

2013

Overview on Ocean Acidification Powerpoint

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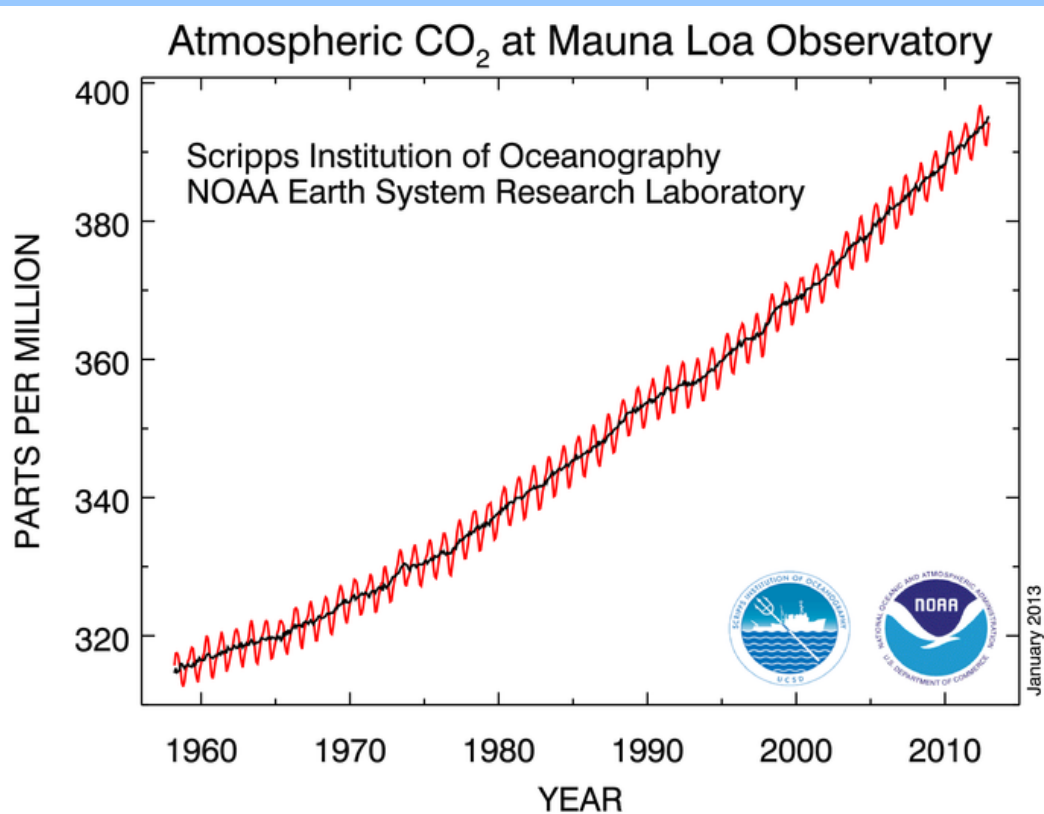
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Overview on Ocean Acidification

