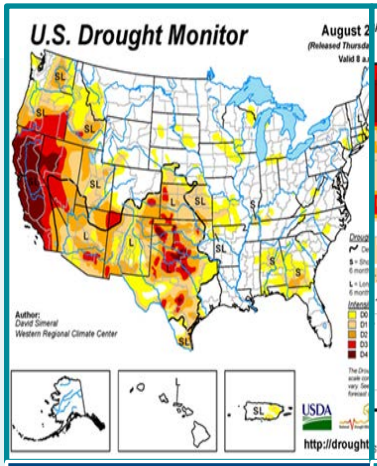
Climate Change: Impacts on Fisheries Management

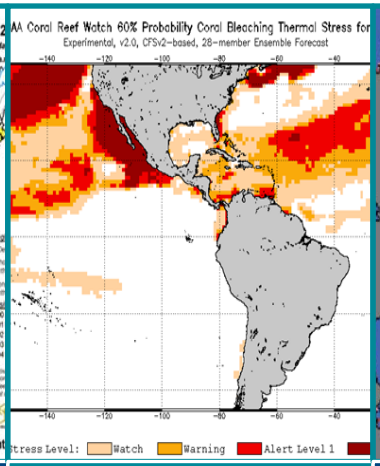
Roger Griffis
Climate Change Coordinator
Office of Science and Technology
NOAA Fisheries

October 2015

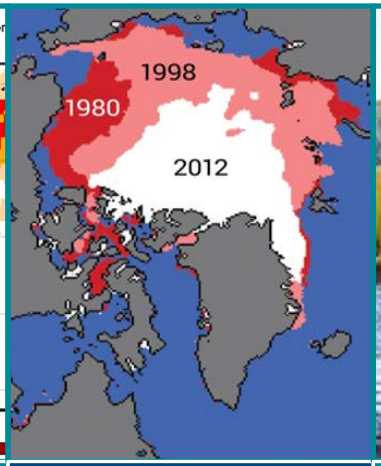
Growing Challenges for Resource Management



Droughts



Warming Oceans



Loss of Sea Ice

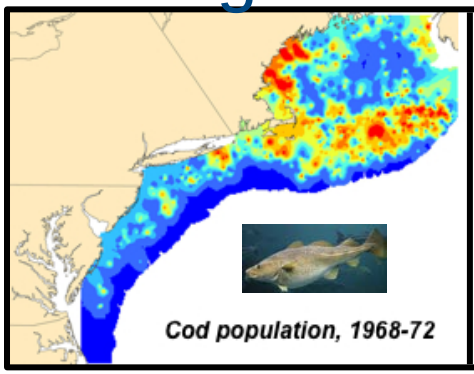
Rising Seas

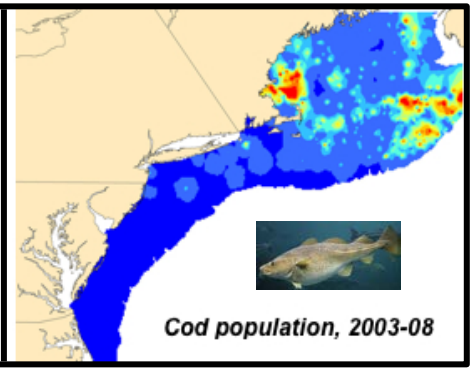
Ocean Acidification

The impacts are real…

Changing Productivity

Shifting Distributions





Changing Abundance

Changing Fisheries

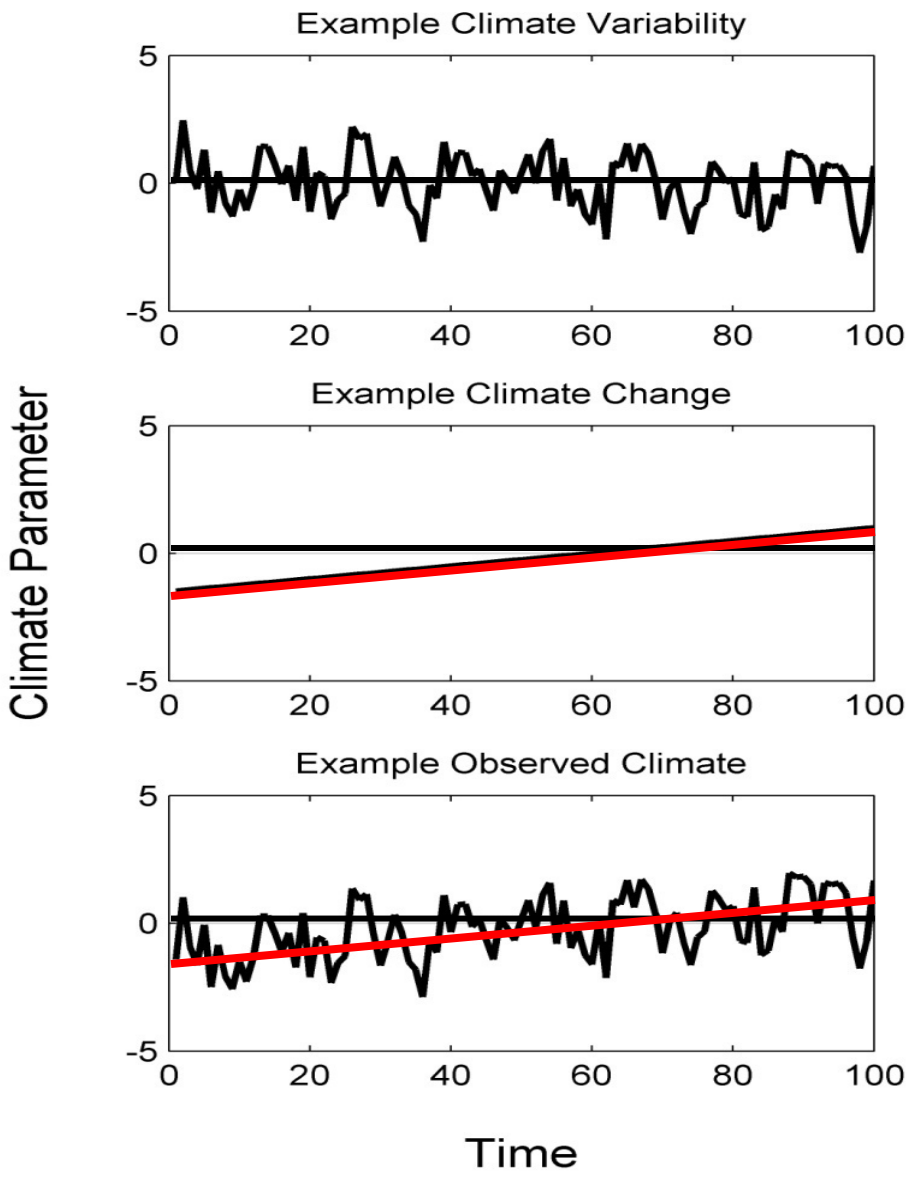
There is much at risk.

- $ 200 billion
- 1.7 million jobs
- Recreation/tourism
- Food security
- Coastal protection
- Natural heritage

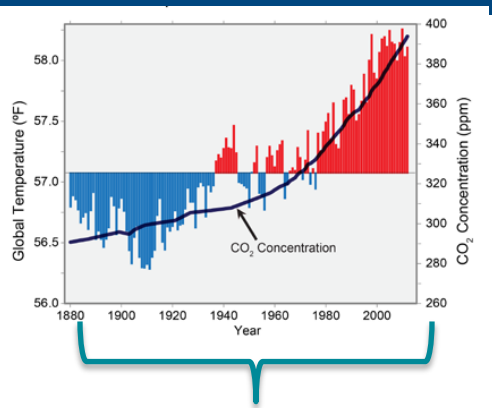
Outline

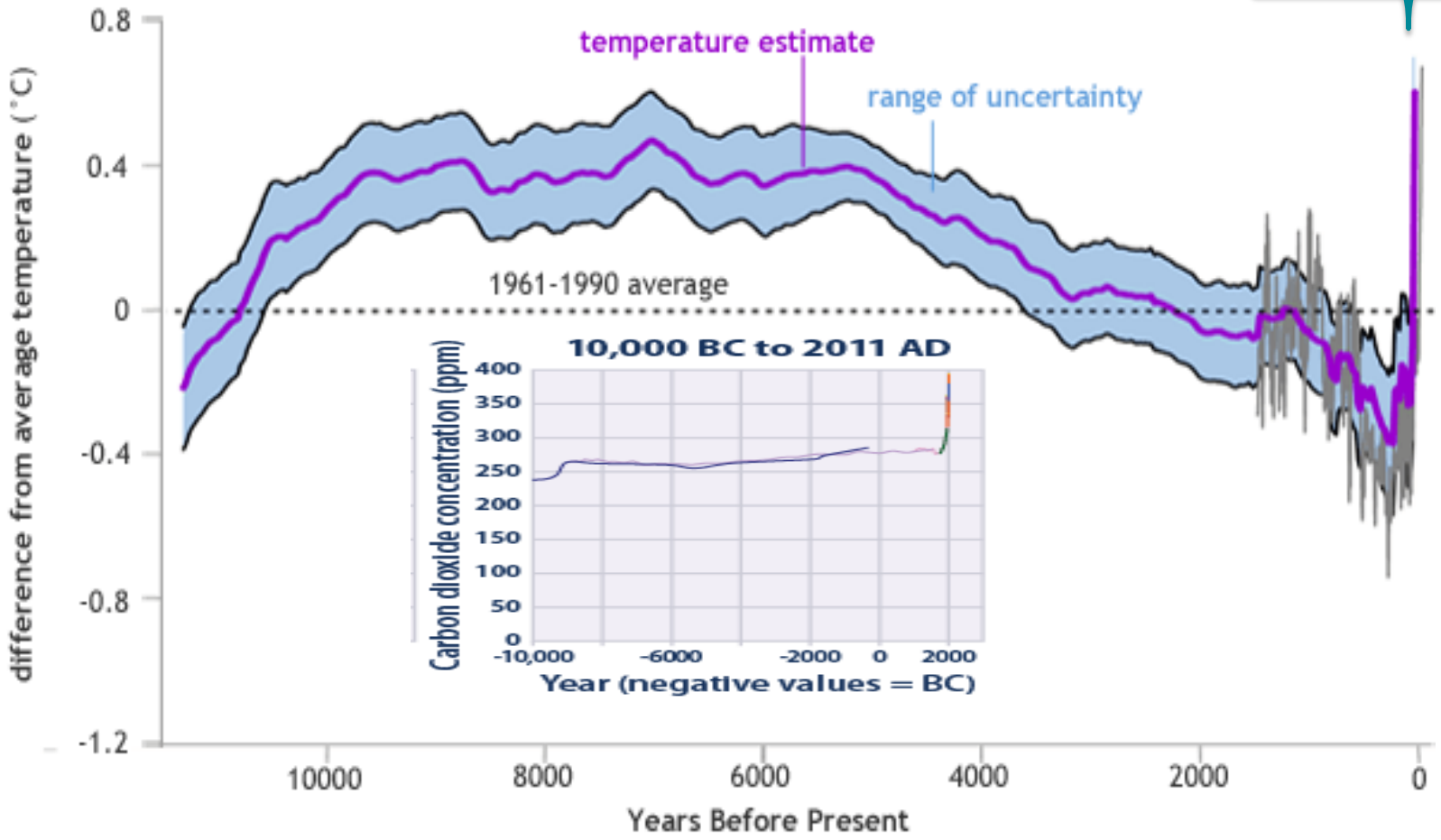
1. What is changing
2. Impacts on Fisheries Management
3. Preparing for change

