

# NORTHEAST CLIMATE INTEGRATED MODELING (NCLIM)

INTEGRATED MODELING TO MEET OCEAN DECISION CHALLENGES

Lisa Kerr



NOAA Eastern Region Climate Services Webinar 4.29.21

# Project Team



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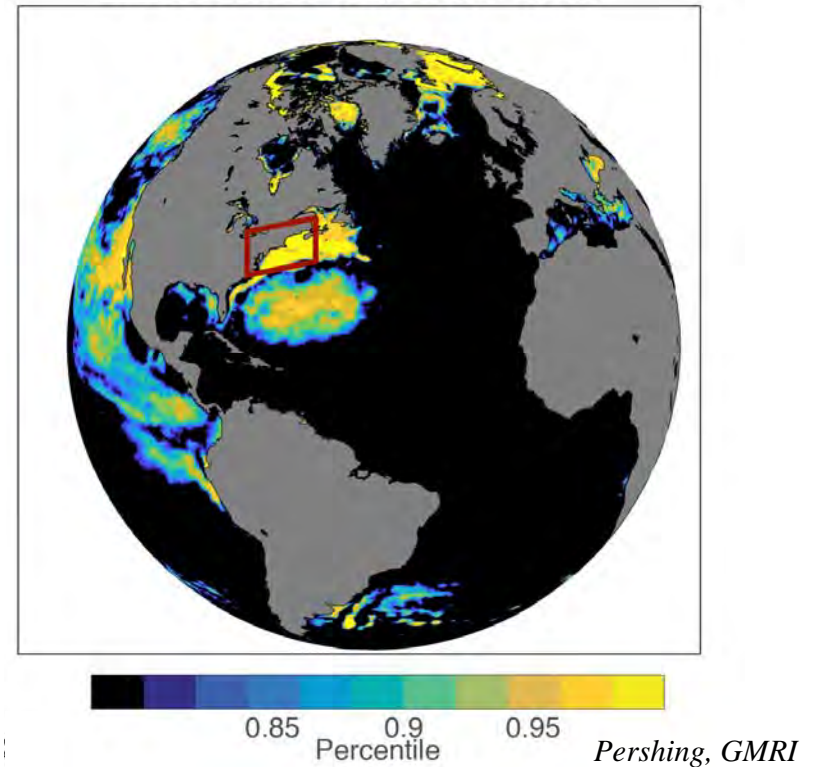
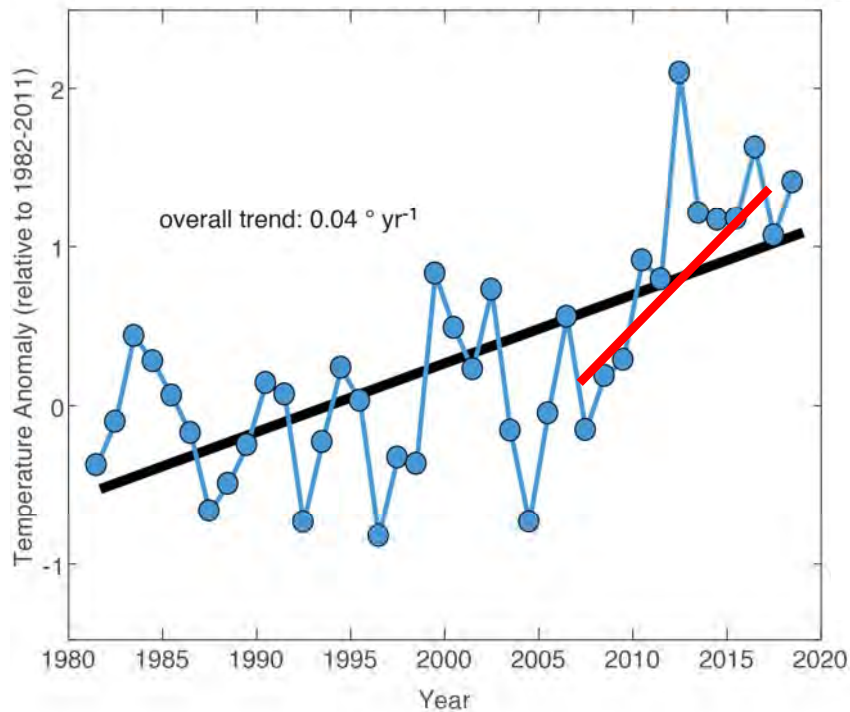


