

Climate vulnerability and resilience in the most valuable North American fisheries



Effects of Climate Change on World's Oceans Symposium.

Washington DC. June 5th, 2018.



Arnault Le Bris

Centre for Fisheries Ecosystems Research

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Acknowledgements

Le Bris A. et al. 2018. Climate vulnerability and resilience in the most valuable US fishery. *Proceeding of National Academy of Sciences USA*, 115 (8) 1831-1836. doi.org/10.1073/pnas.1711122115.

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Funding

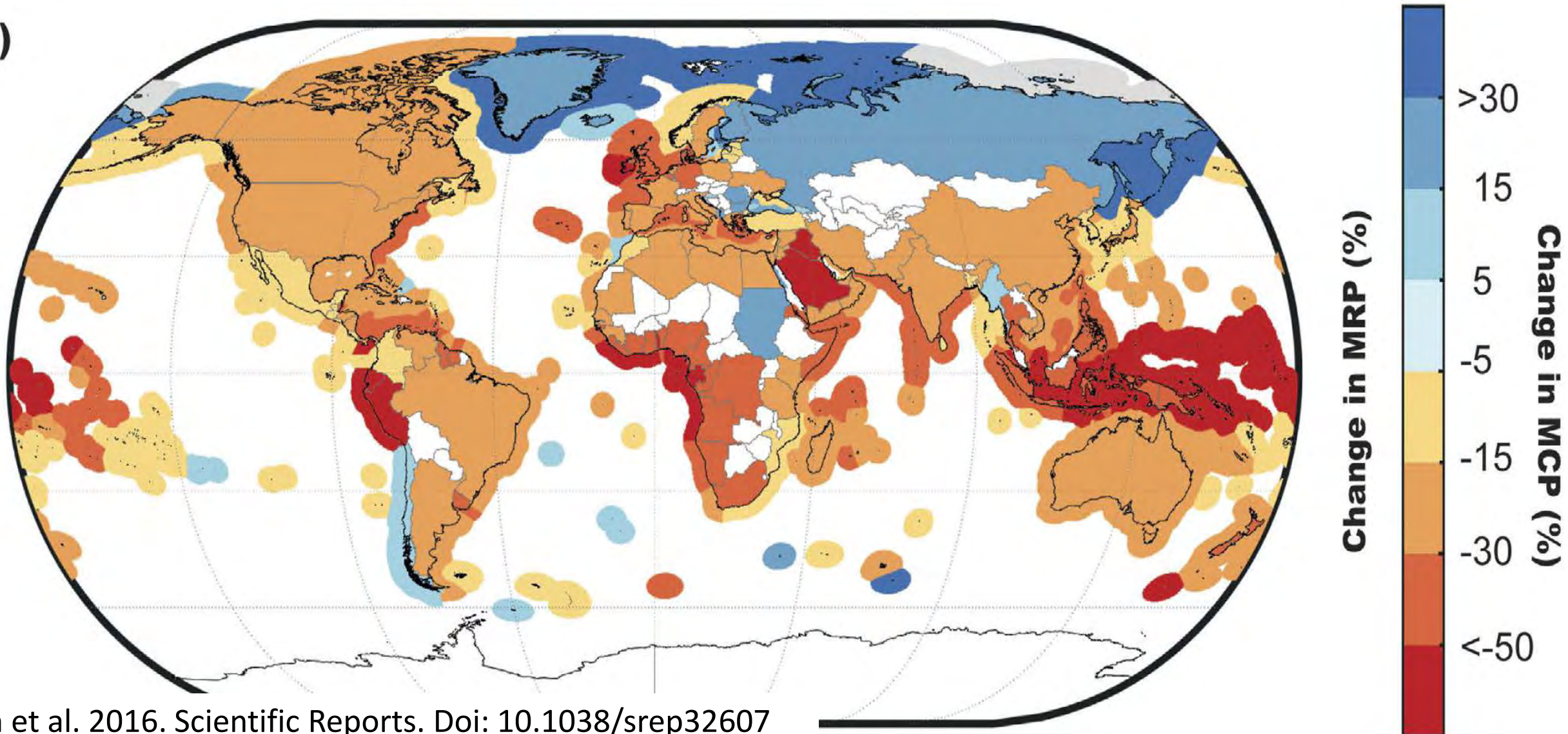
NSF Coastal SEES



Intro - Global climate change and fisheries

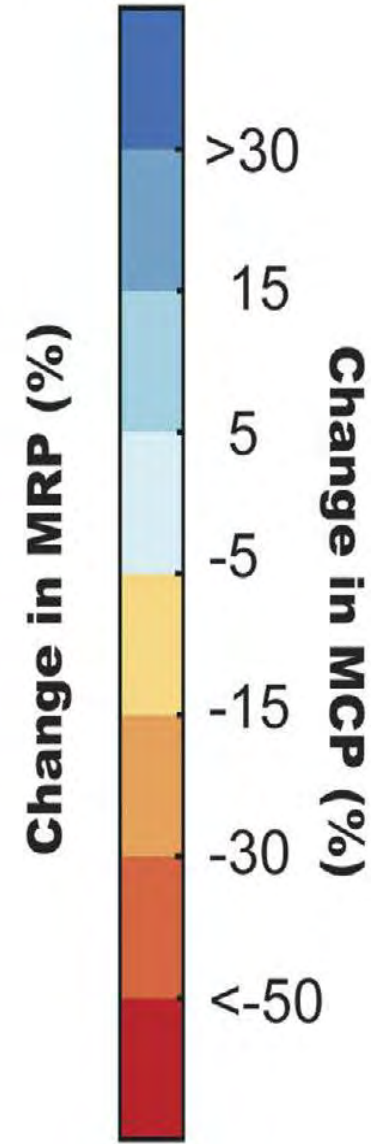
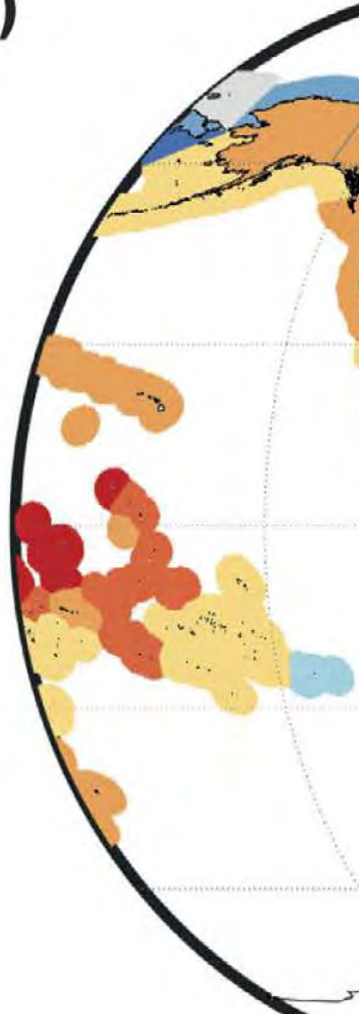
Maximum fishery revenue potential

(a)

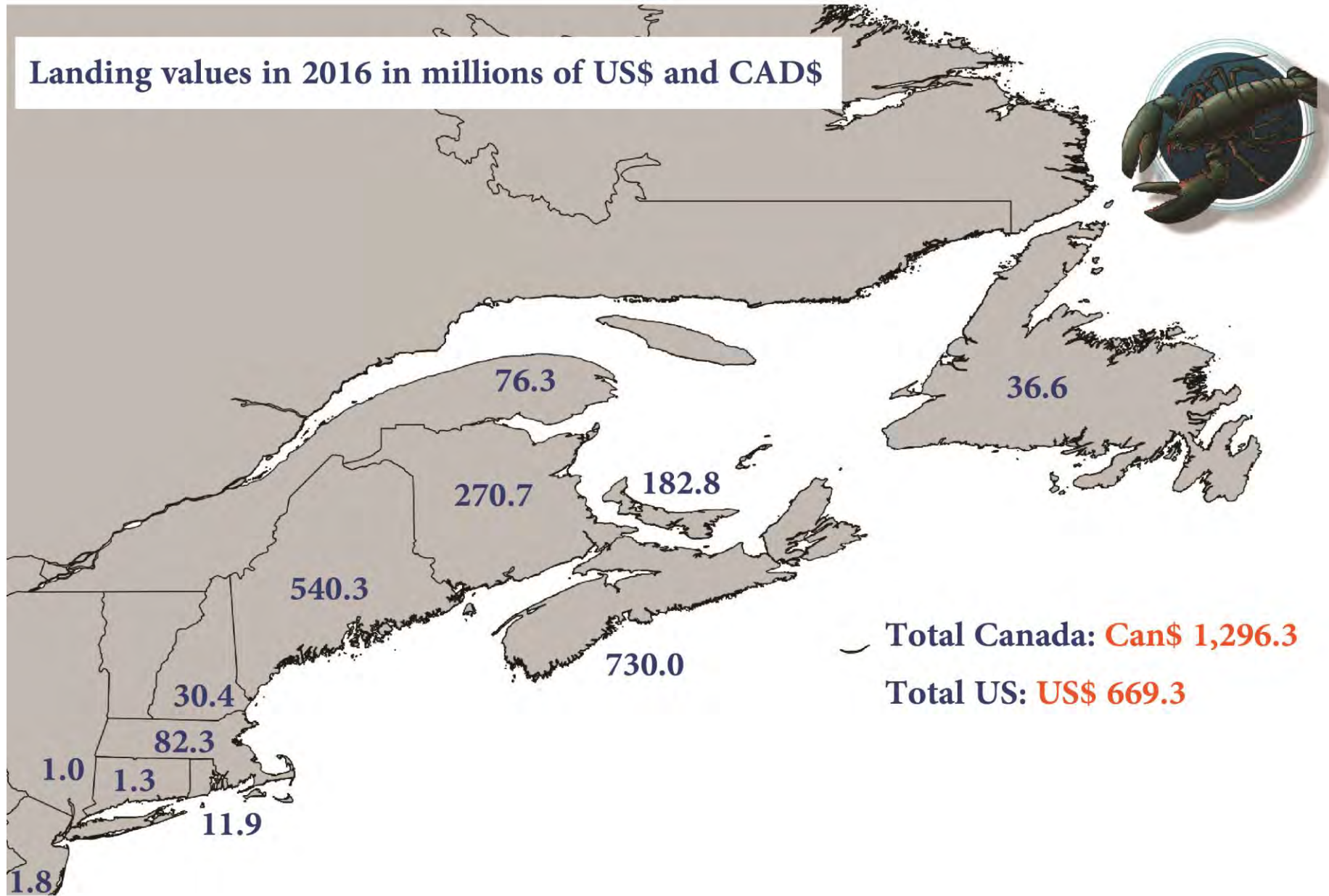


Intro - Global climate change and fisheries

(a)