Climate Variability and Climate Change

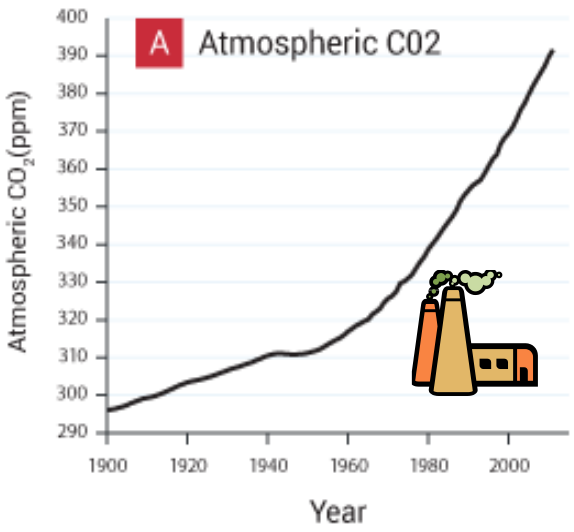


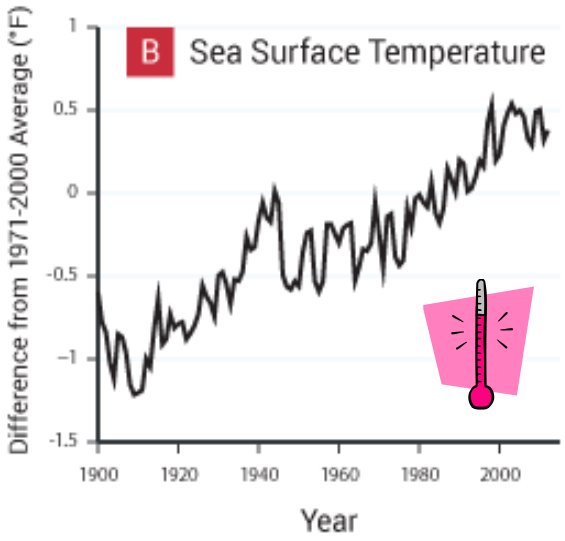
Our Warming Planet

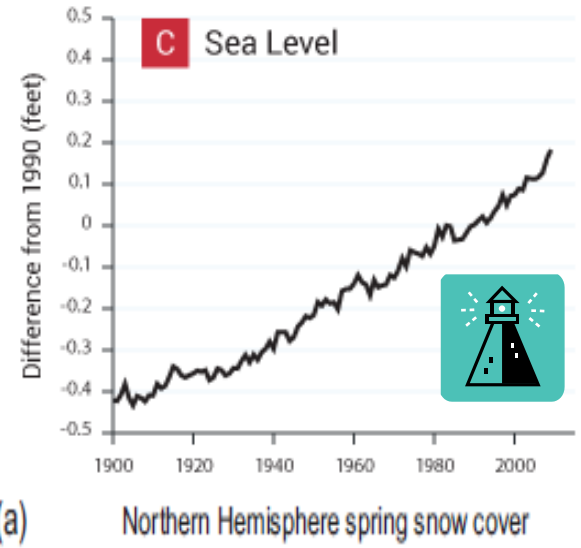


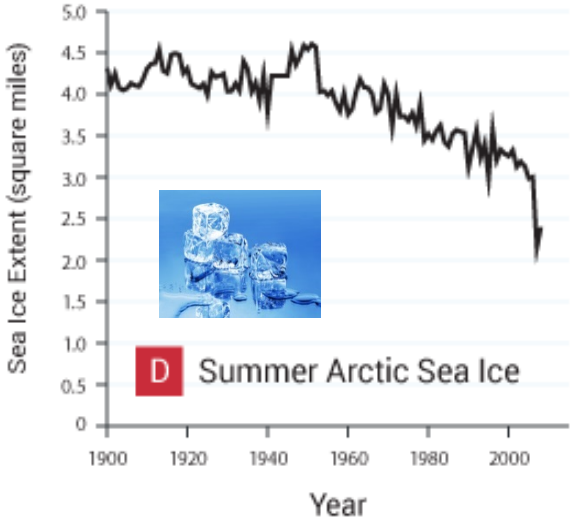


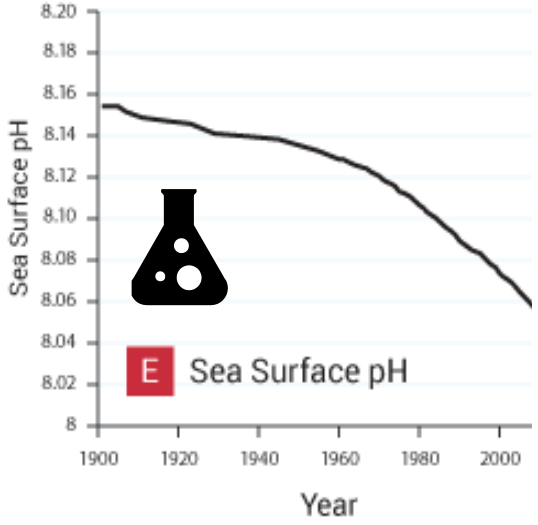
Impacts on Marine and Coastal Ecosystems

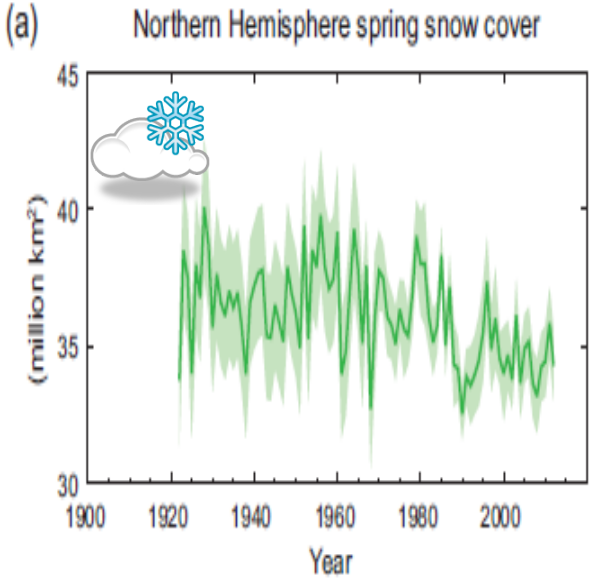


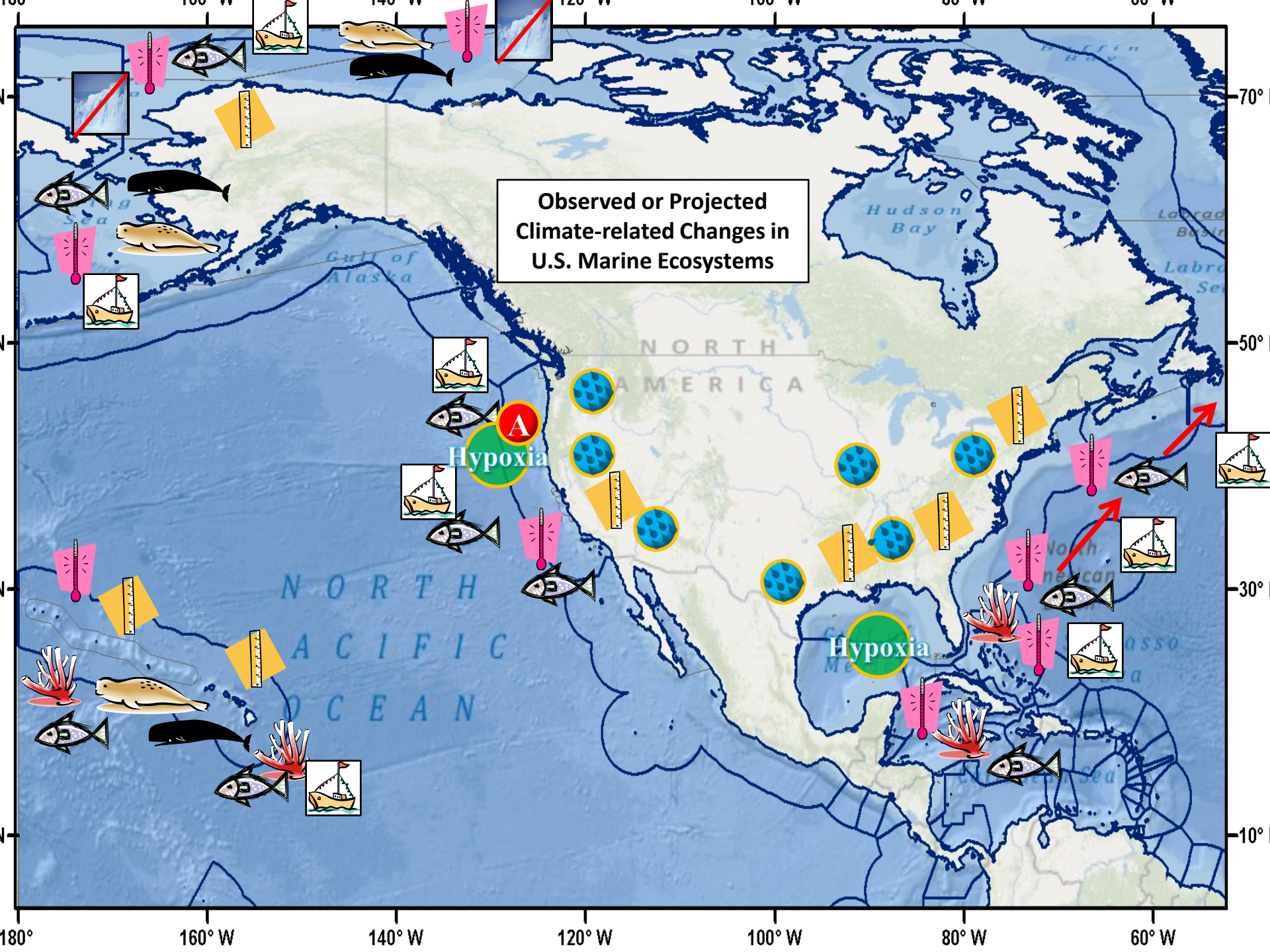








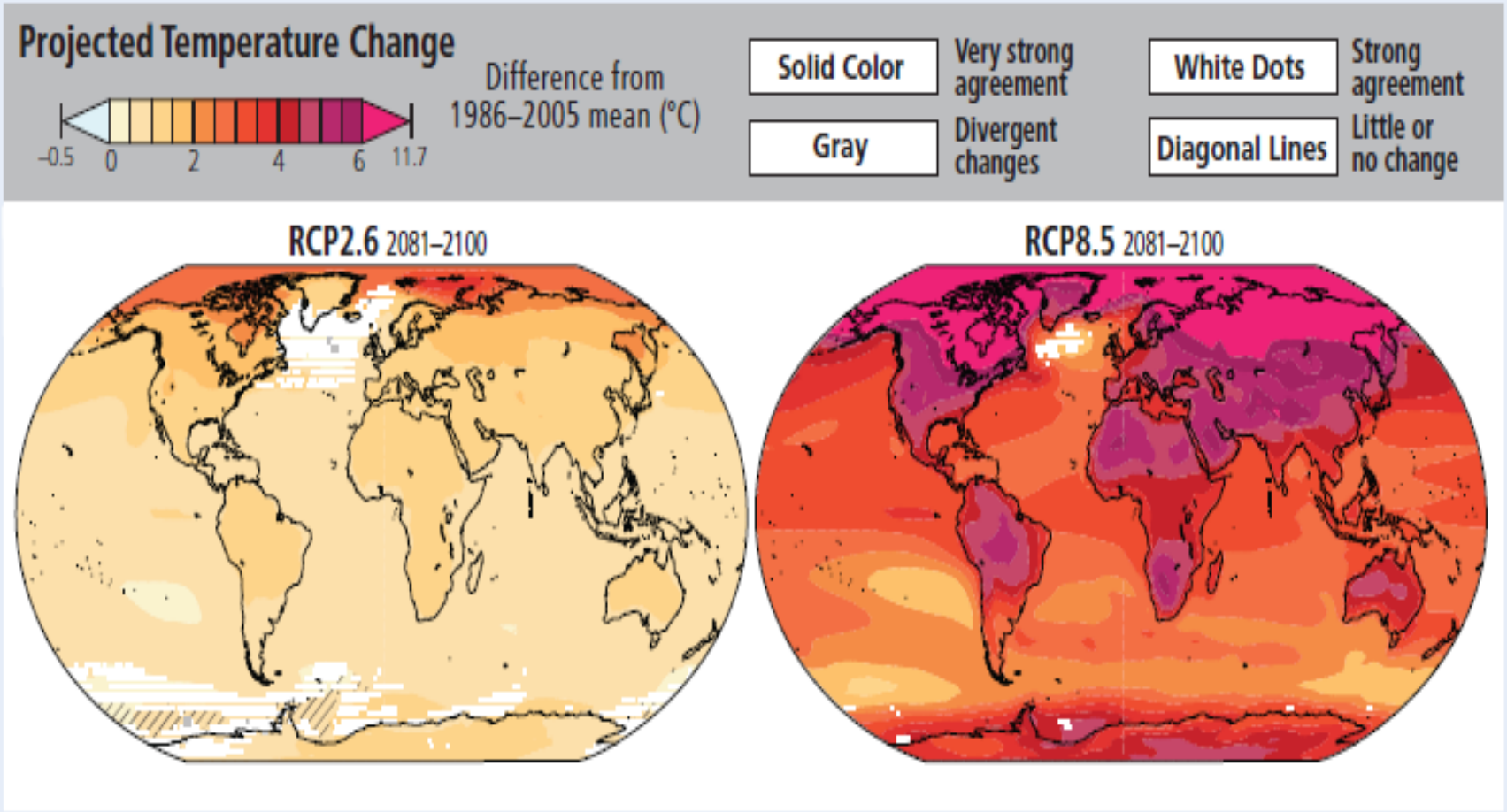



Observed or Projected Climate-related Changes in U.S. Marine Ecosystems
A
Hypoxia
Hypoxia
NORTH AMERICA
NORTH PACIFIC OCEAN
Hudson Bay
Gulf of Alaska
70°
50°
30°
10°
180°
160° W
140° W
120° W
100° W
80° W
60° W

