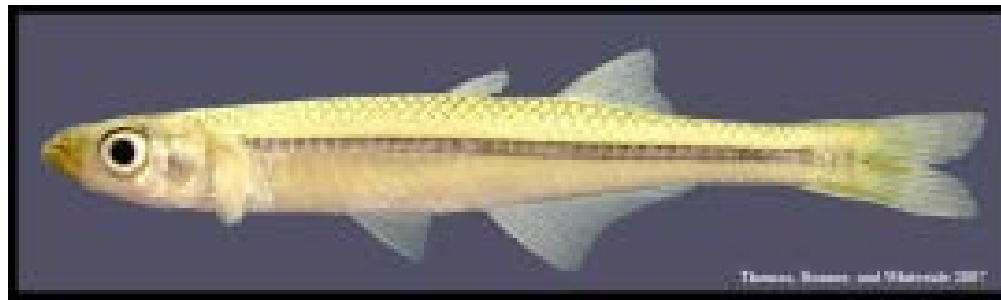


Impacts of ocean acidification on marine life in Long Island Sound



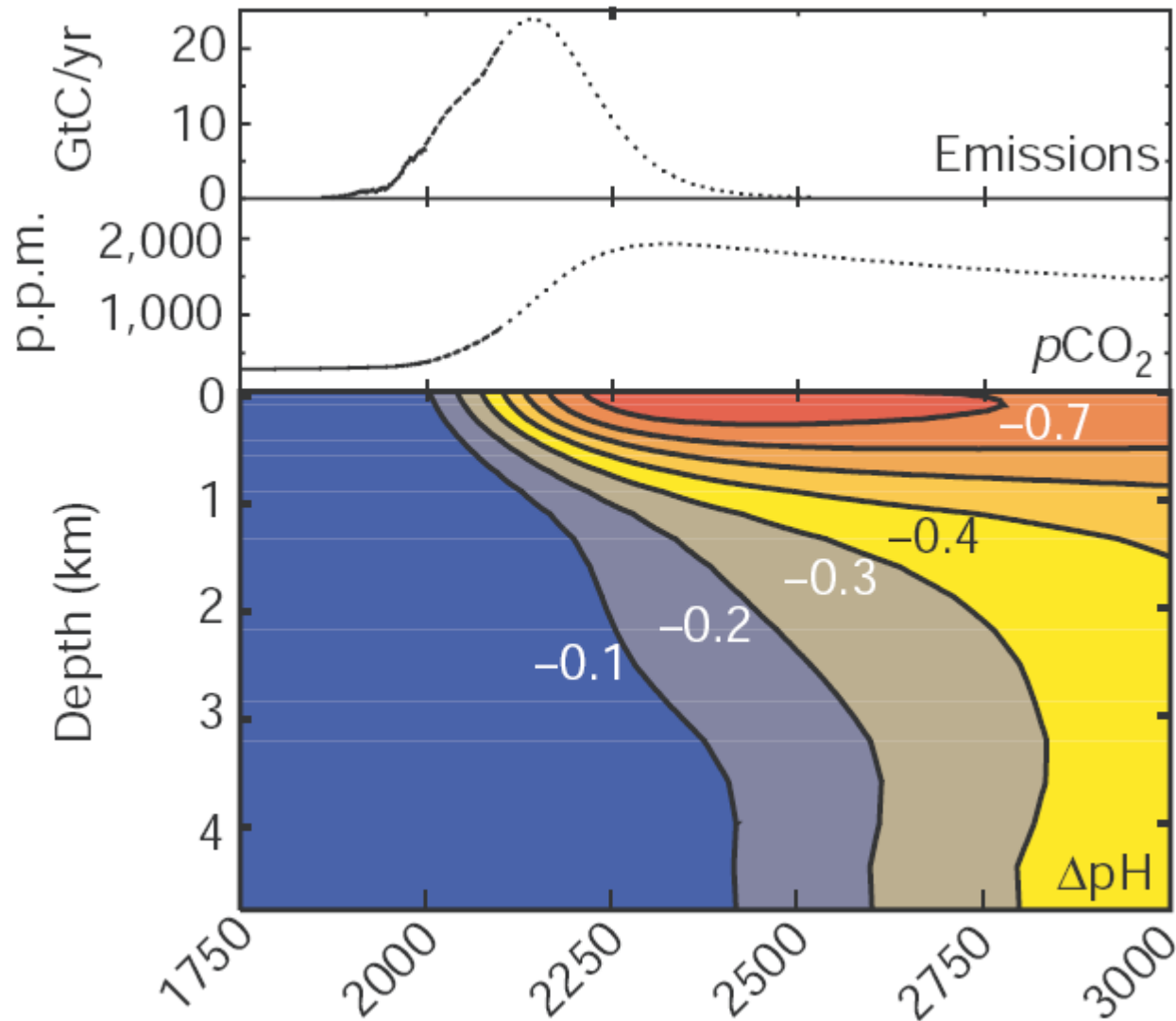
Christopher J. Gobler, PhD



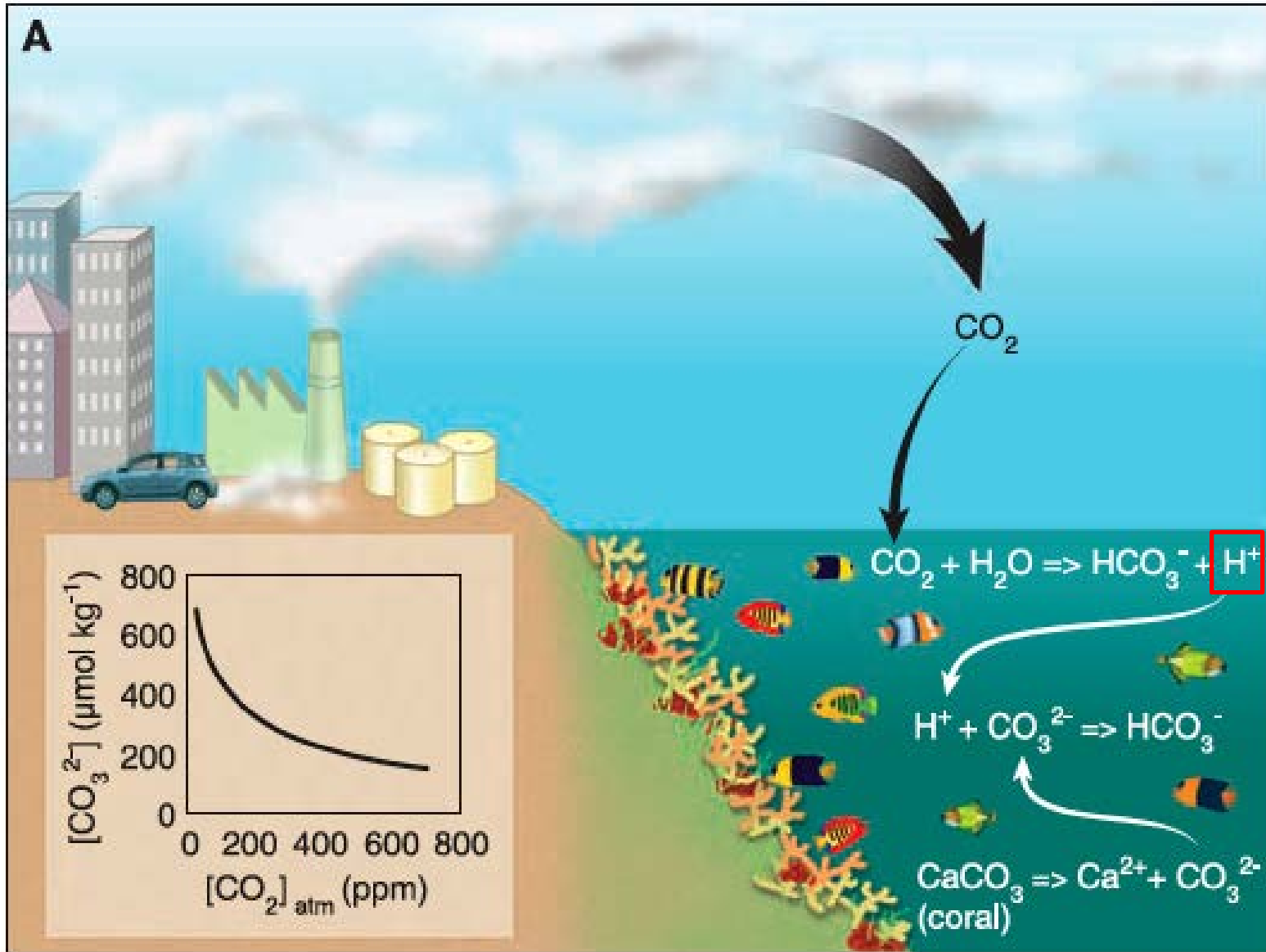
Stony Brook University
*School of Marine and
Atmospheric Sciences*

Anthropogenic carbon and ocean pH

The coming centuries may see more ocean acidification than the past 300 million years.



Ocean acidification



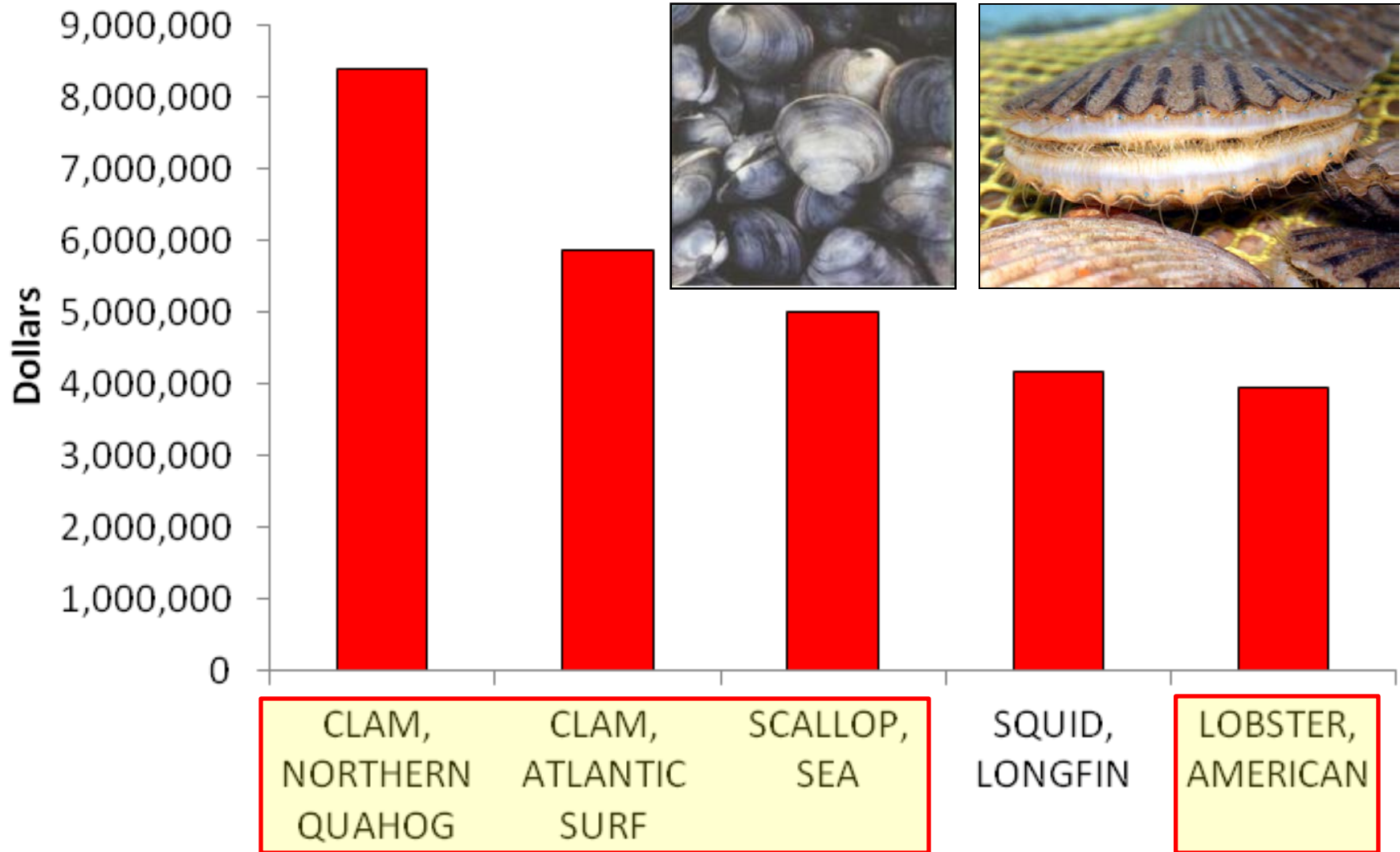
Lower pH,
acidification

Calcifying shellfish potentially vulnerable to ocean acidification



Top fisheries in New York, 2012, NMFS data

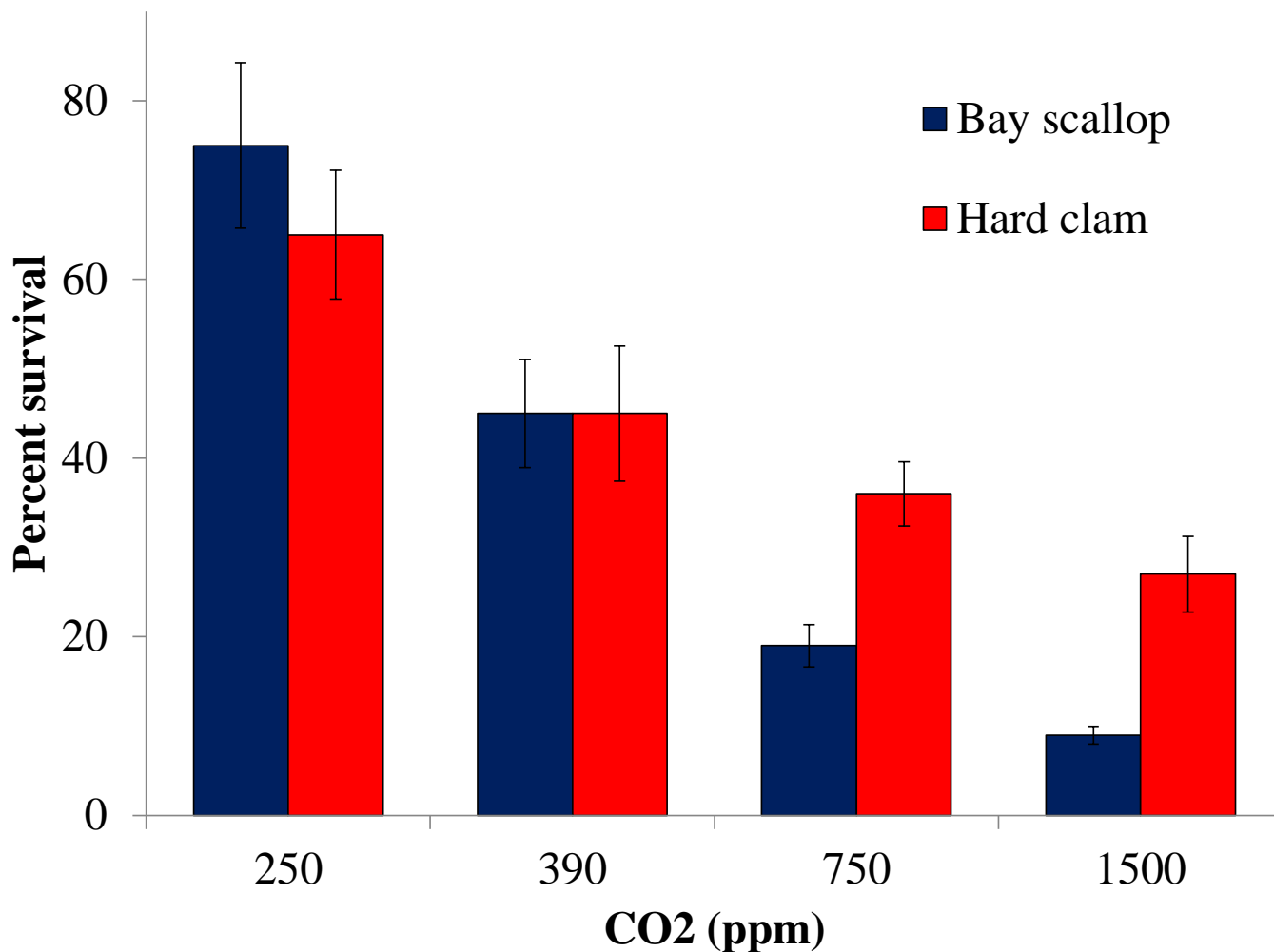
The success of NY's fisheries depends on the ability of marine animals to successfully calcify.



