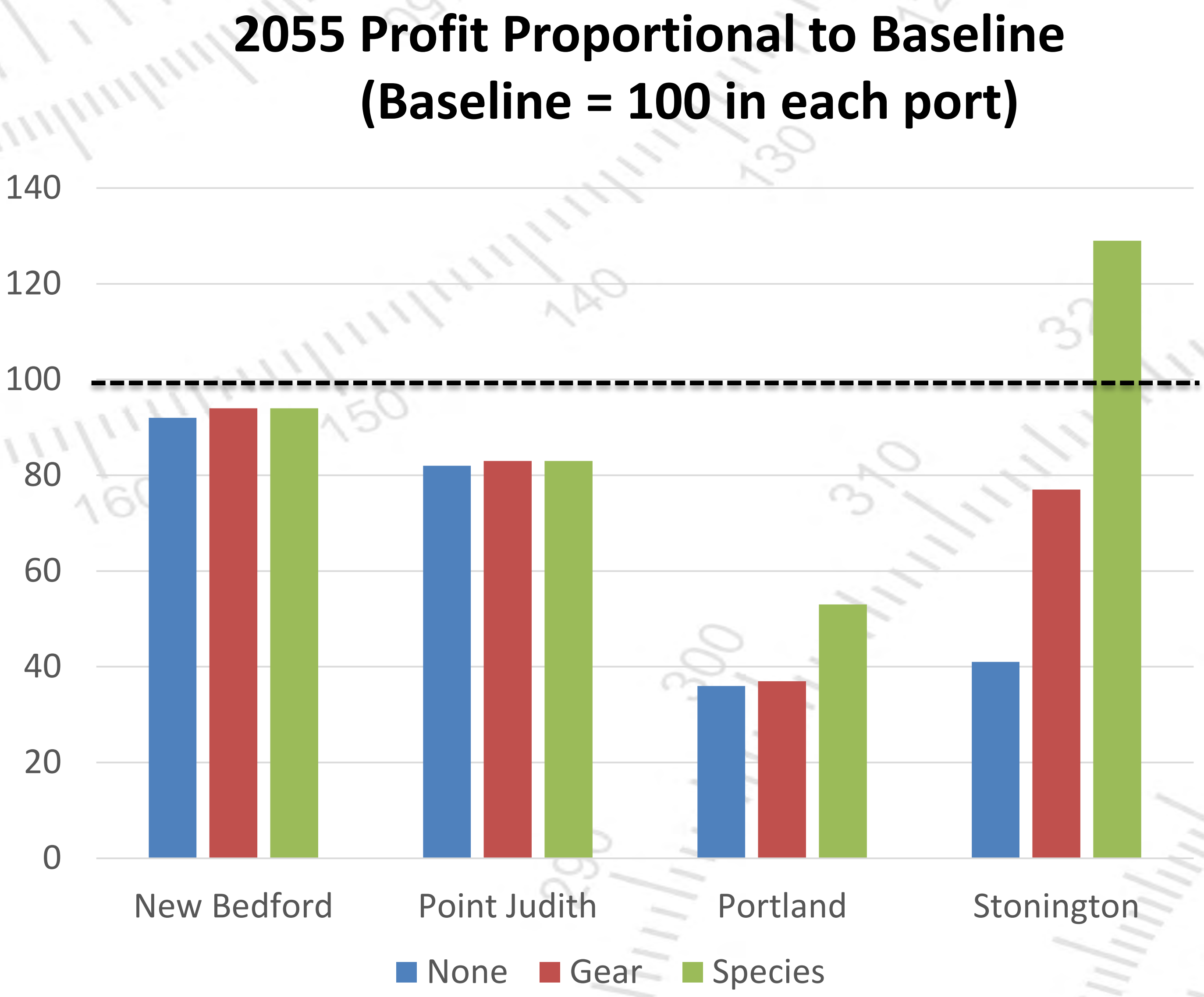
Selected Scenarios

1. Baseline - 2011-2015

2. No Adaptation - Climate impact when no adaptation measures taken

3. Gear Change - Changes in fishing effort by gear type
   - Dredge
   - Gillnet
   - Longline
   - Pot/Trap
   - Purse Seine
   - Trawl
4. Emerging Species - Impact given ability to fish new species
   - Black Sea Bass
   - Squid (Illex & Loligo)
   - Dogfish (Smooth & Spiny)
   - Scup

