# Impacts of climate change and variability on the Northeast Shelf ecosystem and its inhabitants

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**Themes -** A few things to keep in perspective regarding climate

**State of Affairs -** Changes occurring now that will likely have impacts

**Thermal Impacts -** Temperature has a big brush effect on ecosystems and fisheries

**The other $CO_2$ Problem -** Carbon dioxide contributes to greenhouse warming, but also affects ocean chemistry

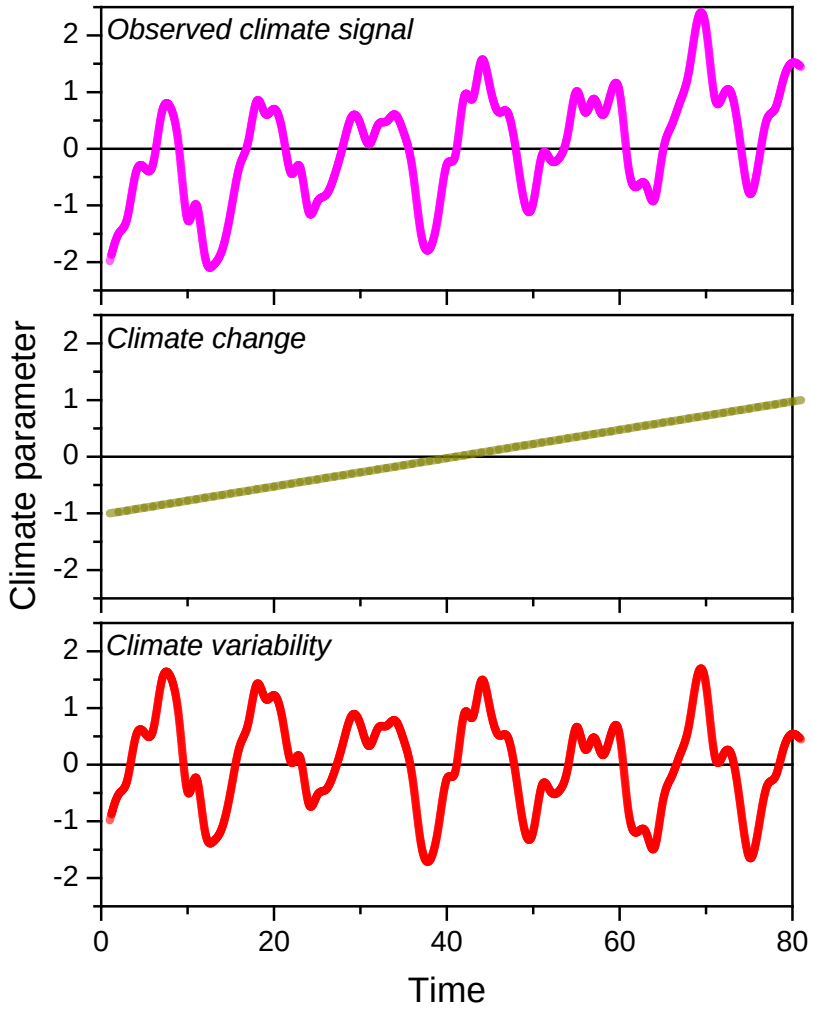
**What time is it? –** The phenology of the ecosystem or the life cycle events of plants and animals influenced by climate variability

A distinction:

The difference between **climate change** and **climate variability**

**Climate change** – change in the climate system

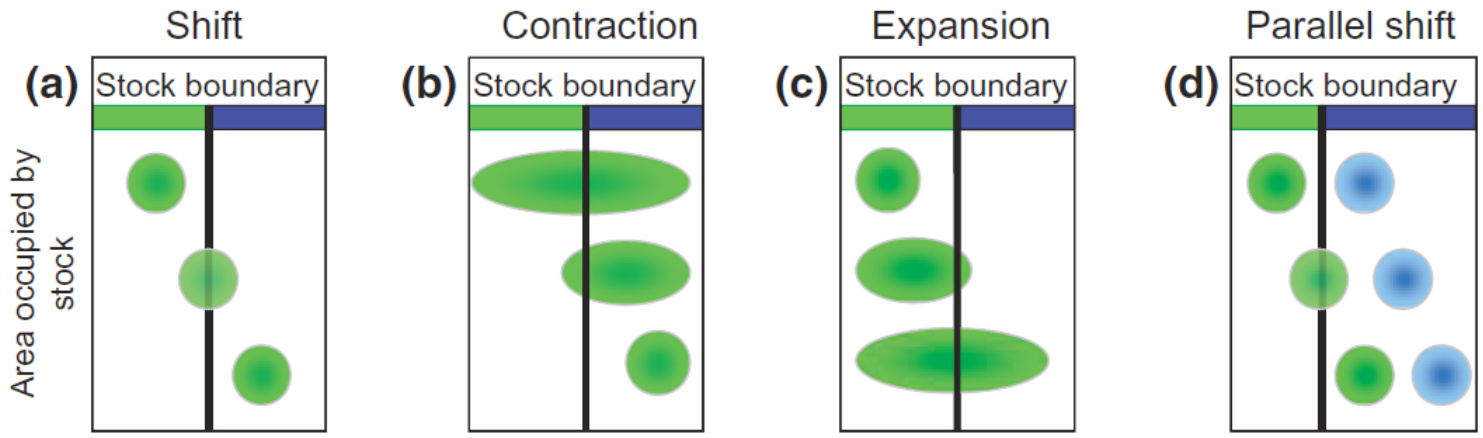
**Climate variability** – natural variability within the climate system



There will be:

Climate **winners** and **losers**

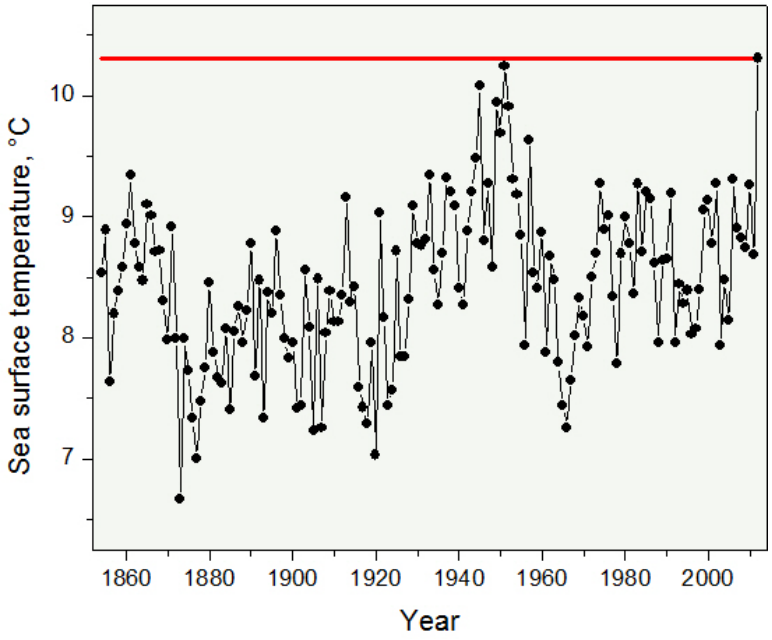
As climate actuates a migration or extirpation of a species, the habitat that is vacated will be filled by a species able to utilize it.




*Link et al. 2010*

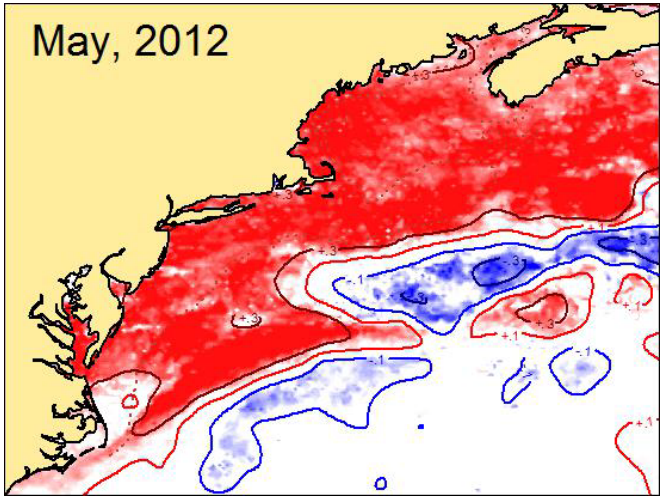
Temperature:

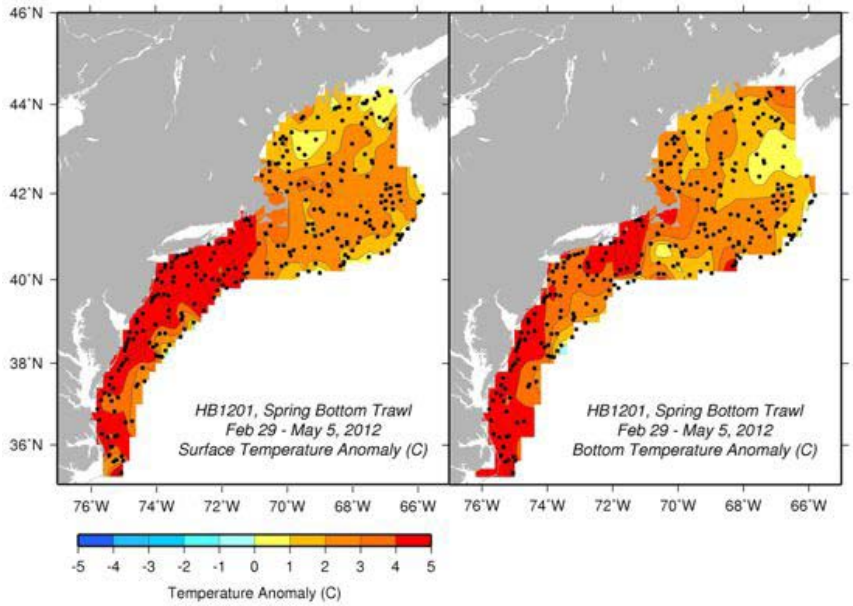
The Northeast Shelf is warming and reached record temperatures during the first half of 2012



Temperature:

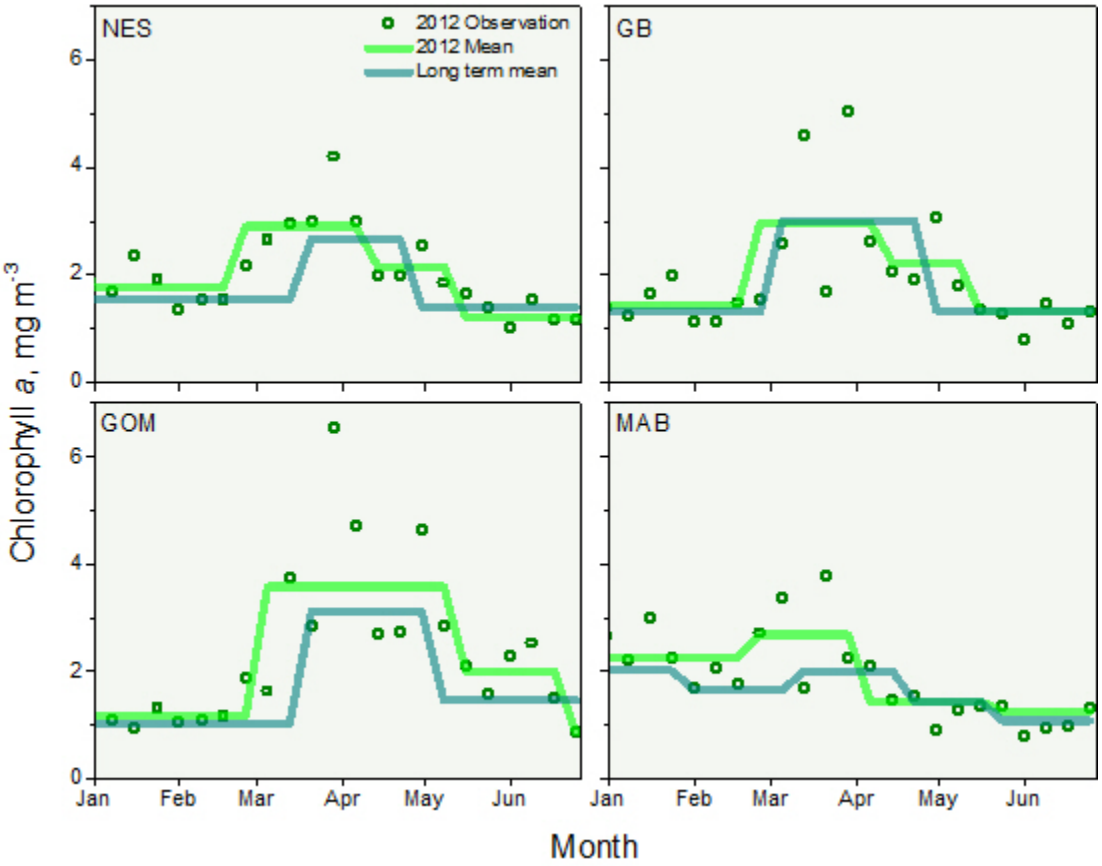
The warming temperature conditions could be found over the entire shelf and from the surface to the bottom.