Effects of past, present, and future ocean carbon dioxide concentrations on the growth and survival of larval shellfish

Stephanie C. Talmage and Christopher J. Gobler¹

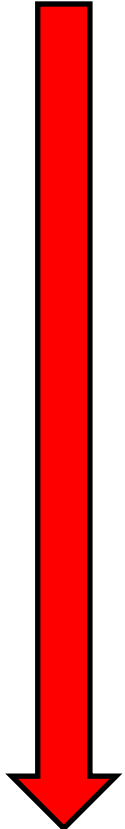
School of Marine and Atmospheric Sciences, Stony Brook University, Southampton, NY 11968



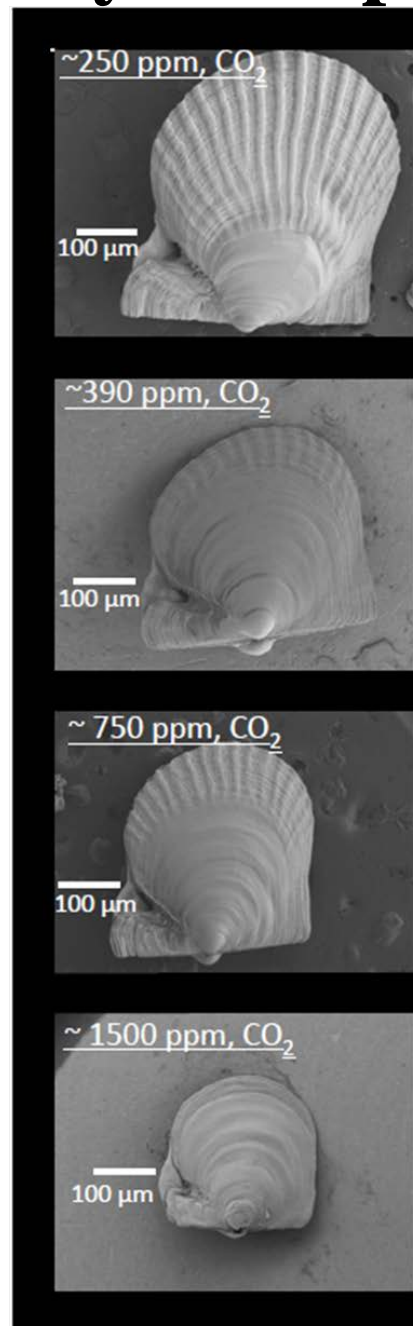
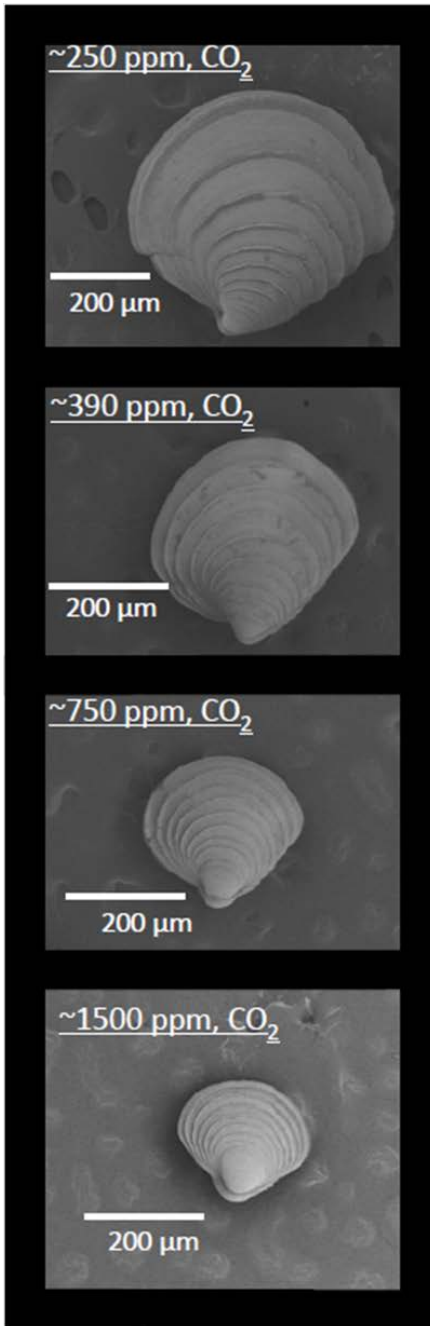
Hard clam

Bay scallops

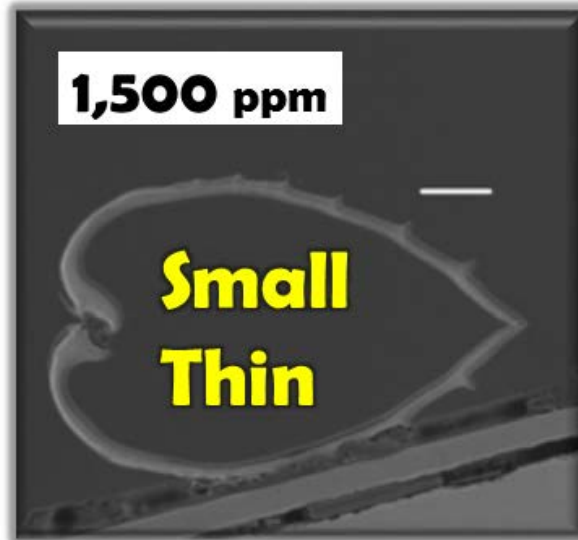
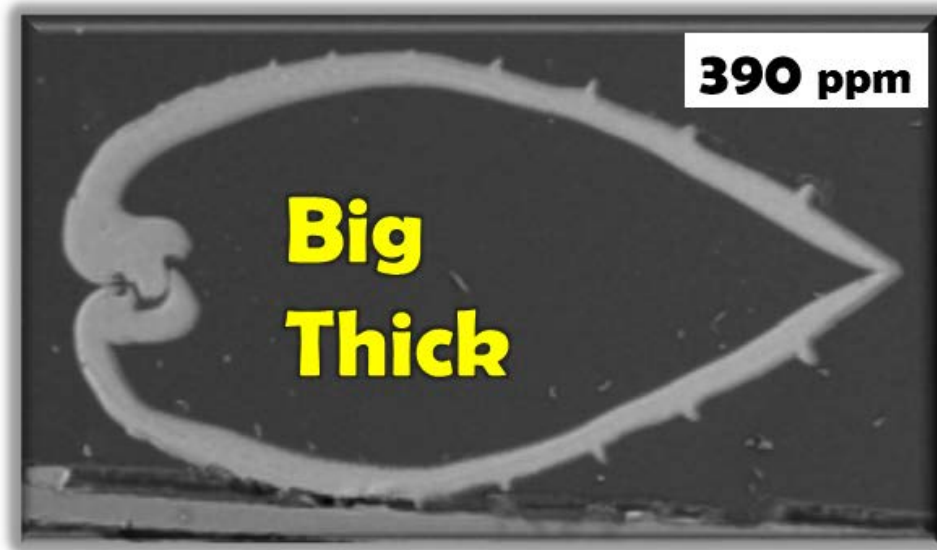
Low CO₂



High CO₂



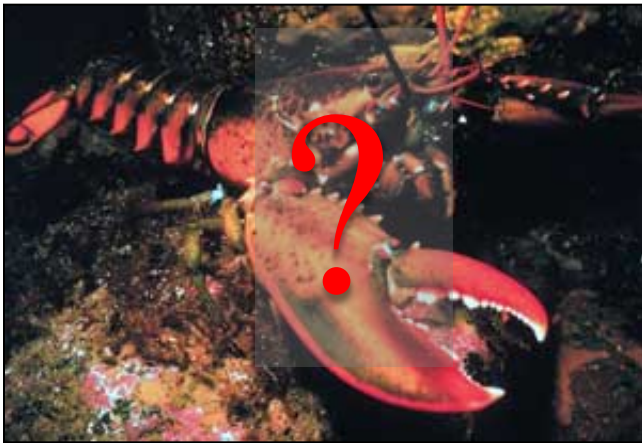
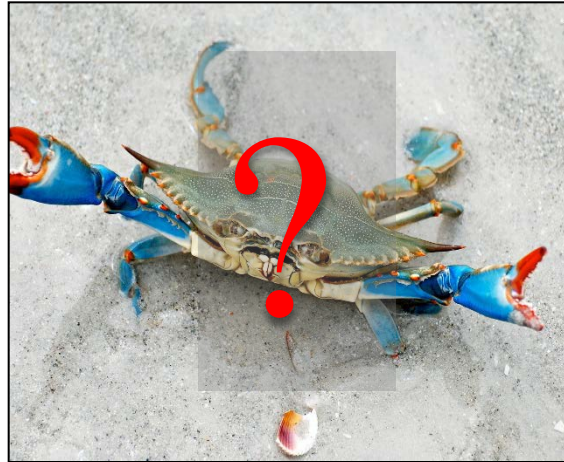
Cross-section of juvenile clams



**2 week
exposures**

**Talmage &
Gobler
PNA\$ 2010**

Calcifying shellfish negatively affected by ocean acidification

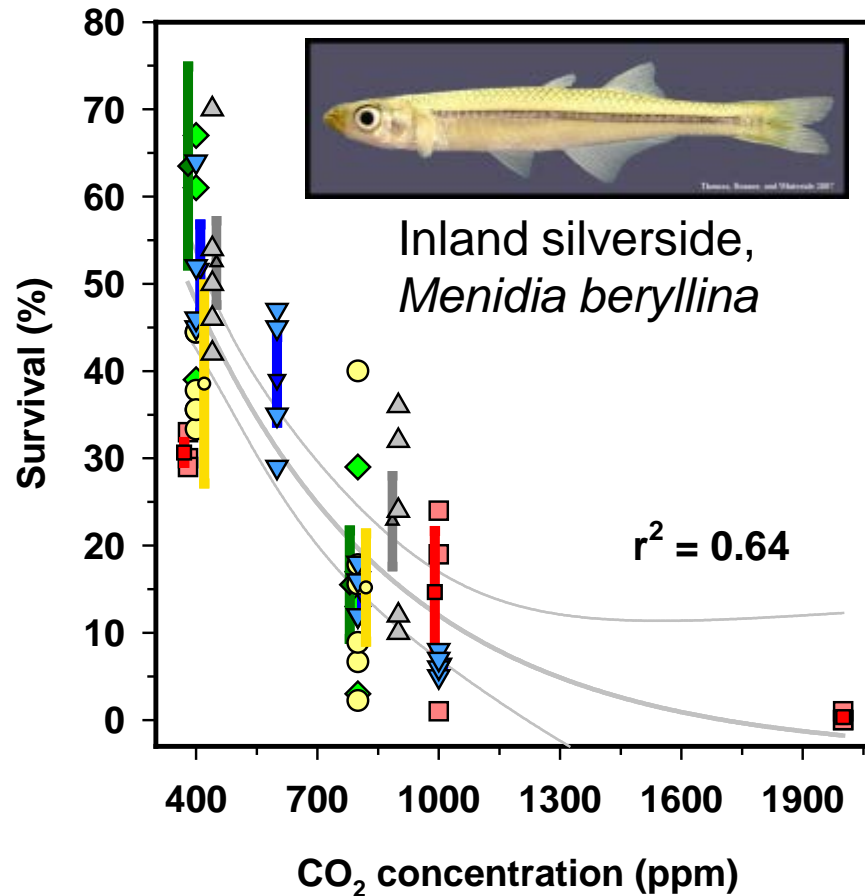


Ocean acidification and fish:
One less thing to worry about?