Tim Miller

**Funding:**

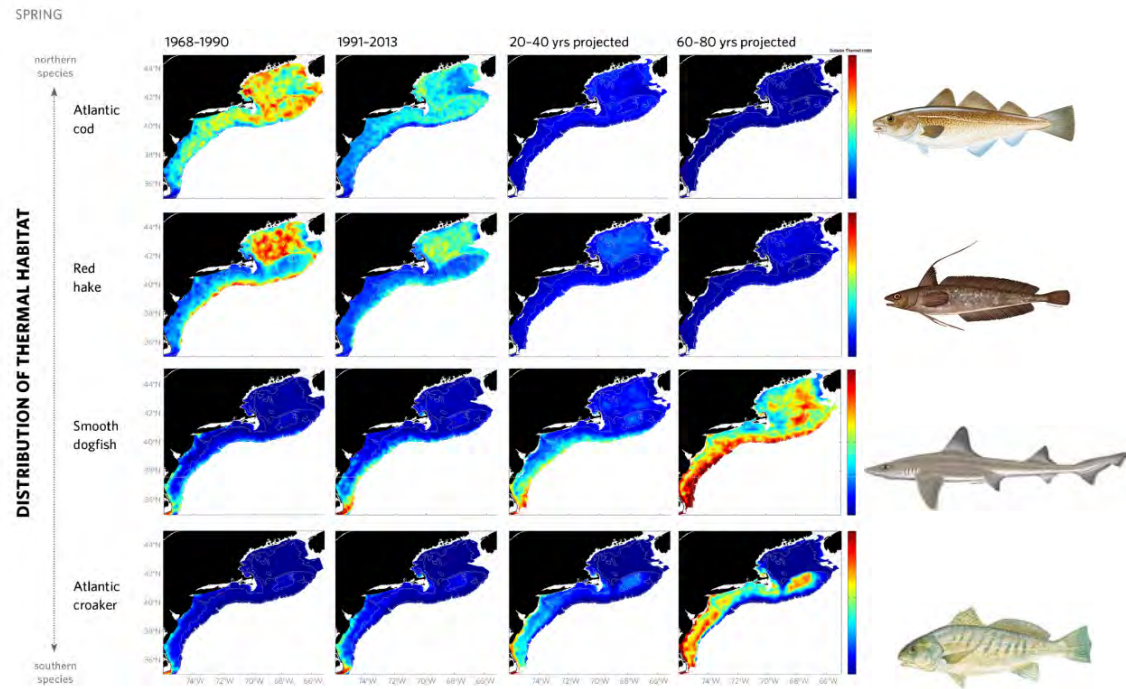
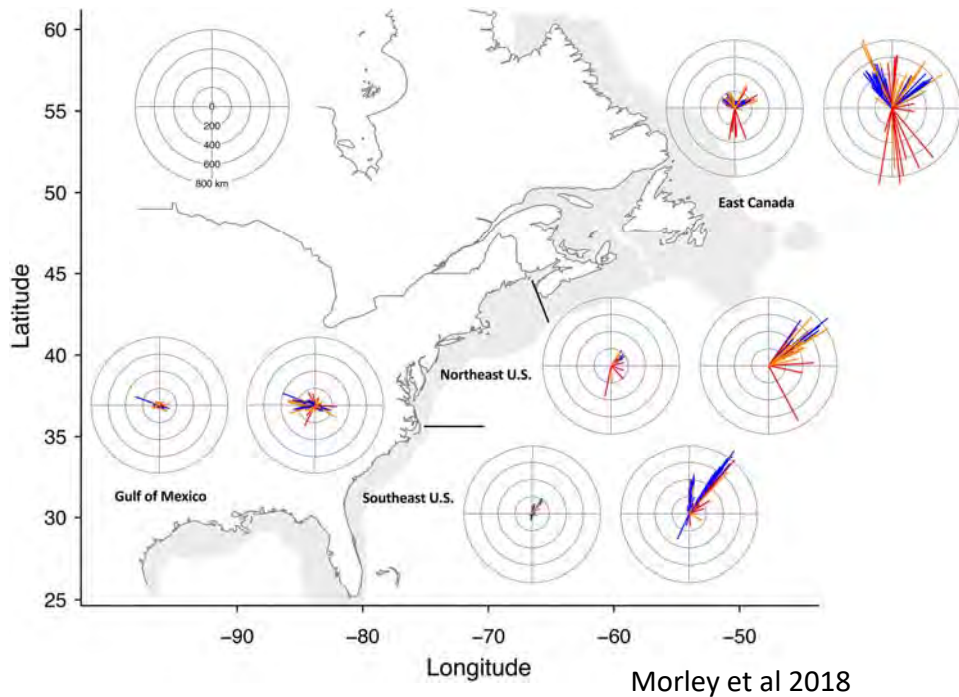