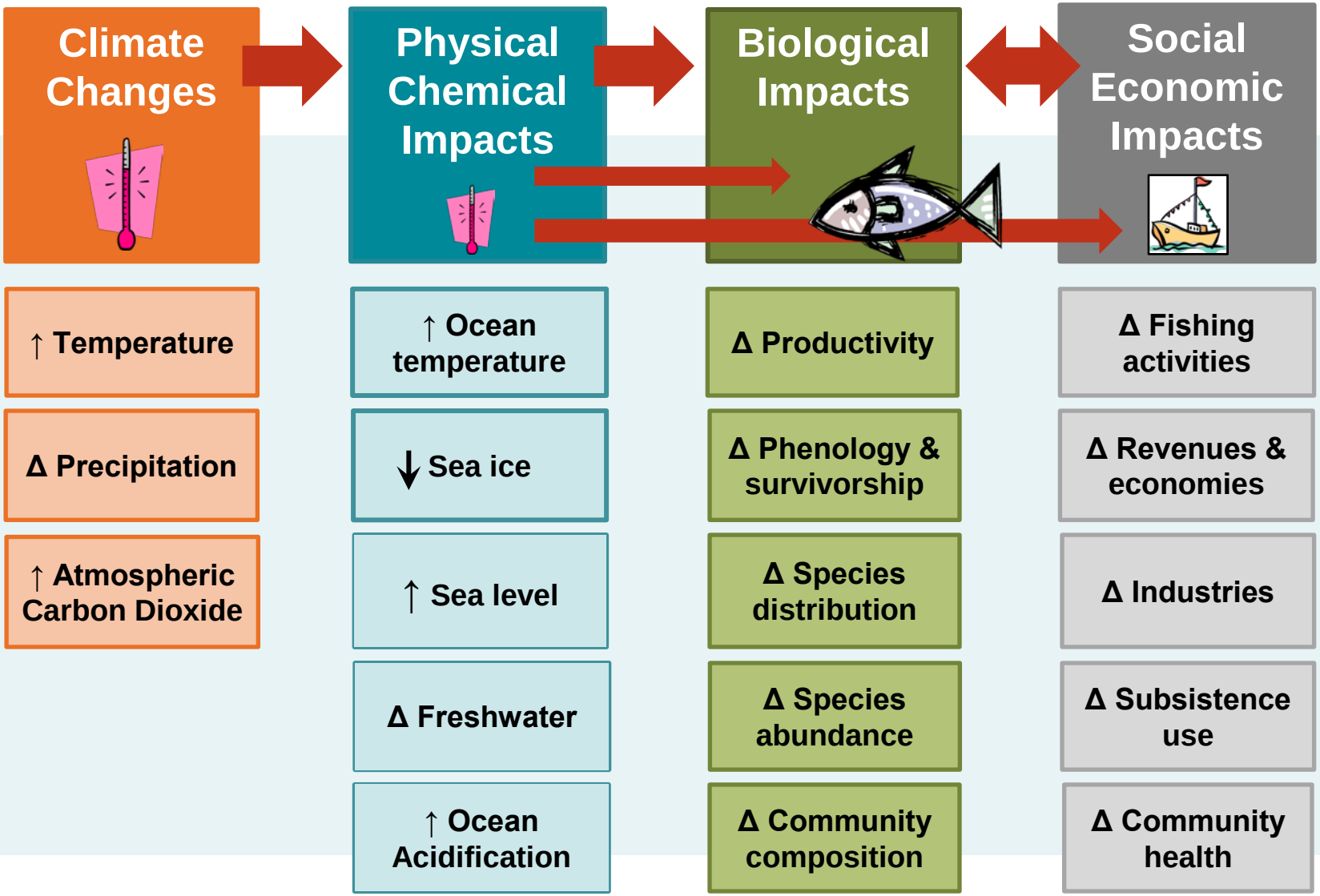
Oceans Will Continue to Change

Projected Average Annual Surface Temperature (IPCC AR5)

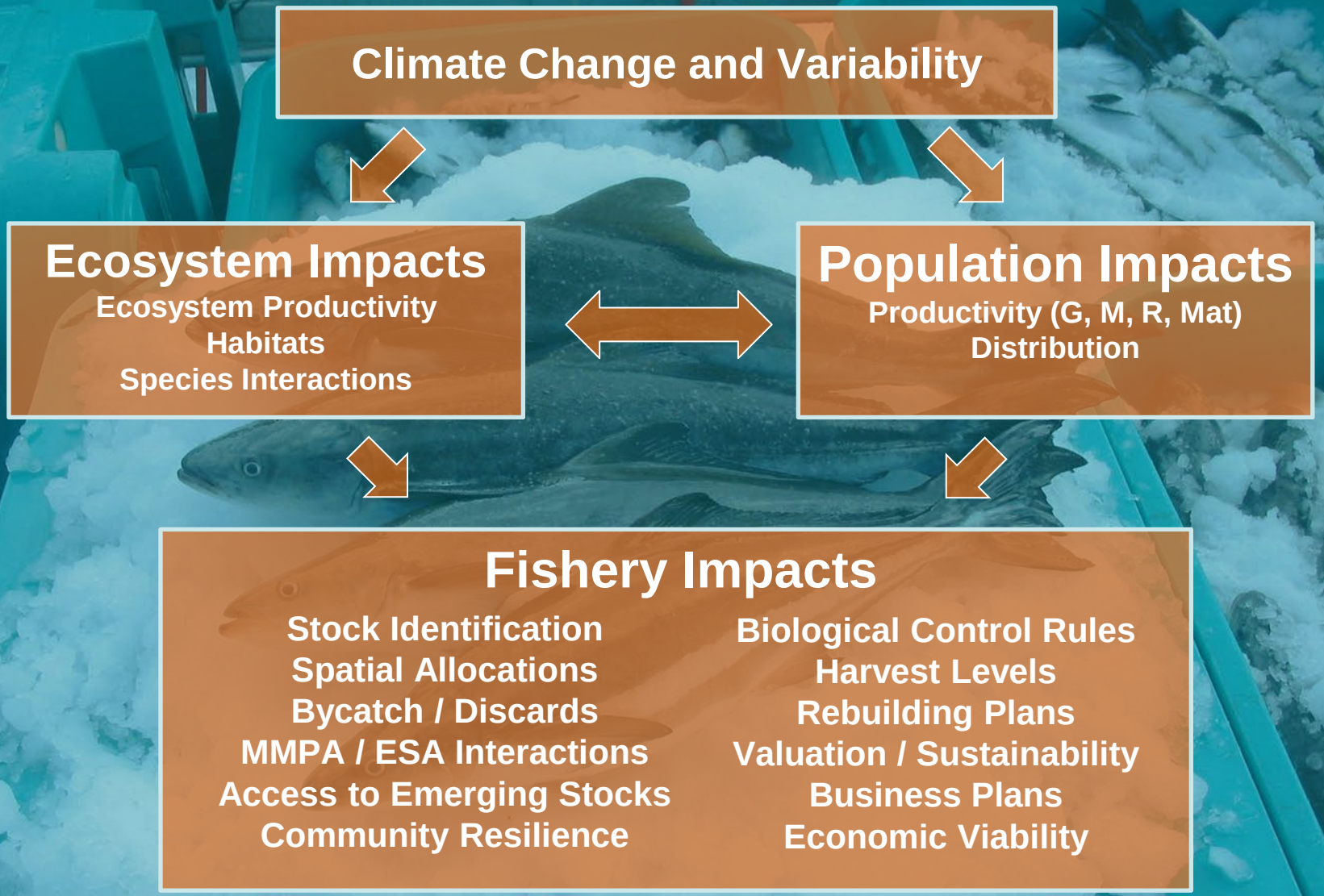
(C)



The Impacts Are Expected to Increase



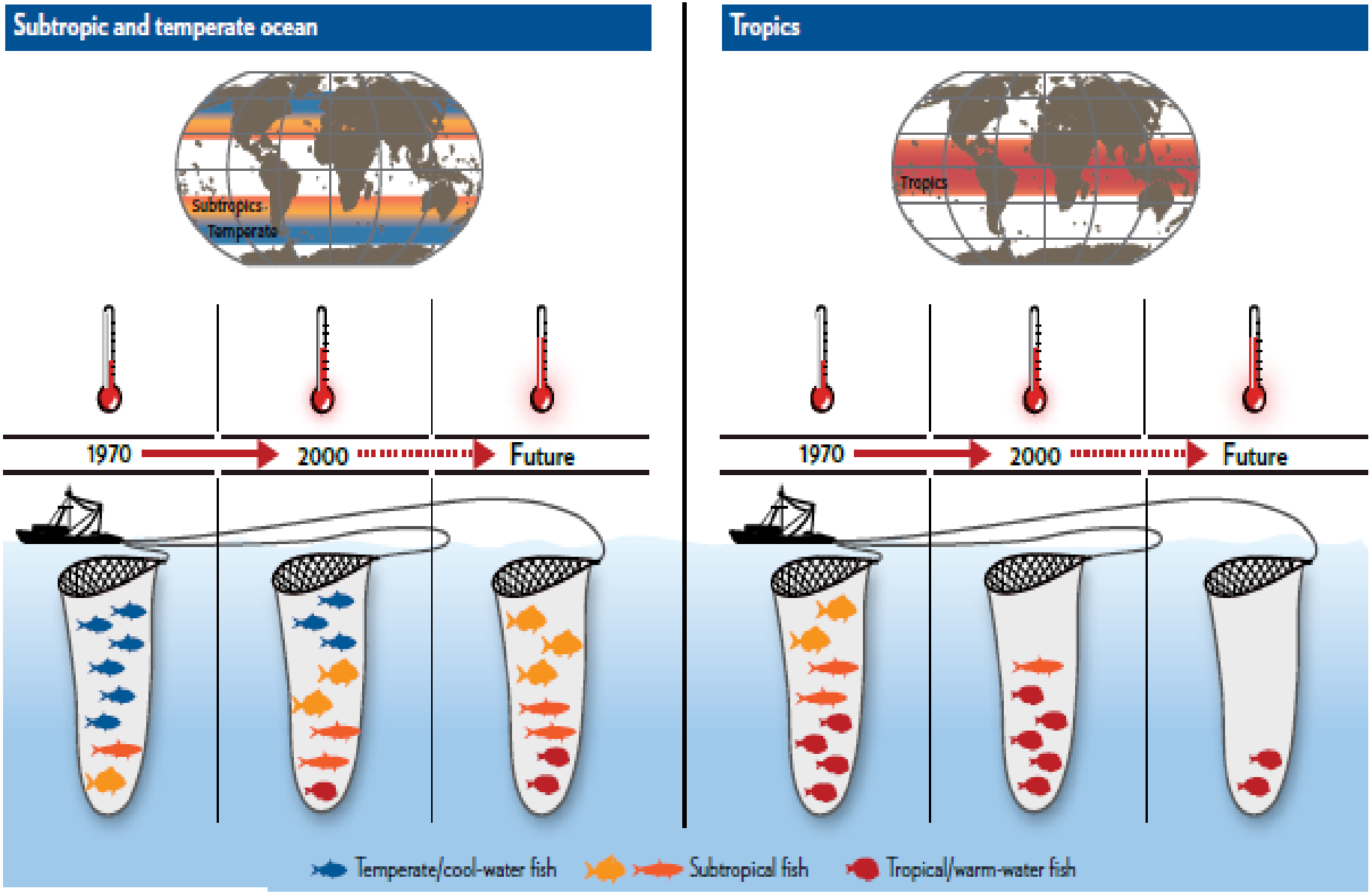
Implications for Fisheries Management



Climate Impacts: Fish Distributions

- Shifts in latitude
- Shifts in depth
- Changes in range
- Shifts in habitat use
- Different rates of change
- Shifts in community composition

