Climate change and closed area management in the Northeast region

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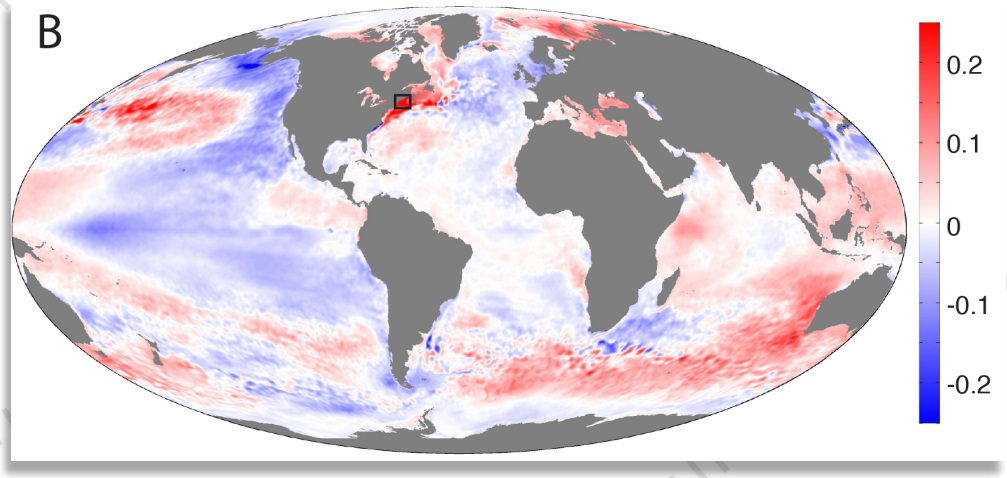
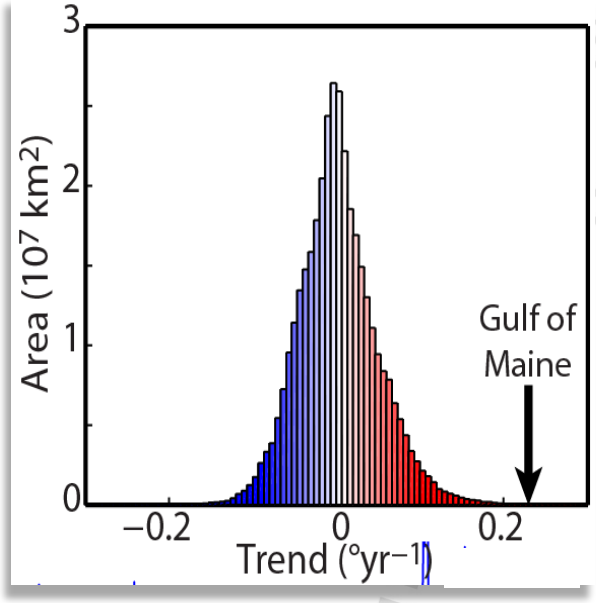
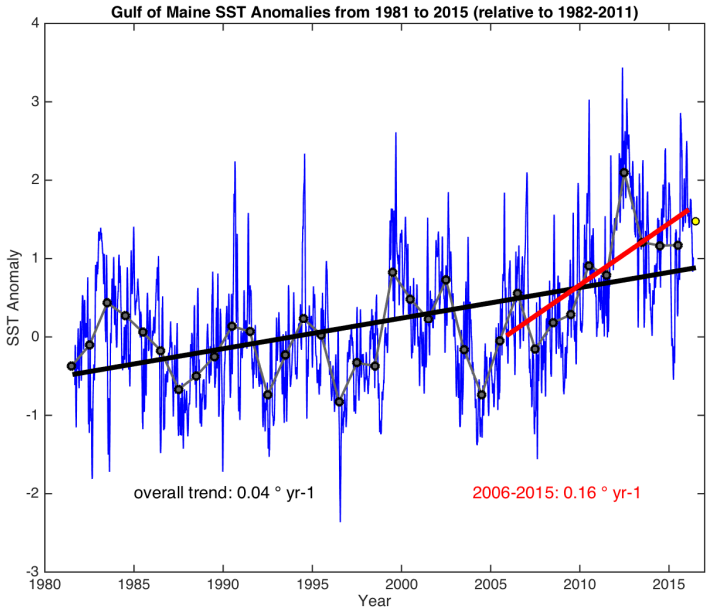
Science. Education. Community.

