



**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*)

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  - a. Resilience of Individual Stocks or Species
  - b. Ecosystem Resilience
  - c. Resilience of Fishing Businesses

# 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)

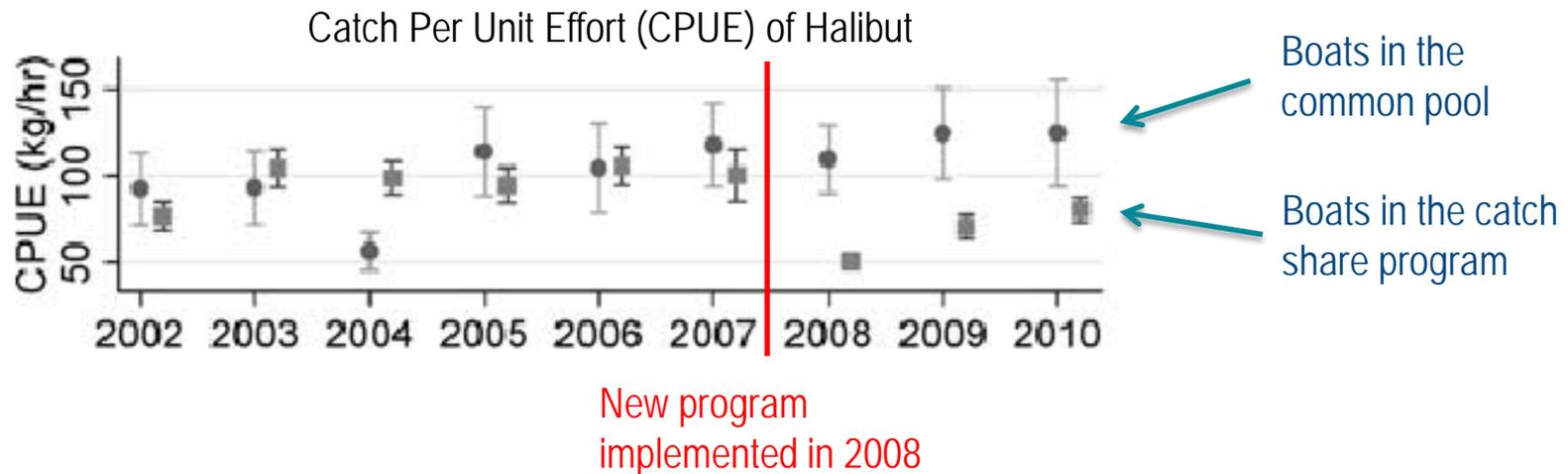
- Adjust reference points to changes in species productivity
- Adjust allocations to new species distributions
- *Adjust practices or gears as fish community composition changes*
- Create flexible, nimble management systems



# Example 1- Adjust Fishing Practices as Community Composition Changes:



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



Abbott et al. 2015. Land Economics

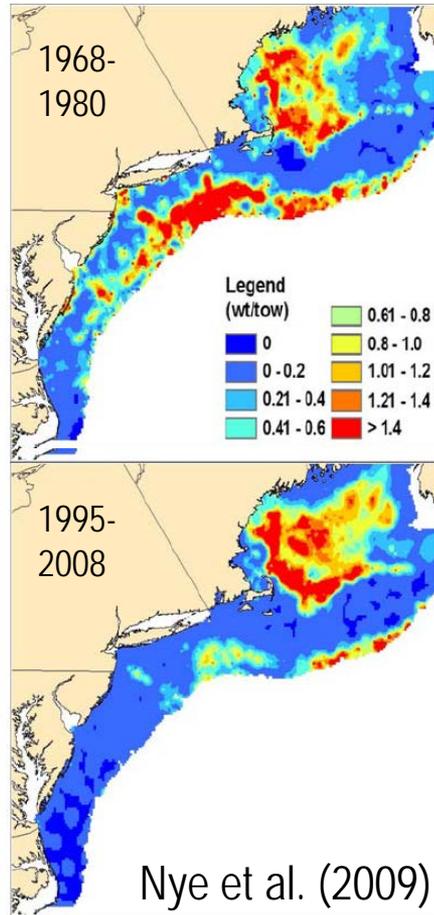
# Approach 2a-- Manage to Increase Resilience of Stocks/Species



