Fisheries and Climate Change in the Gulf of Maine: Challenges and Opportunities for Fishing Communities

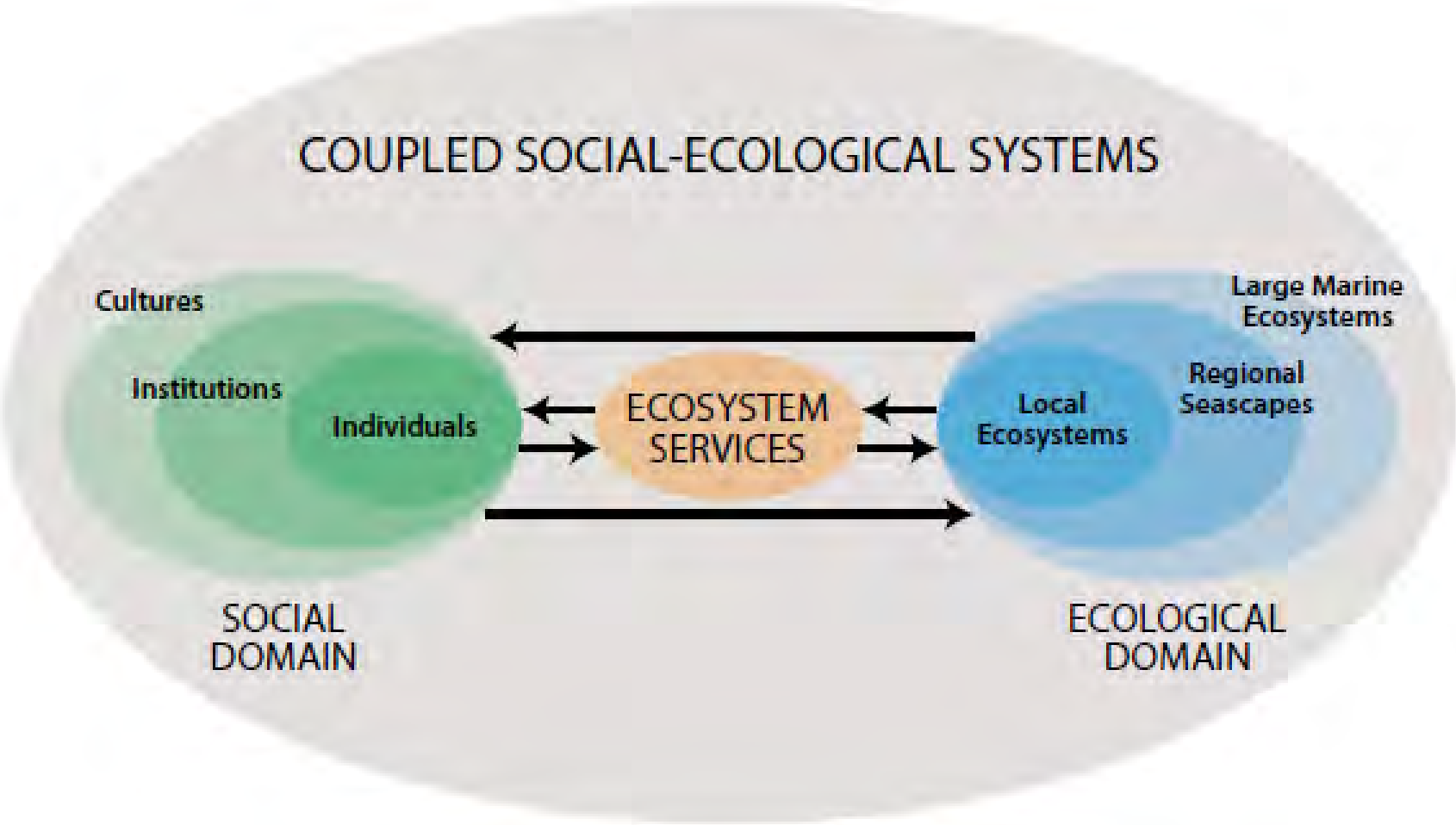
Coastal NH Climate Summit

May 13, 2016

Dr. Erik Chapman – UNH Fisheries Extension Specialist

Sea Grant New Hampshire

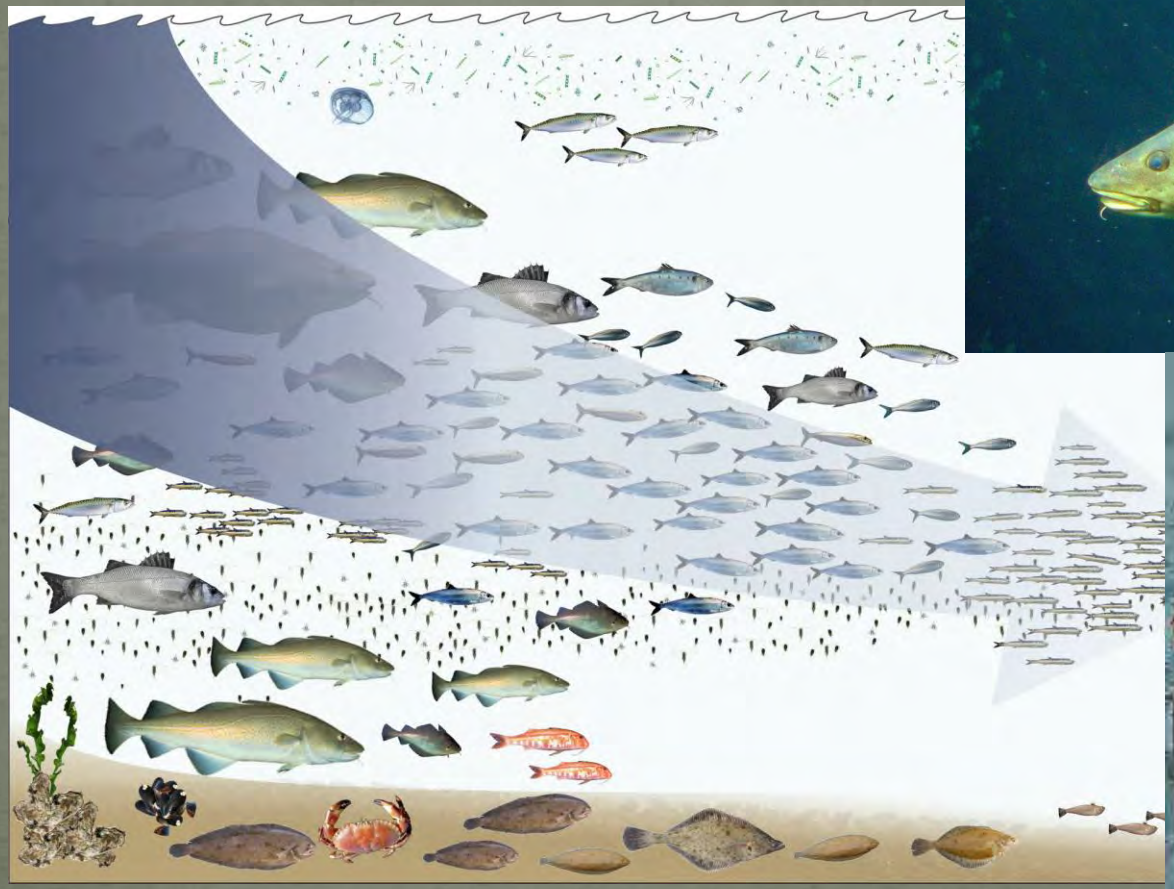
University of New Hampshire Cooperative Extension


COUPLED SOCIAL-ECOLOGICAL SYSTEMS
Cultures
Institutions
Individuals
ECOSYSTEM SERVICES
Large Marine Ecosystems
Regional Seascapes
Local Ecosystems
SOCIAL DOMAIN
ECOLOGICAL DOMAIN