# A Rapidly Changing Gulf of Maine



Over the last 35 years, the Gulf of Maine has warmed at a rate four times greater than the global average with a decadal warming rate that few marine ecosystems have experienced.

# A Changing Gulf of Maine: Fish Distribution



Increasing ocean temperatures results in northward shifts for many species with the potential for major changes in species complex along the Shelf.

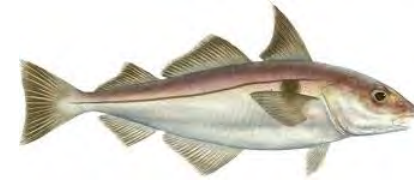
# A Changing Gulf of Maine: Fish Productivity



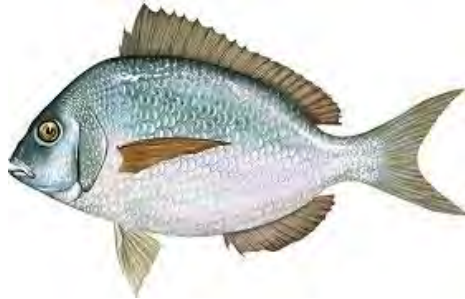
Decreases in cod and lobster productivity have been linked to increases in temperature

# A Changing Gulf of Maine: Species Composition

Some are currently at high abundance



And new species are arriving.



