How the Gulf of Maine Can Help Us Learn to Live in a Warmer World

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AGNETIC

Outline

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- Climate change
- Rapid warming in the Gulf of Maine
- Impact of temperature on cod & lobster
- Towards adaptation

Acknowledgements: NSF Coastal SEES Lenfest Ocean Program







Moana Loa CO2 from NOAA ESRL

IPCC AR4, 2014



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 - changes "could be deleterious from the point of view of human beings."





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 - "opening of the fabled Northwest Passage."



NASA GISS Global Mean Surface Temperature





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Drought & Ice







Thanks to Melting Ice, Cruise Ship Travels Northwest Passage

The giant luxury cruise liner Crystal Serenity is on its way from Alaska to New York City through the Arctic's Northwest Passage.

Sept. 9, 2016, at 9:21 a.m.



People preparing to take a polar plunge in the Bering Sea in front of the luxury cruise ship Crystal Serenity, which anchored just outside Nome, Alaska last month. MARK THIESSEN/AP

Climate projections





IPCC AR4, 2014

Climate projections





- Temperature
- Ocean acidification
- Sea level rise

IPCC AR4, 2014

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Gulf of Maine SST Anomalies Relative to 1982-2011



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Gulf of Maine SST Anomalies Relative to 1982-2011



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Gulf of Maine Warming





Gulf of Maine Warming





Gulf of Maine Warming





Gulf of Maine & the North Atlantic



Adapted from Saba et al. (2016) JGR, 121:118-132



Rhamstorf (1997) Nature, 388:825-826

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Cod

- Arguably, the most important fishery in American history
 - first export from New England
 - 70,000 tons/year in late 1800s
 - catch limit reduced to 350 tons in 2014

















- Warming leads to reduced recruitment and survival
- Not accounting for warming made management hard
- Cod can be rebuilt but
 - rate and level depends on temperature



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Level of warming

	mild	average	severe
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Level of warming



Years to rebuild





- Most valuable fishery in the US
 - \$500M landed value in Maine alone
 - 75% of Maine's landed value
 - increasing catches in Maine, decrease in southern New England





































Lobster Summary

- Past warming led to
 - collapse of lobster in south
 - explosion in the north
- Future warming will
 - prevent a recovery in south
 - lead to a decline in the north



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Lessons from the Gulf of Maine

- Global warming is real and it will impact things that we care about
 - lobster, cod
 - shrimp, squid, black sea bass
 - people and communities



Adaptation & Resilience

Space



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- The Gulf of Maine is warming rapidly
- Warming has impacted human & natural communities
- Adaptation requires acknowledging climate
- Good management builds resilience
 - Pershing, A. J., et al. 2015. Science, 350: 809-812.
 - Mills et al. 2013. Oceanography, 26: 191-195