The Gulf of Maine is warming faster than 99% of world's oceans





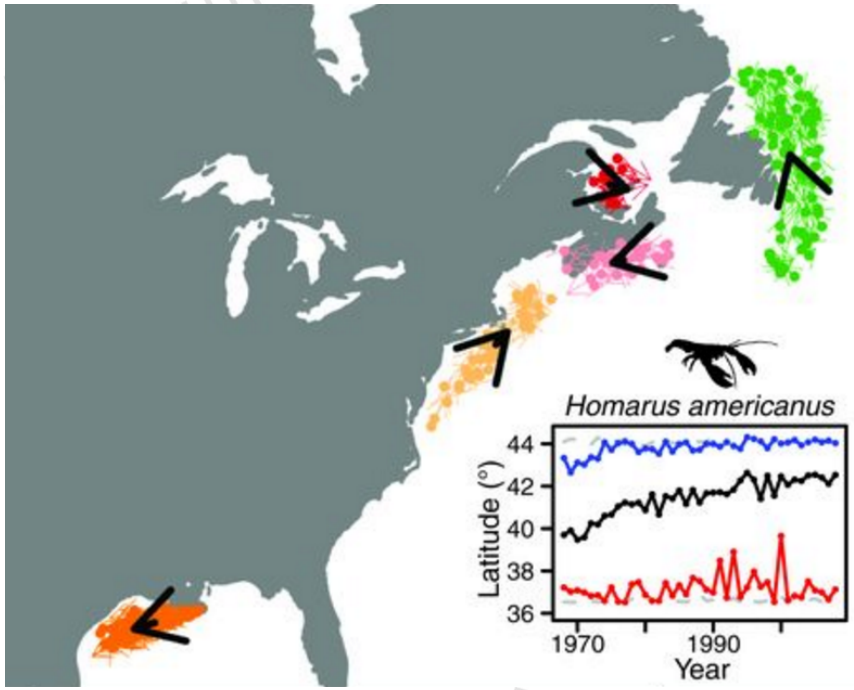


Pershing et al. 2015

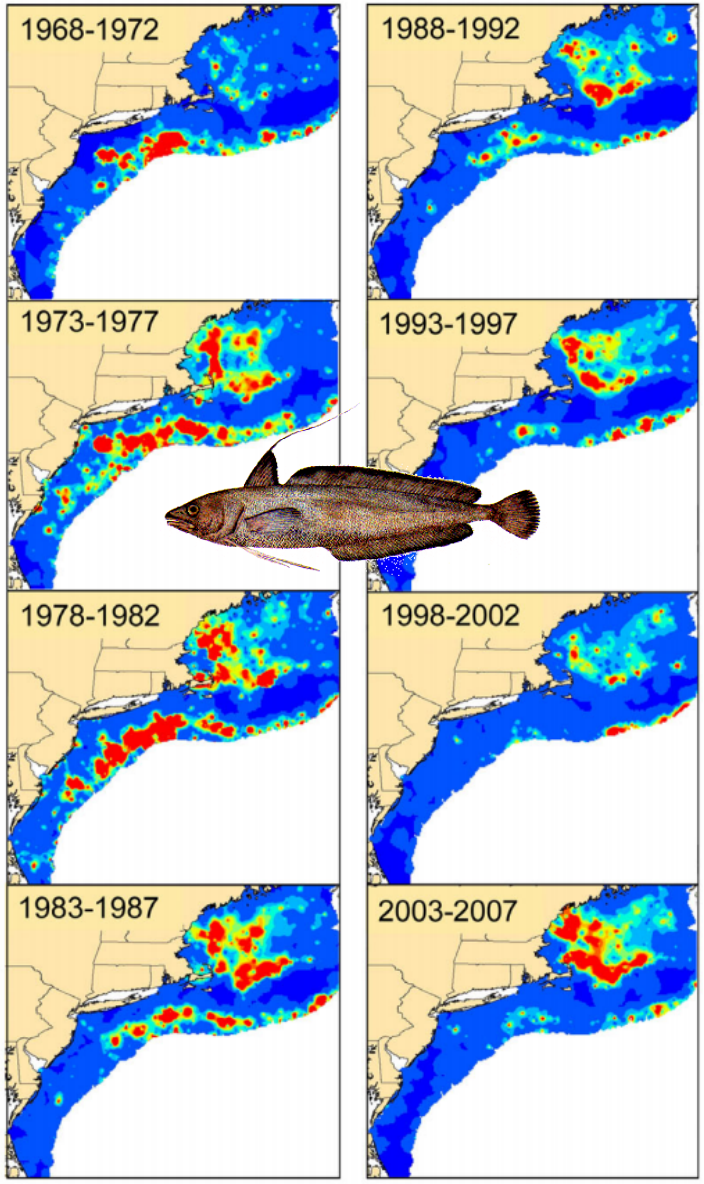
Impact on Fisheries

Many species are changing their distribution – Moving north (in our region)

Multiple taxa (Pinsky et al. 2013)

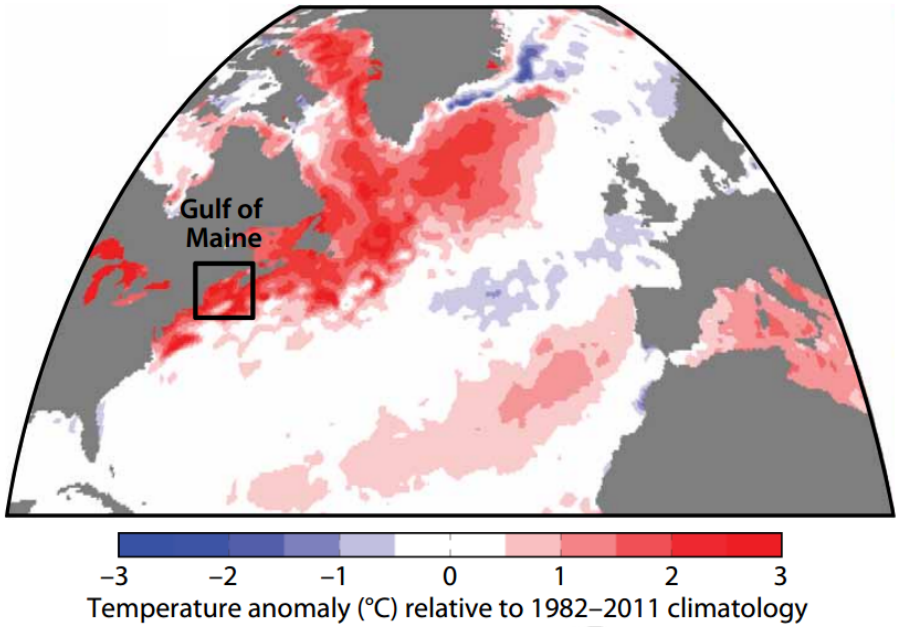


Red hake (Nye et al. 2009)