# A Shift to Forward Looking Decision Making

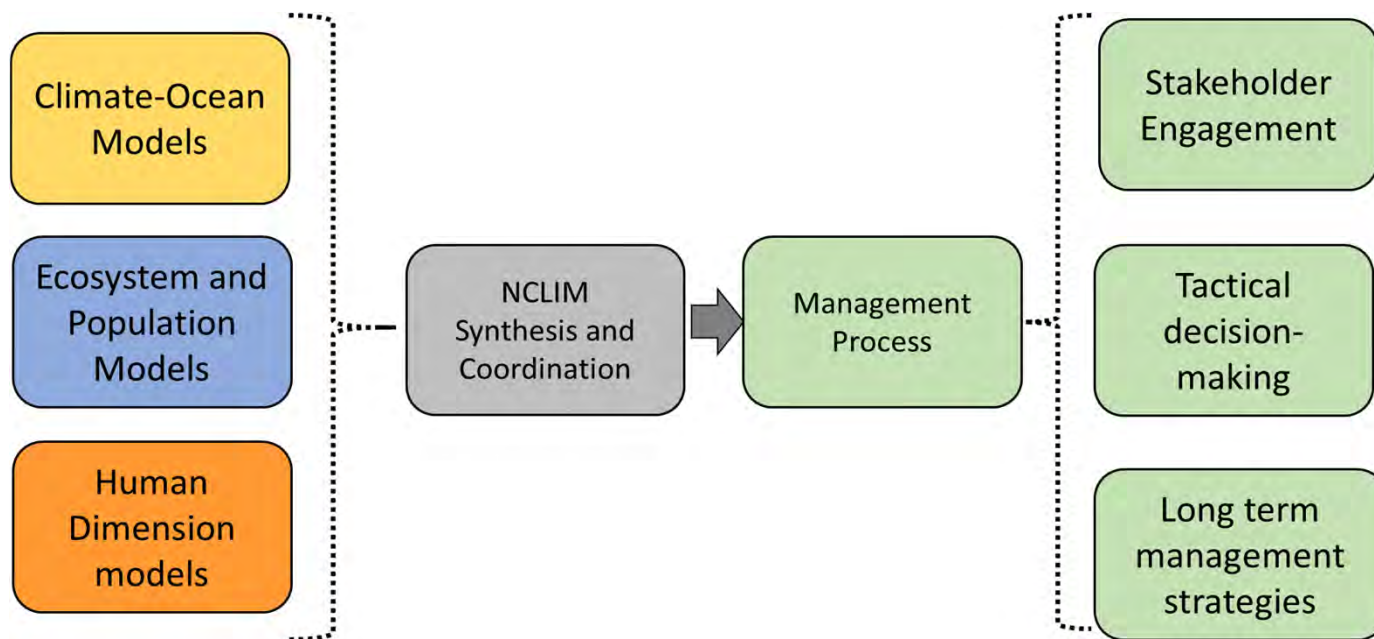
What are the conditions under which future fishing will occur?

How do we sustainably harvest resources as they move outside historic ranges and exhibit directional trends in productivity?

How will fisheries stay profitable when fisheries productivity and distribution change?

# Project Goal

Develop an integrated modeling framework to inform marine resource decision-making under projected climate change in the Northeast U.S. shelf ecosystem.





# Project Objectives

- I. Develop a **regional community of practice** that integrates broad interdisciplinary and regional perspectives on climate-fisheries.
- II. Build a flexible **integrated modeling framework** for climate informed fisheries decision making in the Northeast U.S.
- III. **Apply the framework** and deliver candidate climate-informed assessment models to the research stock assessment processes.

# I. Develop a NCLIM Community of Practice

1. Advance capacity of the broad regional team to develop products that support fisheries and marine resource management, as well as a general understanding of a changing marine ecosystem.
2. Promote mutual learning across disciplines to enable integration and linkages across individual research and modeling efforts.
3. Transfer of climate knowledge, tools, and products within NOAA to the region.

# I. Develop a NCLIM Community of Practice



# I. Develop a NCLIM Community of Practice

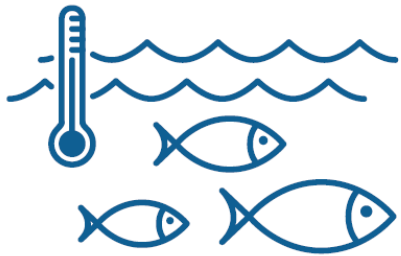
- US Northeast Climate-Fisheries PI Workshop (November 2020)
- US Northeast Climate-Fisheries Seminar Series (last Thursday of the month, noon)
- Survey of Northeast Climate-Fisheries community
- AFS Symposium:  
    “Climate Informed Fisheries Management” (Nov 6-10, 2021)
- Virtual NCLIM meeting: summer/fall 2021



