Fish in the Future Ocean: Lessons from Physiological Studies

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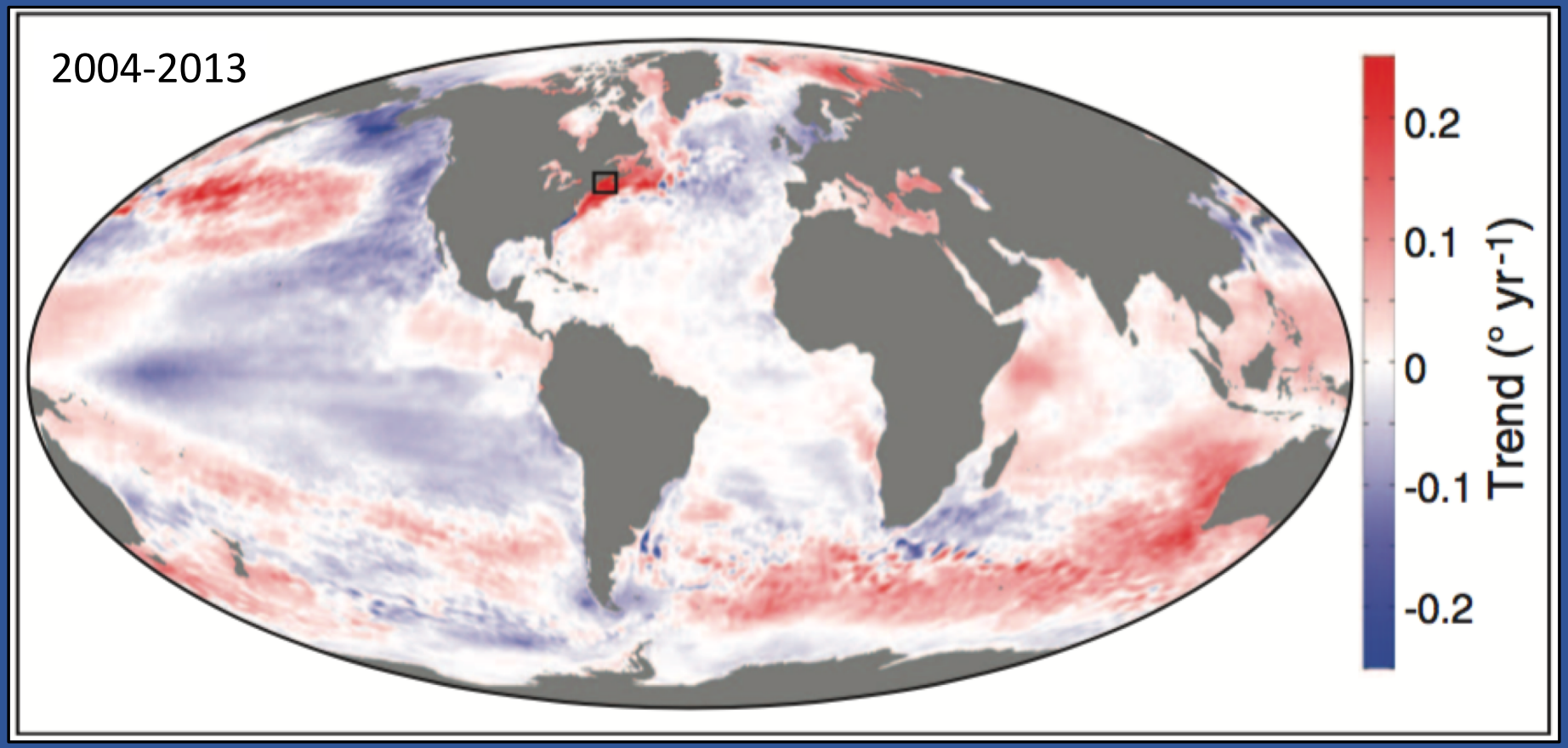
Changing Ocean Conditions - Observed

