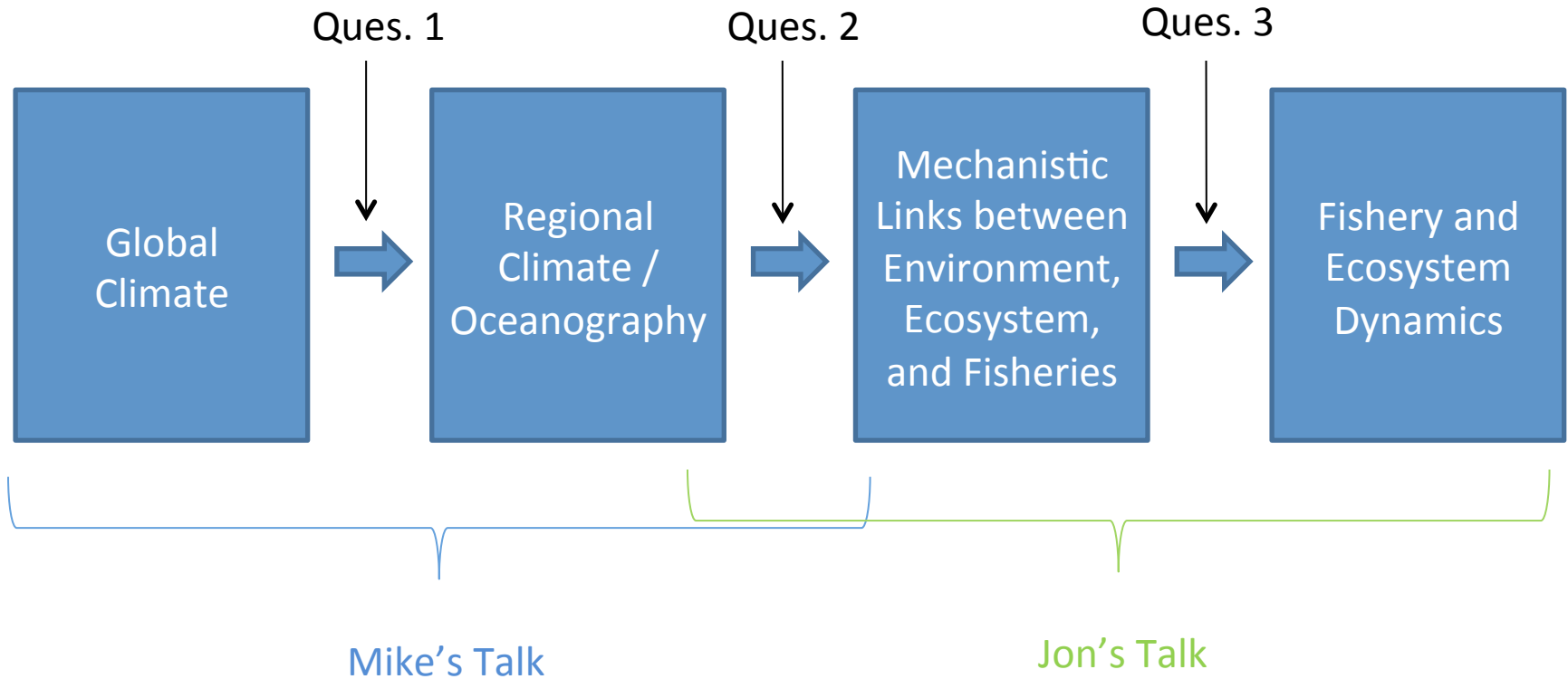


Understanding Climate Impacts on Fish
Stocks of the Northeast Shelf Large
Marine Ecosystem: Key Research Needs
and Future Directions