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%



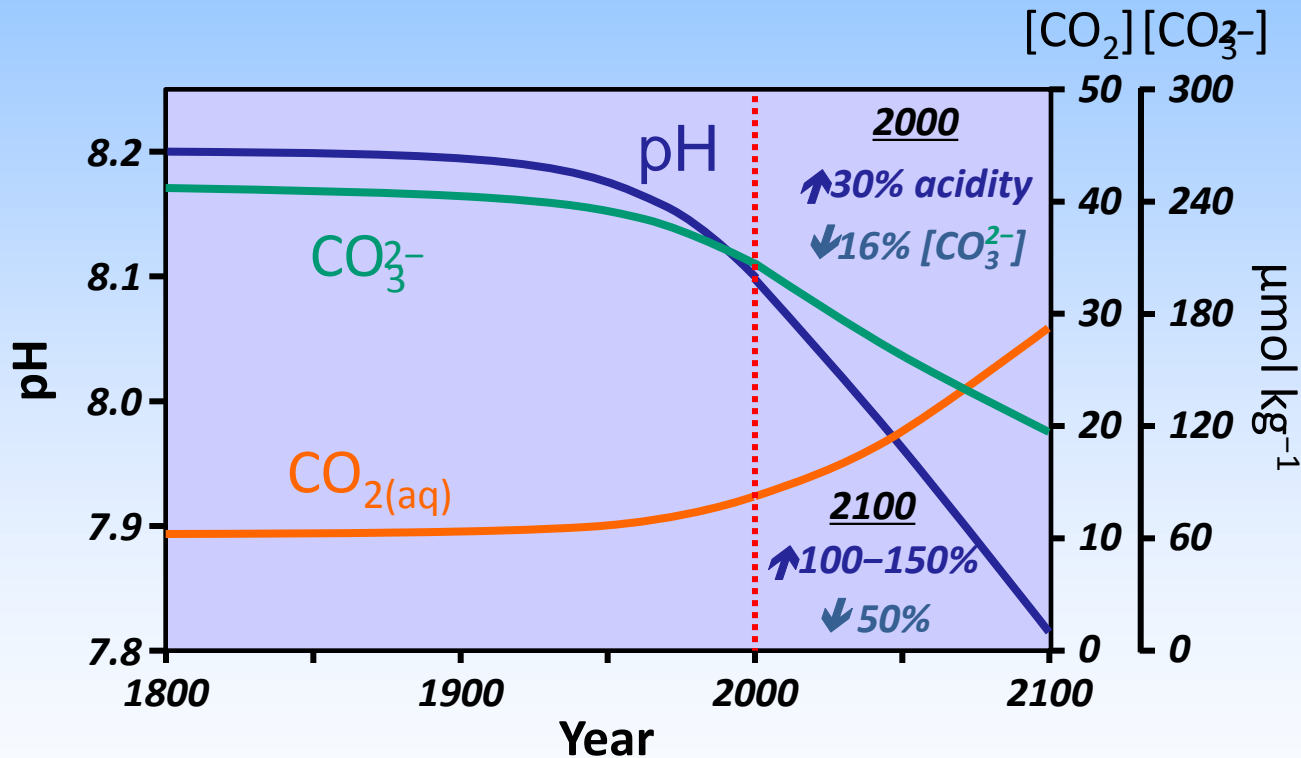
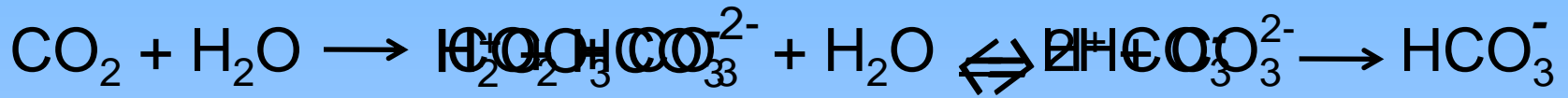
$2.3 \pm 0.4 \text{ Pg C y}^{-1}$