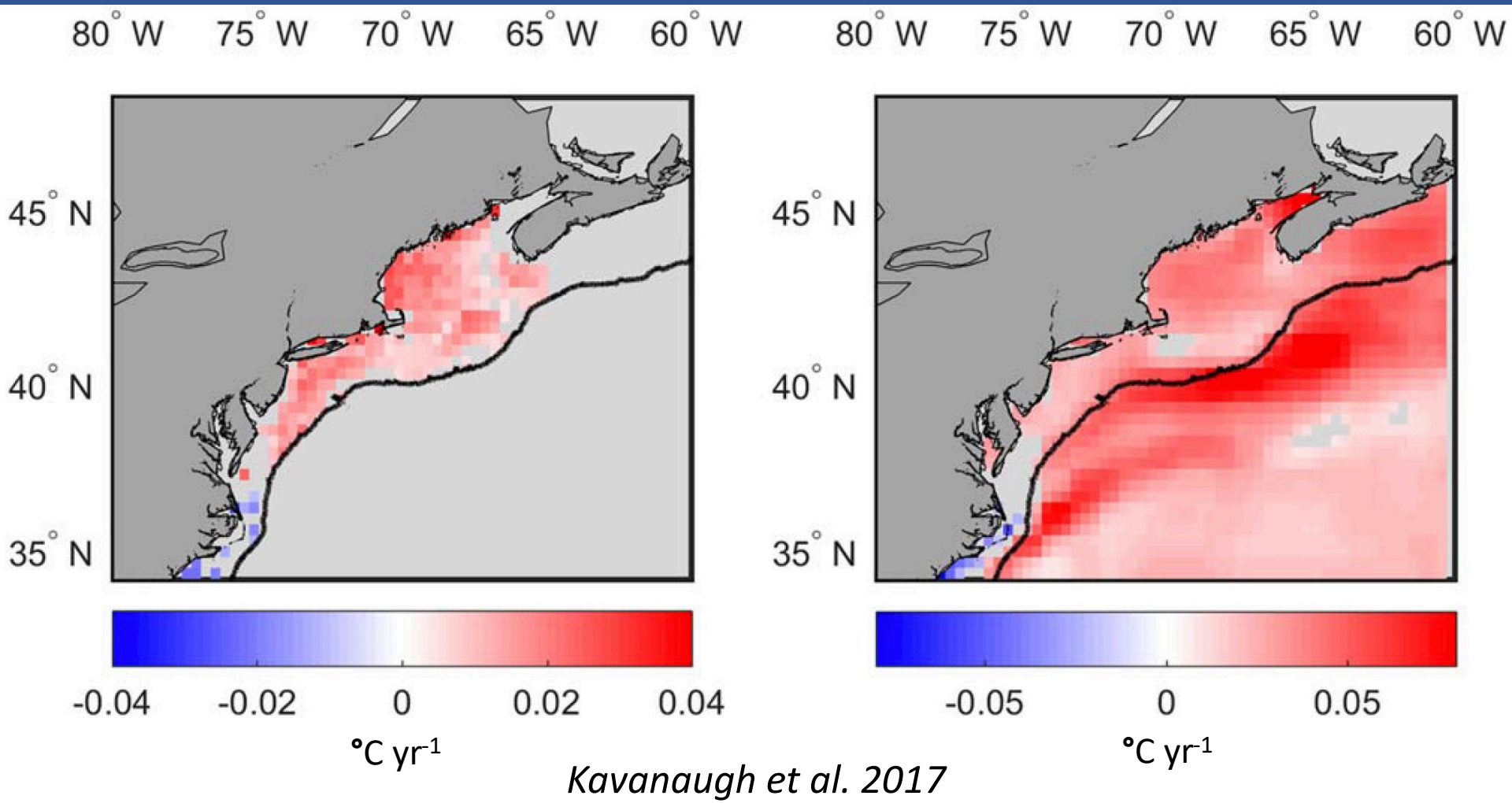


Pershing et al. 2015

Changing Ocean Conditions - Observed

1982-2014

Benthic **Surface**



Kavanaugh et al. 2017

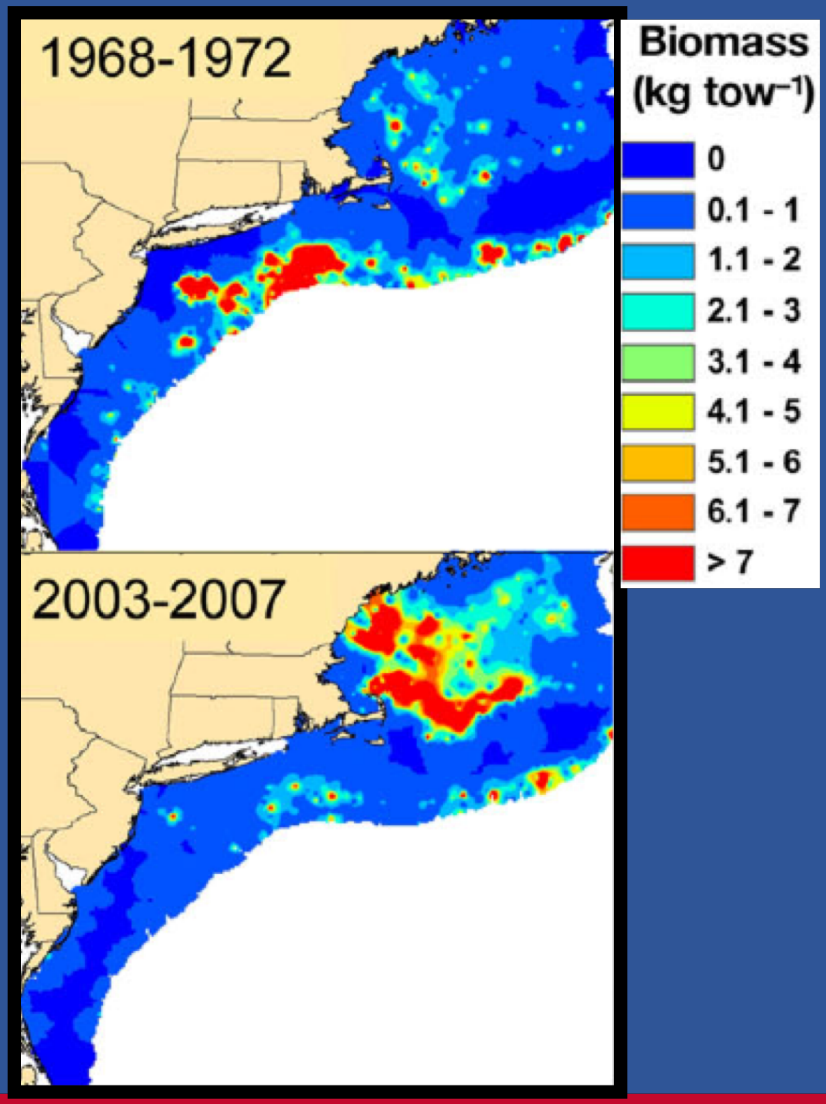
Observed Fish Response

Shifts in species distributions

- Poleward

Red Hake example

Nye et al. 2009

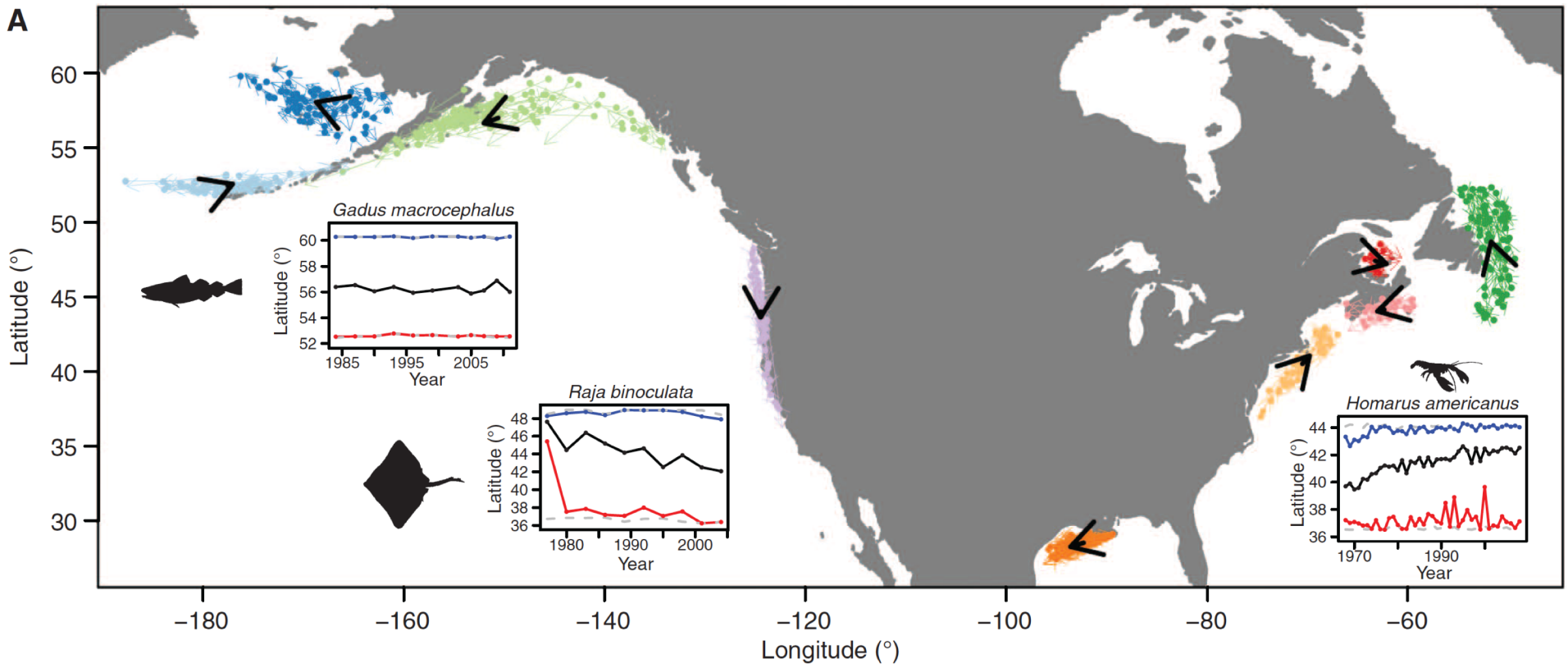


Observed Fish Response

Shifts in species distributions

- Poleward, but not always
- Track climate velocities