23 Jul 2013
Providence, RI

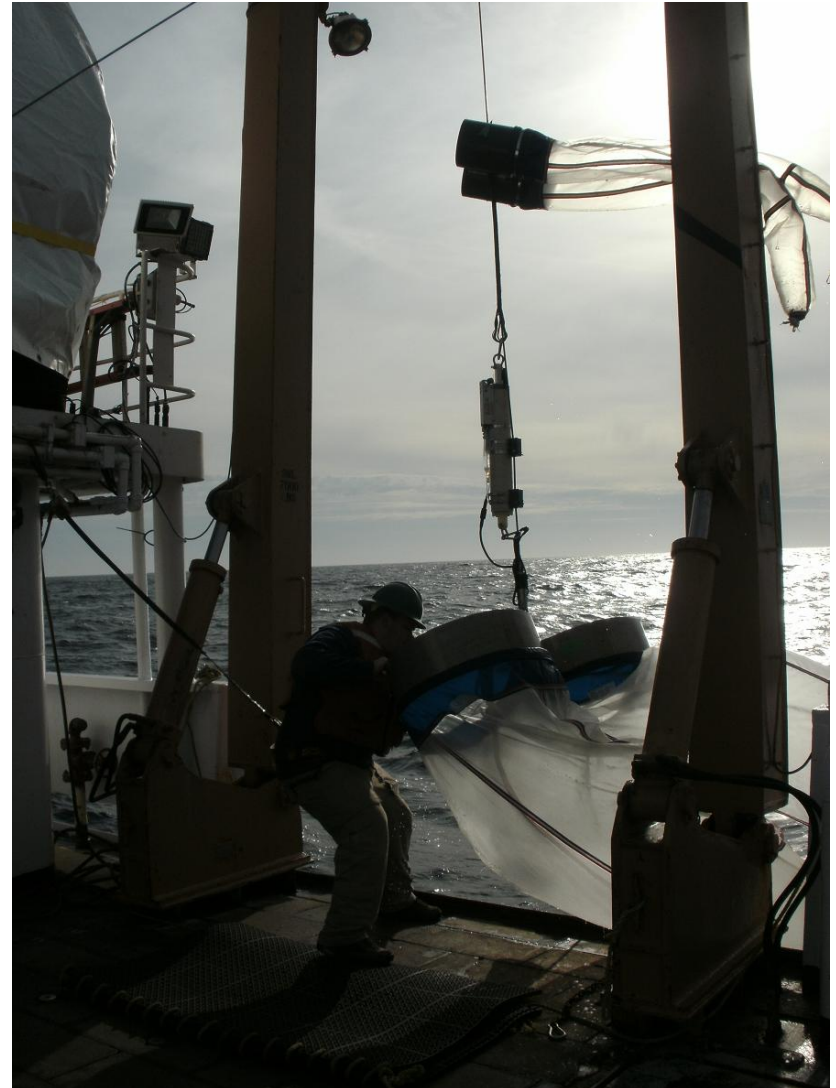
Climate – Fisheries Interactions

Introduction



Outline

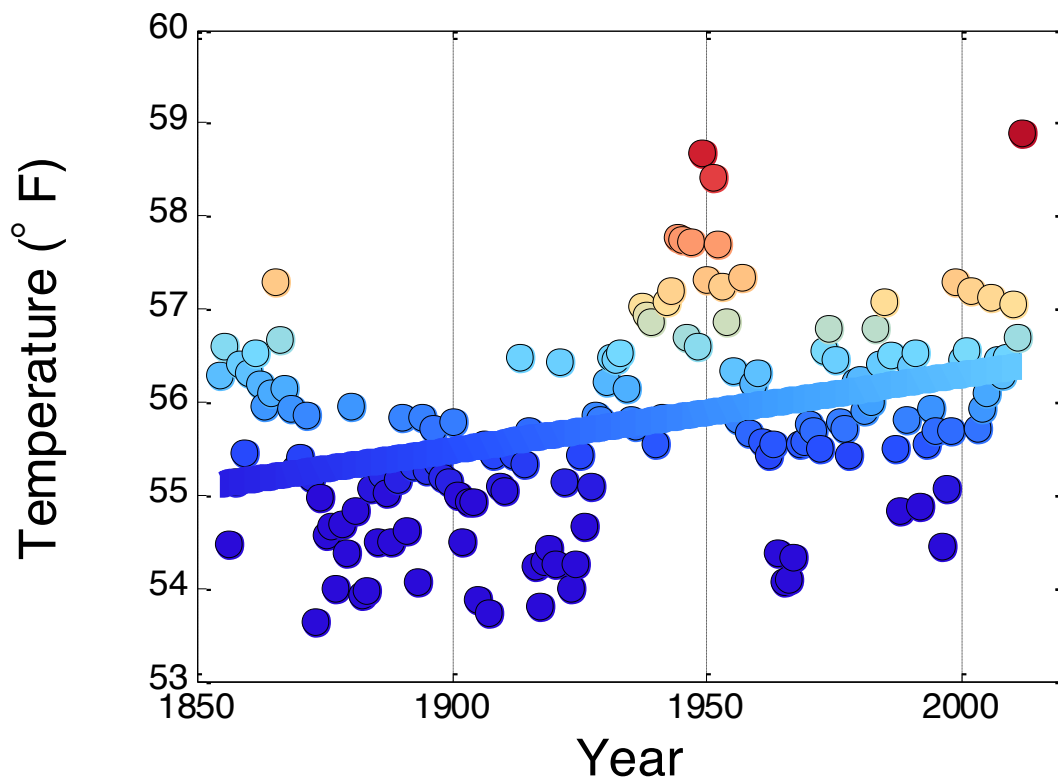
- Climate conditions
- Biological conditions
- Coupled climate-biology projections
- Review of past approaches
- Paths forward
- NOT A REVIEW; AN OVERVIEW



Climate Conditions

Northeast US Shelf Temperature

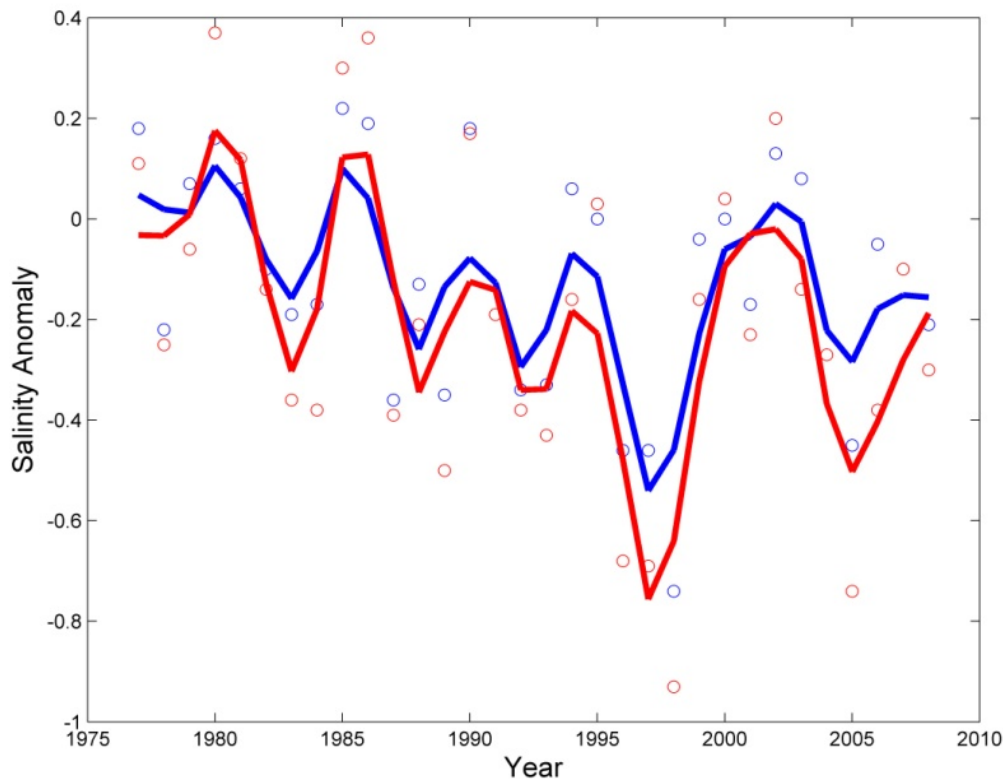
- ~ 1.25 °C increase
- Substantial inter-annual and decadal variability



Climate Conditions

Northeast US Shelf Salinity

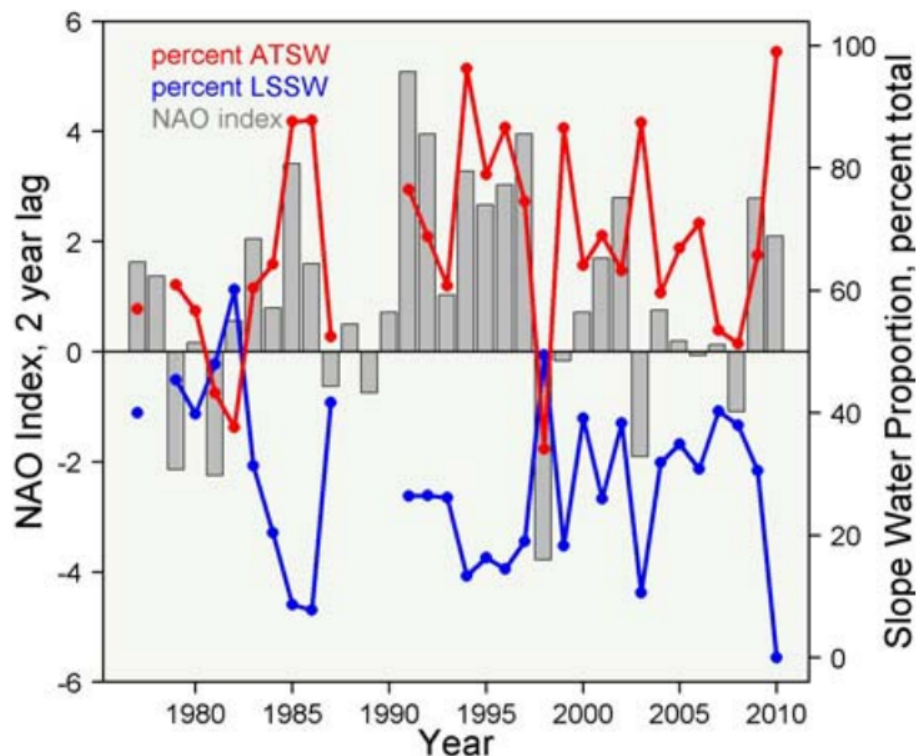
- ~0.5 decrease
- Substantial inter-annual and decadal variability