Intro - A lobster tale: the American lobster fishery



Intro - A lobster tale: the American lobster fishery

Landing values in 2016 in millions of US\$ and CAD\$



~10,000 licenses

~7,940 licenses

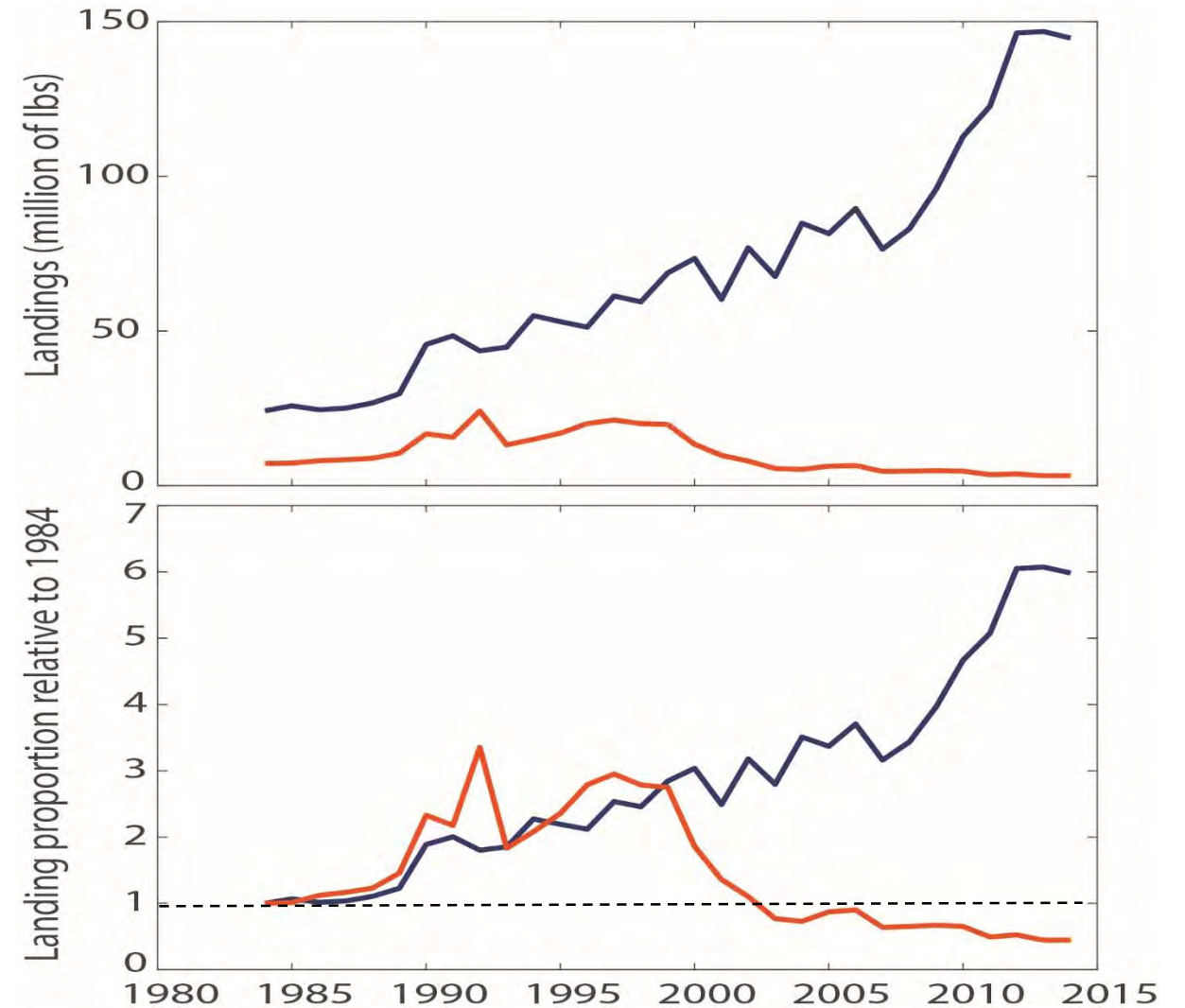
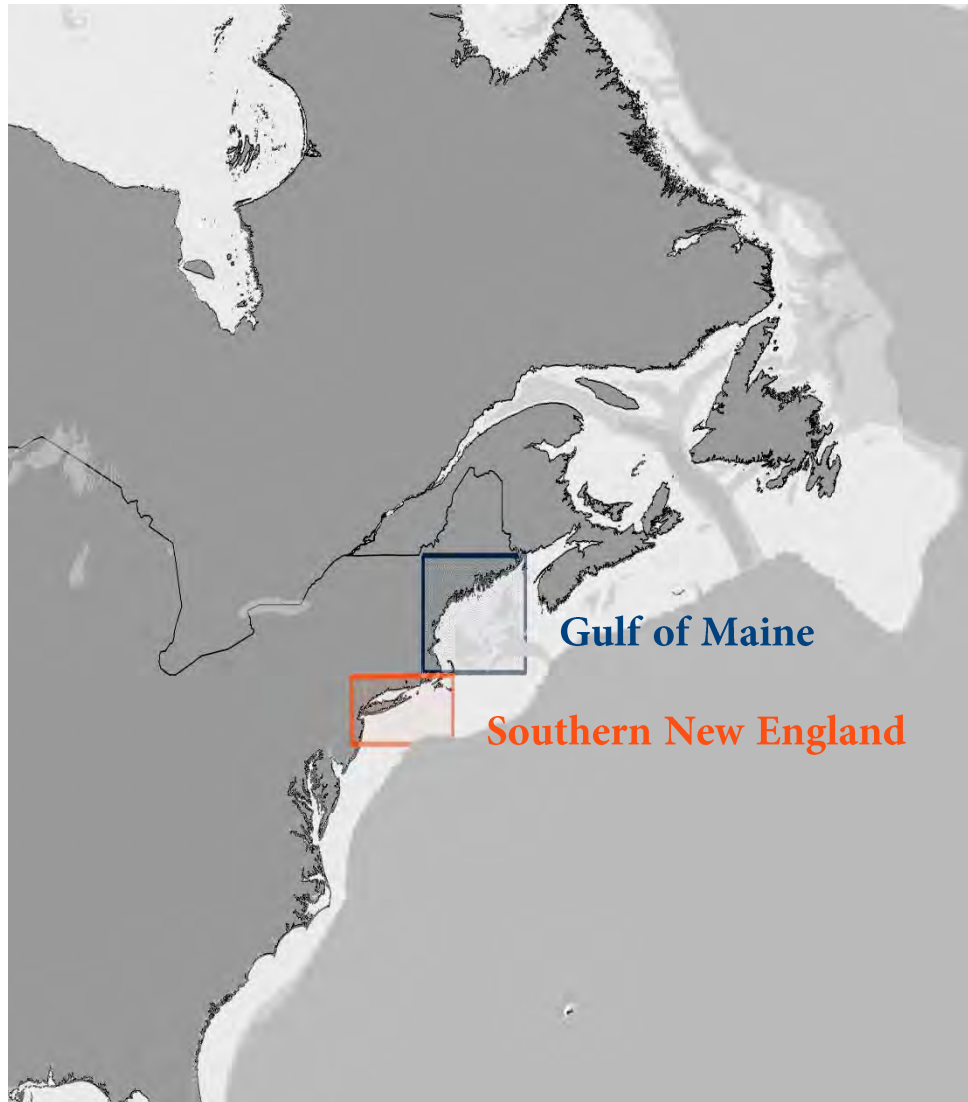
Total Canada: **Can\$ 1,296.3**