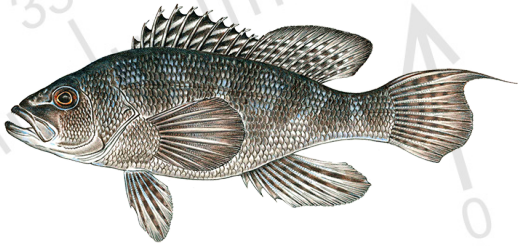


2012 Ocean Heat Wave

- Led to episodic poleward range shift of some species
- Impacts on ecology



Mills et al. 2013

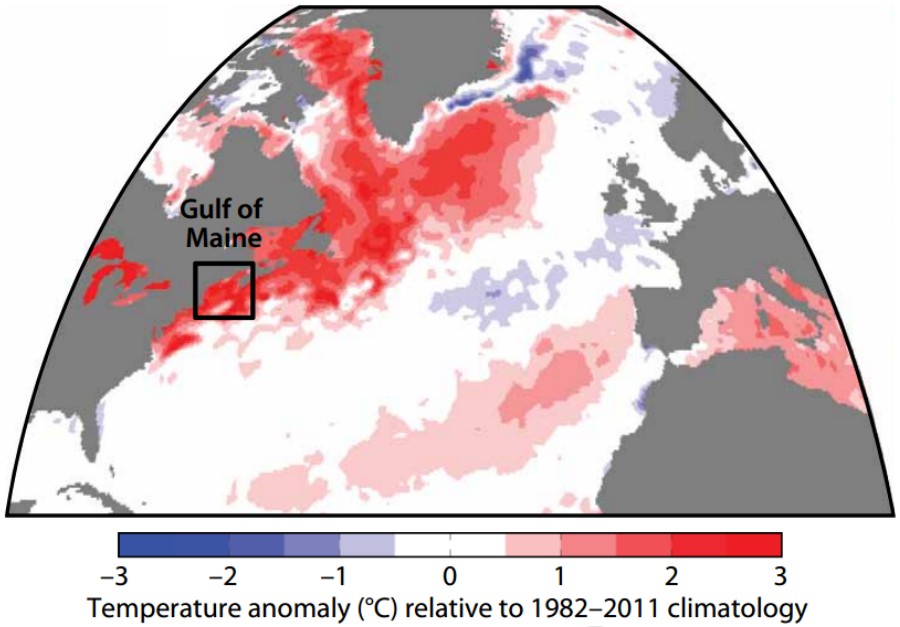


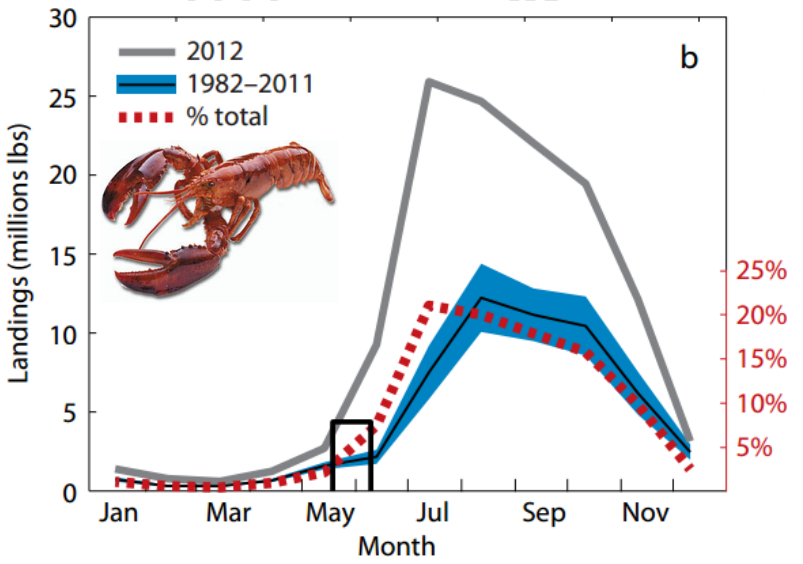
Black sea bass → lobsters?

Butterfish → seabirds

2012 Ocean Heat Wave

- Led to changes in phenology for some species which had major impacts on economics in the region (i.e., lobster industry)

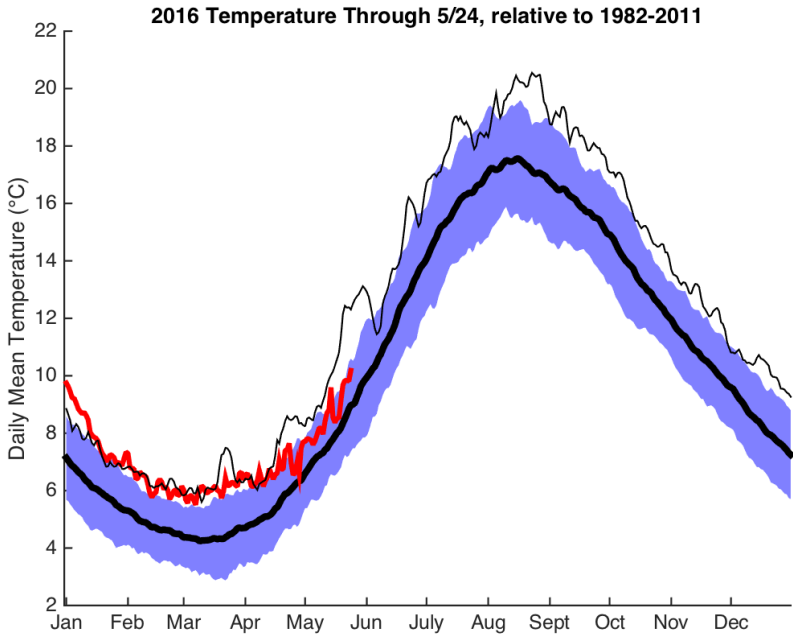


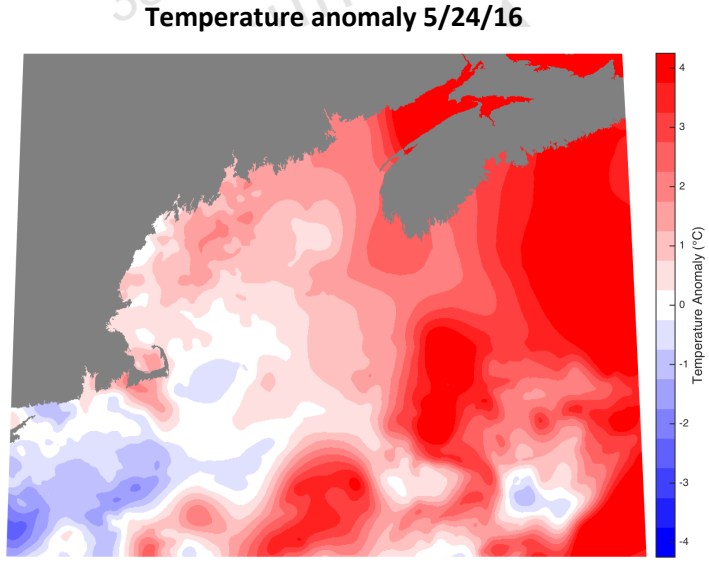


Mills et al. 2013

Ocean Heat Waves

- 2016 is on track to be a warm summer?