Climate Conditions

Northeast US Shelf Labrador Slope Water

- Decrease in LSSW
Northeast
Channel
- Substantial inter-
annual and
decadal variability

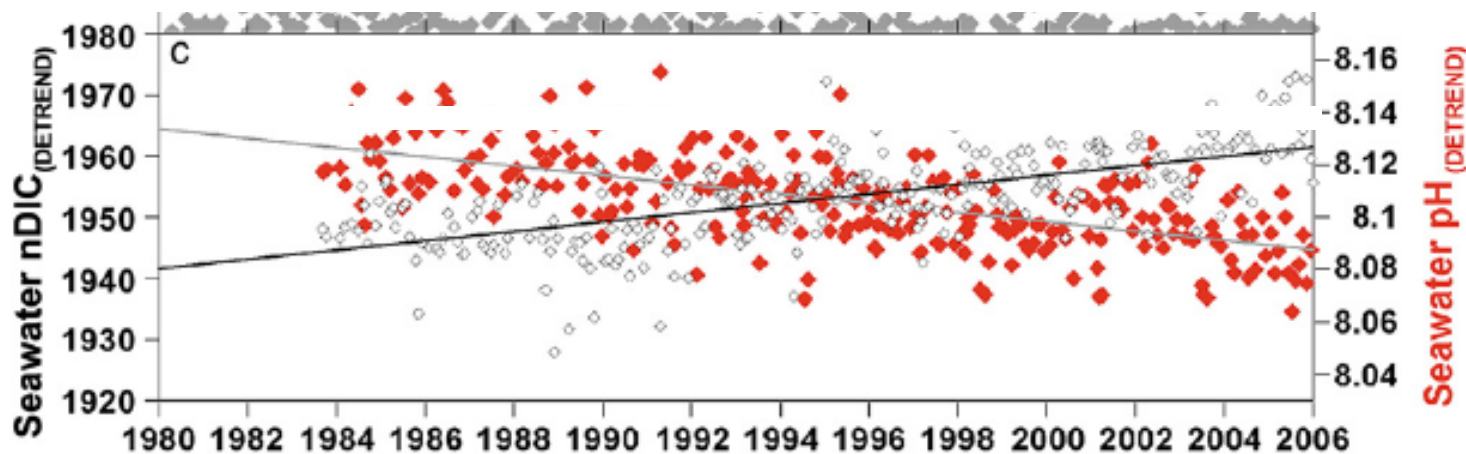
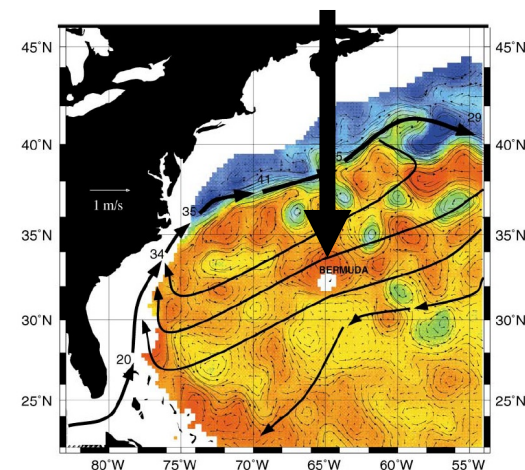


Climate Conditions

Northeast US Shelf Acidification

- Decrease pH; increase DIC
- Substantial regional and seasonal variability

Bermuda Atlantic Time Series (BATS)

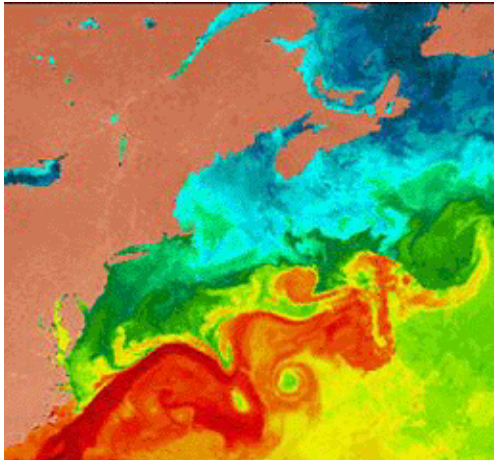


Bates NR, Peters AJ (2007) Marine Chemistry 107:547-558

Rebuck et al. in prep

Climate Conditions

Physical ecosystem is variable and changing over the long-term



Wind patterns – Archer and Calderia (2008)

Precipitation and streamflow – Hayhoe et al. (2007)

Nutrients – Townsend et al (2010)

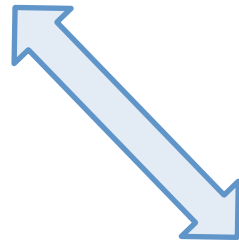
Large-scale circulation – Hakkinen and Rhines (2009)

And more.....

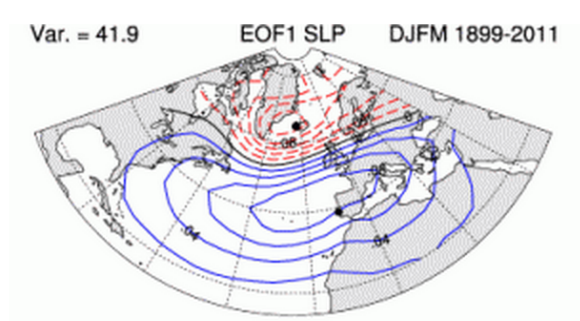
Climate Conditions



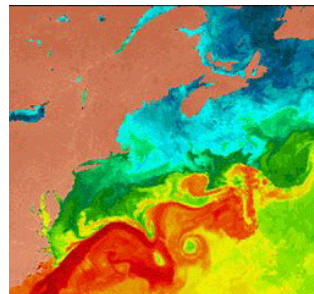
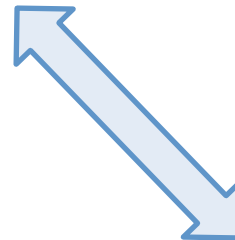
Global