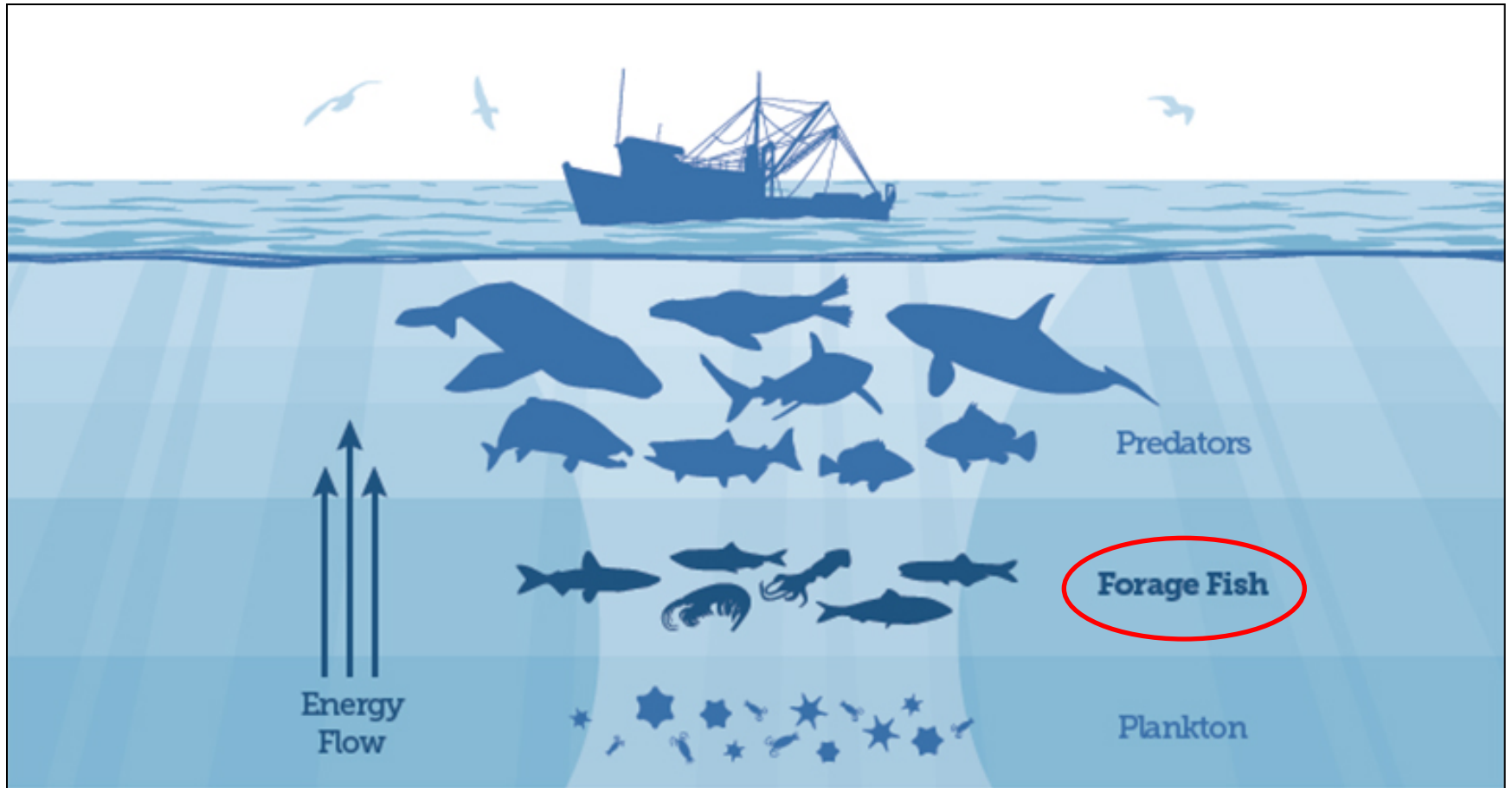


Reduced early life growth and survival in a fish in direct response to increased carbon dioxide

Hannes Baumann, Stephanie C. Talmage and Christopher J. Gobler*



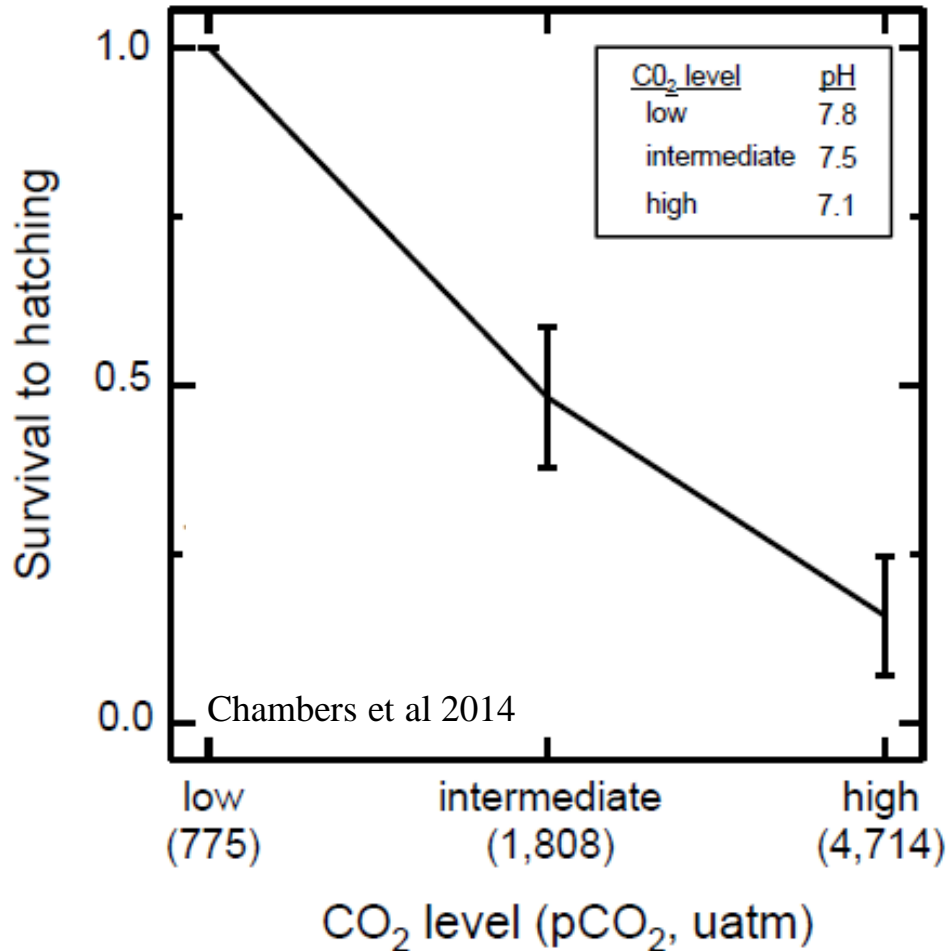
Forage fish: an important energetic link



But the commercial and recreational fish are OK?



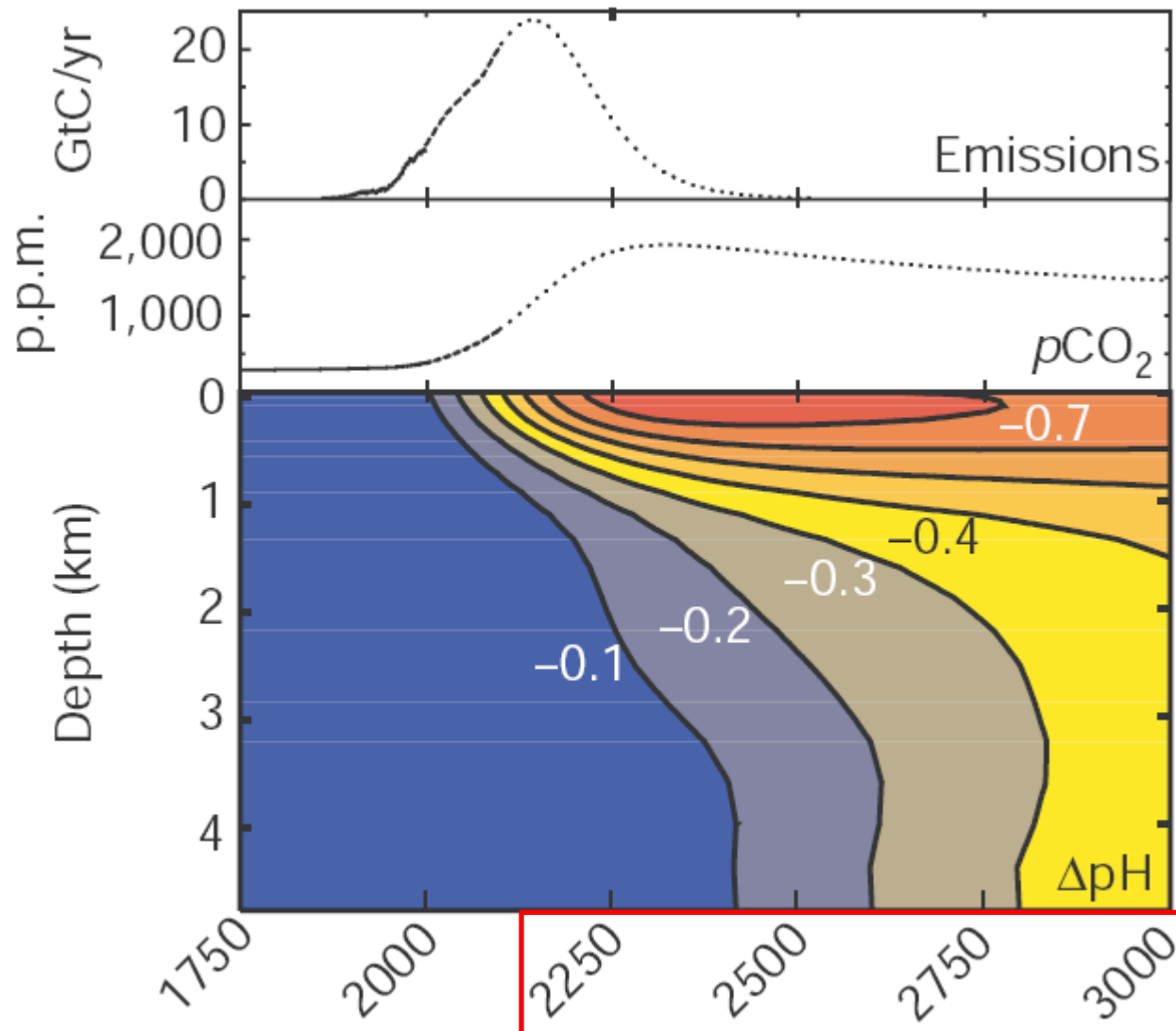
Larval summer flounder are highly vulnerable to OA



US fisheries are valued at >\$5B annually.

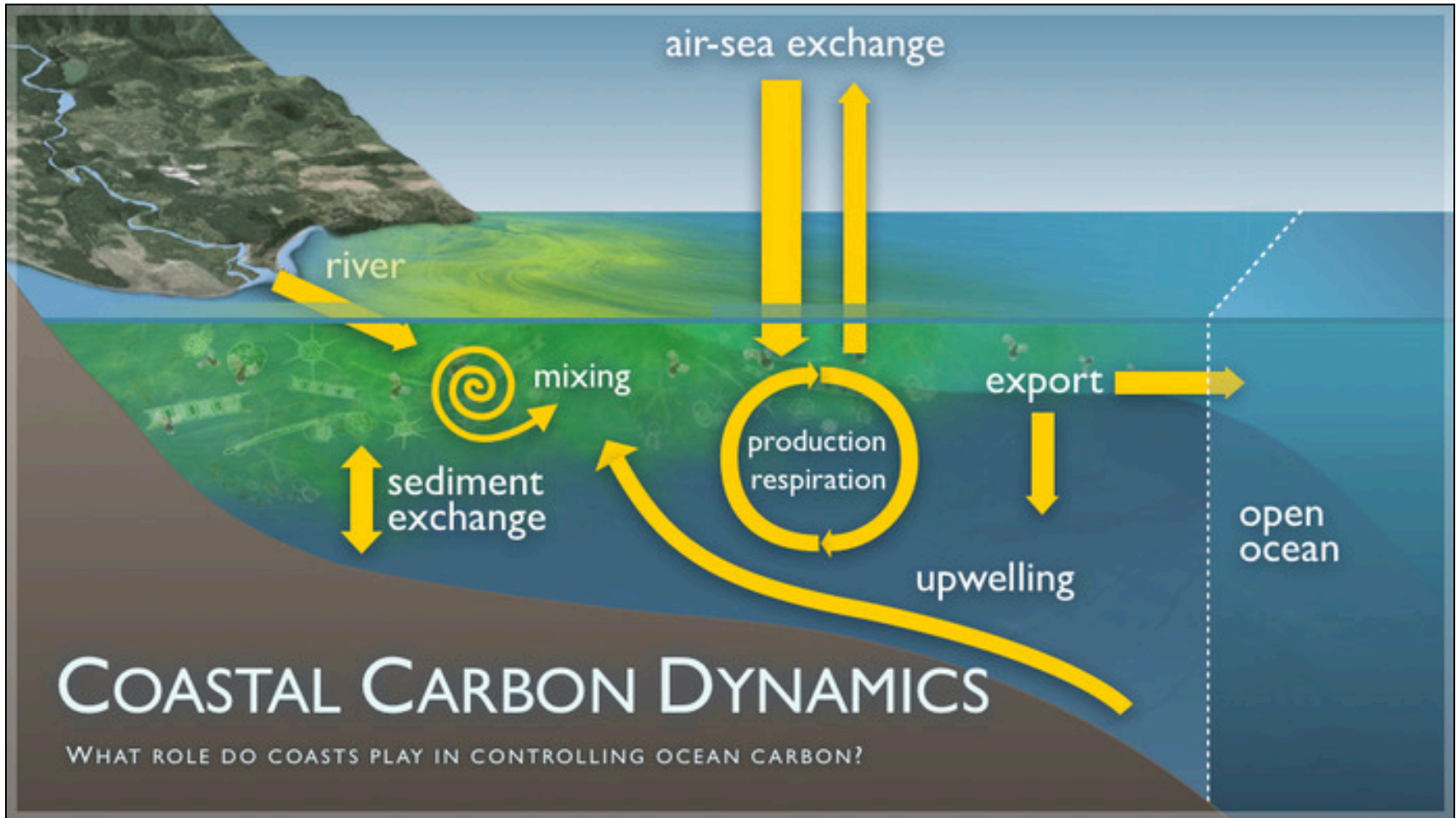
Anthropogenic carbon and ocean pH

The coming centuries may see more ocean acidification than the past 300 million years.