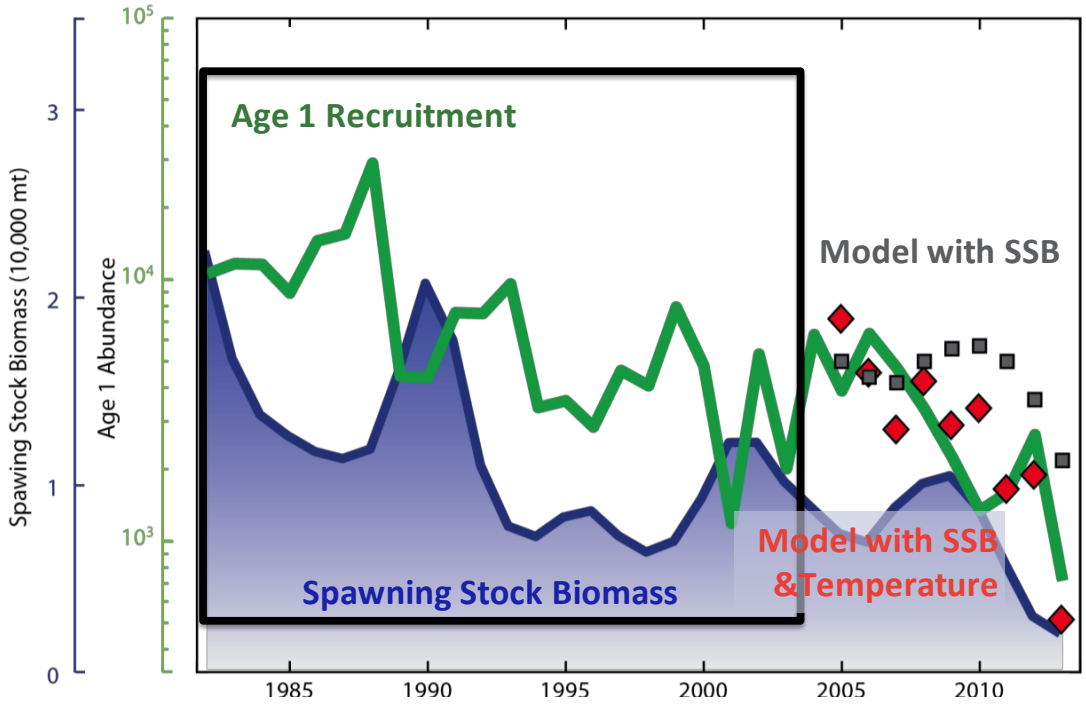


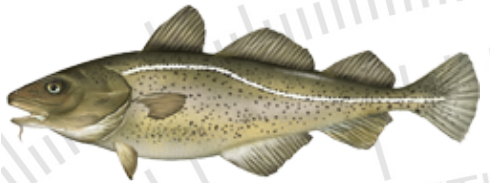


Pershing, unpublished

Impact of warming on fisheries productivity

The 2012 ocean heat wave, and general warming, may have also led to increased mortality in cod, exacerbating an already dire situation with cod at historical lows due to overfishing (Pershing et al. 2015).





Pershing et al. 2015; Data from 2014 stock assessment (Palmer, 2014)

The role of fishery closed areas

Current

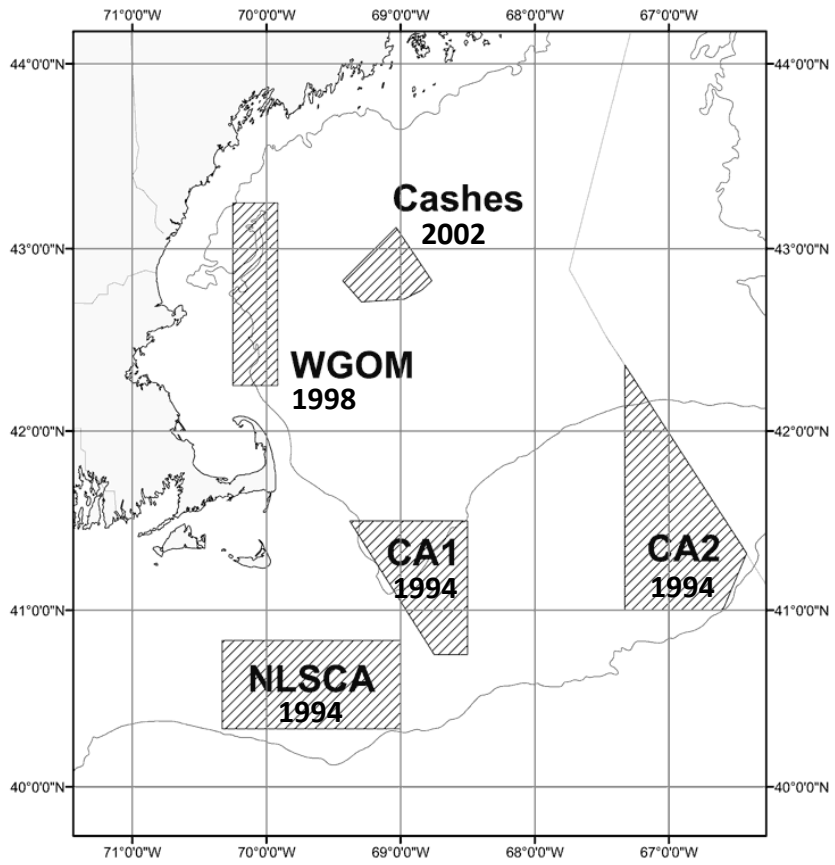
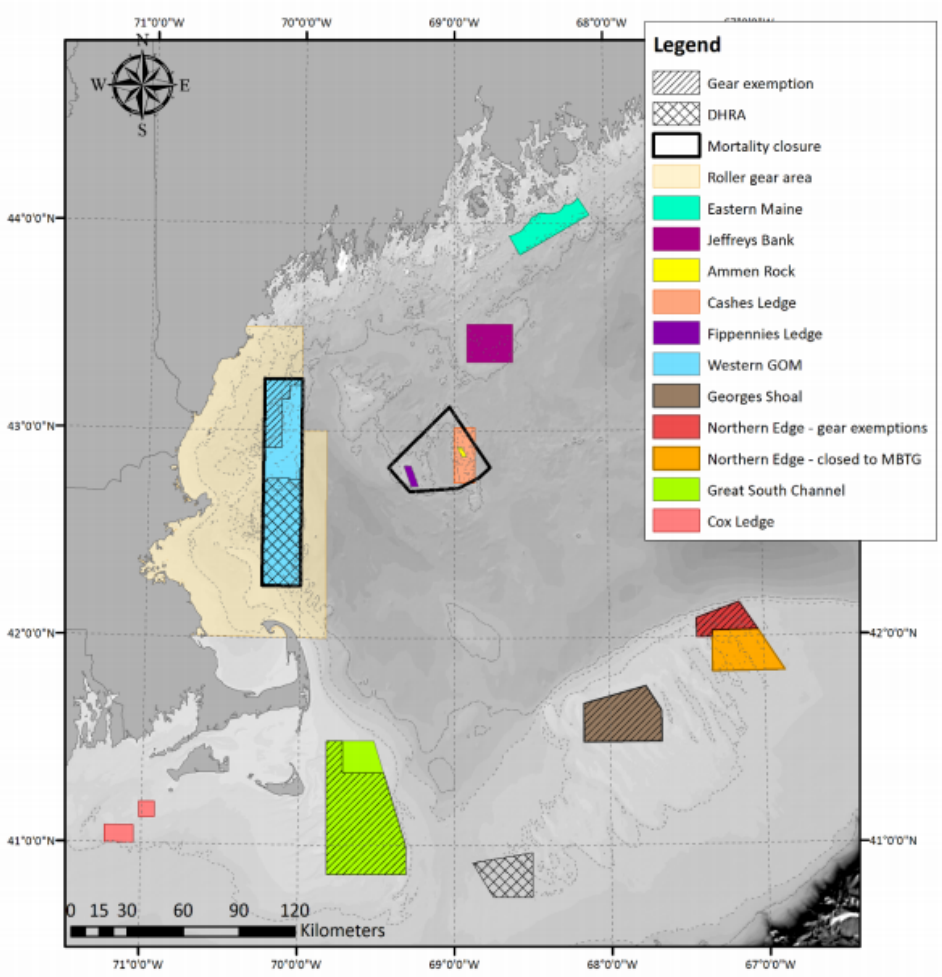


Figure 4.1. Location of five year-round groundfish closed areas in the Gulf of Maine - Georges Bank region. (Cashes = Cashes Ledge; WGOM = western Gulf of Maine; NLSCA = Nantucket Lightship Closed Area; CA1 = Closed Area I; and CA2 = Closed Area II.)