Total US: **US\$ 669.3**

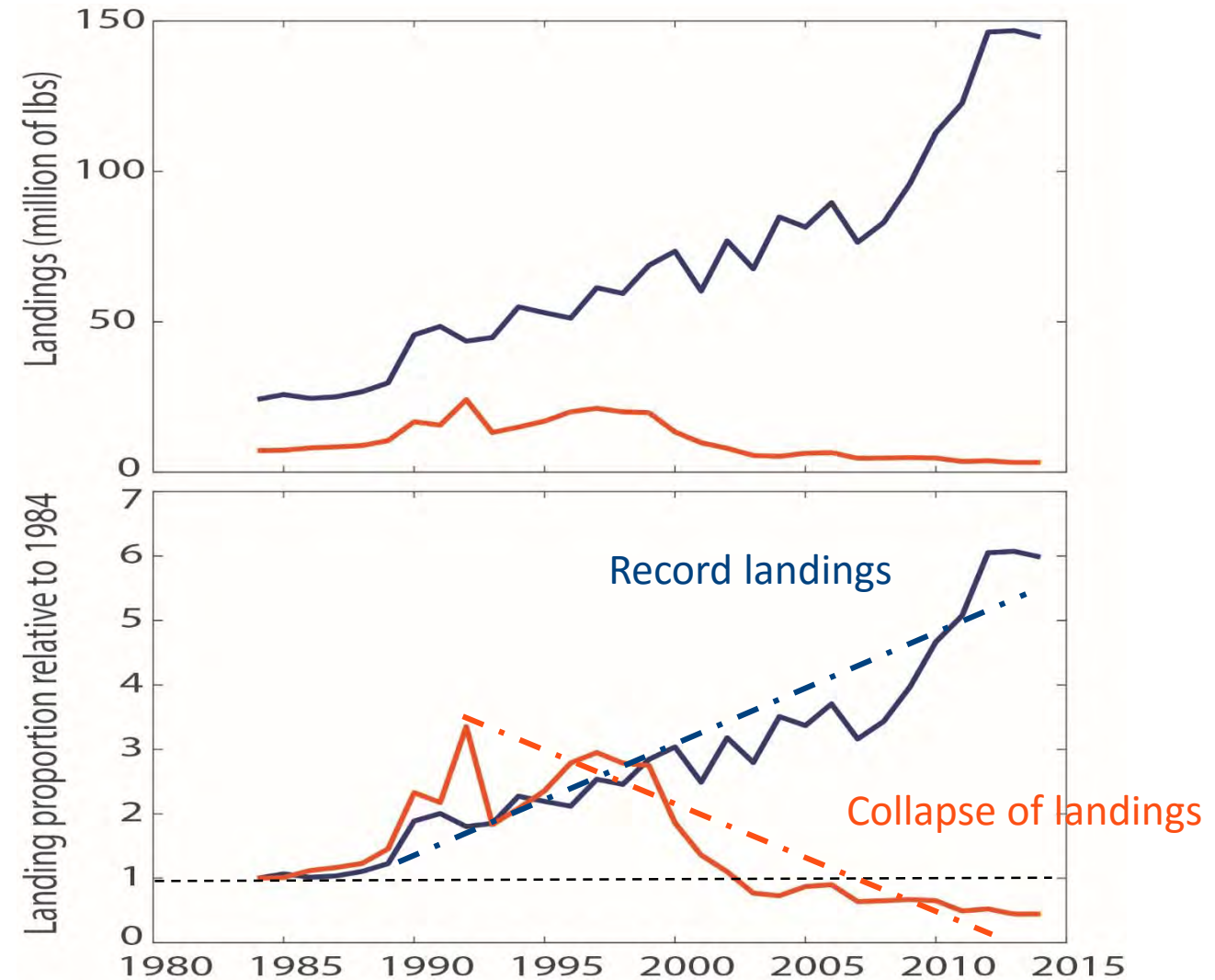
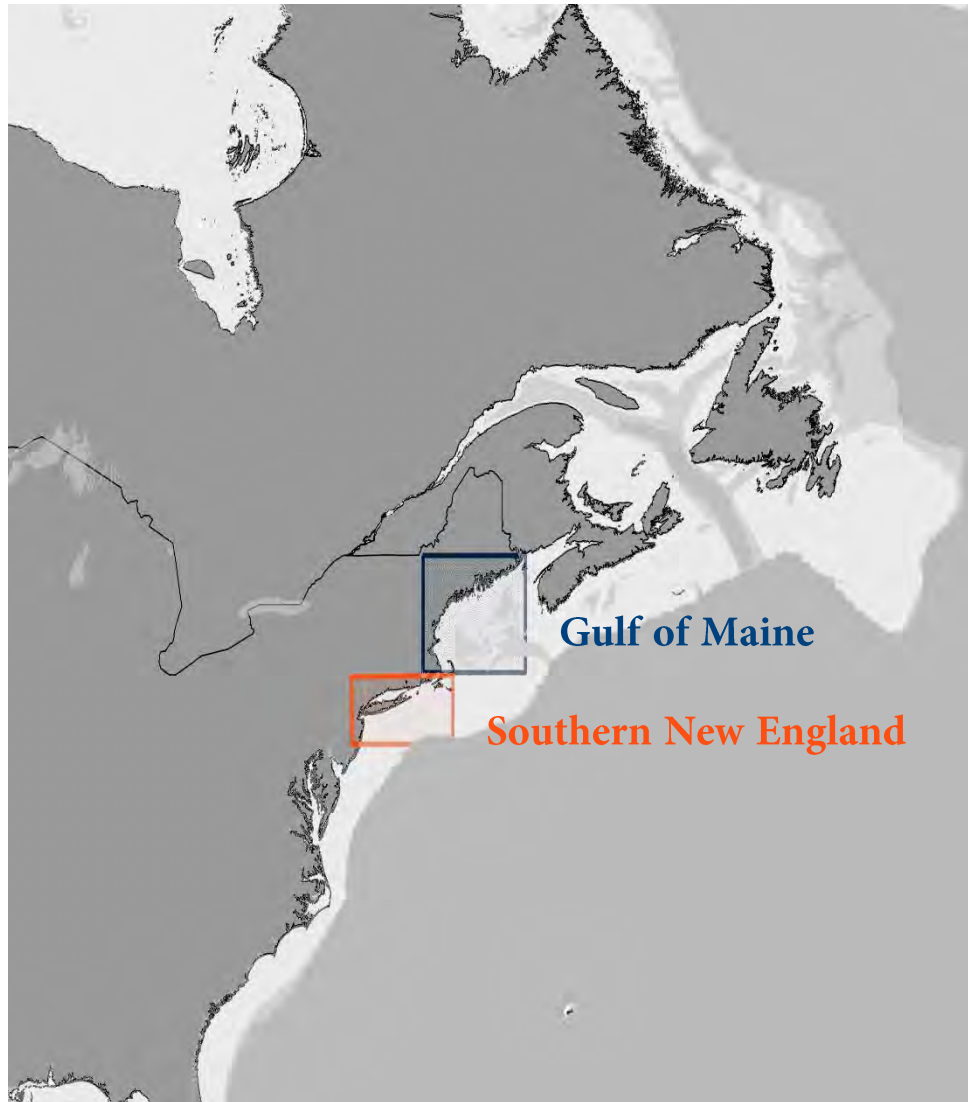
1.8

Intro - A lobster tale: Gulf of Maine and southern New England

Lobster in the US managed in two stocks: Gulf of Maine and southern New England

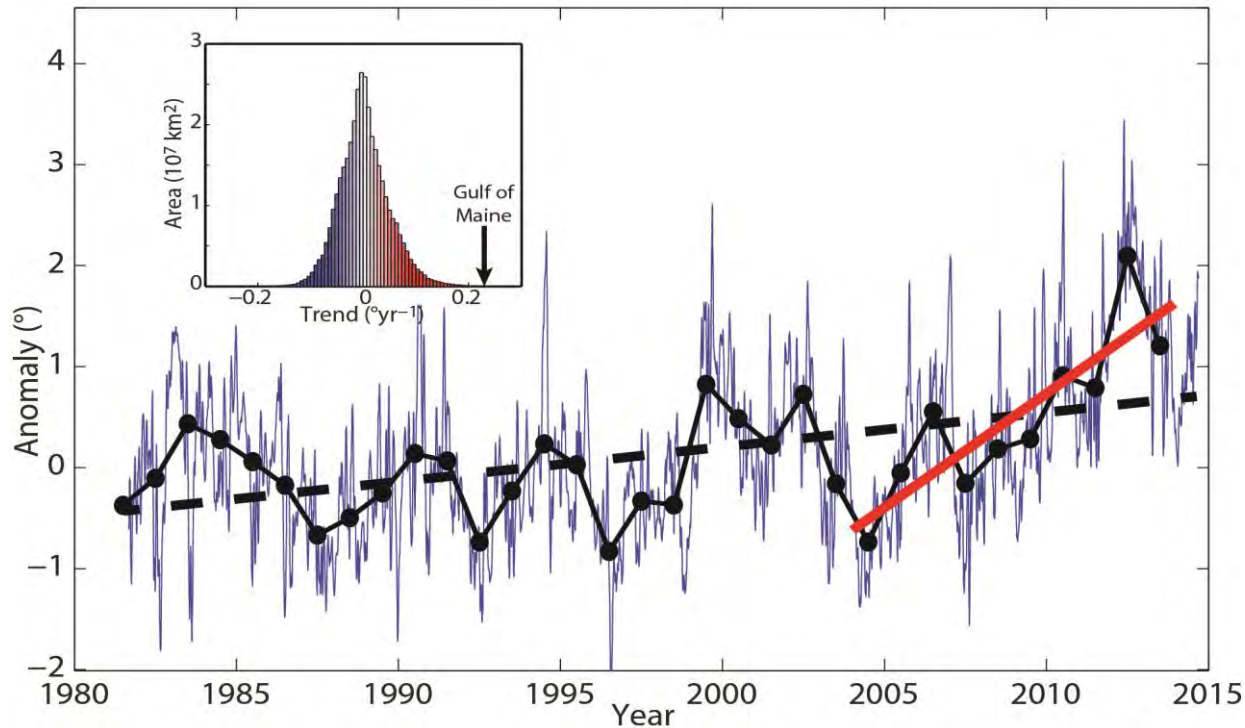


Intro - A lobster tale: Gulf of Maine and southern New England



Intro – a lobster tale: Gulf of Maine and southern New England

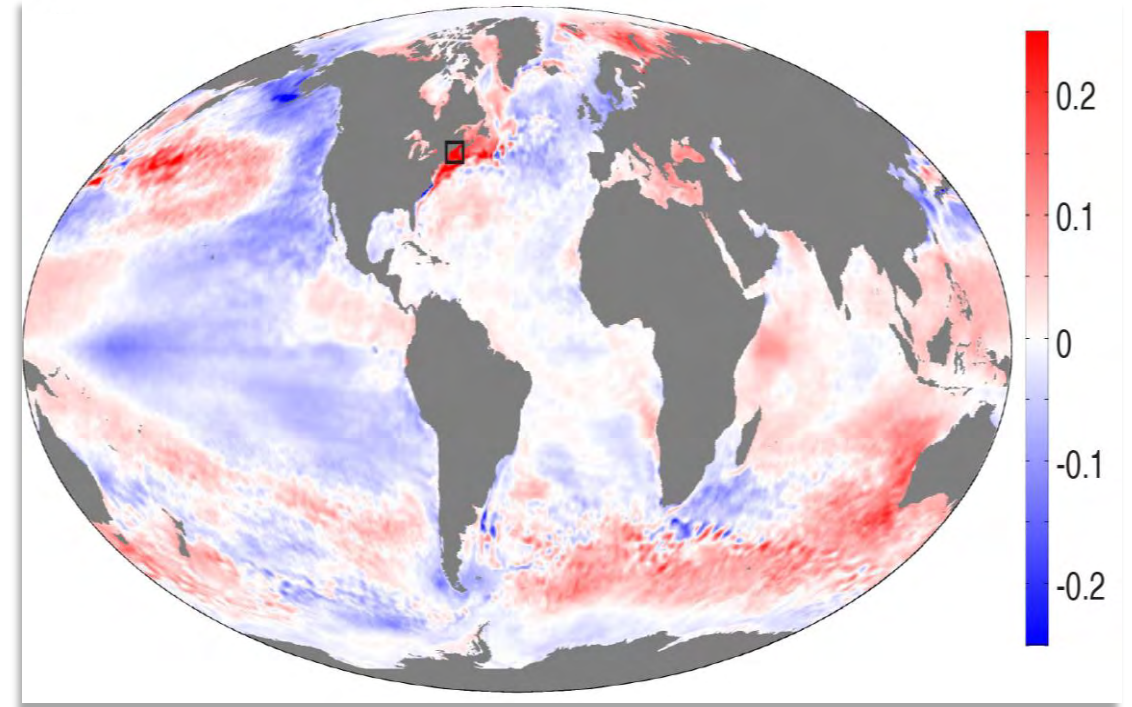
Exceptional warming in the northeast US and in the Gulf of Maine