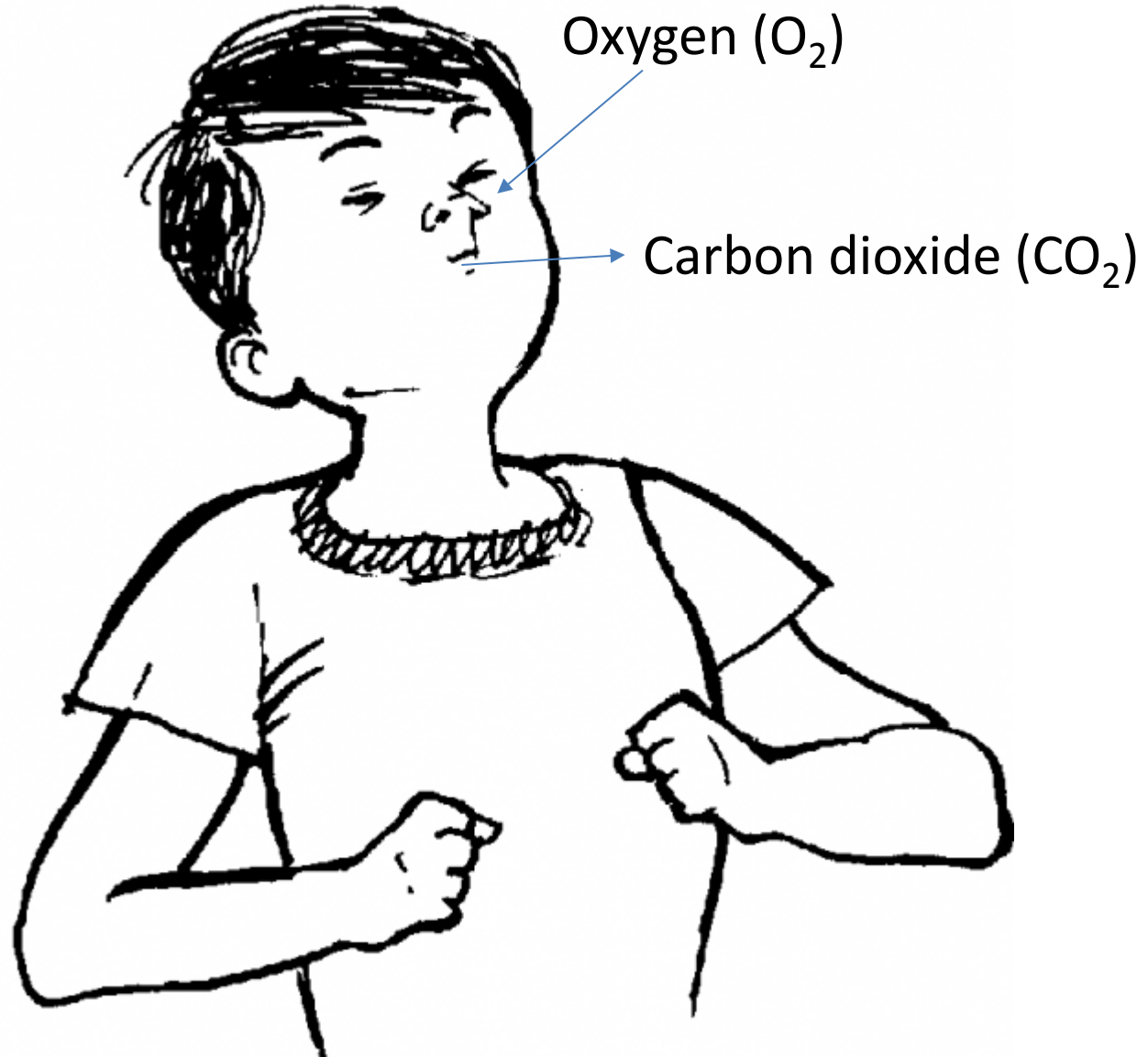


Coastal ocean acidification:

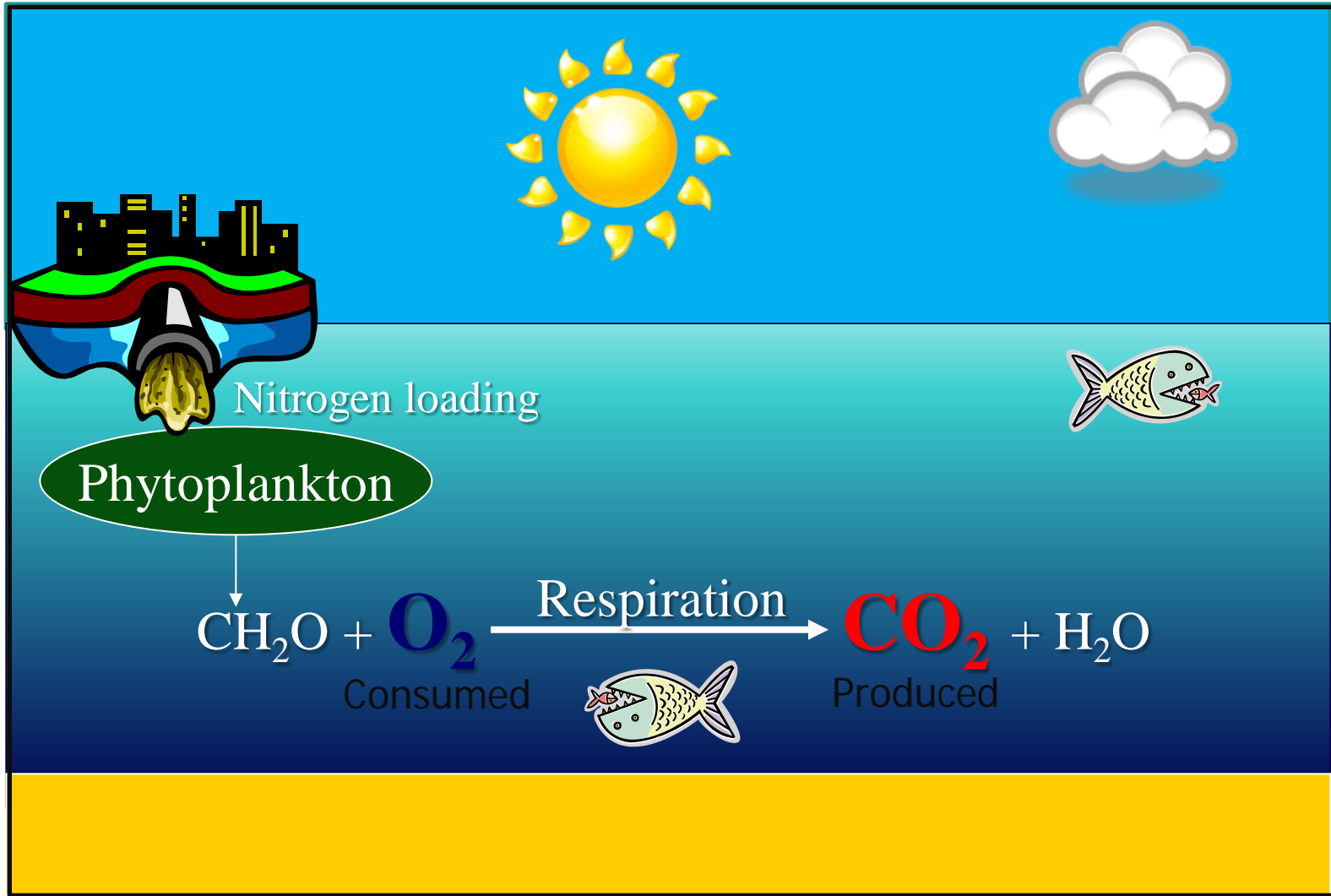
Why wait?



Take a deep breath...



Nitrogen loading leads to low oxygen and high CO₂



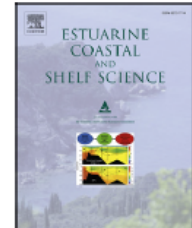
“More algae and warm temperatures during summer make bacteria **hyperventilate**”



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Invited feature

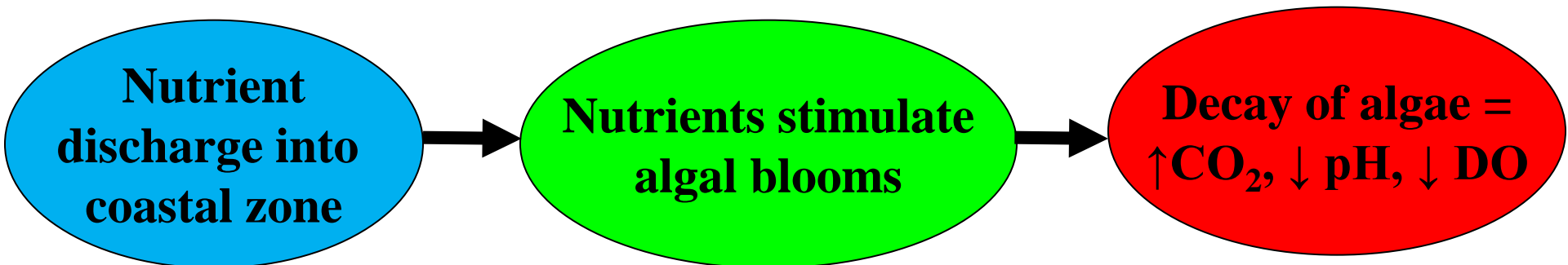
Coastal ocean acidification: The other eutrophication problem



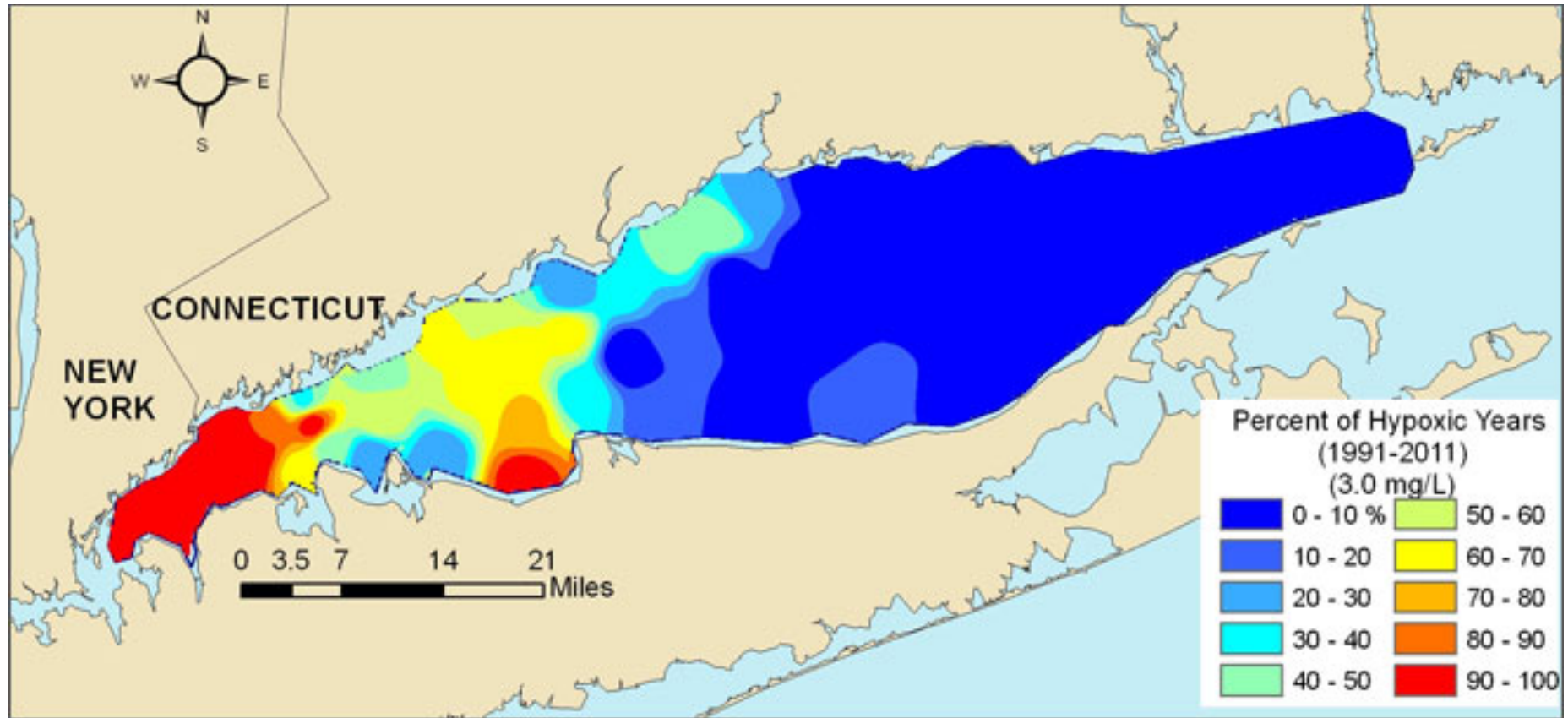
Ryan B. Wallace ^a, Hannes Baumann ^a, Jason S. Grear ^b, Robert C. Aller ^a,
Christopher J. Gobler ^{a,*}

^a Stony Brook University, School of Marine and Atmospheric Sciences, 239 Montauk Hwy, Southampton, NY 11968, USA

^b US Environmental Protection Agency, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, Office of Research and Development, 27 Tarzwell Dr, Narragansett, RI 02882, USA