Proposed



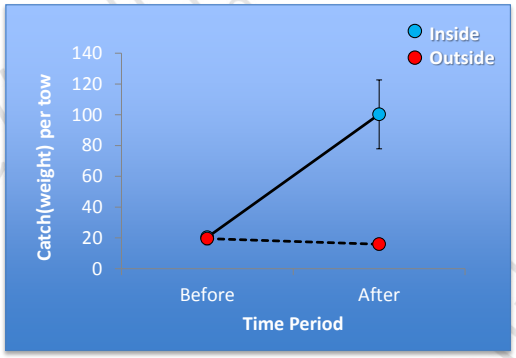
The role of fishery closed areas

Current closures were all intended to curb fishing mortality on groundfish (particularly cod, haddock and yellowtail flounder).

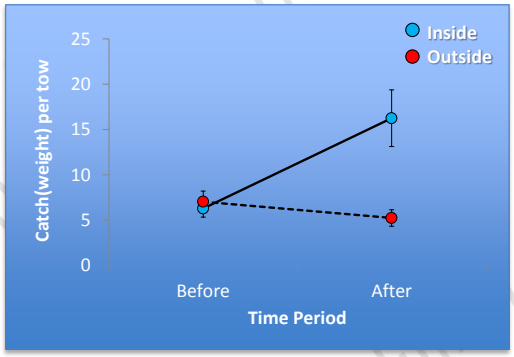
How well are they achieving this goal?

Are they conferring any other benefits to fisheries?