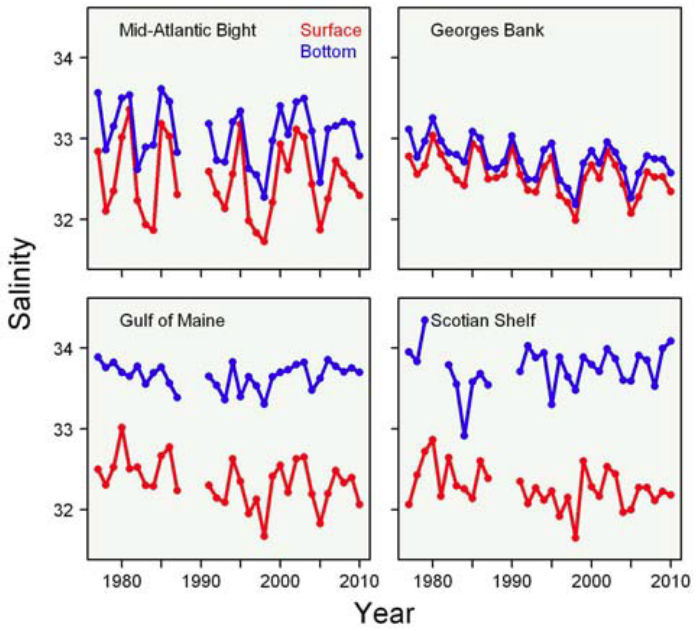
Bloom timing:

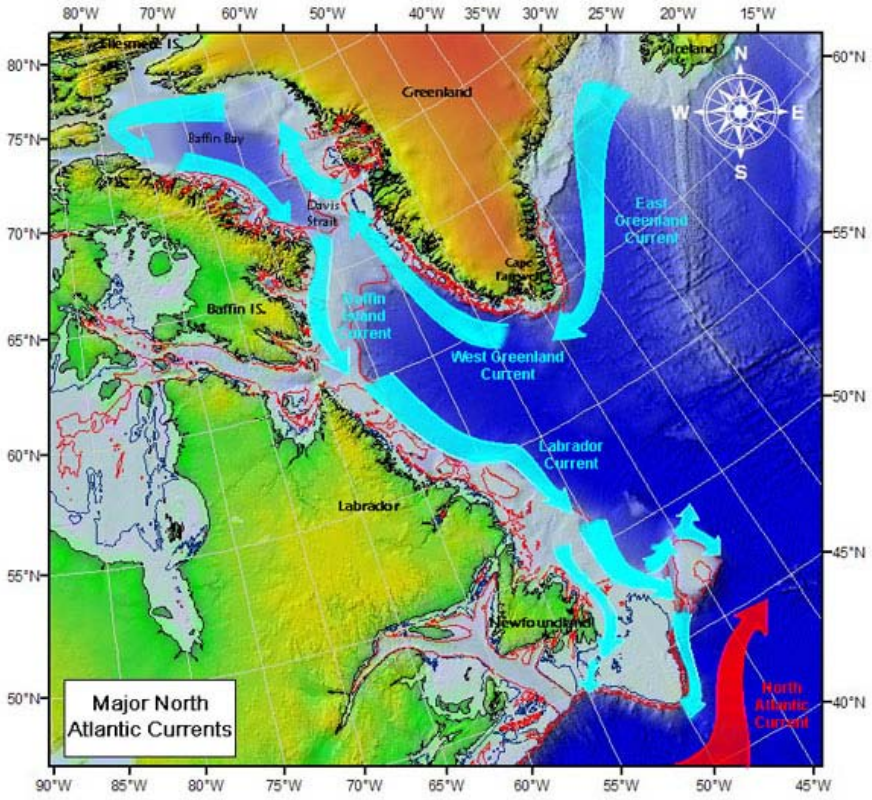
The spring bloom is the engine that powers the ecosystem. The spring bloom start date in 2012 was the earliest recorded for the satellite ocean color data series.



Salinity:

Evidence of variability and change that is linked to freshwater input from the Arctic.

