

# Ocean Warming and Marine Fisheries in the Northeast U. S.

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Northeast Monthly Climate Update

November 30, 2017



Gulf of Maine  
Research Institute

Science. Education. Community.

# Outline

- Warming on the Northeast Shelf
- Impacts on species and fisheries
- Resilience and adaptation in fisheries

## Acknowledgements:



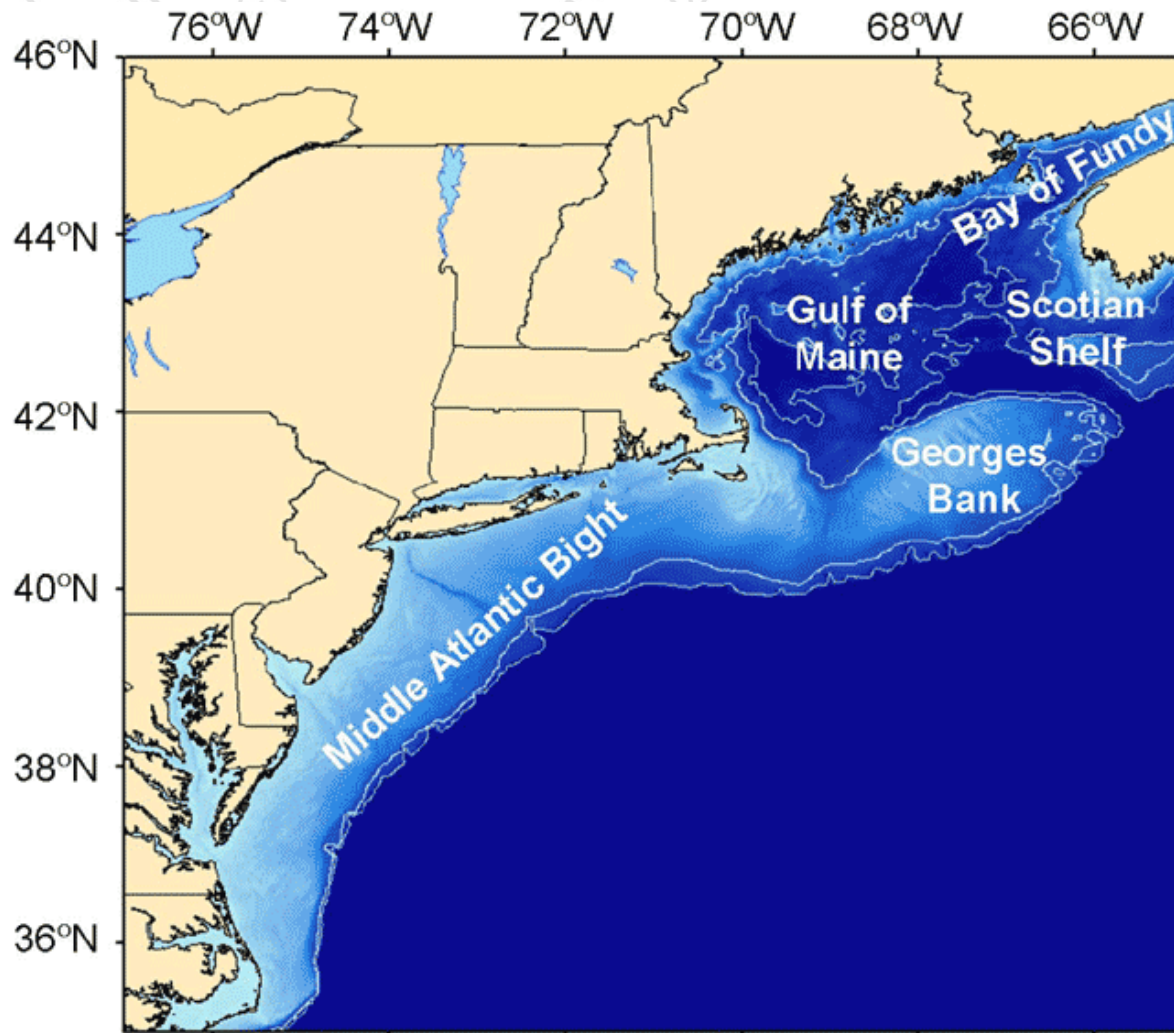
LENFEST  
OCEAN  
PROGRAM



# Outline

- **Warming on the Northeast Shelf**
- Impacts on species and fisheries
- Resilience and adaptation in fisheries

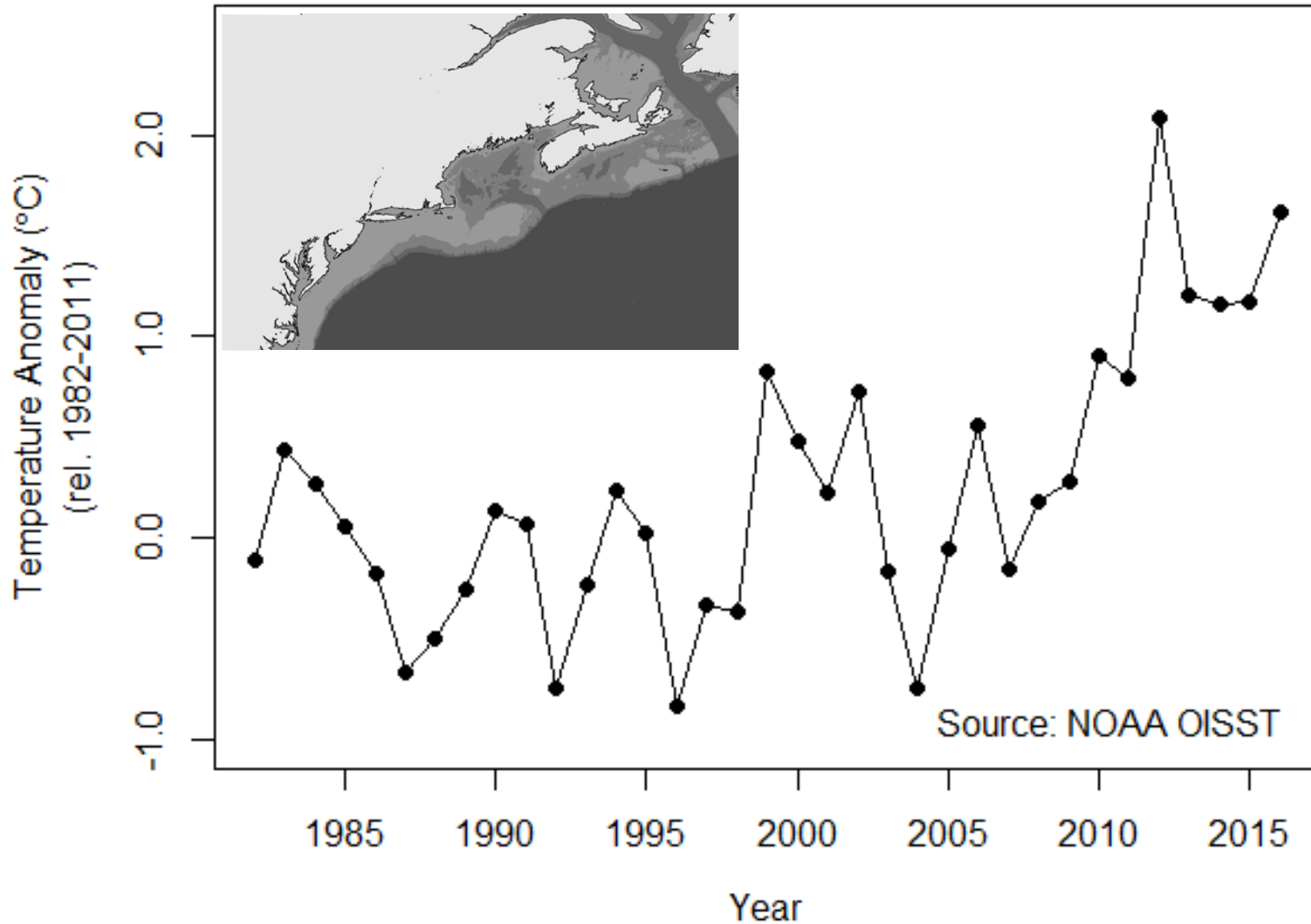
# Northeast U. S. Shelf



(NEFSC 2015)

