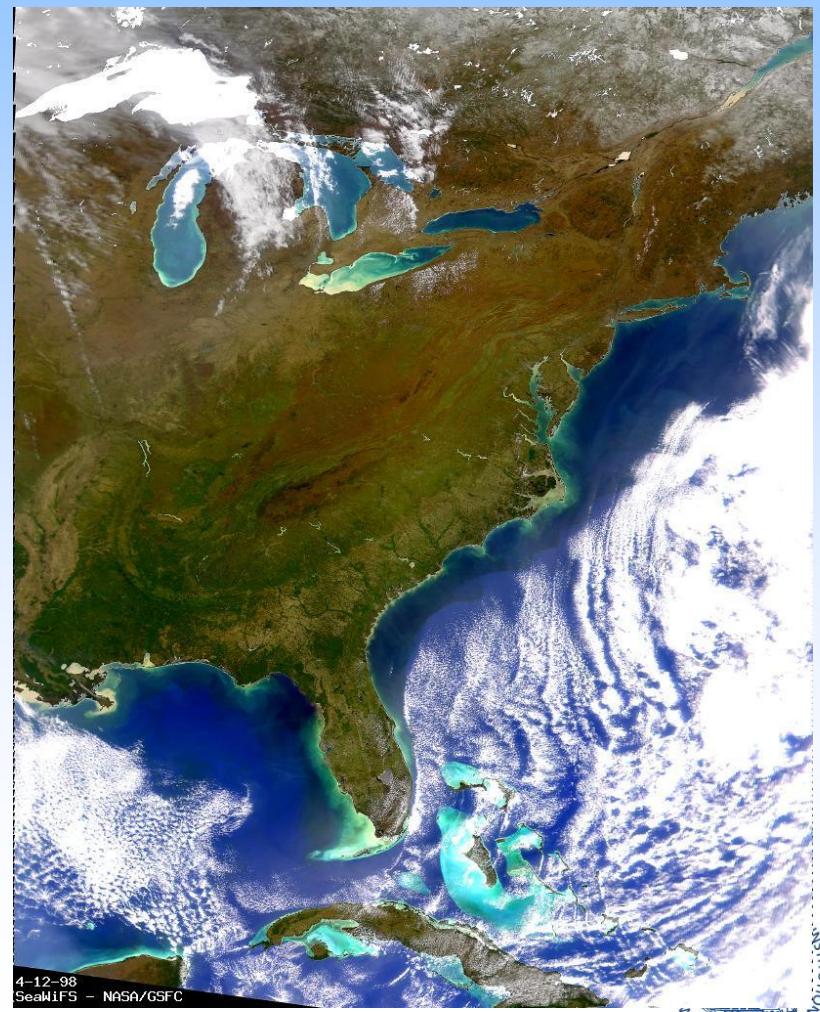
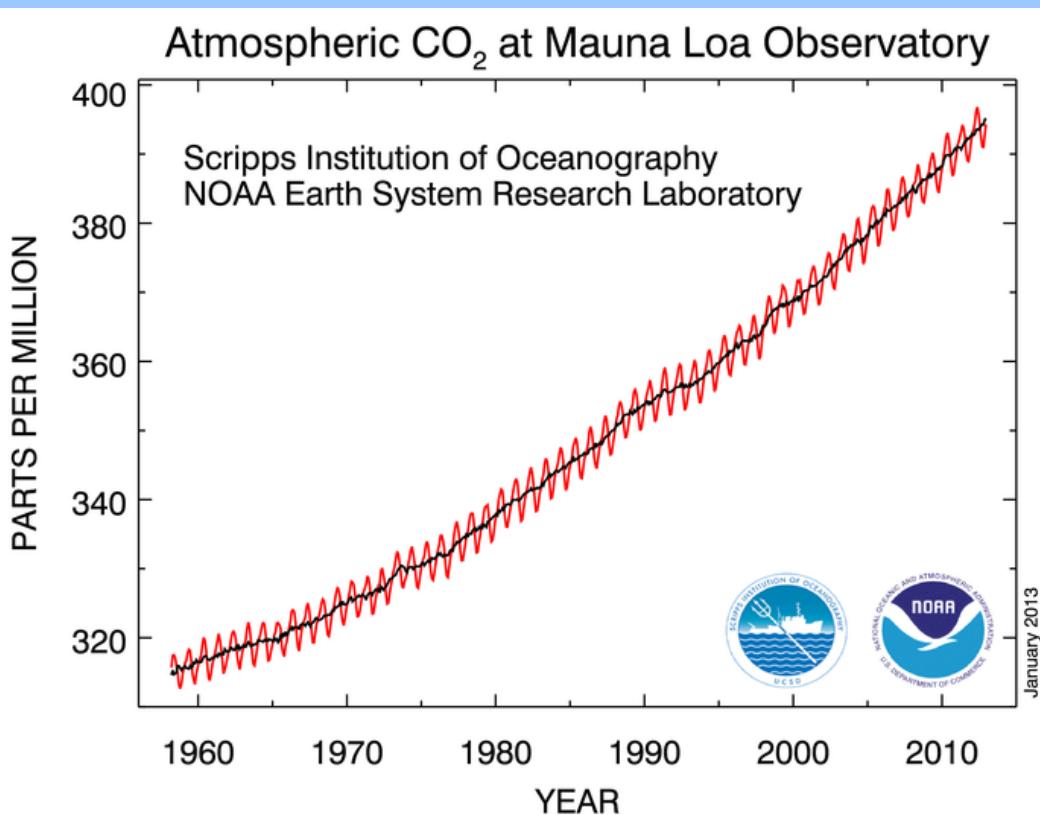


Overview on Ocean Acidification

Casco Bay “Mud Summit” (Jan. 2013)

Casco Bay Estuary Partnership, U. Southern Maine

Scott Doney Woods Hole Oceanographic Institution



Fate of Anthropogenic CO₂ Emissions (2000-2009)

