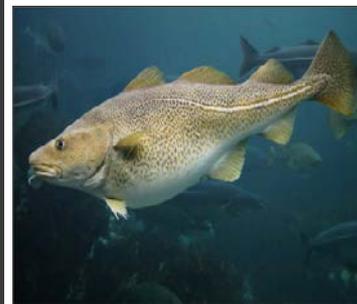


# Getting to Climate Savvy Fisheries Management:

How can we rapidly advance the  
delivery and use of tools and  
information?

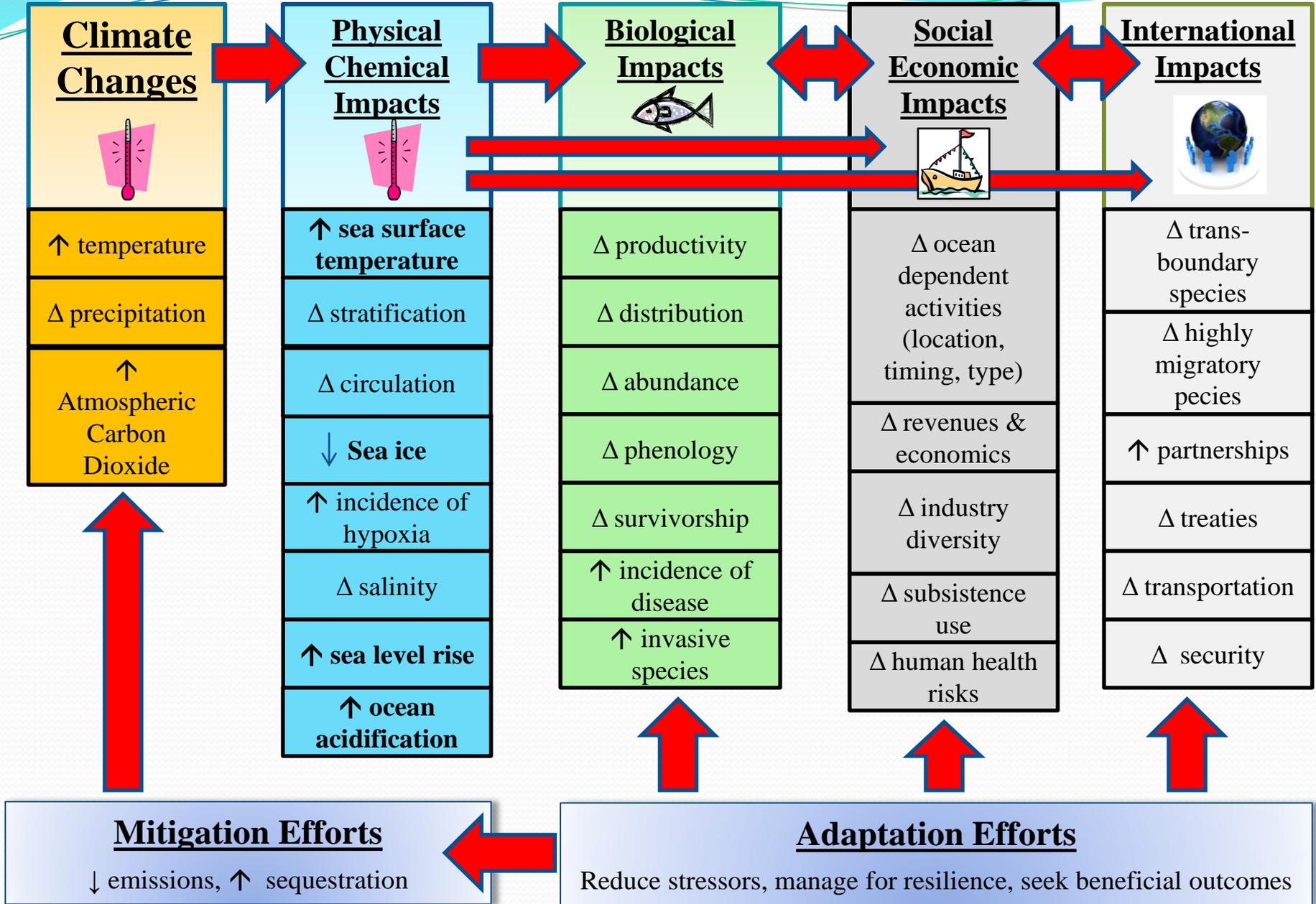


# Impacts and Risks In a Changing Climate

- **Climate change is already impacting marine ecosystems** and the communities & economies that depend on them.
- **These impacts are expected to increase.**
- **There is much at risk** domestically and internationally (food, jobs, revenue, human health, security, heritage etc).
  - Food: 1.5 billion people (world-wide)
  - Fisheries Jobs: 43.5 million (world-wide), 1.3 million (US)
  - Fisheries economies: \$200 B in sales/income impacts (US)
  - Coastal economies: 60 % GDP (US)
  - International relations, transportation and security issues