SST anomalies in the Gulf of Maine

Dotted line: warming trends since start of time series $\sim 0.04^{\circ}\text{C yr}^{-1}$

Red line: warming trends over the last 10 years $\sim 0.23^{\circ}\text{C yr}^{-1}$

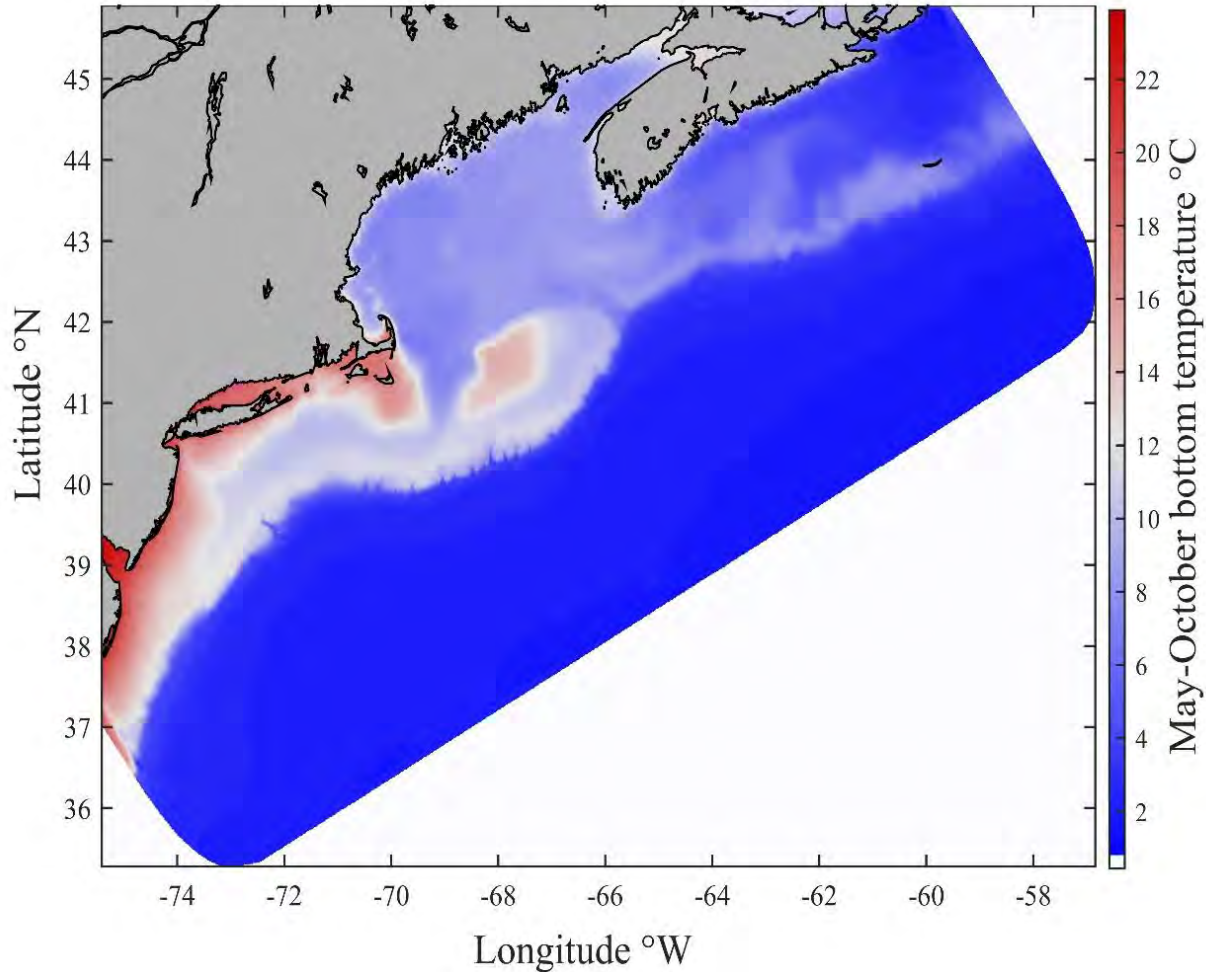


Global SST trends between 2004 to 2014.

Intro - A lobster tale: Gulf of Maine and southern New England

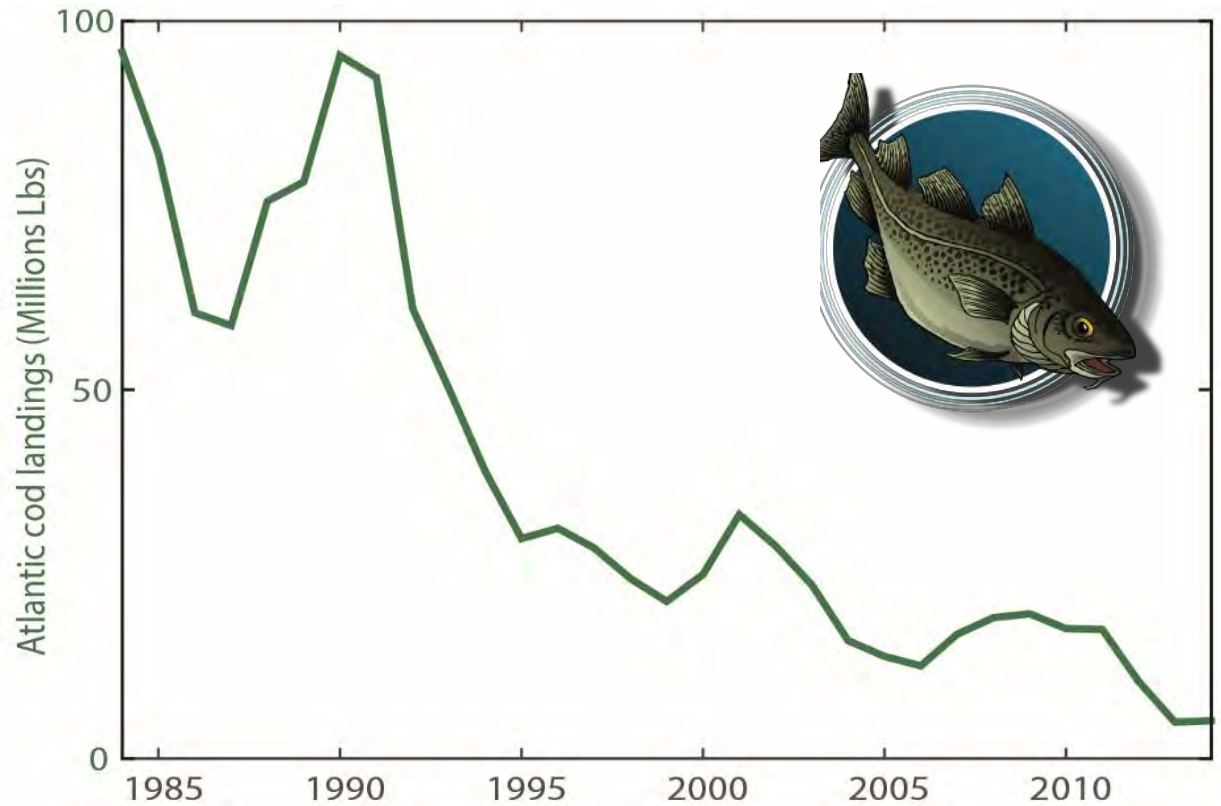
Difference in temperature

Exceptional warming in the northeast US



Lobster predators

Landings of Atlantic cod in the Gulf of Maine



Intro - A lobster tale: Gulf of Maine and southern New England

Epizootic Shell disease

Difference in harvest strategies



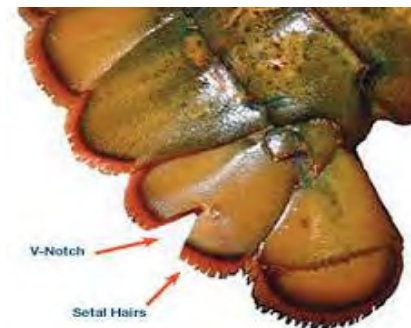
Prevalence of shell disease on lobster in commercial traps sampling (ASMFC 2015)

Gulf of Maine

- Minimum size limit since 1870. Nowadays: 83 mm CL
- Maximum size limit since 1917. Nowadays: 128 mm CL
- V-notching mandatory since 1910. High buy in.

Southern New England

- Nowadays: minimum size limit of 86 mm CL
- No max size limit until 2008, since then 140 mm CL
- No mandatory V-notching. Low buy in



State:	New York	Connecticut & New York	Rhode Island		Massachusetts			New Hampshire	Maine			
Area:	612-613	611	616	539	537-538	521	514	513	513	512	511	467
1992		0.6%										
1993		0.5%										
1994		1.0%										
1995		1.0%										
1996		1.6%	0%	0.3%								
1997		2.3%	0%	4.3%								
1998		2.1%	0.2%	19.0%								
1999		3.9%	0.8%	20.3%								
2000		4.6%	2.2%	21.8%	9.4%	0%	3.7%					
2001		5.9%	2.2%	22.6%	11.6%	2.2%	6.5%					
2002		9.7%	3.1%	30.6%	25.9%	0.4%	5.5%	0.2%				
2003		13.0%	3.1%	24.9%	29.0%	0.9%	3.9%	0.3%	<0.05%	<0.05%	<0.05%	0%
2004	19.4%	6.2%	2.6%	27.9%	11.5%	0.5%	2.3%	0.2%	<0.05%	<0.05%	<0.05%	0%
2005	*5.8%	8.7%	2.3%	26.2%	14.3%	0.4%	2.3%	0.1%	<0.05%	<0.05%	<0.05%	0%
2006	na	na	1.7%	27.6%	23.9%	0%	1.2%	0.1%	<0.05%	<0.05%	<0.05%	0%
2007	na	9.1%	5.1%	21.8%	24.6%	0.6%	3.7%	0.1%	<0.05%	<0.05%	<0.05%	0%
2008	0%	7.9%	1.6%	**28.9%	26.7%	0.2%	2.4%	0.1%	<0.05%	<0.05%	<0.05%	0%
2009	*8.2%	14.3%	na	**28.5%	32.7%	0.2%	1.1%	0.1%	<0.05%	<0.05%	<0.05%	0%
2010	*31.1%	8.2%	na	33.9%	21.9%	0.3%	2.6%	0.1%	0.1%	<0.05%	<0.05%	0%
2011	26.9%	15.0%	na	29.5%	37.7%	0.2%	4.2%	0.3%	0.2%	<0.05%	<0.05%	0%
2012	0%	5.2%	na	34.0%	18.6%	0.6%	3.1%	0.5%	0.3%	<0.05%	<0.05%	0%
2013	na	na	na	†14.5%	37.2%	0.9%	5.5%	0.6%	0.1%	<0.05%	<0.05%	<0.05%