$1.1 \pm 0.7 \text{ Pg C y}^{-1}$



+

$7.7 \pm 0.5 \text{ Pg C y}^{-1}$



$4.1 \pm 0.1 \text{ Pg C y}^{-1}$

Atmosphere

47%



2.4 Pg C y^{-1}

Land
27%

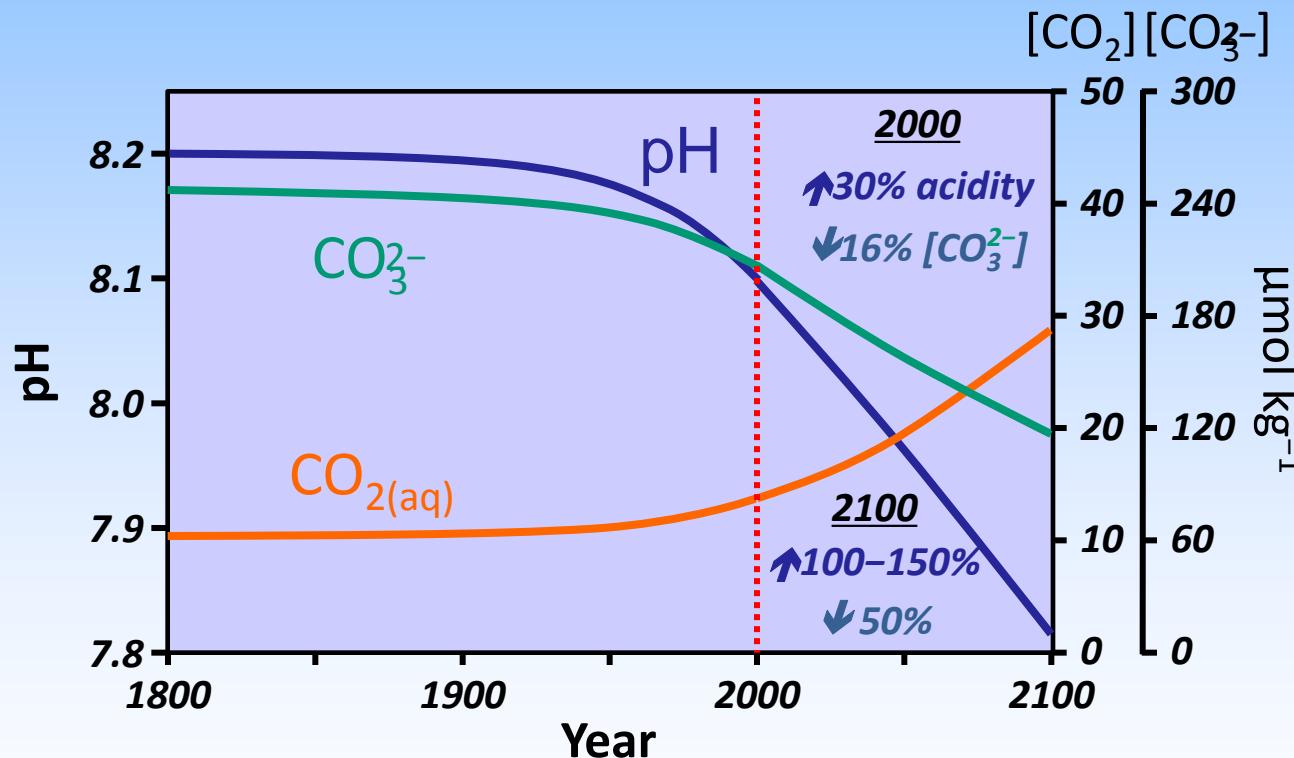
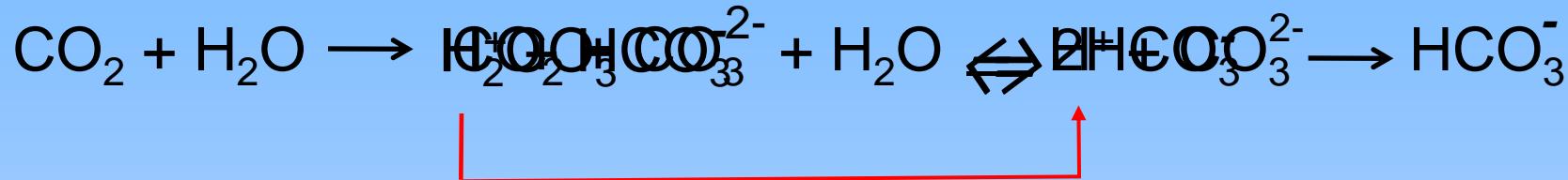


$2.3 \pm 0.4 \text{ Pg C y}^{-1}$

Oceans
26%



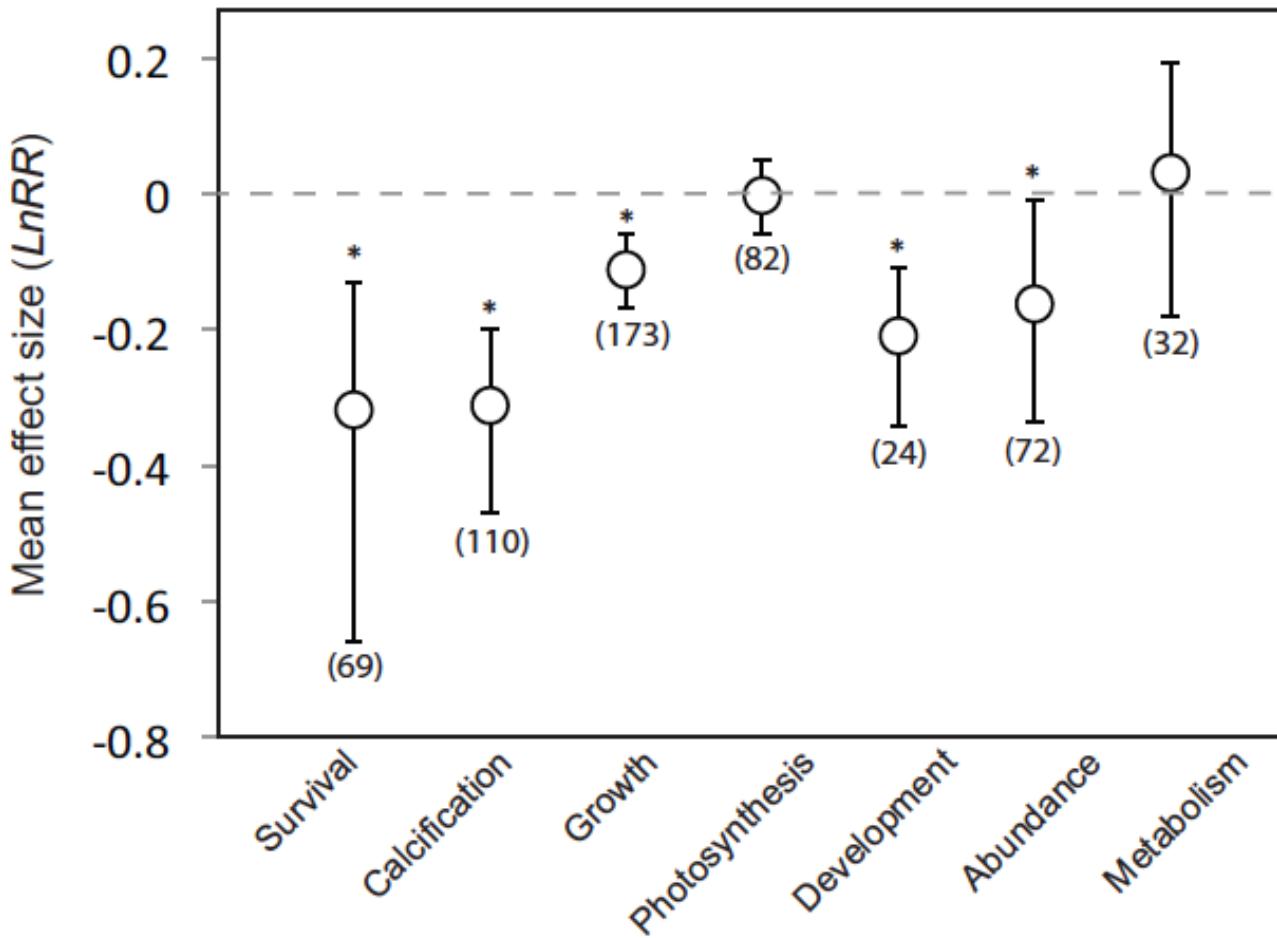
Ocean Acidification



Wolf-Gladrow et al. (1999)