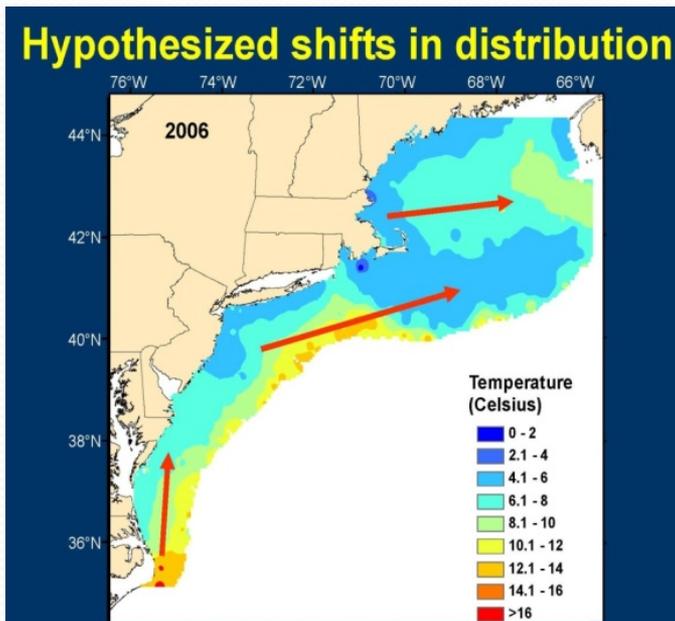
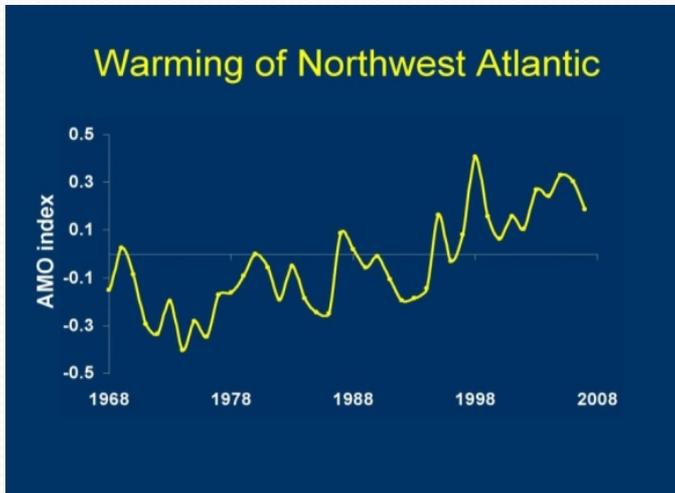


# Impacts of Climate Change on Marine Ecosystems



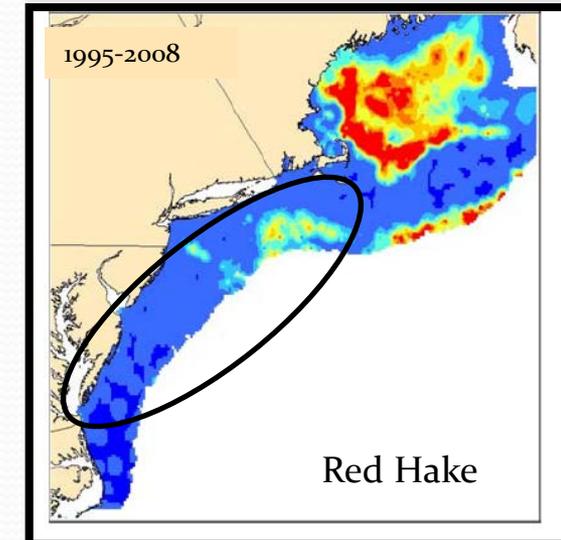
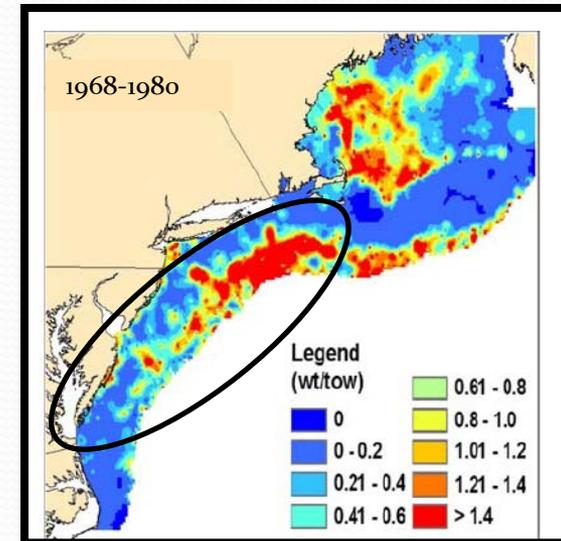
# Shifting Fish Distributions with Warming Ocean Temperatures

Eastern U.S. Waters (Cape Hatteras to Canadian Border)



## Over past 40 yrs:

- **60% major fish stocks have shifted distributions poleward** (1 mile yr<sup>-1</sup>) and/or deeper (0.8 ft yr<sup>-1</sup>).
- **Species shifting at different rates** (25-200 miles poleward)
- **Also changes in abundance, phenology, species assemblages**
- **Why changing?**
- **Future changes?**