Need to further understand mechanisms and linkages



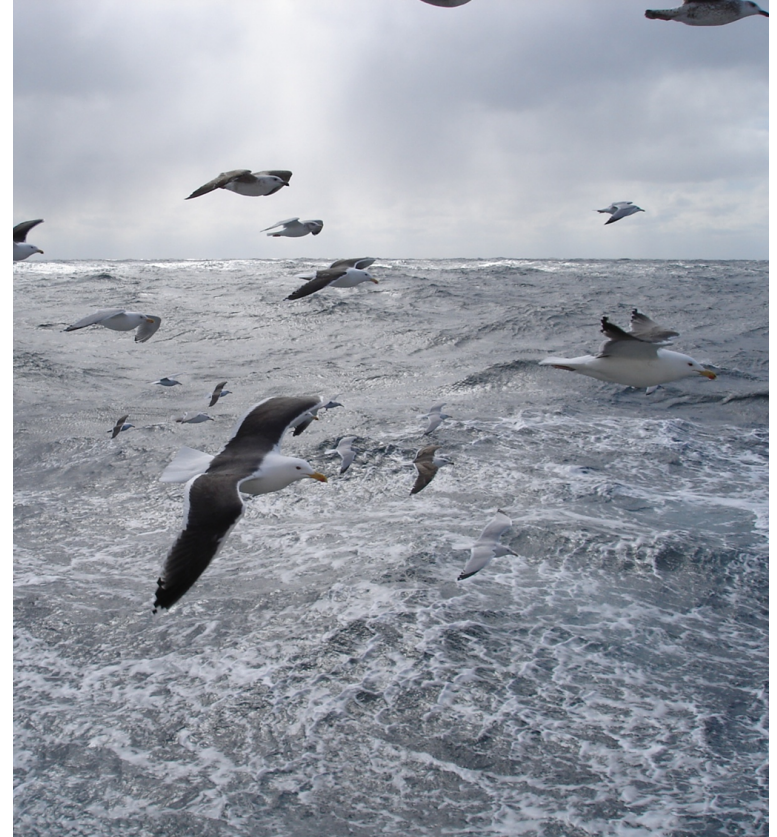
Basin



NEUS Shelf

Outline

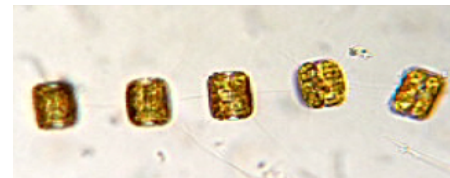
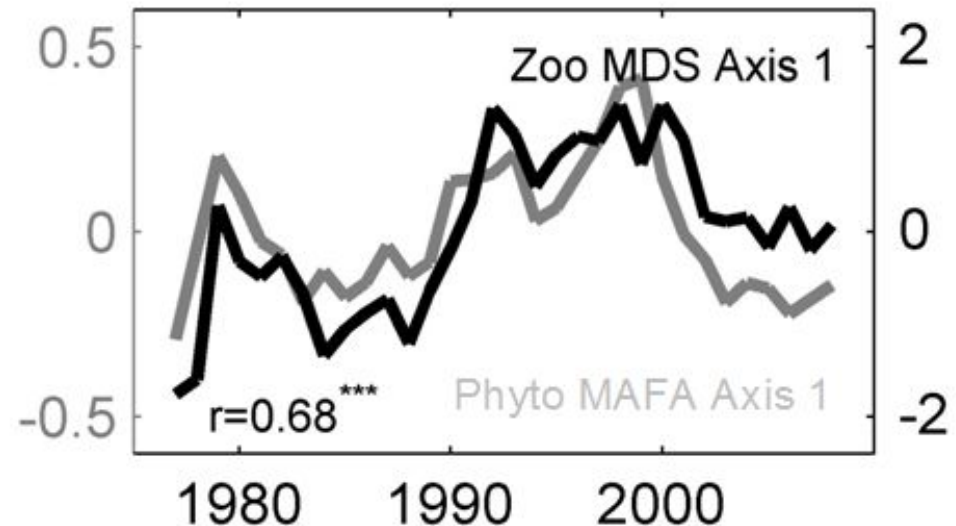
- Climate conditions
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- Paths forward



Biological Conditions

Northeast US Shelf Plankton

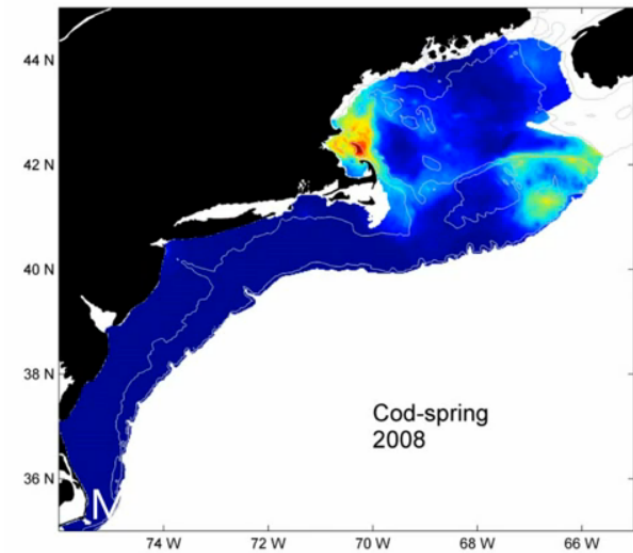
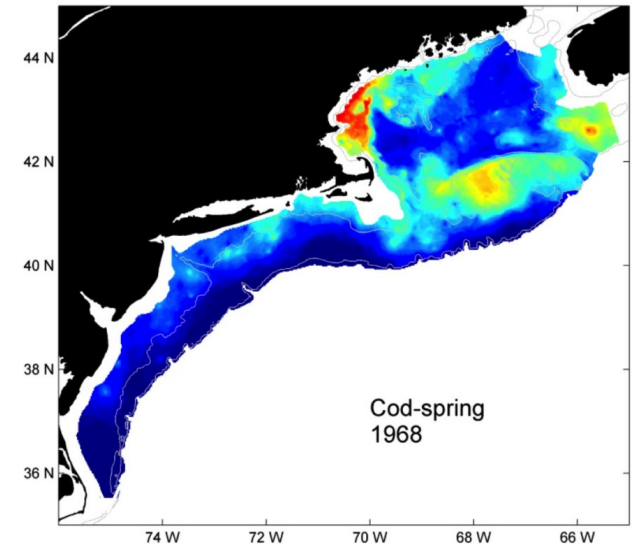
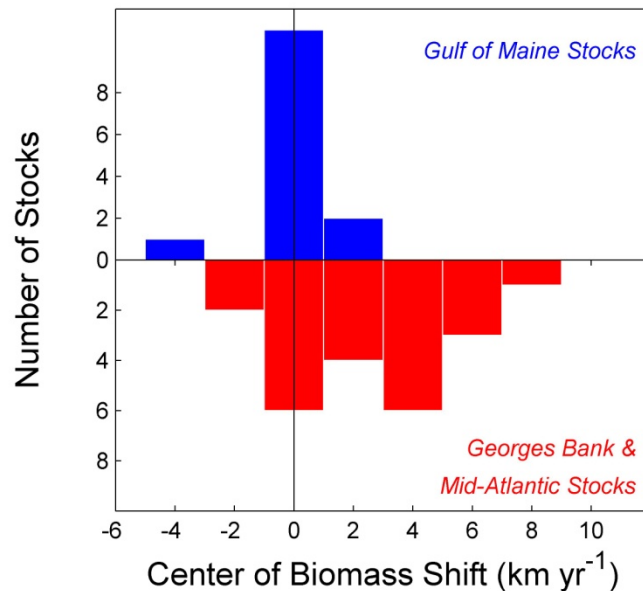
- Substantial inter-annual and decadal variability
- Coherence between phyto- and zooplankton