RED
OCEAN

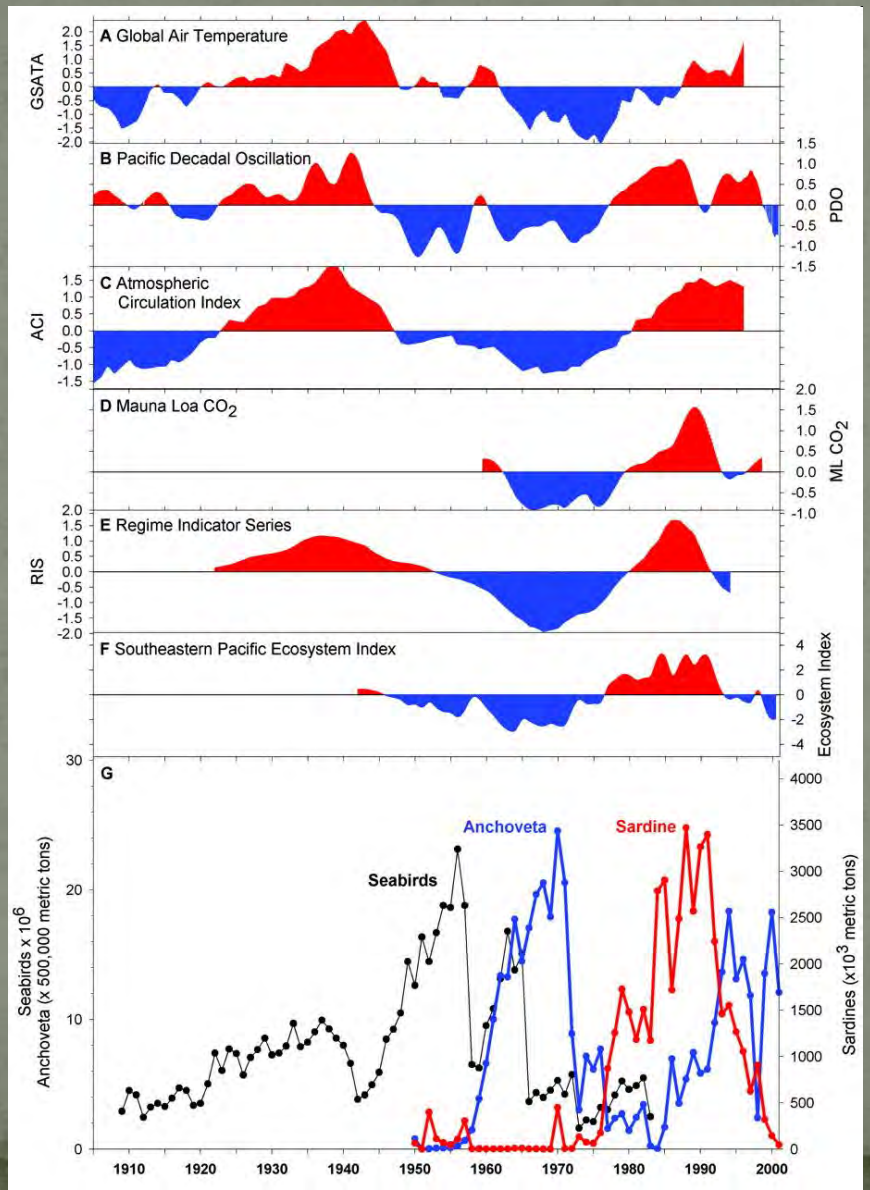
Human impacts

- Fishing



Climate Variability and Fish

(Chavez et al. 2003, Science, Vol 299)

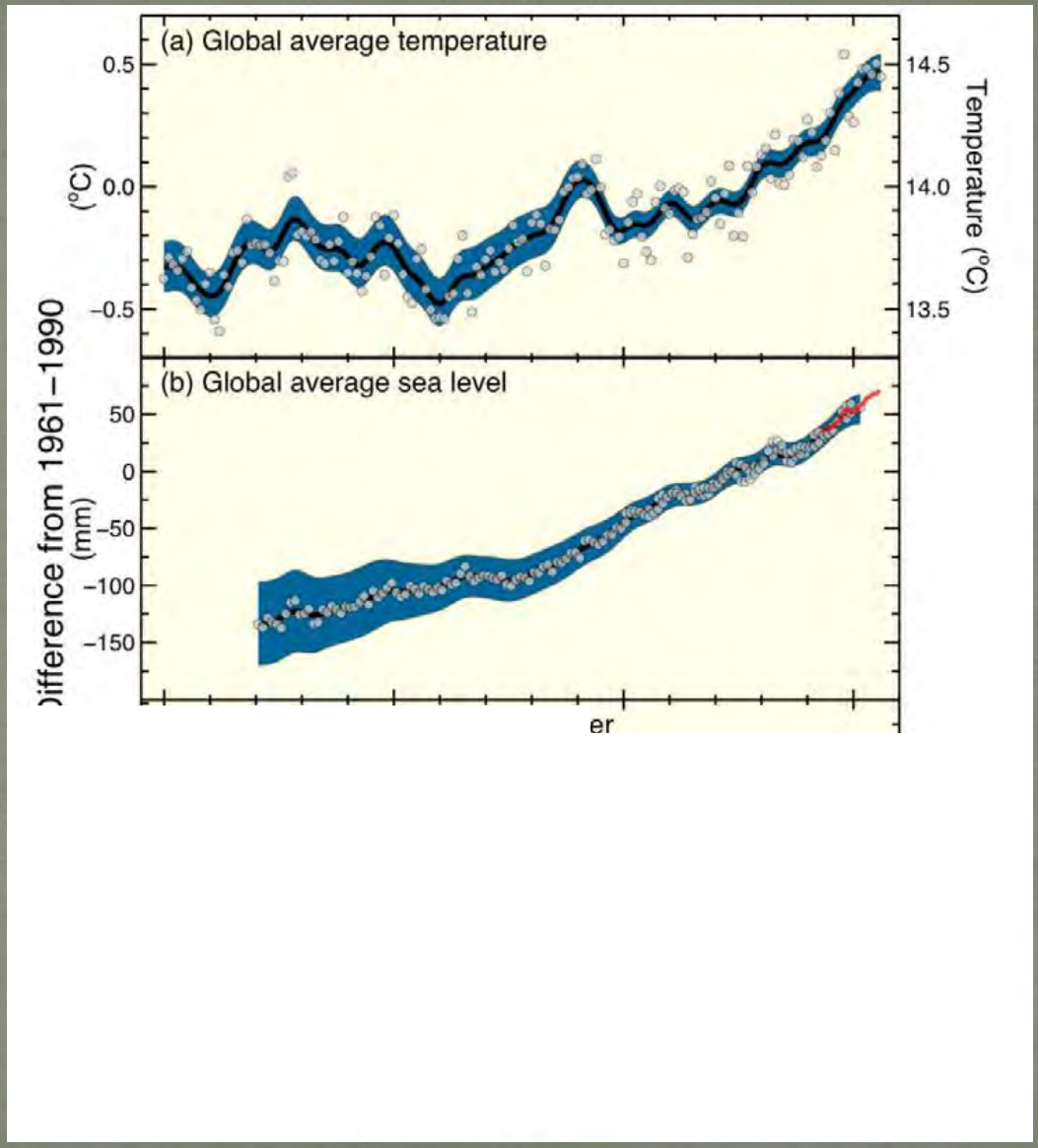


Cod # = fishing and climate index

Synergies between climate and management for Atlantic cod fisheries at high latitudes

Olav Sigurd Kjesbu[a,1], Bjarte Bogstad[a], Jennifer A. Devine[a], Harald Gjøsæter[a], Daniel Howell[a], Randi B. Ingvaldsen[b], Richard D. M. Nash[a], and Jon Egil Skjæraasen[a]

Striped Bass # = fishing and Atlantic Multi-decadal Oscillation (AMO)


(a) Global average temperature
0.5
0.0
−0.5
(°C)
14.5
14.0
13.5
Temperature (°C)
(b) Global average sea level
50
0
−50
−100
−150
(mm)
Difference from 1961–1990
er