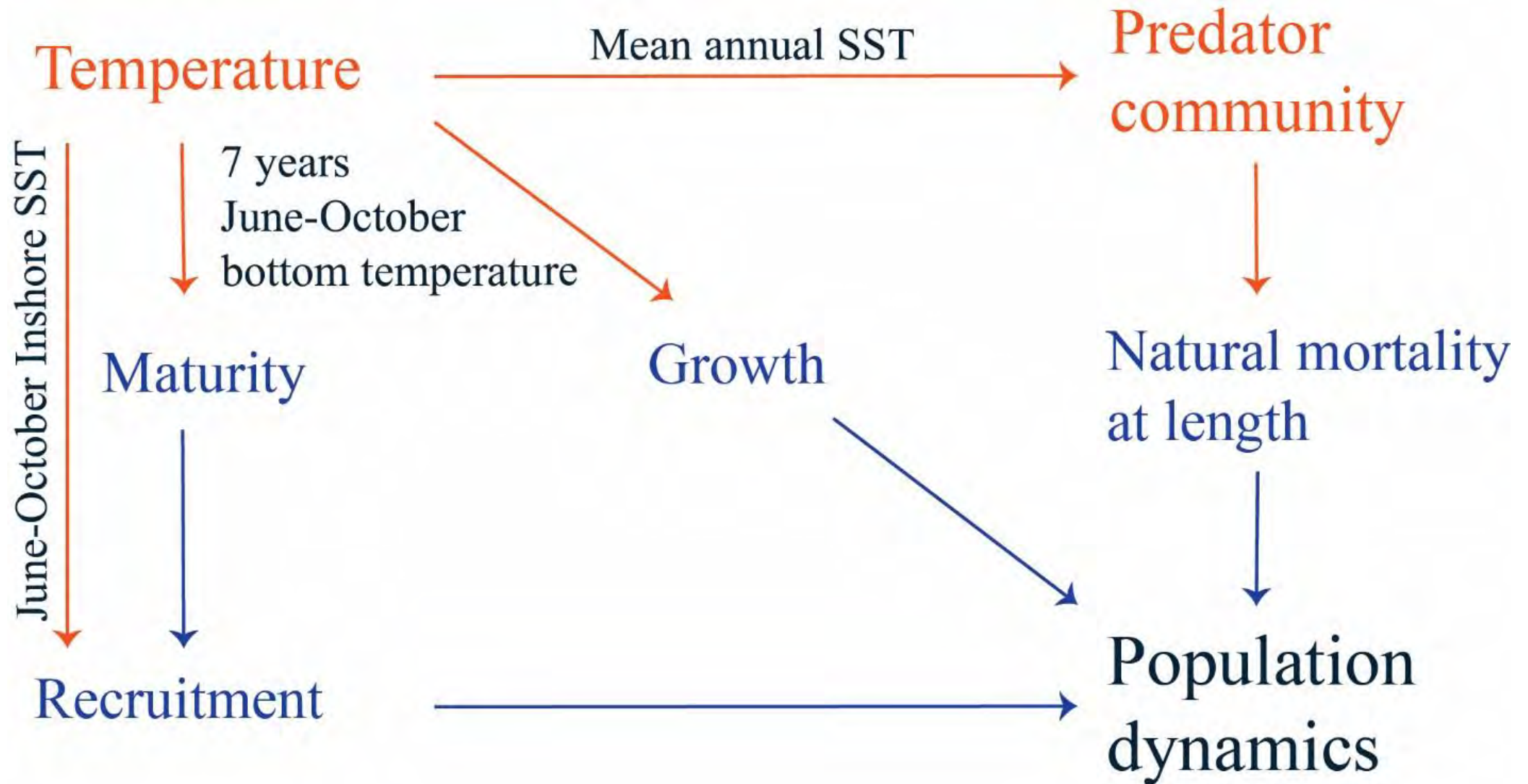
Research questions and objectives

1. What were the main drivers of the contrasting productivities observed in the Gulf of Maine and southern New England lobster fisheries? (i.e. Temperature, management, shell disease, predators)
2. Will the Gulf of Maine experience a similar fate as southern New England if warming continues?

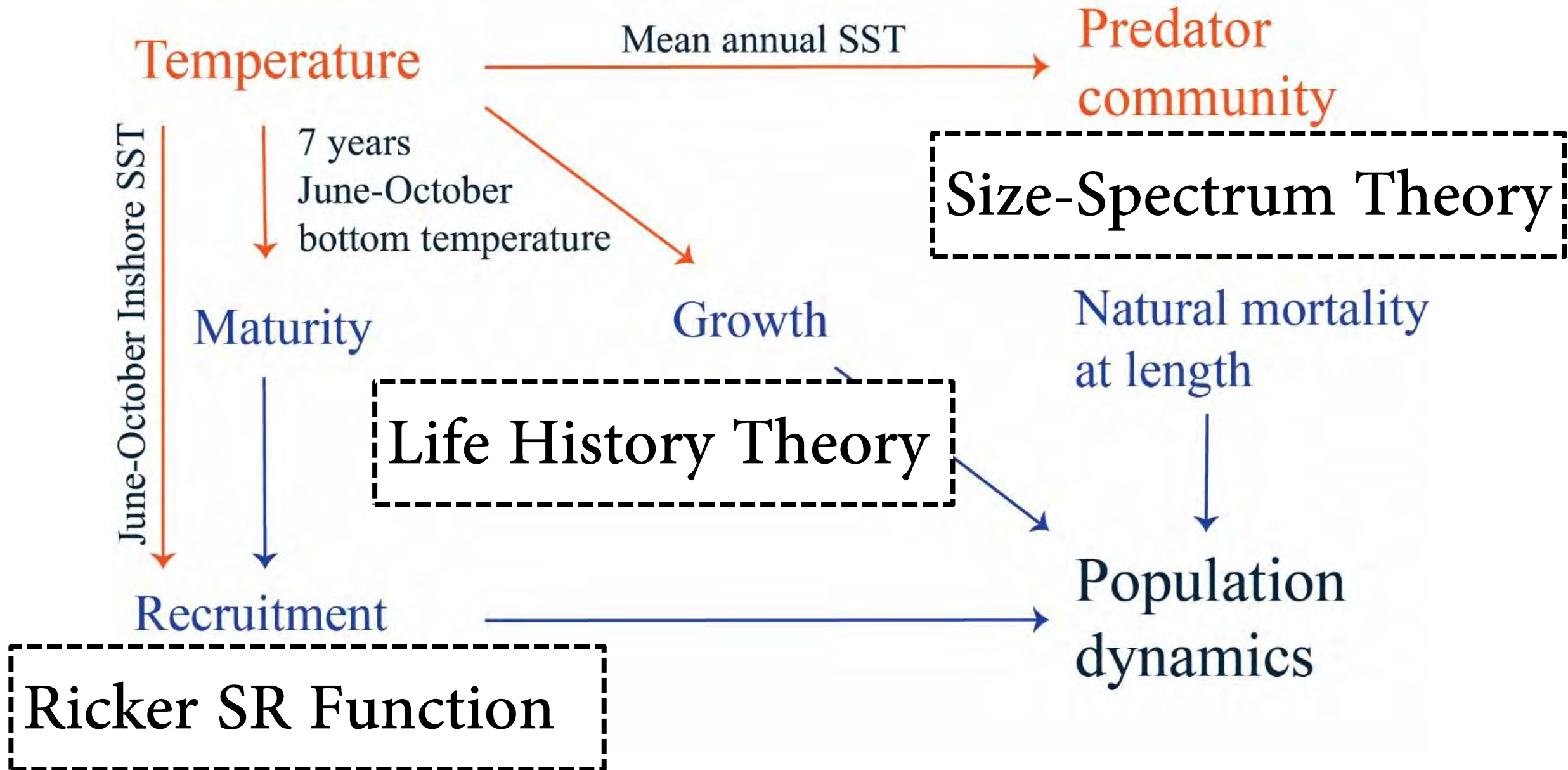
Objectives:

- Develop a simple **simulation model** that integrates climate, population dynamics, and fisheries dynamics to reconstruct past trajectories of the two stocks.
- Use the model to evaluate the role of the different factors
- Use the model to project future trends in the fisheries
- Identifying harvest strategies that confer resilience to climate vulnerable fisheries