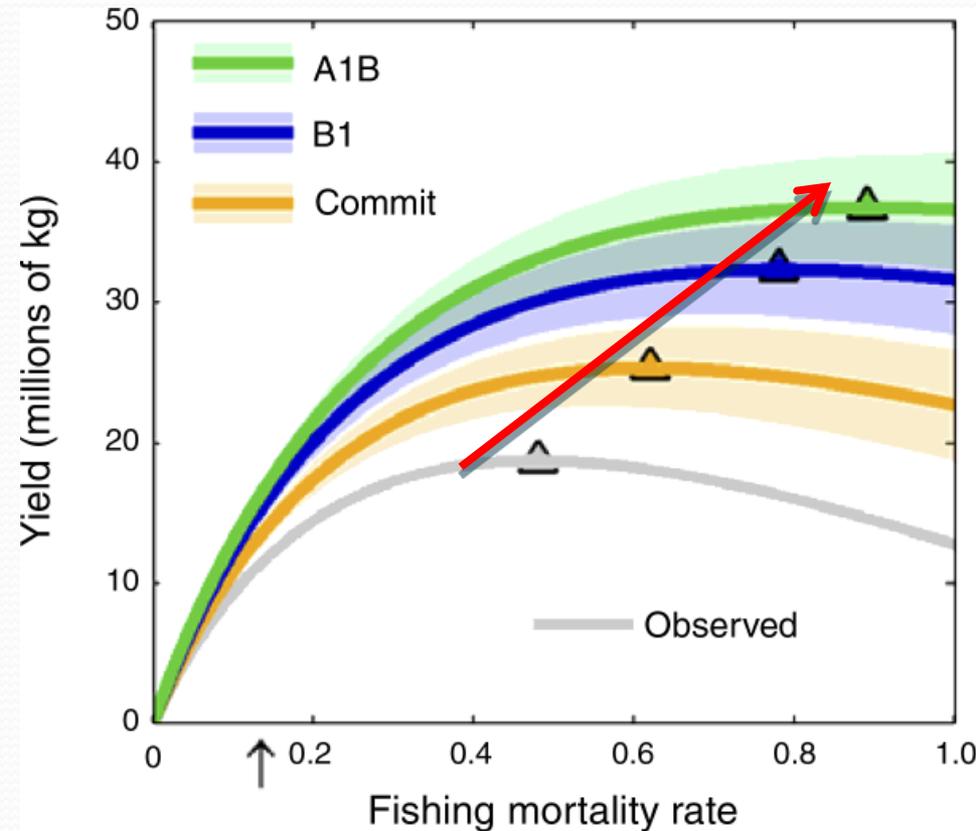


# Will Some Species Thrive In A Changing Climate?

## Projected Increase in Atlantic Croaker Populations

### PROJECTIONS:

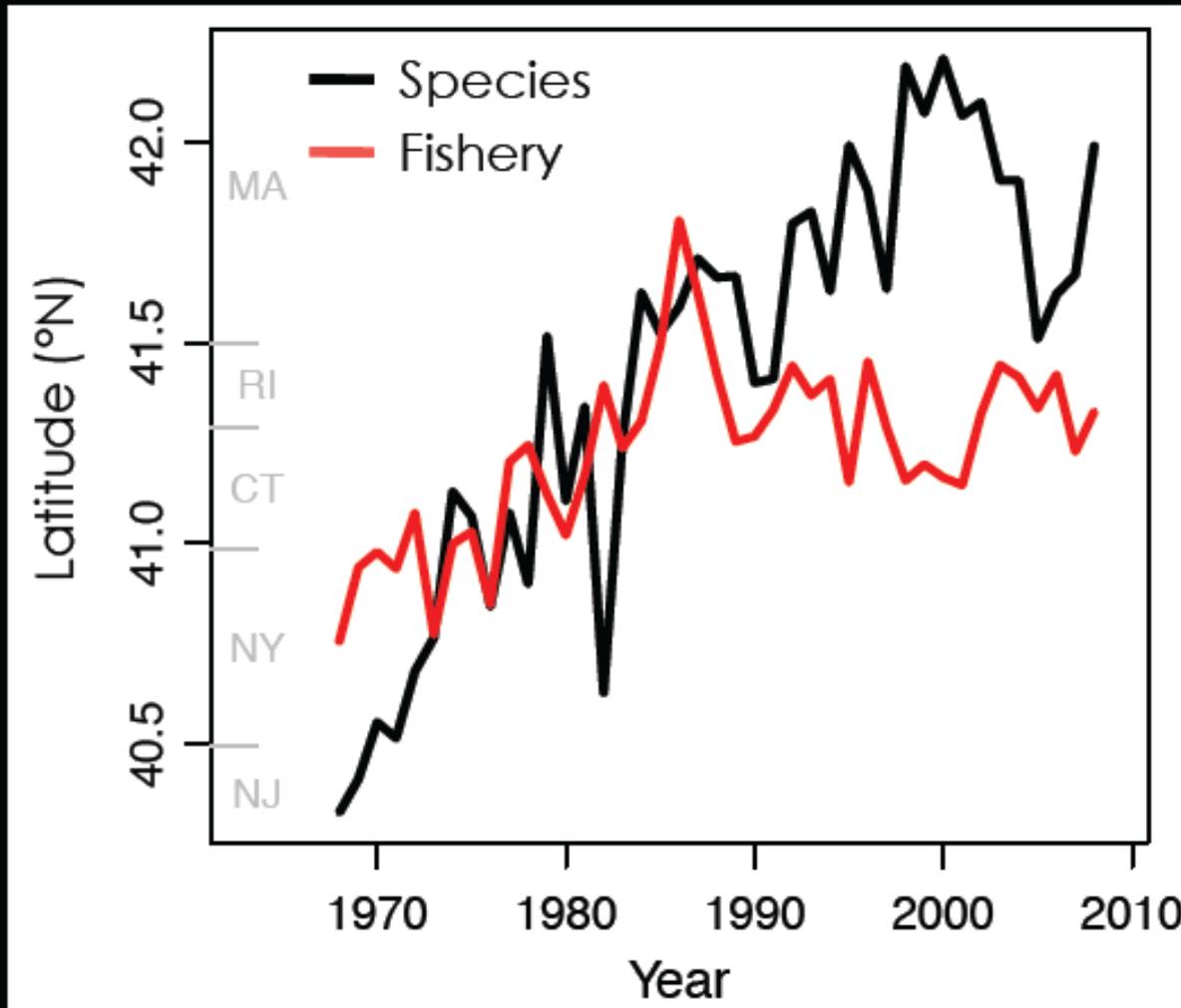
- Increased juvenile recruitment
- 50-100 km northward shift in distribution (2010-2100)
- 60-100% increased biomass
- 30-100% increased maximum sustainable yield
- Potential increased fisheries?



Triangles = fishing rates at maximum sustainable yields (FMSY) .

From Hare et al 2010.