Signature of ocean warming in global fisheries catch

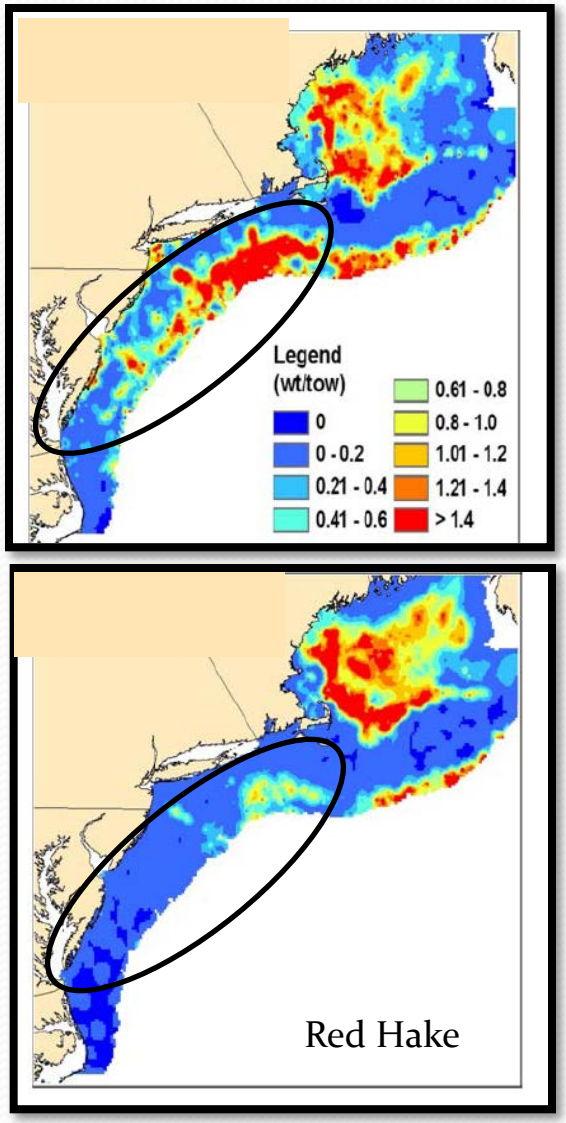


Cheung et al 2013 Nature 497

Shifting Atlantic Fish Stock Distributions

Over past 40 yrs:

- 60% fish stocks shifted poleward.
- Some shifted deeper.
- Some faster than others
- Increasing average ocean temperatures
- What's affecting distributions?
- Can we predict future distributions?



Nye et al. 2009. MEPS 393: 111-139

East Coast Warming & Fisheries Management

Declines

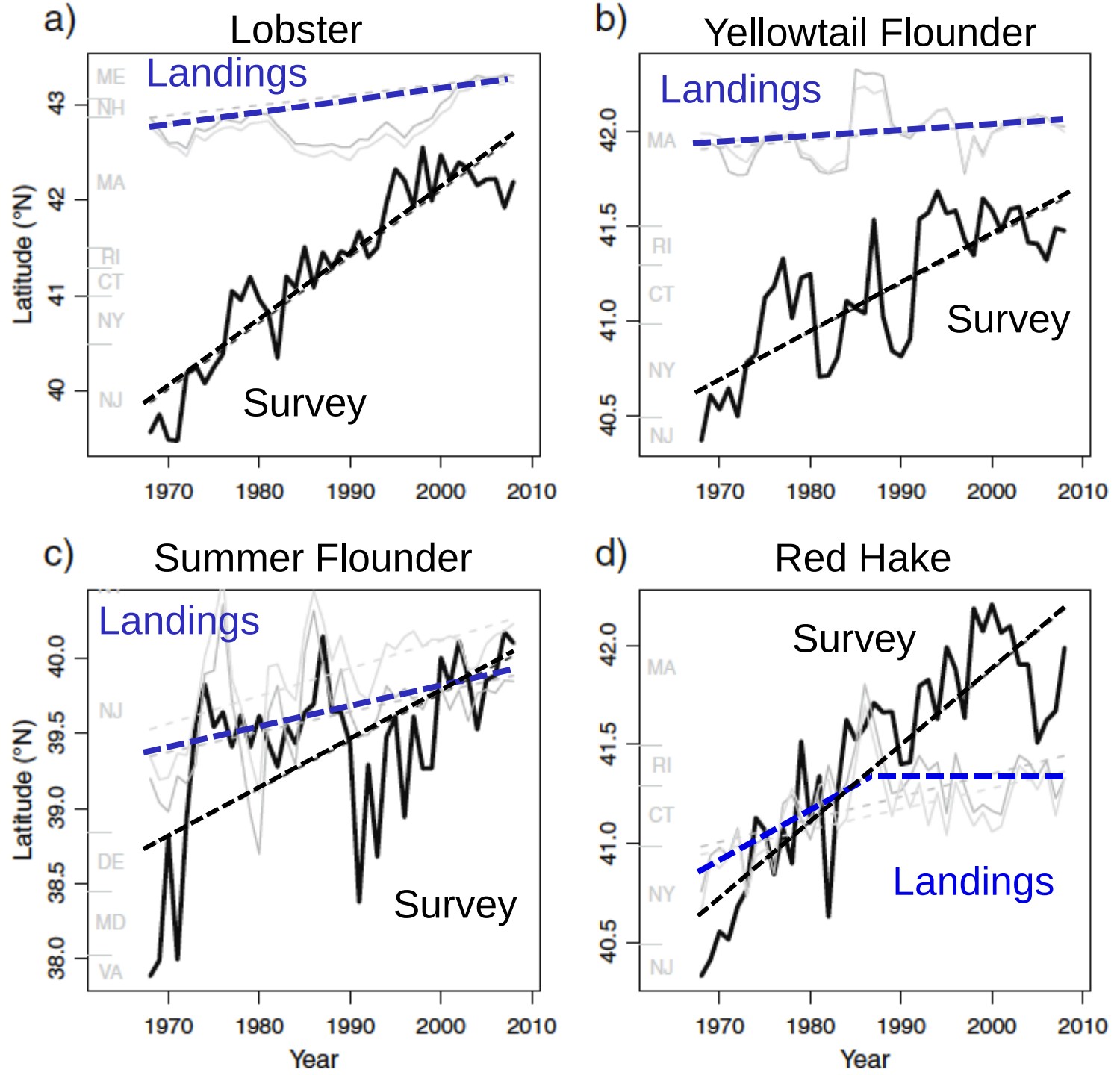
Increases

Fisheries losses

Increases

Change Allocations?

Management Plan?



Do fishers follow shifting fish stocks?

(Yes but more slowly and only where possible)

Pinsky & Fogarty 2012. Climatic Change. 115: 883-891.

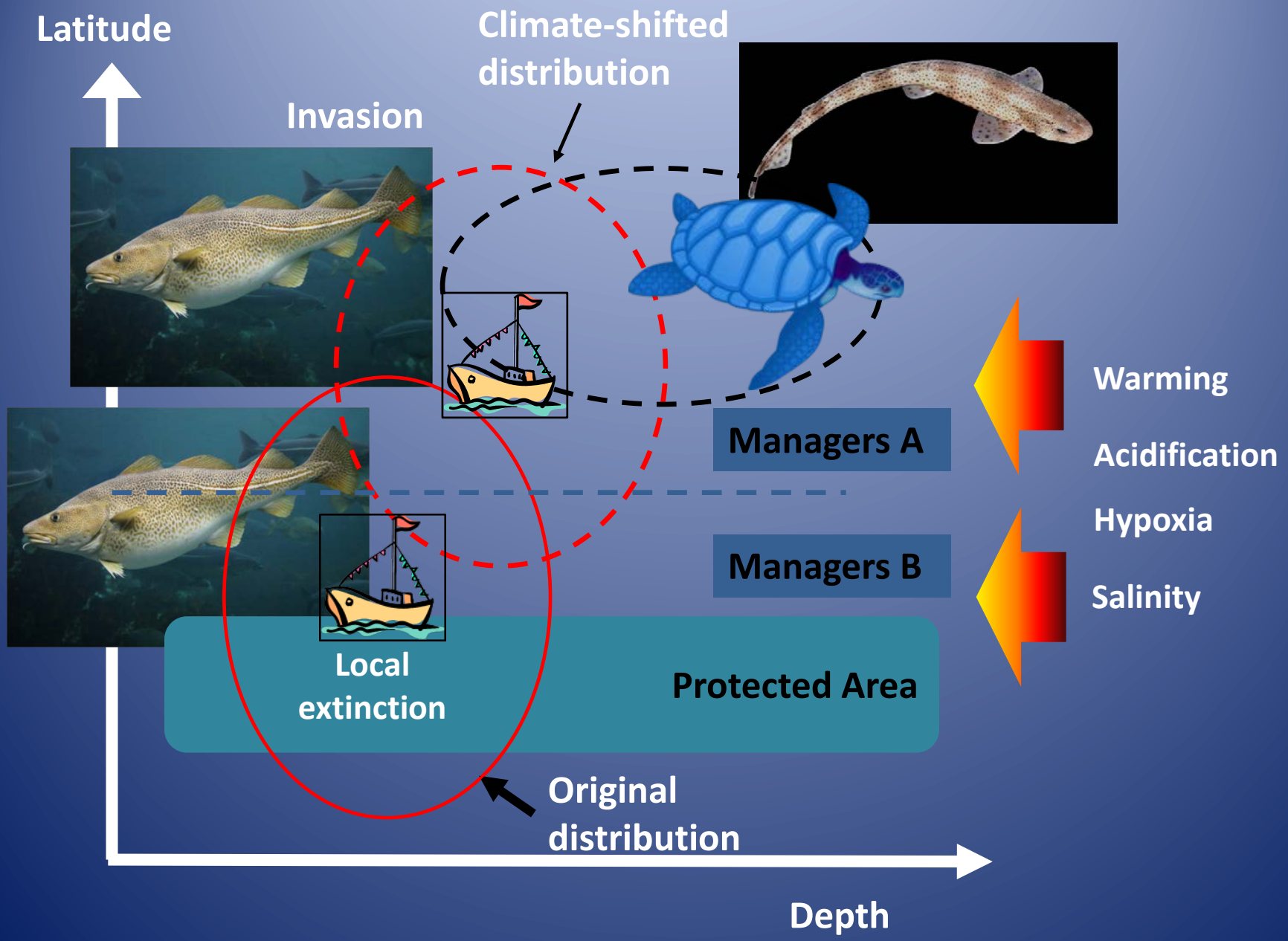
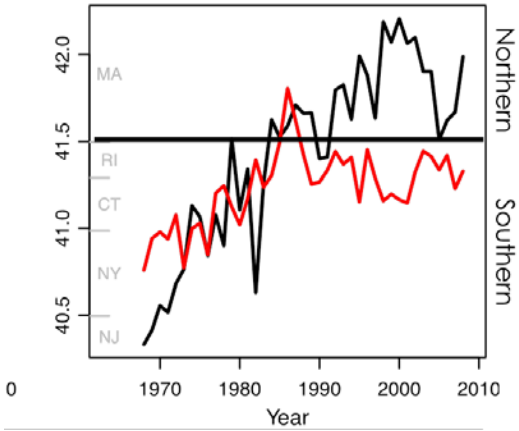


Figure courtesy of William Cheung, Univ. of British Columbia

Implications for Fisheries Management?

