



**NOAA
FISHERIES**

Literature Review of Management Approaches in a Changing Climate

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Need

Climate Change is a long-term change in part of the land-atmosphere-ocean system

Already observing impacts of climate change on variety fish stocks

Expected Changes:

- Changes in stock ***productivity***
- Changes in ***distribution***
- Changes in species ***interactions***
- Changes in species ***habitats***



Question and Goal

Question:

Fish stocks are being impacted by climate change. What are the options for fisheries management?

Goal:

Review the literature and compile approaches for creating resilient fisheries in a changing climate



Disclaimer

The ideas presented here are from the literature and do not represent the views of NMFS

NMFS does not necessarily endorse the ideas and in some cases, NMFS may not have the authority to implement them



Outline of Literature Review

1. Reactive Management (Adjust Management After Changes Occur)
2. Proactive Management (Manage to Increase ***Resilience***)
 - a. *Resilience* of Individual Stocks or Species
 - b. Ecosystem *Resilience*
 - c. *Resilience* of Fishing Businesses
3. Underlying Practices that Could Improve Management

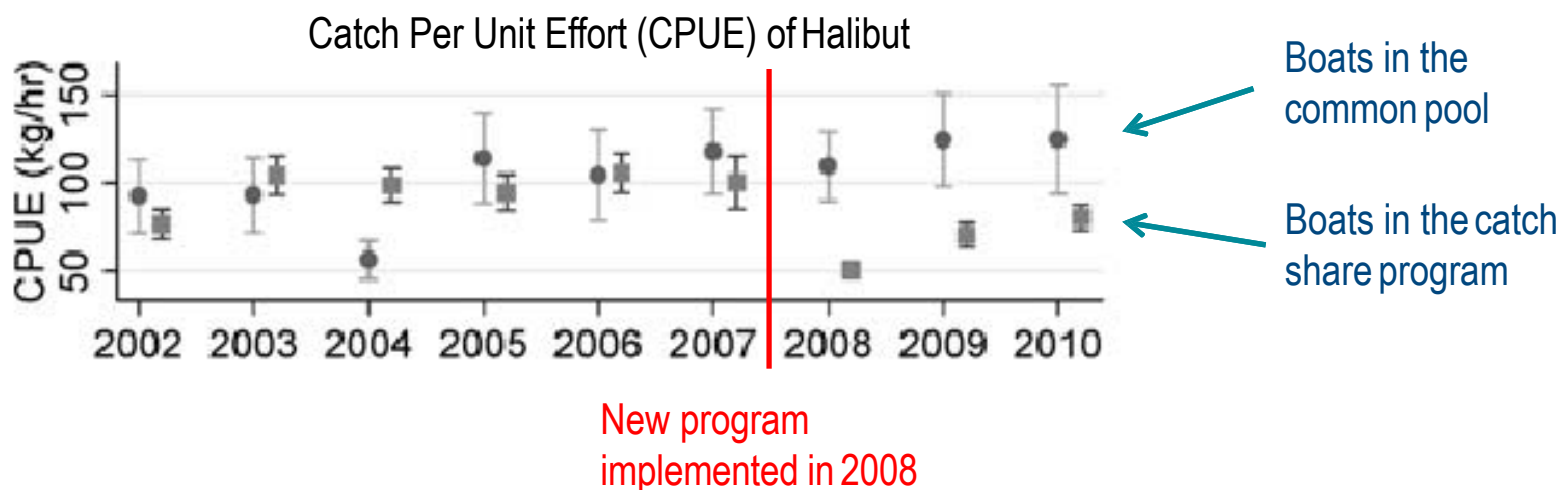
Approach 1– Reactive Management (Adapt Management to Account for Observed Changes)

- Creating flexible, nimble management systems-
- Adjusting reference points after changes in species productivity or stock structure have occurred-
- Adjusting fisheries allocations after species abundances or distributions have changed-
- **Adjusting fishing practices or gears as fish community composition changes-**



Example 1- Adjusting Fishing Practices as Community Composition Changes:

Fishermen changed location, behavior, and timing of fishing to reduce the catch of halibut, a limiting species