Pinsky et al. 2013



Observed Fish Response

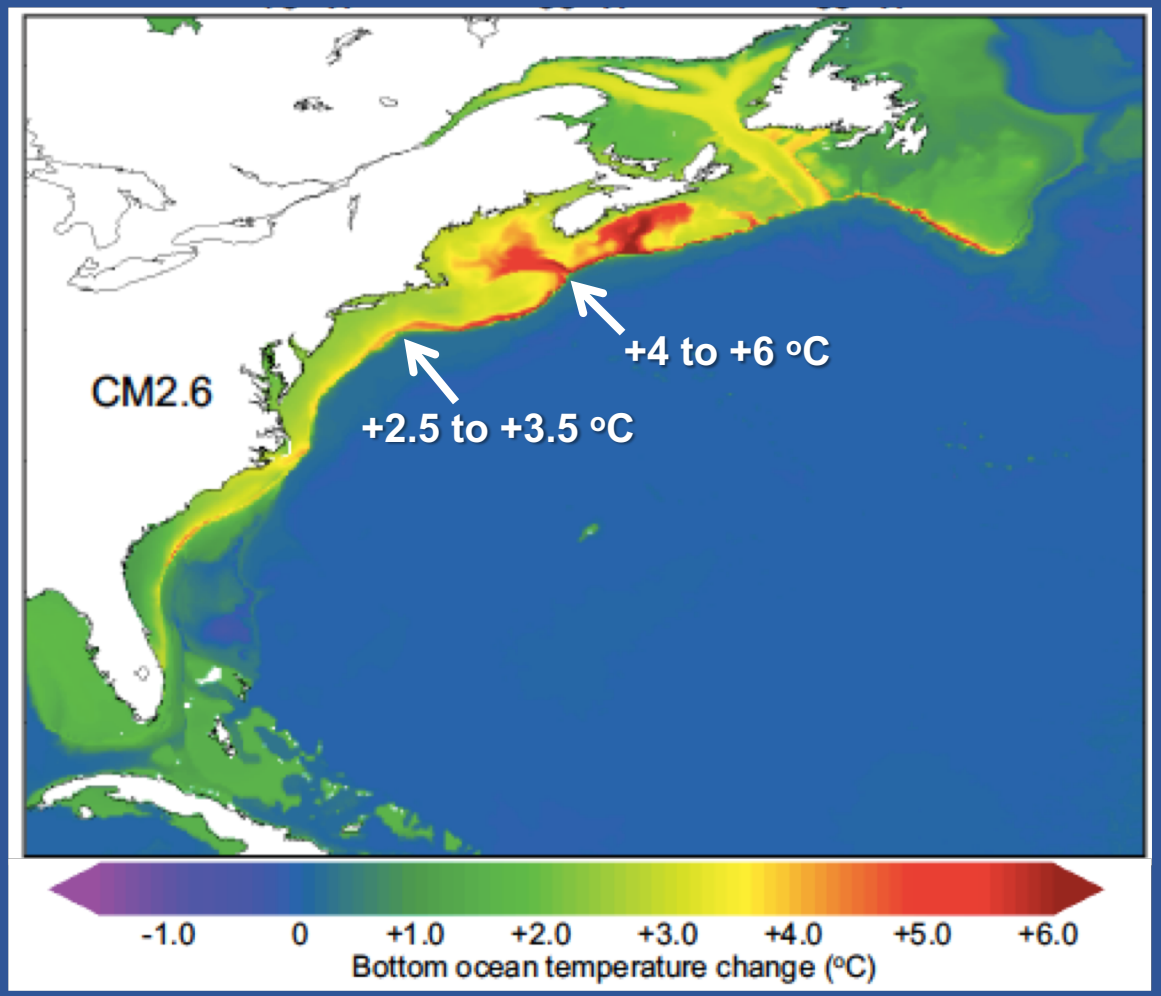
Slow adaptation in the face of rapid warming leads to collapse of the Gulf of Maine cod fishery

Andrew J. Pershing,[1*] Michael A. Alexander,[2] Christina M. Hernandez,[1†] Lisa A. Kerr,[1] Arnault Le Bris,[1] Katherine E. Mills,[1] Janet A. Nye,[3] Nicholas R. Record,[4] Hillary A. Scannell,[1,5‡] James D. Scott,[2,6] Graham D. Sherwood,[1] Andrew C. Thomas[5]