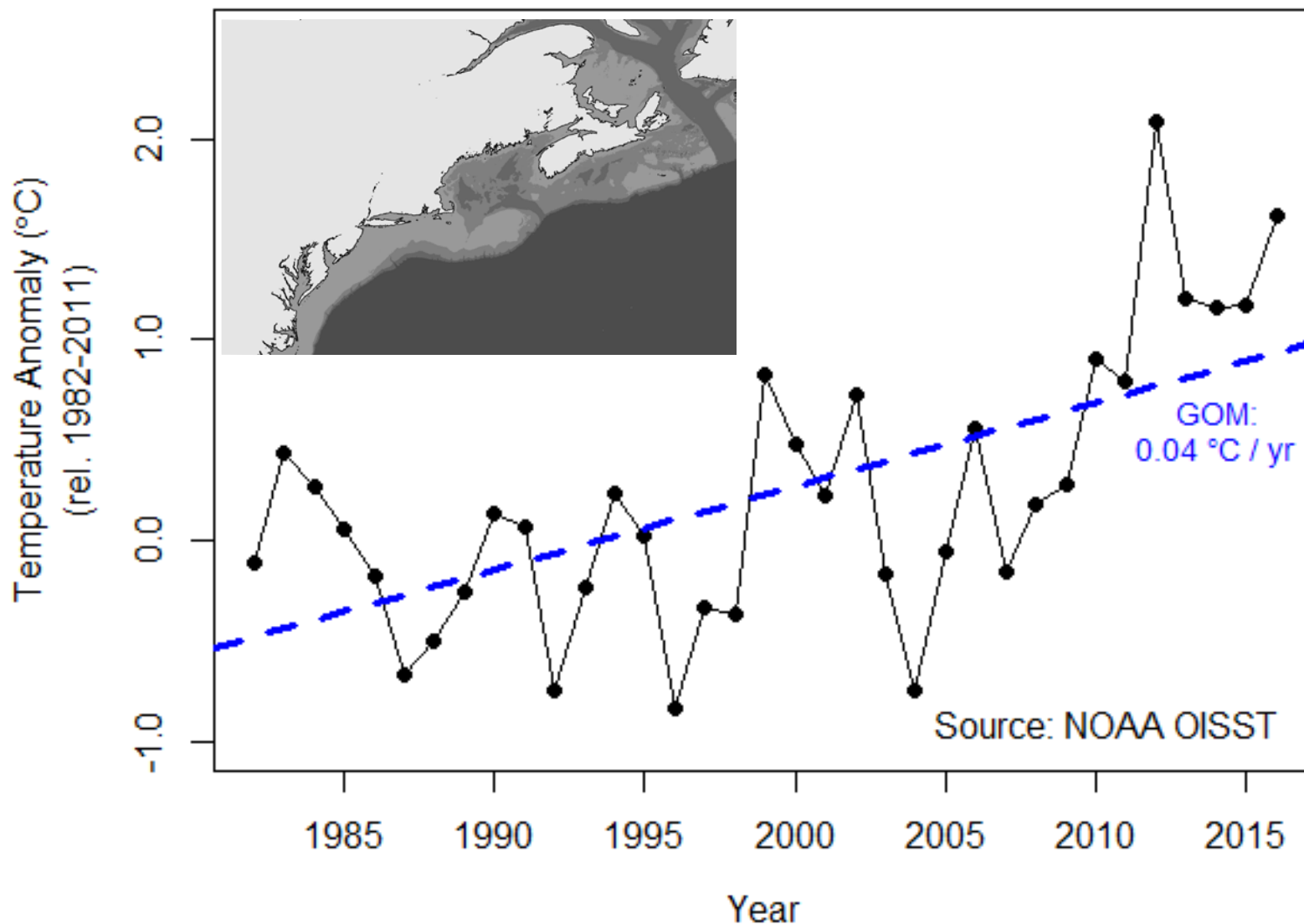
# Rapid warming trend

## Gulf of Maine Sea Surface Temperature



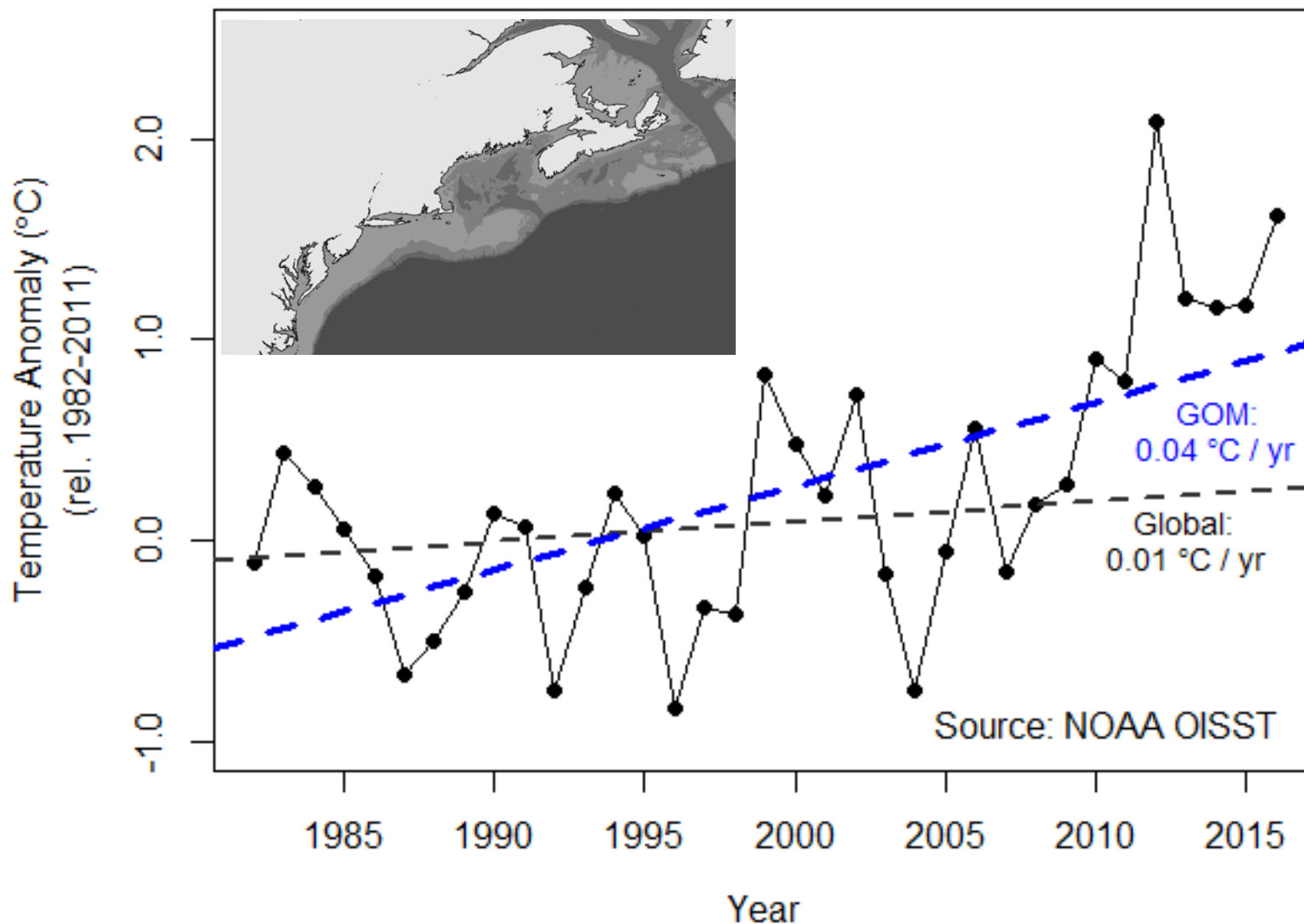
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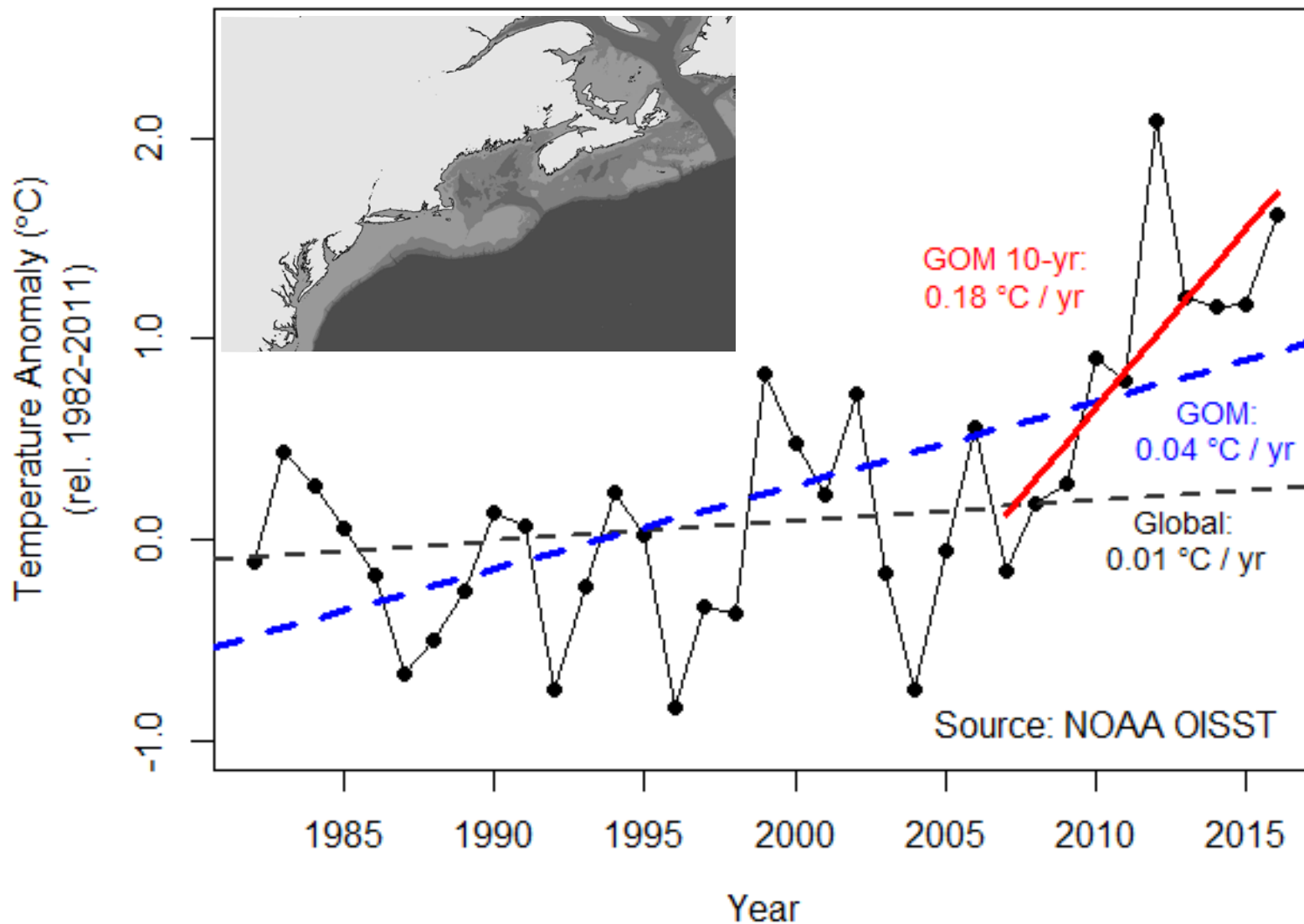
# Rapid warming trend

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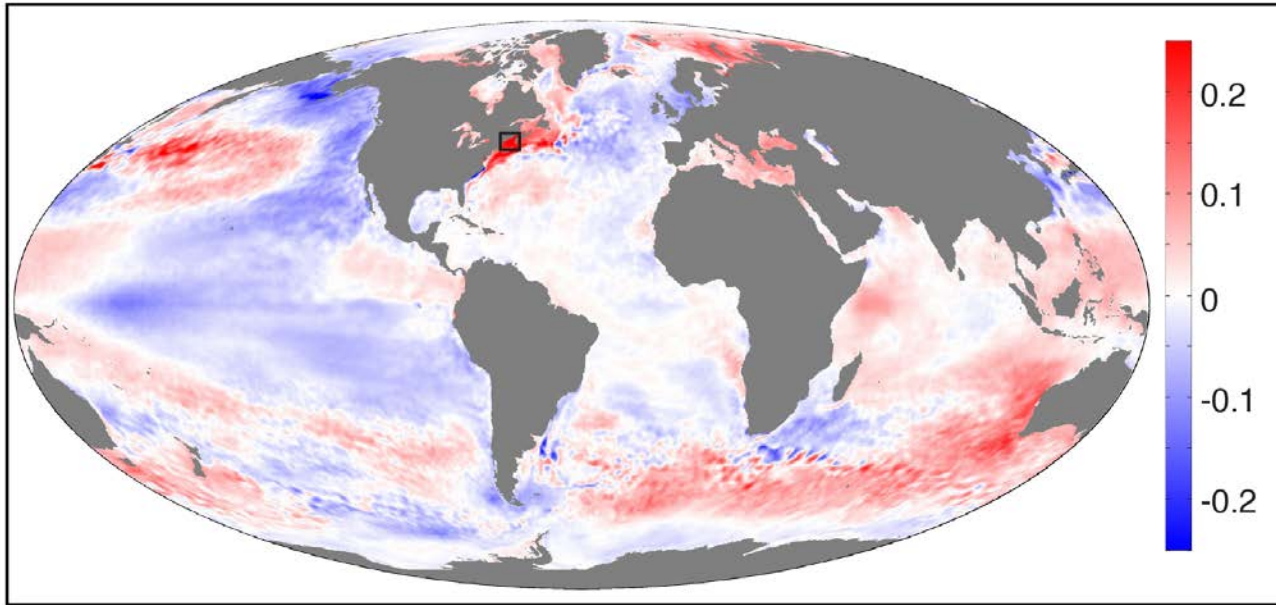
# Rapid warming trend