Results for key ports



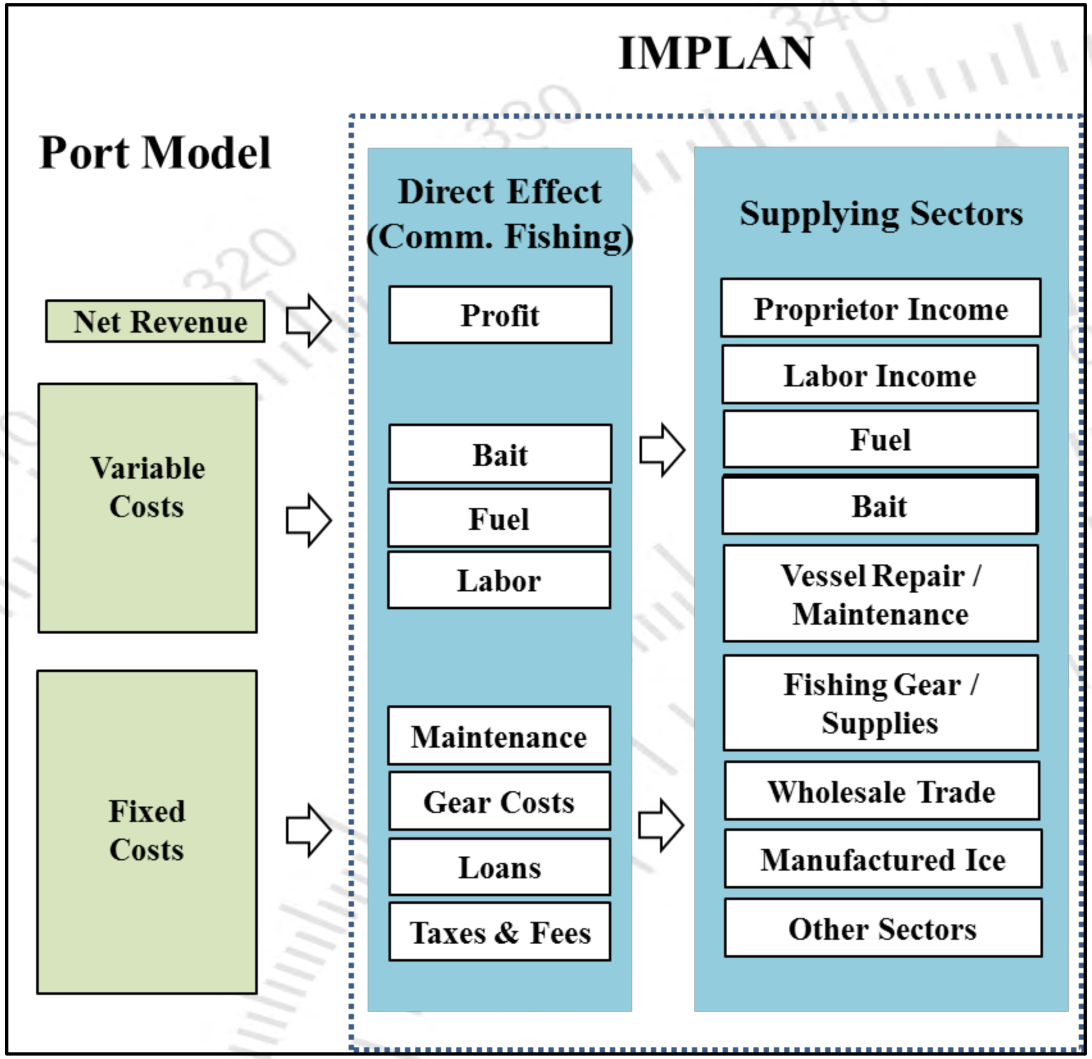
- Relatively minor impacts in New Bedford and Pt. Judith
- Substantial impacts in Portland
- Substantial benefits of adaptation in Stonington

Community Impacts

Scaling economic impacts: fishing sector → community → region

Input-Output model generates county/regional estimates of changes to:

- Employment
- Income
- Supporting Industries
- Tax Revenue



Conclusions & future work

Conclusions:

- Impacts and adaptation benefits depend on baseline mix of activities
- Key species (lobster, scallop) have large influence on specialist ports
- Not allowing adaptation can overstate impacts
- Supporting new fisheries may be key to adaptation
- Profit levels key to understanding industry health, local impacts

Future improvements:

- Allow adjustment of footprints
- Extend to other ports
- Specify fishing activities in greater detail

Thank You

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Kathy Mills' poster
S14-P5

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