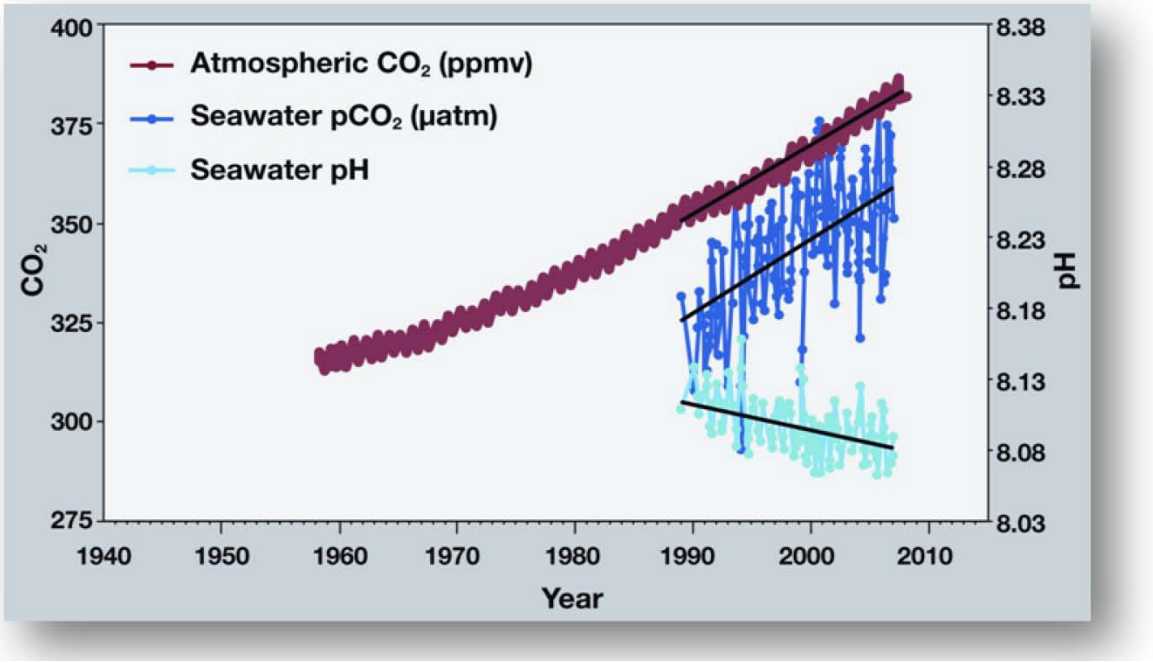



*EcoAP 2012*
*Greene and Pershing 2007*

Acidification:

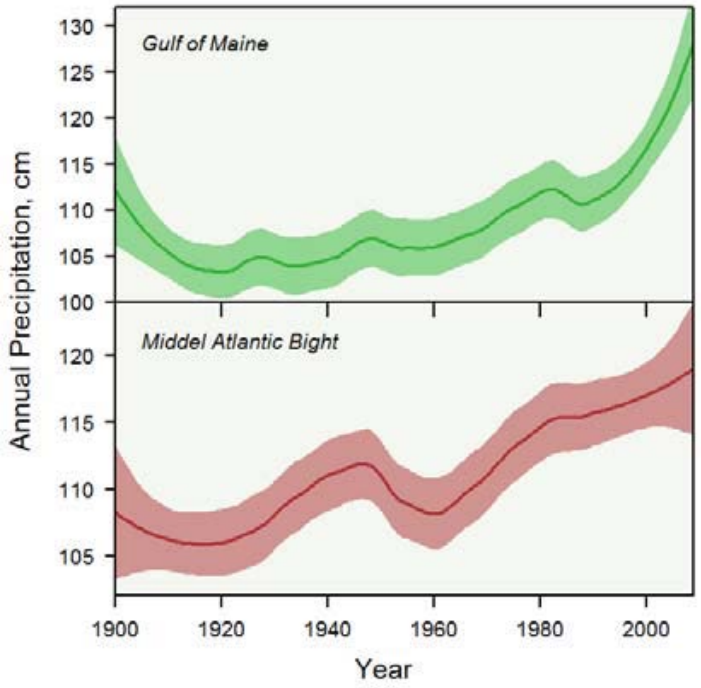
The other $CO_2$ problem - changing chemistry in marine waters caused by increased atmospheric carbon dioxide, resulting in a decrease in ocean pH.




*Feely 2008*

Other:

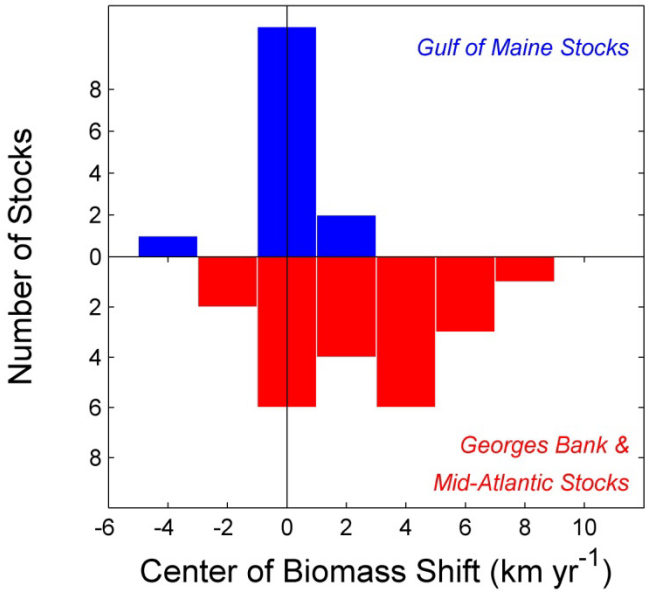
Wind patterns (Archer and Calderia 2008), precipitation and stream flow (Hayhoe et al. 2007), nutrients (Townsend et al. 2010), basin-scale circulation (Hakkinen and Rhines 2009), sea-level rise (Yin et al. 2009)…



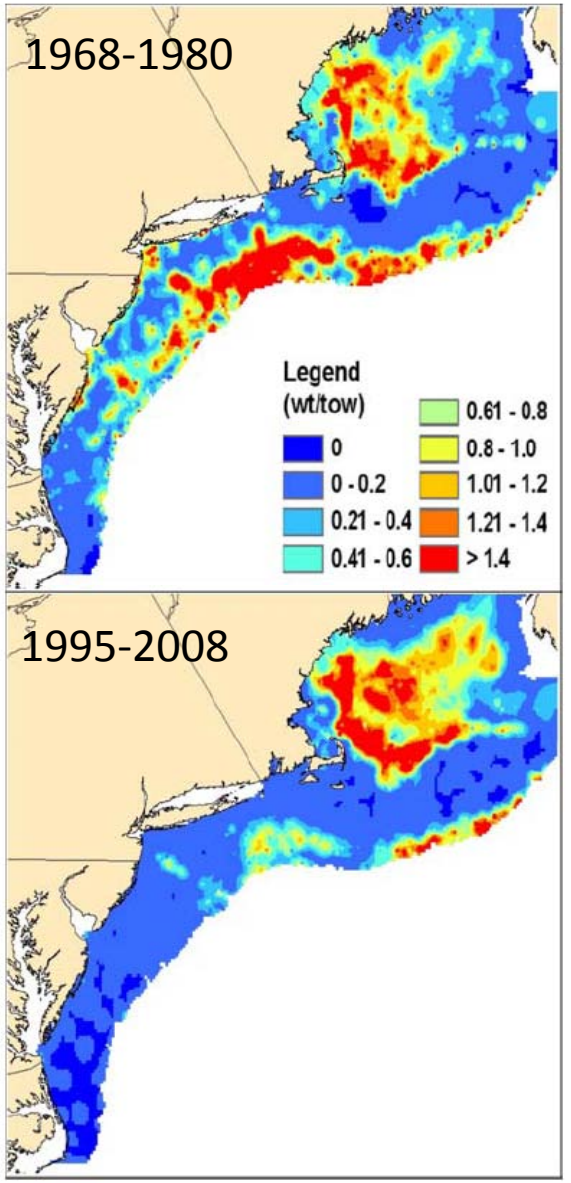

*EcoAP 2012*

Shifting species distributions:

Over recent years, many stocks have shifted distribution, the more pronounced movements associated with species from the southern end of the ecosystem and less so for those from the Gulf of Maine.



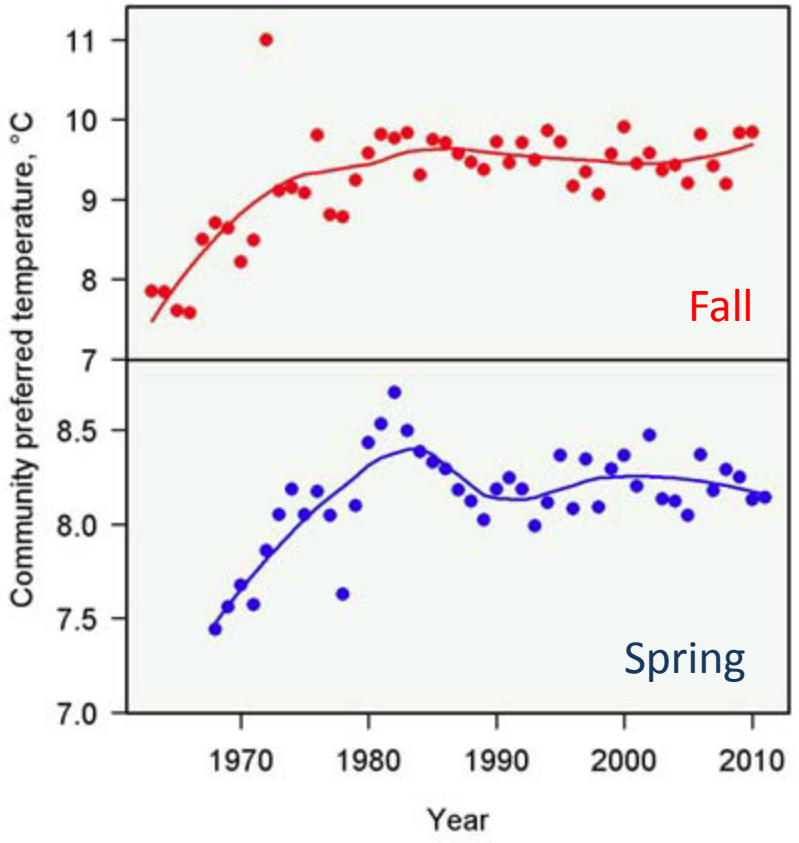

Red hake




*Nye et al. (2009)*

Shifting communities distributions:

The fish community on US Northeast Continental Shelf is shifting to one composed of warmer water fauna.

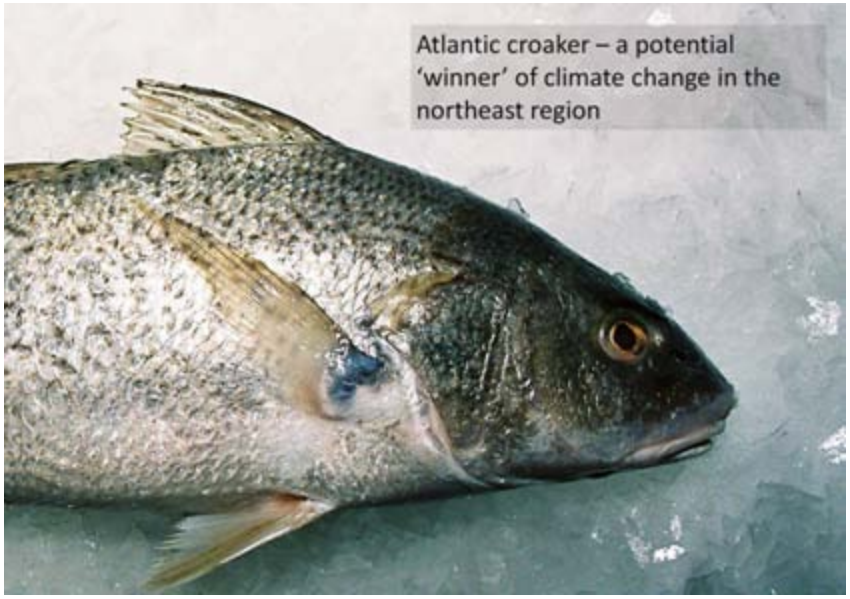


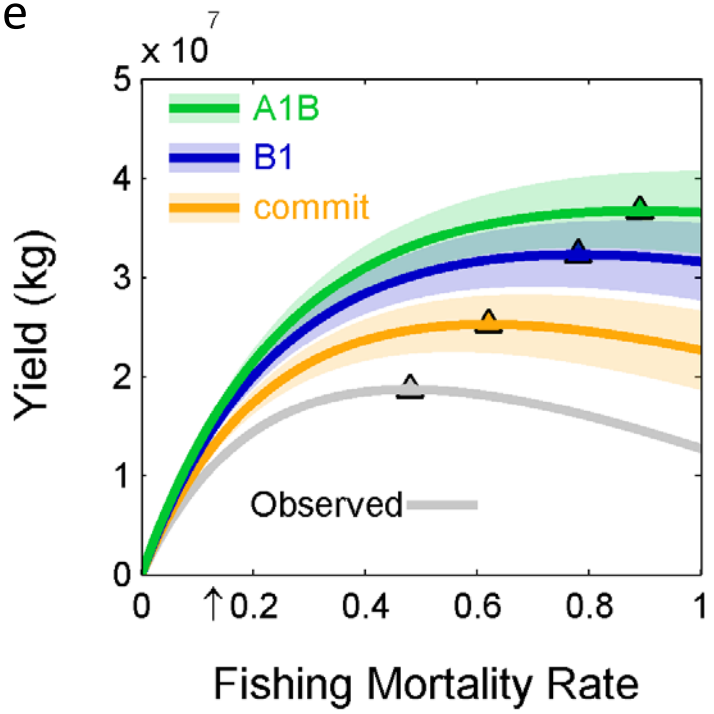

*EcoAP (2009)*

Potential for increased yield:

Atlantic croaker is expected to have increasing yield (MSY) with increasing temperature in the mid-Atlantic into southern New England.