Oceans

26%

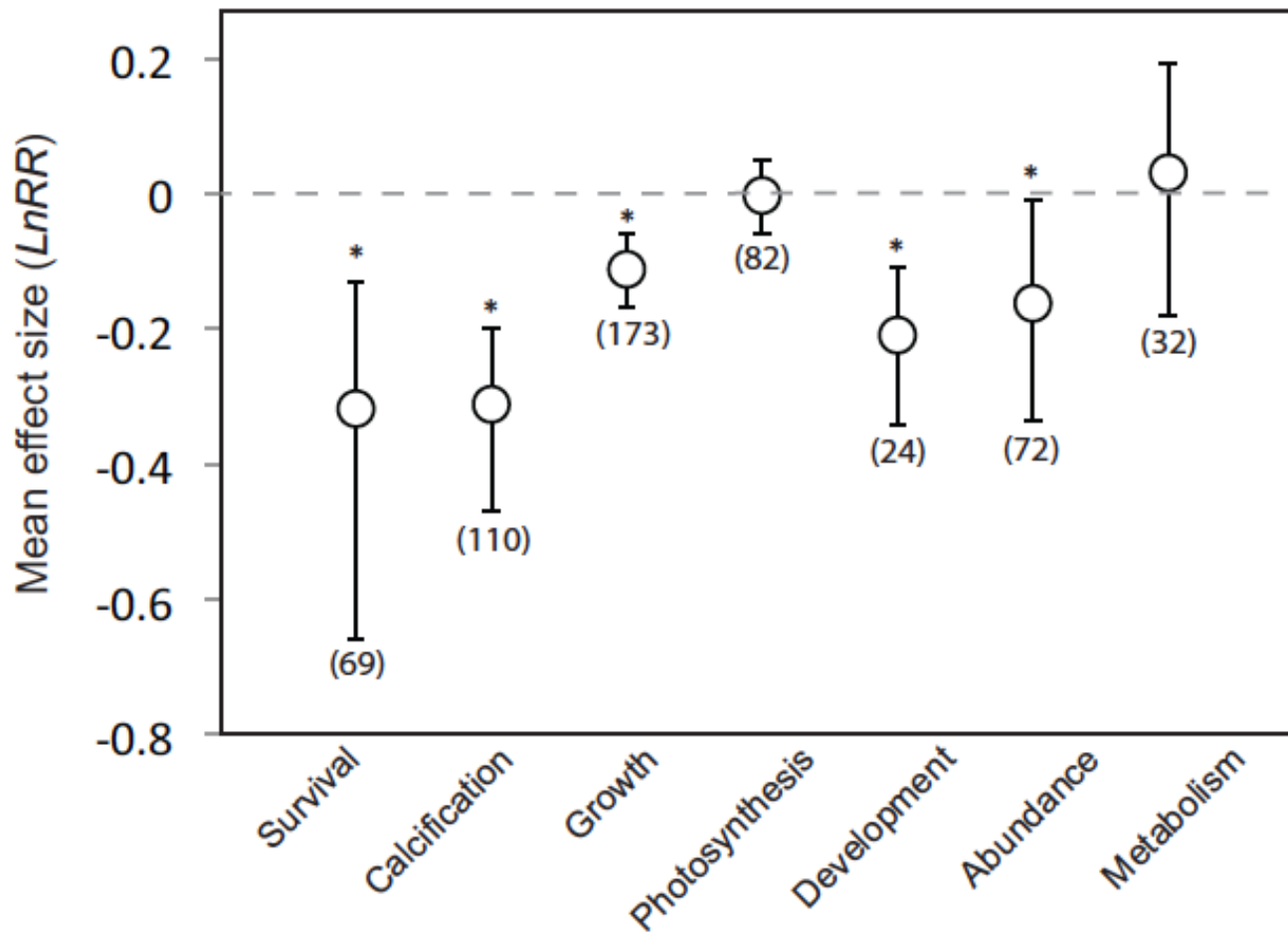



Ocean Acidification



Wolf-Gladrow et al. (1999)