Pershing et al. 2015

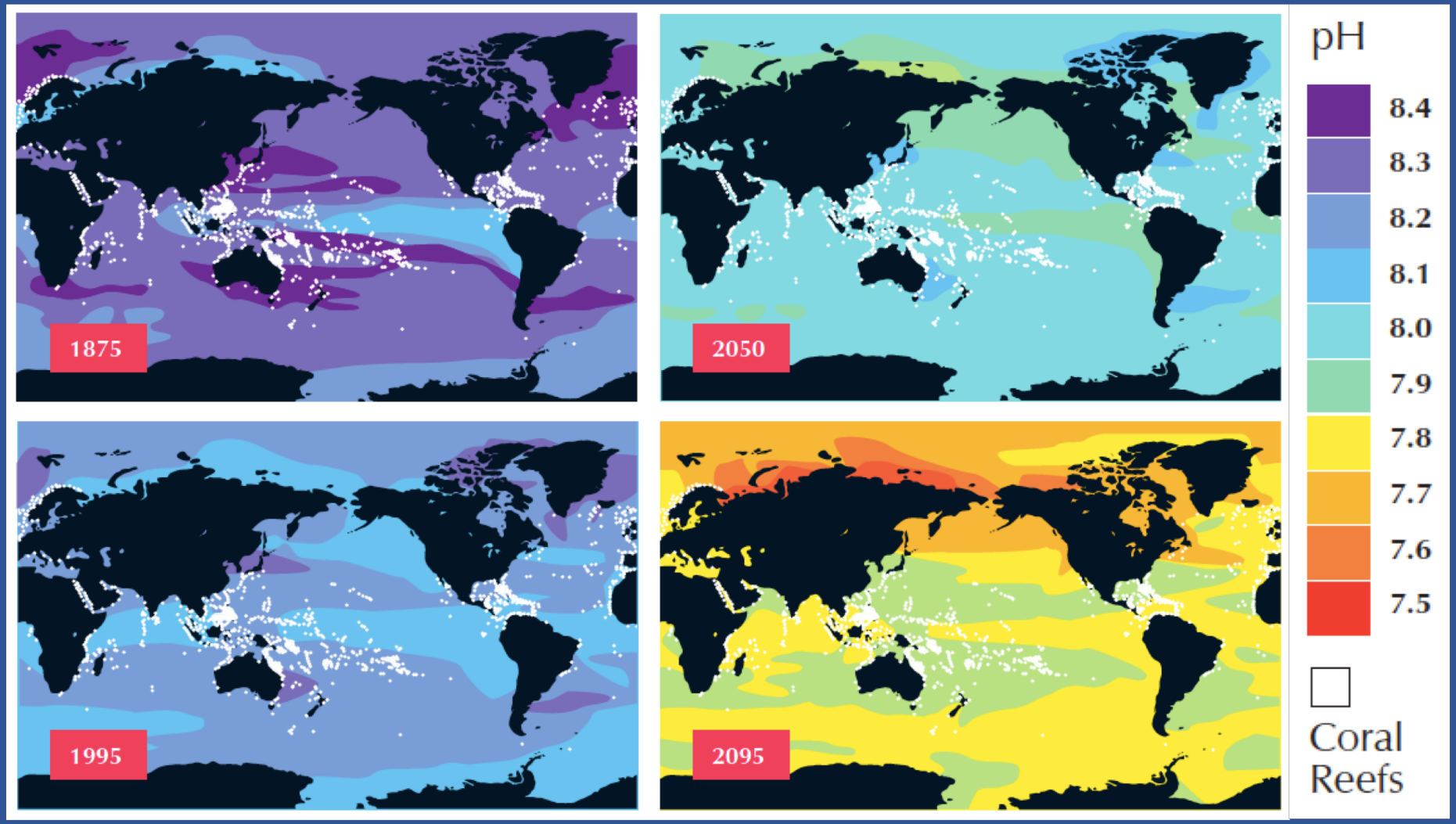
Changing Ocean Conditions - Projections

80-yr projection using doubling of CO_2



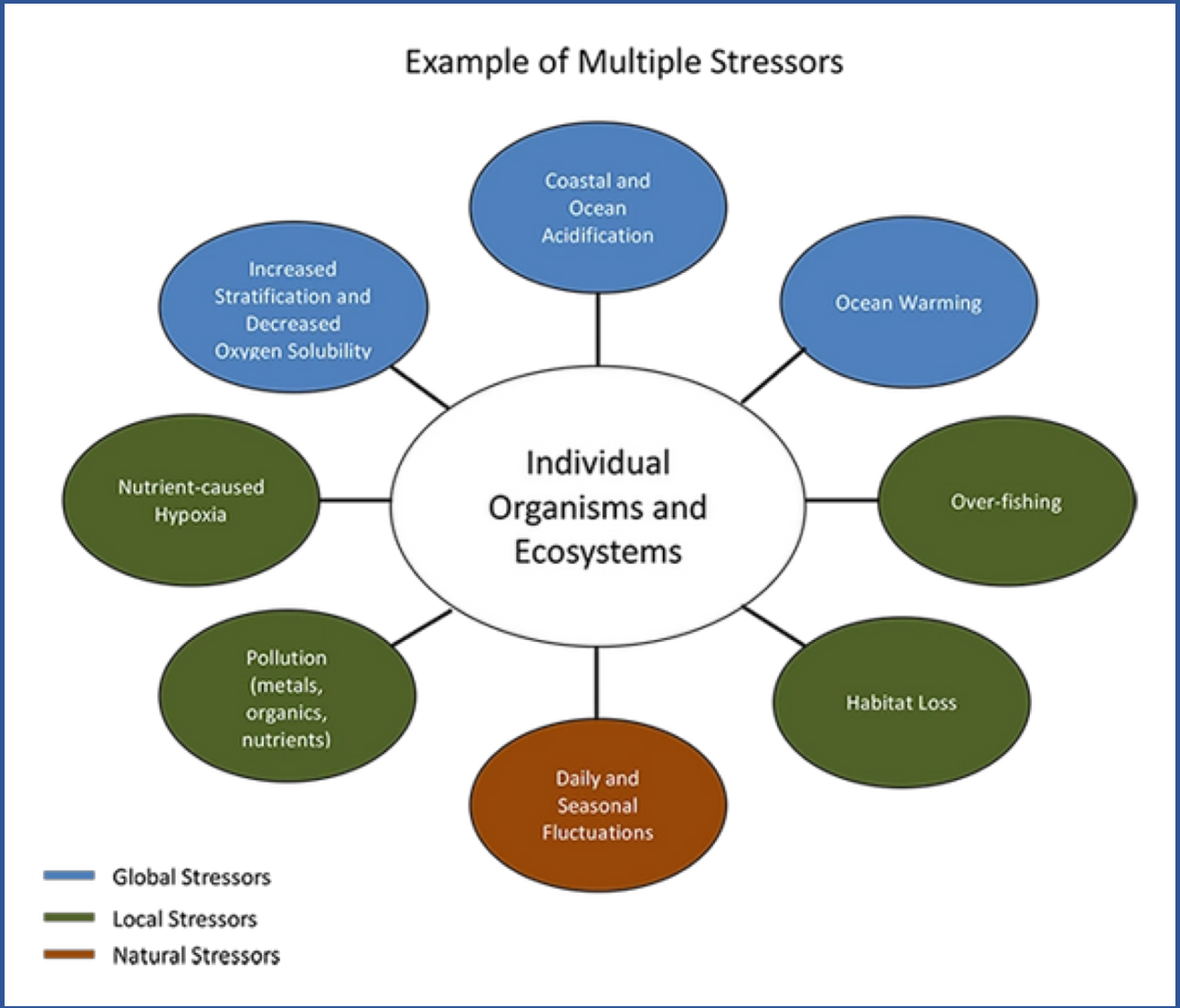
V. Saba et al. 2016

Ocean Acidification - Projections



Modified from Feely et al. 2009

And…More Stressors

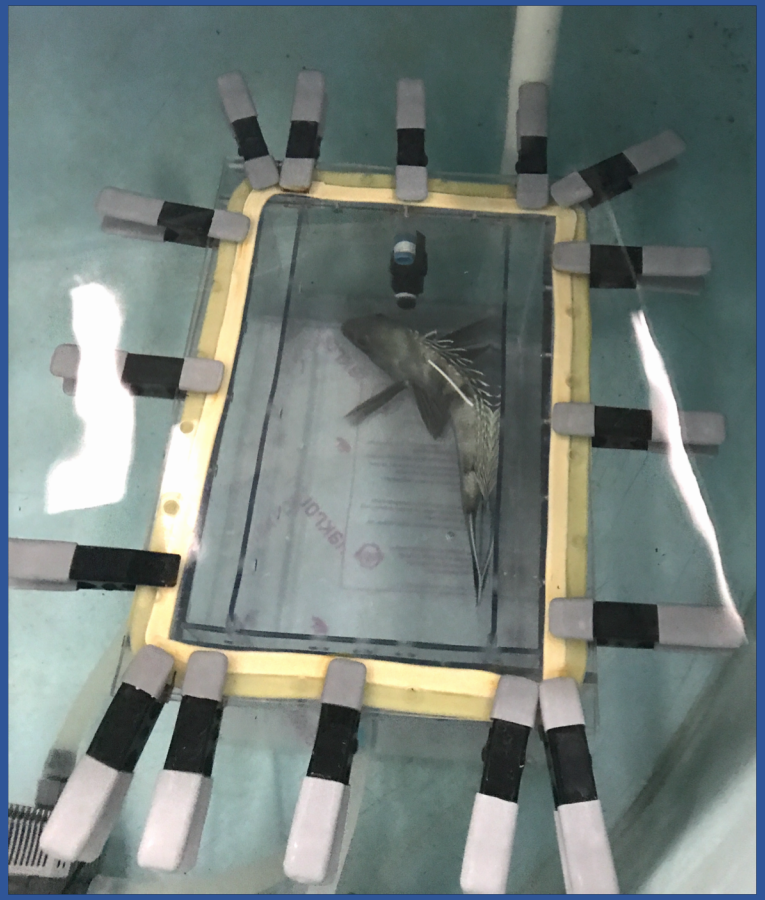


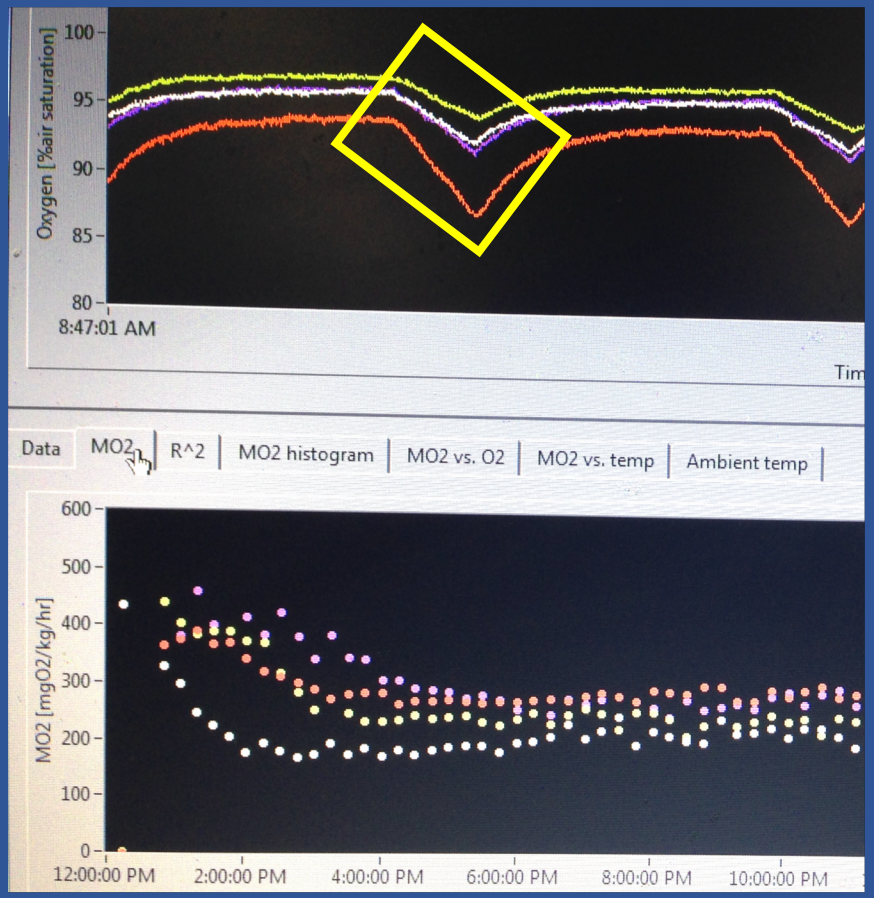
Stressor Effects on Physiology

- Changes in metabolic rate
  - Temperature/Acidification: Higher requirement for oxygen, food
  - Hypoxia/Acidification: Metabolic suppression
- Impacts to oxygen carrying capacity
- Changes in heart rate
- Behavioral impairment

  - ➢ Possible food limitation
  - ➢ Reductions in growth/reproduction
  - ➢ Increased predation

What Can Physiological Studies Tell Us?