Croaker is potentially a climate **winner** for the Northeast Shelf Ecosystem.



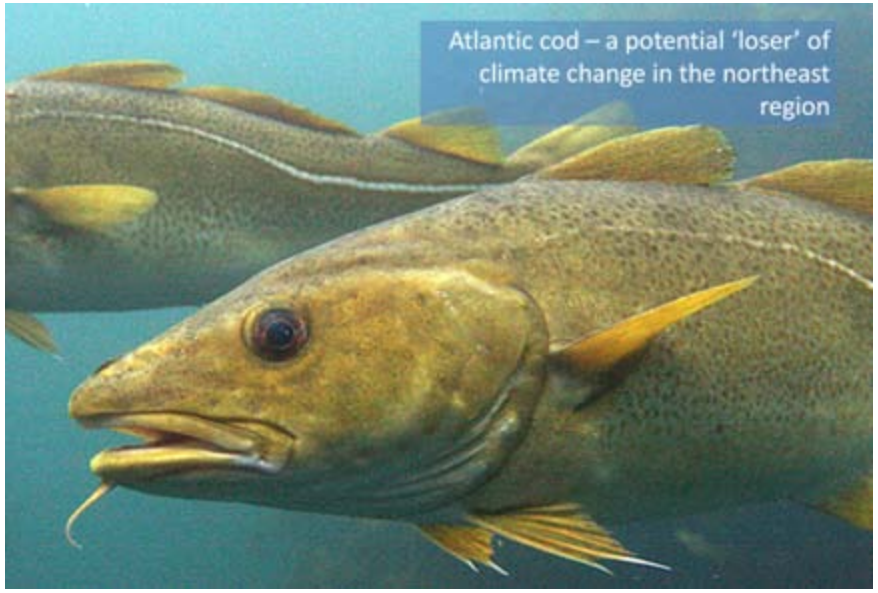



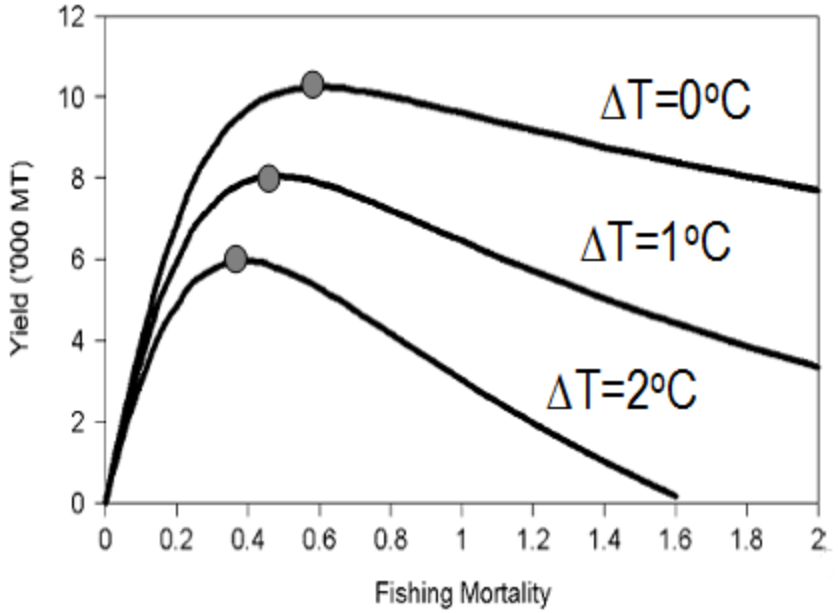

*Hare et al. (2010)*

Potential for decreased yield:

Atlantic cod is expected to have decreasing yields (MSY) with increasing temperature in the southern New England into the Gulf of Maine.

Cod is potentially a climate **loser** for the Northeast Shelf Ecosystem.

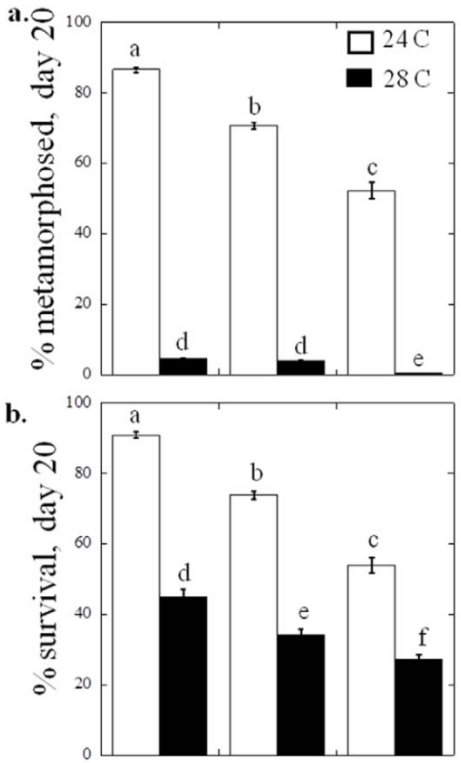



*Fogarty et al. (2008)*

Other:

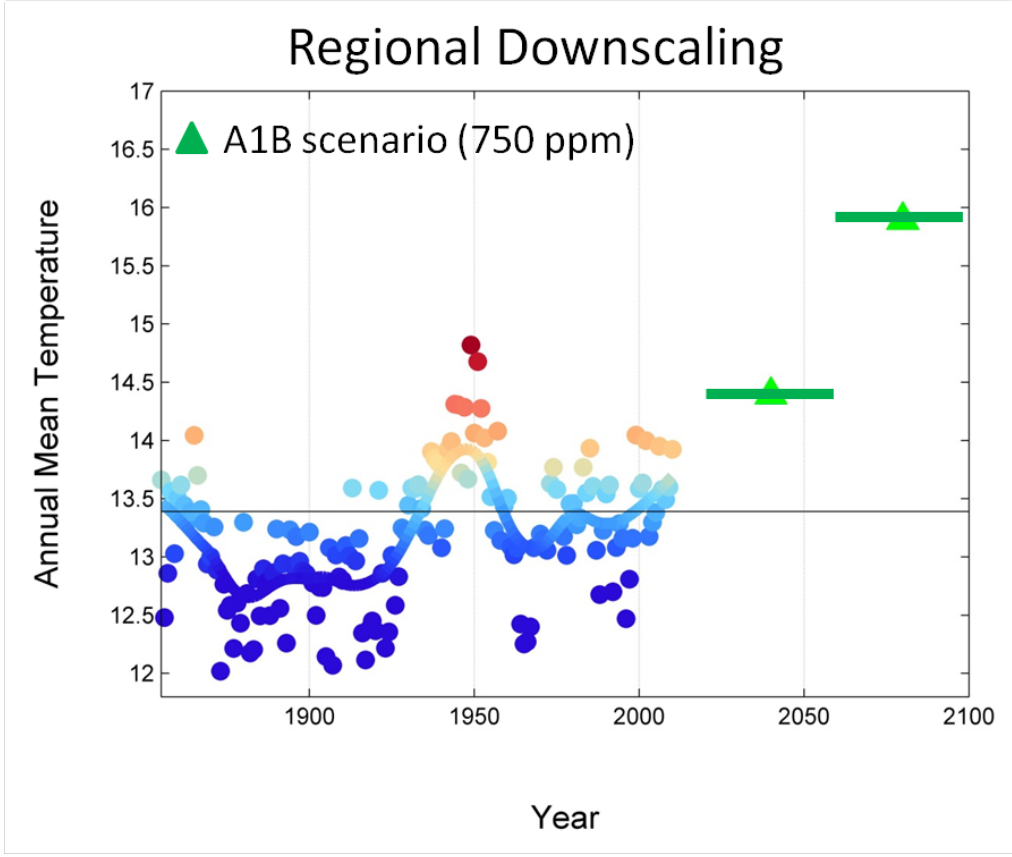
Mackerel distribution (Overholtz et al. 2011), Atlantic salmon post-smolt mortality (Friedland et al. 2012), surf clam depth distribution (Weinberg 2005), larval clam survival (Talmage and Gobler 2011), phytoplankton productivity (Balch et al. 2012), zooplankton community structure (Kane 2007)…




*Talmage and Gobler (2011)*

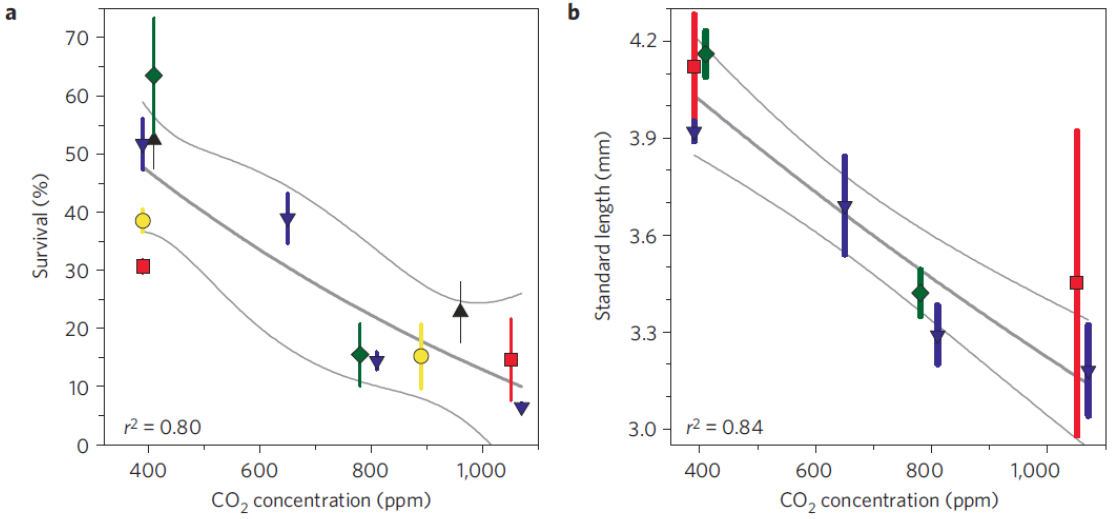
Climate projection of temperature:

Temperature is expected to increase during the coming century.



Physiological stress:

Increased metabolic costs to maintain homeostasis manifests itself in decreased growth, morphological anomalies, and reduced survival.