Meta-analysis of biological impacts



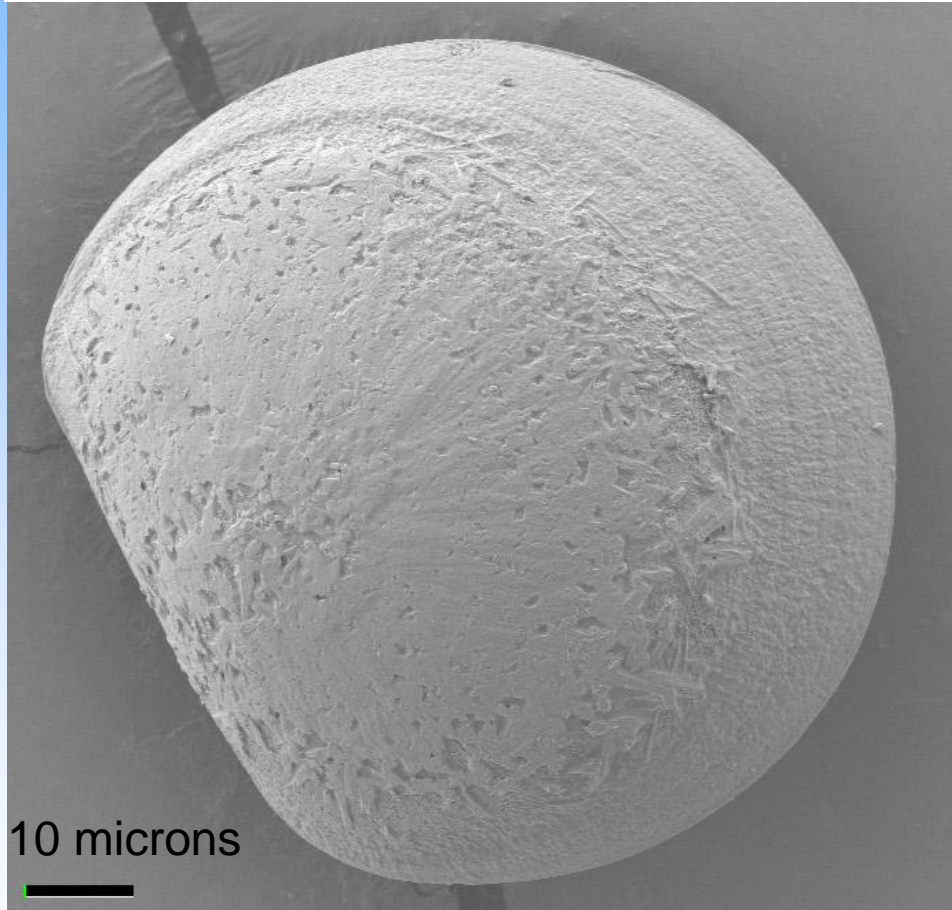
 Molluscs	Survival	-34%
	Calcification	-40%
	Growth	-17%
	Development	-25%
	Abundance	

	Not tested or too few studies
	Enhanced <25%
	95% CI overlaps 0
	Reduced <25%
	Reduced >25%

Kroecker et al. (2009; submitted)

Negative Impacts of CO₂ on Mollusks

Ambient CO₂ (Vineyard Sound)