Science
AAAS

Climate Change and Distribution Shifts in Marine Fishes

Allison L. Perry, *et al.*

Science **308**, 1912 (2005);
DOI: 10.1126/science.1111322

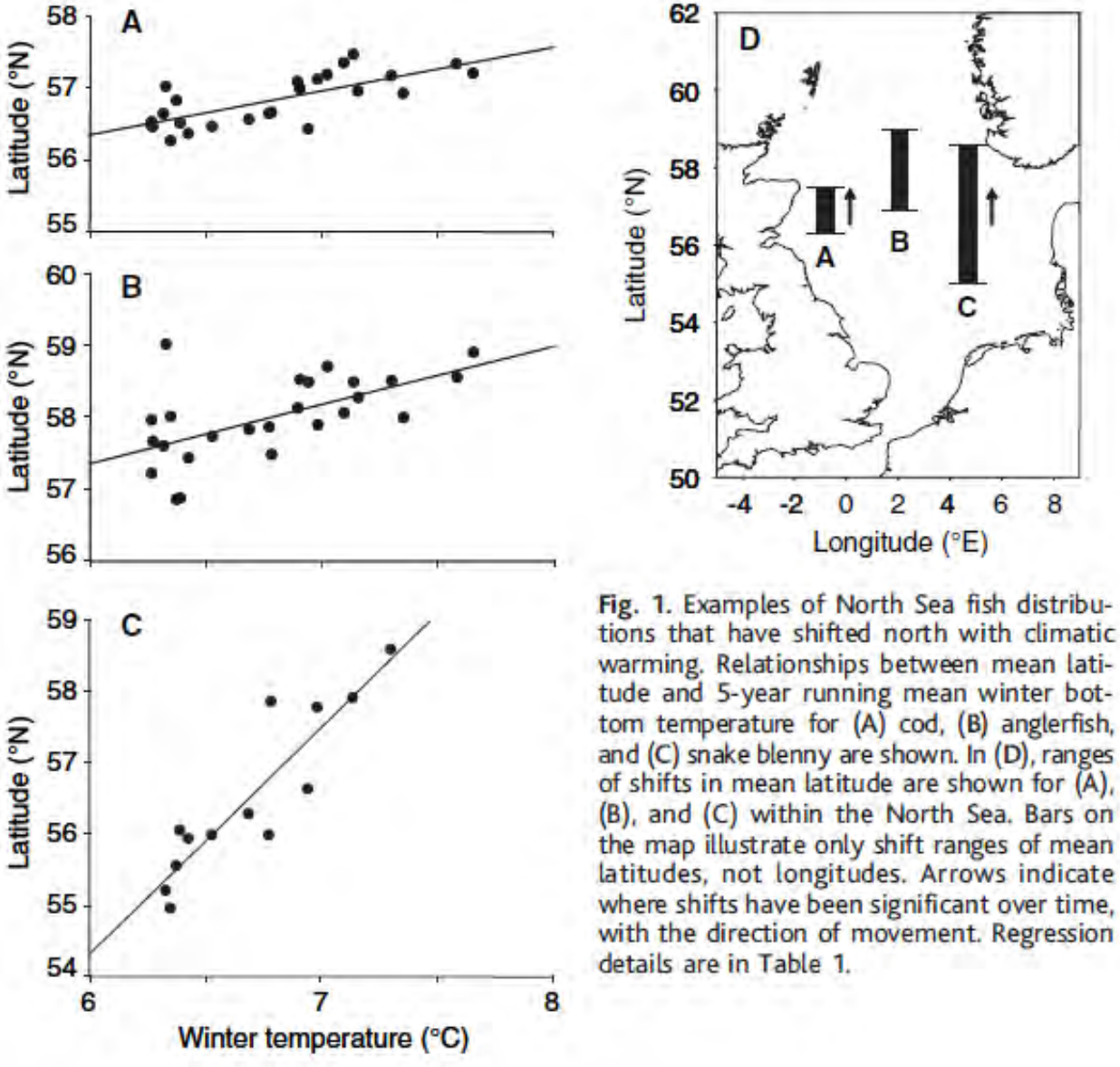
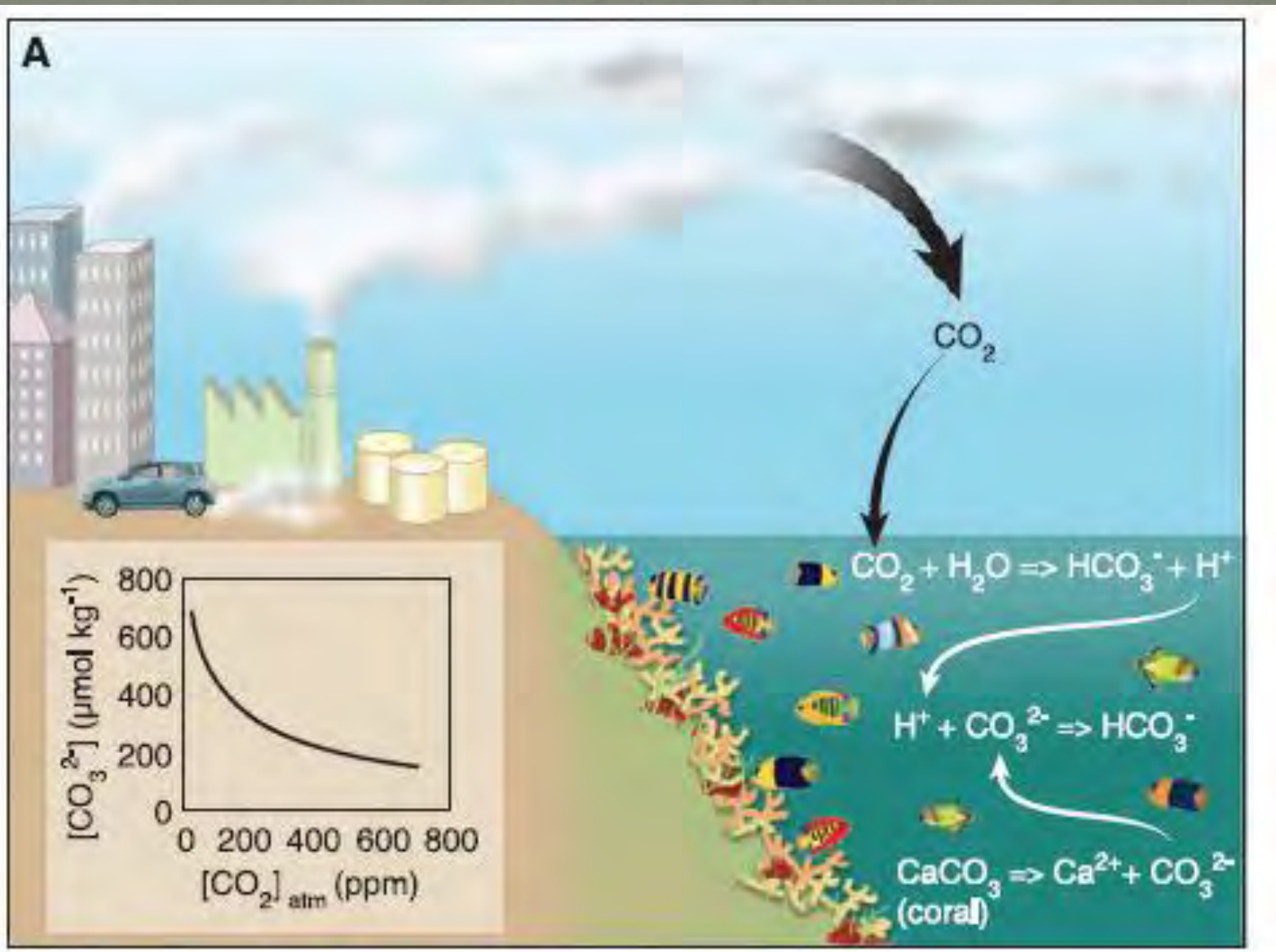


Fig. 1. Examples of North Sea fish distributions that have shifted north with climatic warming. Relationships between mean latitude and 5-year running mean winter bottom temperature for (A) cod, (B) anglerfish, and (C) snake blenny are shown. In (D), ranges of shifts in mean latitude are shown for (A), (B), and (C) within the North Sea. Bars on the map illustrate only shift ranges of mean latitudes, not longitudes. Arrows indicate where shifts have been significant over time, with the direction of movement. Regression details are in Table 1.

Ocean Acidification



Example…Pacific Northwest, Puget Sound Shellfish Industry

Estuarine, Coastal and Shelf Science 88 (2010) 442–449

Contents lists available at ScienceDirect

Estuarine, Coastal and Shelf Science

journal homepage: www.elsevier.com/locate/ecss

The combined effects of ocean acidification, mixing, and respiration on pH and carbonate saturation in an urbanized estuary

Richard A. Feely [a,*], Simone R. Alin [a], Jan Newton [b], Christopher L. Sabine [a], Mark Warner [c], Allan Devol [c], Christopher Krembs [d], Carol Maloy [d]

[a] Pacific Marine Environmental Laboratory/NOAA, 7600 Sand Point Way NE, Seattle, WA 98115, USA
[b] Applied Physics Laboratory, University of Washington, Box 355640, Seattle, WA 98105, USA
[c] School of Oceanography, University of Washington, Box 355351, Seattle, WA 98195, USA
[d] Washington State Department of Ecology, PO Box 47710, Olympia, WA 98504-7710, USA

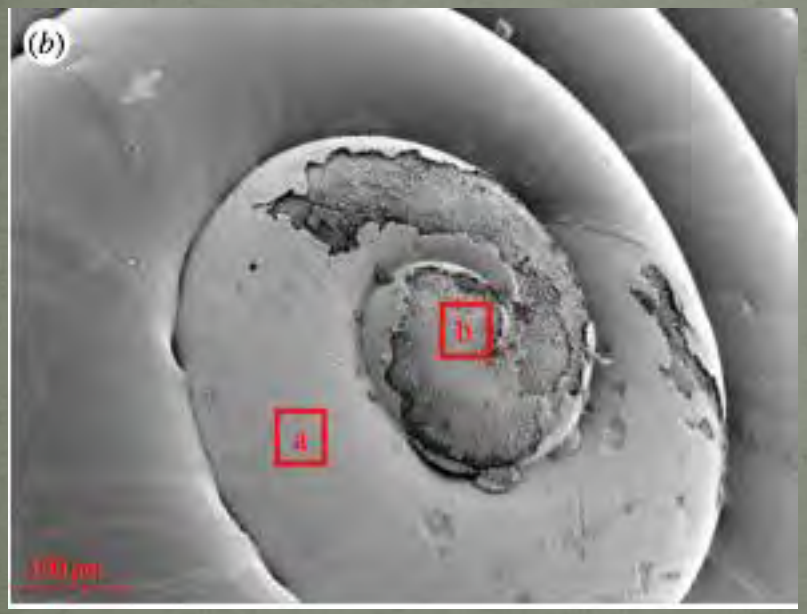
Example…Alaskan pink salmon and pteropods

PROCEEDINGS OF THE ROYAL SOCIETY B

rspb.royalsocietypublishing.org

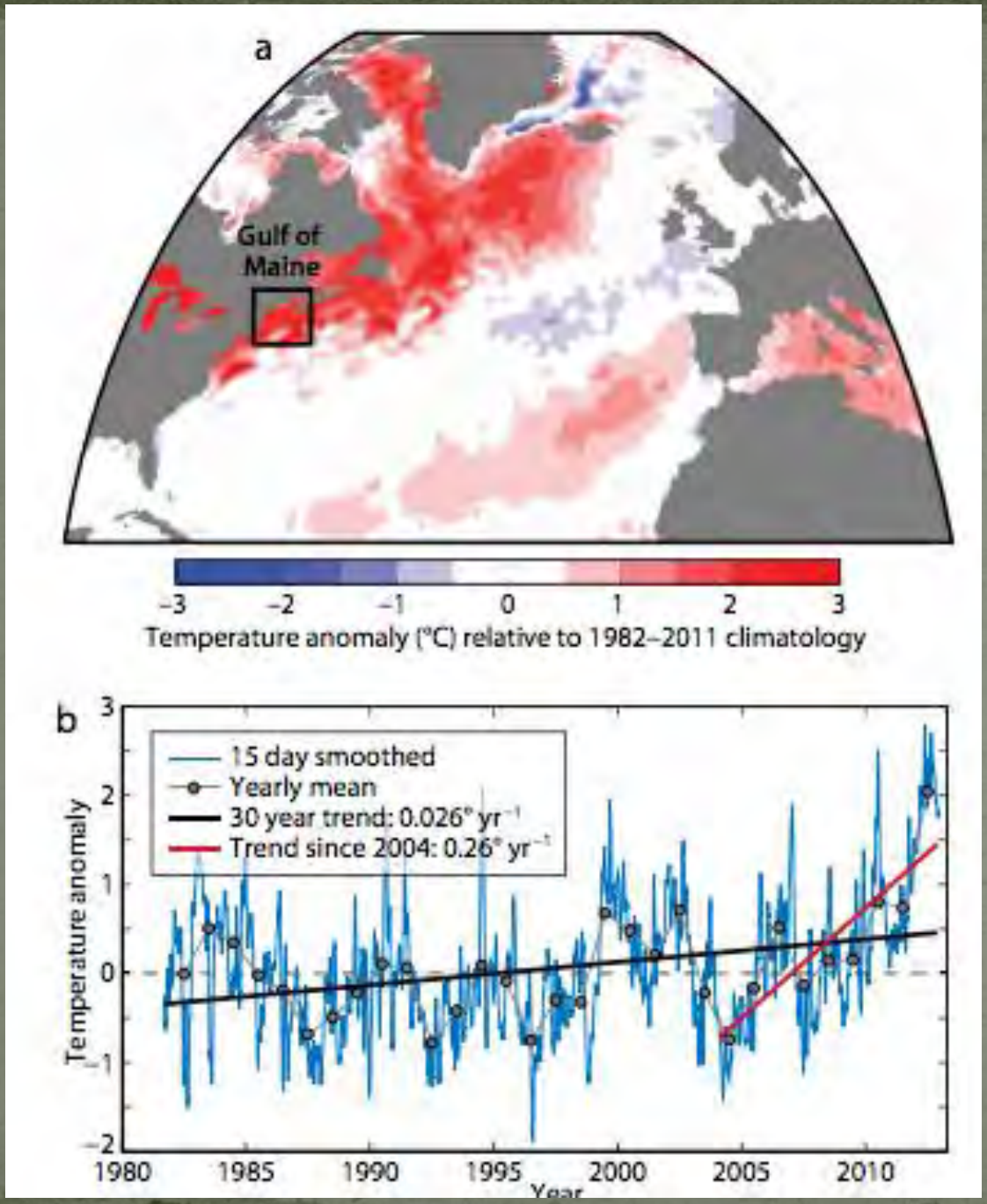
Limacina helicina shell dissolution as an indicator of declining habitat suitability owing to ocean acidification in the California Current Ecosystem