Changes in distributions

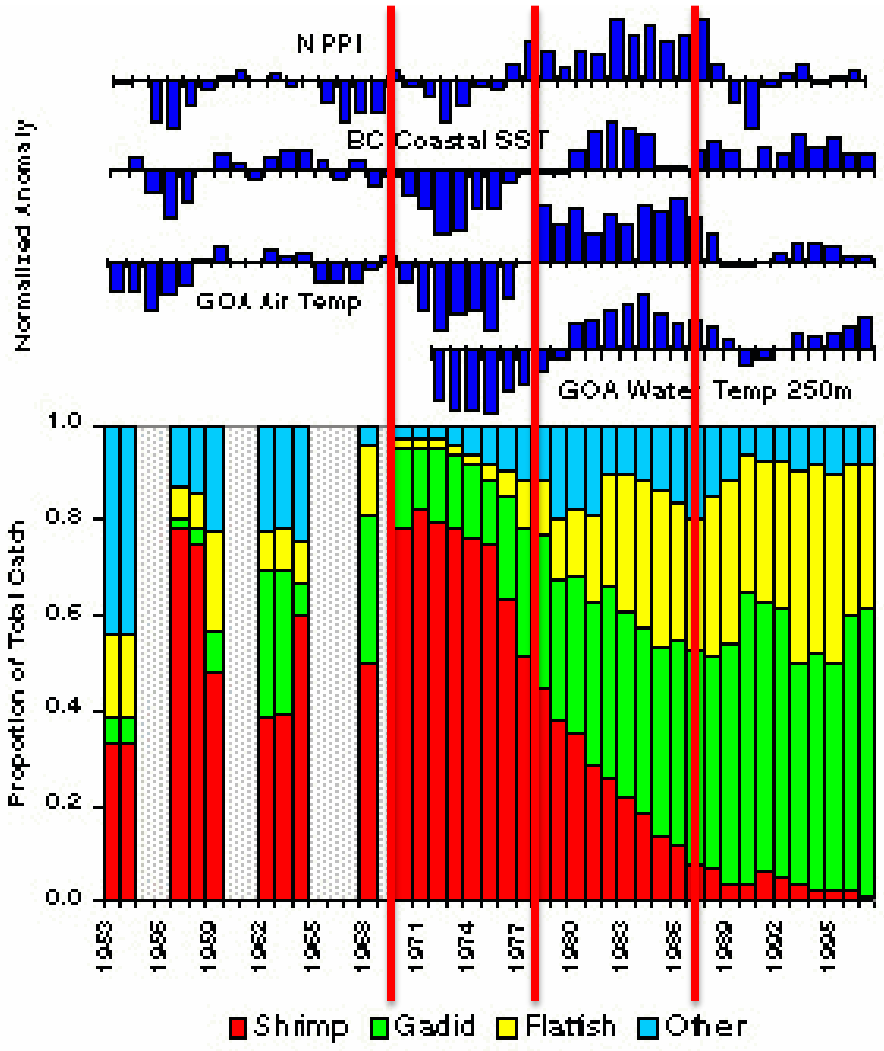
- How to identify when shifts have occurred?
- Need to adjust surveys?
- Need to adjust allocations?
- What habitats to protect?
- How to manage for changes in bycatch and species interactions?
- How to approach new fisheries?



Climate Impacts: Fish Abundance

- Ecosystem productivity (food)
- Population level
- Population structure
- Tipping points?

Climate shifts perturb fisheries and have socio-economic impacts.



(from Anderson and Piatt, 1999)

Late 1960's

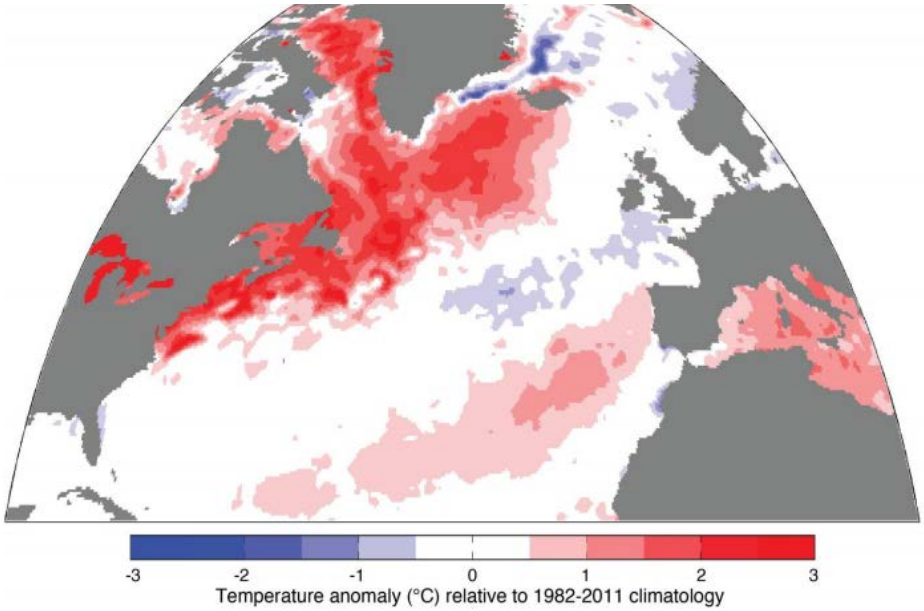
Late 1970's

1980's

Bottom trawl surveys, Pavlov Bay, AK
(from Botsford et al. 1997)

Example: 2012 Heat Wave in Gulf of Maine

Largest, most intense SST anomaly in North America

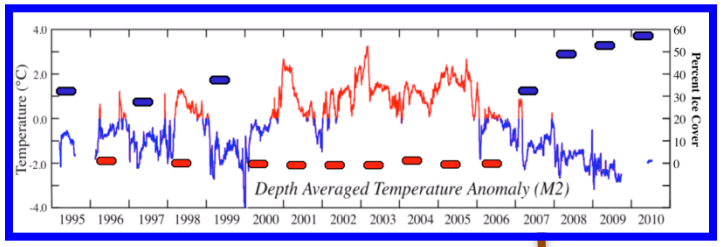


NOAA FISHERIES

Mills et al. 2014

Bering Sea Pollock

North Pacific Fishery Management Council



5

North Pacific Fishery Management Council

NPCREP - Mooring 2

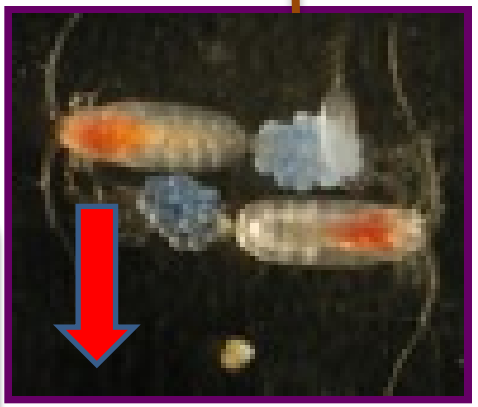
4

NPCREP

1

2005 temperature and zooplankton data show unfavorable ocean conditions for recruitment

Help?



3

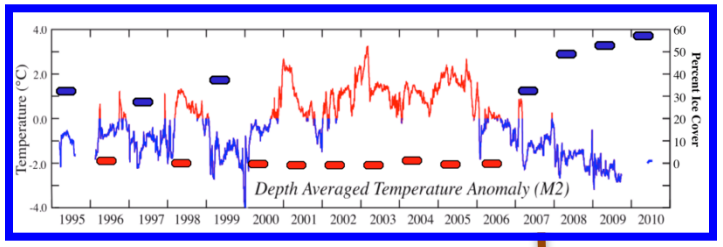
2

NOAA

Bering Sea Pollock

North Pacific Fishery Management Council

5



North Pacific Fishery Management Council

4

NPCREP

2005 temperature and zooplankton data show unfavorable ocean conditions for recruitment

1

Help?

3

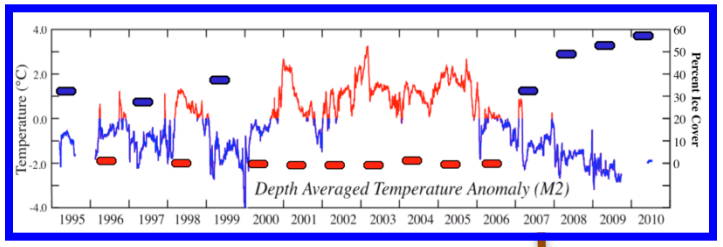
Stock assessment model reveals low/declining recruitment

2

NOAA

Bering Sea Pollock

North Pacific Fishery Management Council



1 2005 temperature and zooplankton data show unfavorable ocean conditions for recruitment

2 Stock assessment model reveals low/declining recruitment

3 NMFS warnings of poor environmental conditions reported in assessments

4 Science and Statistical Committee (SSC) receives warning and recommends harvest reductions

Help?

NPCREP

5

North Pacific Fishery Management Council

NOAA

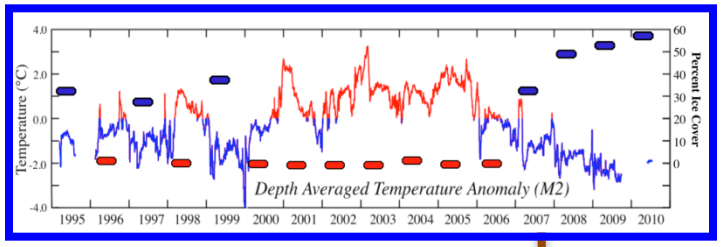
Bering Sea Pollock

Quota reduced during bad times preventing longer term impacts (and increased when good times returned)

North Pacific Fishery Management Council

Council adopts SSC recommendation to reduce pollock harvest

5



NPCREP - Mooring 2

2005 temperature and zooplankton data show unfavorable ocean conditions for recruitment

1

NPCREP

Science and Statistical Committee (SSC) receives warning and recommends harvest reductions

4

Help?

NMFS warnings of poor environmental conditions reported in assessments

3

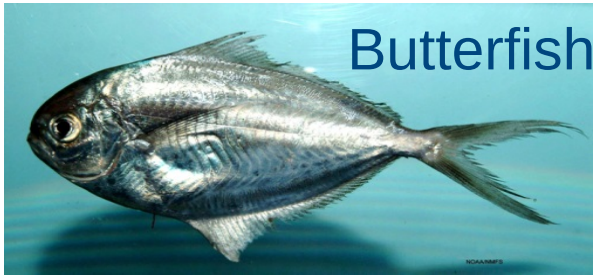
Stock assessment model reveals low/declining recruitment

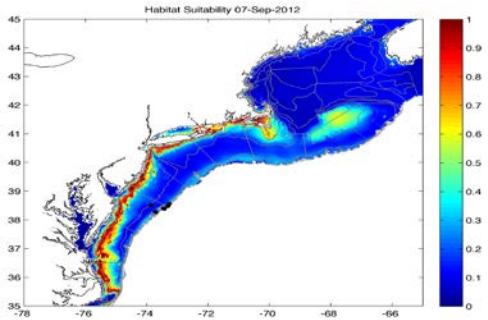
2

NOAA

Improving Stock Assessments for Climate-Ready Fisheries Management

- Identified Butterfish thermal preferences
- Identified ocean areas with those temperatures
- Included both in stock assessment models
- Improved stock assessment
- More effective fishery management in changing conditions