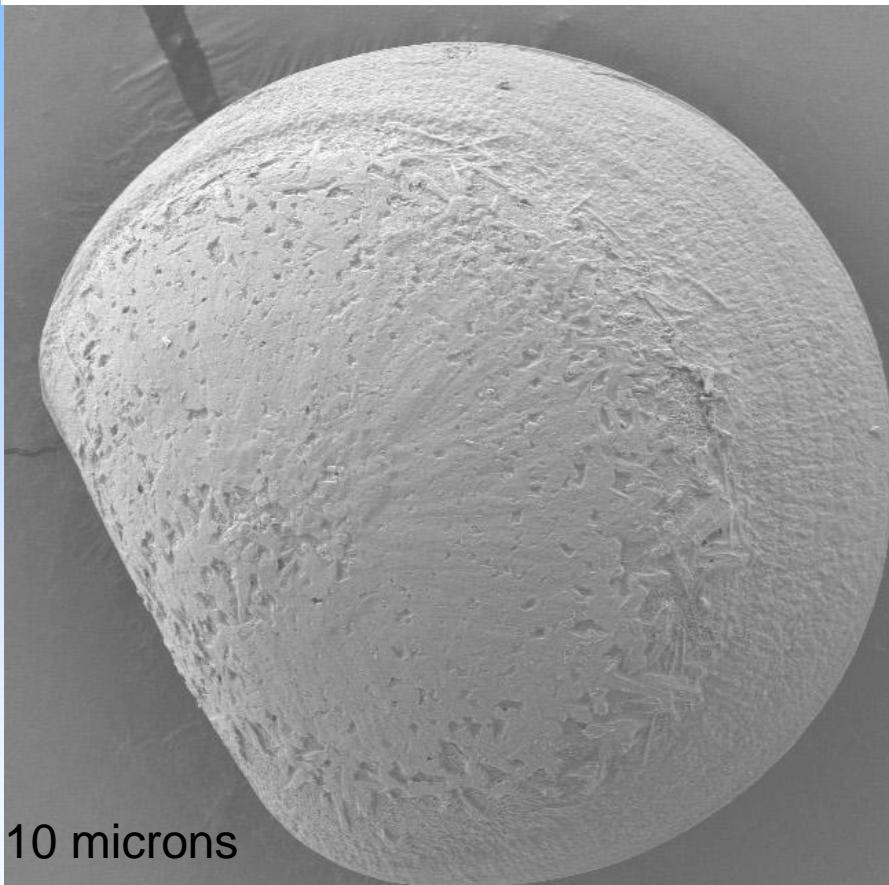
Meta-analysis of biological impacts



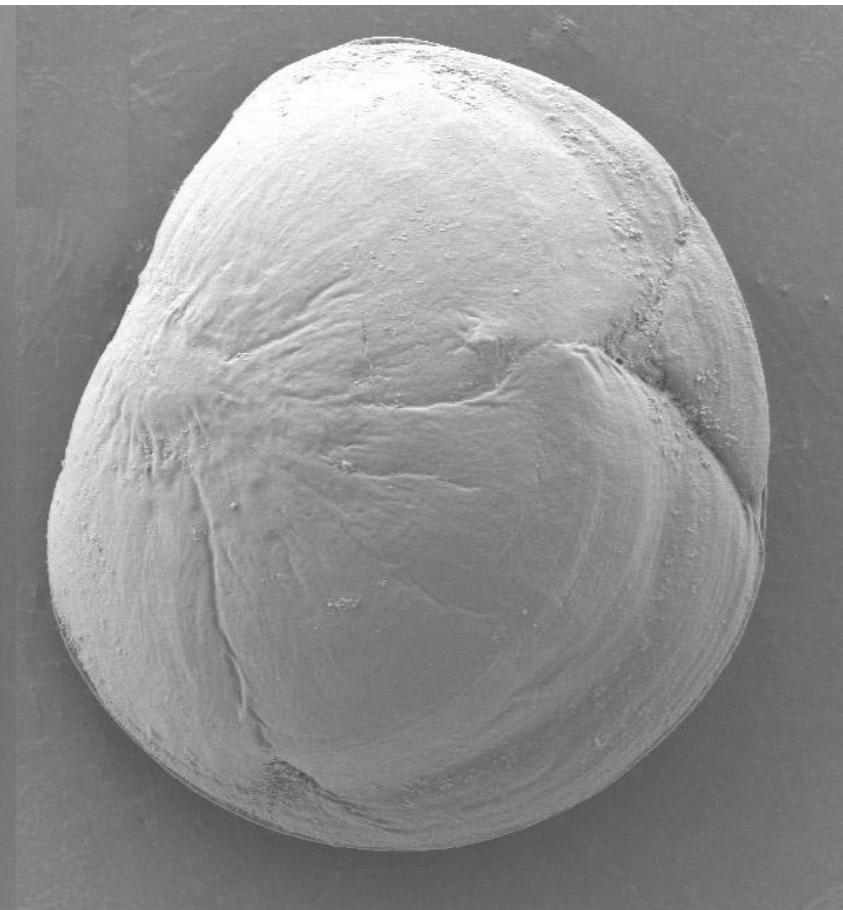
Kroecker et al. (2009; submitted)

Negative Impacts of CO₂ on Mollusks

Ambient CO₂ (Vineyard Sound)



High CO₂ (estuaries, future)