N. Bednaršek[1], R. A. Feely[1], J. C. P. Reum[2], B. Peterson[3], J. Menkel[4], S. R. Alin[1] and B. Hales[5]



Combined effects of fishing and climate change….

- Fishing
  - Reduces size and genetic variability in a population
  - Changes size and age-at-maturity
- Fish stocks are MORE vulnerable (less resilient) to effects of climate change



Mills et al. Ocean Policy, 2013


ME 6146 T
BADGER'S ISLAND, MAINE

Current Situation

Sustainability requires adapting to dynamic and unpredictable…….

- Markets
- Management
- Ecosystems

Fishing Communities

Vol. 393: 111–129, 2009
doi: 10.3354/meps08220

MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser

Published October 30

Changing spatial distribution of fish stocks in relation to climate and population size on the Northeast United States continental shelf

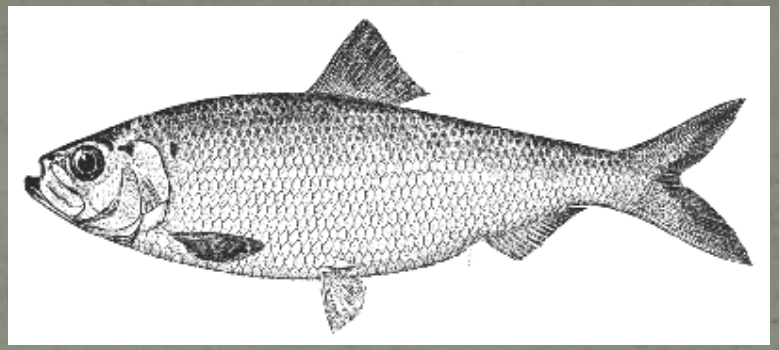
Janet A. Nye[1,*], Jason S. Link[1], Jonathan A. Hare[2], William J. Overholtz[1]

[1]National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole Laboratory, 166 Water St., Woods Hole, Massachusetts 02543, USA

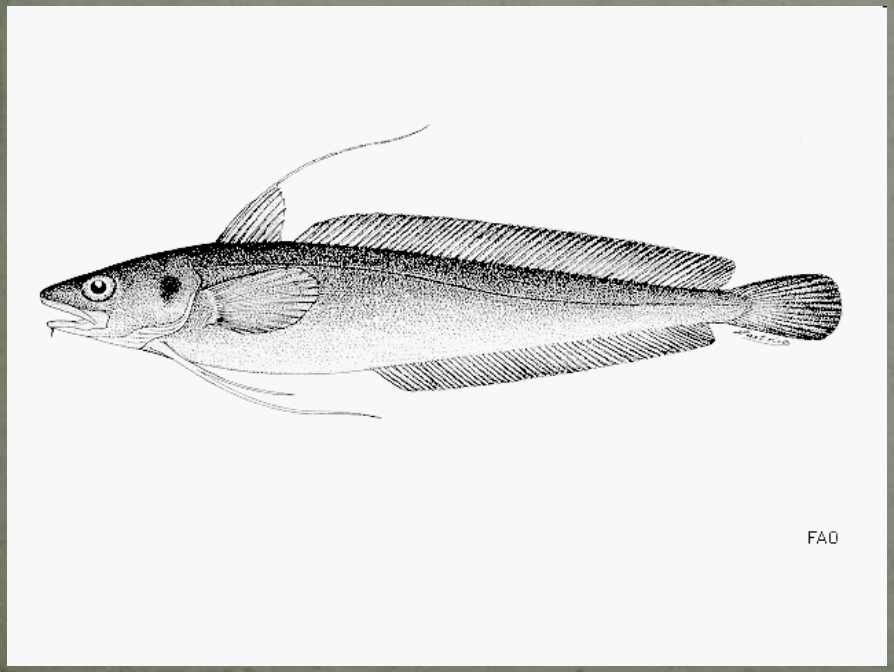
[2]National Marine Fisheries Service, Northeast Fisheries Science Center, Narragansett Laboratory, 28 Tarzwell Drive, Narragansett, Rhode Island 02882, USA

American shad

Alewife



Red hake



Yellowtail flounder

Atlantic croaker

Atlantic cod

Cod larva

CLIMATE CHANGE

Slow adaptation in the face of rapid warming leads to collapse of the Gulf of Maine cod fishery

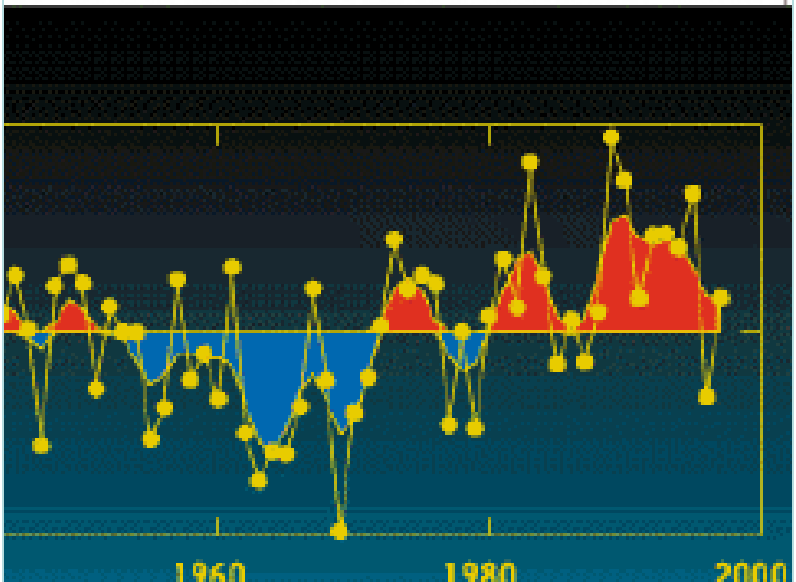
Andrew J. Pershing,[1]* Michael A. Alexander,[2] Christina M. Hernandez,[1]† Lisa A. Kerr,[1] Arnault Le Bris,[1] Katherine E. Mills,[1] Janet A. Nye,[3] Nicholas R. Record,[4] Hillary A. Scannell,[1,5]‡ James D. Scott,[2,6] Graham D. Sherwood,[1] Andrew C. Thomas[5]

Several studies have documented fish populations changing in response to long-term warming. Over the past decade, sea surface temperatures in the Gulf of Maine increased faster than 99% of the global ocean. The warming, which was related to a northward shift in the Gulf Stream and to changes in the Atlantic Multidecadal Oscillation and Pacific Decadal Oscillation, led to reduced recruitment and increased mortality in the region's Atlantic cod (*Gadus morhua*) stock. Failure to recognize the impact of warming on cod contributed to overfishing. Recovery of this fishery depends on sound management, but the size of the stock depends on future temperature conditions. The experience in the Gulf of Maine highlights the need to incorporate environmental factors into resource management.

Gulf of Maine Cod = Fishing and climate index?