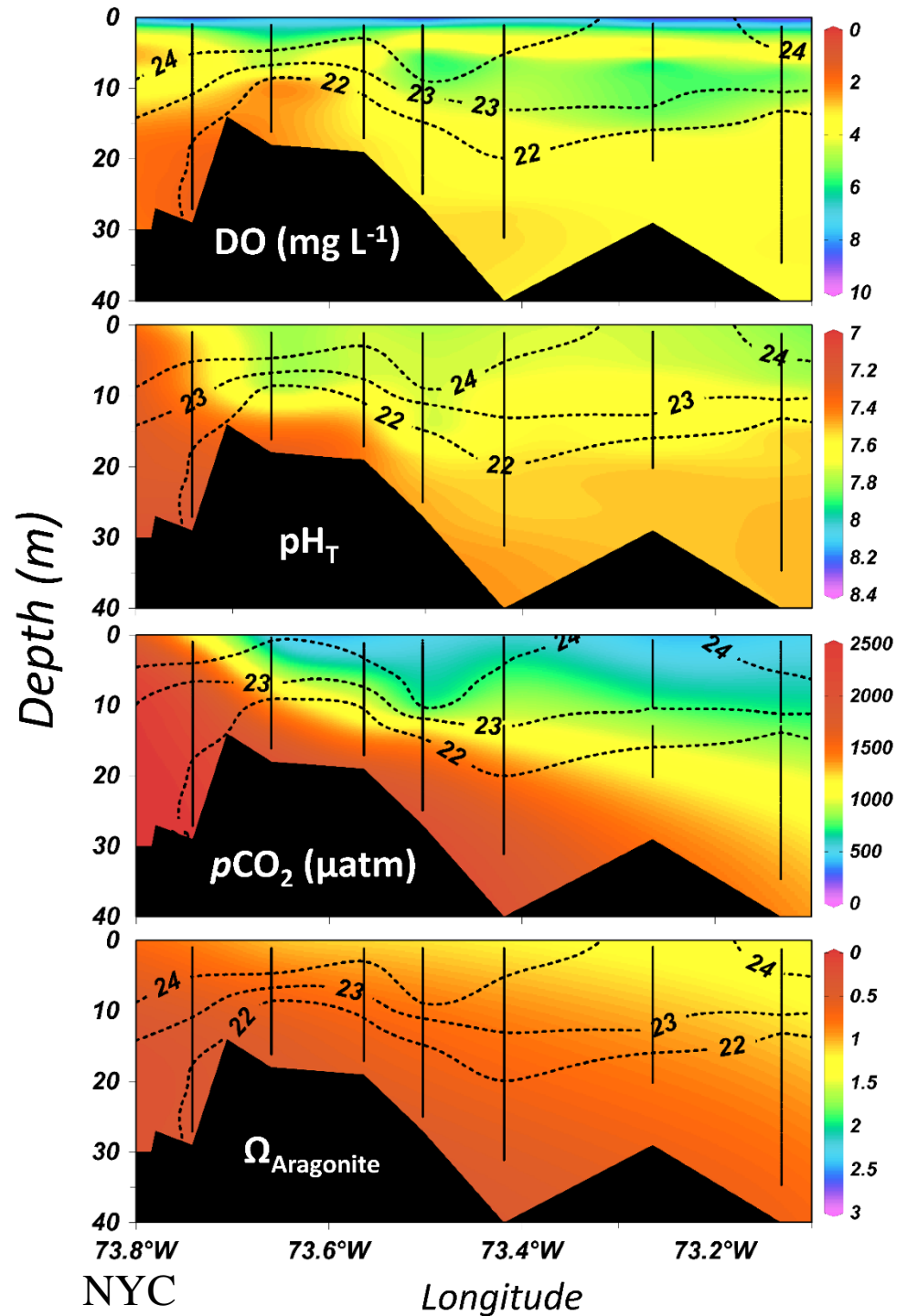


The annual occurrence of hypoxia and acidification in Long Island Sound

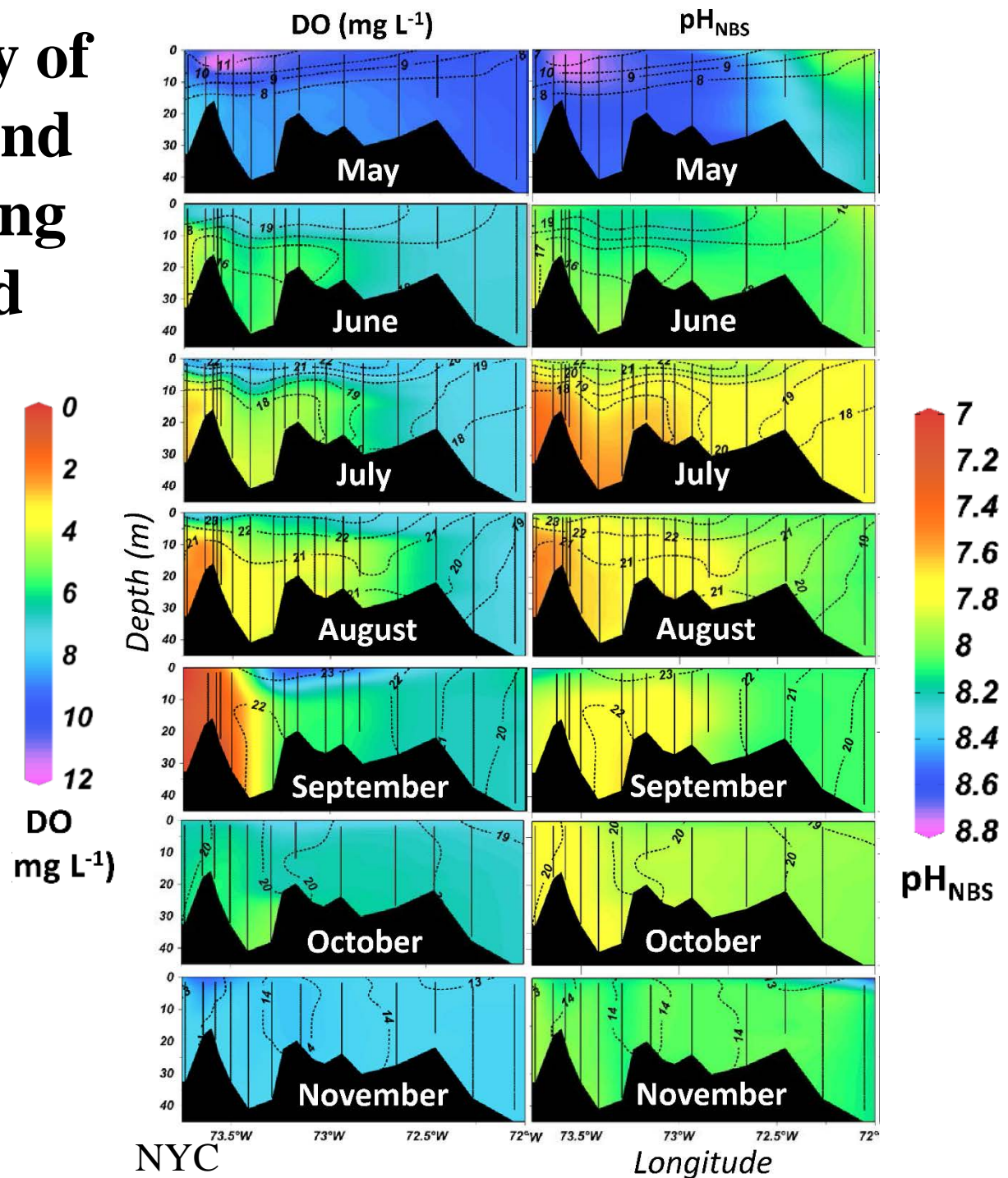


Co-occurrence of low oxygen and acidification in Long Island Sound

The intensity of acidification in Long Island Sound during summer exceeds levels project for the open ocean in 2100.

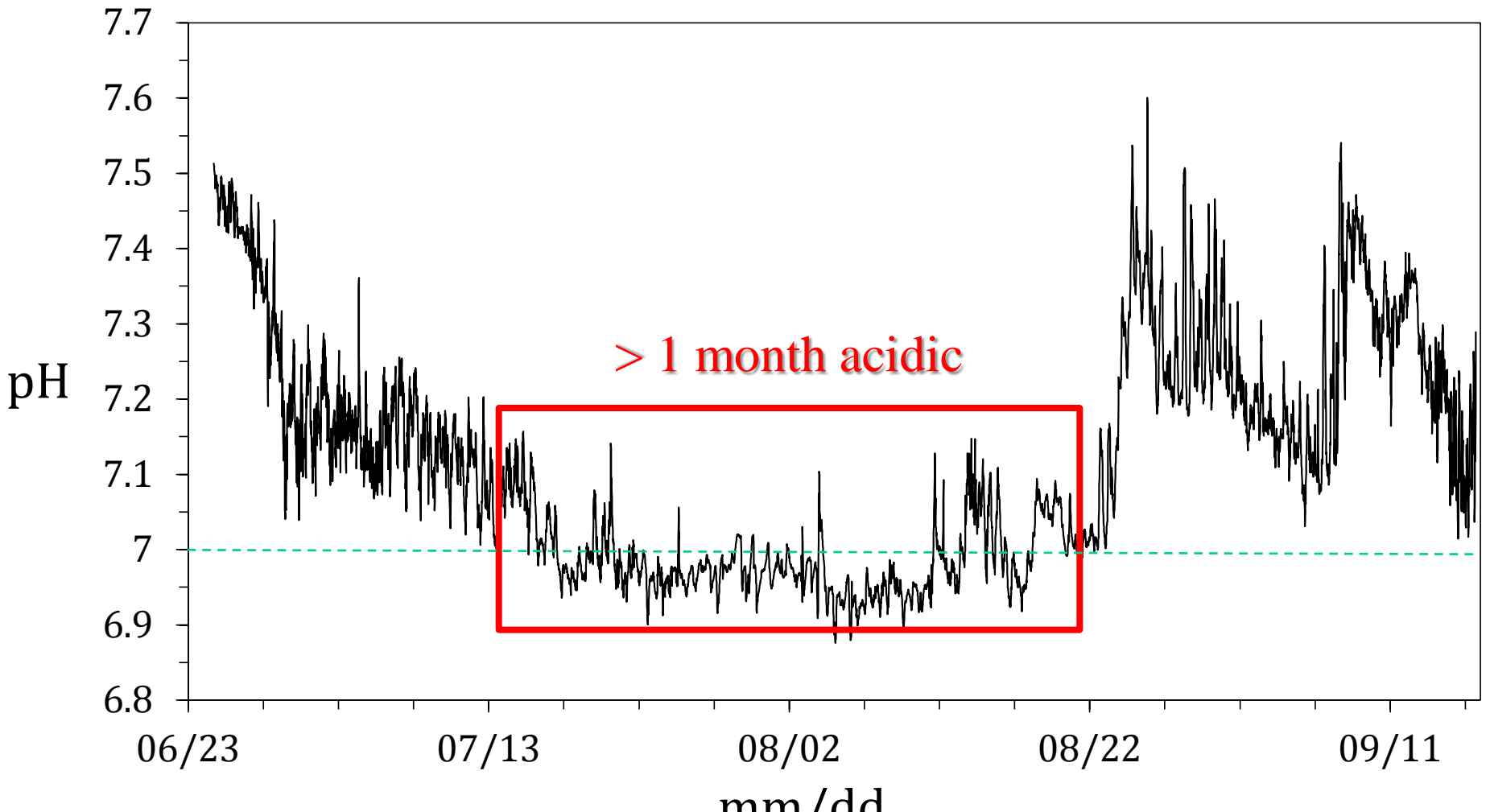


The seasonality of acidification and hypoxia in Long Island Sound

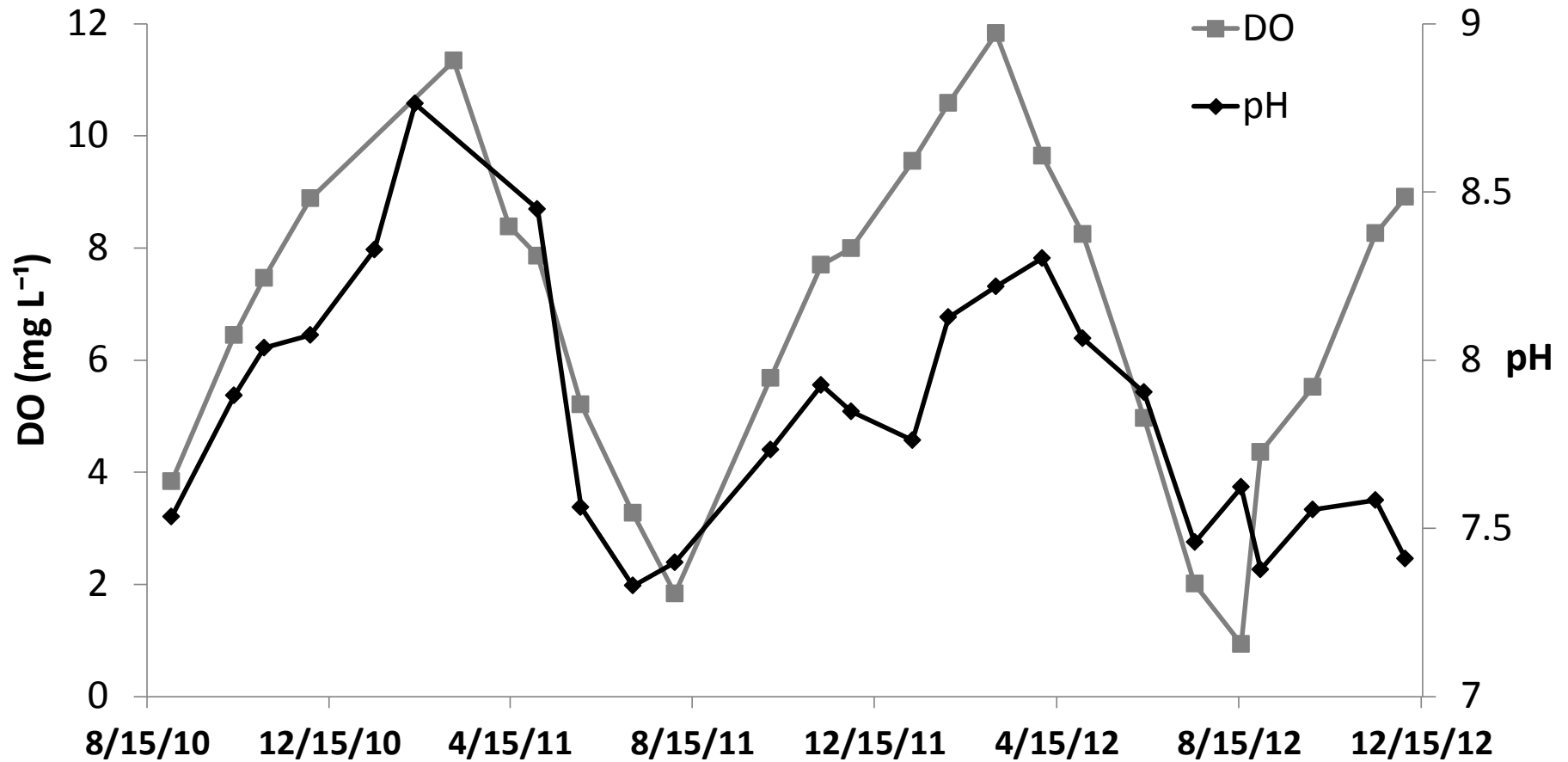



Wallace et al, 2014, ECCS;
CTDEEP data set

Temporal dynamics of acidification, Western Long Island Sound, bottom water pH, 2014



Bottom DO & pH from western LIS (st. A4)

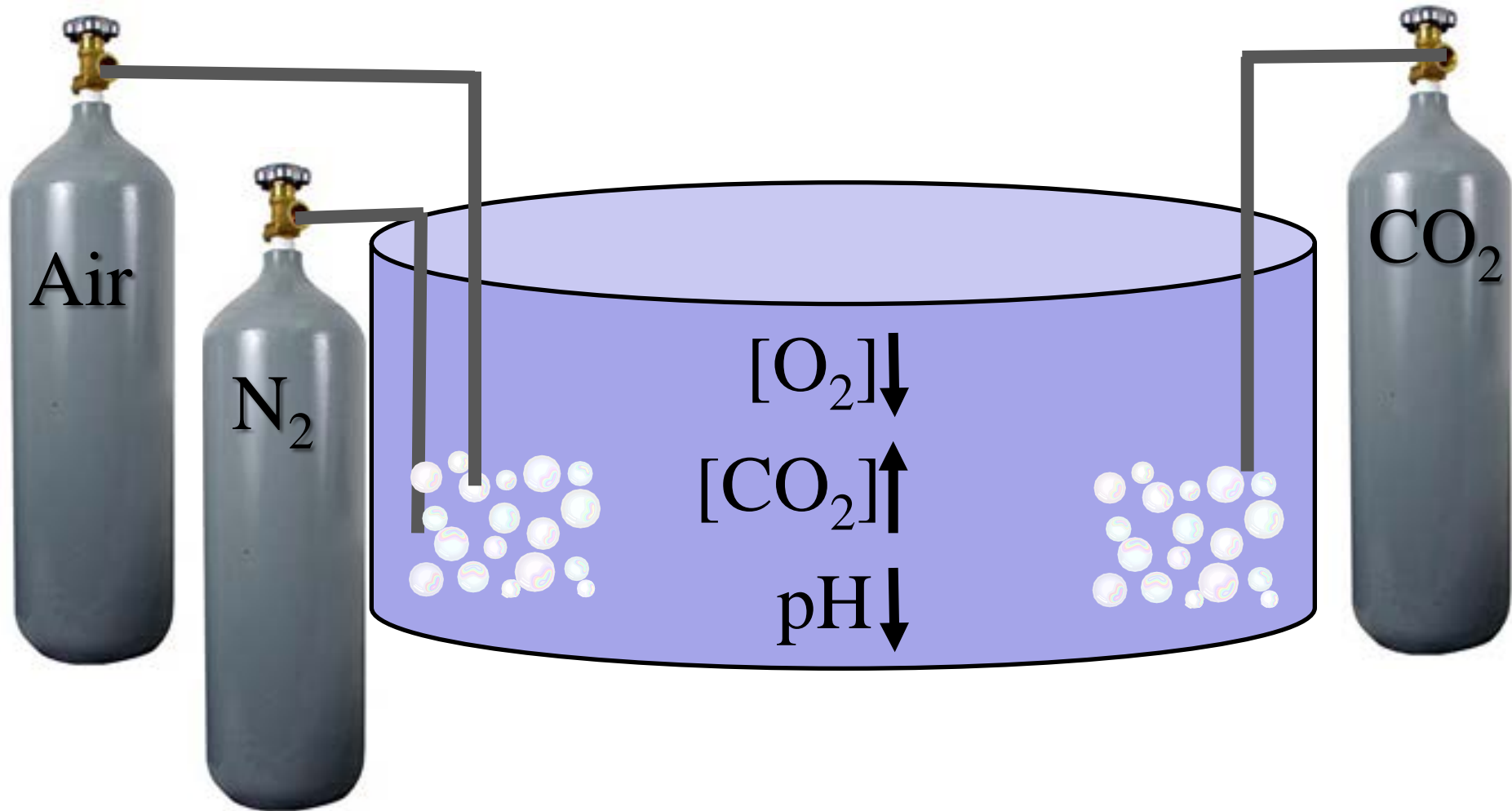


A fisherman in a boat is handling a large metal cage filled with crabs. The fisherman is wearing a blue long-sleeved shirt, orange overalls, and blue gloves. He is looking up and to the right. Another person in a grey jacket and yellow gloves is visible in the background, also working with the cage. The cage is made of black metal mesh and is filled with crabs. The background shows a cloudy sky and the sea.