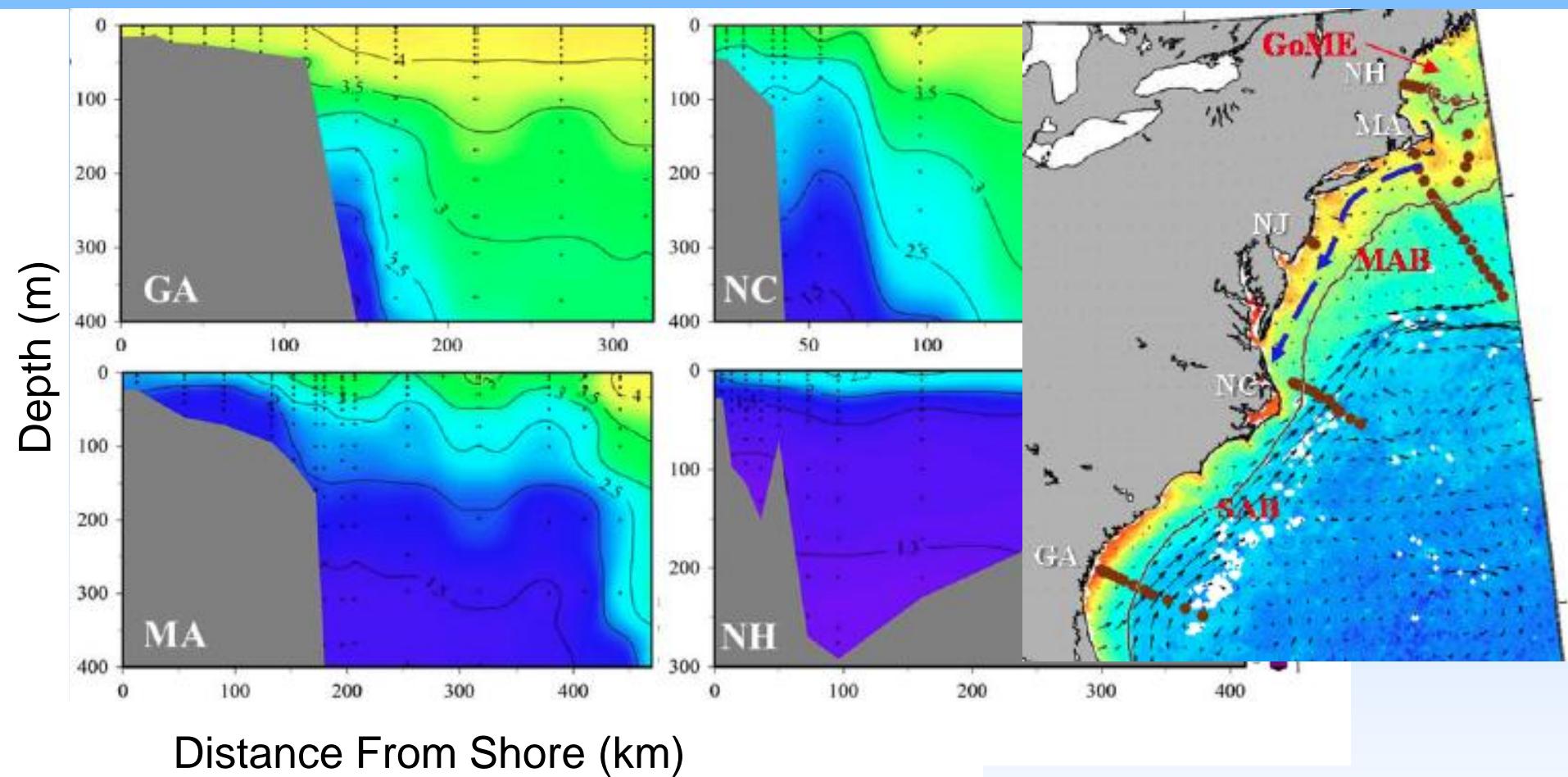


10 microns

Eastern Oyster Larvae

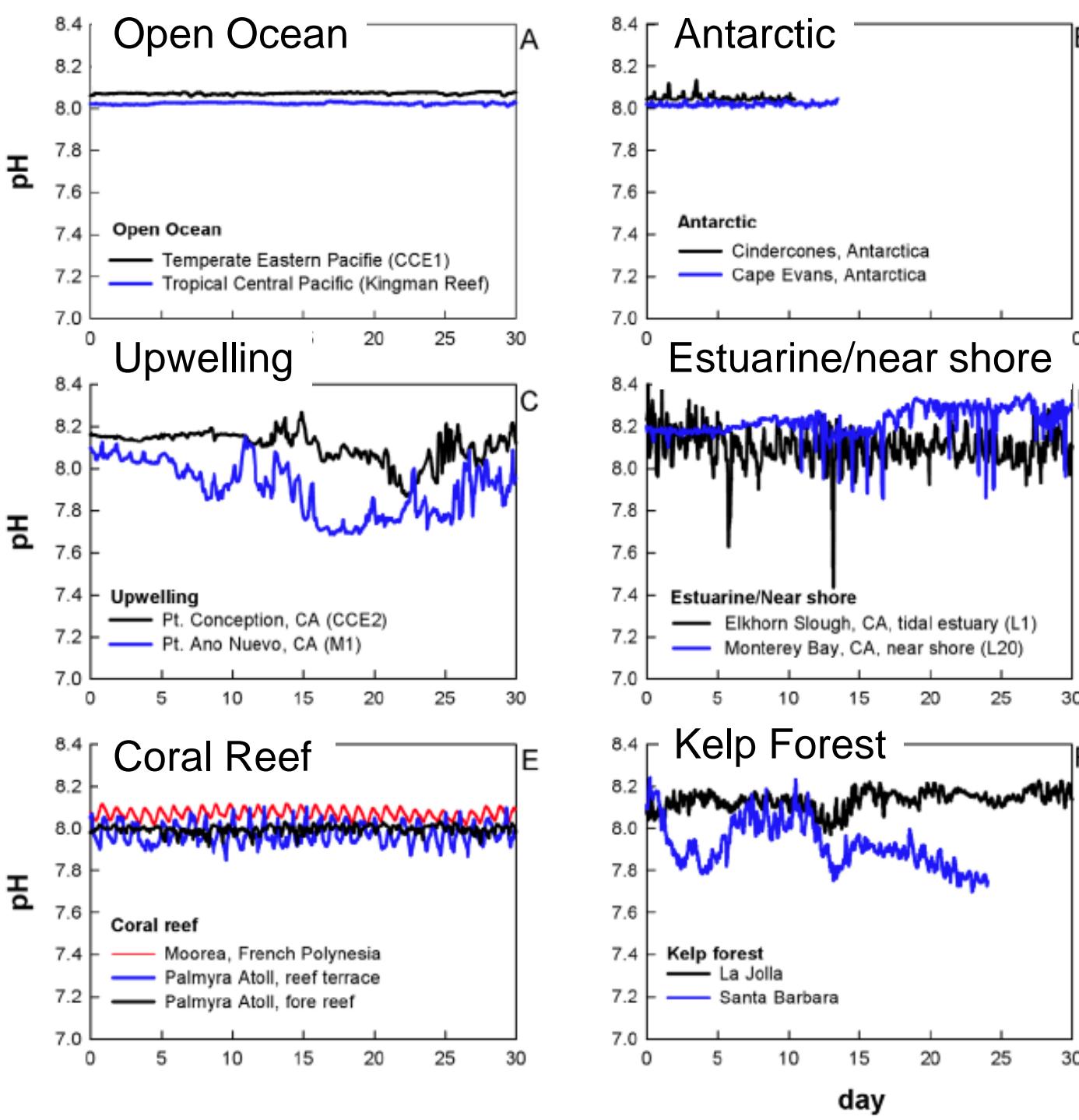
Anne Cohen & Dan McCorkle
WHOI (2012)