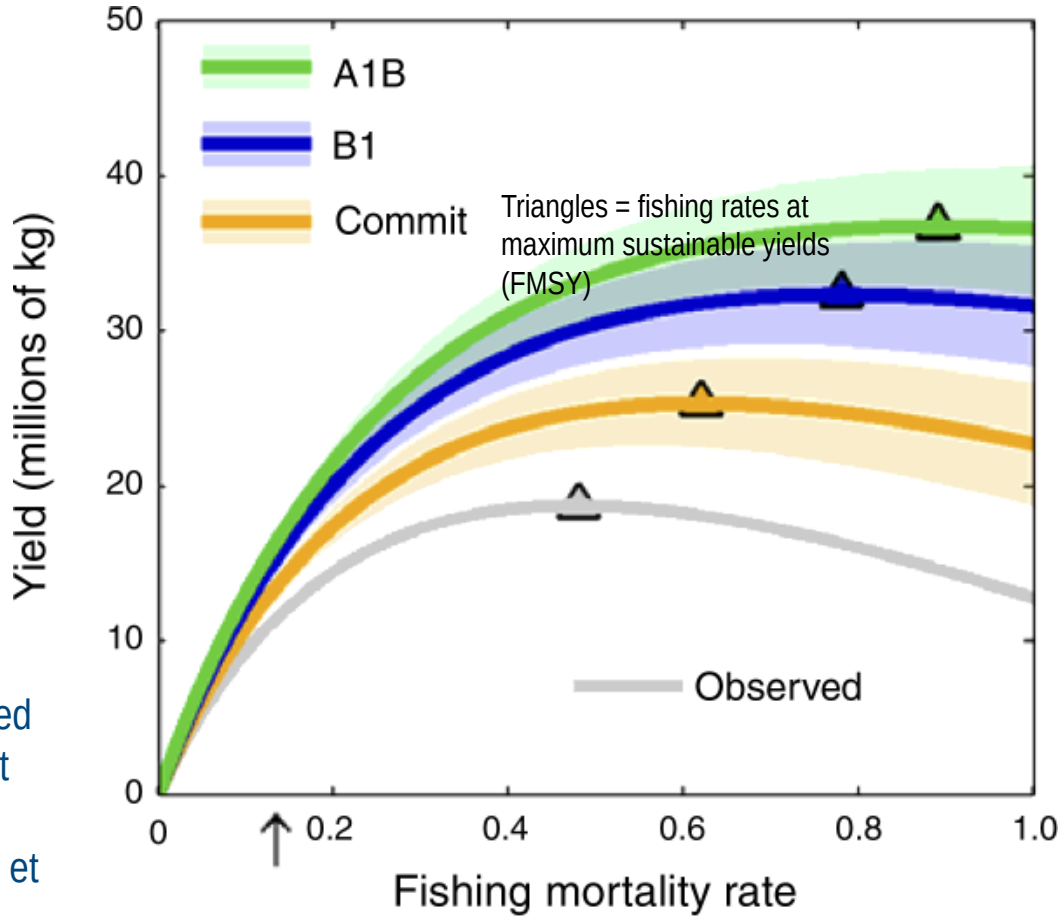




NOAA FISHERIES

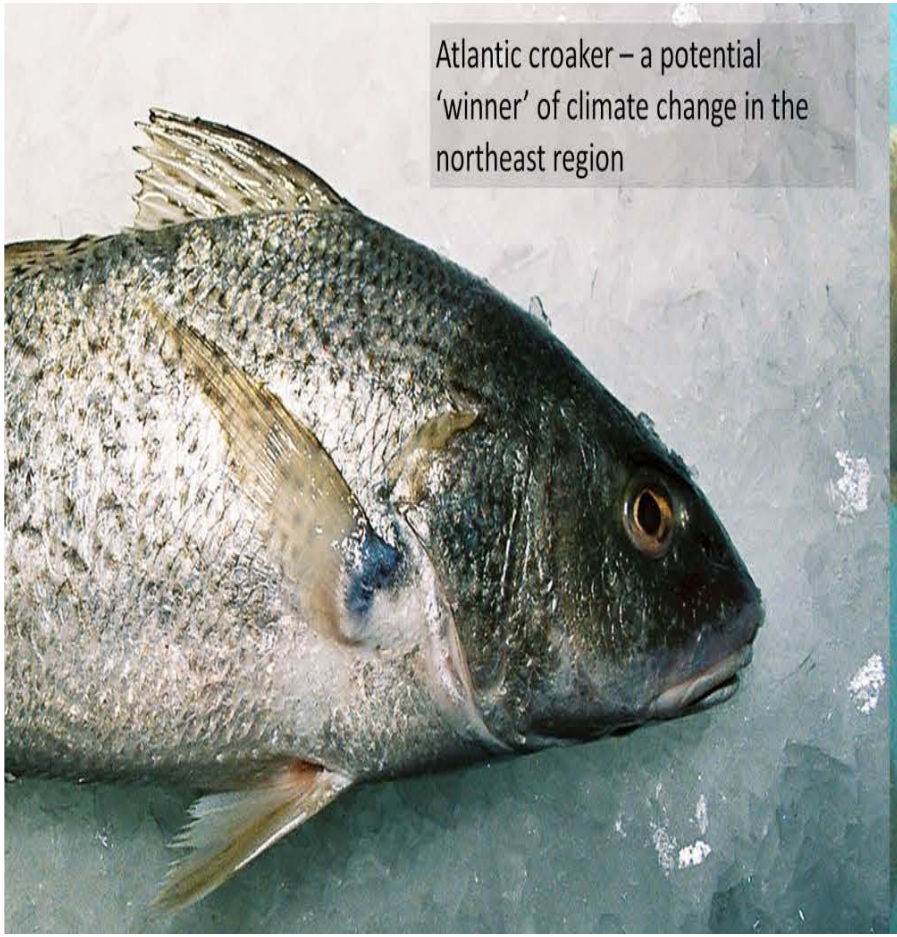
http://www.mafmc.org/newsfeed/2014/butterfish-assessment

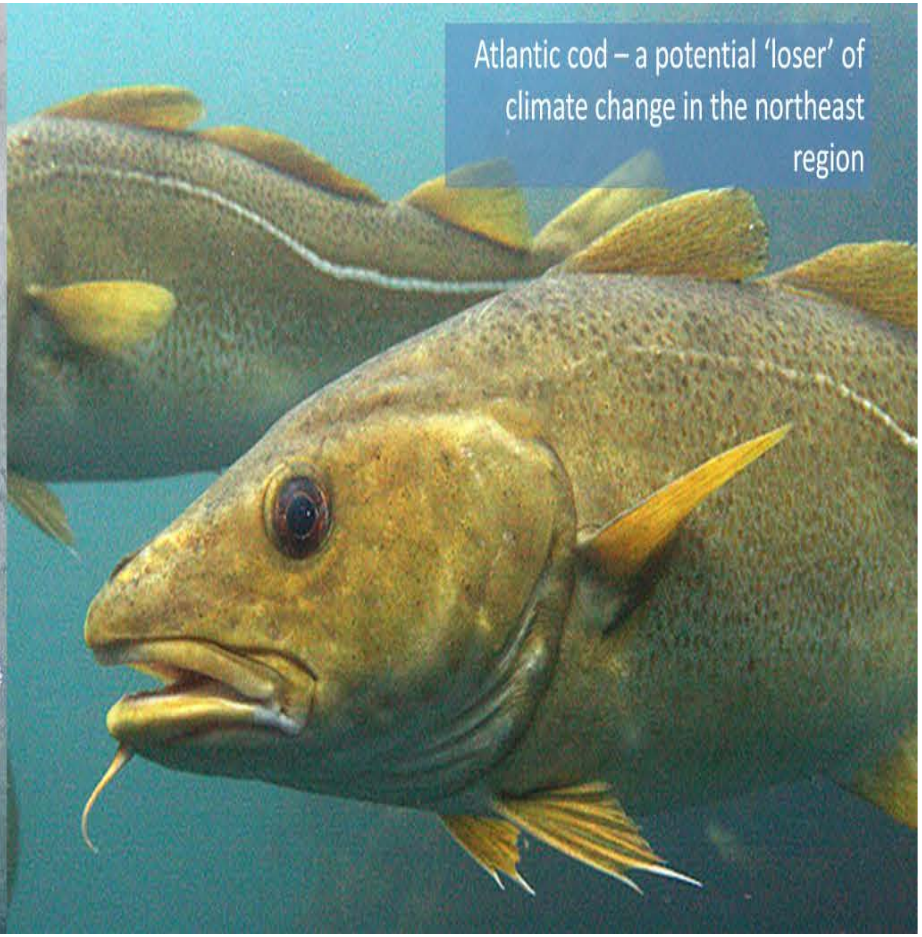
Resource levels under future climate conditions?



Atlantic croaker fishery yield, in the mid-Atlantic region, as a function of fishing mortality rate based on the temperature-dependent stock–recruitment model and ensemble multi-model mean of three climate scenarios (A1B, B1, and commit). (Hare et al. 2010)

Planning for Climate Related Changes on Stocks

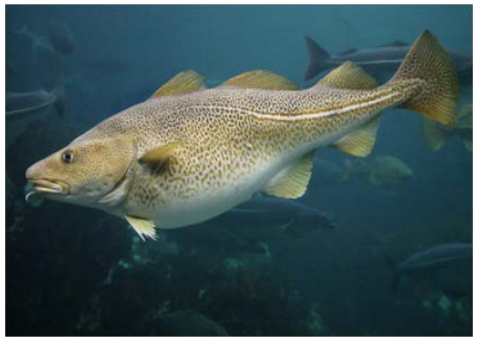




Implications for Fisheries Management?

Changes in abundance/productivity:

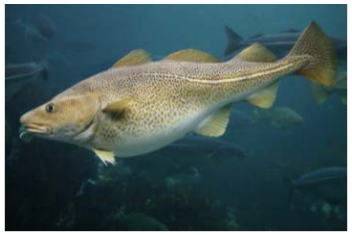
- How improve environmental sensitivity of stock assessments?
- When and how to adjust biological reference points?
- How incorporate into harvest levels?
- How incorporate into rebuilding plans?
- How approach new fisheries?
- When/where affect aquaculture practices?
- How assist affected sectors & communities?




CHANGE
AHEAD

What is Climate-ready Fisheries Management?