## Gulf of Maine Sea Surface Temperature



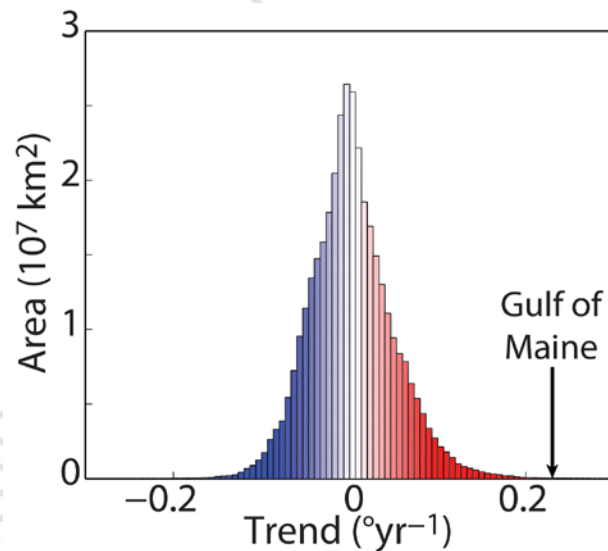
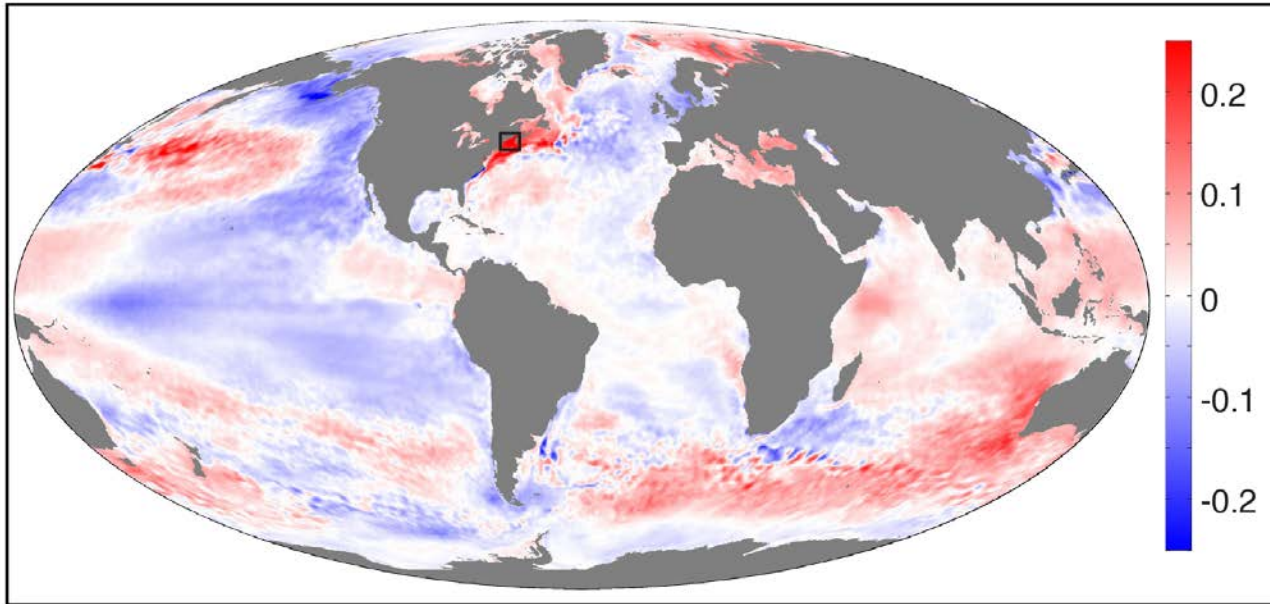


# Rapid warming trend



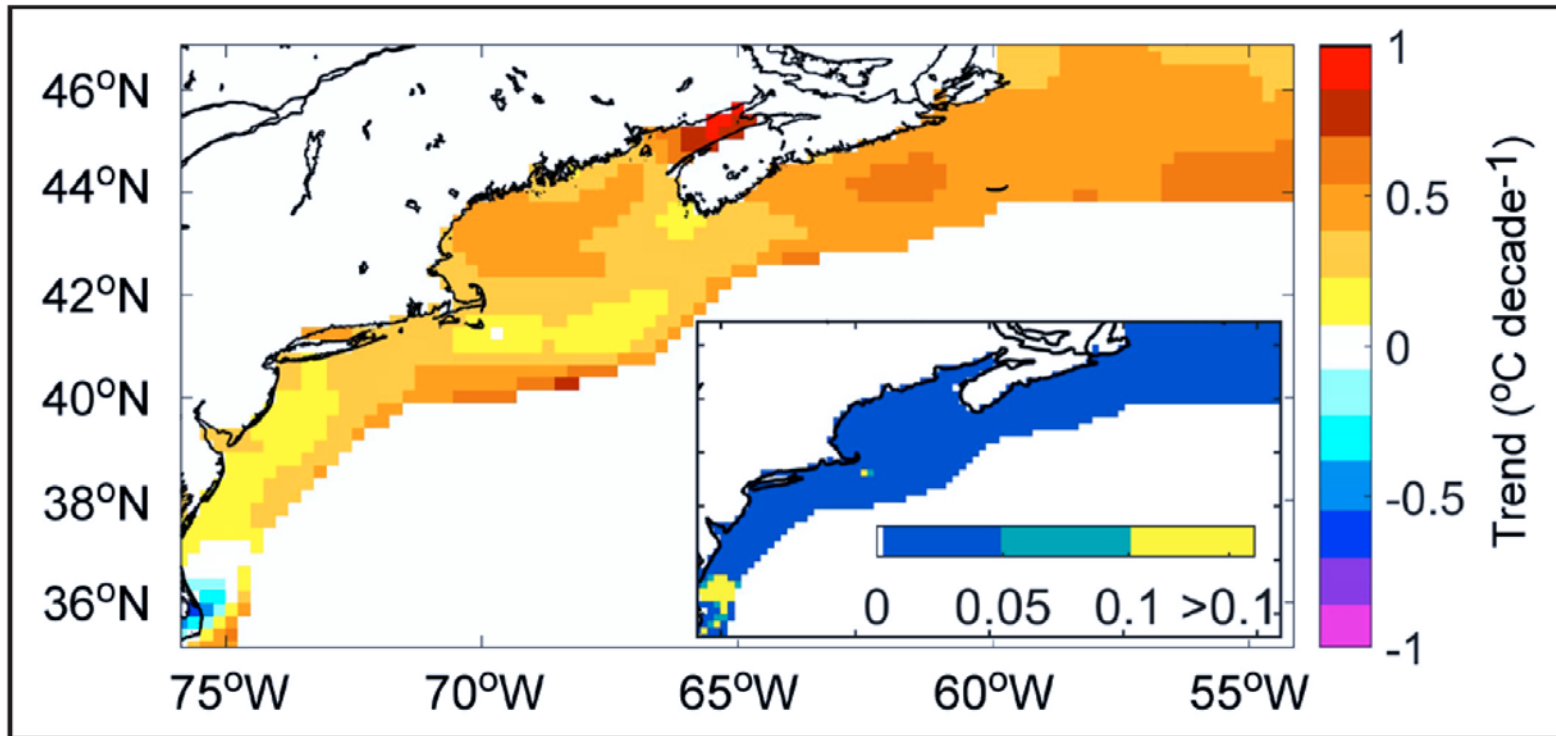
(Pershing et al. 2015)

# Rapid warming trend



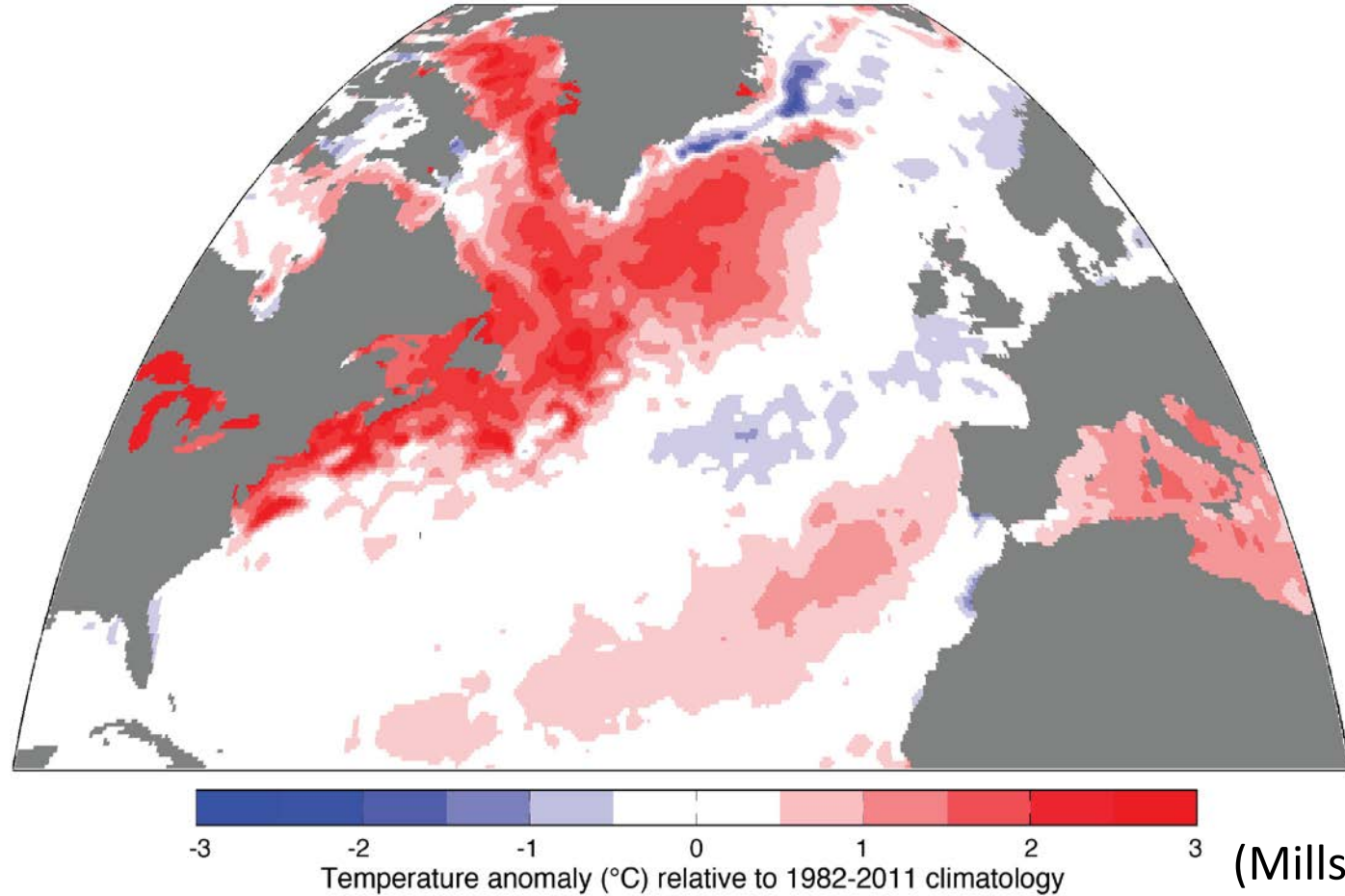
(Pershing et al. 2015)