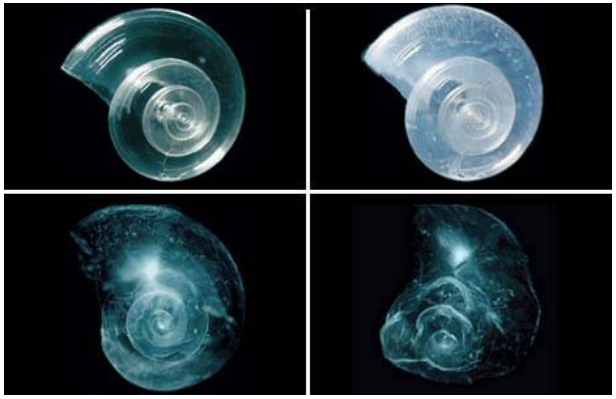


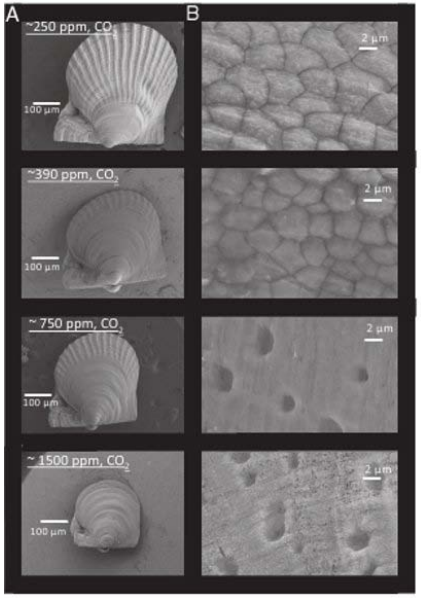


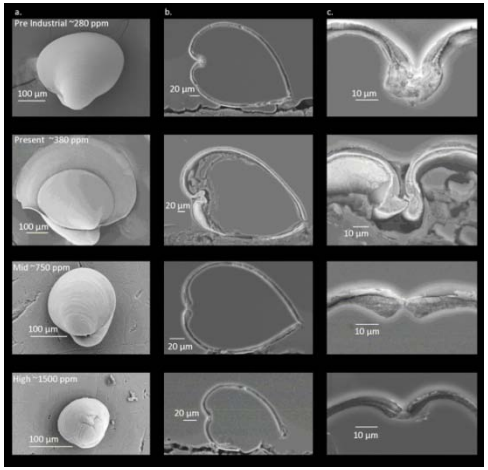
*Baumann et al. (2011)*

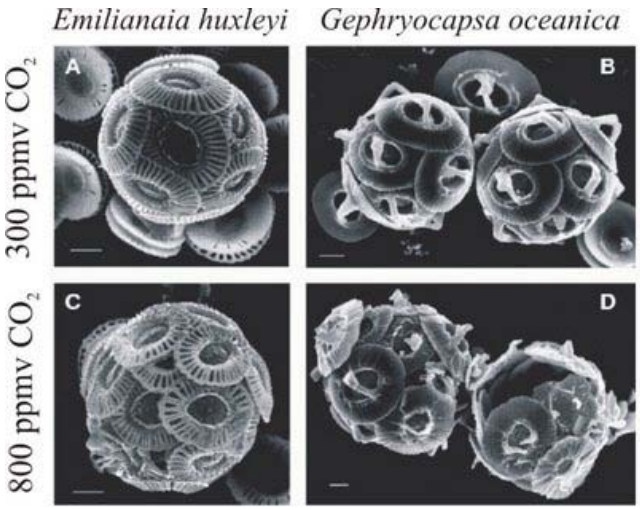
Calcified structures:

Saturation states for calcite and aragonite ($\Omega$) will shift with pH, affecting the ability of shells to form in plankton and shellfish.



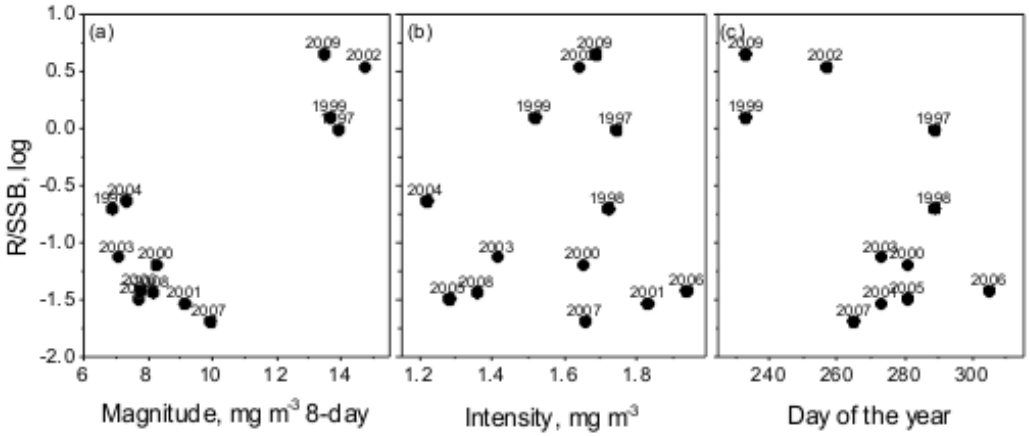


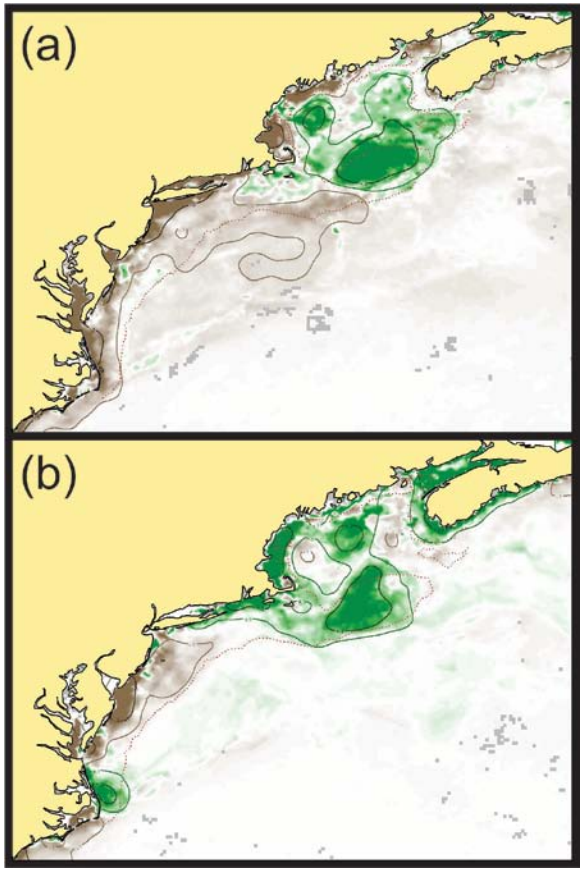



Bloom timing and haddock recruitment:

Early and high magnitude fall blooms on Georges Bank favors the recruitment of haddock.



## Conclusions:

The Northeast Shelf is a complex ecosystem undergoing dramatic changes in the physical forcing impacting the ecosystem.

The ecosystem is experiencing changes in thermal regime, productivity, and upper trophic level communities.

Climate projections suggest that these changes will continue to present challenges to managers and user groups to adapt to changing conditions and ecosystem properties.

Resident species, like fish and shellfish, will have to exhibit rapid adaptive radiation to avoid becoming climate losers.

They will need to be more like dogs who are among the champions of adaptive radiation.

Acknowledgements:

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