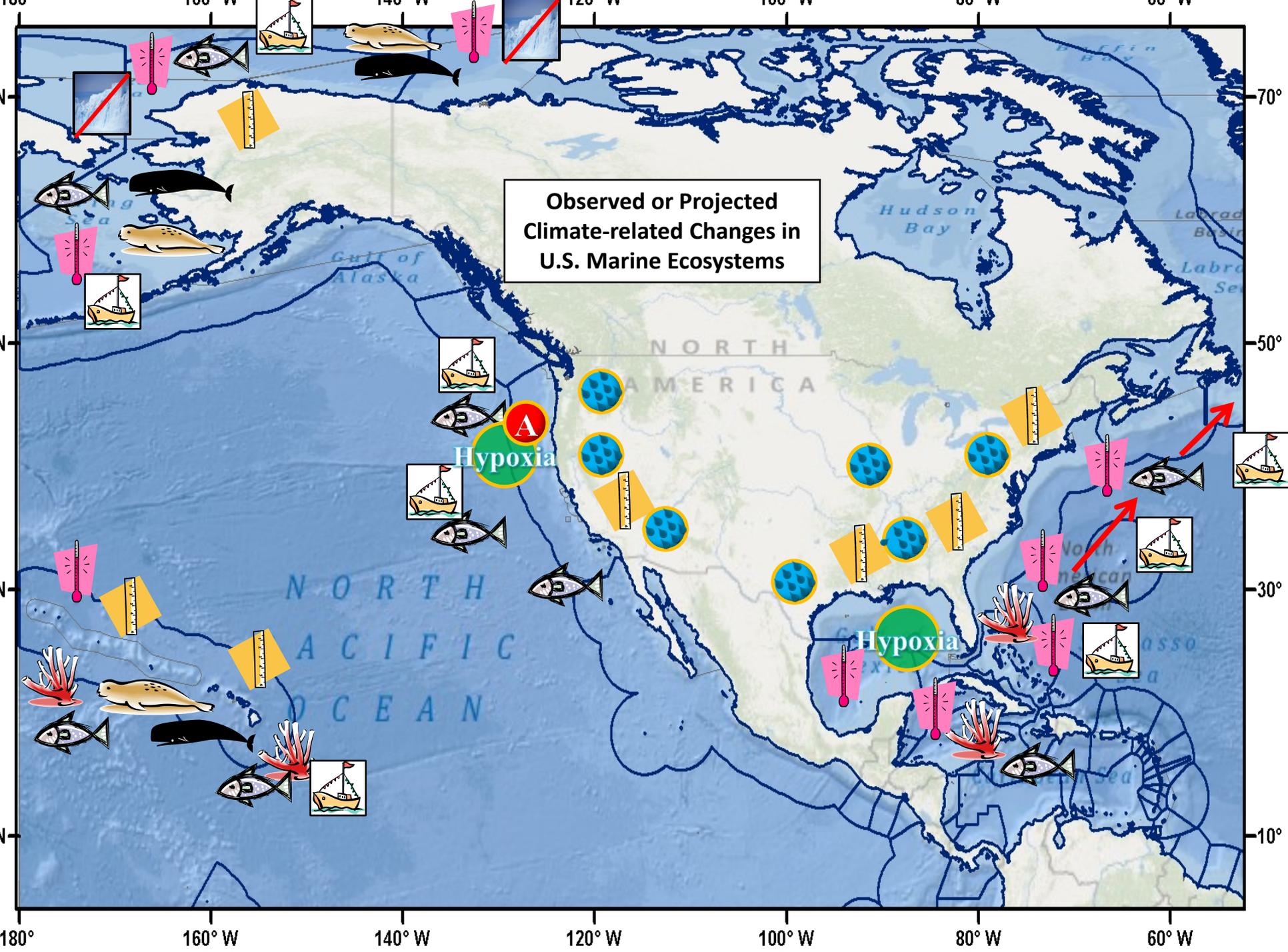
# Fishery landings shift poleward, too



*Urophycis chuss*



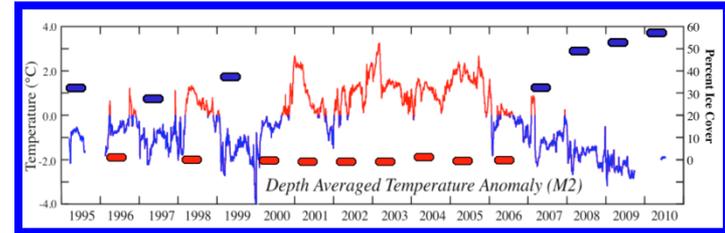
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# MANAGING FISHERIES IN CHANGING CLIMATE

??

5



4



2005 moored temperature and zooplankton data reveal unfavorable ocean conditions for recruitment

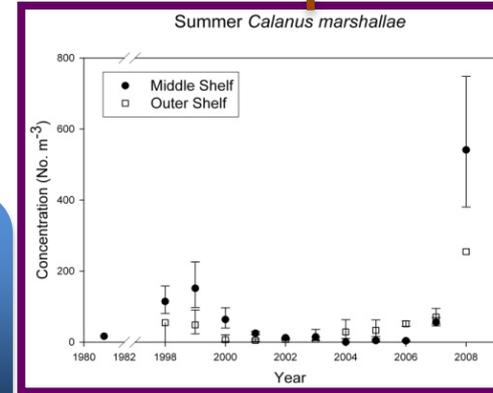


Help?



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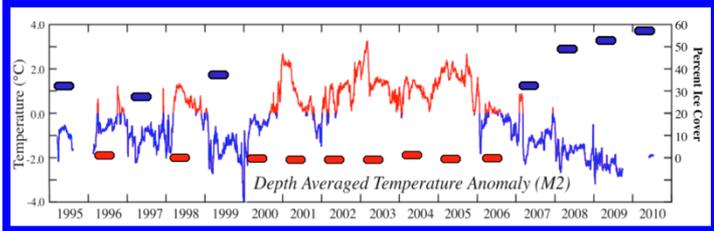
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# MANAGING FISHERIES IN CHANGING CLIMATE

??

5



4



2005 moored temperature and zooplankton data reveal unfavorable ocean conditions for recruitment

1



NPCREP - Mooring 2

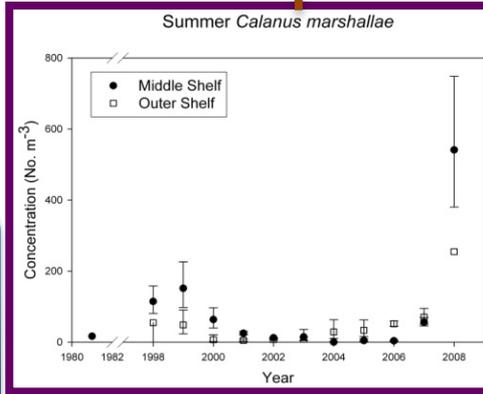
Help?