# Rapid warming trend



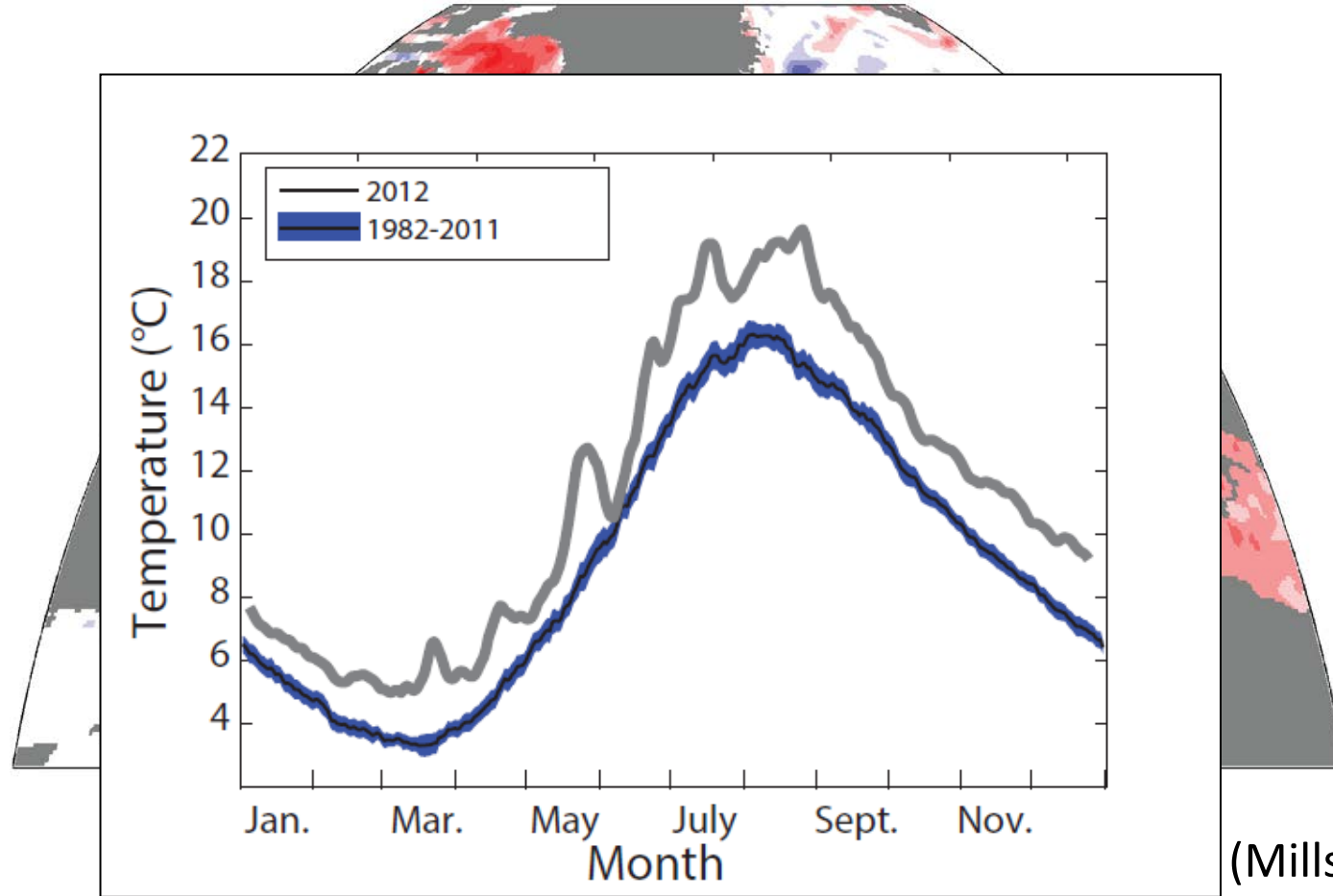
(Thomas et al. 2017)

# Warm events—2012 heat wave



- Largest, most intense SST anomaly ever in the North Atlantic
- Comparable in scale to El Nino
- Warming comparable to predictions for end of century

# Warm events—2012 heat wave

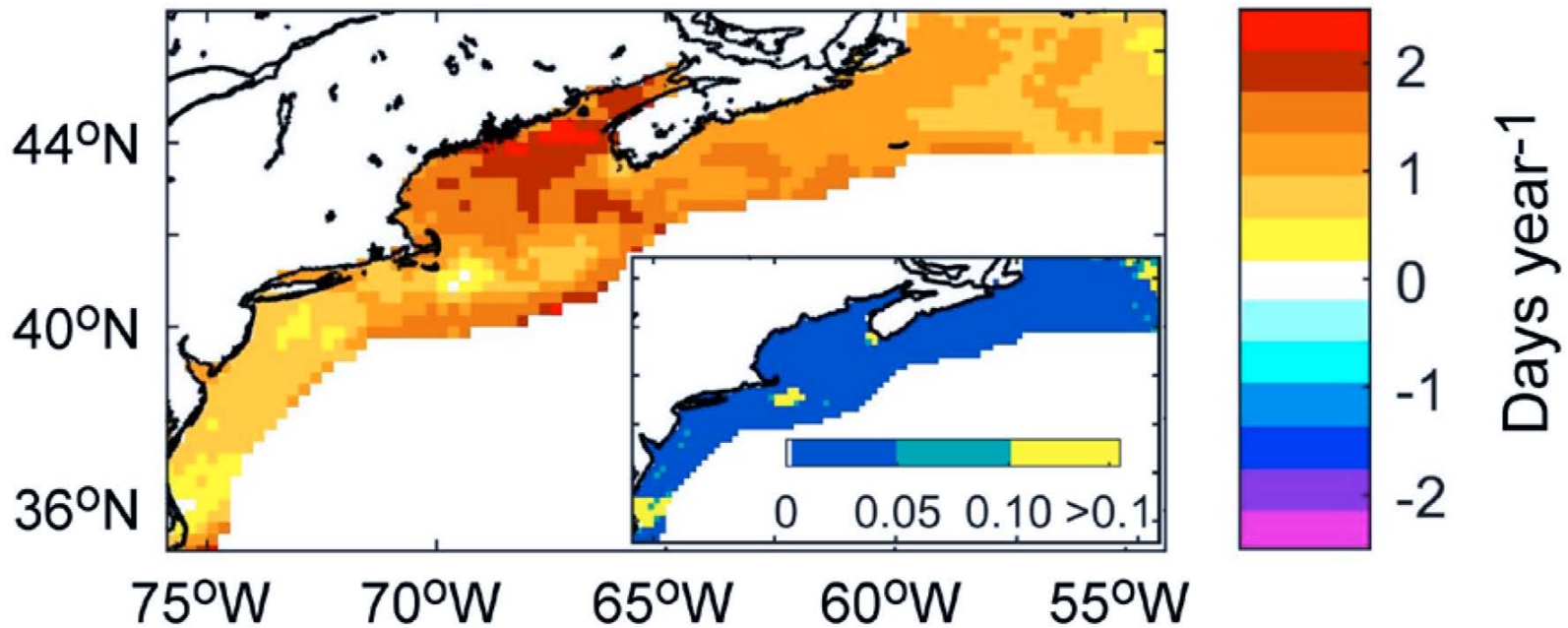


(Mills et al. 2013)

- Largest, most intense SST anomaly ever in the North Atlantic
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# Changing seasonality

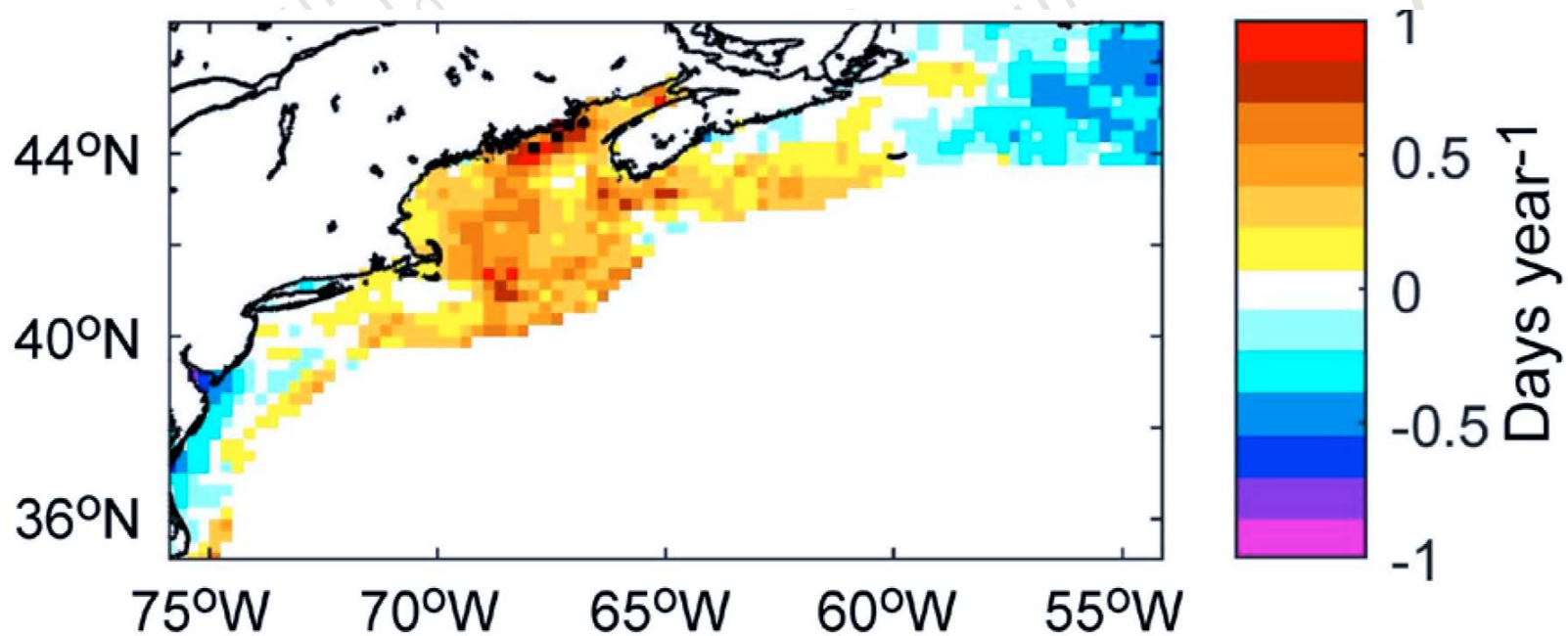
- Length of “summer” increasing
  - 2 days/yr in Gulf of Maine since 1982



(Thomas et al. 2017)

# Changing seasonality

- Difference between end of summer and start of summer
  - “summer” lengthening due to later end for most of region
  - “summer” lengthening due to earlier start in mid-Atlantic



(Thomas et al. 2017)

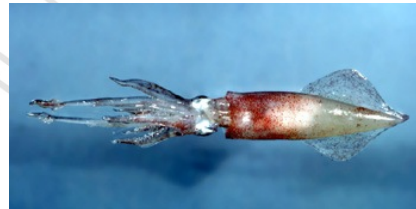
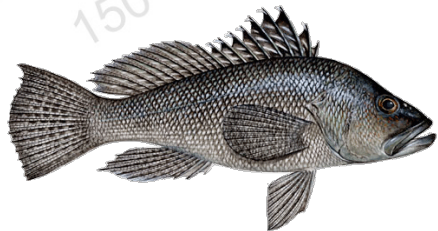
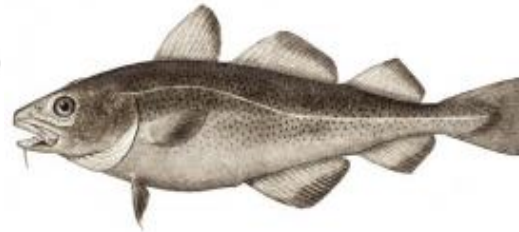
# Outline

- Warming on the Northeast Shelf
- **Impacts on species and fisheries**
- Resilience and adaptation in fisheries