1. Sustain the basics



2. Plan for a changing future

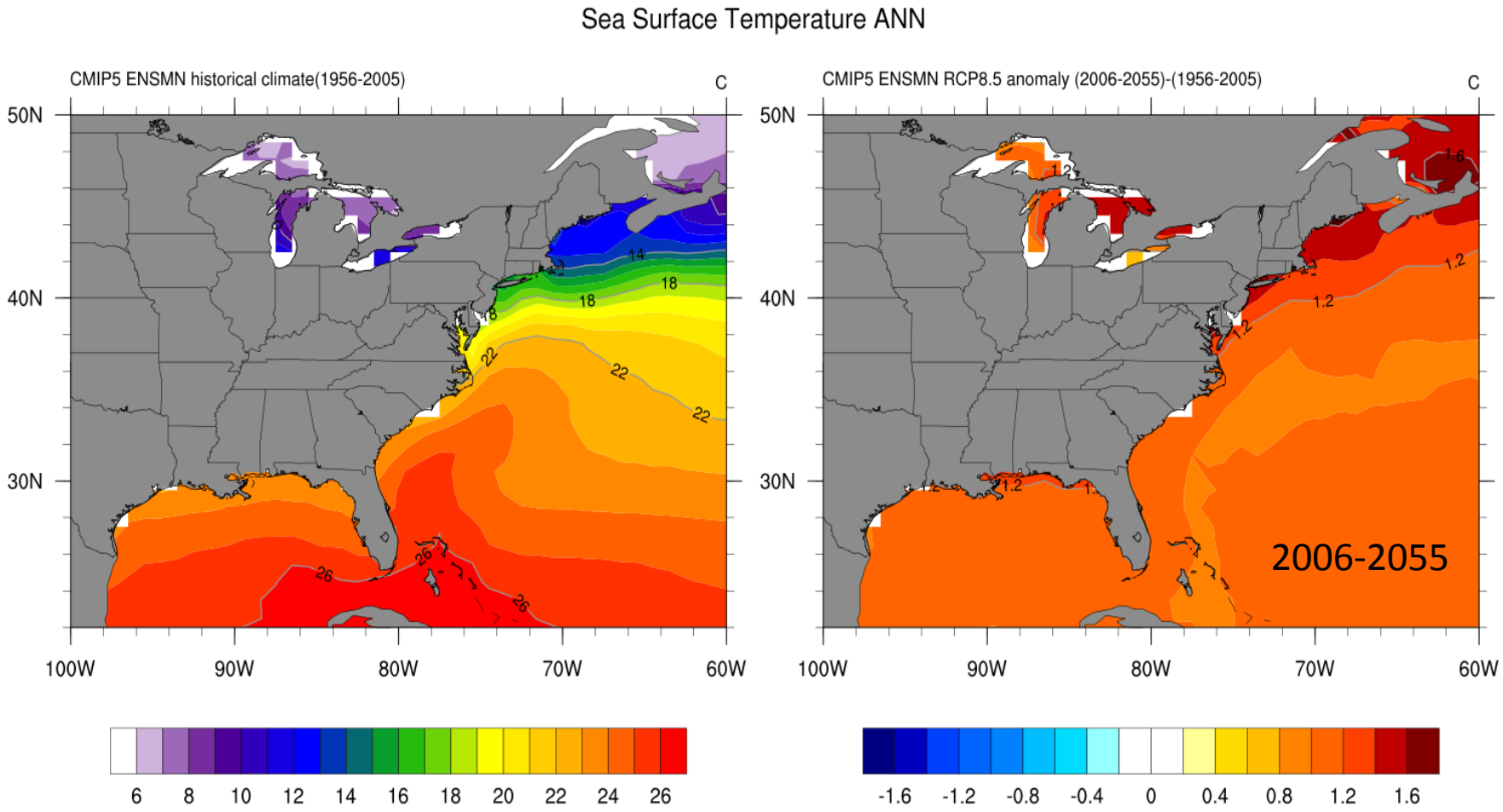
3. Monitor for surprises

4. Have flexible, responsive management.

5. Consider barriers to adaptation

We have good idea what to plan for

Climate projections – NE Surface Temperature

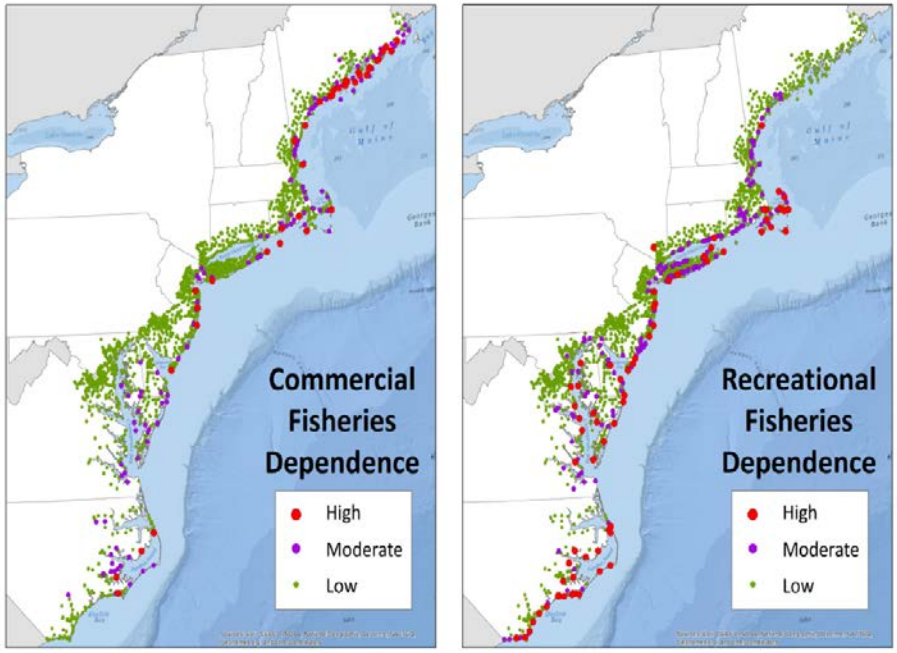


http://www.esrl.noaa.gov/psd/ipcc/ocn/ Jamie Scott and Mike Alexander

Assessing Risks and Resilience of Fishing Communities

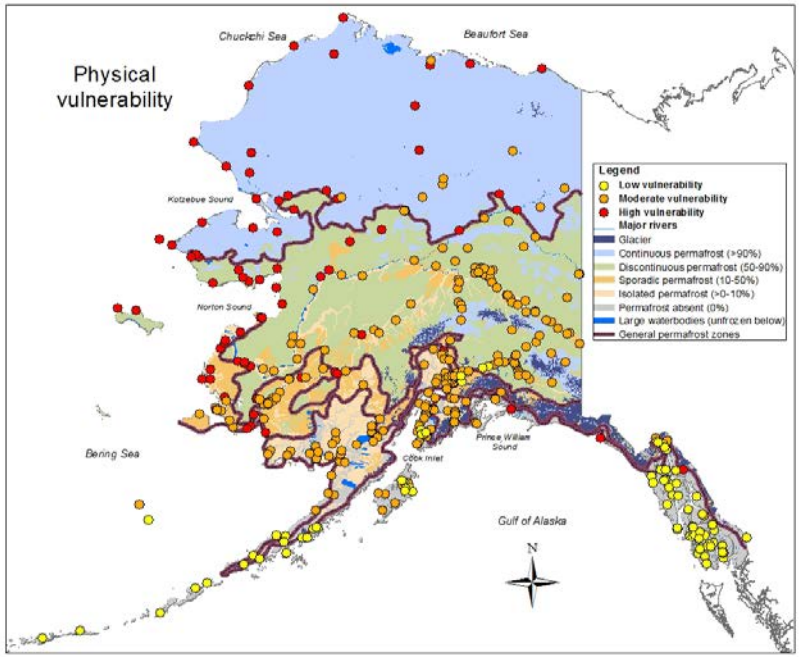
What is changing? Who is at risk? How increase resilience?

TRACKING CHANGE



NMFS Community Vulnerability and Resilience Indicators Project

WHAT IS VULNERABLE?



Alaska Fishing Community Vulnerability Assessment
Himes-Cornell and Kasperski 2015

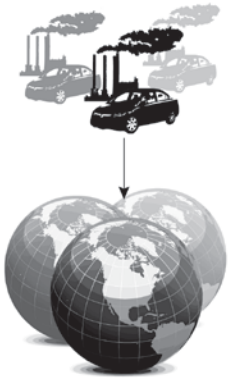
Projecting future conditions and management strategies

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Alaska CLIMate Project

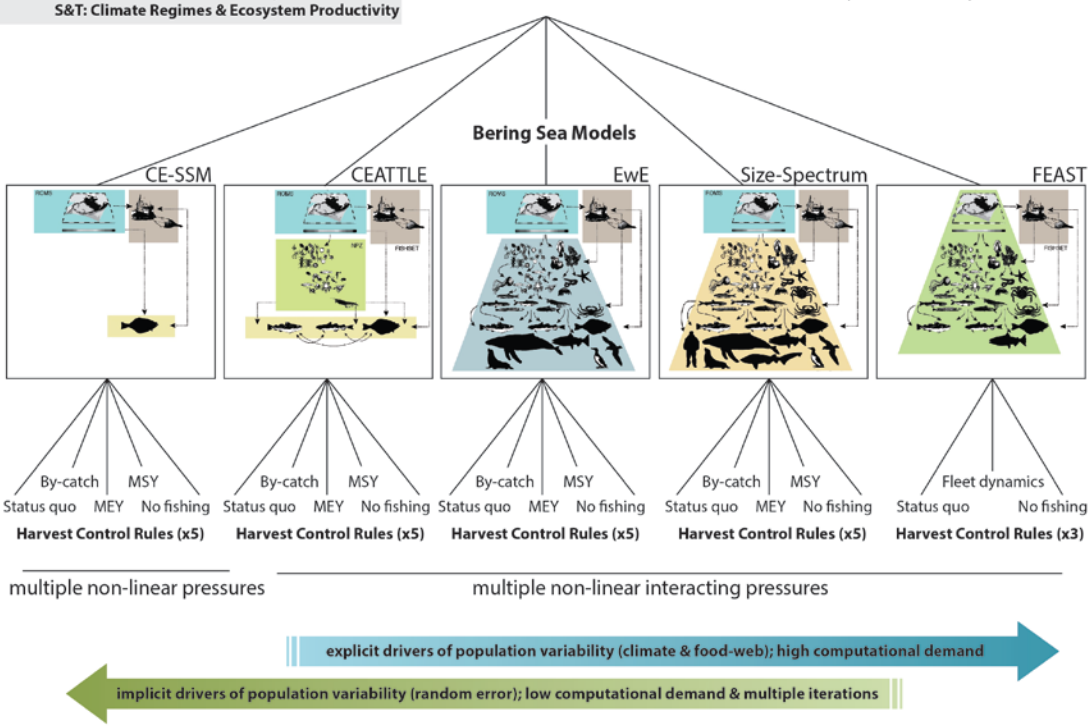
Anne Hollowed (AFSC, SSMA/REFM)
Kirstin Holsman (AFSC, REEM/REFM)
Alan Haynie (AFSC ESSR/REFM)
Stephen Kasperski (AFSC ESSR/REFM)
Jim Ianelli (AFSC, SSMA/REFM)
Kerim Aydin (AFSC, REEM/REFM)
Trond Kristiansen (IMR, Norway)
Al Hermann (UW JISAO/PMEL)
Wei Cheng (UW JISAO/PMEL)
André Punt (UW SAFS)

FATE: Fisheries & the Environment
SAAM: Stock Assessment Analytical Methods
S&T: Climate Regimes & Ecosystem Productivity



IPCC Scenarios (x3)
AR4 A1B
AR5 RCP6.0
AR5 RCP8.5

Global Climate Models (x 11)
ECHO-G (AR4 A1B)
MIROC3.2 med res. (AR4 A1B)
CGCM3-t47 (AR4 A1B)
CCSM4-NCAR- PO (AR5 RCP 6.0 & 8.5)
MIROCESM-C- PO (AR5 RCP 6.0 & 8.5)
GFDL-ESM2M*- PO (AR5 RCP 6.0 & 8.5)
GFDL-ESM2M*- PON (AR5 RCP 6.0 & 8.5)



Climate scenarios

Ocean scenarios

Ecosystem scenarios

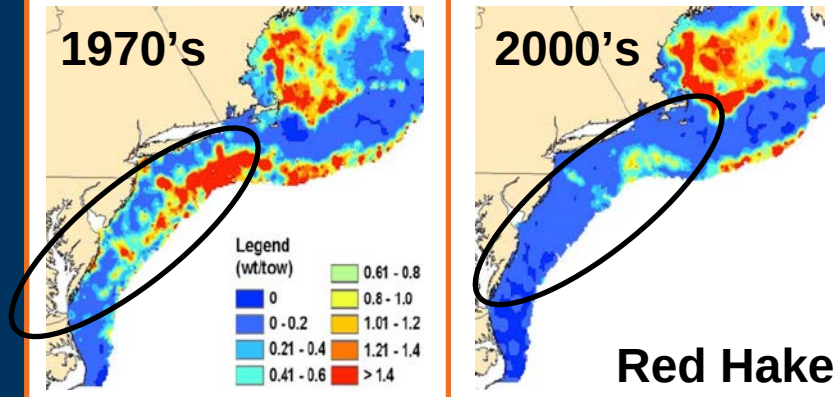
Fishing scenarios

Management scenarios

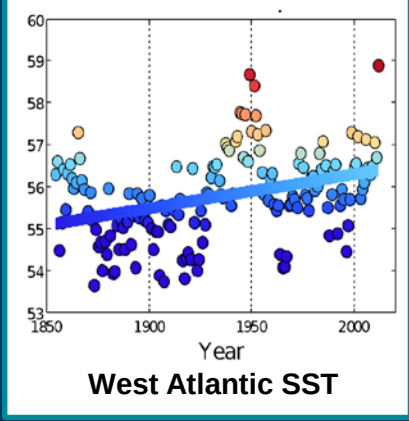
Informed Options

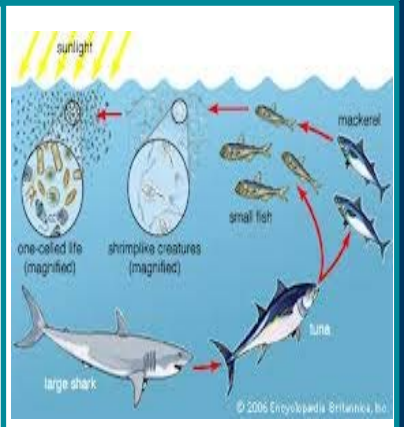
Growing Demands for Information

WHAT IS CHANGING?

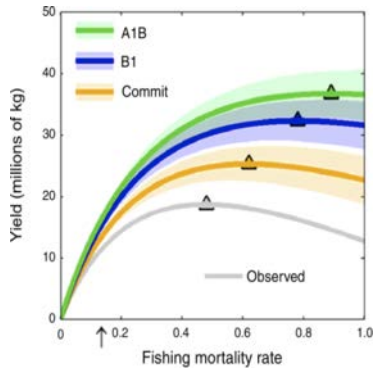


WHY IS IT CHANGING?