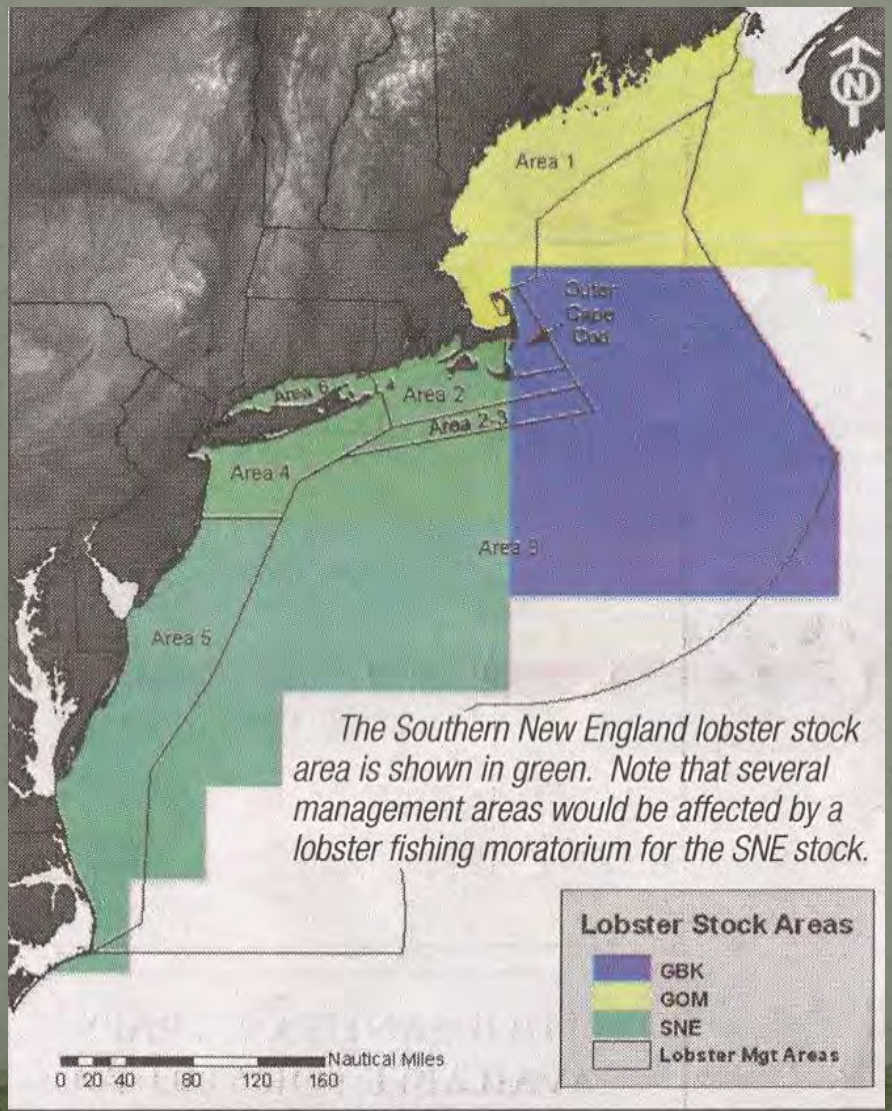
Cod Catch

North Atlantic Oscillation (NAO)

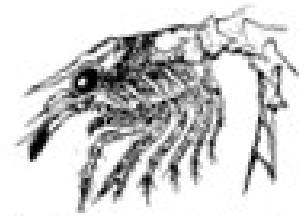


SNE lobster stock in 'recruitment failure'; TC calls for five-year fishing moratorium

by Janice M. Plante



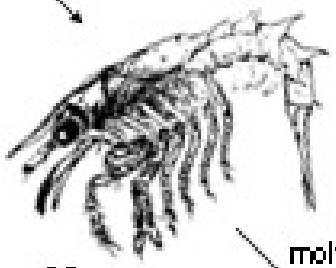
The Southern New England lobster stock area is shown in green. Note that several management areas would be affected by a lobster fishing moratorium for the SNE stock.



Stage I

8 mm = 0.3 in

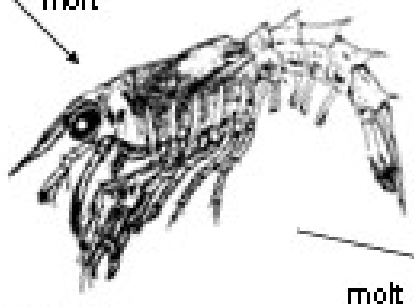
molt



Stage II

9 mm = 0.35 in

molt



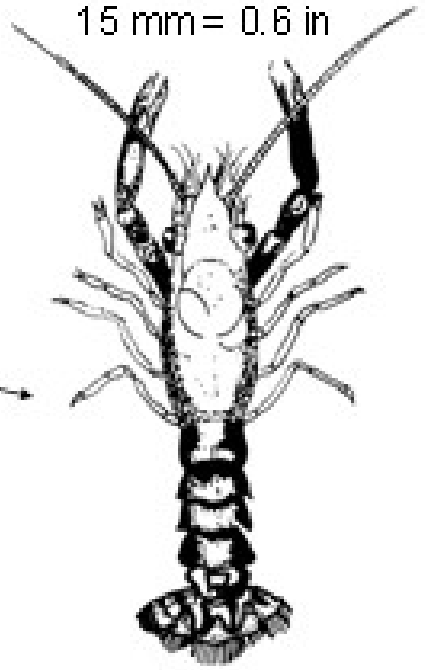
Stage III

11 mm = 0.43 in

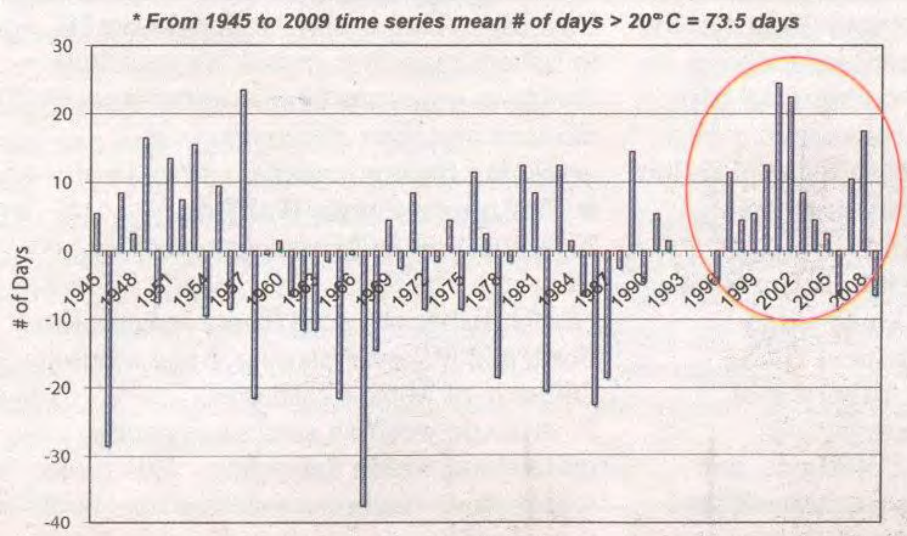
molt

Stage IV

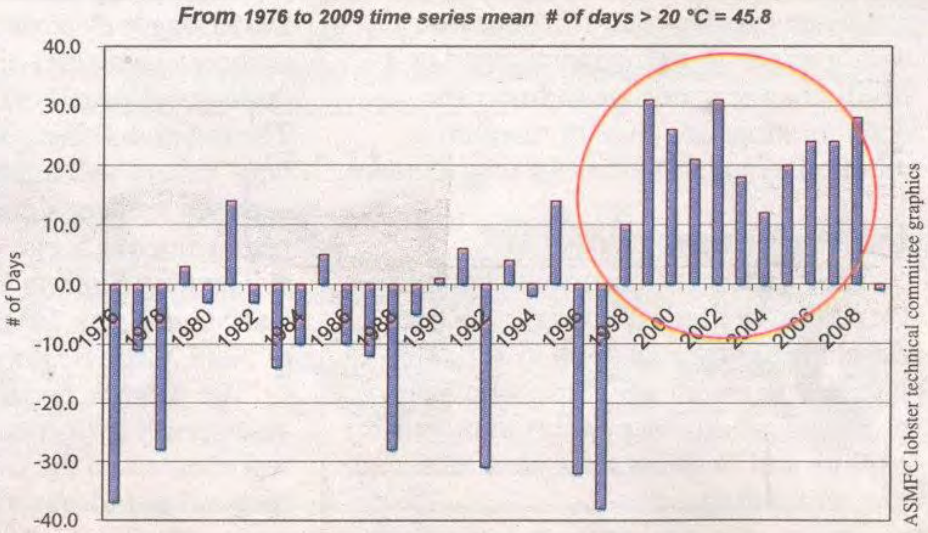
15 mm = 0.6 in



Total Days above 20° c in Southern New England

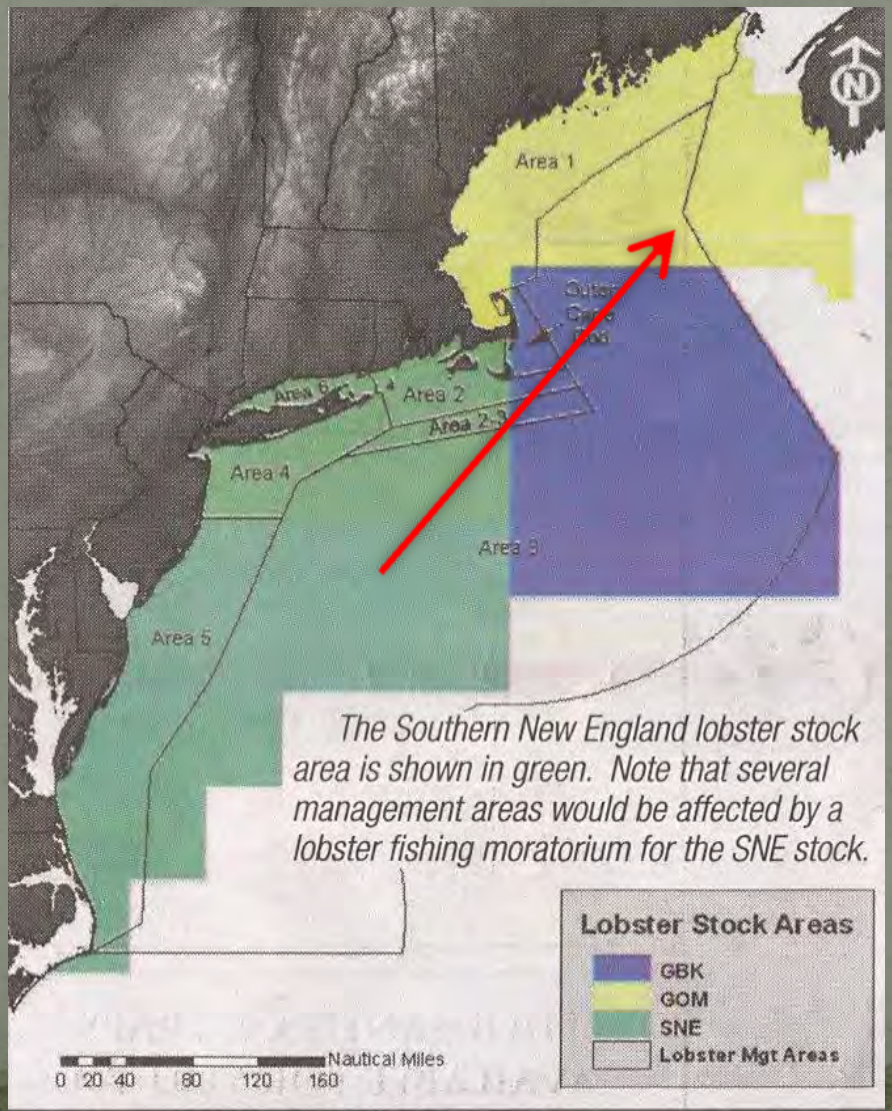


Woods Hole, MA sea-surface temperature from 1945 to 2009. From 1999 on, temperatures often rose above 20°C. Lobsters avoid water greater than 19°C.