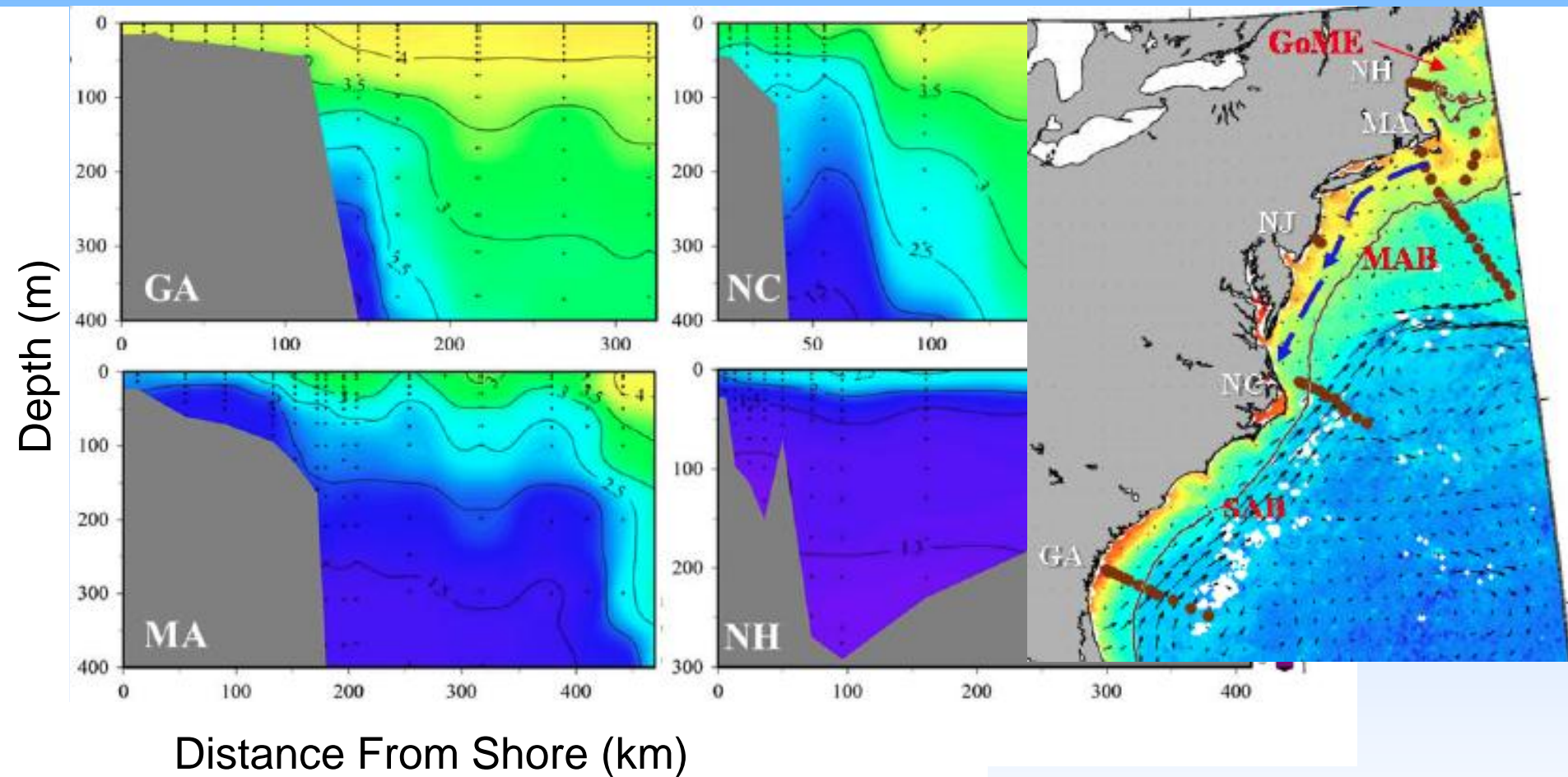
Eastern Oyster Larvae

High CO₂ (estuaries, future)



Anne Cohen & Dan McCorkle
WHOI (2012)