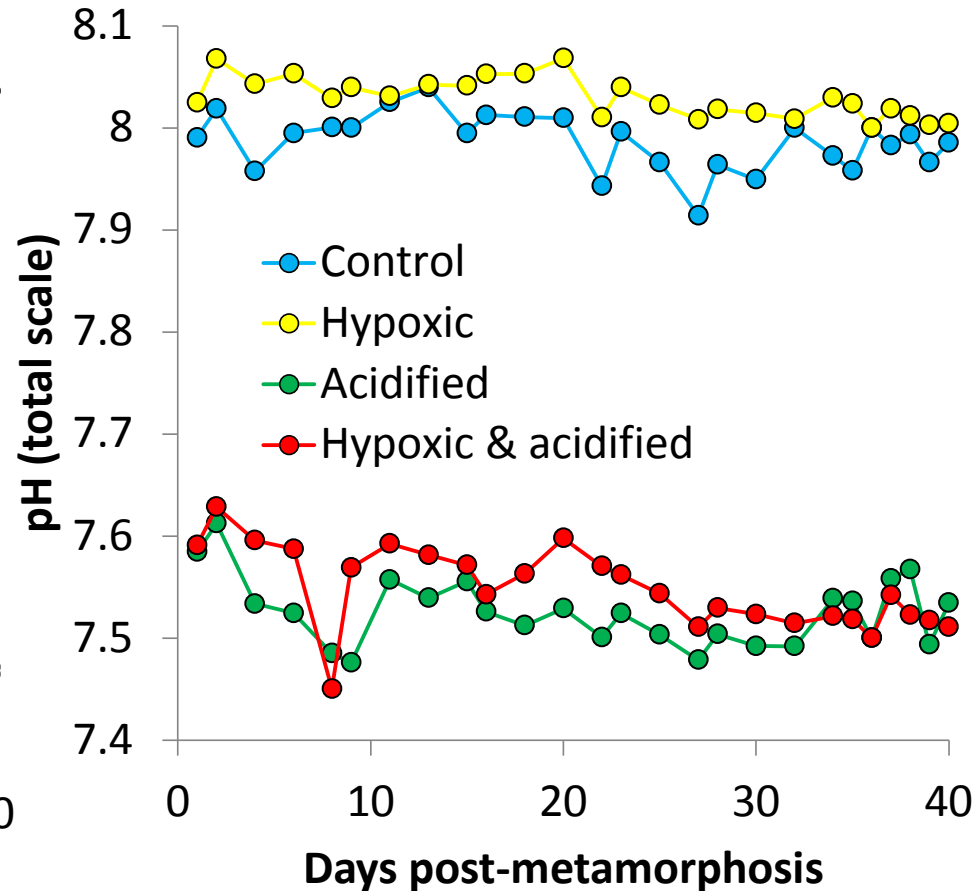
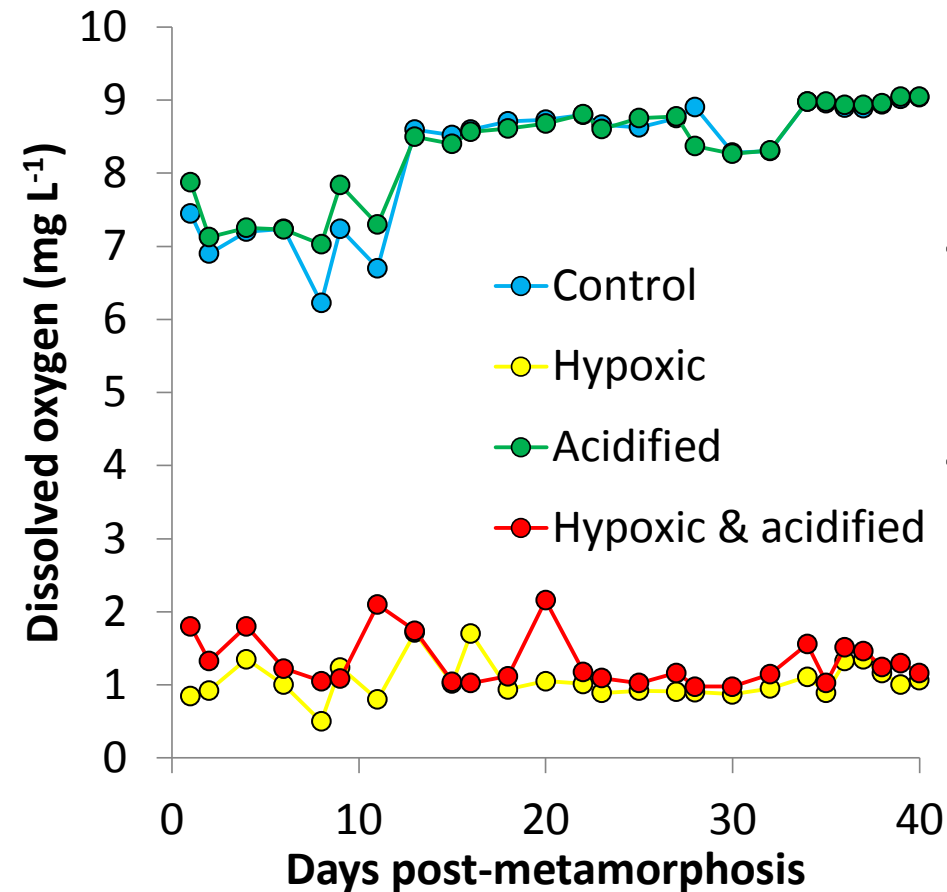
*How does
acidification and
low oxygen effect
marine life?*

Credit: Travis Dove Photography

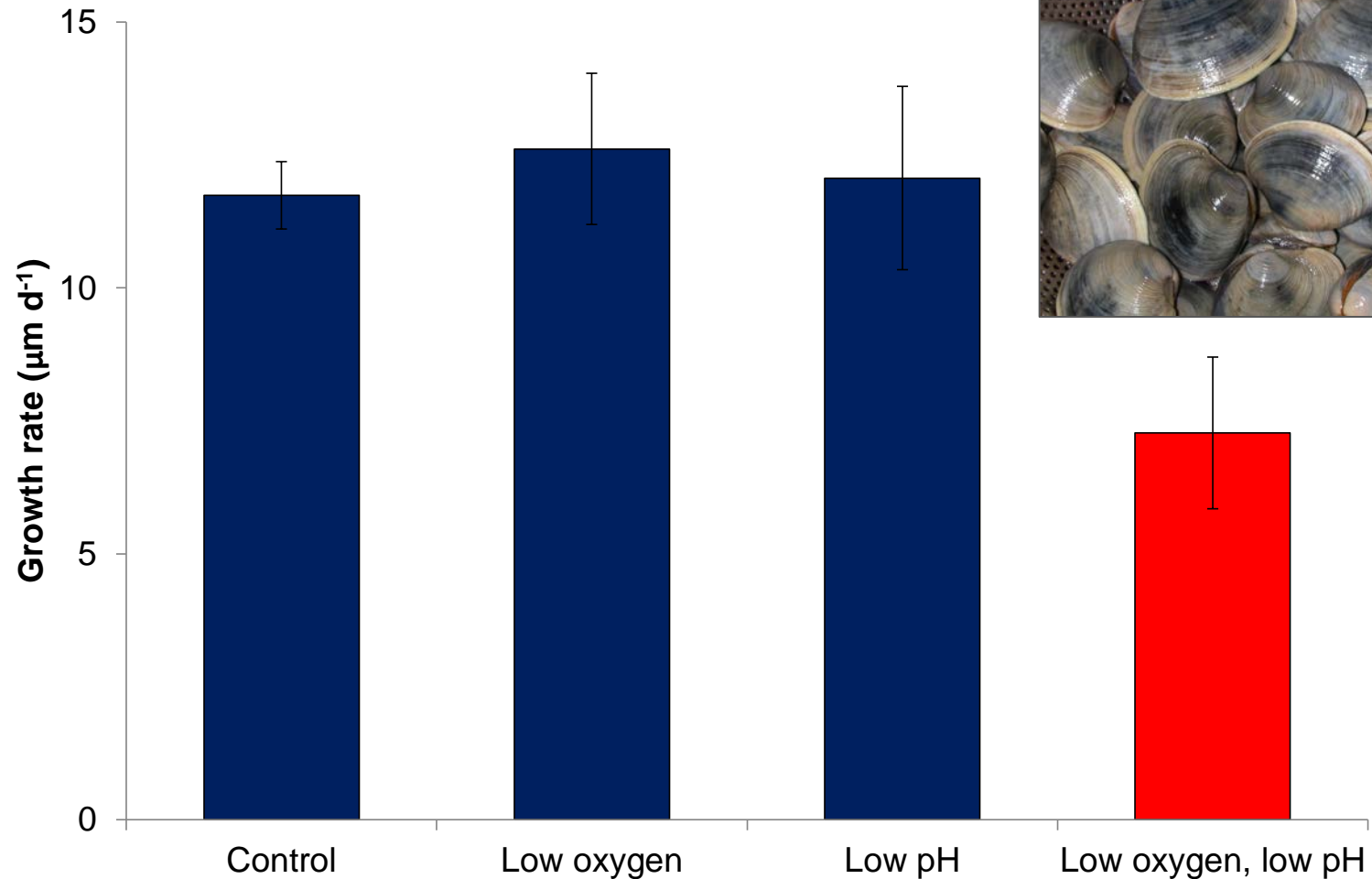
Bubbling with N_2 gas, CO_2 gas, and air to create hypoxic and/or acidified conditions



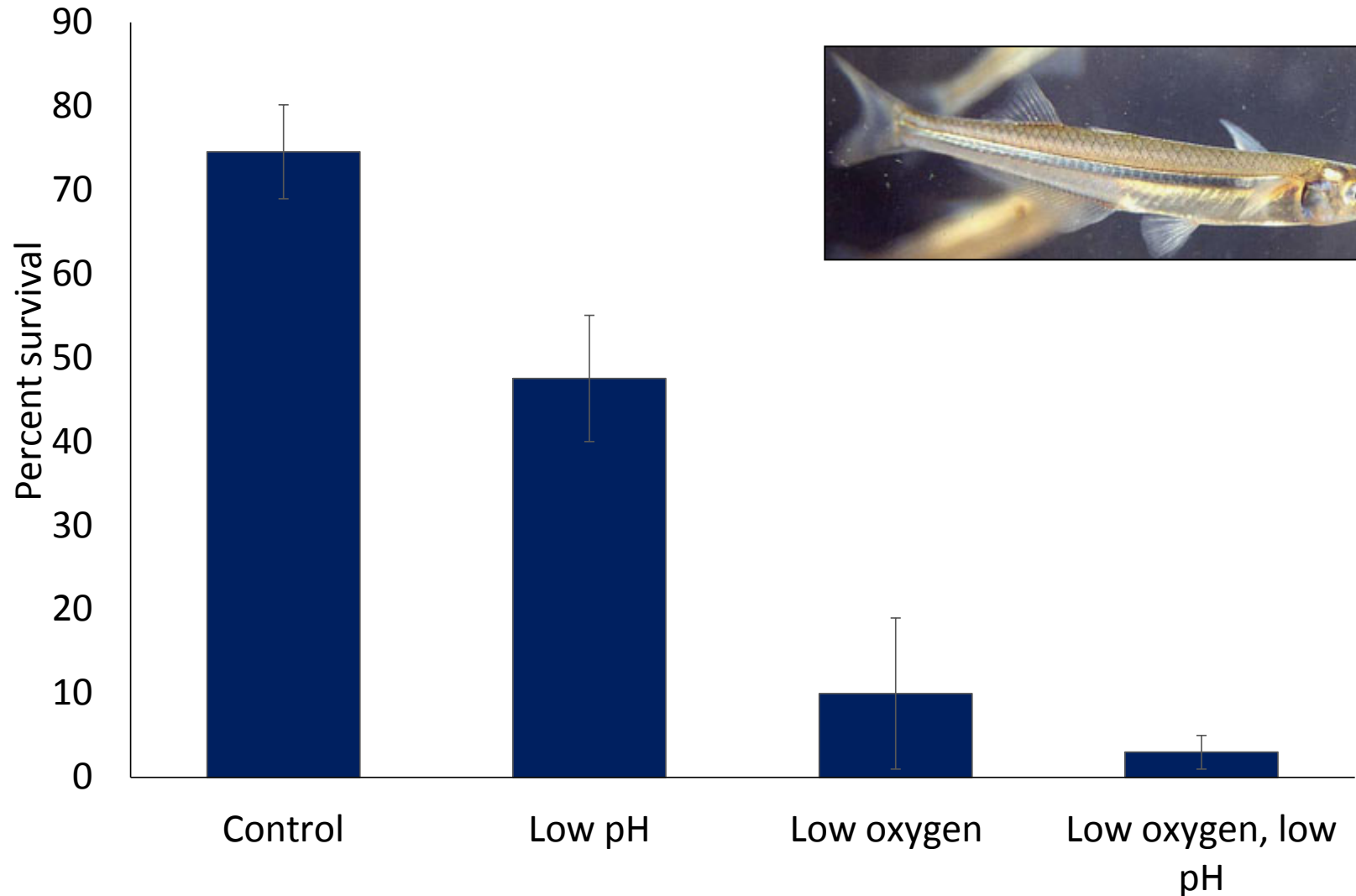
Experimental dissolved oxygen and pH levels achieved via mixtures of N₂, CO₂, and air



Growth of juvenile hard clams (4 months old) exposed to low oxygen and acidification