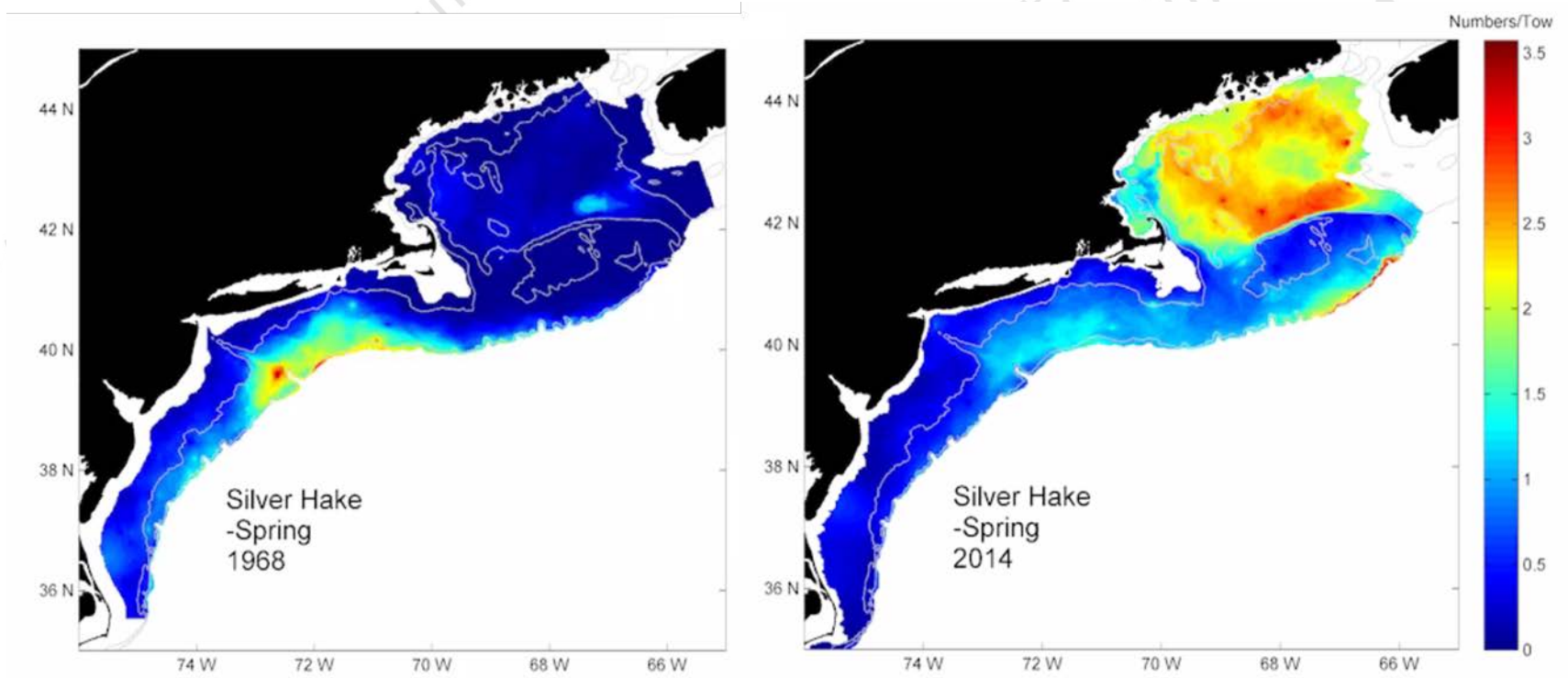
# Ecological effects

- Changes in ecosystem and populations
  - Distribution
  - Productivity
  - Timing
  - Interactions



# Spatial distribution

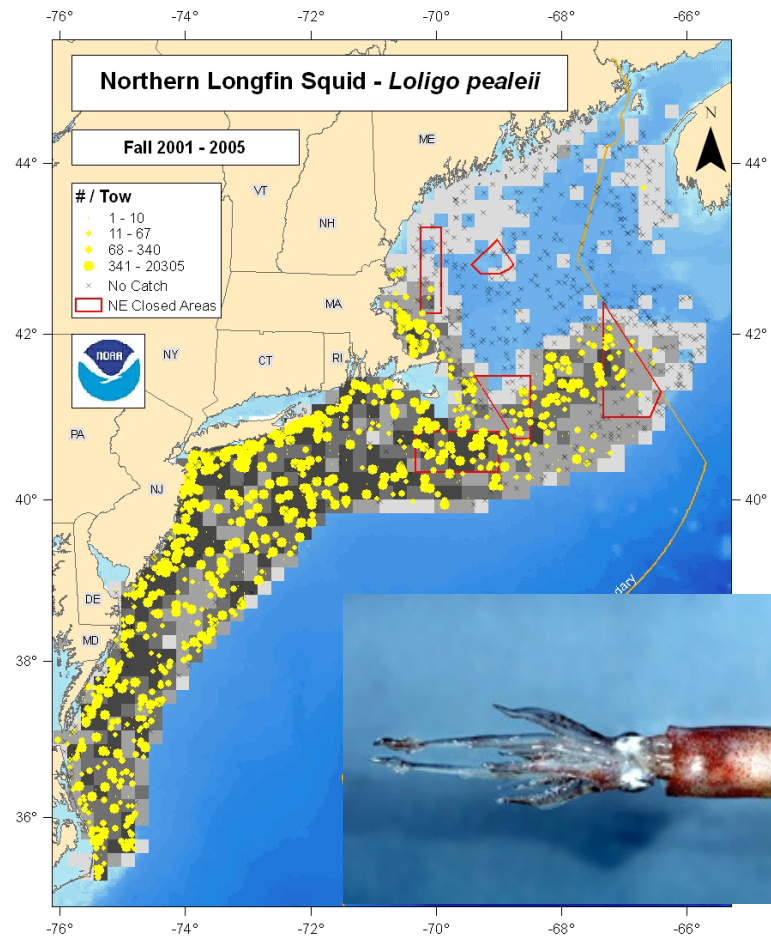
Many stocks moving poleward and to deeper depths  
(Nye et al. 2009)



(NEFSC 2015)

# Spatial distribution

## Mid-Atlantic species moving into the Gulf of Maine





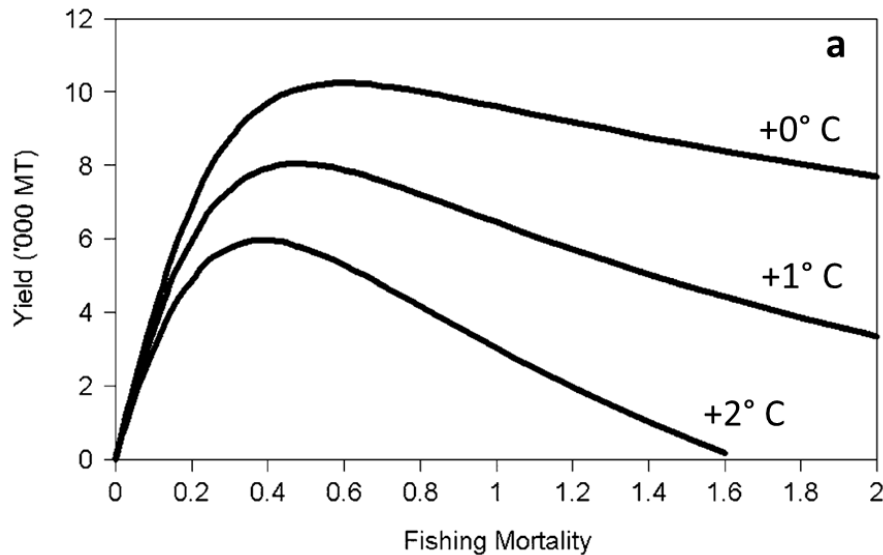
# Population productivity

Many mechanisms and pathways :

e.g., temperature, pH, disease, predator-prey interactions

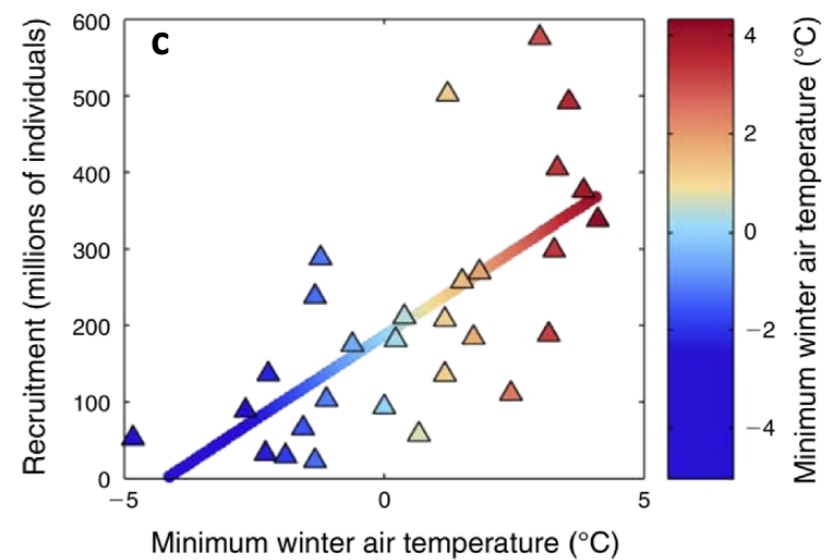
e.g., individual growth, reproduction, recruitment, mortality

## Atlantic cod



(Fogarty et al. 2008)

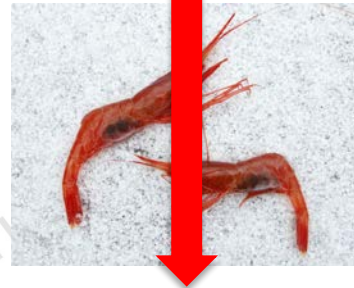
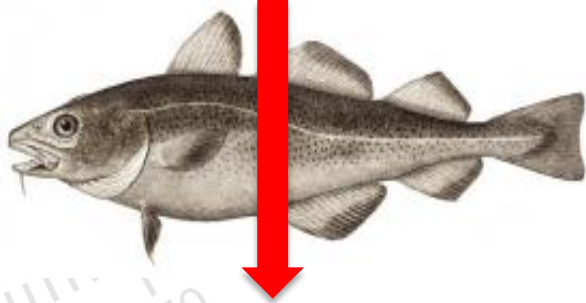
## Atlantic croaker



(Hare et al. 2010)

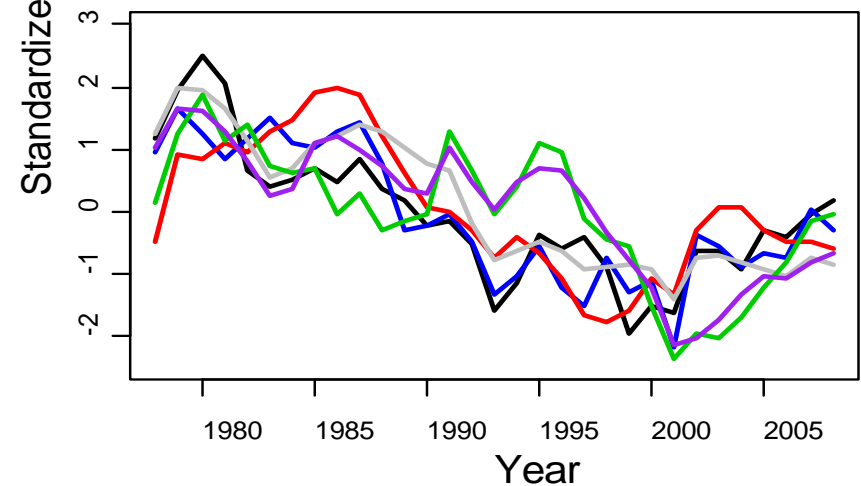
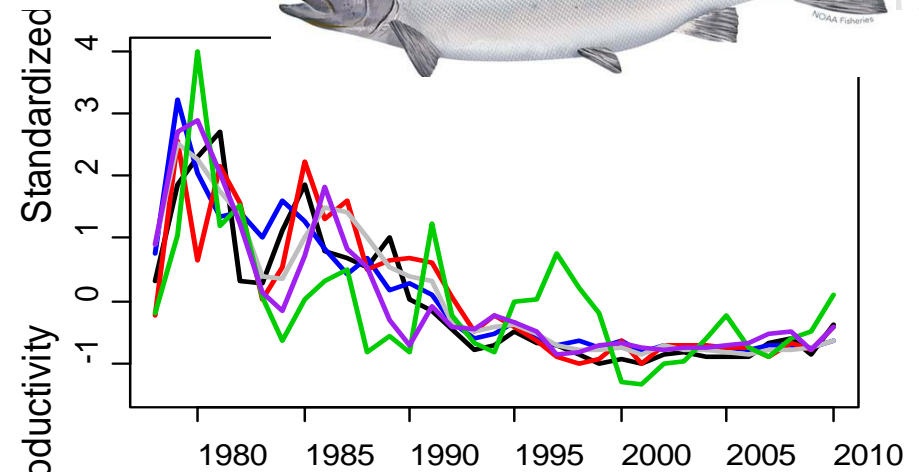
# Population productivity

- Effects on commercially-targeted species



# Population productivity

- Effects on protected species



(Mills et al. 2013)