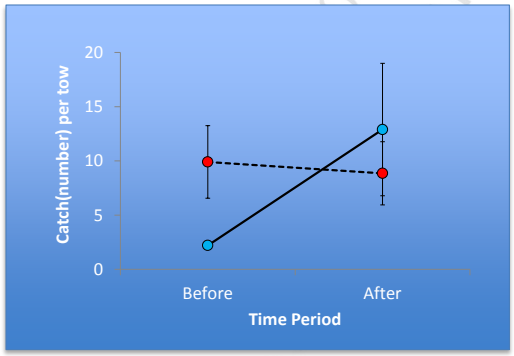
Closed Area 1 Haddock



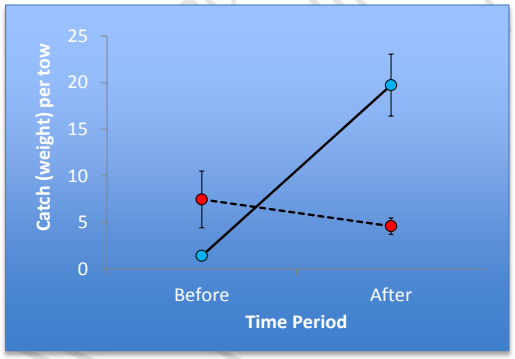
Closed Area 1 Winter Flounder



Nantucket Lightship Haddock



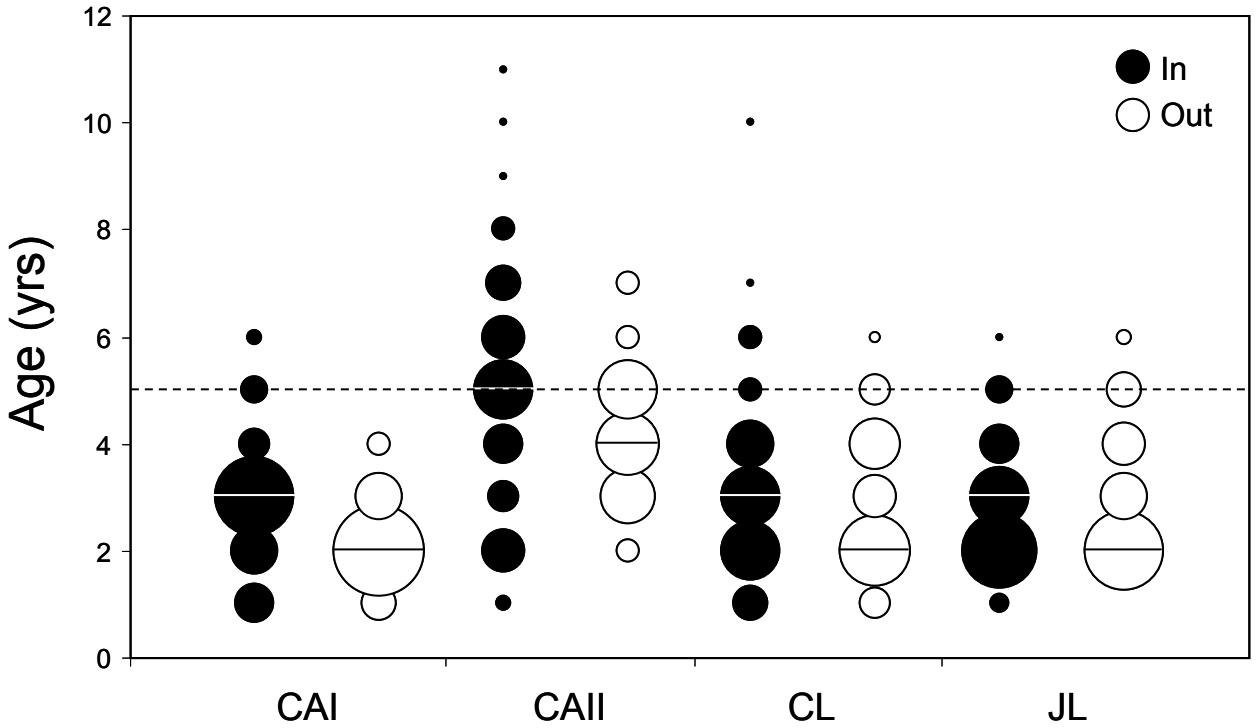
WGOMCA Haddock



Kerr & Kritzer, unpublished

The role of fishery closed areas

An age benefit for cod



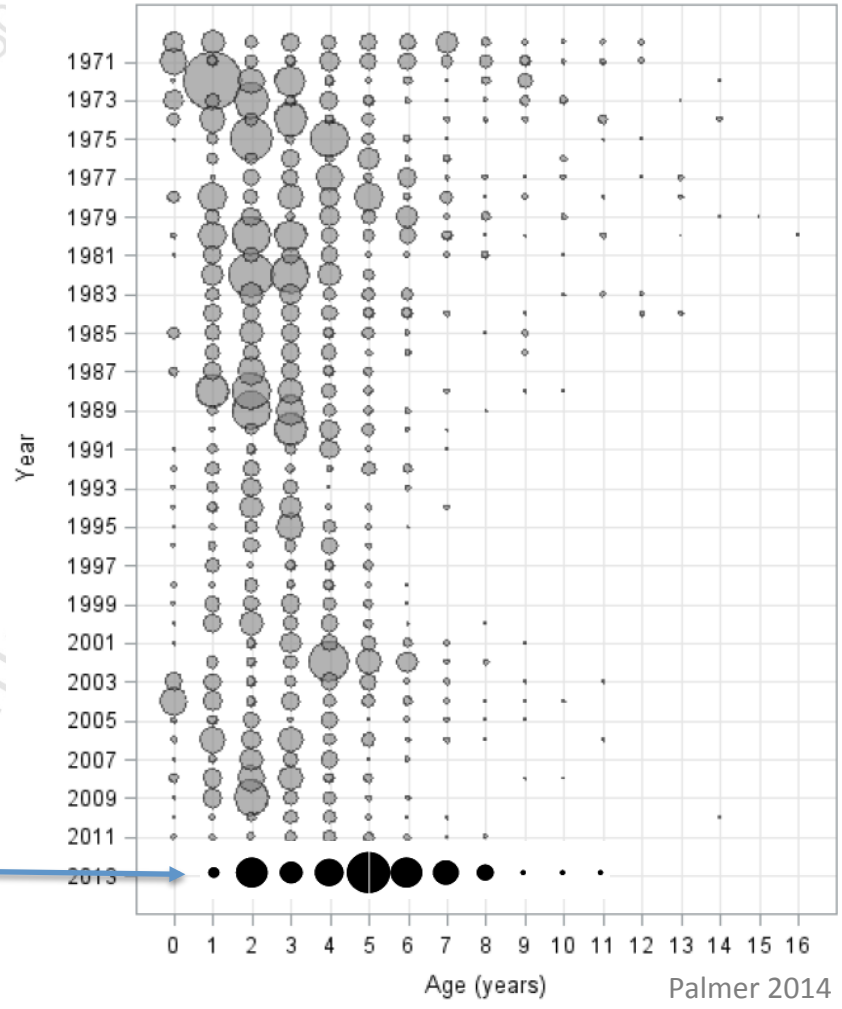
Sherwood et al. 2015

Median age was **1 year older** inside closed areas compared to adjacent open grounds for all areas; there were **~10x more older cod** (>5 years) inside than outside closed areas.

The role of fishery closed areas

Why is age result important?

Gulf of Maine cod stock is notably devoid of older individuals



Except in closed areas

Palmer 2014

The role of fishery closed areas

Why is age result important?

"*Big old fat fecund female fish (BOFFFFs)*" are important for productivity and stable recruitment dynamics in fish (Hixon et al. 2013).

In cod, the role of BOFFFFs may be to impart resiliency to the population (ability to recover from low biomass and to even out short-term fluctuations in recruitment success as may be caused by changes in oceanographic conditions) (LeBris et al. 2015).

Closed areas appear to be our best tool for protecting old fish and, in doing so, maintaining population resiliency.

The issue of scale

Closed areas were shown to enhance age structure in cod (Sherwood et al. 2015)

What size closed area is required to provide this benefit?

Is there a habitat bias associated with this benefit?

These questions are part of a study that we will be carrying out this summer at Cashes Ledge.

The issue of scale

Ammen rock is assumed to be the preferred habitat for older cod at Cashes Ledge.

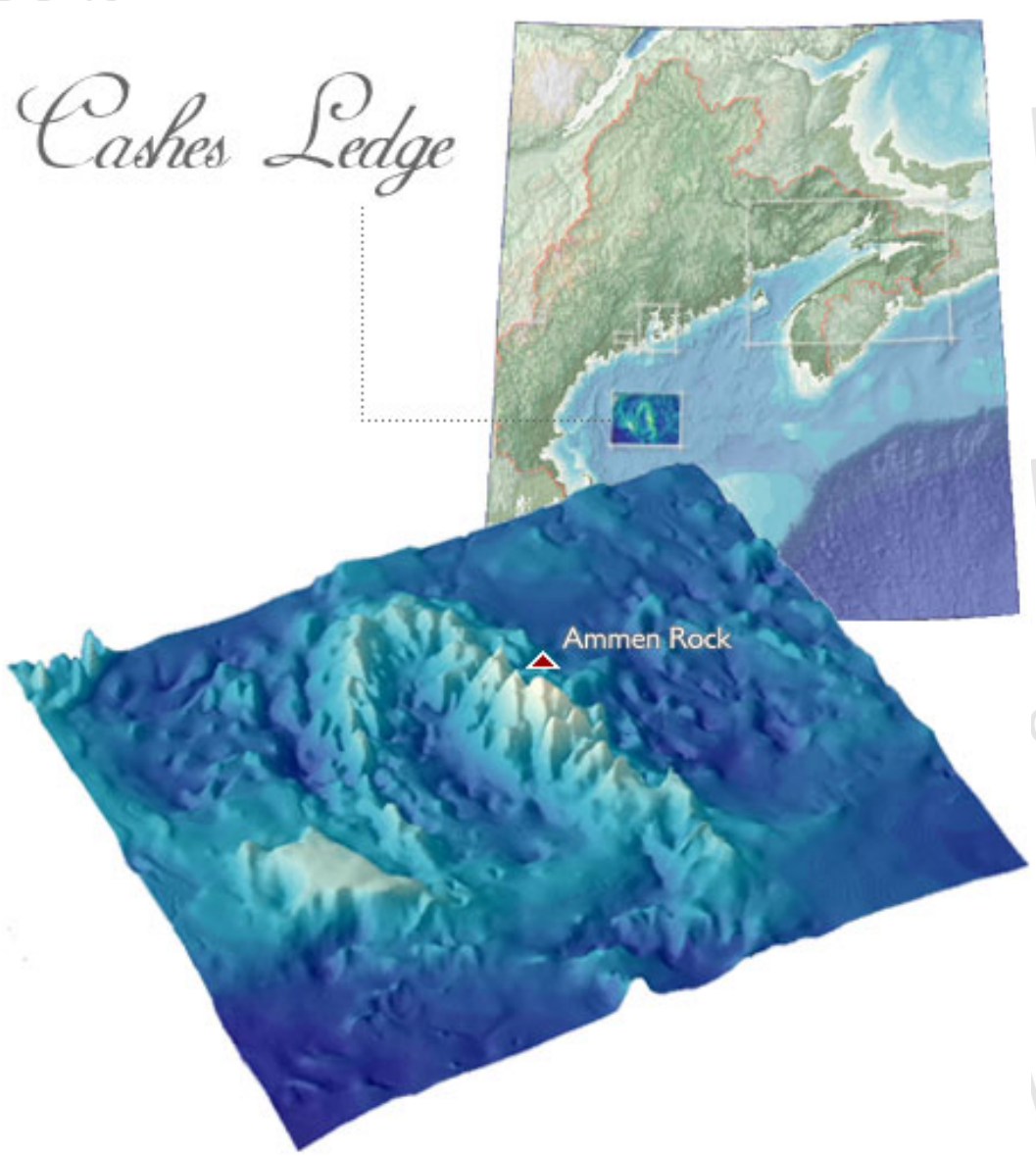
Plan: Sample at variable distances from Ammen rock.