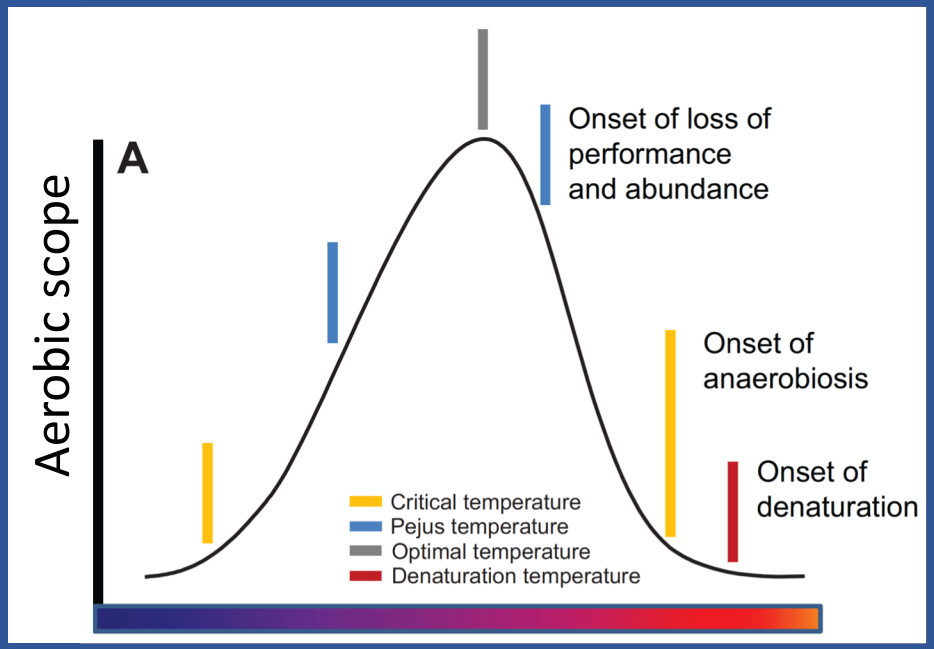




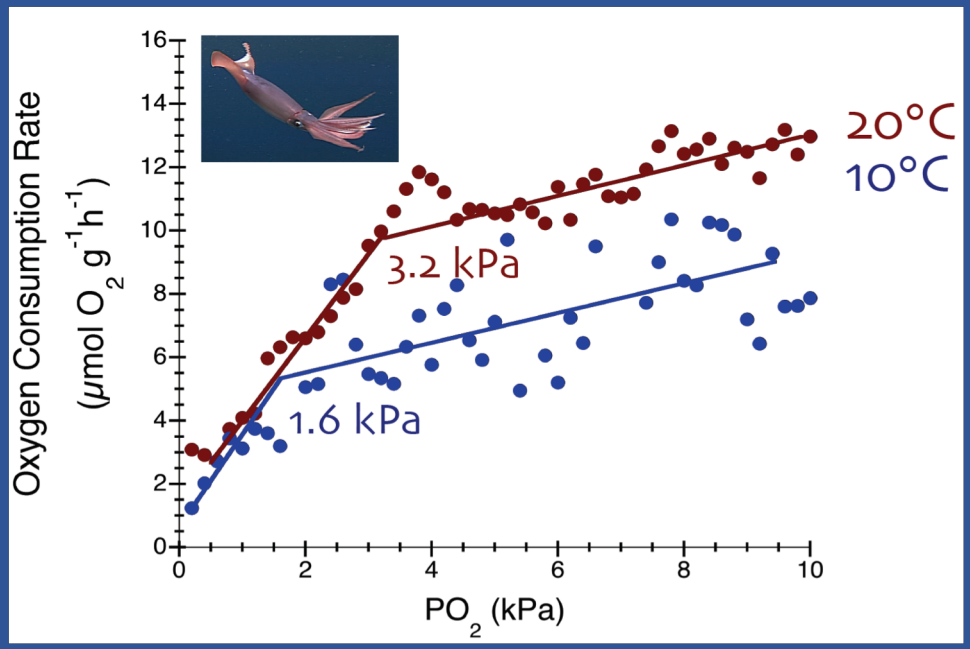
*Emily Slesinger: Tomorrow, 1:40pm
Latest Advances in Black Sea Bass (*Centropristis striata*) Research and Management

What Can Physiological Studies Tell Us?

- Optimal Conditions and Critical thresholds



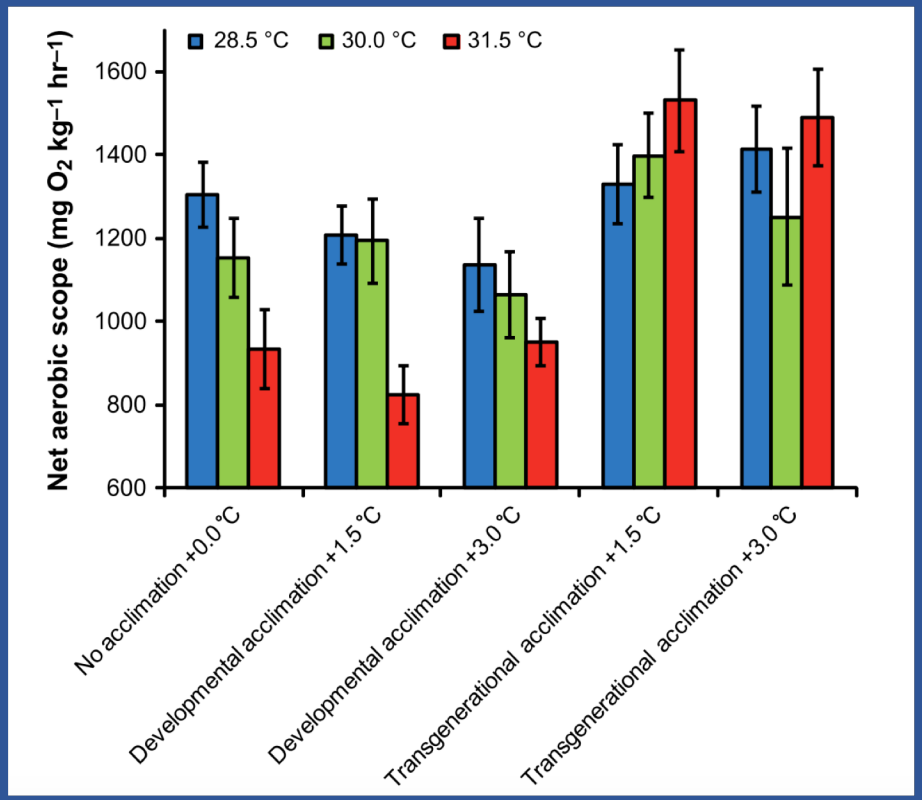
Clark et al. 2013



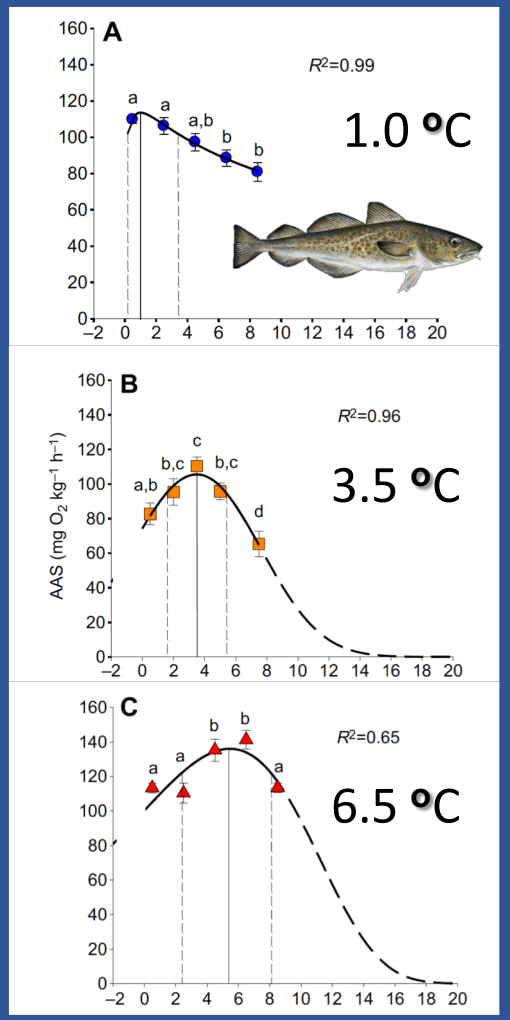
Trueblood & Seibel 2013

What Can Physiological Studies Tell Us?

- Optimal Conditions and Critical thresholds
- Acclimation and adaptation capacity



Donelson et al. 2012; Munday et al. 2013



Drost et al. 2015

What Can Physiological Studies Tell Us?