Millstone Power Station, Long Island Sound bottom temperature from 1976 through 2009.

Ecosystem Migration



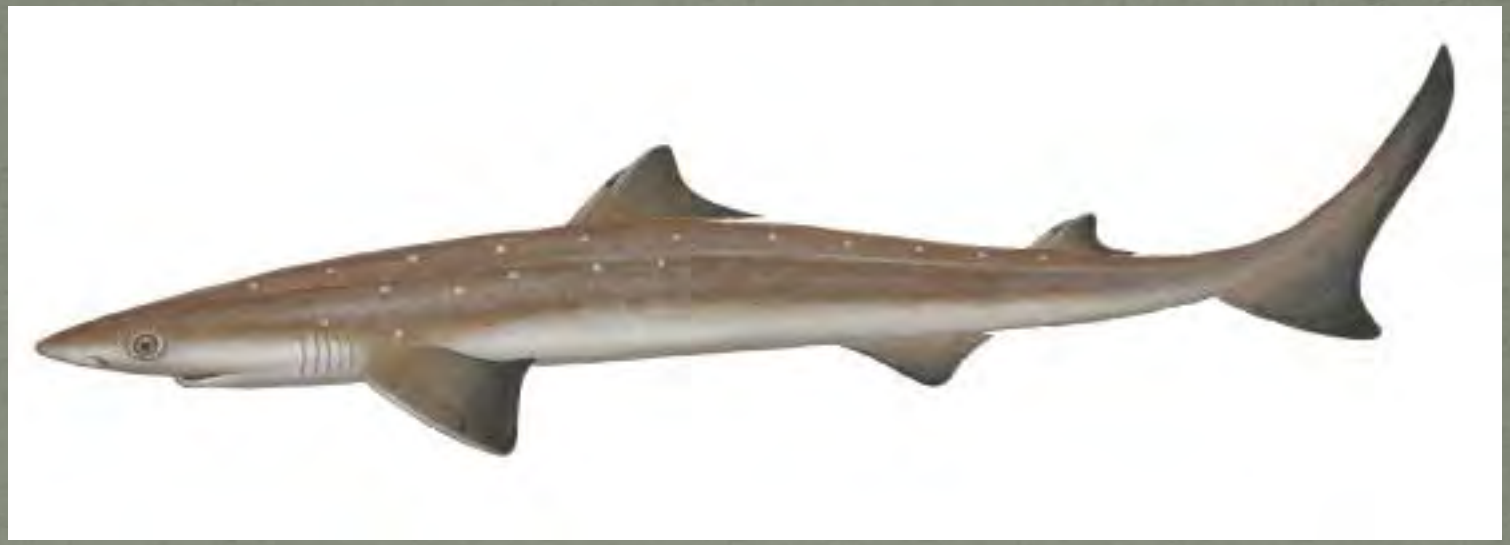
Northern Shrimp

Invasive green crab

Expanding ranges…

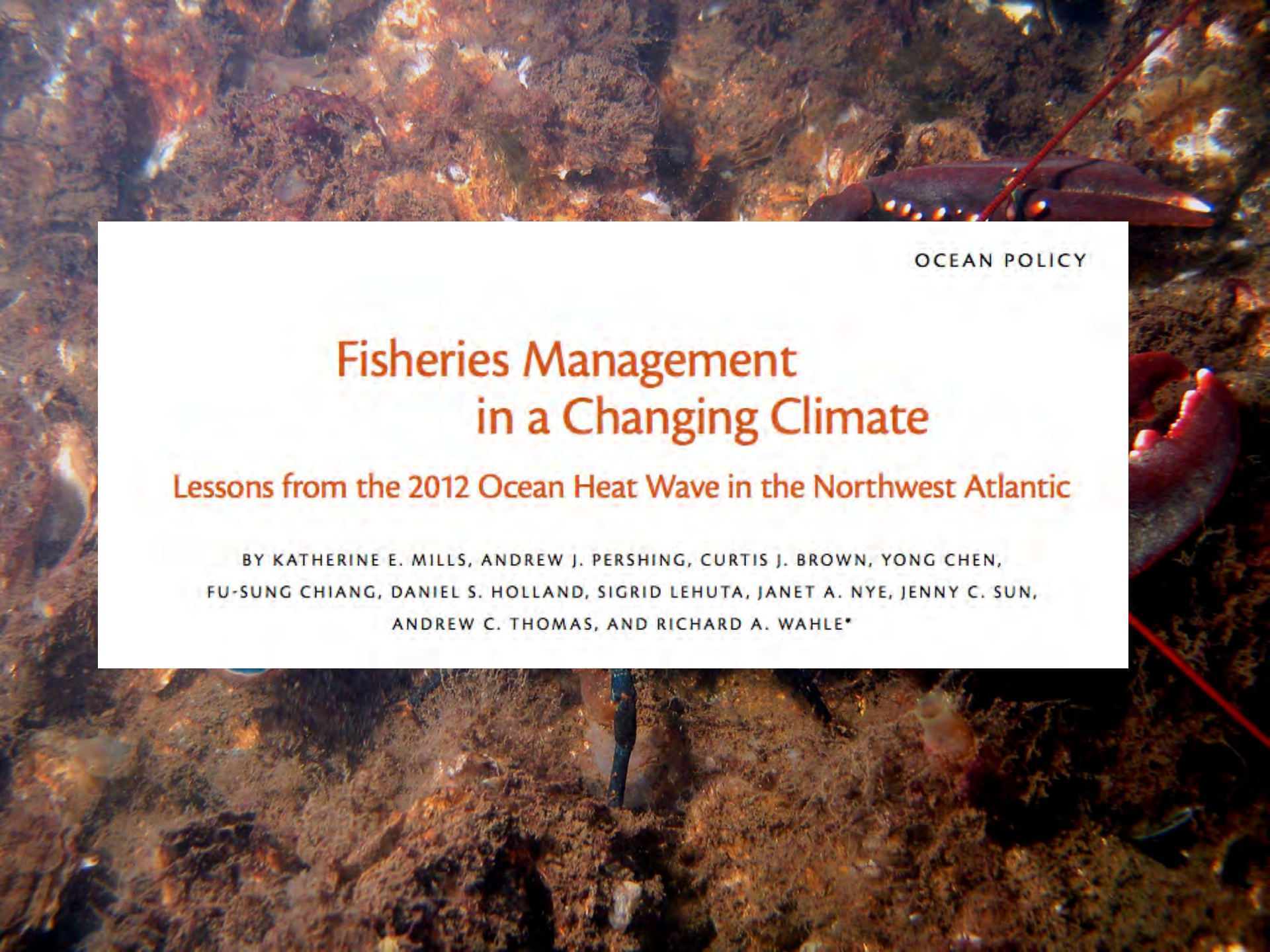
Expanding ranges…

Expanded period of occupation by predators



Spiny dogfish

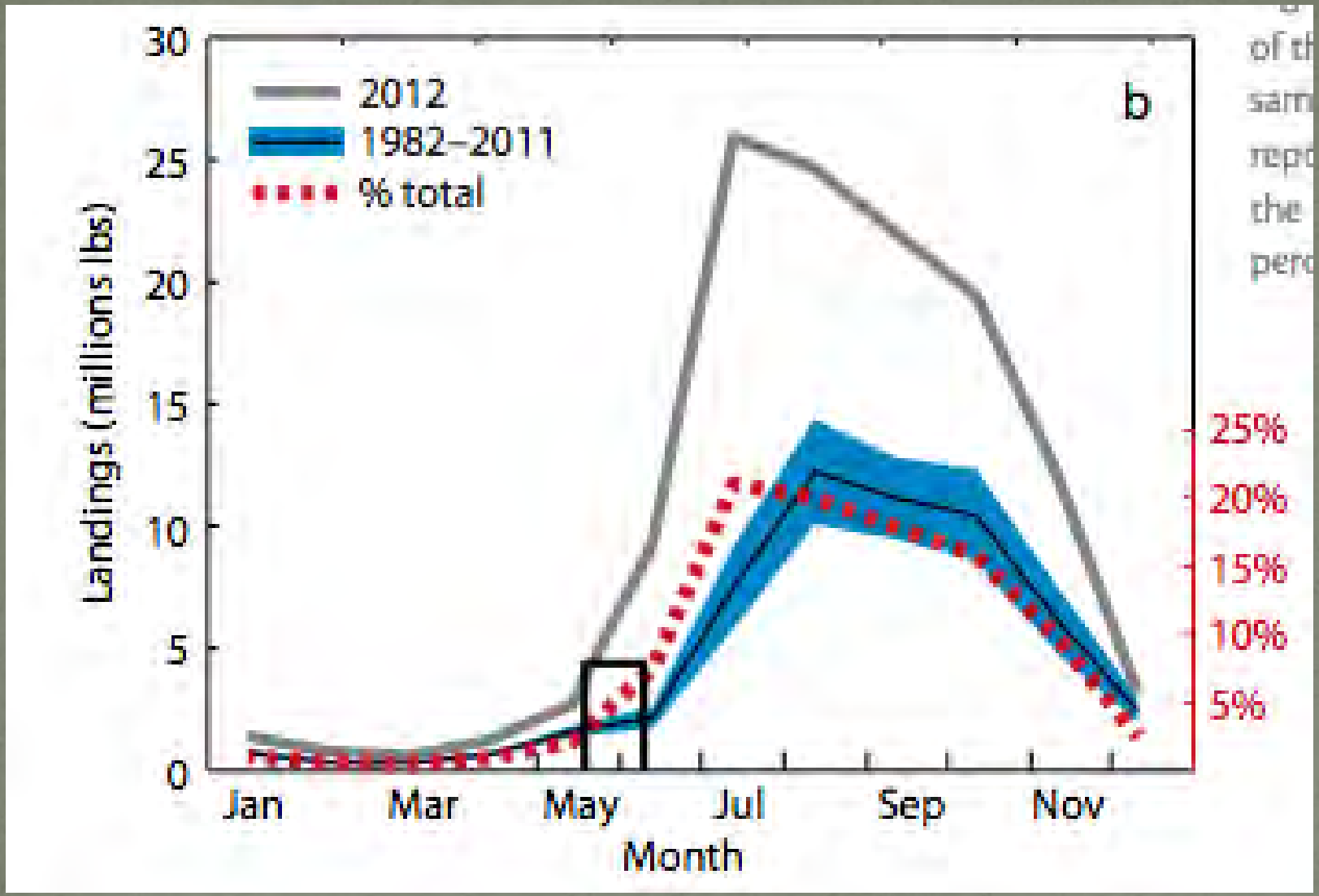
2012 – Historic warm year