Biological Conditions

Northeast US Shelf Fisheries

- 24 of 36 stocks shifted poleward and/or deeper

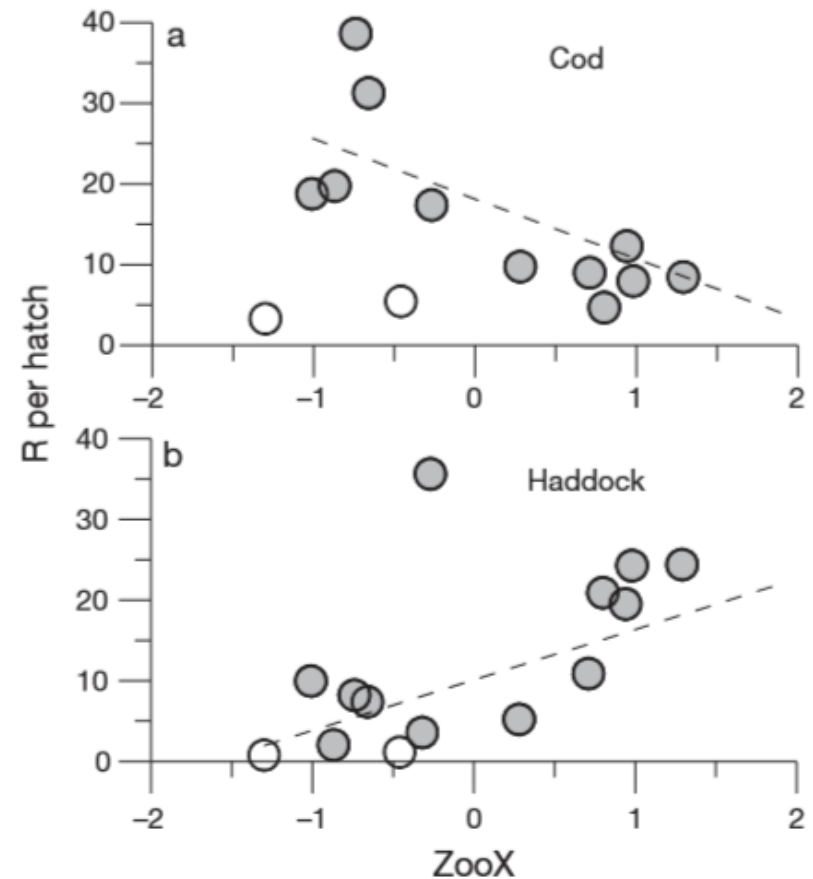


Nye JA et al. (2009) MEPS 393:111-139

Biological Conditions

Northeast US Shelf Fisheries

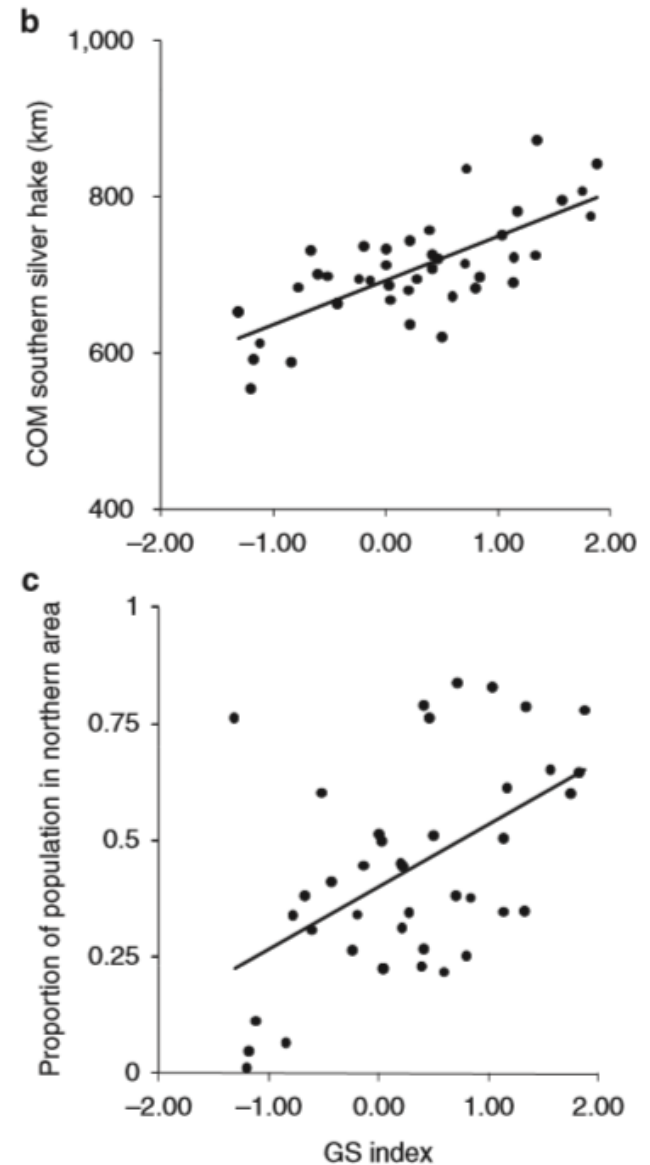
- Recruitment / hatch and recruitment / SSB related to zooplankton community and abundance



Biological Conditions

Northeast US Shelf Fisheries

- Distribution of silver hake related to Gulf Stream position (indicator of regional hydrodynamics)



Biological Conditions

Biological ecosystem is variable and changing over the long-term



Mackerel distribution -
Overholtz et al. (2011)

Atlantic salmon- Friedland
et al. (2003)

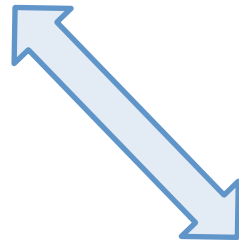
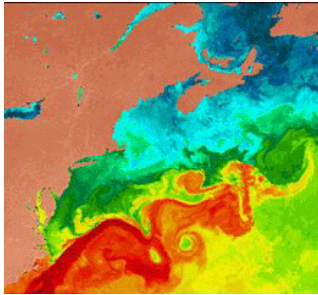
Shellfish – Weinberg (2005),
Talmage and Gobler (2010)

Phytoplankton – Balch et al.
(2012)

And more ...