Sample at various depths within and around the closed area.

Utilize both gillnet and acoustic survey gear.

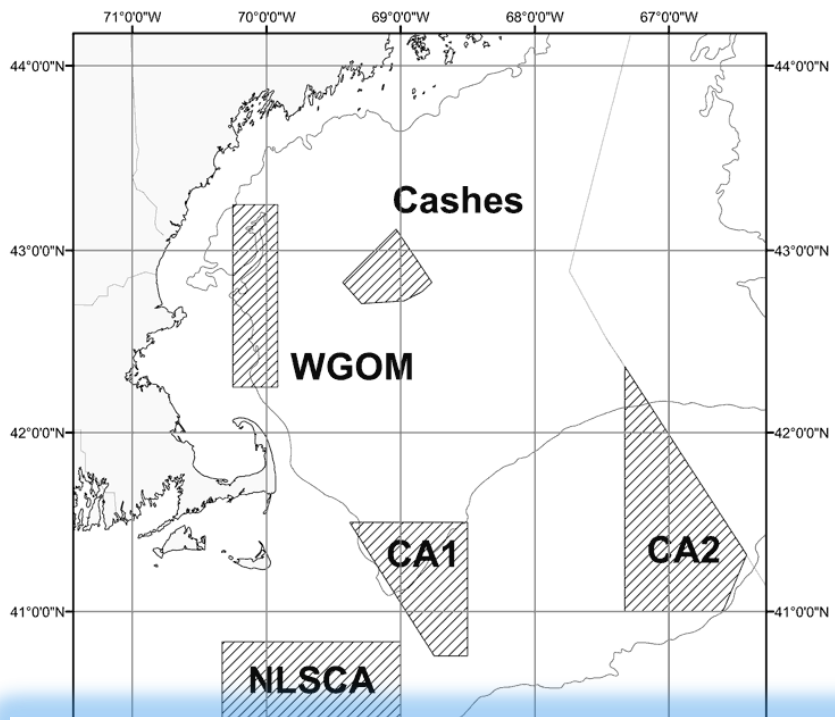
Question: Are older cod distributed evenly throughout closed area?

Thought: Smaller closed areas, matched to key habitats, may be the best strategy for maintaining cod age structure and biomass.

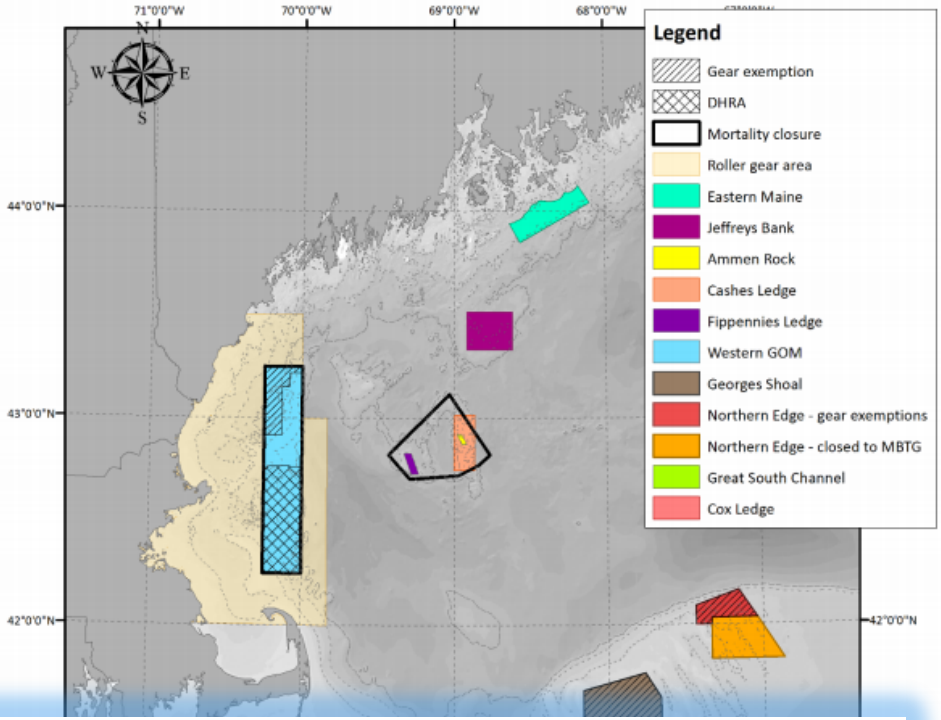


The issue of scale and connectivity

Current



Proposed



The proposed closed area strategy may provide more connectivity for species on the move as part of both their normal behavior and as a result of changing ocean conditions. For example, eastern Maine may become a thermal refuge for some species (cod?), and a new closed area there may be strategic.

The issue of scale and connectivity

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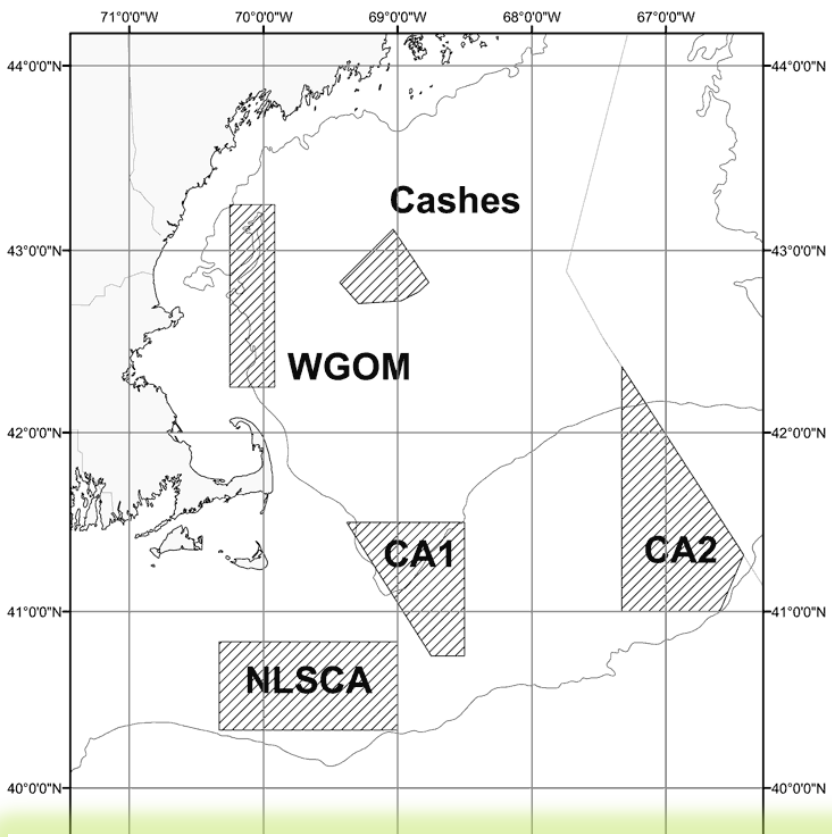
Current