Acidification along the U.S. East Coast



Wang et al. L&O in press

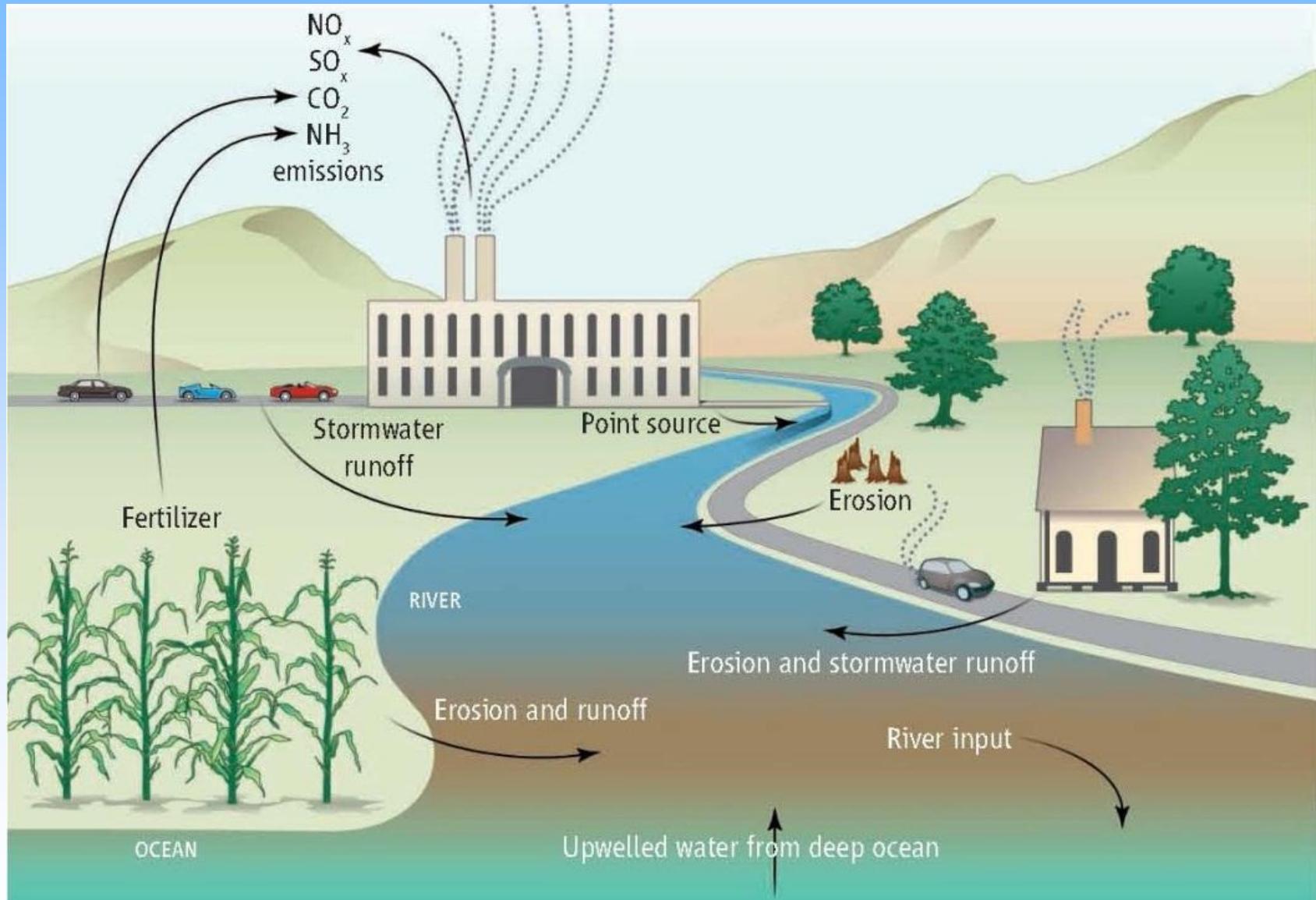
High Frequency Natural Variability



Hofmann et al.
PLoS 2011



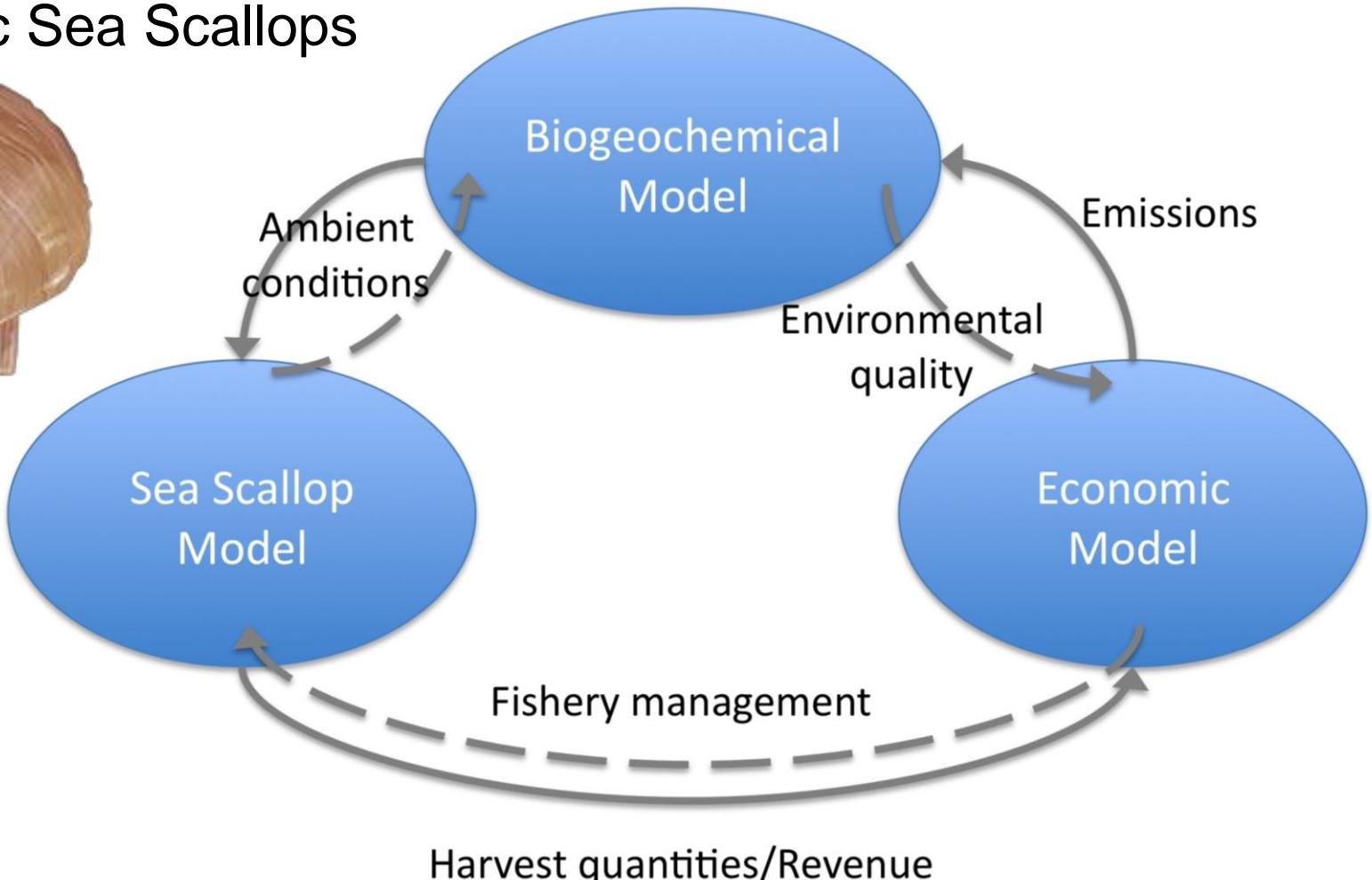
Other Local Sources of Acidification



Doney et al. PNAS 2007; Doney Science 2010; Kelly et al. Science 2011

Coupling Natural & Social Science

Atlantic Sea Scallops



Collaboration with J. Hare
& D. Hart, NOAA/NMFS





Ocean Acidification: From Knowledge to Action

Washington State's Strategic Response

<http://www.ecy.wa.gov/water/marine/oceanacidification.html>



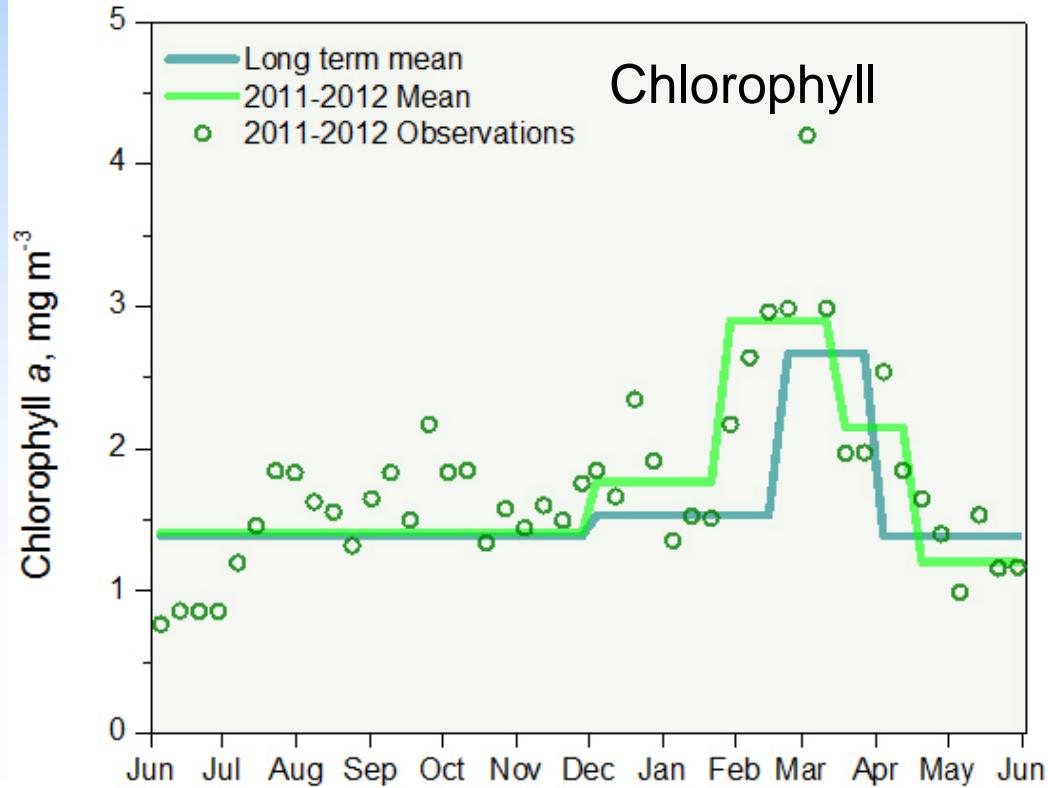
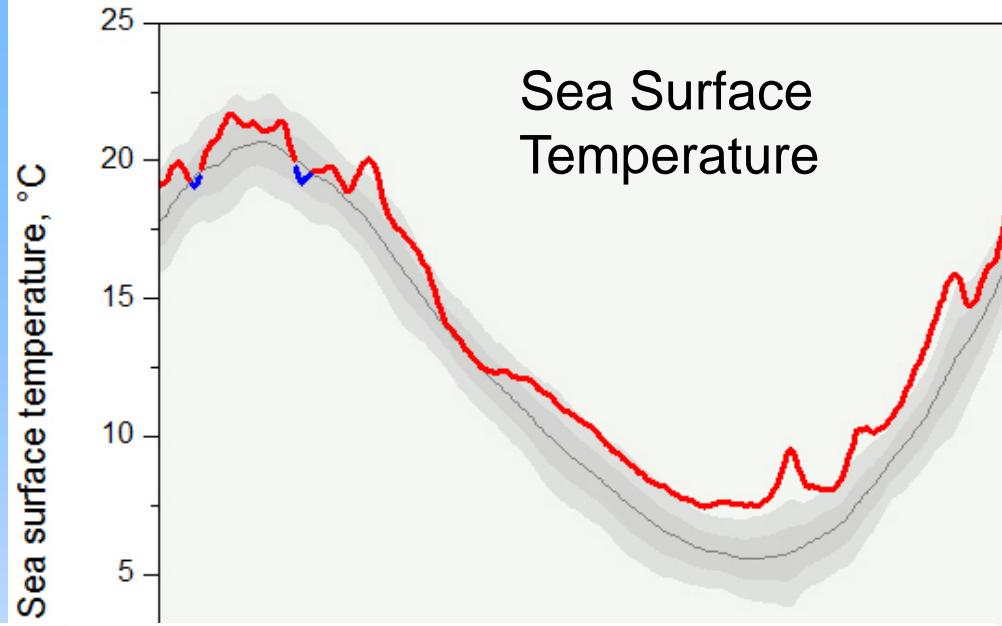
November 2012