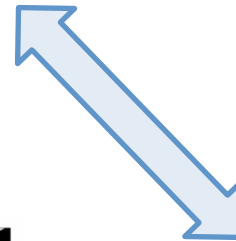
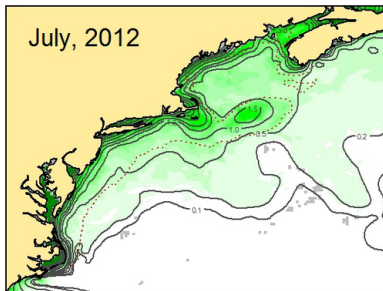
Biological Conditions

NEUS Shelf

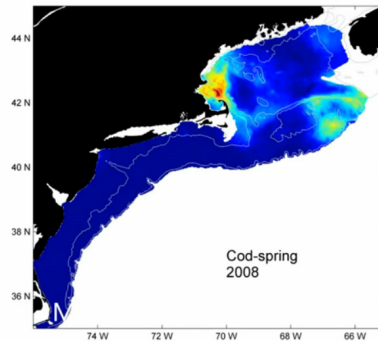


Need to further understand mechanisms and linkages

NEUS Ecosystem



NEUS Fisheries



Outline

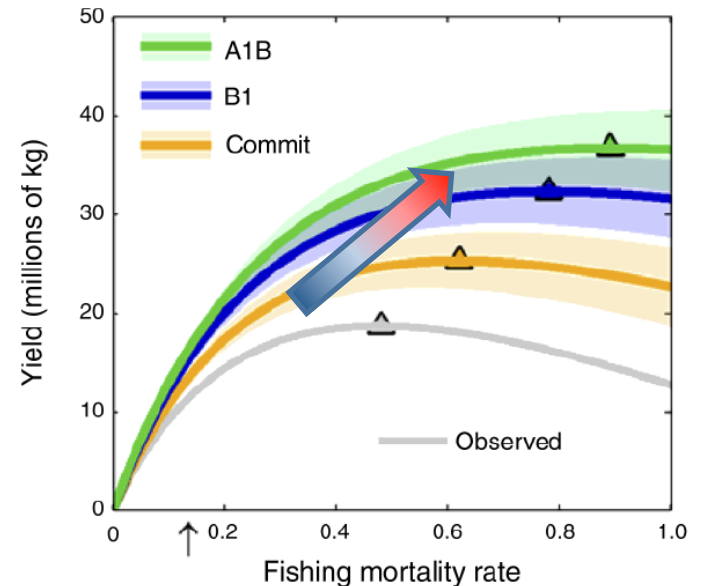
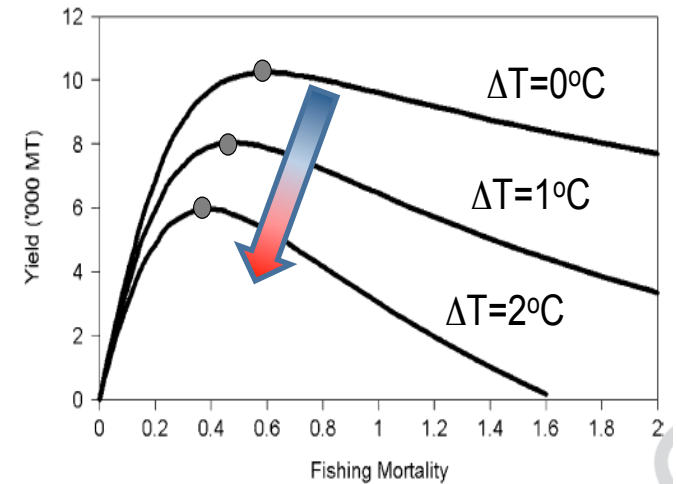
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Projections

Climate-Fisheries

- Atlantic cod productivity projected to decrease
- Atlantic croaker productivity projected to increase
- Temperature-modified recruitment functions

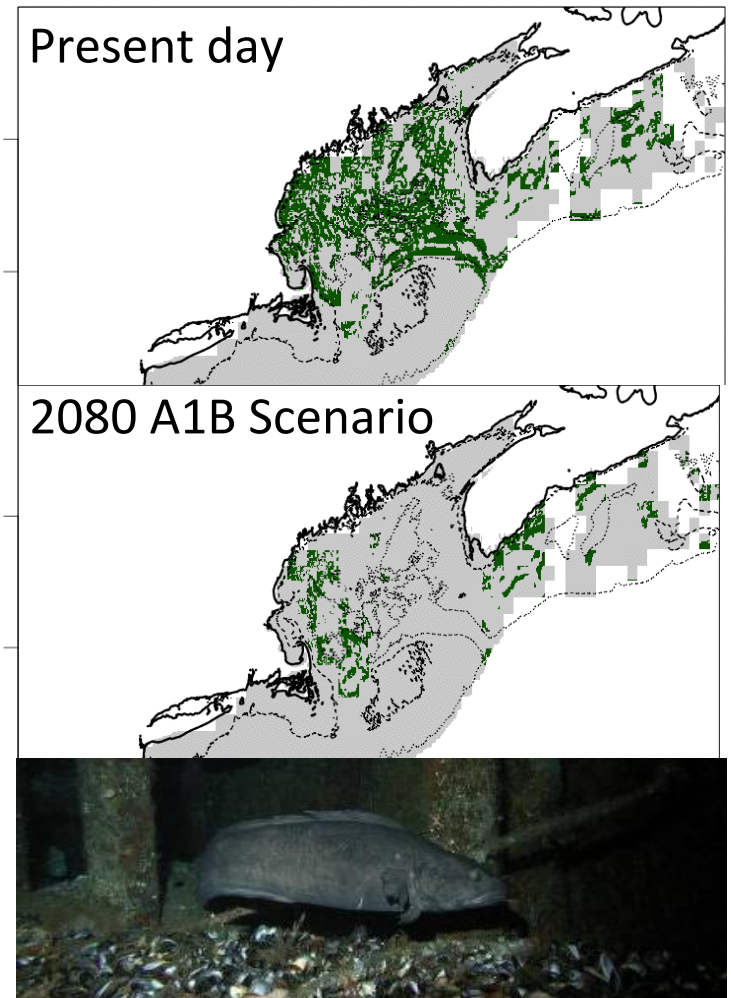


Projections

Climate-Fisheries

- Cusk distribution projected to constrict
- Thermal / bottom roughness niche model