Model parameterization – Climate and population dynamics



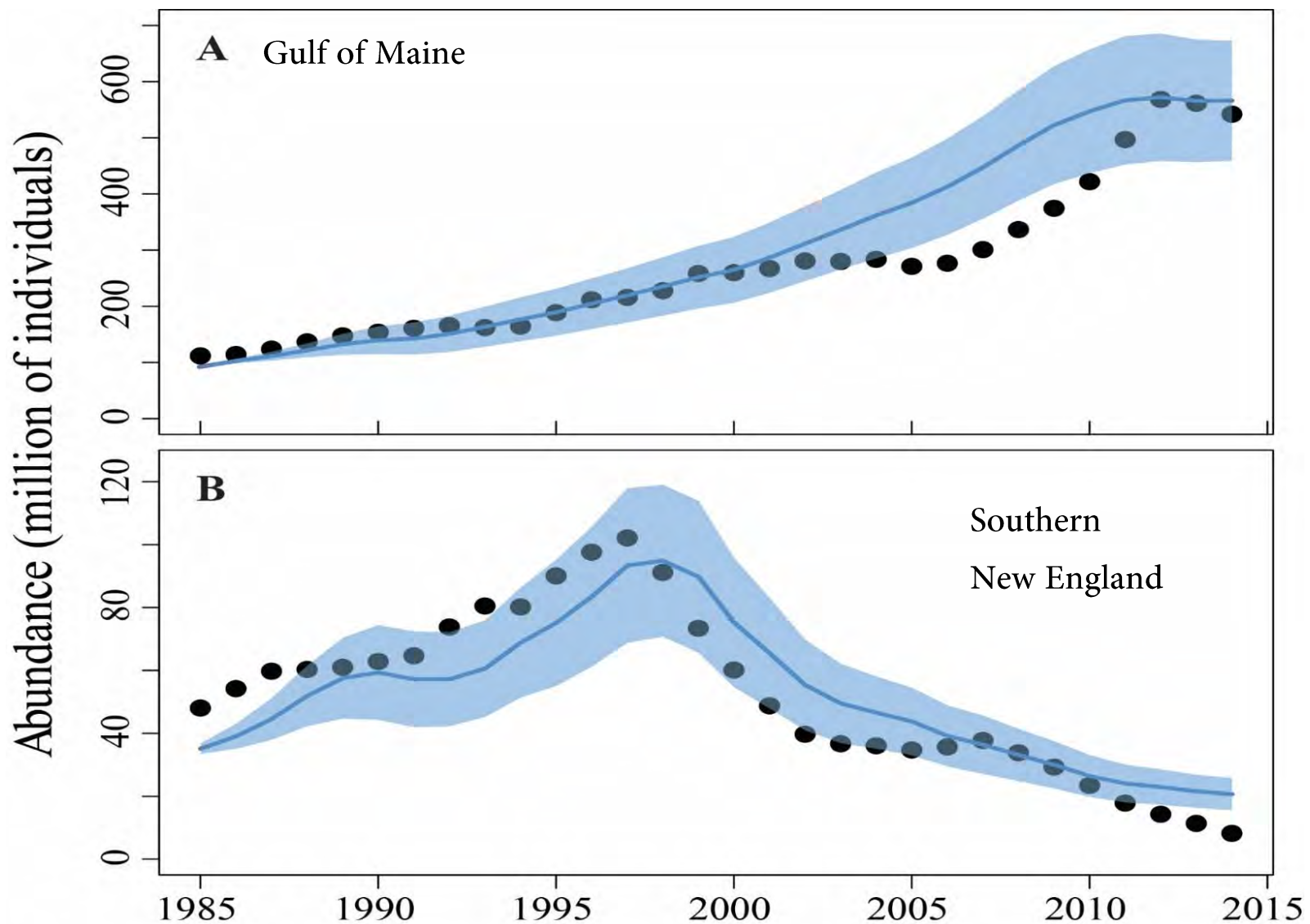
Model parameterization – Climate and population dynamics



Model simulations - validation

Inputs:

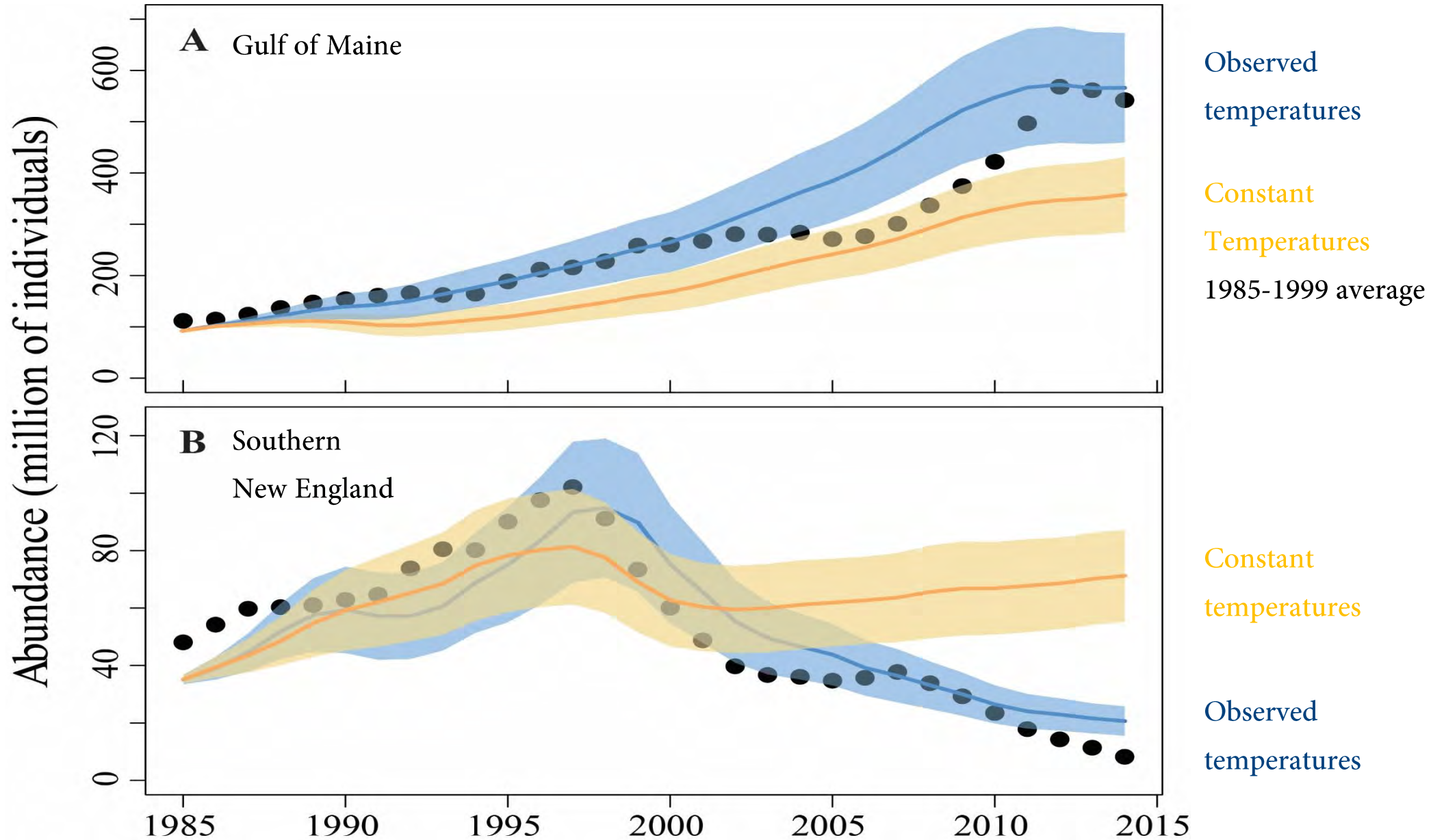
- Abundance at length in 1984
- Monthly temperatures
- Monthly landings