3

Stock assessment model reveals low/declining recruitment

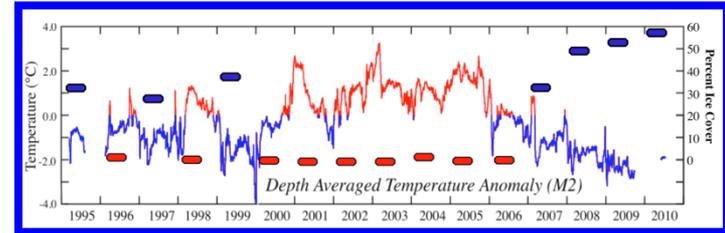
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# MANAGING FISHERIES IN CHANGING CLIMATE

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5



4



2005 moored temperature and zooplankton data reveal unfavorable ocean conditions for recruitment

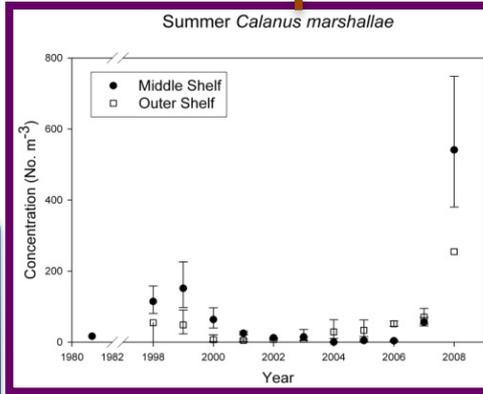


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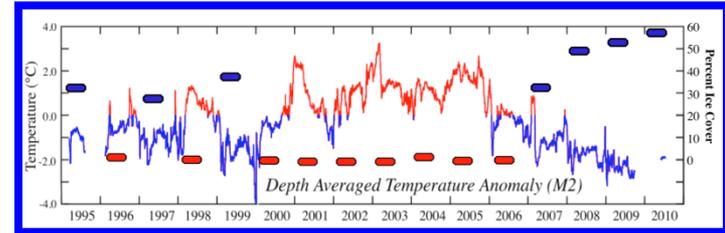
NPCREP warning of poor environmental conditions reported in assessment documents

Stock assessment model reveals low/declining recruitment

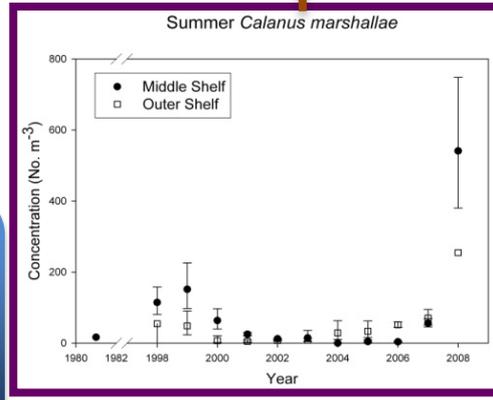


# MANAGING FISHERIES IN CHANGING CLIMATE

??



NPCREP - Mooring 2



North Pacific Fishery Management Council



Help?

4 Fishery Management Council's Science and Statistical Committee (SSC) receives warning

1 2005 moored temperature and zooplankton data reveal unfavorable ocean conditions for recruitment

3 NPCREP warning of poor environmental conditions reported in assessment documents

2 Stock assessment model reveals low/declining recruitment



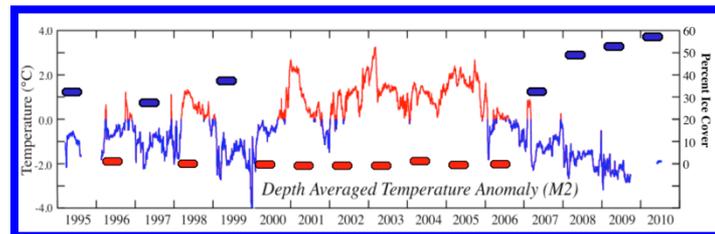
# BERING SEA POLLOCK

# MANAGING FISHERIES IN CHANGING CLIMATE



??

5 Council adopts SSC recommendation to reduce pollock harvest based on assessment and continuation of poor (warm) environmental conditions



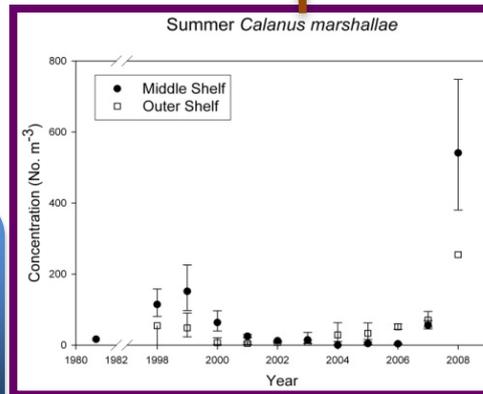
4 Fishery Management Council's Science and Statistical Committee (SSC) receives warning



1 2005 moored temperature and zooplankton data reveal unfavorable ocean conditions for recruitment



Help?



3 NPCREP warning of poor environmental conditions reported in assessment documents

2 Stock assessment model reveals low/declining recruitment

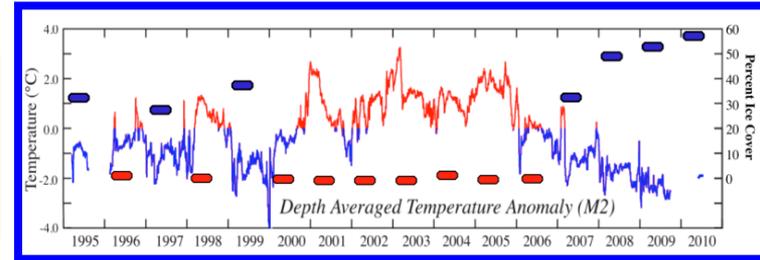


# MANAGING FISHERIES IN CHANGING CLIMATE

Quota cut from 1.6 to 0.8 million tons



5 Council adopts SSC recommendation to reduce pollock harvest based on assessment and continuation of poor (warm) environmental conditions



4 Fishery Management Council's Science and Statistical Committee (SSC) recommends reducing pollock harvest



1 2005 moored temperature and zooplankton data reveal unfavorable ocean conditions for recruitment