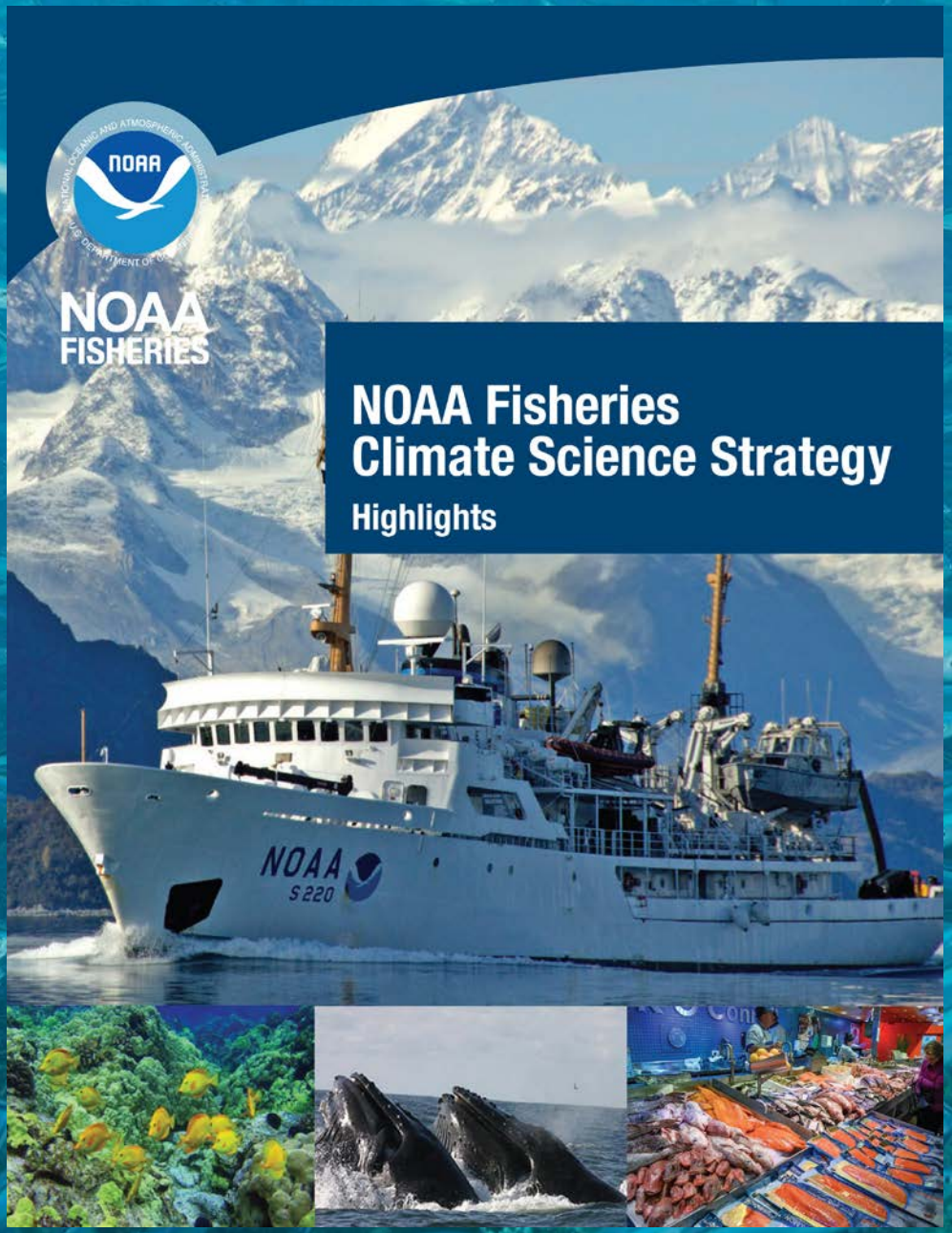




HOW WILL IT CHANGE?



HOW TO RESPOND?


NOAA
FISHERIES
NOAA Fisheries
Climate Science Strategy
Highlights
NOAA
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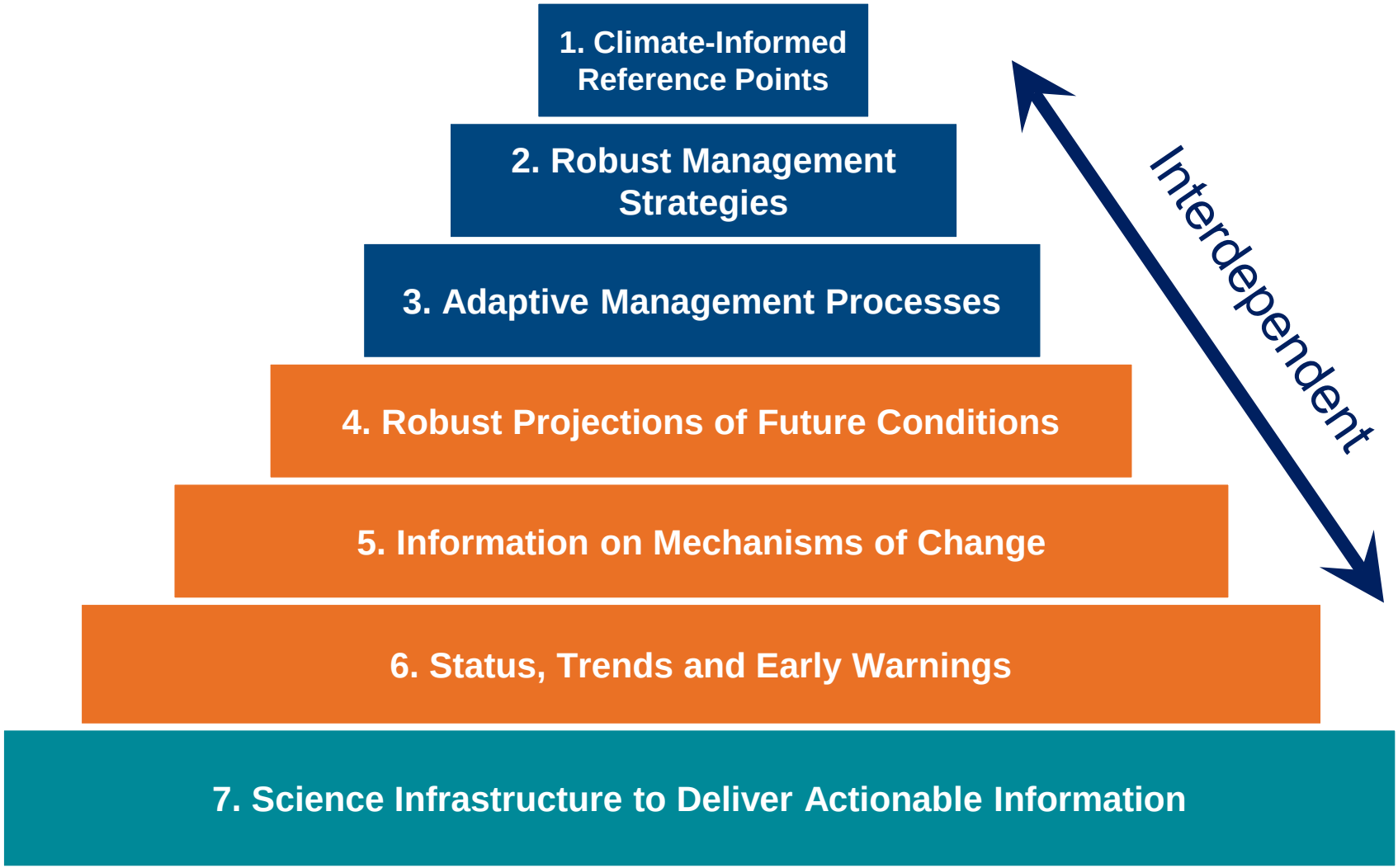
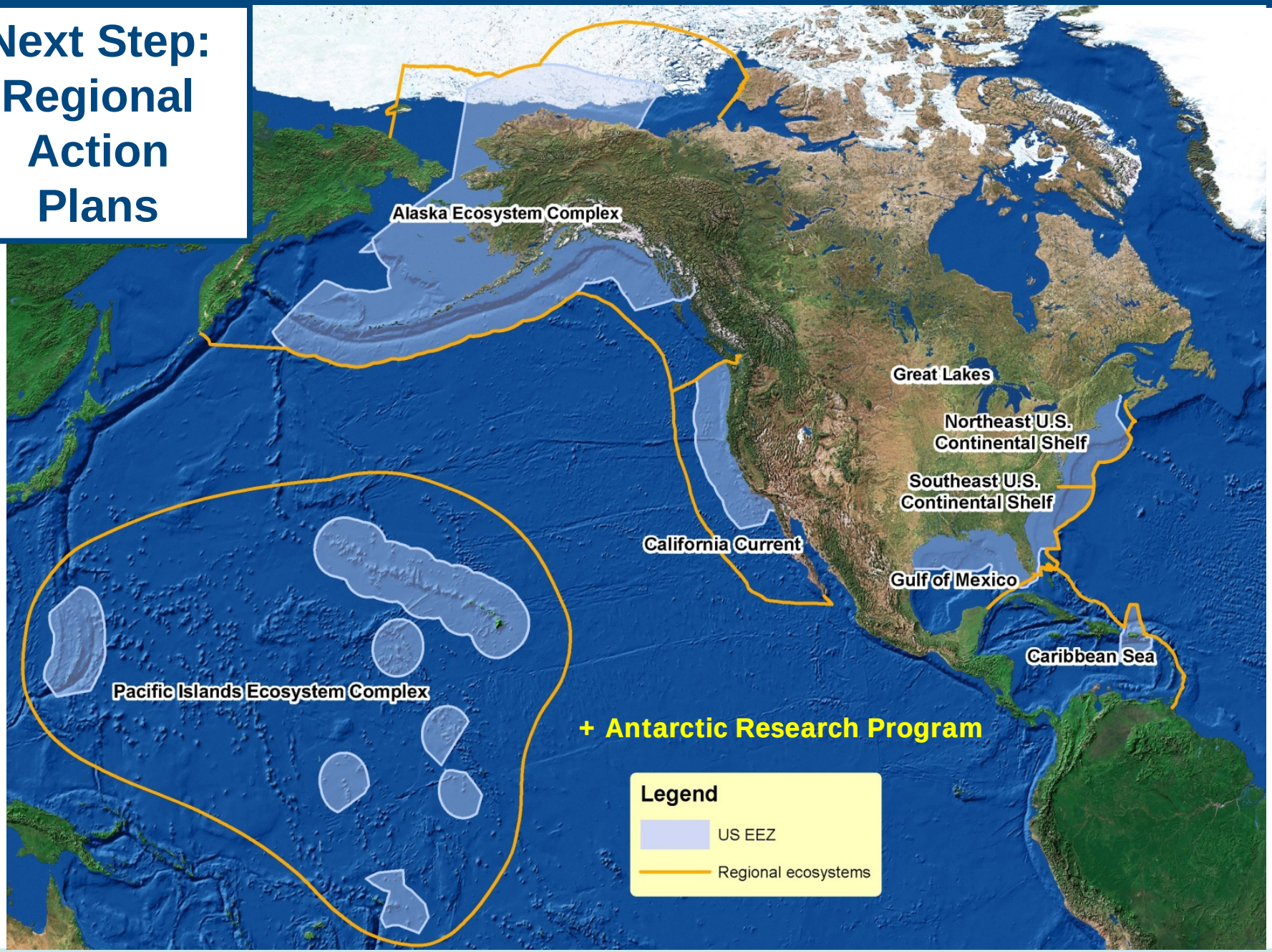
Climate Science Objectives



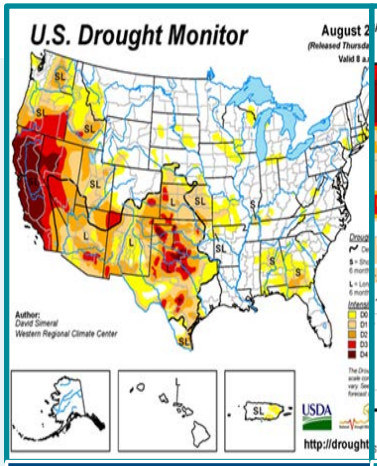
Expected Results

- ***Better tracking*** of ecosystem changes that provide early warnings of climate-related changes.
- ***Increased understanding*** of what's vulnerable and the mechanisms of change.
- ***Near and long term forecasts*** of ocean and resource conditions.
- ***Climate sensitive*** resource assessments and biological reference points.
- ***Robust management scenarios.***
- ***Reduced impacts and increased resilience.***

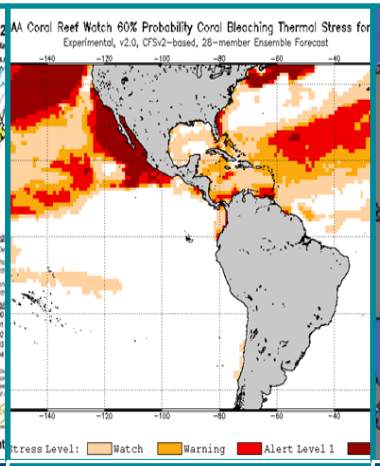
Next Step: Regional Action Plans



Growing Challenges for Resource Management



Droughts



Warming Oceans

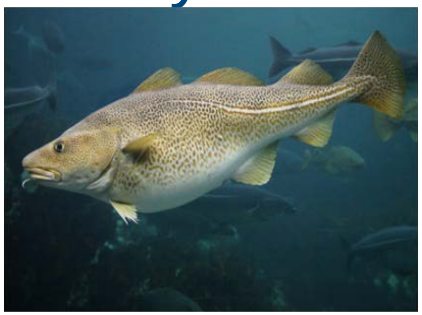
Loss of Sea Ice

Rising Seas

Ocean Acidification

Action now can reduce impacts and increase resilience.

Ecosystems



Businesses

Communities


Thank you
www.st.nmfs.noaa.gov/ecosystems/climate