Abbott et al. 2015. Land Economics

Approach 2a-- Managing to Increase Resilience of Stocks/Species



- Incorporating environmental parameters into stock assessments and management measures
- Managing for uncertainty- scenario planning
- Protecting age structure and old females
- Decreasing existing stressors
- Enhancing or translocating stocks
- ***Managing to promote adaptive capacity***

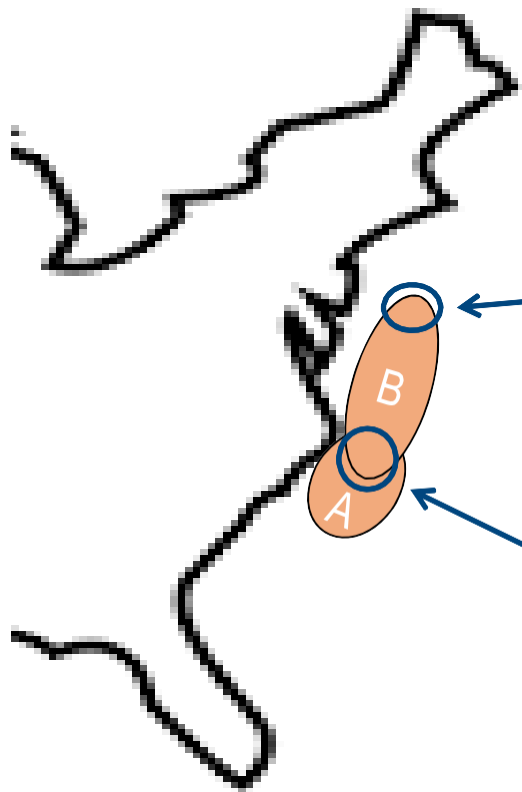
Example 2a- Managing to Promote Adaptive Capacity

- “Life history variants may be the raw material of population recovery and they need to be preserved” (Waldman et al. 2016)
- Management decisions can impact:
 - genetic diversity
 - diversity in life histories/habitat use



Example 2a- Managing to Promote Adaptive Capacity

What are the impacts of distribution shifts on genetic diversity?



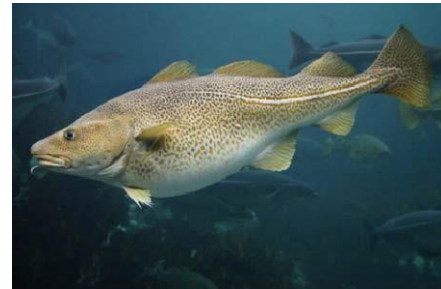
The leading edge often has lower diversity, but it can contain the alleles best adapted to the new conditions– these animals are the “source for most of the surviving lineages”

The rear edge often has high genetic diversity as it contains historical alleles

Source: Pauls et al. 2013

Approach 2b-- Managing to Increase Resilience of Ecosystem

- Protecting Key Habitats and Species-
- ***Designing appropriate marine reserves-***
- Applying Ecosystem Models to Better Understand Species' Responses and Create Robust Management-



Example 2b- Designing Appropriate Marine Reserves

The literature suggests three options for creating marine reserves that are effective even through a changing climate

- 1) Locate reserves to include the habitat/species we want to protect in addition to the areas where we expect them to move (Hobday 2011)
- 2) Periodically reexamine and modify reserves to ensure they are maintaining their goals
- 3) Create reserves to be dynamic, where boundaries are tied to environmental conditions (Hobday et al. 2010; Cambell 2013)