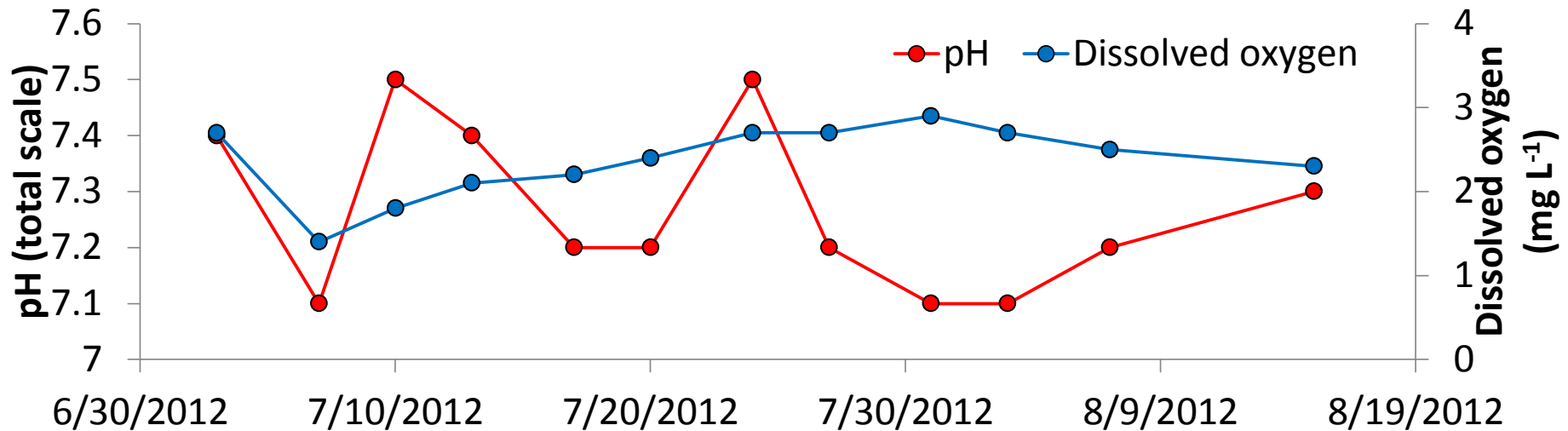


Survival of larval silversides exposed to low oxygen and low pH (acidification)

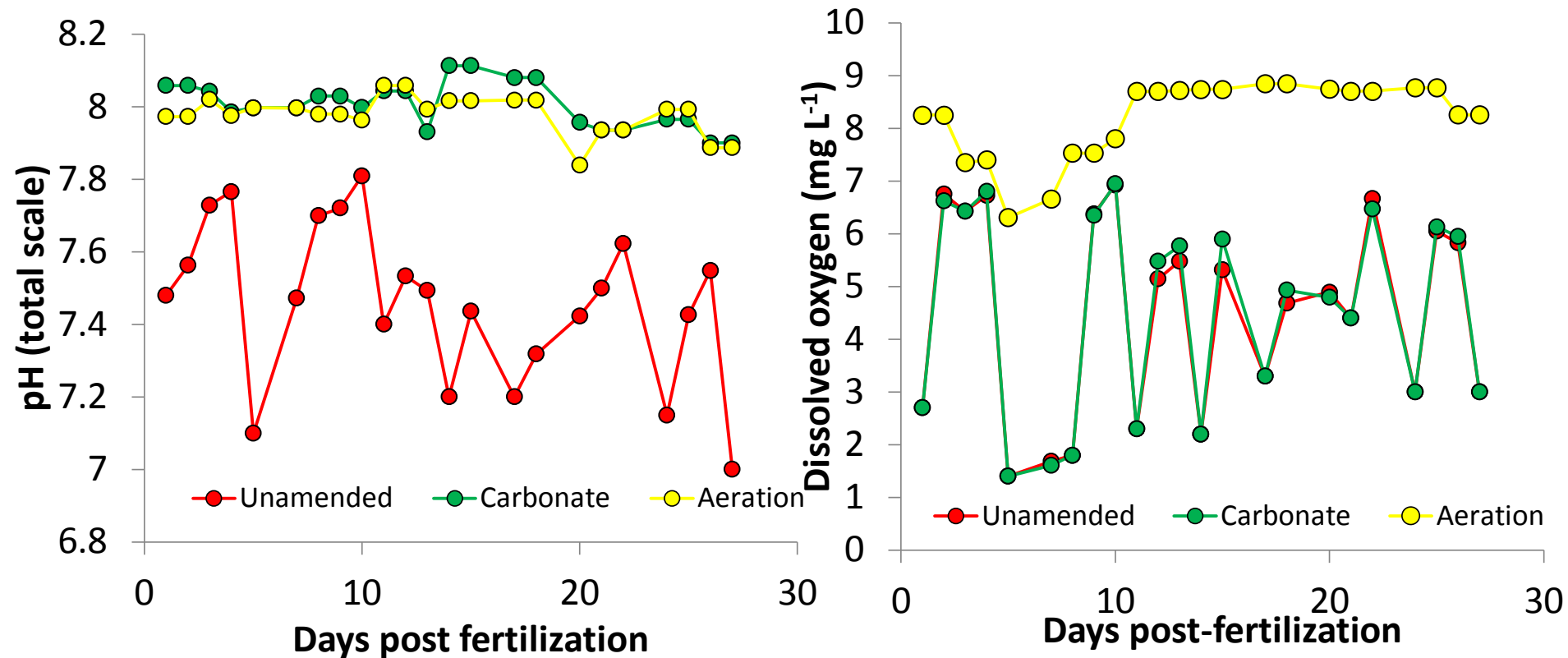


Are there effects in an ecosystem setting?

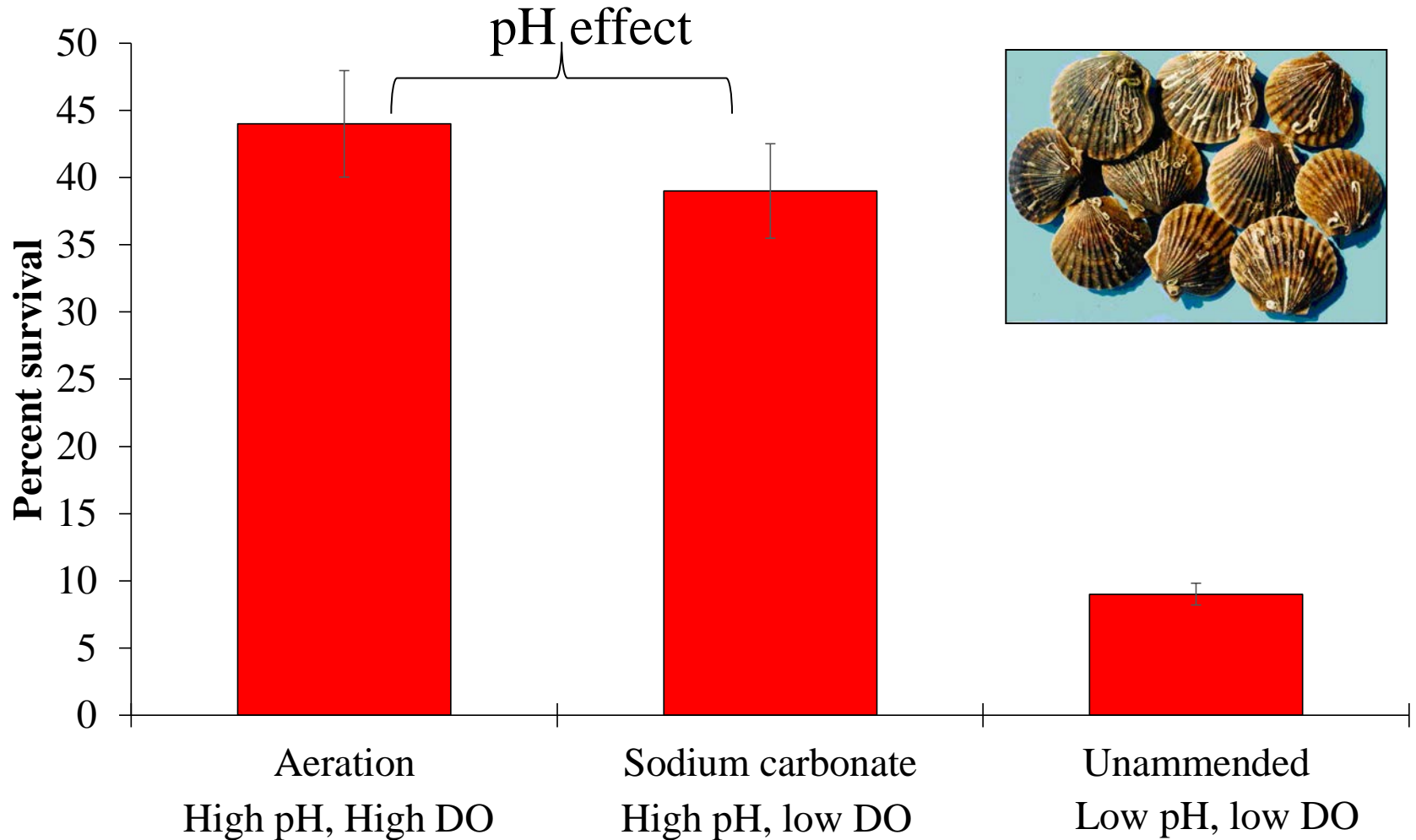
The Forge River, NY, USA



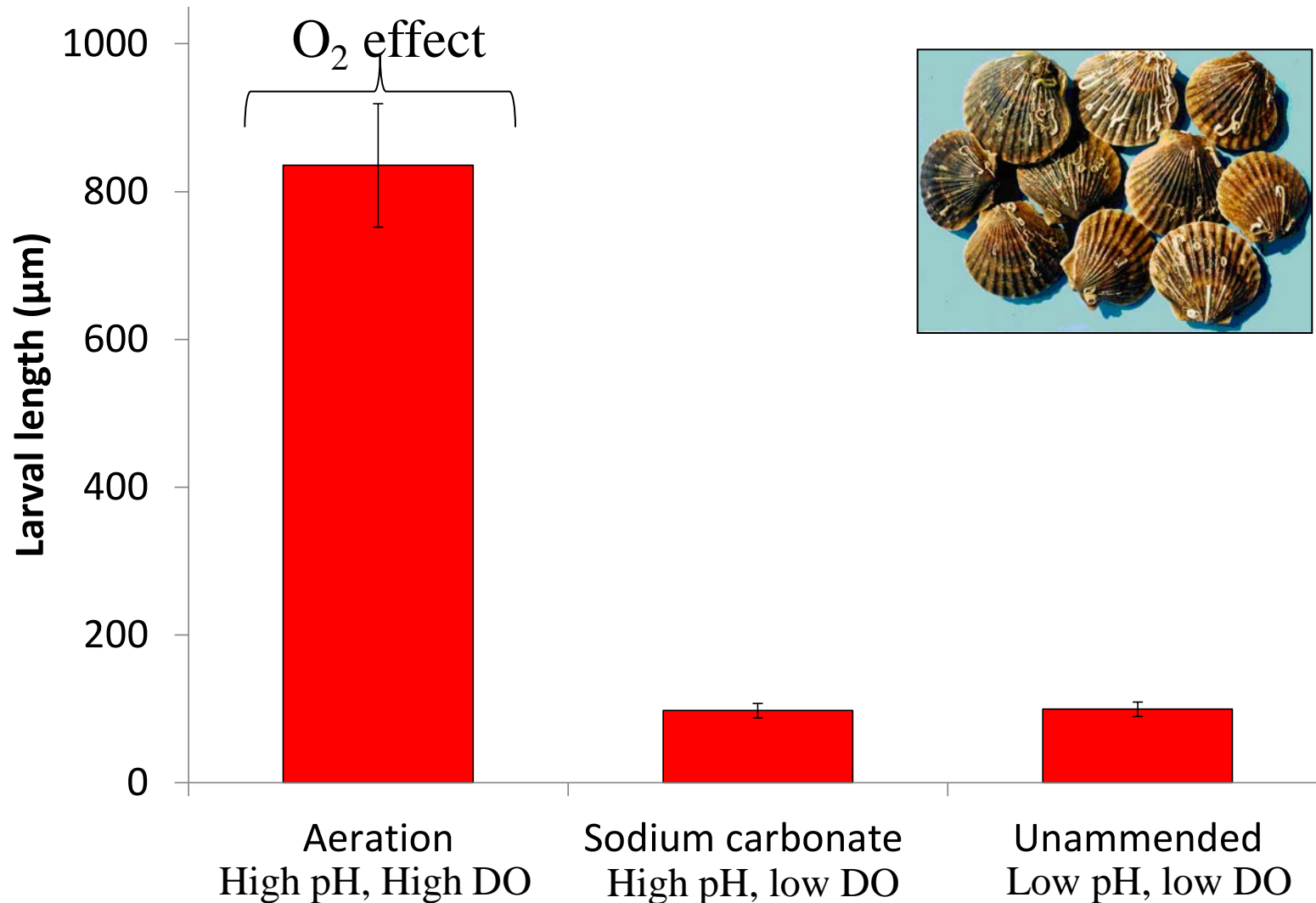
Amending hypoxic and acidified water via sodium carbonate addition and aeration







Effects of carbonate and aeration on **survival** bay scallop larvae in hypoxic and acidified water



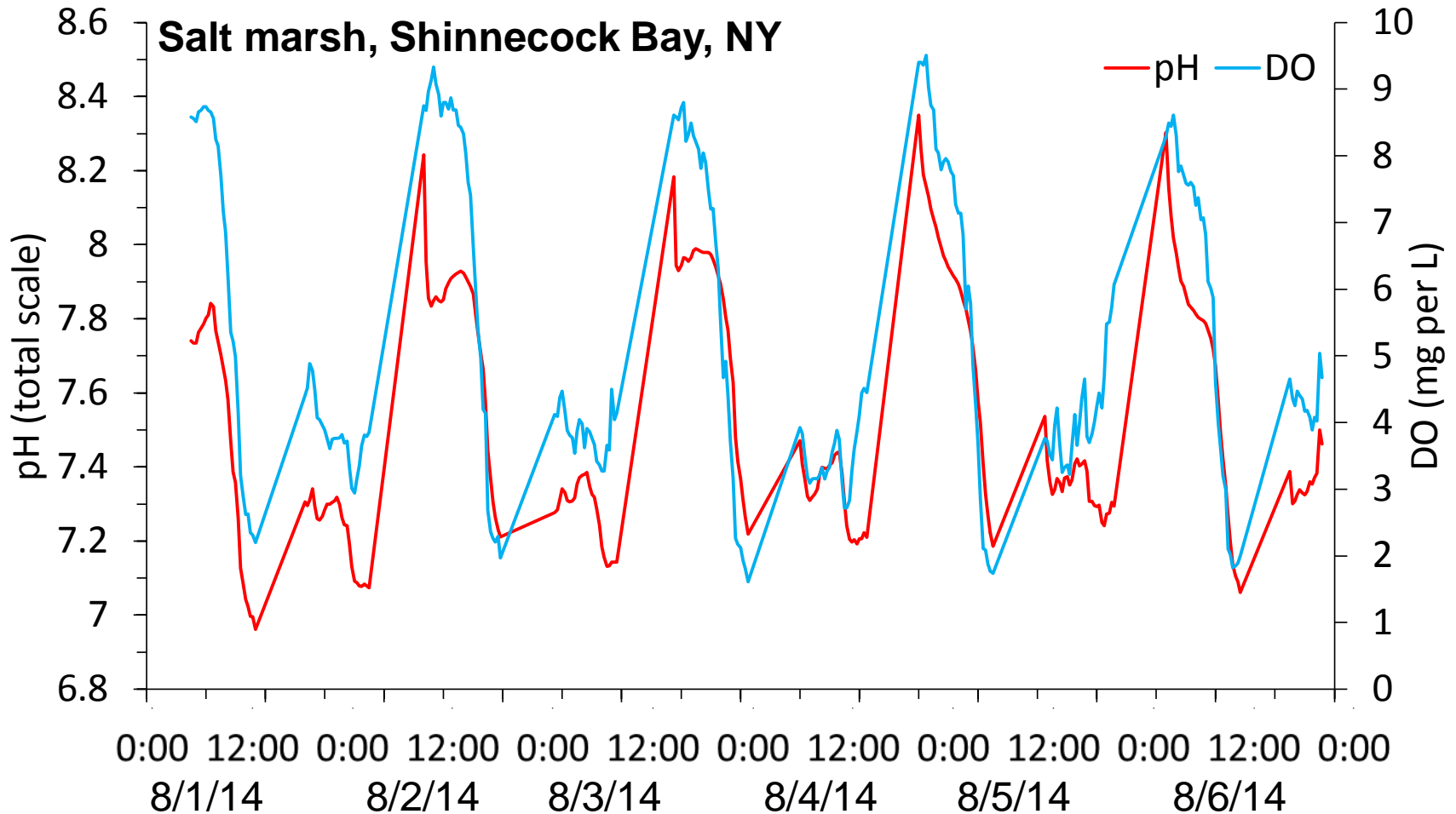
Effects of hypoxia and acidification on **size** of bay scallop larvae