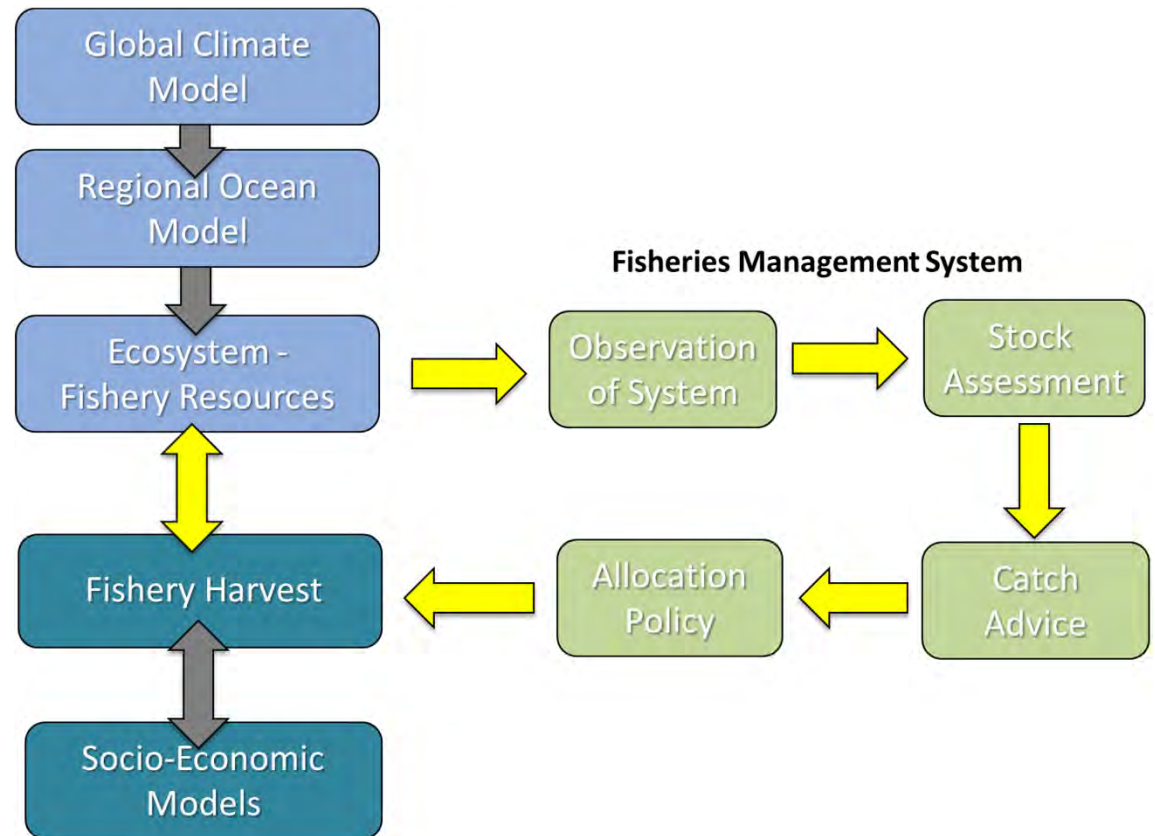
The image shows a promotional graphic for the NOAA Fisheries Webinar Series. It features the NOAA logo and the text "NOAA FISHERIES Webinar Series". Below this, it states "Sponsored by the U.S. Northeast Climate-Fisheries Seminar Series" and provides a Google Meet code: <https://meet.google.com/paw-jhrb-nzr>. The main part of the graphic is a table titled "2021 Webinar Series Schedule (noon - 1pm):".