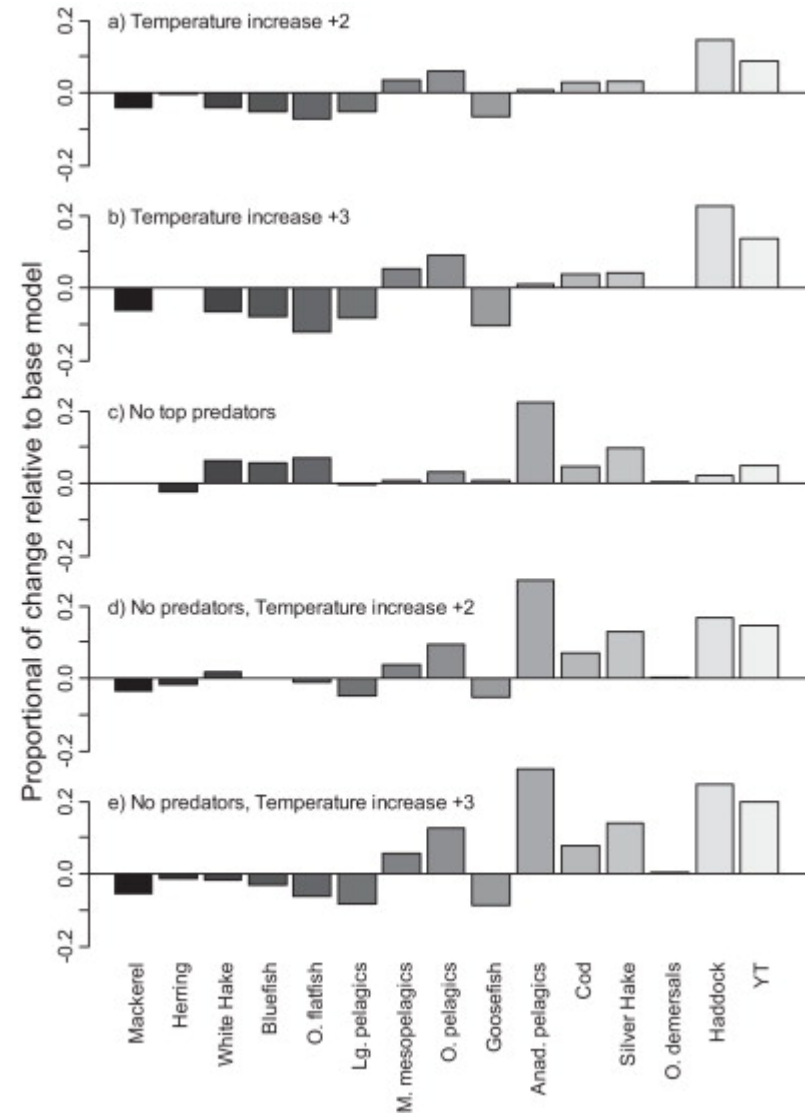
Projected Cusk Habitat (■)



Projections

Climate-Fisheries

- Species interactions important
- Modeling suggest mostly additive effects of climate and predation

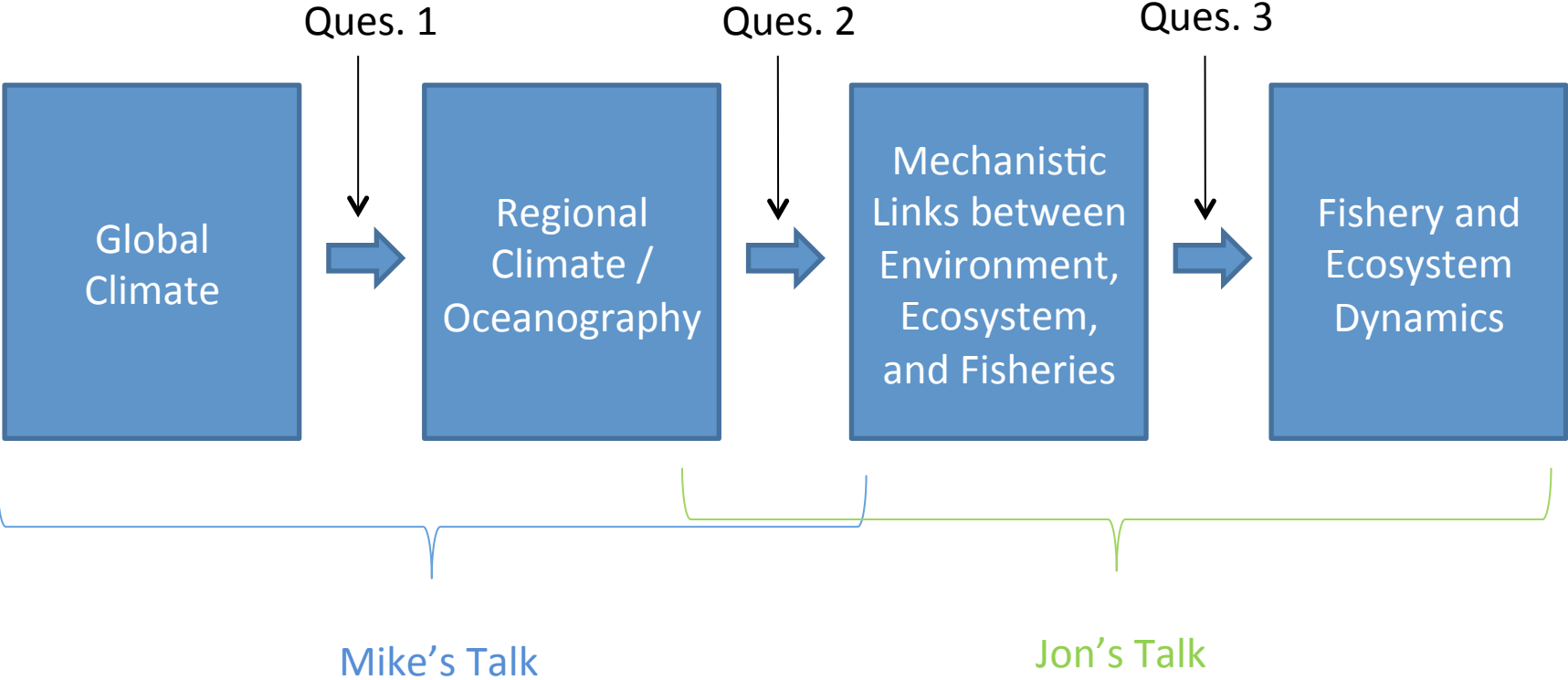


Outline

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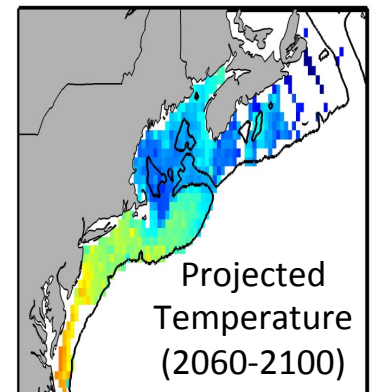
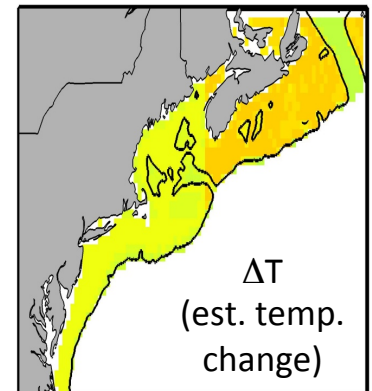
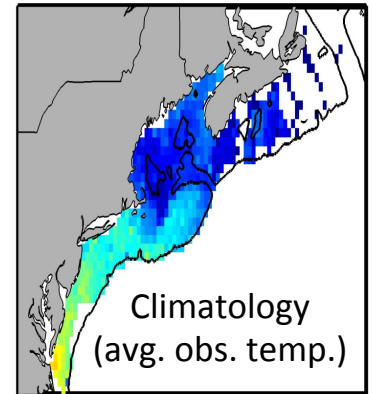
Review of Approaches