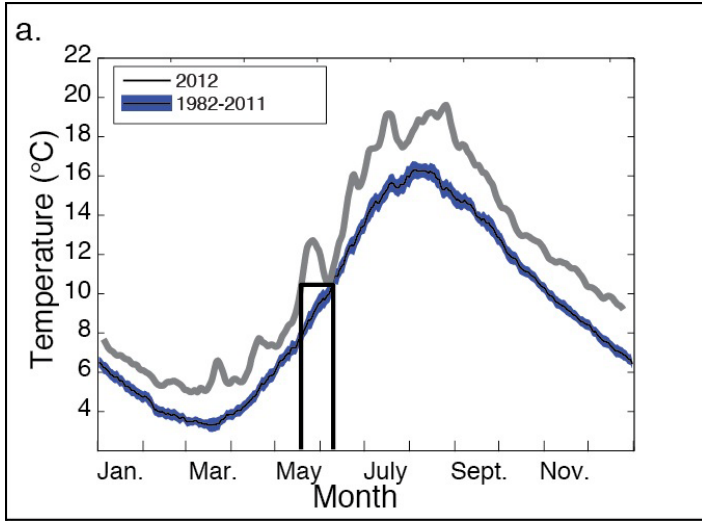
## New England's lobster fishery

- Valued at over \$617 M in 2015
- Most valuable species fished in U.S. since 2014
- Accounts for 88% of NH's landed value and 80% of Maine's



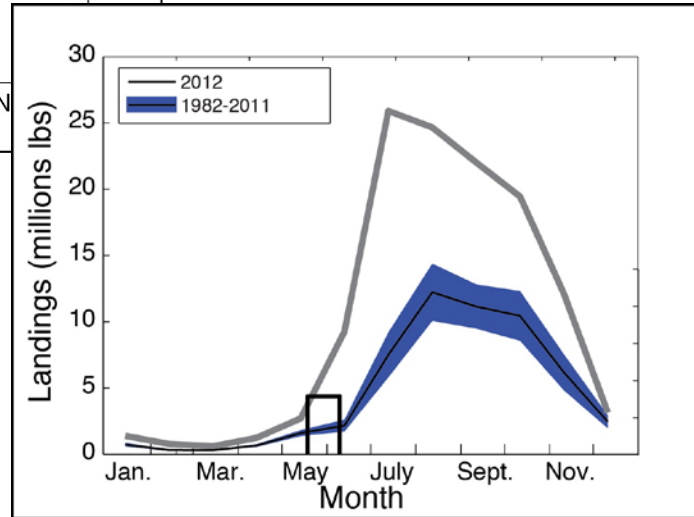
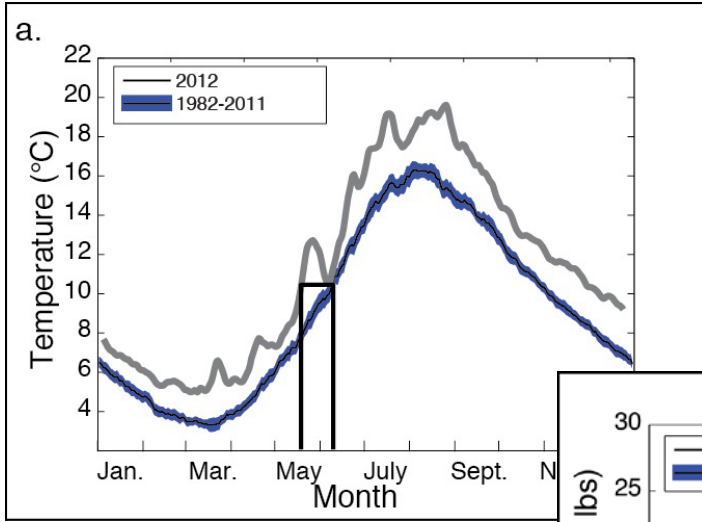


# Phenology



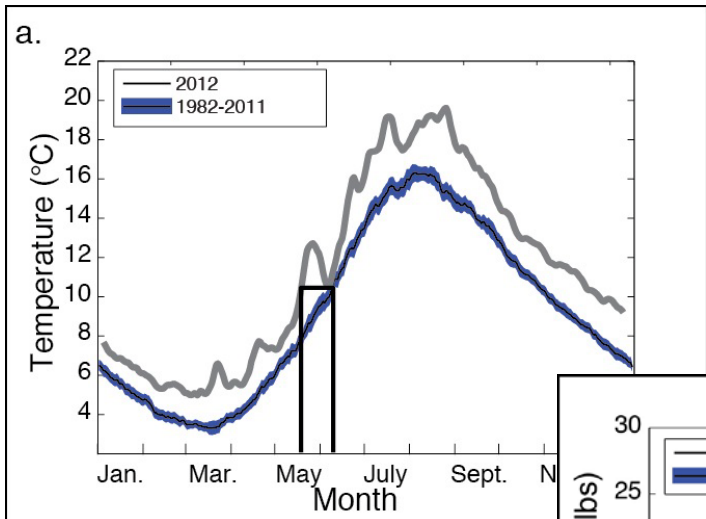
(Mills et al. 2013)

# Phenology

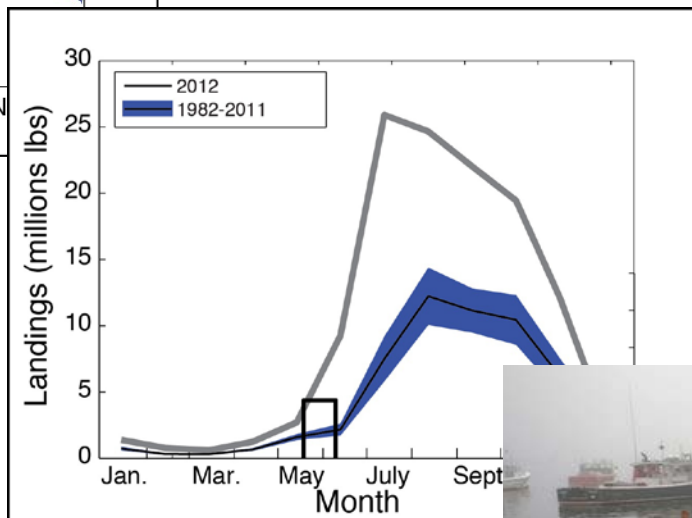


(Mills et al. 2013)

# Phenology



(Mills et al. 2013)



# Outline

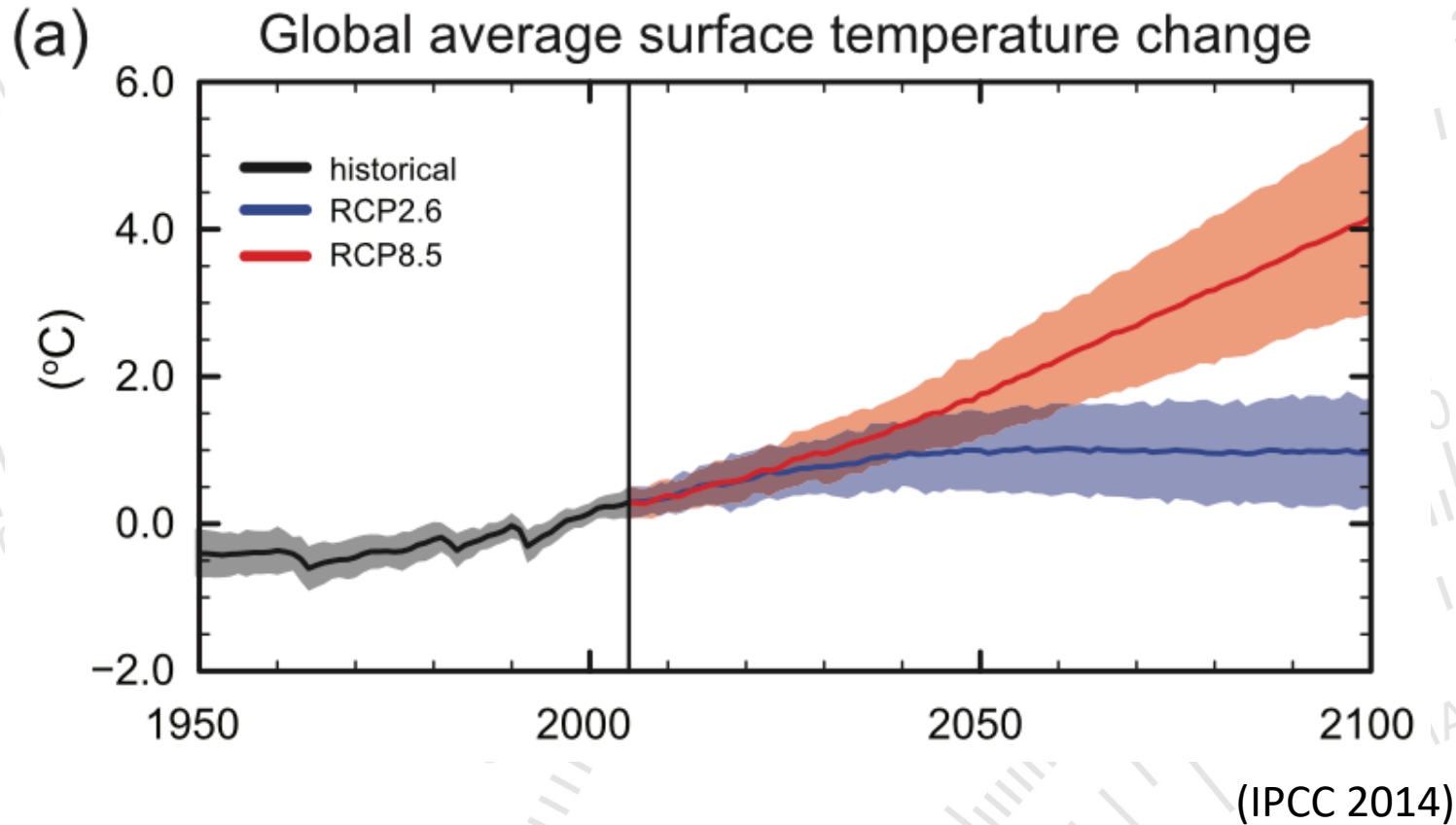
- Warming on the Northeast Shelf
- Impacts on species and fisheries
- Resilience and adaptation in fisheries

# Climate resilience and adaptation

## Challenges:

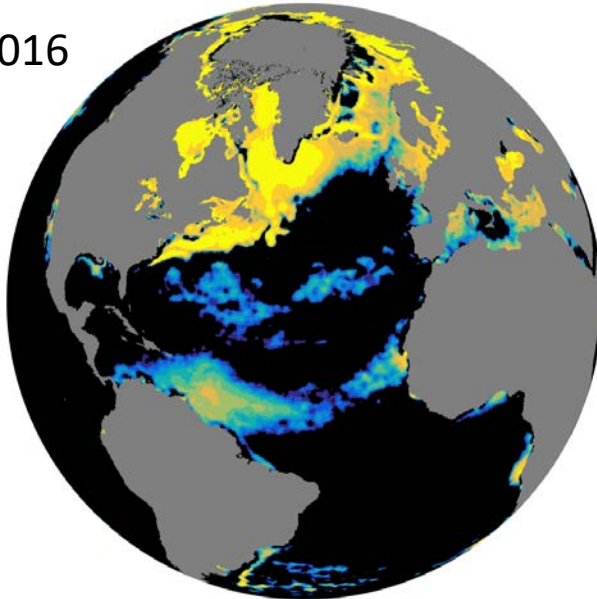
- Moving beyond historical analogues
- Differential response rates (biological and human)
- Changing social, economic, institutional contexts