Fisheries Management in a Changing Climate

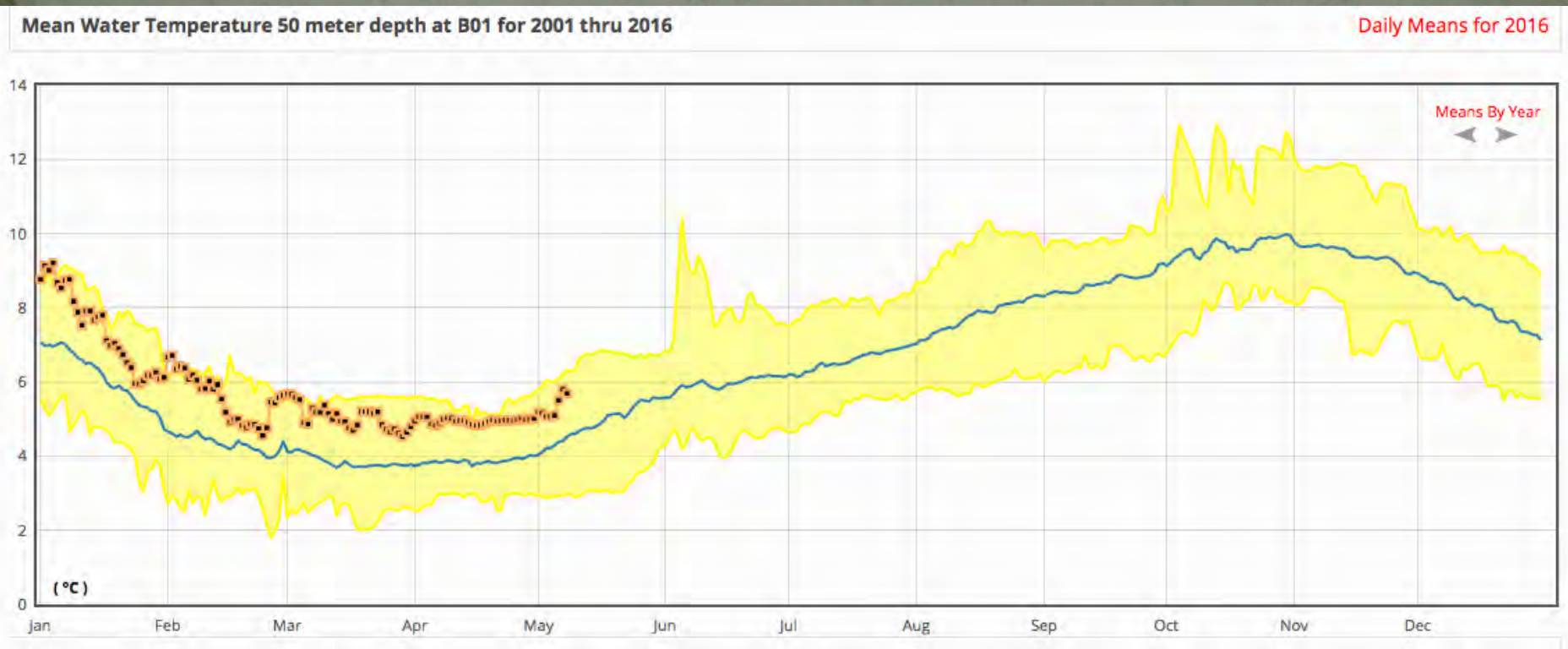
Lessons from the 2012 Ocean Heat Wave in the Northwest Atlantic

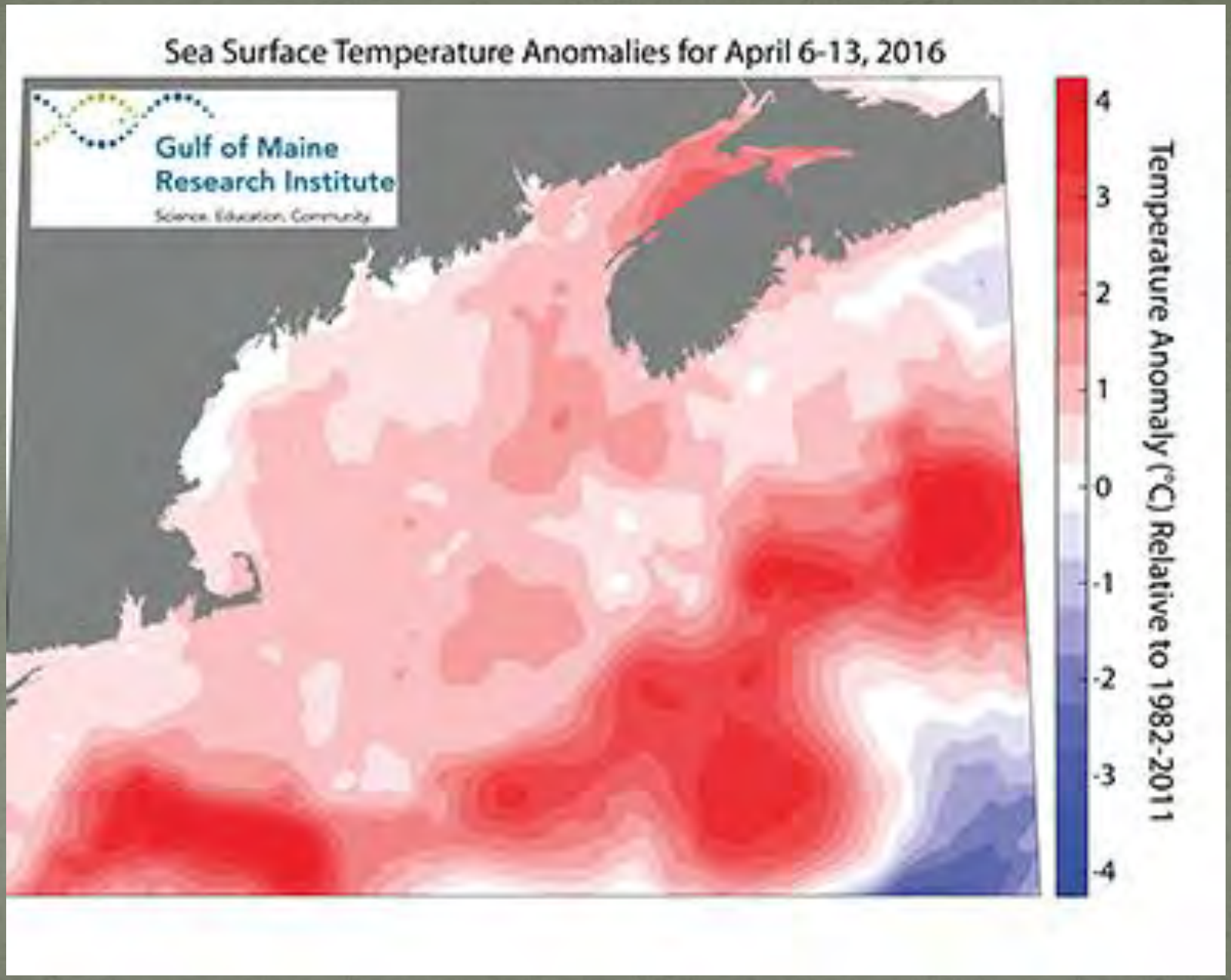
BY KATHERINE E. MILLS, ANDREW J. PERSHING, CURTIS J. BROWN, YONG CHEN, FU-SUNG CHIANG, DANIEL S. HOLLAND, SIGRID LEHUTA, JANET A. NYE, JENNY C. SUN, ANDREW C. THOMAS, AND RICHARD A. WAHLE*