- Optimal Conditions and Critical thresholds
- Acclimation and adaptation capacity
- Scope of phenotypic plasticity

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- Relative importance of abiotic and biotic factors on organism response

Oxygen Limitation ?

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Oxygen Limitation ?

Prey Availability ?

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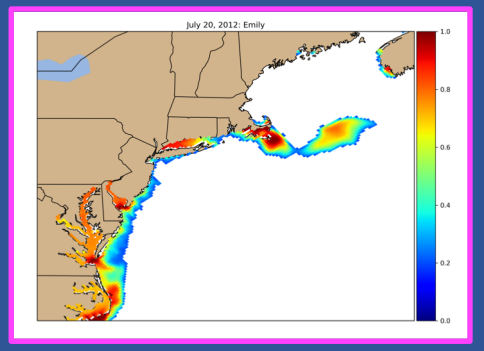
- Optimal Conditions and Critical thresholds
- Acclimation and adaptation capacity
- Scope of phenotypic plasticity
- Relative importance of abiotic and biotic factors on organism response

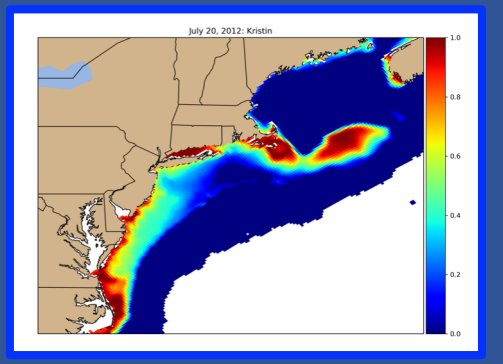
Oxygen Limitation ?

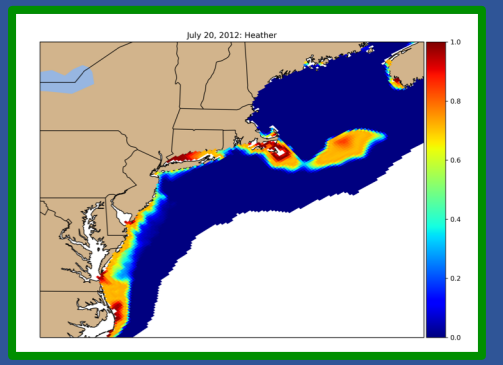
Prey Availability ?

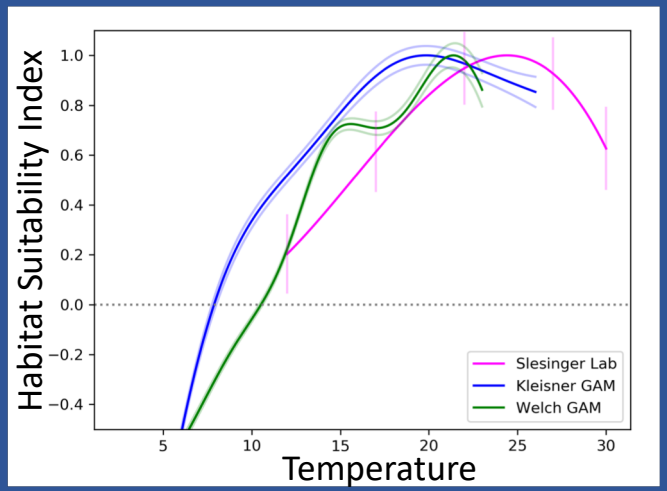
Predation ?

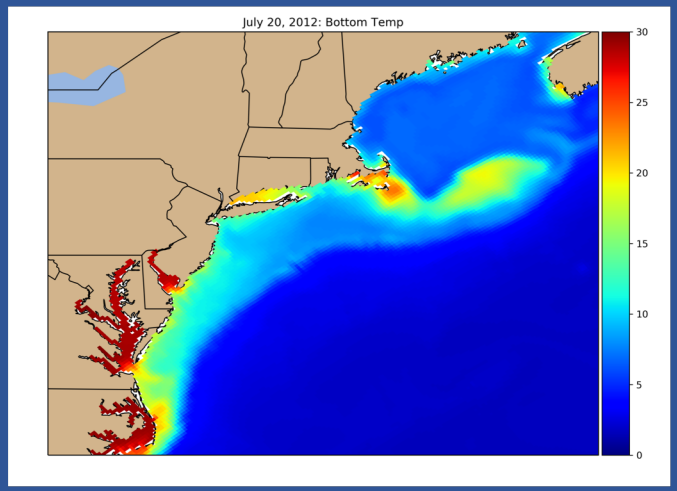
Integrating Physiological Parameters into Habitat Projections