Washington State Blue Ribbon Panel

- Reduce emissions of CO₂
- Reduce local land-based contributions to ocean acidification
- Adapt to & remediate impacts of ocean acidification
- Monitor and investigate causes & effects of ocean acidification



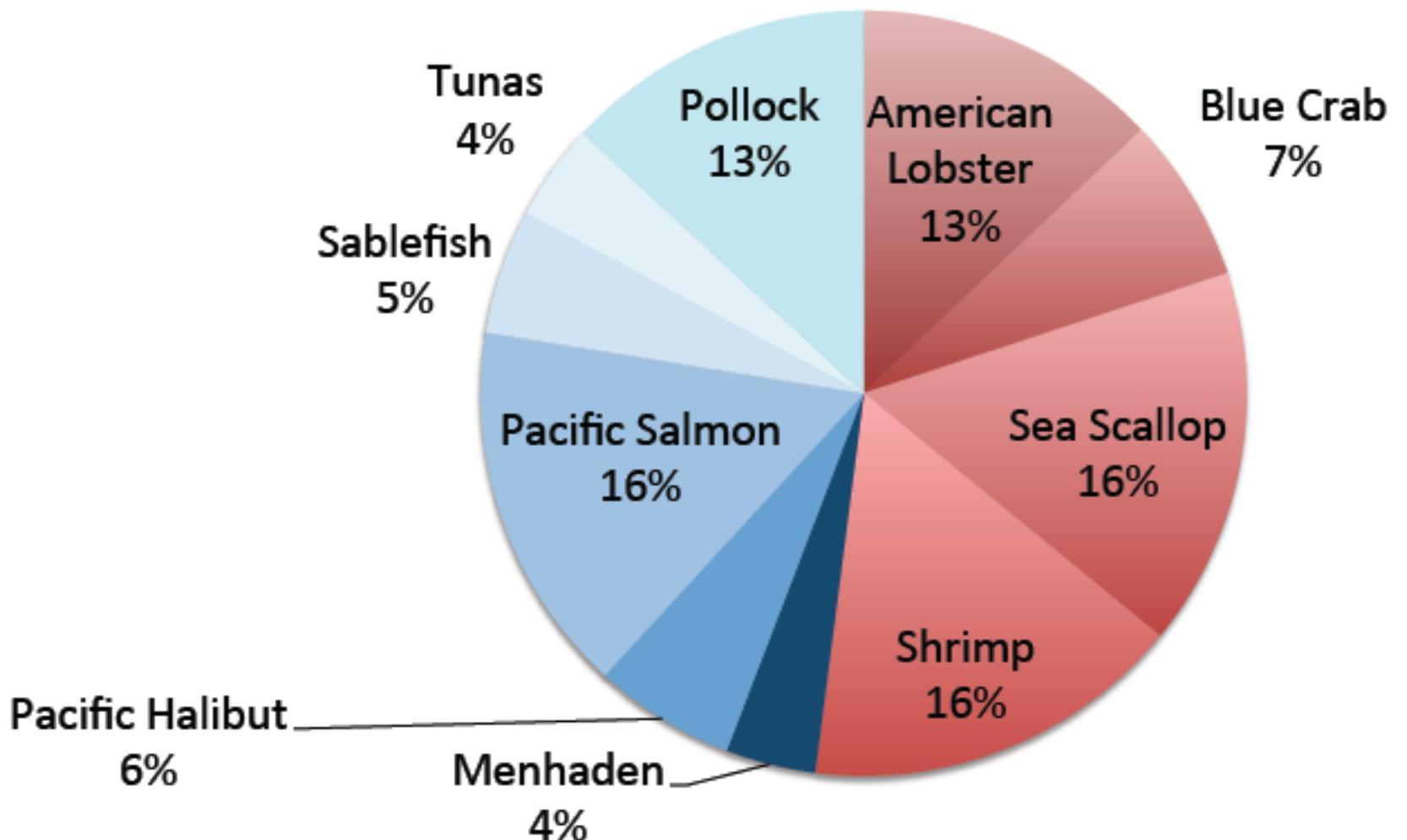
Northeast Shelf Warming (2011-2012)