Review of Approaches

Downscaling (Global to NEUS Shelf)

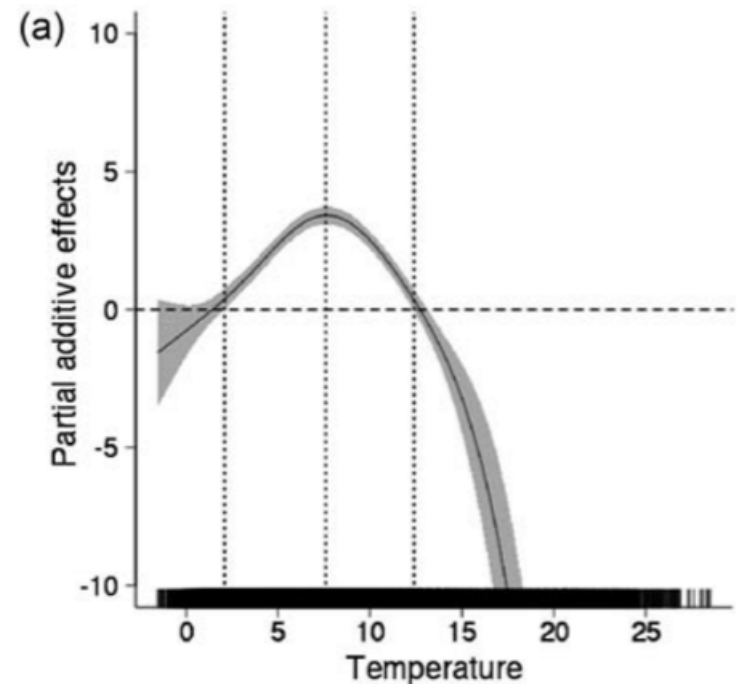
- Cod – bias corrected SST; empirical link bwt SST & BT
- Croaker – bias corrected airT; empirical link between airT and estT
- Cusk – bias corrected BT



Review of Approaches

Mechanism (Climate to Biology)

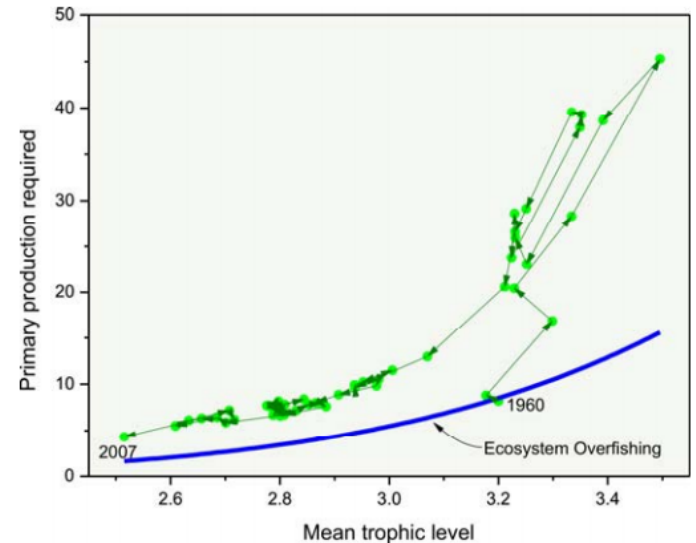
- Cod – correlative: temperature effect on recruitment
- Croaker – correlative: winter temperature effect on juvenile survival / recruitment
- Cusk – correlative: 2 parameter niche model



Review of Approaches

Dynamics (Biology to Fisheries)

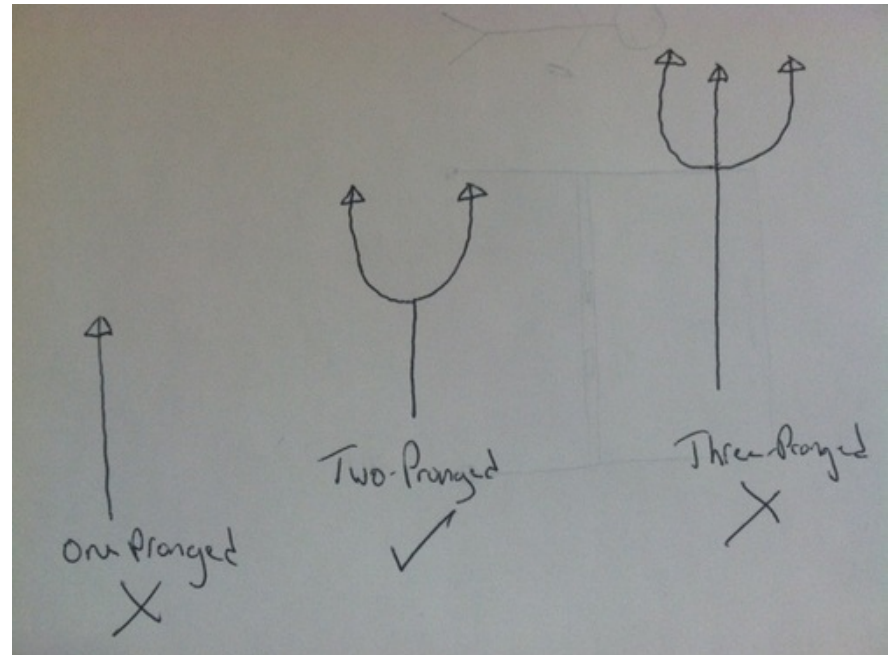
- Population productivity
- Population distribution
- Ecosystem productivity
- Ecosystem structure



Paths Forward

Two-pronged Approach

- Continue current enterprise
- Improve enterprise



<http://middlemgmtphrases.tumblr.com/>

Paths Forward

Augment current scientific enterprise

- Add climate to current models and assessment
- Climate scenarios with ecosystem models
- Outreach to fishery managers and stakeholders
- Climate vulnerability analysis

Paths Forward

Improve scientific enterprise

- Process based mechanistic hypotheses and models
- Decadal and sub-decadal projections
- Other environmental factors (e.g., salinity, ocean acidification)
- Species interactions and explicit spatial dynamics
- Address "exiting" and "emerging" fisheries

Challenge Ahead

50+ managed fishery stocks

12 stocks currently overfished

7 stocks subject to overfishing

20+ marine mammal and sea turtle species