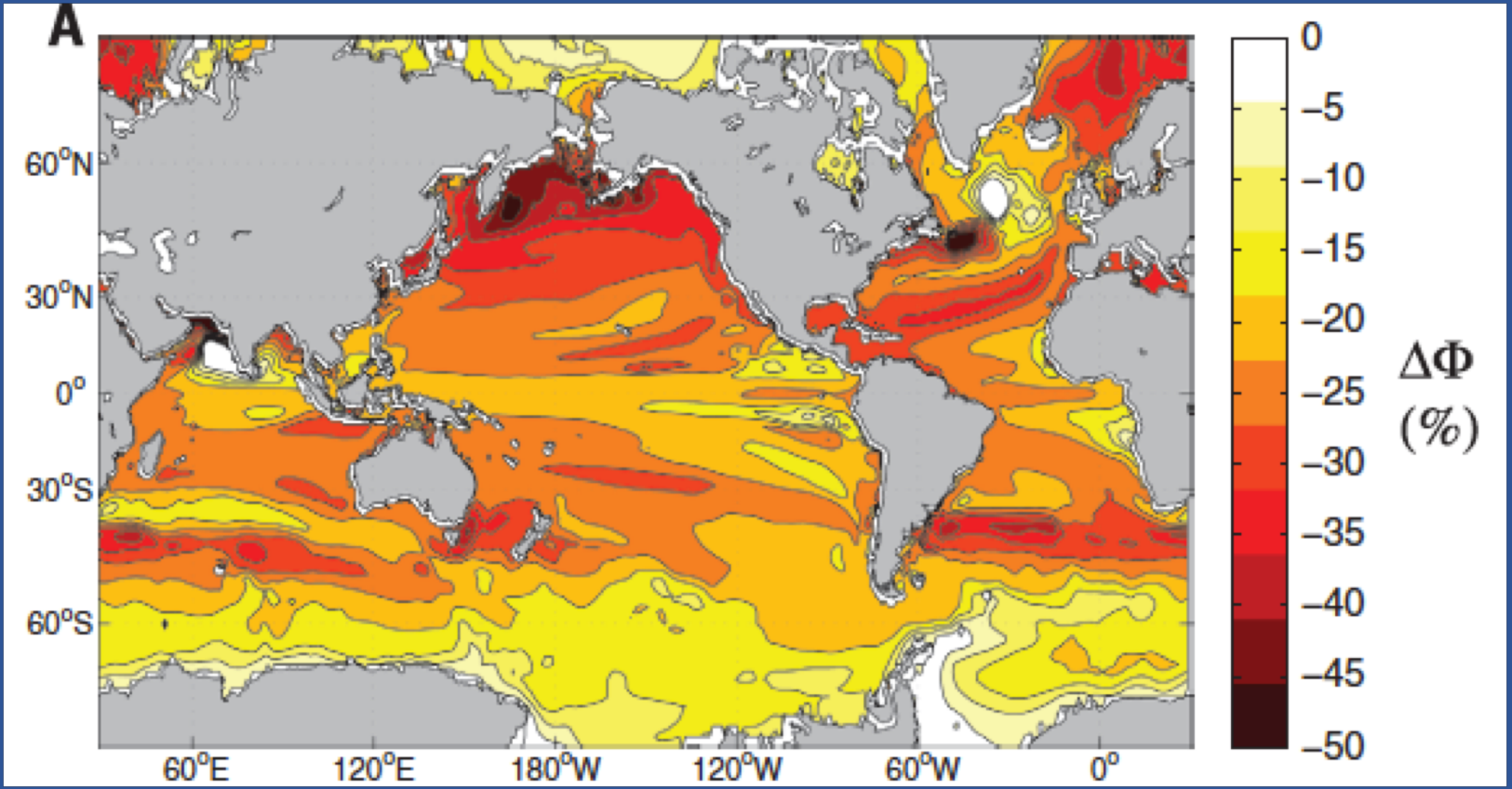






Integrating Physiological Parameters into Habitat Projections

Change in metabolic index from 1971–2000 to 2071–2100.



Deutch et al. 2015

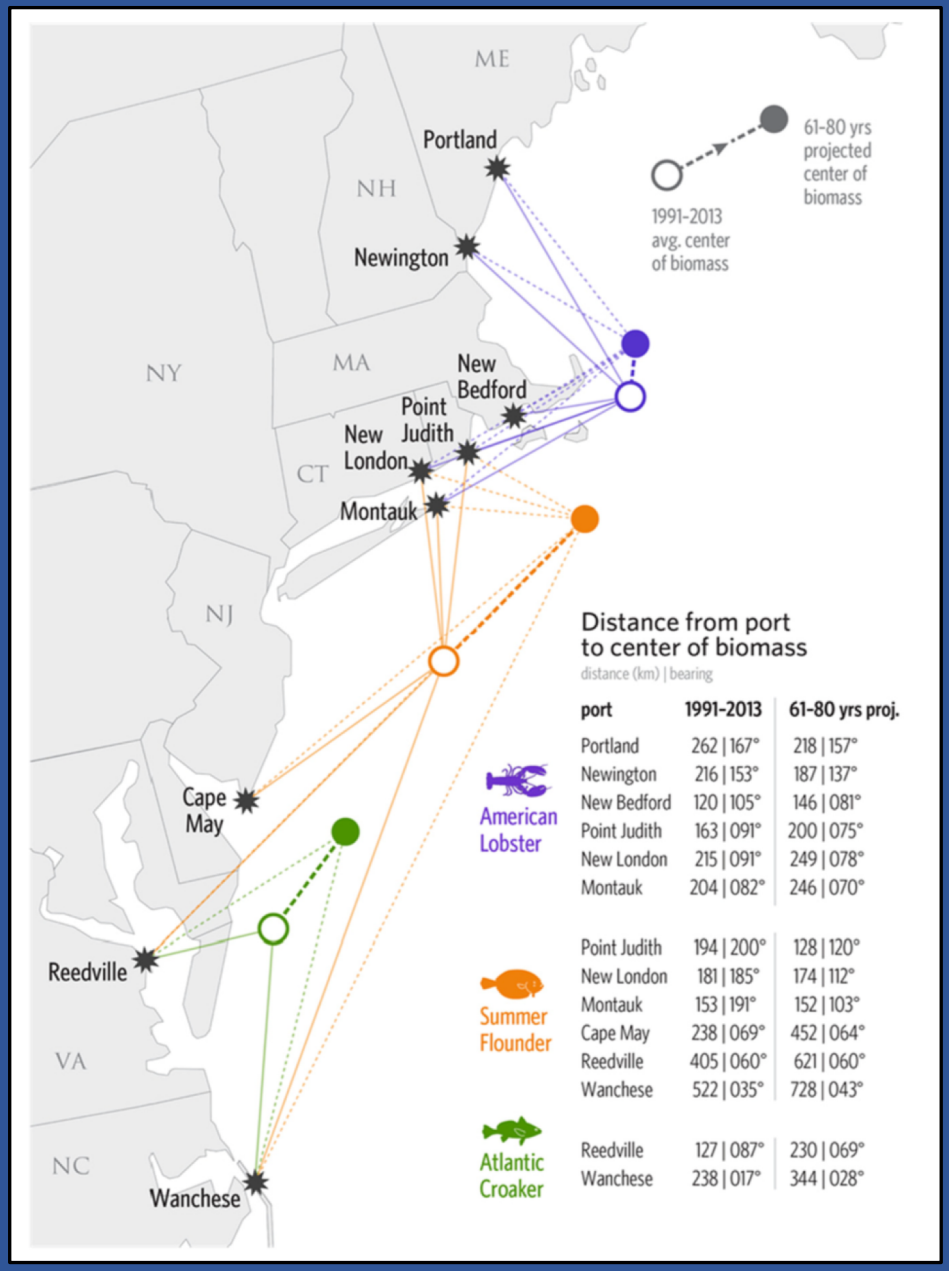
Significance

Economic & Social

Value of Landings

Rank	Species	Thousand Dollars
1	Lobsters	679,214
2	Crabs	678,727
3	Shrimp	488,384
4	Salmon	460,166
5	Pollock	449,198
6	Scallops	440,496
7	Cod	264,191
8	Flatfish	263,615
9	Oysters	213,773
10	Clams	206,299

Kleisner et al. 2017



Introduction to Today's Presentations

1. Lian Guo (*Student): University of Massachusetts, Amherst
   - Warming Lakes: How Temperature Affects Anadromous Juvenile River Herring Physiology
2. Dan Crear (*Student): Virginia Institute of Marine Science
   - Metabolic Responses of Cobia, *Rachycentron Canadum*, to Warming and Hypoxia
3. Alyssa Andres (*Student): University of South Florida
   - An Investigation of the Effects of Rising Temperature on Metabolic Scope in the Spiny Dogfish, *Squalus Acanthias*
4. Gail Schwieterman (*Student): Virginia Institute of Marine Science:
   - Interactions of Acute Temperature and pH Changes on Metabolic Rates and Hypoxia Tolerance: A Comparison between Mid- and North-Atlantic Species

Thanks!

Enjoy the Session