# Climate resilience and adaptation

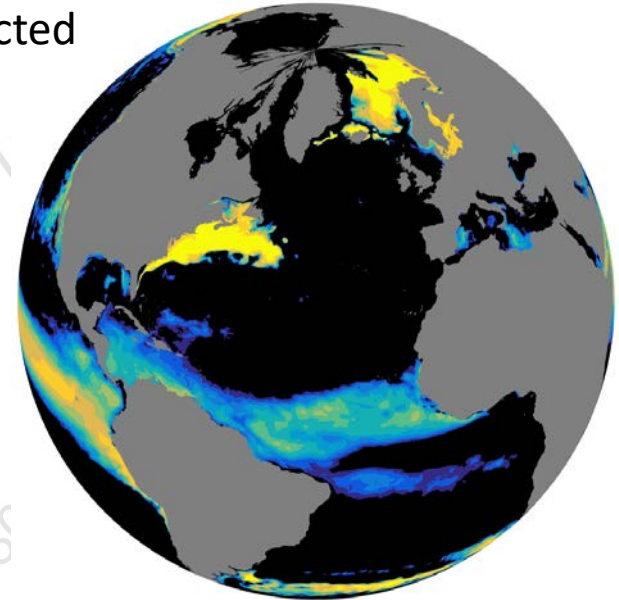


# Climate resilience and adaptation

2002-2016

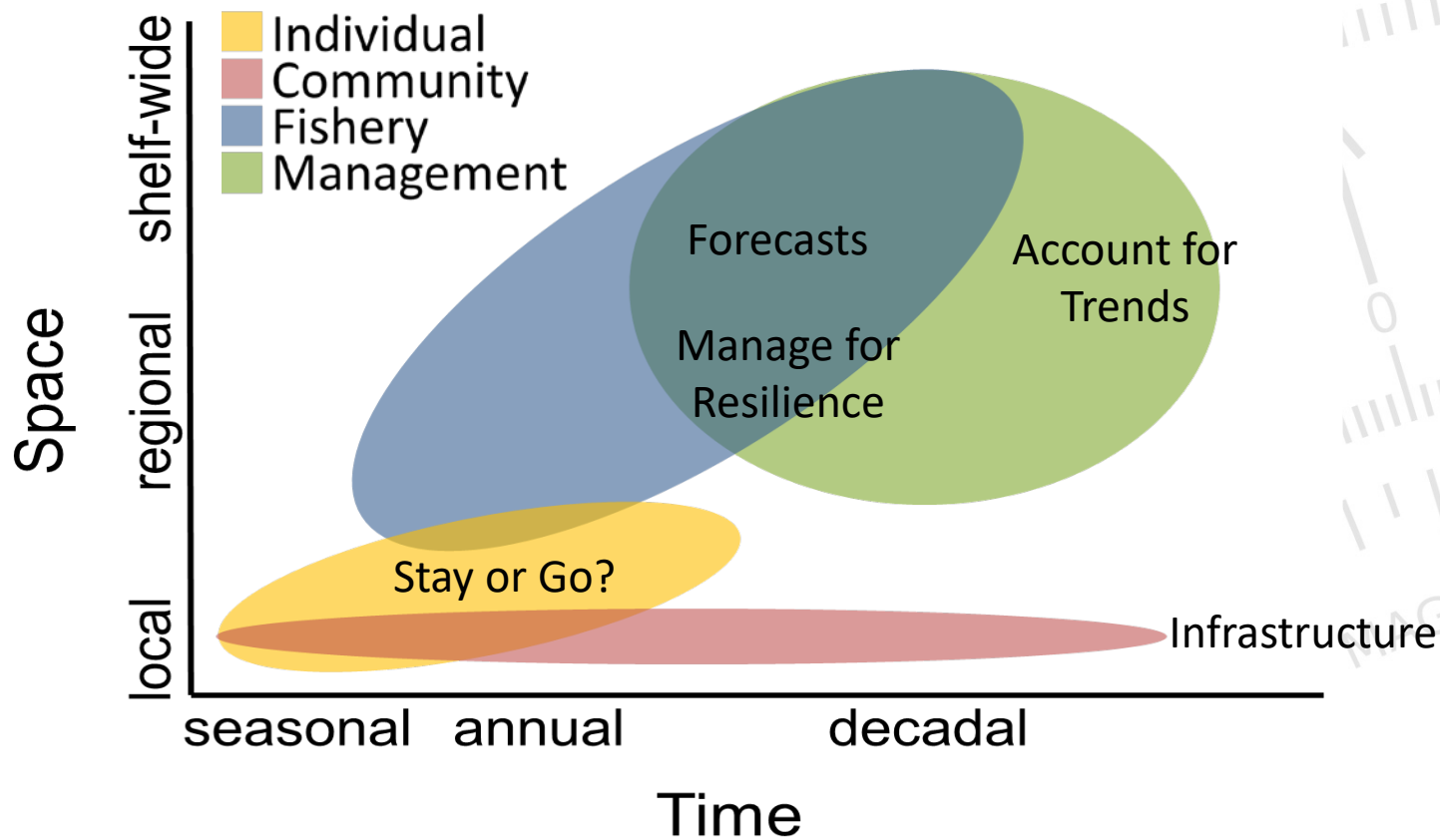


Predicted



(Saba et al. 2016)

# Climate resilience and adaptation



(Mills et al., in prep.)



# Climate resilience and adaptation

## Challenges:

- Moving beyond historical analogues
- Differential response rates (biological and human)
- Changing social, economic, institutional contexts

## Responses:

- Assess vulnerabilities and opportunities
- Build industry and community capacity for adaptation
- New climate-relevant information streams

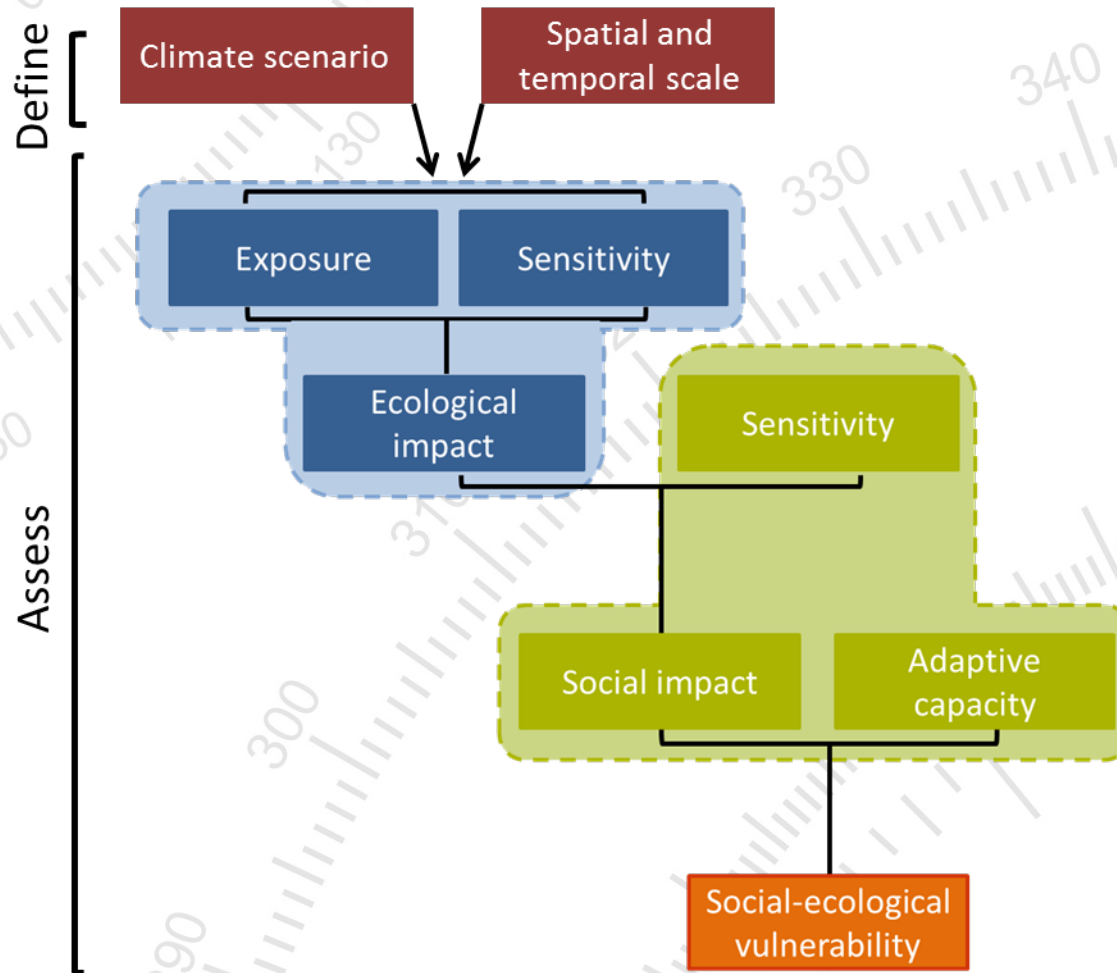
# Climate resilience and adaptation

## ***Evaluating Social-Ecological Vulnerability and Climate Adaptation Strategies for Northeast U. S. Fishing Communities***



- Assess vulnerability of fishing communities to climate impacts
- Evaluate social and economic outcomes of climate-driven changes in species availability
- Quantify benefits of potential adaptation strategies
- Identify factors that facilitate or hinder adaptation

# Social-ecological vulnerability assessment



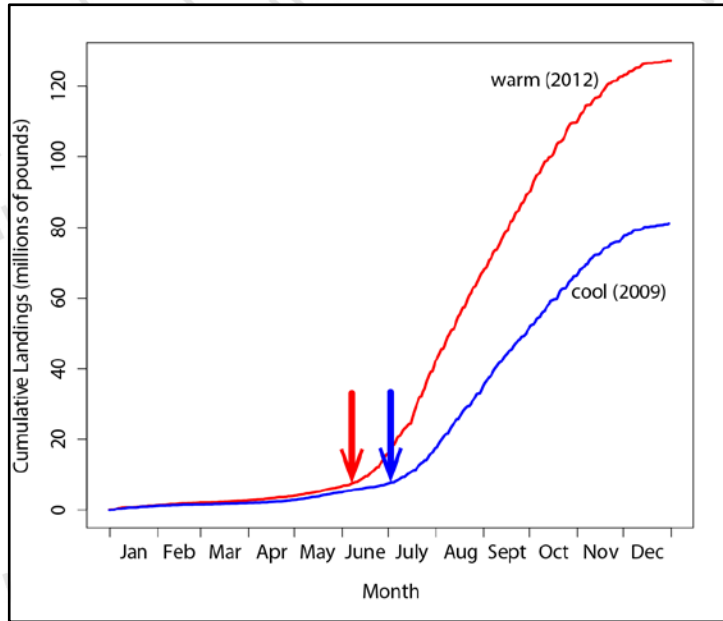
*Adapted from Cinner et al. 2013; Johnson and Welch 2010*

