Development of robust management strategies for Northeast groundfish fisheries in a changing climate

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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.
Warming in Northeast Shelf waters is reshaping the ecosystem in ways that impacts key resources and communities.
Several groundfish have declined despite low fishing, whereas others have increased. Evidence suggests differential responses of groundfish to current and future climate change (Hare et al. 2016).
Because of the rapid pace of change in this region, there is a critical need to develop fishery management strategies that are resilient to climate variability and climate change.

Management Strategy Evaluation (MSE) is a process used to simulate the workings of a fisheries system that enables testing different management strategies to see which can achieve desired objectives.
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<td>Habitat health</td>
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Benefits of Management Strategy Evaluation

- Decision-makers consider longer-term trade-offs
- Moves away from ad hoc decision making.
- Moves toward pre-defined harvest strategies to satisfy explicit management objectives.
  
  e.g. long-term sustainability, stability and profitability
- Structured process to engage a range of stakeholders.

MSE provides the basis to:

- Compare strategies given the policy objectives
- Identify which strategies are likely not to work
  
  “if a strategy does not perform adequately in computer simulations, why would you expect it perform adequately in the real world”
- Identify core uncertainties

Project Goal

**Develop** candidate management procedures that **consider** climate-driven changes and **evaluate** whether they result in more adaptive, successful management of groundfish species given forecasted climate change in the Northeast Shelf Large Marine Ecosystem.
Objective 1: Evaluate how principal groundfish species will respond to regional climate change.

Objective 2: Investigate plausible approaches to tailoring fisheries management procedures to the prevailing environmental state.

Objective 3: Quantify the ecological and economic performance of alternative fisheries management procedures in a changing climate.
Operating models of groundfish stocks, with modeled relationships between temperature and life-history processes. Project impacts of future climate change

Cod and haddock-like OMs will be conditioned on general exploitation patterns and stock development from Georges Bank and Gulf of Maine stocks.
Temperature and life history processes

- **Recruitment-temperature**
  - Guan et al. 2017
  - Pershing et al. 2015
  - Brodziak 2009
  - Fogarty et al. 2008
  - Drinkwater et al. 2005

- **Growth-Temperature**
  - Millar and Myers 1990
  - Campana et al. 1995
  - Fogarty et al. 2008
  - Gaichas et al. 2017

[Diagram showing the relationship between sea surface temperature and recruitment.]

Brodziak (2009)

[Diagram showing the relationship between bottom temperature and mean growth at 65 cm.]

Shackell et al. (1997)
Fisheries Management Procedures

Mortality

Growth

Recruitment

Stock Assessment Model

Simulated data

Biological Reference Points

Harvest Control Rule

Evaluate performance of climate-responsive or climate-informed:

- stock assessment methods
- biological reference points
- harvest control rules
Quantify the performance of alternative fisheries management procedures in a changing climate

• Ecological and economic metrics of performance
• Evaluate tradeoffs

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Anticipated Outcomes

• Application of MSE to address climate effects on key species in a mixed-stock fishery
• Model differential response of groundfish to climate change.
• Test climate responsive and informed management strategies to understand management performance.
• Provide insight on economic and ecological risks & returns of the alternative fisheries management strategies.
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