<http://www.nefsc.noaa.gov/eco sys/advisory/current/advisory.html>

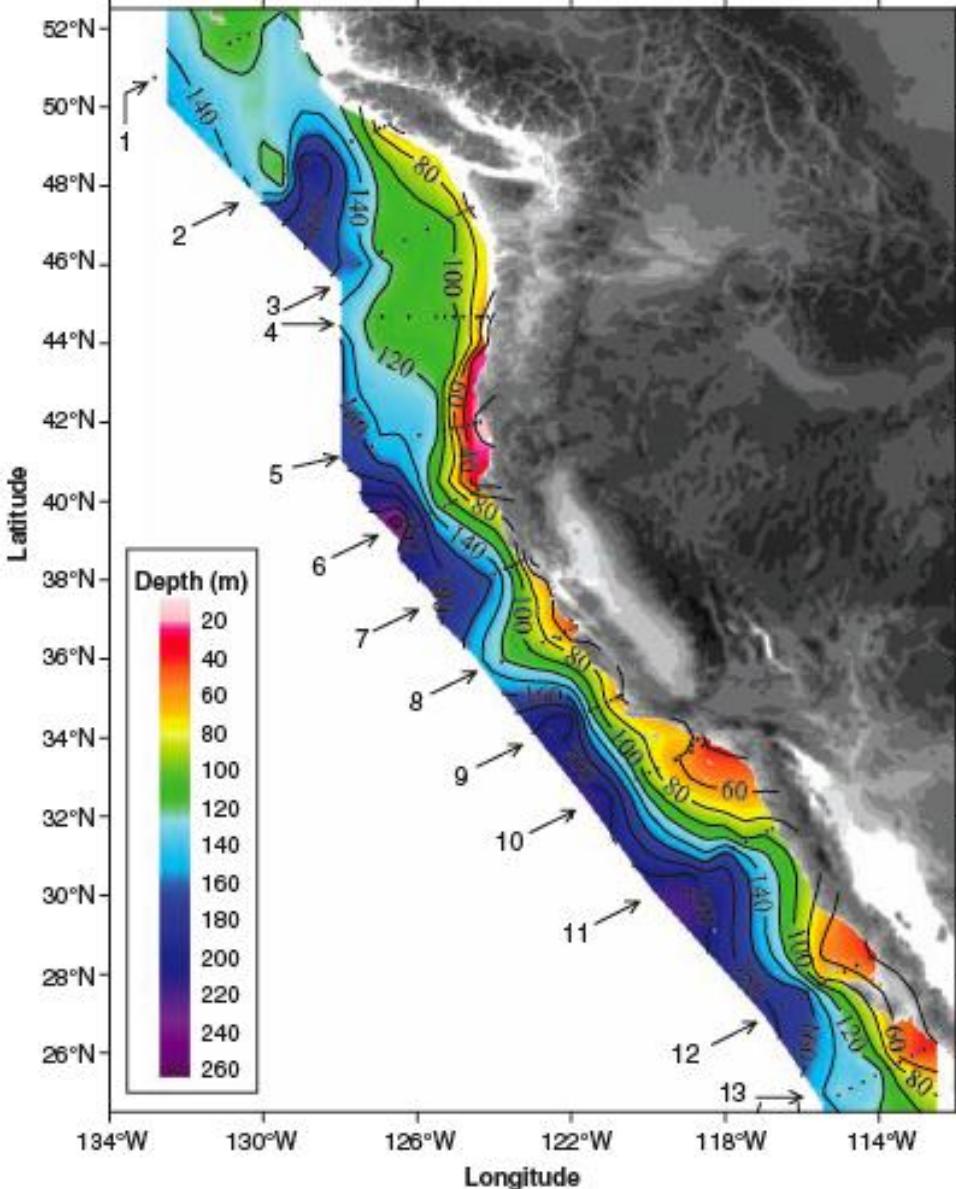


Valuable Commercial Shellfish Fisheries



U.S. ex-vessel revenue ~\$4 Billion/year
NOAA NMFS; Cooley & Doney ERL 2009





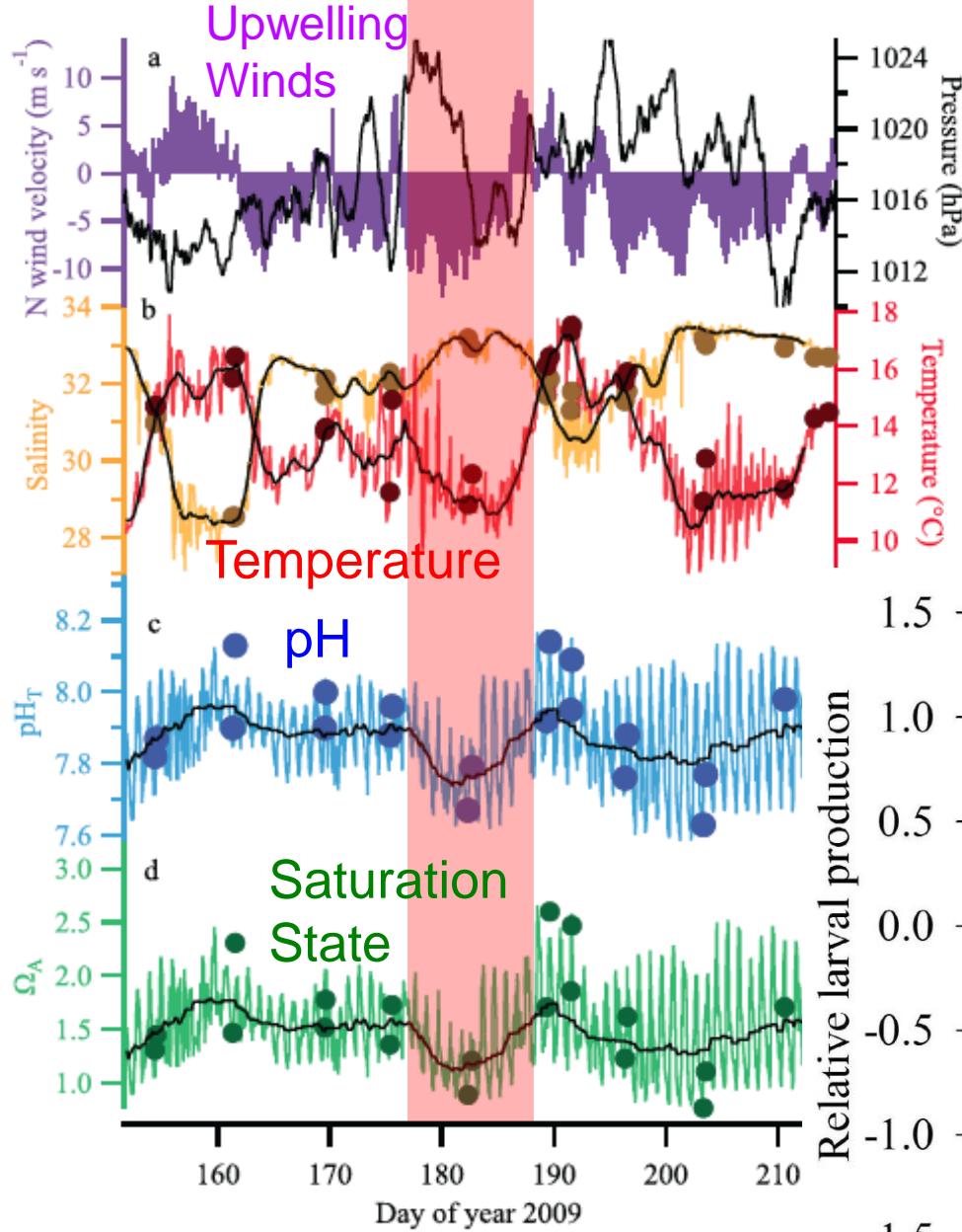
Collapse of Pacific NW Oyster Hatcheries

The Seattle Times

Oysters in deep trouble: Is Pacific Ocean's chemistry killing sea life?