# In-depth analyses in four communities

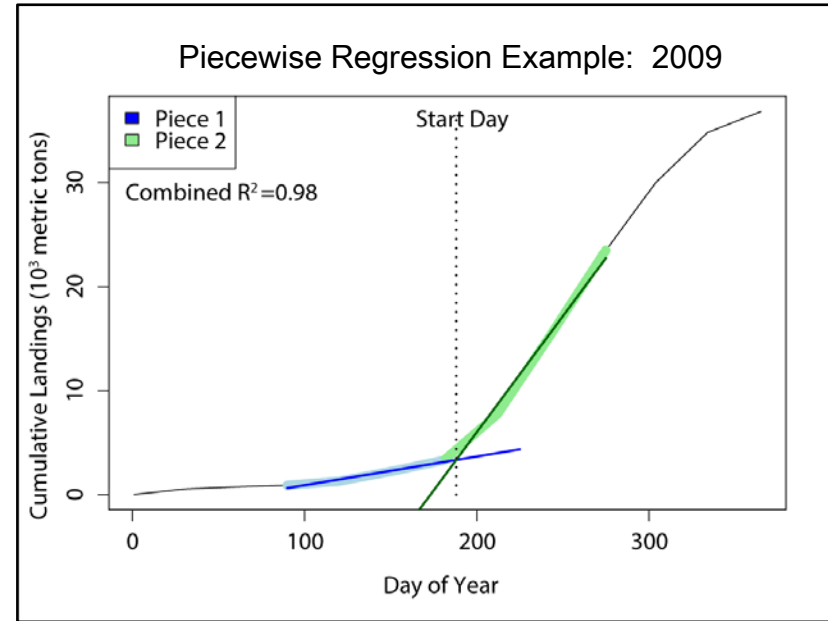
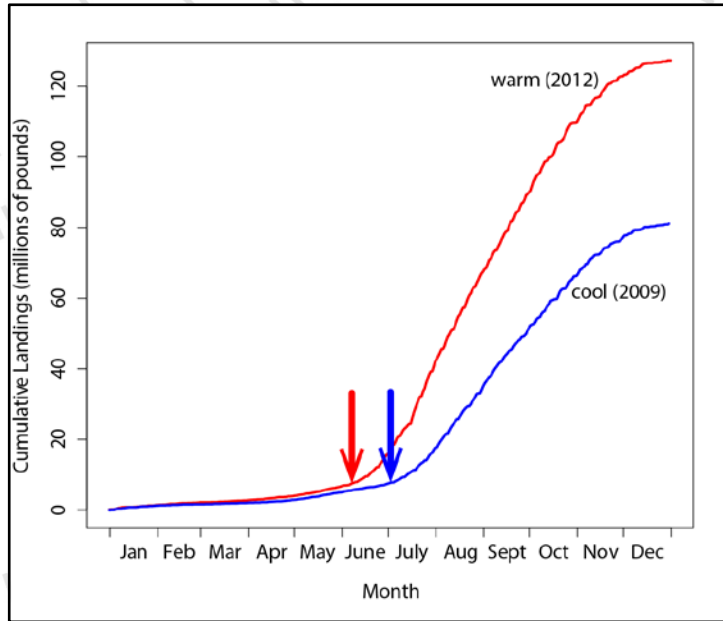
	North	South
Low diversity	Stonington, ME	New Bedford, MA
High diversity	Portland, ME	Point Judith, RI

- Model social and economic outcomes
- Identify and evaluate adaptation strategies of interest
- Assess factors that facilitate or hinder adaptation

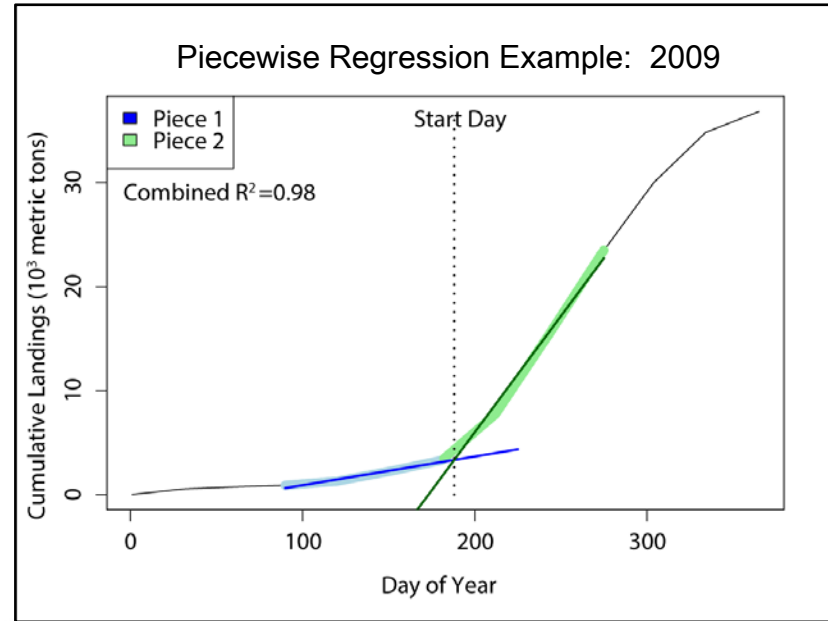
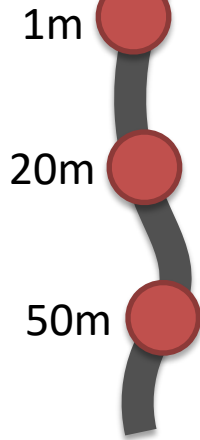
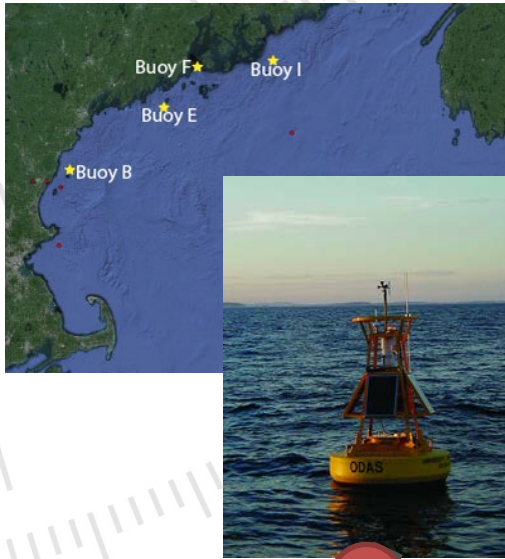
# New information streams: forecasts



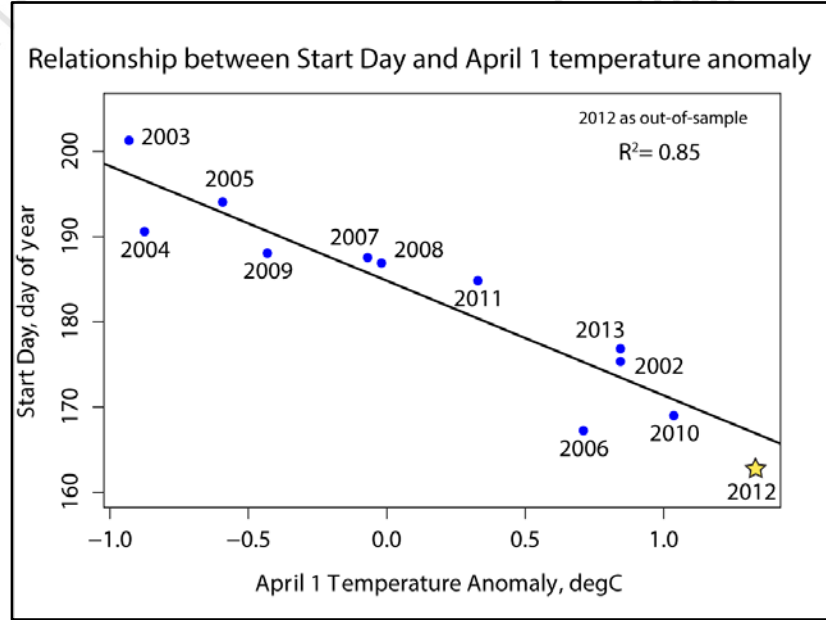
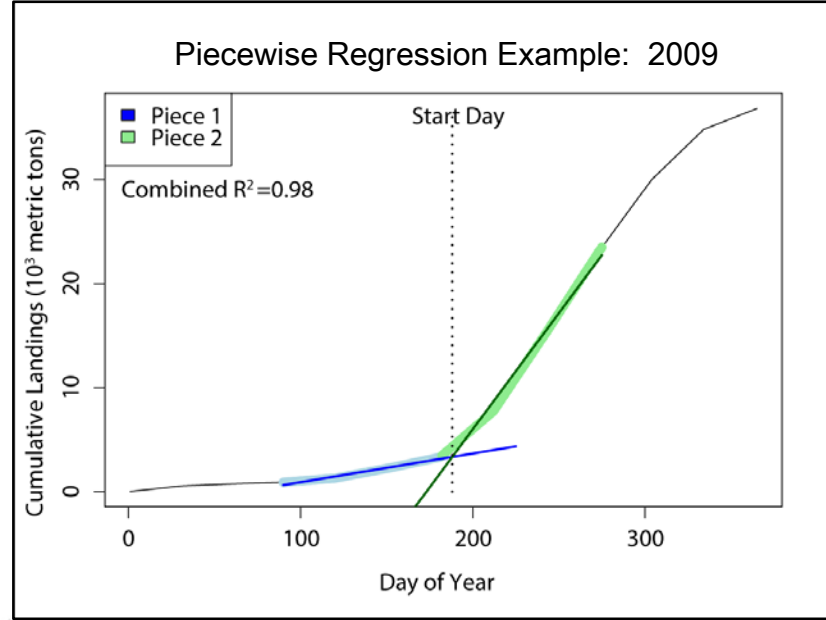
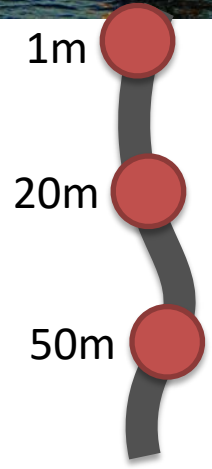
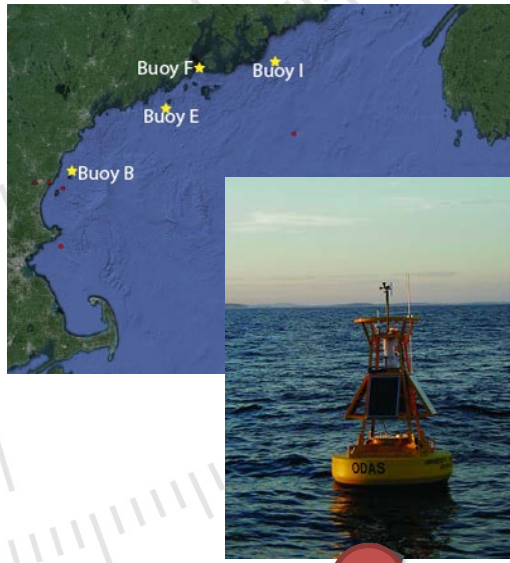
# New information streams: forecasts



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# New information streams: forecasts

## April 13 Forecast

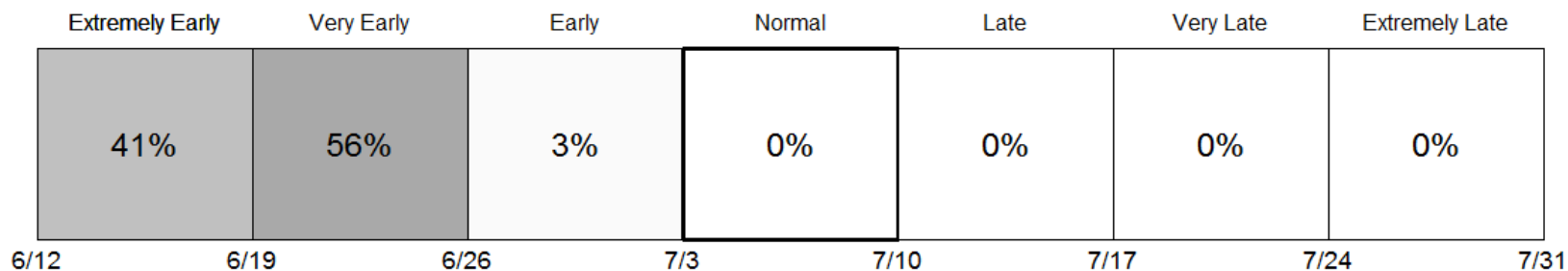


Photo: Curt Brown, Ready Seafood

# Forecast development with industry

- What decisions do participants face that would be supported by forecasts?
- How do they currently use information?
- In what form is information most useful?
  - Access
  - Format
  - Communication
  - Training

# Conclusions

- Warming on Northeast Shelf:
  - Rapid rate, extreme events, seasonal timing
- Effects on species in the region
- Impacts communities and management systems
- Northeast communities are at forefront of building readiness for climate adaptation
  - New efforts to support adaptation—assessments, information, strategies
  - Opportunities to learn globally-relevant lessons here
- Consider future conditions when making decisions

# Questions?

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