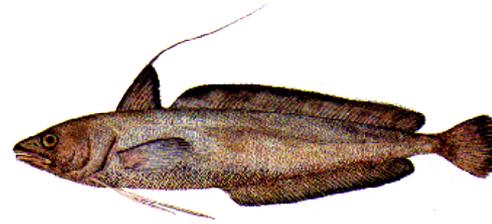
- Incorporate environmental parameters into stock assessments
- Manage for uncertainty- scenario planning
- Protect age structure and old females
- Decrease existing stressors
- Enhance or translocating stocks
- *Manage to promote adaptive capacity*

# Example 2a- Manage to Promote Adaptive Capacity

Distributional shift of Red Hake

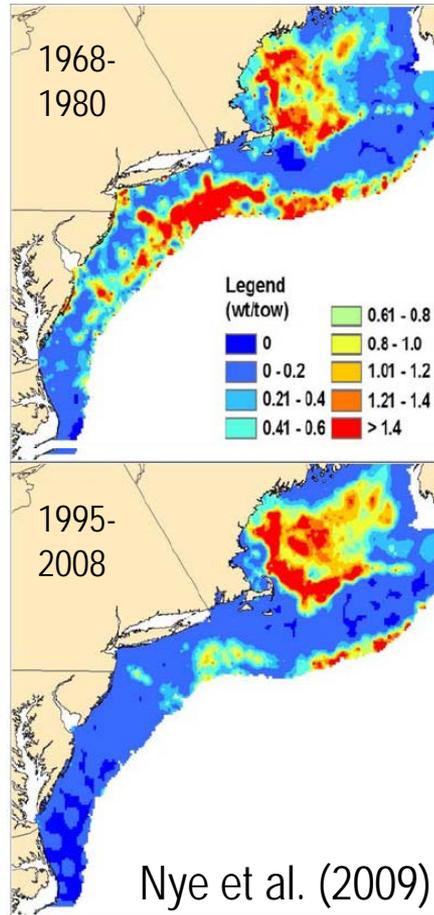


# Example 2a- Manage to Promote Adaptive Capacity

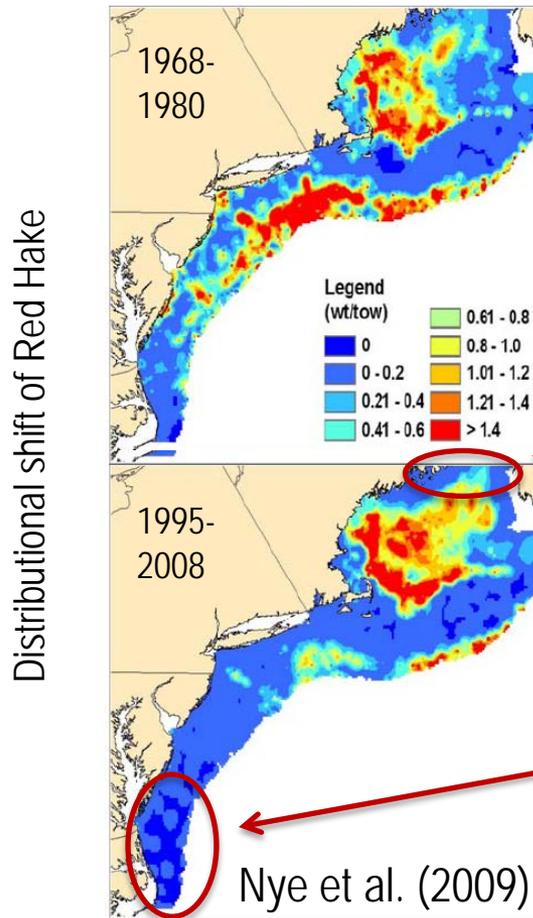
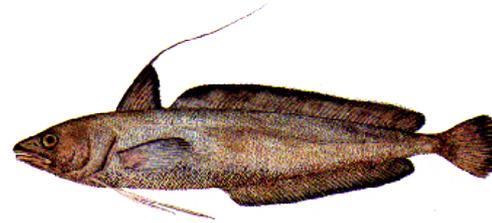