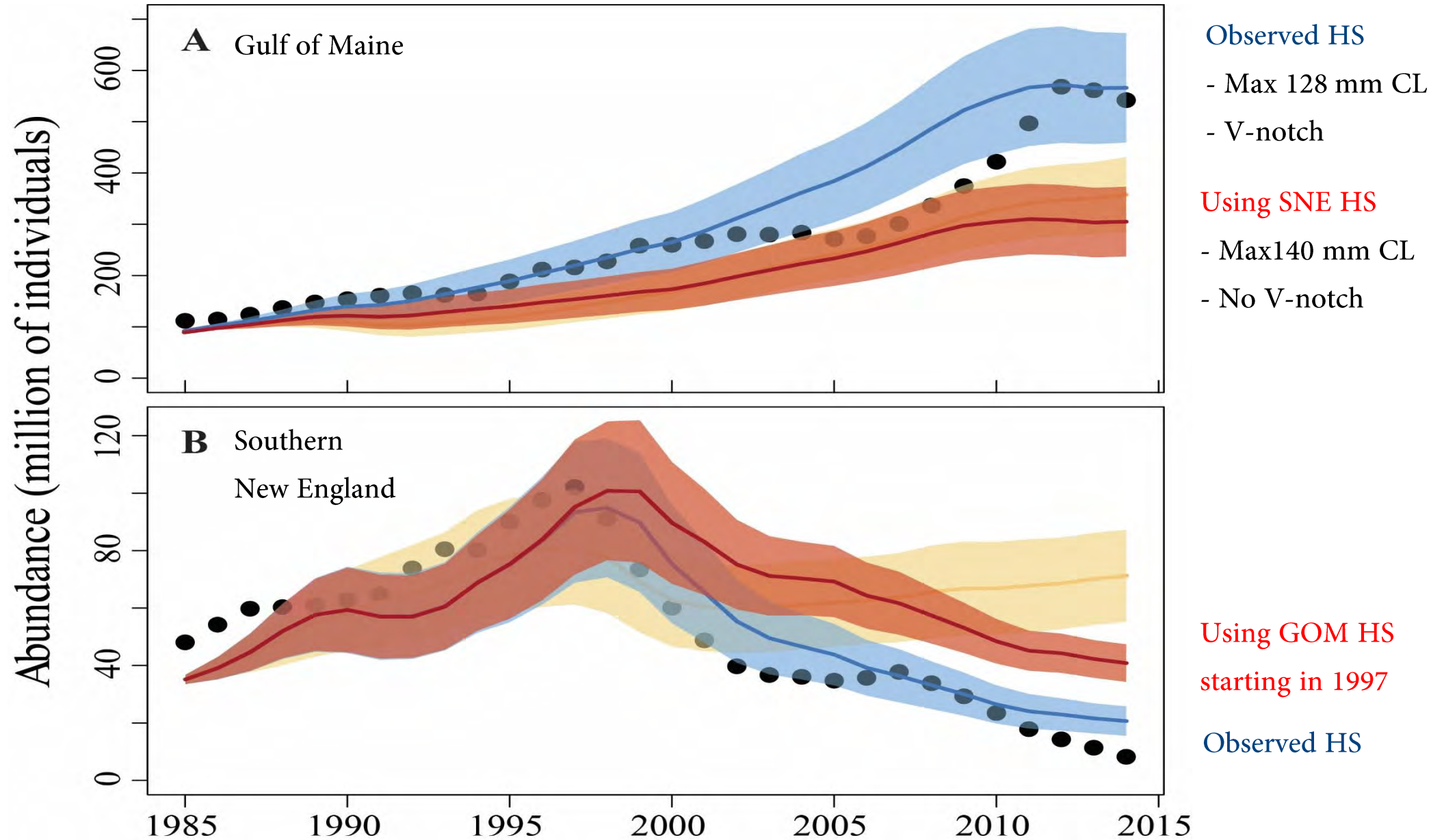
Estimation from
our model

Black dots: estimates from
2015 stock assessment

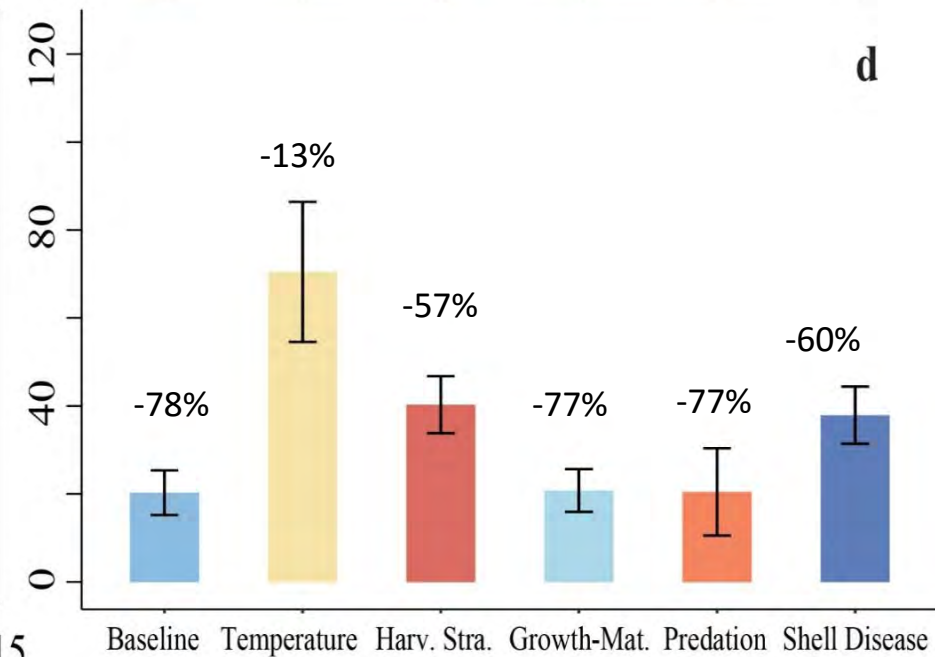
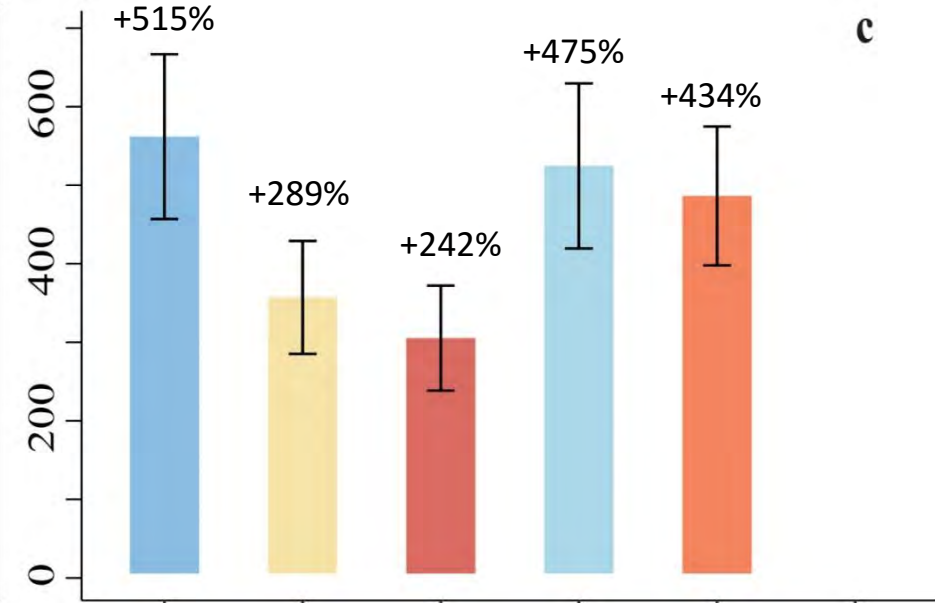
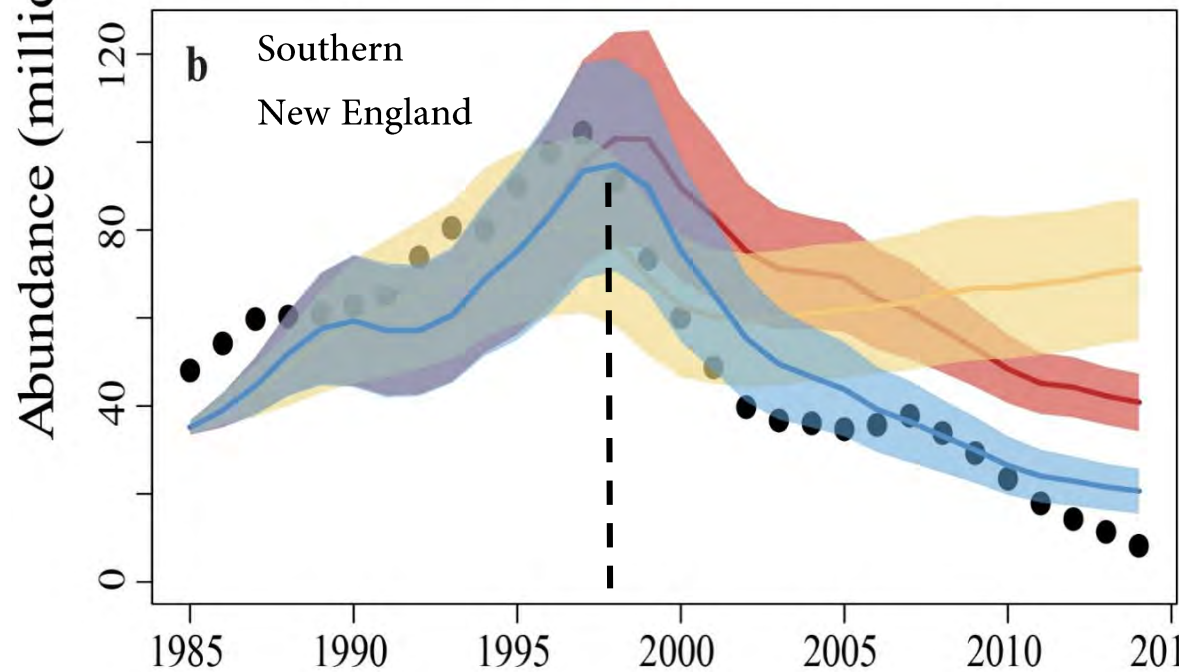
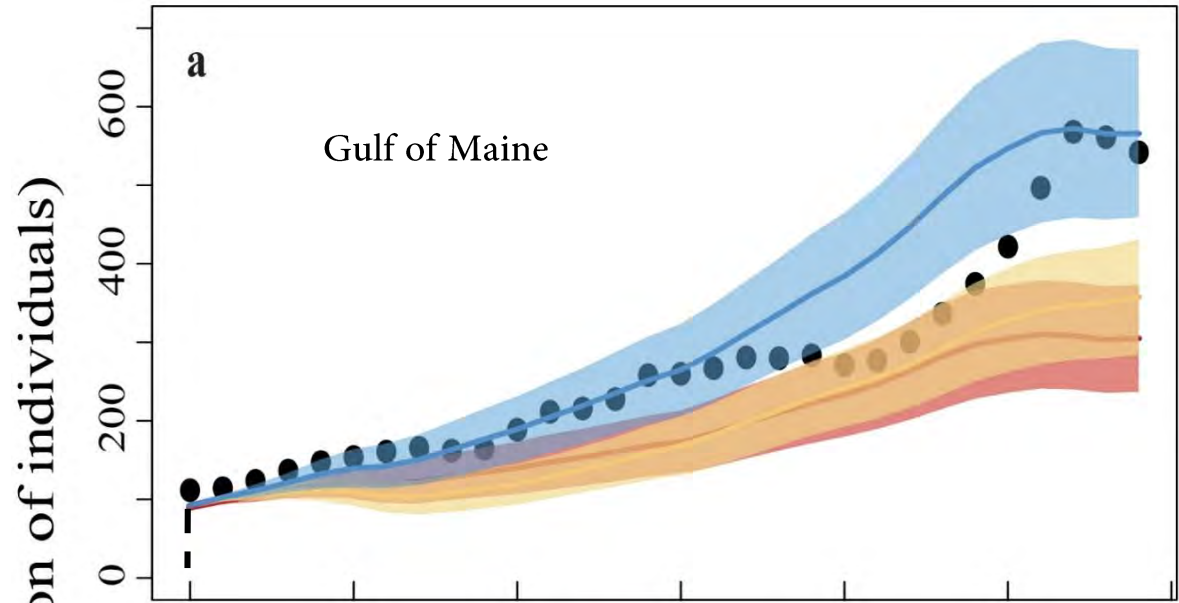
Model simulations - temperature



Model simulations – harvest strategies (HS)