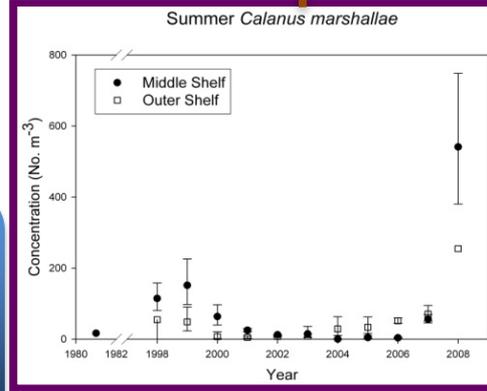


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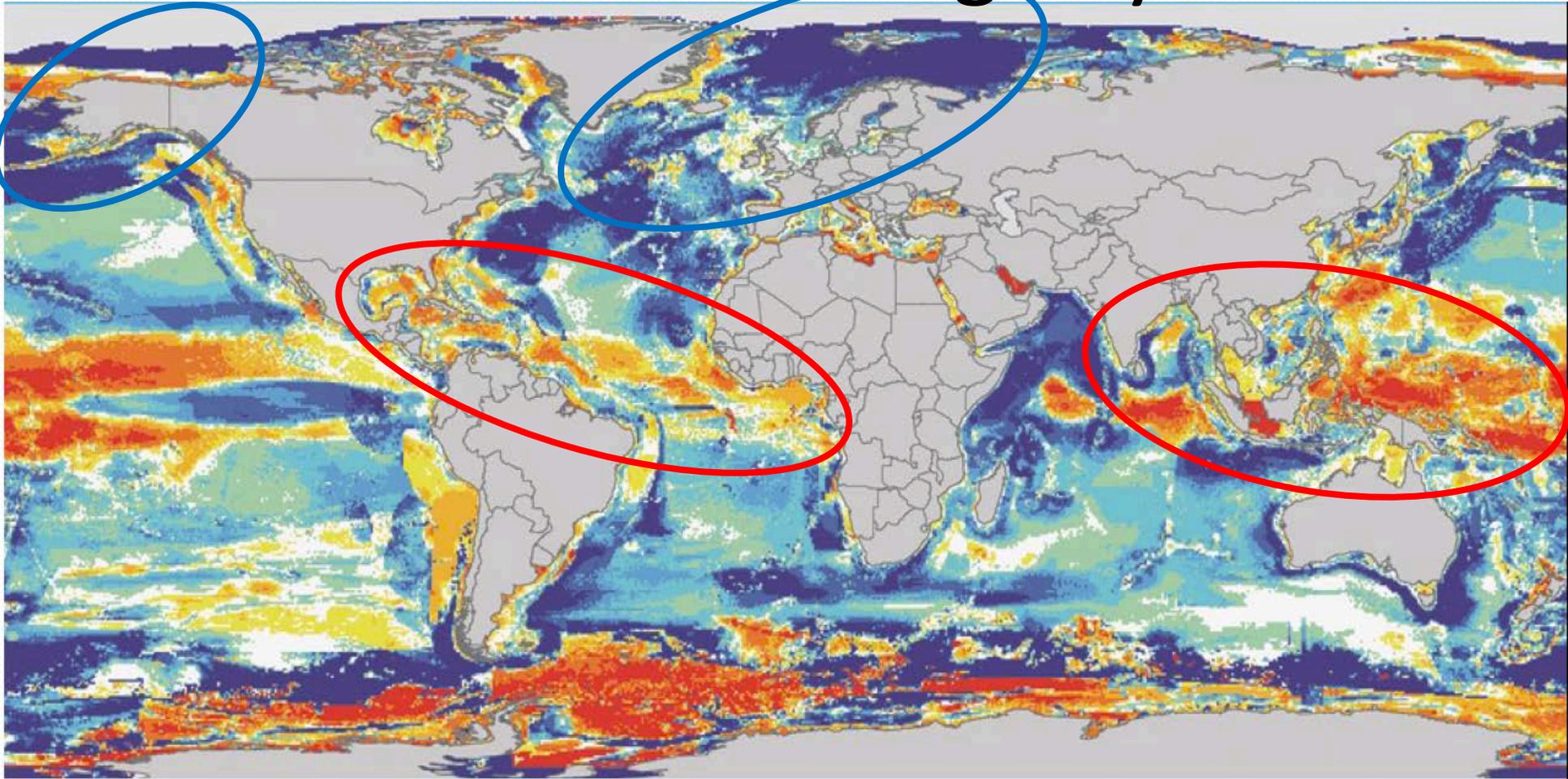


3 NPCREP warning of poor environmental conditions reported in assessment documents

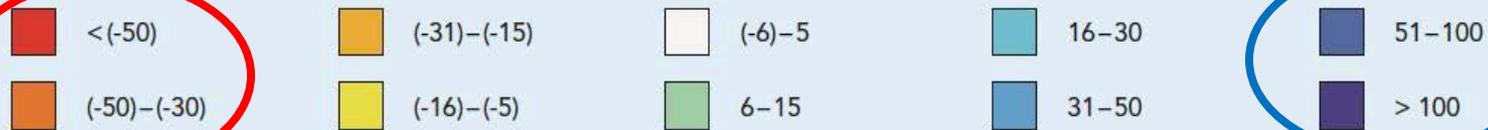
2 Stock assessment model reveals low/declining recruitment



# How will fish catch change by 2100?



Change in Catch Potential (% relative to 2005)