STEVE RINGMAN / THE SEATTLE TIMES

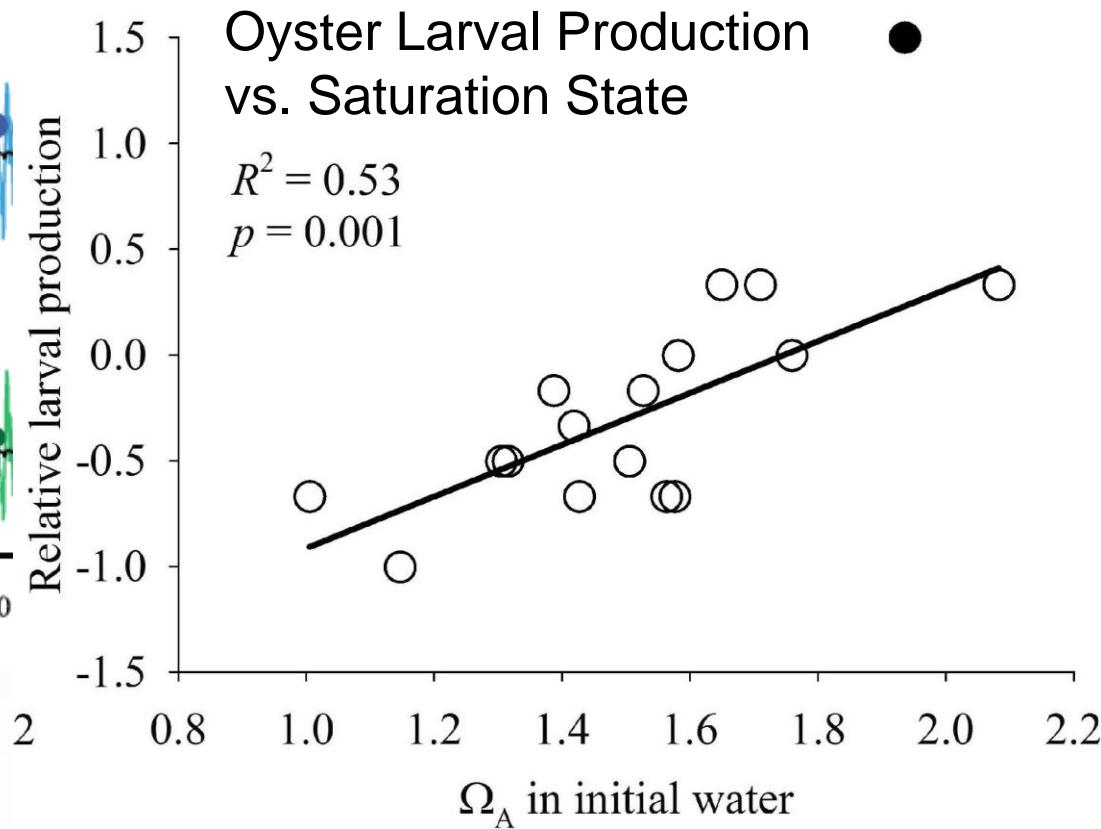


Reduced Larval Production During Upwelling Events

Oyster Larval Production vs. Saturation State

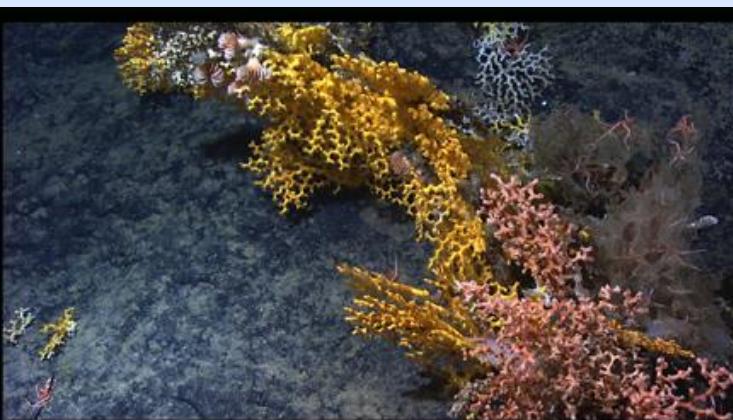
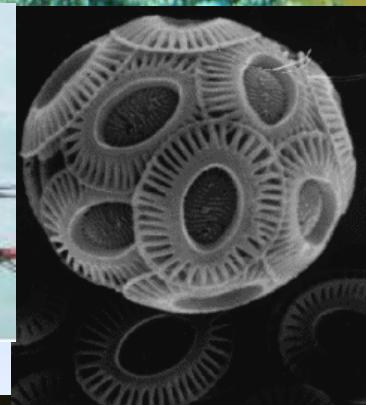
$$R^2 = 0.53$$

$$p = 0.001$$

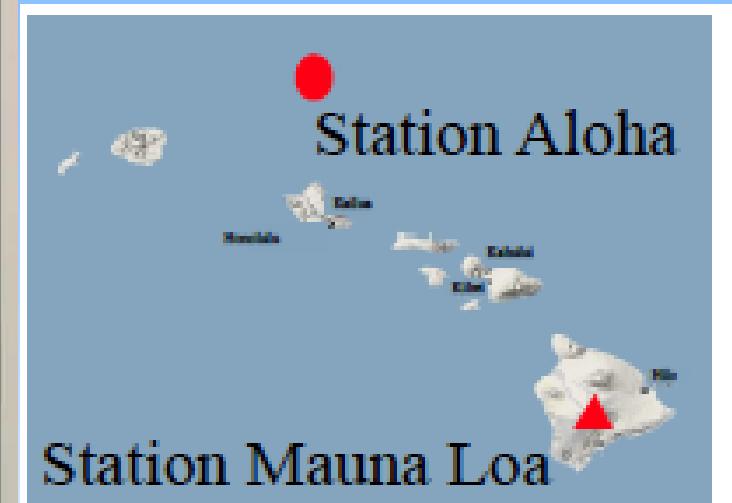
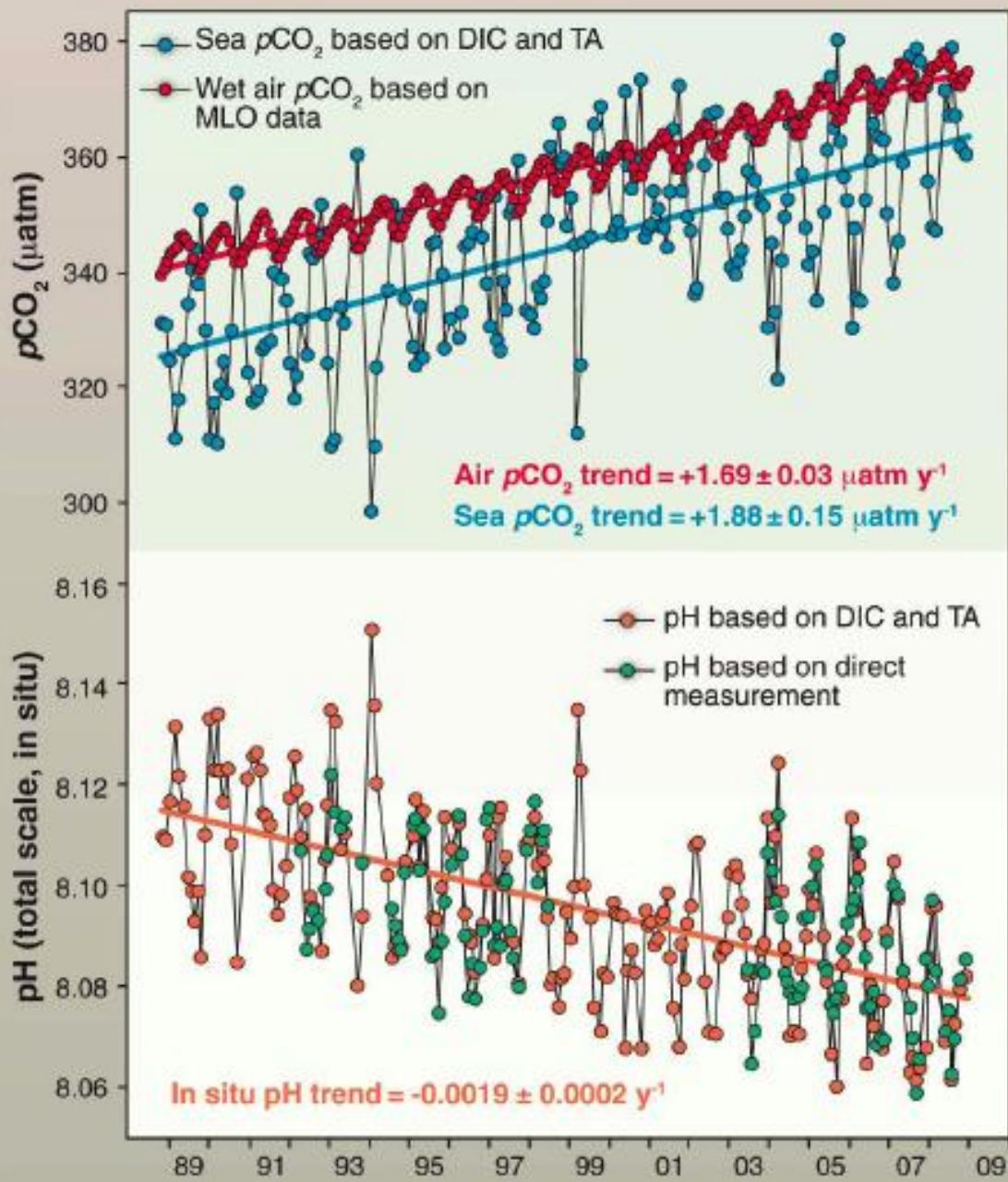


Marine Life Susceptible to Ocean Acidification

- Reduced shell formation
- Habitat loss
- Less available prey



Changing Seawater Chemistry



Doney et al. Ann. Rev.
Mar. Sci. 2009
Dore et al. PNAS 2009