Date	Speaker	Title	
1/28/21	Vincent Saba (NEFSC)	NOAA's high-resolution global climate model utilization in marine species distribution modeling.	Add seminar
2/25/21	Tom Kentner & Chris Haak (NEFSC)	Use of joint and single species distribution models for the Northeast Regional Habitat Assessment (NRHA).	Add seminar
3/25/21	Zhuomin Chen (WHOI)	Seasonal Prediction of Bottom Temperature on the Northeast U.S. Continental Shelf.	Add seminar
4/29/21	Gavin Fay (SMST)	Integrating responses to environmental drivers of system change within ecosystem-based fishery management procedures.	Add seminar
5/27/21	Jaime Paller (URI OSO)	Circulation changes at the Tail of the Grand Banks cause predictable environmental change on the Northeast US and Canadian Shelf.	Add seminar
6/24/21	Brian Stock & Tim Miller (NEFSC)	Temperature-linked assessments for winter flounder and Gulf of Maine cod.	Add seminar
7/29/21	Alexa Friedson (Rutgers)	Understanding and forecasting species range dynamics in the oceans.	Add seminar
8/26/21	Samantha Siedlecki & Kelly McGary (UConn)	Regional drivers of interannual and spatial variability of OA variables on the NE shelf.	Add seminar
9/30/21	Shannon Meseck (NEFSC)	Ocean acidification effects on Eastern oysters, surfclams, and Atlantic sea scallops: Commonalities and differences?	Add seminar
10/28/21	Mackenzie Mazur & Lisa Kerr (GMRI)	Evaluating the performance of Northeast Groundfish Fisheries Management in a Changing Ocean.	Add seminar
11/18/21	Chris Chantares (NEFSC)	Biological consequences of a changing climate on the pre-recruit life stages of NE US finfish, effects of CO2 and thermal environments.	Add seminar
12/16/21	Andrew Ailyn & Kathy Mills (GMRI)	Shifting species and climate adaptation pathways for Northeast U. S. fishing communities.	Add seminar

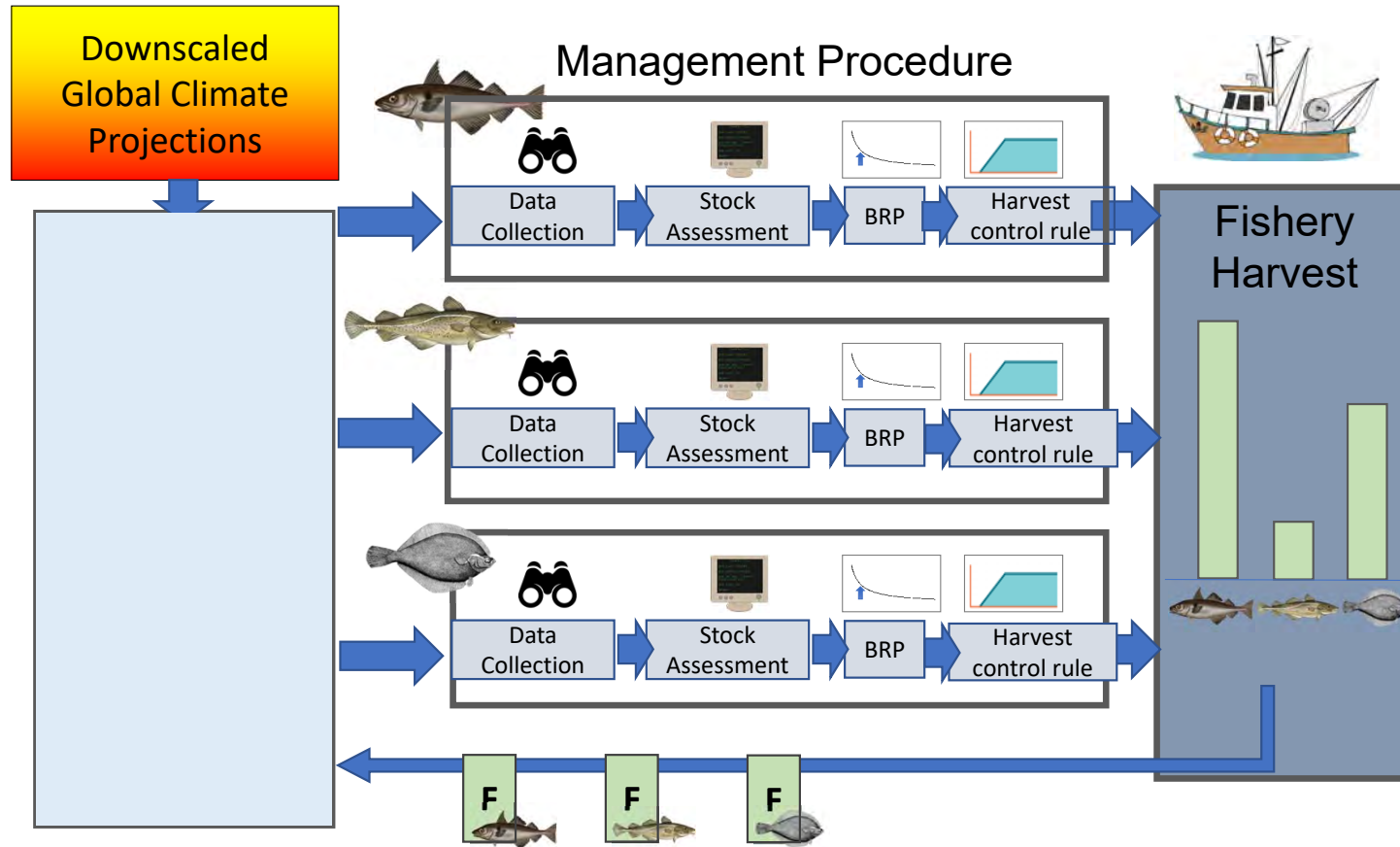
## II. Build an Integrated Modeling Framework