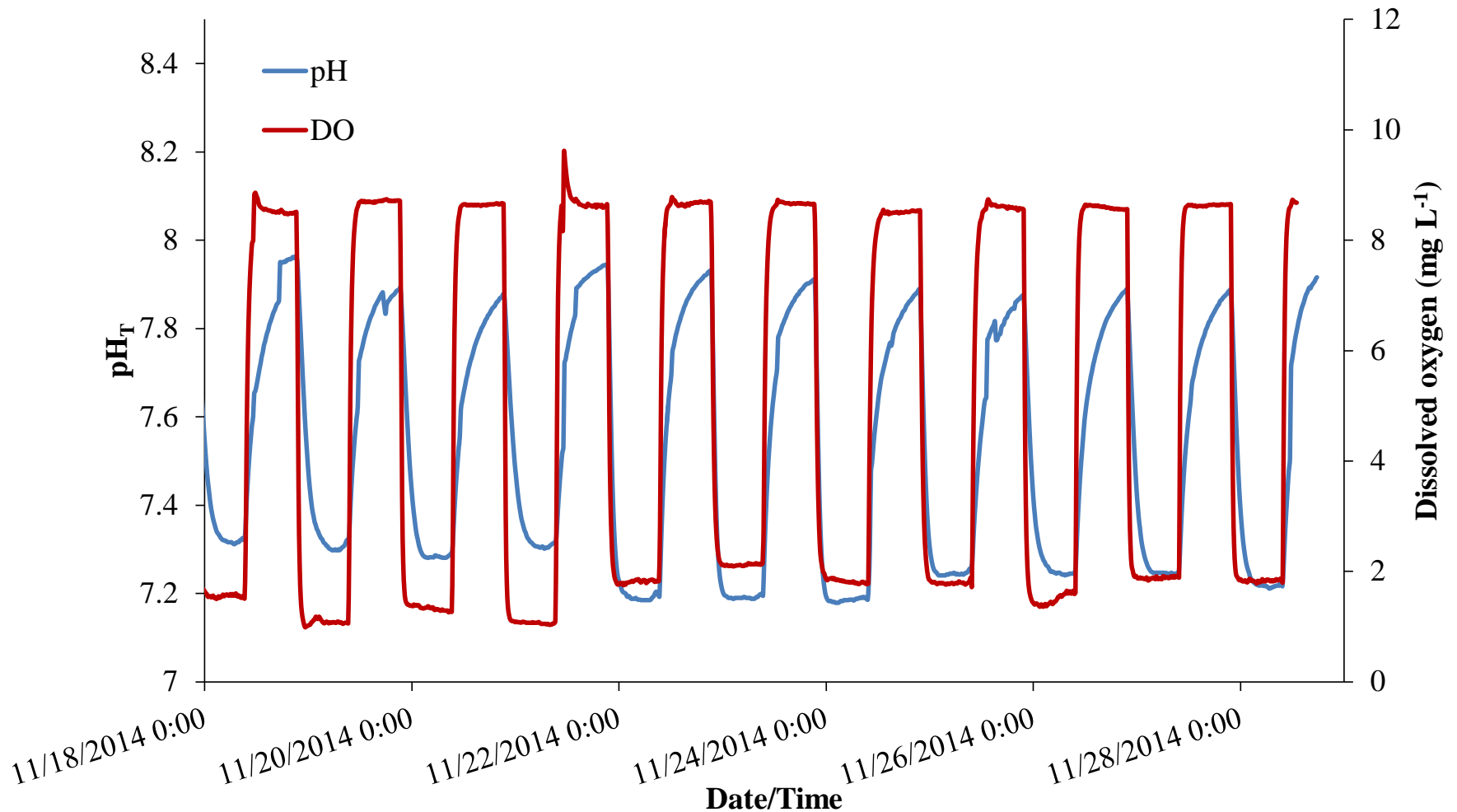
Excessive nitrogen loading leads to hypoxia or low oxygen

<p>Day</p> 	<p>Night</p> 
<p>Photosynthesis produces oxygen Respiration consumes oxygen</p> <p>Oxygen high</p> 	<p><u>No photosynthesis</u> Respiration consumes oxygen</p> <p>Oxygen low</p> 
<p>Sediment</p>	<p>Sediment</p>

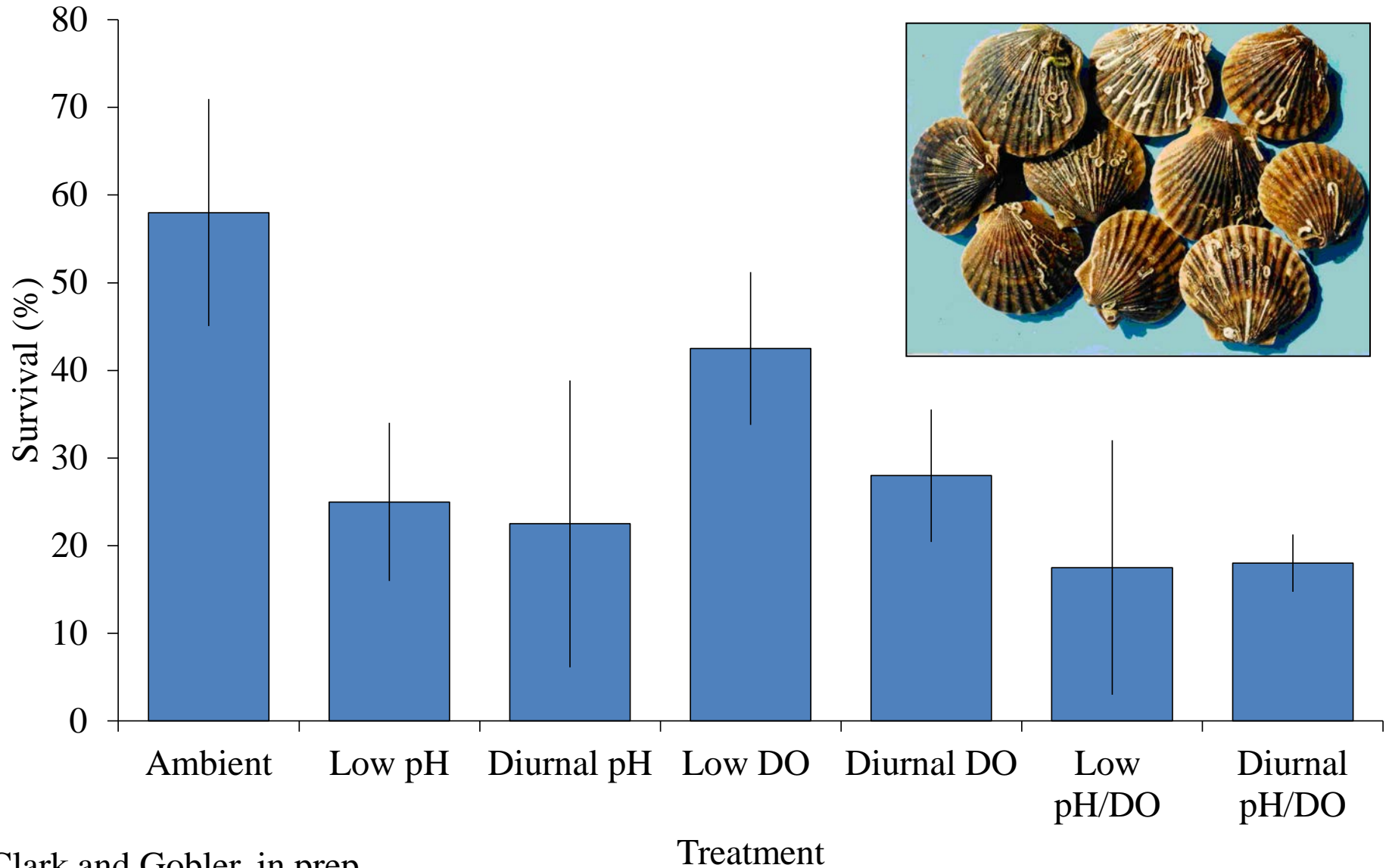
How do diurnal patterns in pH and DO affect marine life?



Experimental patterns in hypoxia and acidification

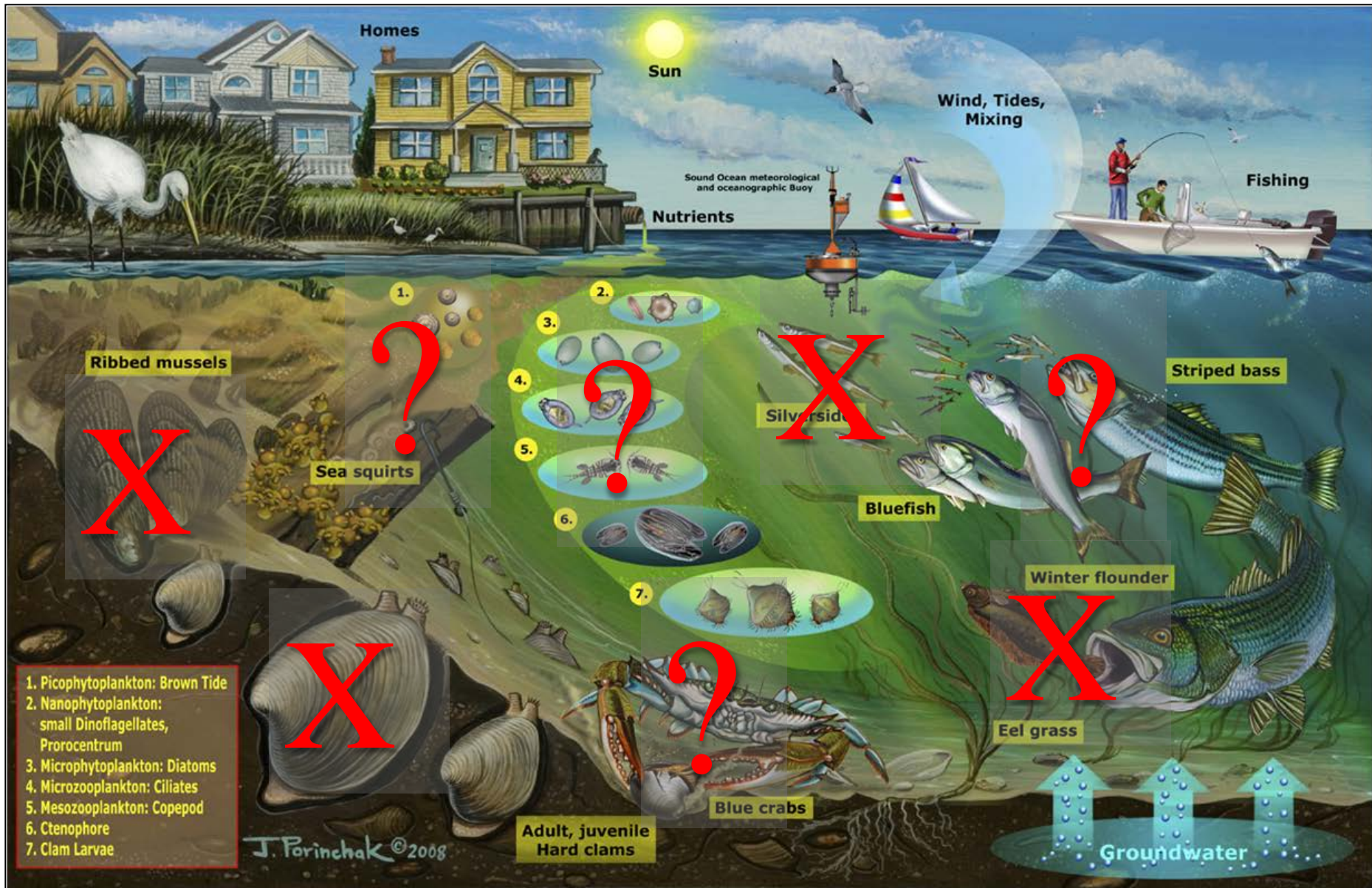


Survival of larval scallops exposed to chronic and diel fluctuations in hypoxia and acidification



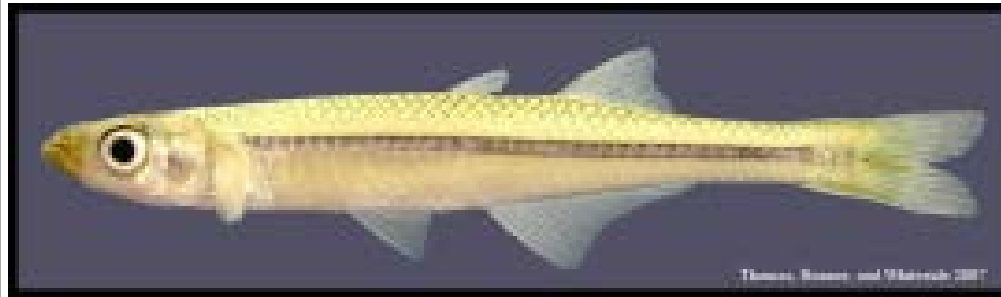
The fate of marine ecosystems under OA?

- complex; many interactions, many unknowns



Conclusions:

- US East Coast estuaries experience hypoxia and acidification during the seasons when early life stage fish and shellfish are spawned and are developing.
- The levels of hypoxia and acidification attained in estuaries can both additively and synergistically depress the growth and survival of multiple early life stage forage fish and bivalves.
- Diurnal fluctuation in acidification and hypoxia provides a refuge for some but not all larval bivalves.



The End