What are the impacts on genetic diversity?

Distributional shift of Red Hake



# Example 2a- Manage to Promote Adaptive Capacity



What are the impacts on genetic diversity?

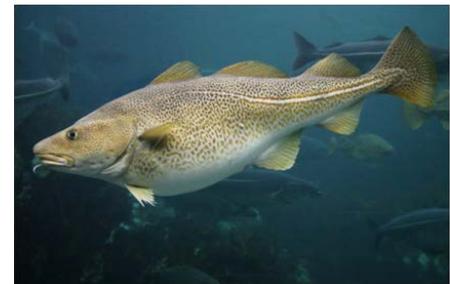
*The leading edge often has lower diversity, but it can contain the alleles best adapted to the new conditions— these animals are the “source for most of the surviving lineages”*

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

Source: Pauls et al. 2013

# Lit Review Approach 2b-- Manage to Increase Resilience of Ecosystem

- *Design appropriate marine reserves*
- Modify gears to increase habitat health
- Recover or enhance degraded habitats
- Protect key functional groups
- Increase use of Ecosystem Based Fisheries Management (EBFM)



# Example- Design 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 remain centered on core areas of stock distribution (Campbell 2013) and are maintaining their goals
- 3) Create reserves to be dynamic, where boundaries are tied to environmental conditions (Hobday et al. 2010; Cambell 2013)