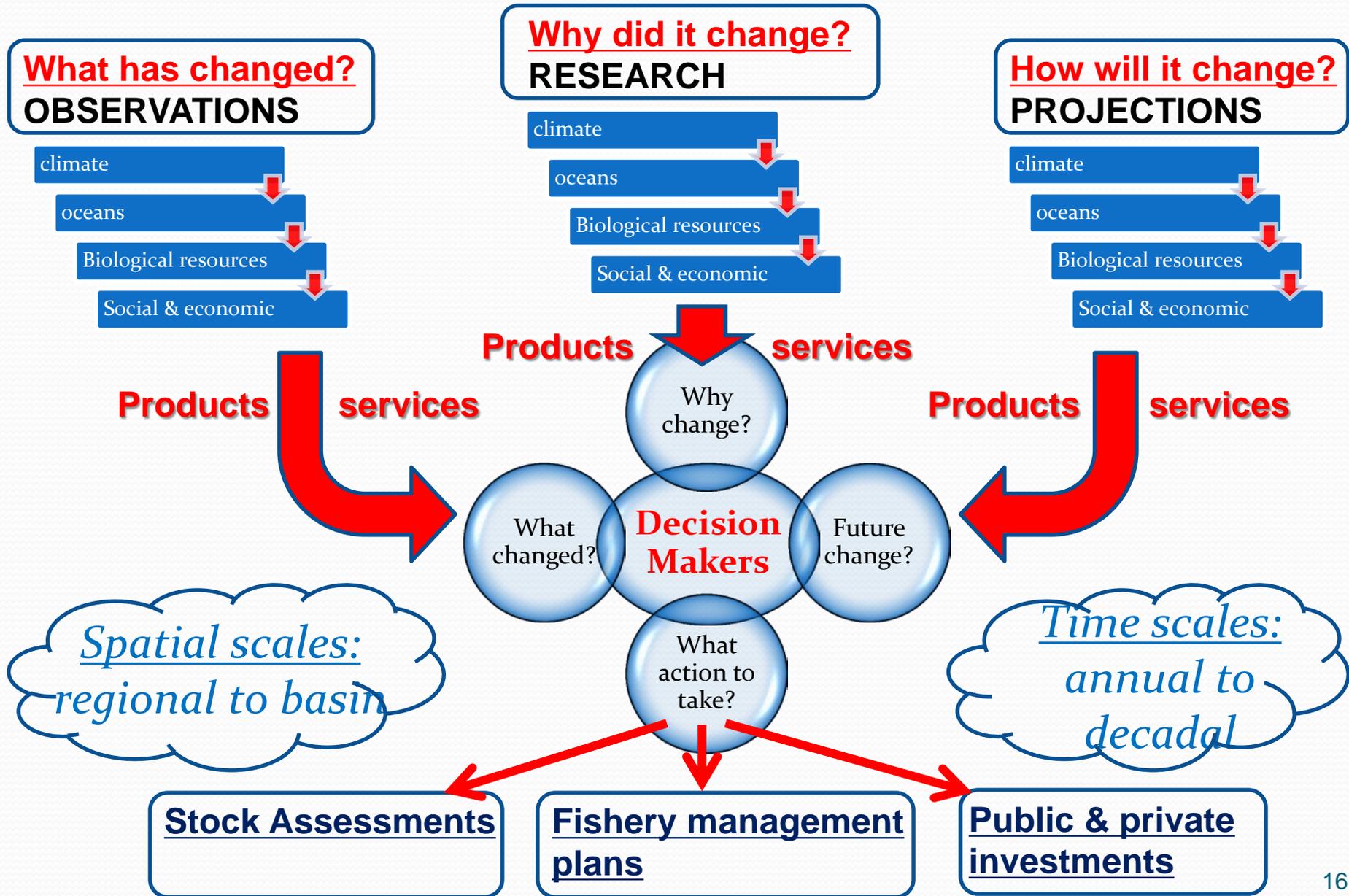


# Growing Demand For Action

- **Diverse audience for marine-climate products and services**
  - *Living marine resource scientists and managers*
    - Federal govt (NOAA, USFWS, USGS, EPA)
    - State govts (35 State Fish and Wildlife Agencies)
    - Indigenous govts (Tribal Fish and Wildlife Agencies)
    - Academic partners (NSF, Sea Grant, universities)
    - International (govts, nongovt entities)
  - *Ocean-dependent industries* (energy, aquaculture, fishing, tourism, shipping)
  - *Ocean-dependent communities & economies* (local, state, regional)
- **Increasing demand for regional products and services**
  - What has changed? Why has it changed?
  - **How, when and where will it change in the future?**
  - How to prepare? How reduce impacts?

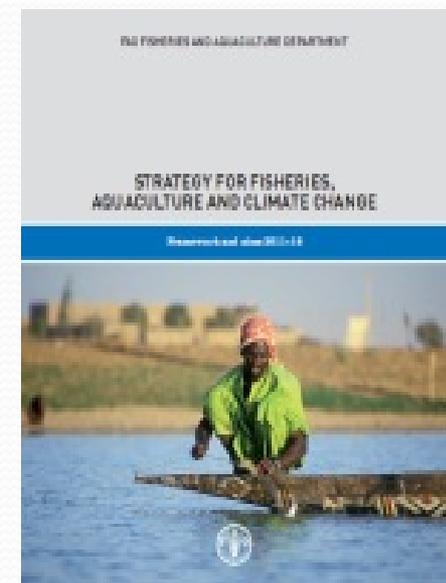
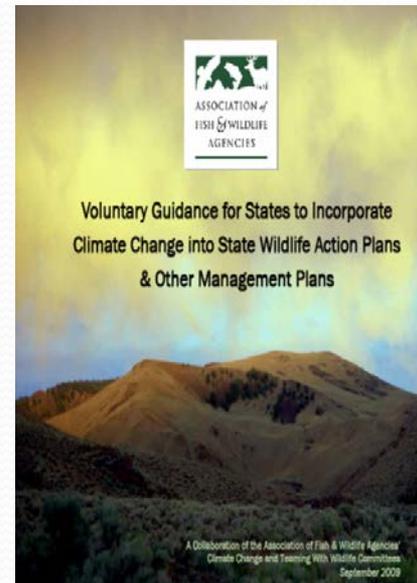
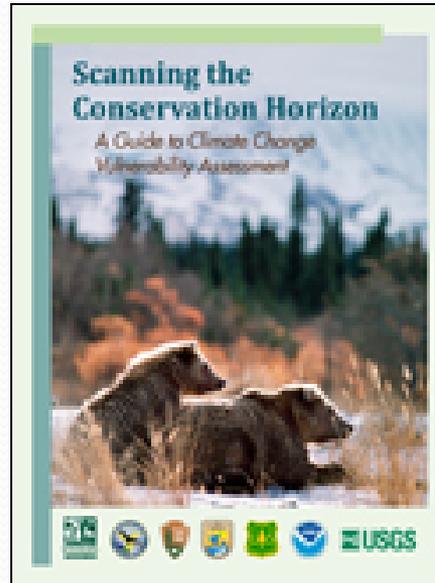
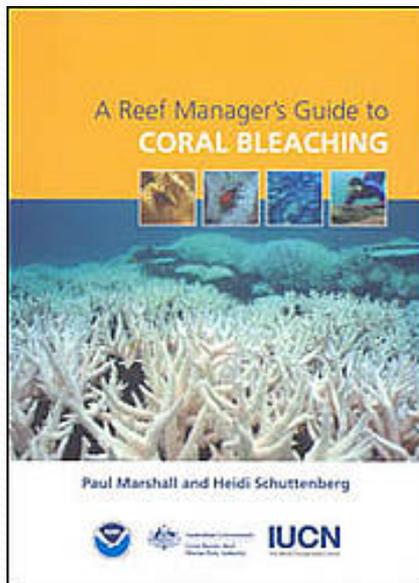