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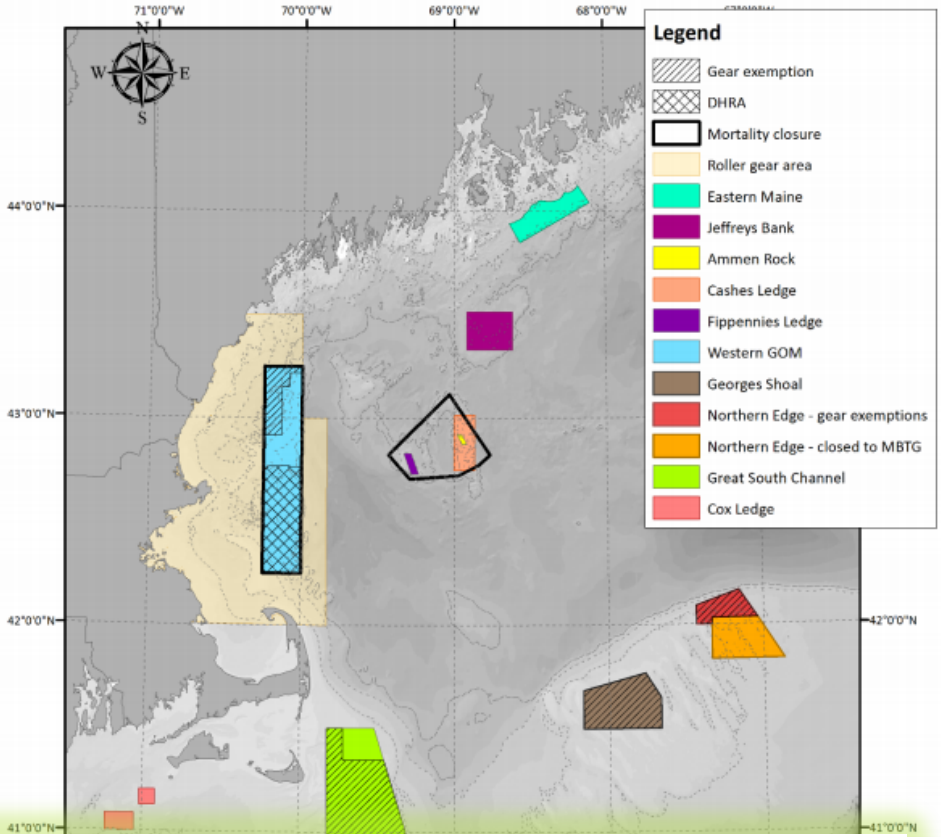


A network of smaller, connected closed areas may also enhance productivity of a diversity of lifestyles including migrant lifestyles within a species…

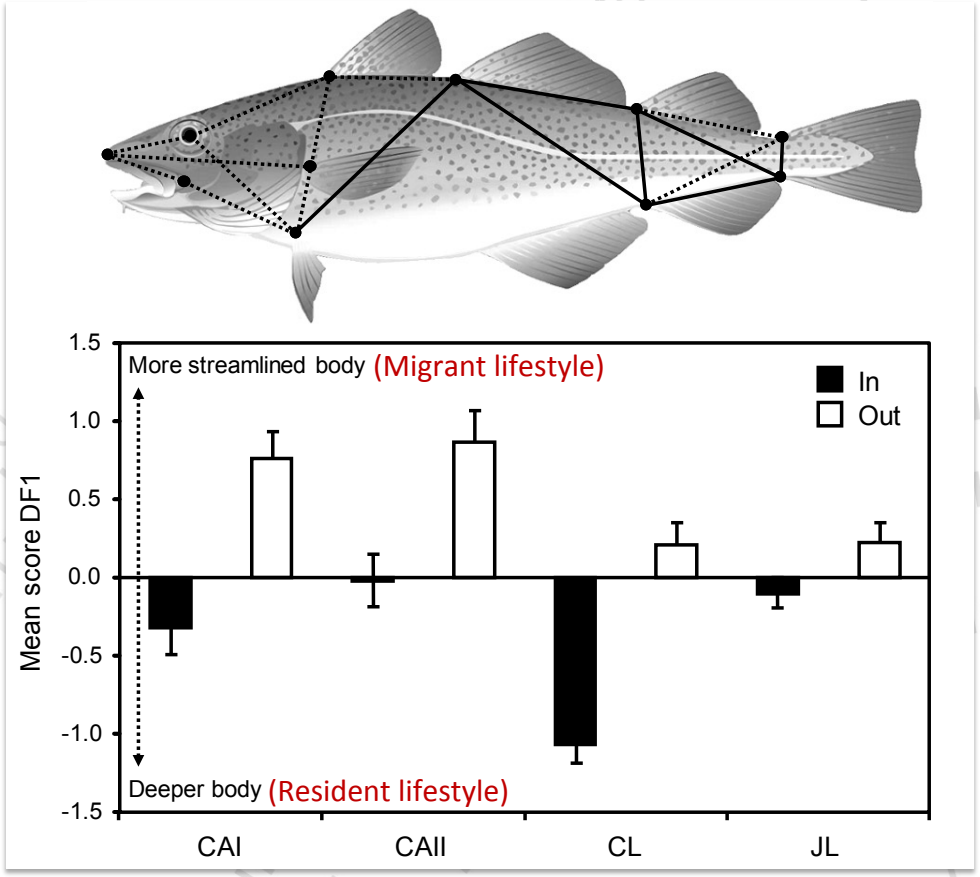
The issue of scale and connectivity

The current configuration of closed areas (few and large) is favoring cod individuals with a resident life-history strategy (inferred from morphometrics).

Migrant fish may be more vulnerable and a loss in population life-history diversity may impact productivity and resilience.

A higher diversity of closed areas (as proposed) may enhance within- species life-history diversity and this may lead to increase in resilience within the population.

Cod morphometrics



Sherwood et al. 2015

Summary

Gulf of Maine is warming faster than 99% of world's oceans.

Ocean heat waves may become more prevalent in the GOM.

Closed areas have a net positive effect on biomass for some species (e.g., haddock), and also preserve age structure of other species (cod).

Preservation of age structure may be crucial for responding to climate variability.

It is unknown what size closed area is required to provide an age benefit.

Smaller, more connected closed areas may be sufficient for age benefit and also enhance life-history diversity (also important for resilience) and may provide thermal refugia for species and individuals on the move.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