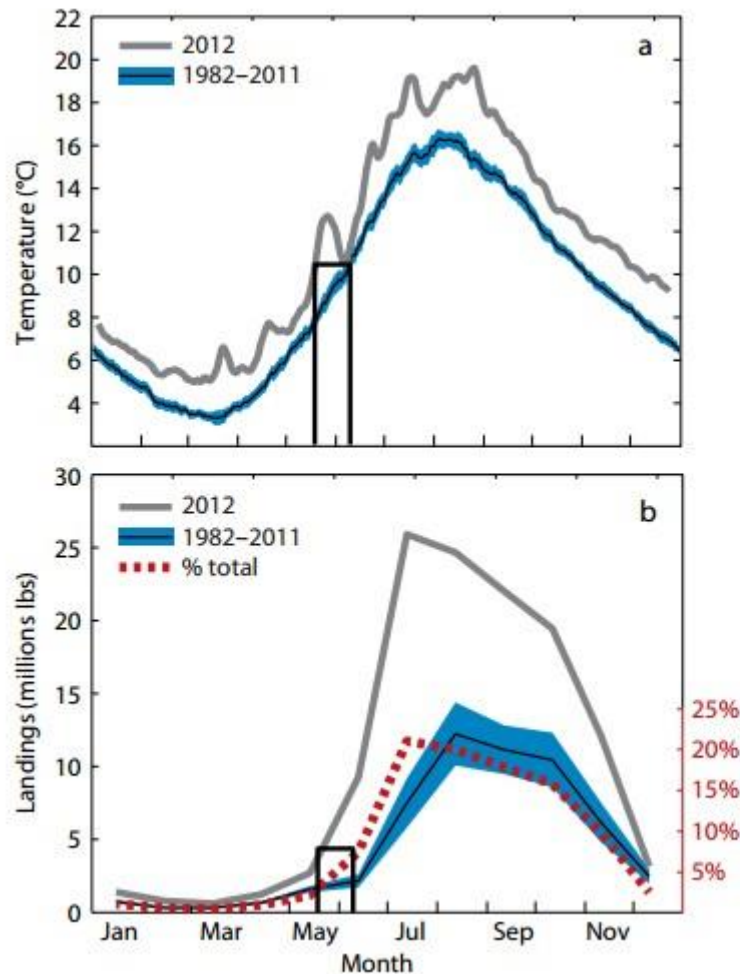


Approach 2c-- Managing to Increase Resilience of Fishing Businesses/Communities

- Providing insurance for fishermen to cover years with poor catch
- Expanding flexibility in fisheries permitting
- ***Improving flexibility in the supply chain***



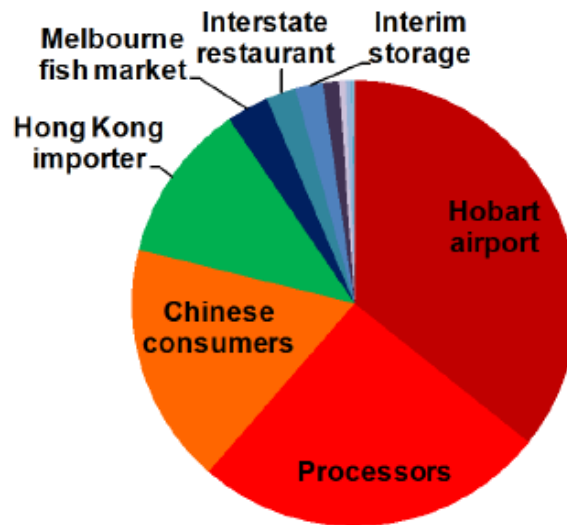
Example 2c- Improving Flexibility in the Supply Chain



Maine lobstermen reeling from low prices, seeking cooperation from dealers

Source Mills et al. 2013; Presentation by Pershing 2013

Example 2c- Improving Flexibility in the Supply Chain



In the Australian southern rock lobster fishery, researchers created a “supply chain index” to identify the critical elements of a supply chain that impact its resilience both today and to changing climate conditions (Plagyani et al. 2014)

Approach 3-- Underlying Practices that Could Improve Management

- Updating and Clarifying Management Goals
- Monitoring for Climate Change
- Using Regional Planning to Address Local Needs



Literature Review Conclusions

- Management will need to be both proactive and reactive to effectively manage fisheries through a changing climate
- Management actions that seek to increase flexibility are needed
- There are actions managers can take to increase resilience of species, ecosystems, and fishing businesses
- The approaches provided here are not comprehensive, and there is not one “right” answer



Questions?

Full NMFS Tech Memo available:

http://www.nmfs.noaa.gov/sfa/publications/technical-memos/nmfs_osf_tm6.pdf