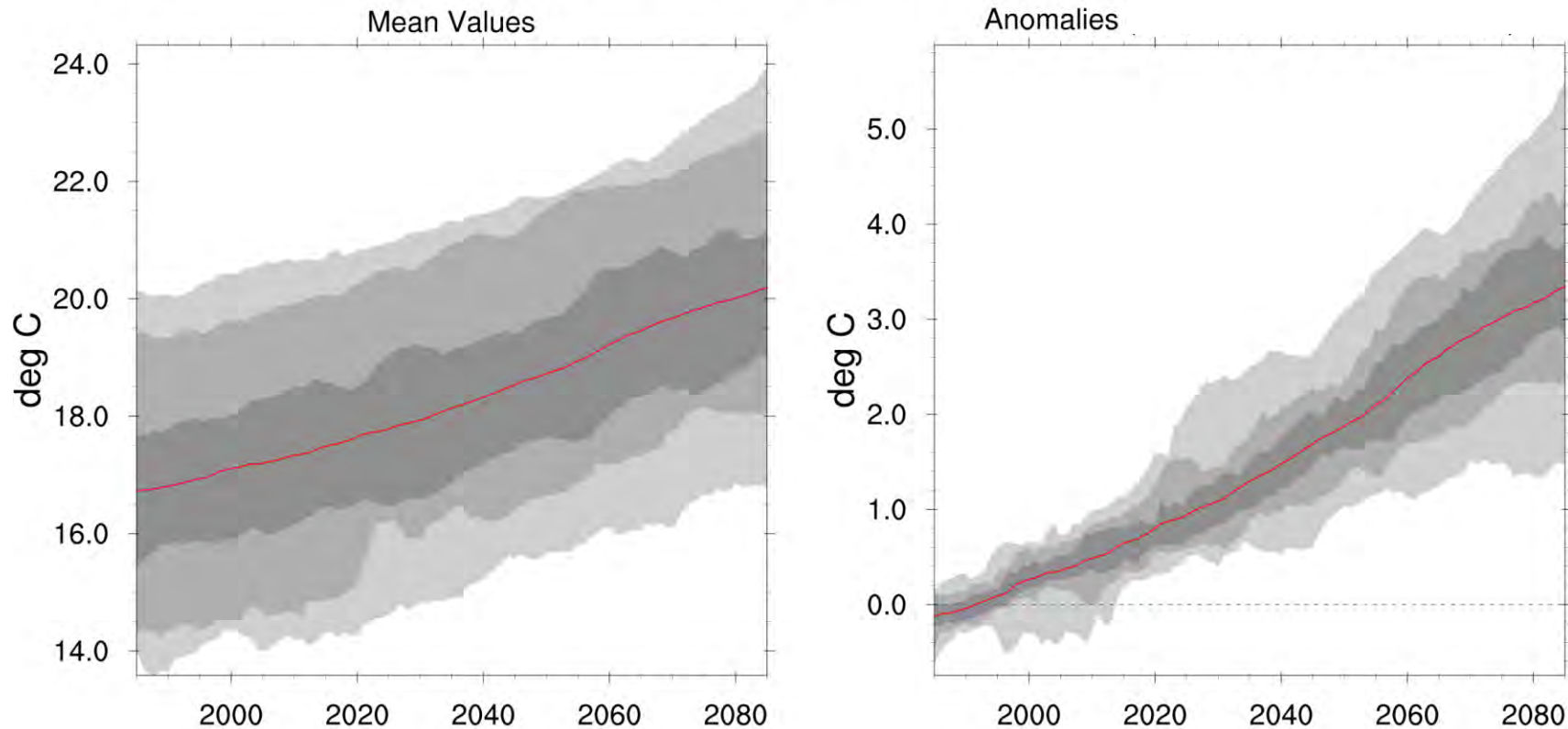
Model simulations – other factors



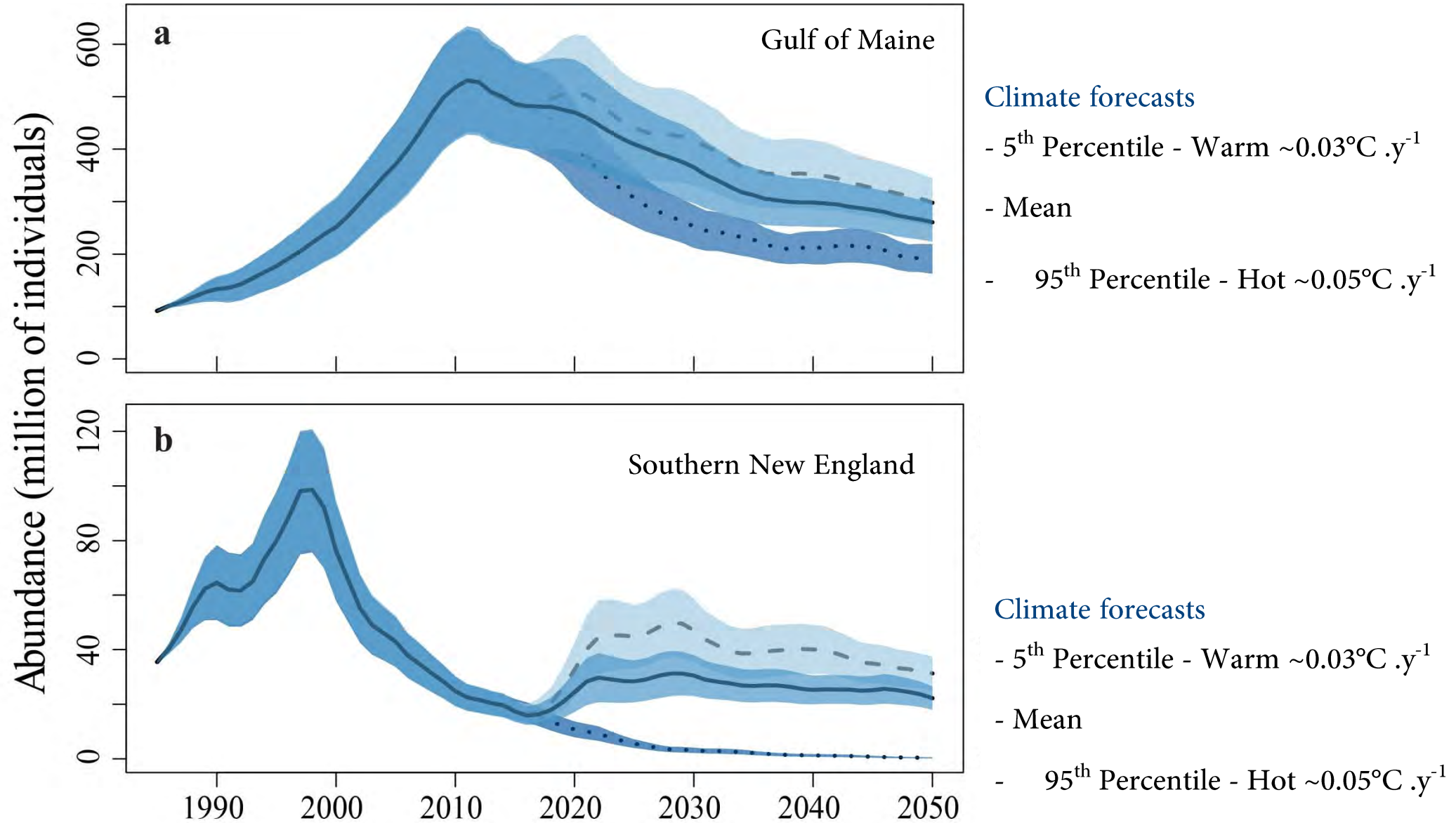
Model projections – Climate forecasts

- Temperature projections from CMIP5 ensemble model – RCP8.5, business as usual.
- 1°x 1° resolution. Anomalies relative to 1984-2014 climate
- For each time series, 3 products: mean, 5th and 95th percentiles

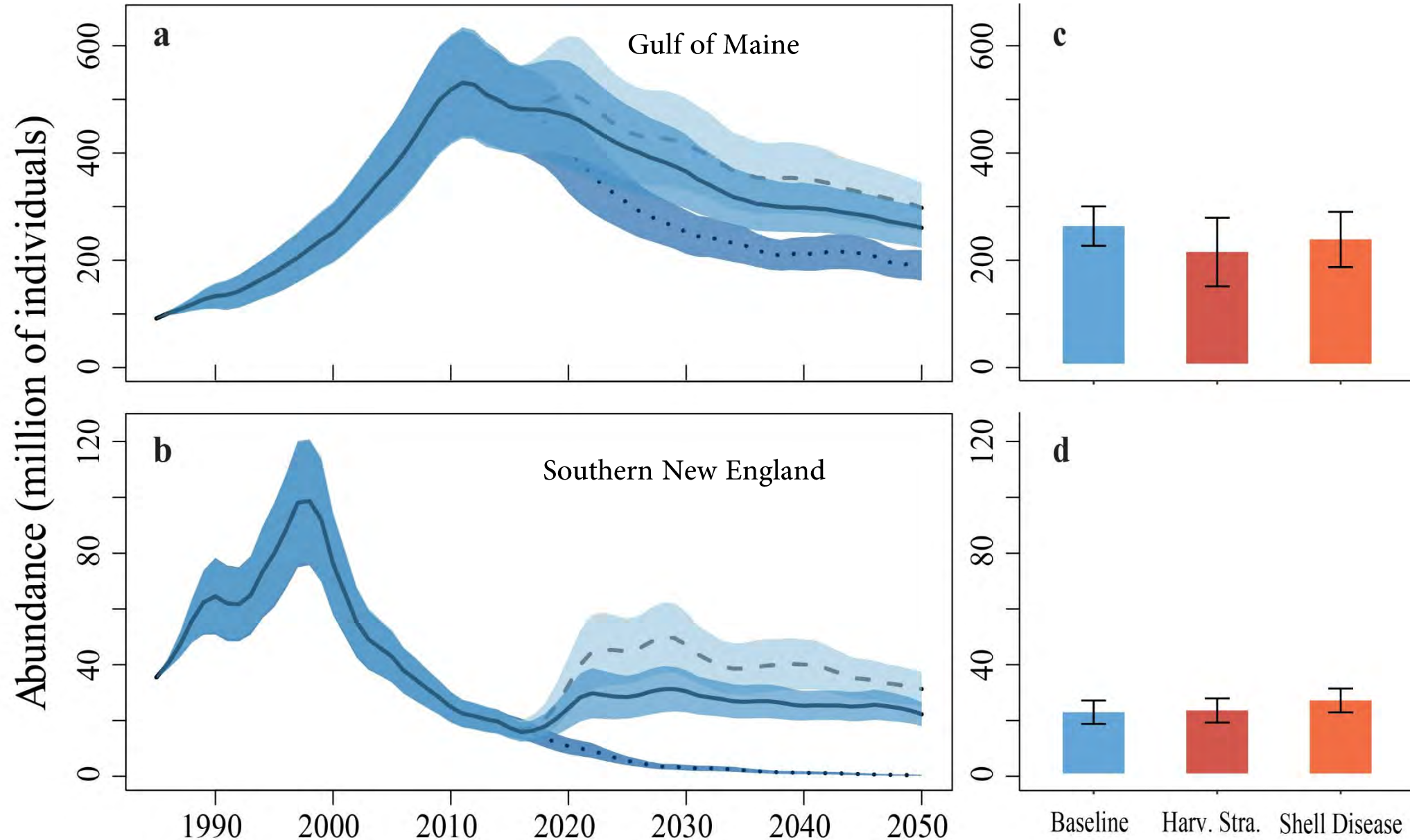
ANN ENSMN tos for Northeast U.S. Continental Shelf with 10 year running mean (20thC + rcp85)



Model projections



Model projections



Conclusions



American lobster fisheries in the US

- Preservation of larger reproductive lobster prepared the Gulf of Maine lobster fishery to capitalize on favorable ecosystem conditions
 - Record breaking landings
- Lack of measures to preserve large reproductive lobster in Southern New England precipitated the warming induced recruitment failure
 - Fishery collapse

Increasing resilience of fisheries to climate change

Locally adapted proactive conservation measures can help capitalize on gains and minimize losses caused by climate change

Winners can win more and losers don't have to loose as much!



Thank you! Questions?

Please do not hesitate to contact me:

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Le Bris A. et al. 2018. Climate vulnerability and resilience in the most valuable US fishery. *Proceeding of National Academy of Sciences USA*, 115 (8) 1831-1836. doi.org/10.1073/pnas.1711122115.