Leveraging existing models  
and expertise



## II. Build an Integrated Modeling Framework

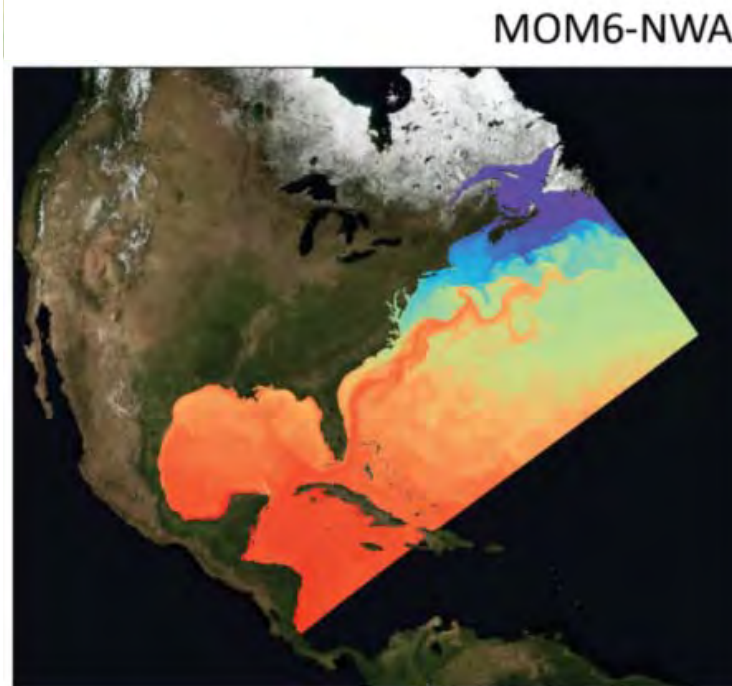


## II. Build an Integrated Modeling Framework

Regional hindcasts and forecasts of ocean conditions in Northeast U.S shelf will inform modeling framework.

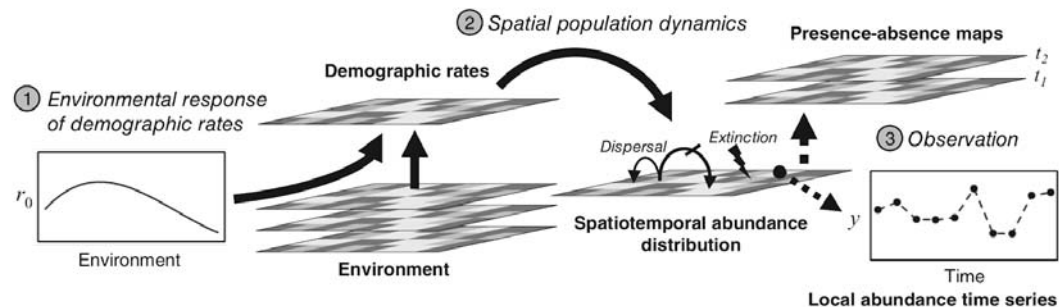
MOM6 will be used to develop a regional hindcast (1980-present).