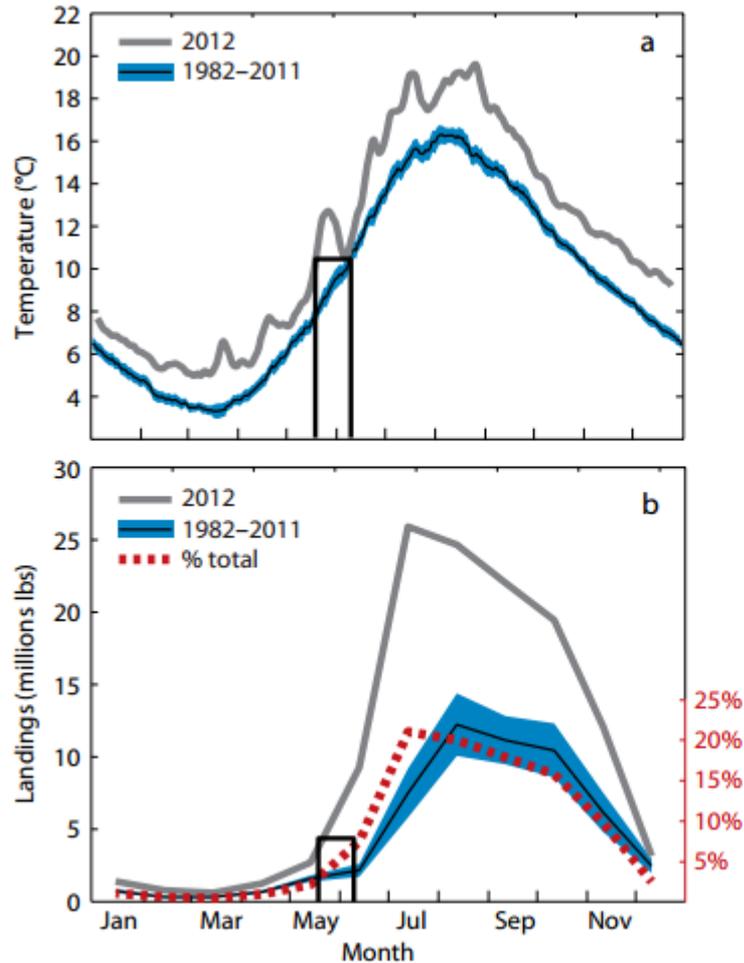


# Lit Review Approach 2c-- Manage to Increase Resilience of Fishing Businesses/Communities

- Expand flexibility in fisheries permitting
- *Improve flexibility in the supply chain*
- Provide insurance for fishermen to cover years with poor catch
- Consider community fishing associations



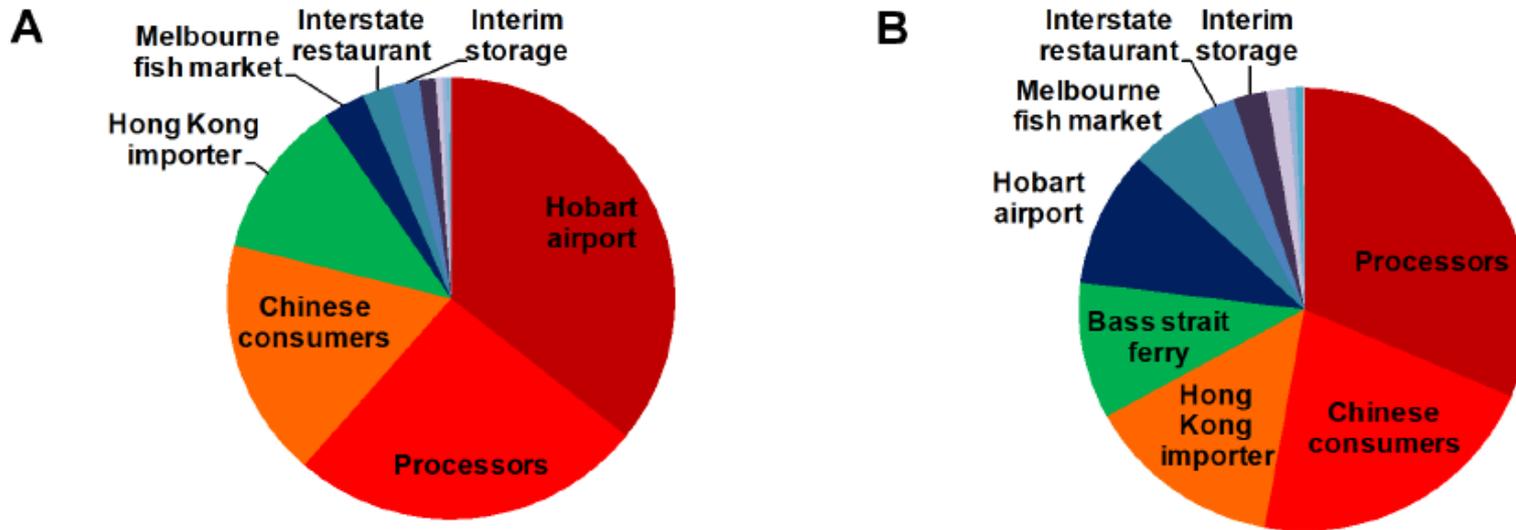
# Example- Flexibility in the Supply Chain



**Maine lobstermen reeling from low prices, seeking cooperation from dealers**

Source Mills et al. 2013; Presentation by Pershing 2013

# Example- 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)

# Literature Review Approach 3-- Underlying Practices that Could Improve Management

- Update and Clarify Management Goals
- Apply Ecosystem Models to Predict Possible Changes
- Monitor for Climate Change
- Use Regional Planning to Address Local Needs



# Literature Review Conclusions

- Management can either be reactive or proactive
- 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
- Suitable approaches will differ depending on local conditions
- Management actions that seek to increase flexibility are recommended