2012
1982–2011
% total
b
Landings (millions lbs)
30
25
20
15
10
5
0
25%
20%
15%
10%
5%
Jan
Mar
May
Jul
Sep
Nov
Month

Longfin squid

NERACOOS


Mean Water Temperature 50 meter depth at B01 for 2001 thru 2016
Daily Means for 2016
Means By Year
14
12
10
8
6
4
2
0
(°C)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Sea Surface Temperature Anomalies for April 6-13, 2016
Gulf of Maine
Research Institute
Science. Education. Community
Temperature Anomaly (°C) Relative to 1982-2011
4
3
2
1
0
-1
-2
-3
-4

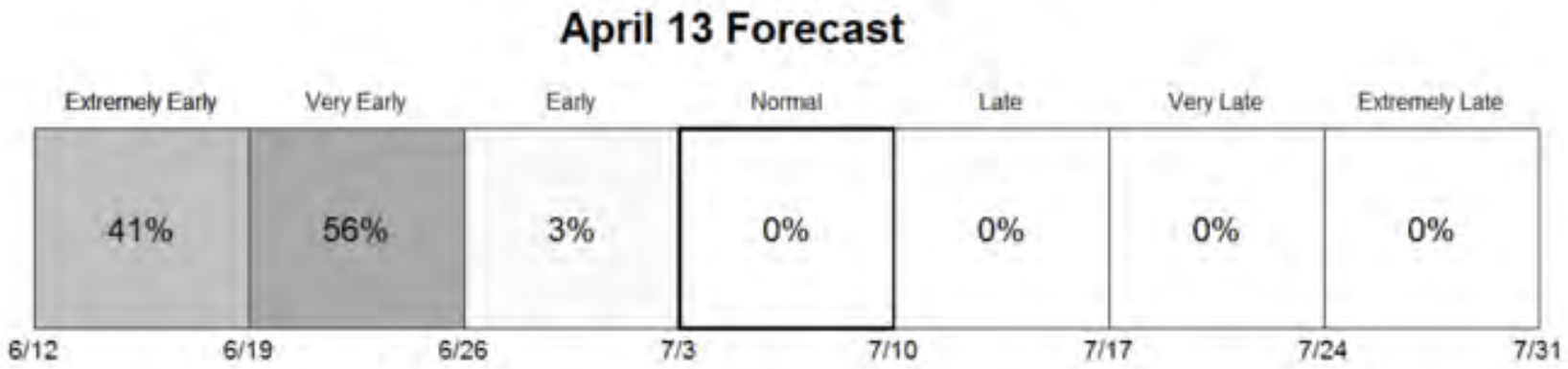
Gulf of Maine Research Institute

Our Focus Our Work Events

Home » Our Work » Research » Project Database » Gulf of Maine Lobster Forecasting

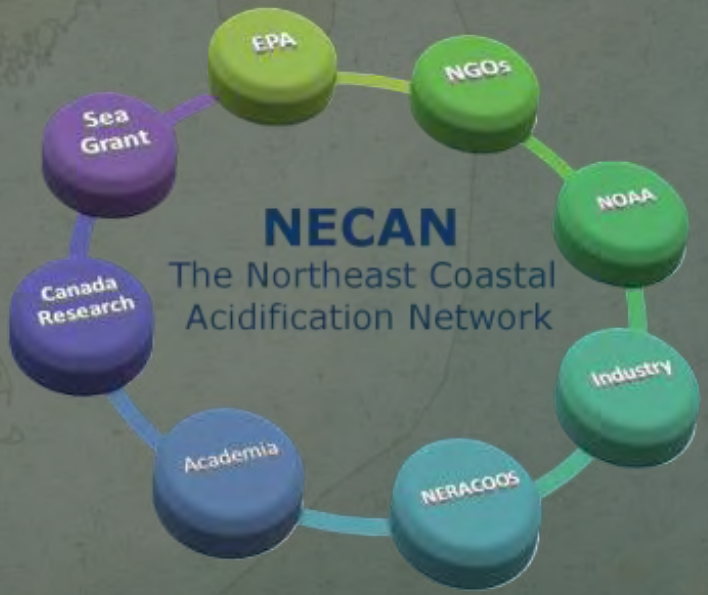
Gulf of Maine Lobster Forecasting

2016 Forecast



Ocean acidification effects in the Northeast?

- Cold water and freshwater input increase vulnerability to ocean acidification
- Remarkably little is know about effects on finfish, lobster and their prey



www.neracoos.org/necan

Challenges….

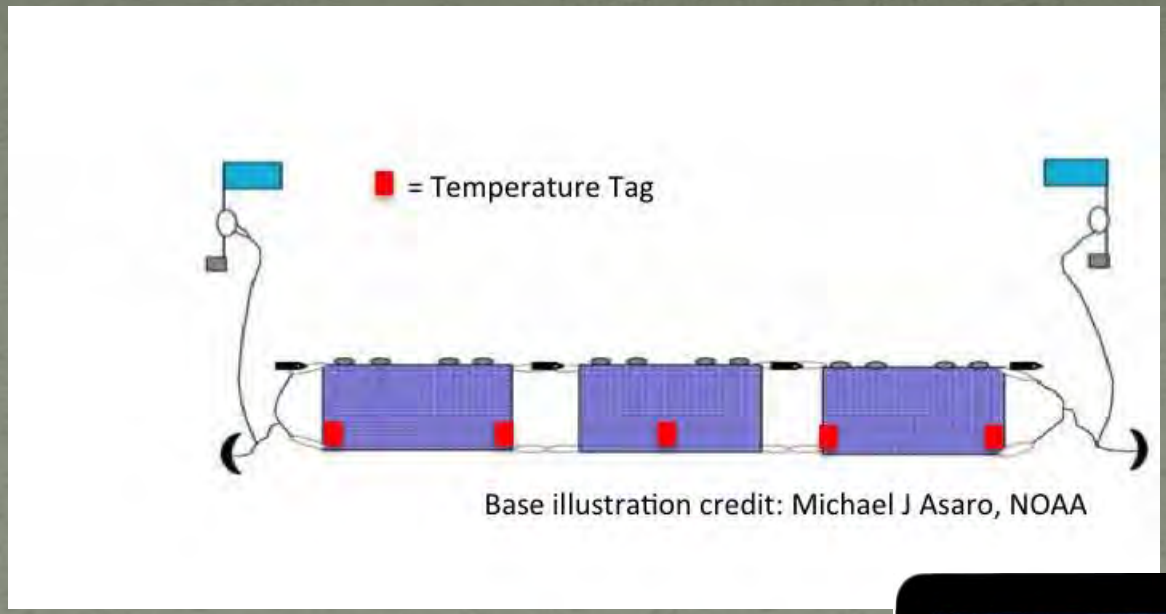
- Access determined by historic distributions
  - Black sea bass permits and markets don't migrate with stocks
  - Groundfish allocations determined by historical catches: 1997 to 2006
- Target stock levels (baselines) determined by historic distribution/abundances
- Fishing technology and knowledge is focused on a small number of stocks
- Single-species management dominates
- We are operating at the limits of science

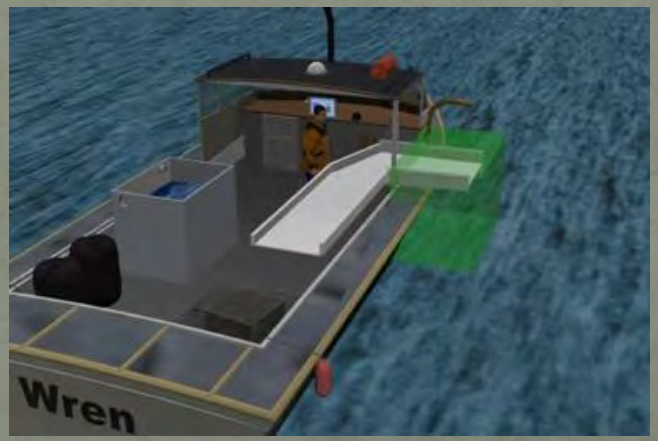
Is adaptation possible?

- Diversify fisheries
  - Diversify, increase value of markets of abundant species (be flexible!)
- Adaptive management
  - Move from single-species to ecosystem-based management
  - Acknowledge lack of precision in science
  - Support flexibility in fishing access
  - Empower fishing communities
- Fishermen, scientists and managers must look at these problems *together*

NH Community-Based Ocean/Fish Habitat Observing Program

NH lobstermen, NH groundfishermen (Sectors), NERACOOS, The Nature Conservancy, NOAA Cooperative Research Program, NOAA Northeast Regional Science Center, UNH

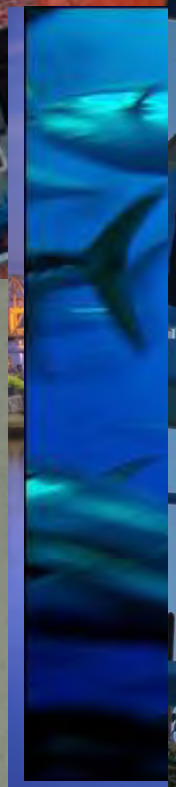

= Temperature Tag
Base illustration credit: Michael J Asaro, NOAA


Wren


S 5 Lbs.
H 8 Lbs.

Take-home

- Species assemblage is shifting
  - Conditions moving away from optimal for some species
  - Conditions moving toward optimal for others
  - New species moving in (opportunities!)
- Phenology is shifting
- Ecology is Changing!
- Ocean acidification is having an effect
- Species are more vulnerable due to combination of fishing and climate change
- We will continue to be at the limits of science
- Fishermen can adapt, but they need our help – and we need theirs…

LISA ANN II
NEWBURYPORT, MA