Long-range projections by forcing MOM6 with output from the CMIP6 global climate projections.

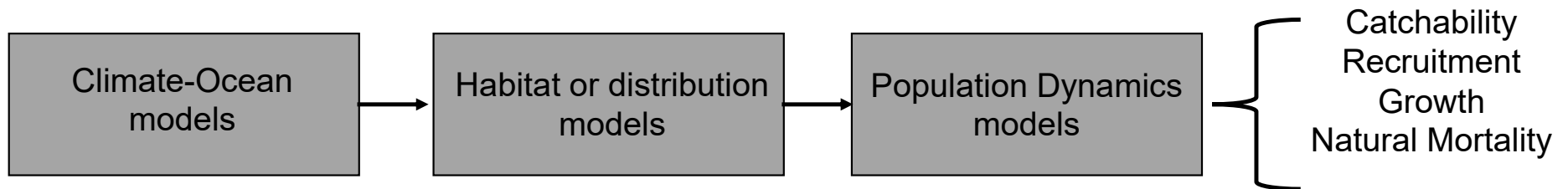


## II. Build an Integrated Modeling Framework

- Develop operating models--basis for testing the performance of alternative assessment and management strategies.
  - *Dynamic range model*: explicit representation of spatial population dynamics of species



- *Coupled distribution-population dynamics model*: implicit representation of climate impacts on spatial population dynamics of species.





# II. Climate-Informed Stock Assessment



**NOAA  
FISHERIES**

Age Structured Assessment Program

The cover of the book "The WHAM: An open-source state-space assessment framework" by Tim Miller and Brian Stock. The cover is blue and white. On the left, there is the NOAA Fisheries logo and the text "NEFSC Woods Hole, MA". The main title "The WHAM:" is written in a large, white, serif font, with "oods", "ole", "ssessment", and "odel" written in a smaller, white, sans-serif font above it. Below the title, it says "An open-source state-space assessment framework" and "Tim Miller and Brian Stock".

Index-based assessment models

The cover of the book "The Stock Synthesis software for stock assessment". The cover features a photograph of a fishing boat at sea. On the left, there is the NOAA Fisheries logo and the text "NOAA FISHERIES NWFS". The main title "The Stock Synthesis software for stock assessment" is written in a large, teal, sans-serif font.

### III. Application of climate-informed assessment models



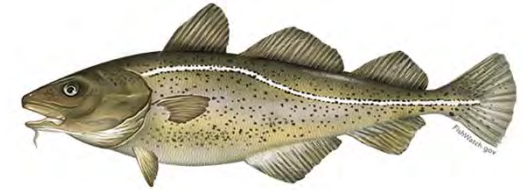
### III. Application of climate-informed assessment models



**Black sea bass (2022): Evidence of climate impacts on distribution and productivity.**

- Current assessment has issues with conflicting indices of abundance (north-south) and retrospective patterns.
- Compare performance of alternative stock assessment models to the status quo assessment.
- Assessment approaches will include incorporating environmental drivers of productivity directly into the assessment and we will explore a variety of mechanisms for dealing with spatial heterogeneity.

# III. Application of climate-informed assessment models



## **Atlantic cod (2023): Evidence of climate impacts on productivity and distribution**

- Current stock assessment (ASAP) has long-standing issue with retrospective bias.
- We will explore assessment models that have the flexibility of accounting for time-varying processes that impact cod productivity with linkage to potential drivers (e.g. temperature).

# Anticipated Outcomes

- Identify and anticipate major ecosystem changes that influence multiple stocks and management decisions.
- Develop framework that supports tactical decision making (e.g., catch advice) and longer-term strategies (e.g., harvest control rules) in Northeast fisheries management.
- Inform decision-making around impacts of shifting species and changes in stock productivity.