# Key Challenges and Opportunities



# How advance climate savvy fisheries management?

- Growing number of tools and approaches
- Growing demand and interest from fisheries management community
- Need for tools, examples, capacity development
- Guides/toolboxes/trainings can make a difference



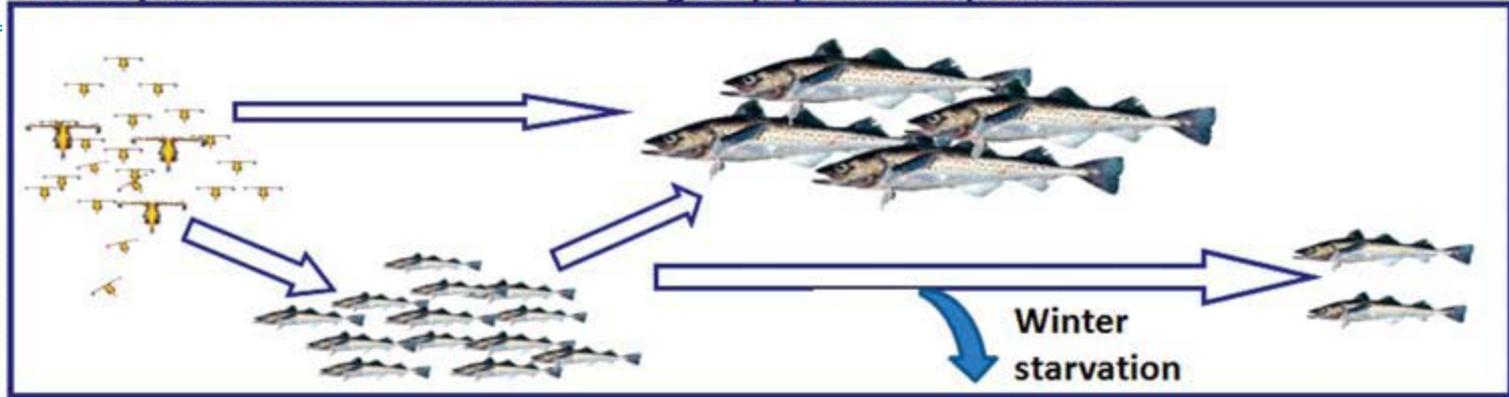
# Focus of this session

- Elicit input on developing a guide to climate ready fisheries management
- Already done? (super lets move on....)
- Worth doing?
- For who?
- What include?
- How make it happen?
- Who's interested?

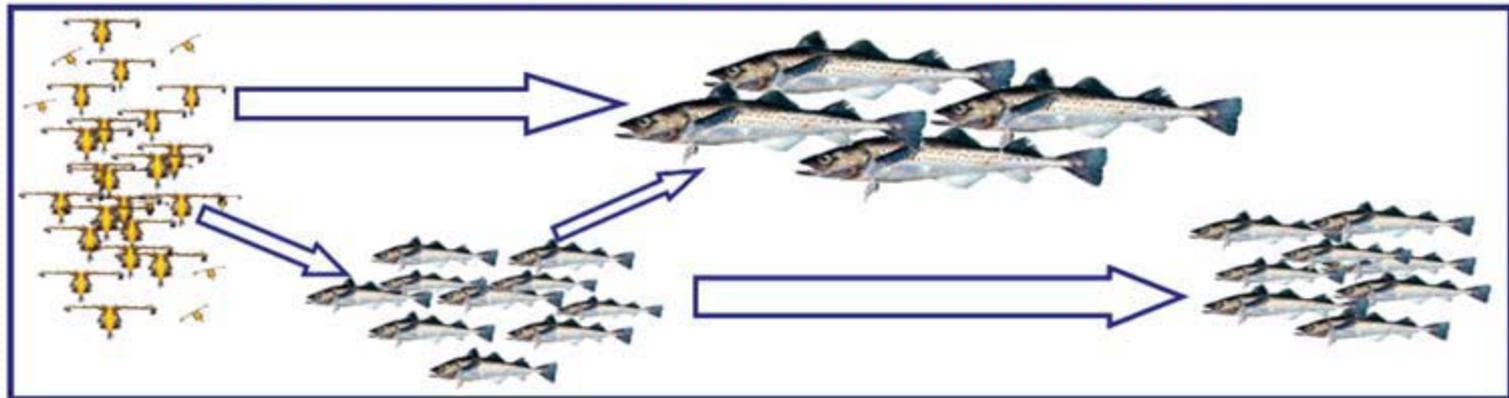


# Backup

### Warm year with late bloom and few large copepods or euphausiids



### Cold year with early bloom and abundant large copepods and euphausiids



Mesozooplankton

Age-0s

Larger pollock

Age-1s

Figure 12. Cartoon illustrating the differences in trophic pathways depending on the availability of mid-to large-copepod, *C. marshallae* and the euphausiid, *T. raschii*, on the southeastern Bering Sea shelf. When large *C. marshallae* and *T. raschii* are not available, predation and cannibalism of age-0 pollock by larger pollock and other fish increases, as does overwinter mortality of age-0 pollock because of insufficient energy stores. When *C. marshallae* and *T. raschii* are abundant, cannibalism and predation on age-0 pollock are decreased and the age-0 pollock might have more abundant energy stores, resulting in stronger recruitment of age-1 pollock.

# Scale of Fisheries and Climate