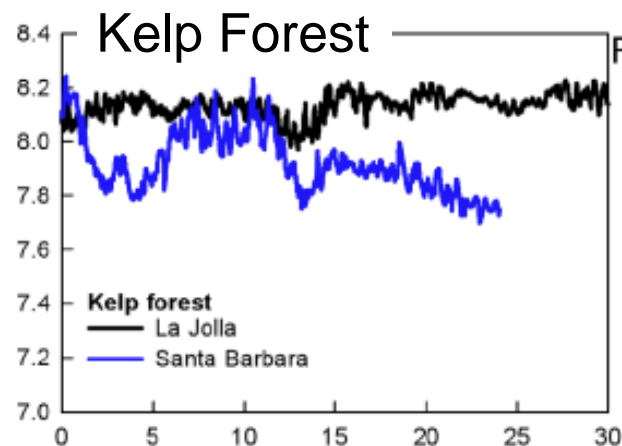
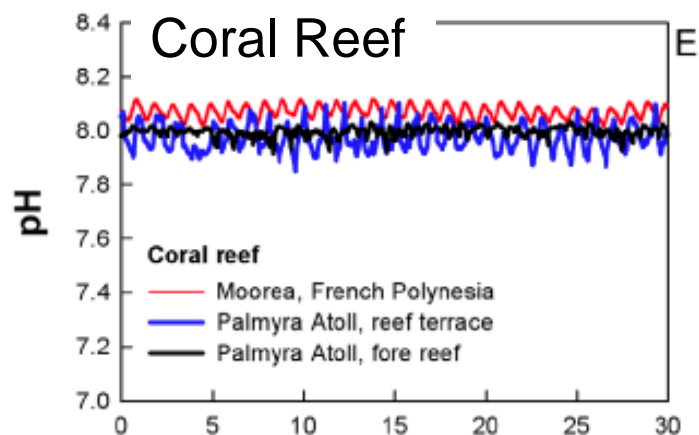
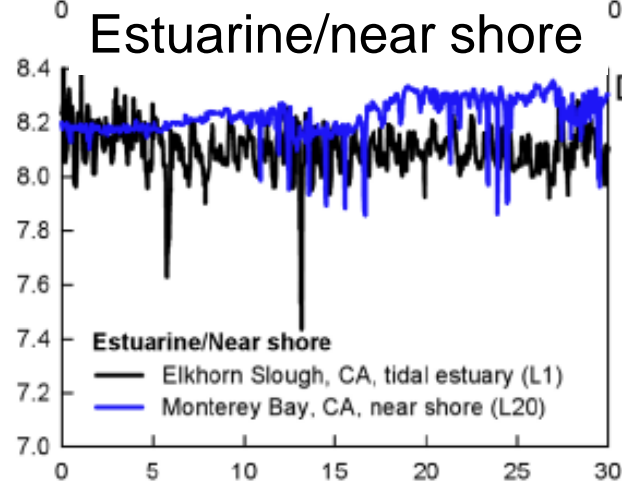
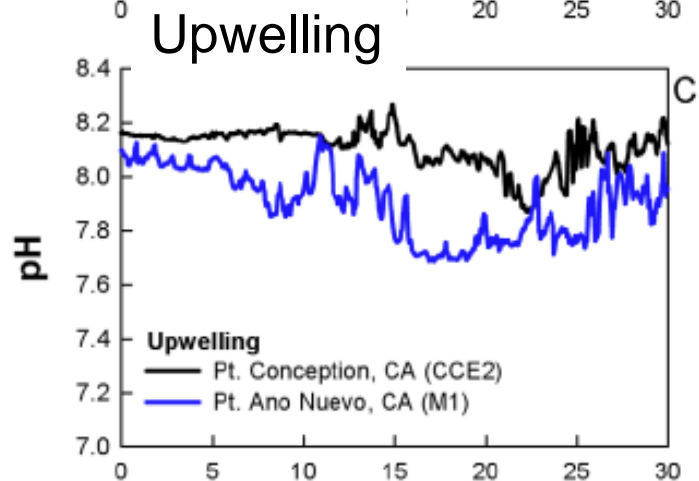
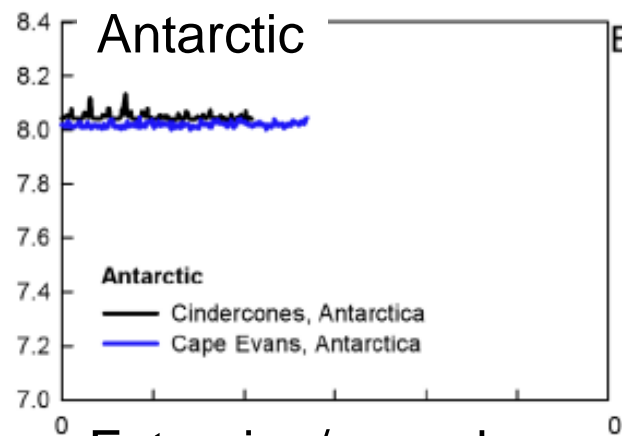
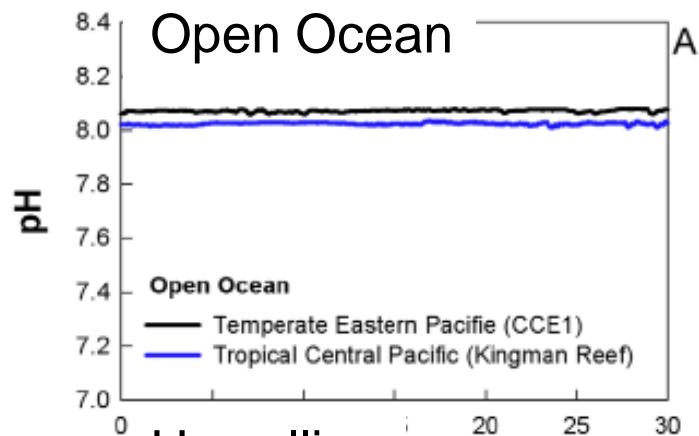
Acidification along the U.S. East Coast



Aragonite Saturation State

Wang et al. L&O in press

High Frequency Natural Variability

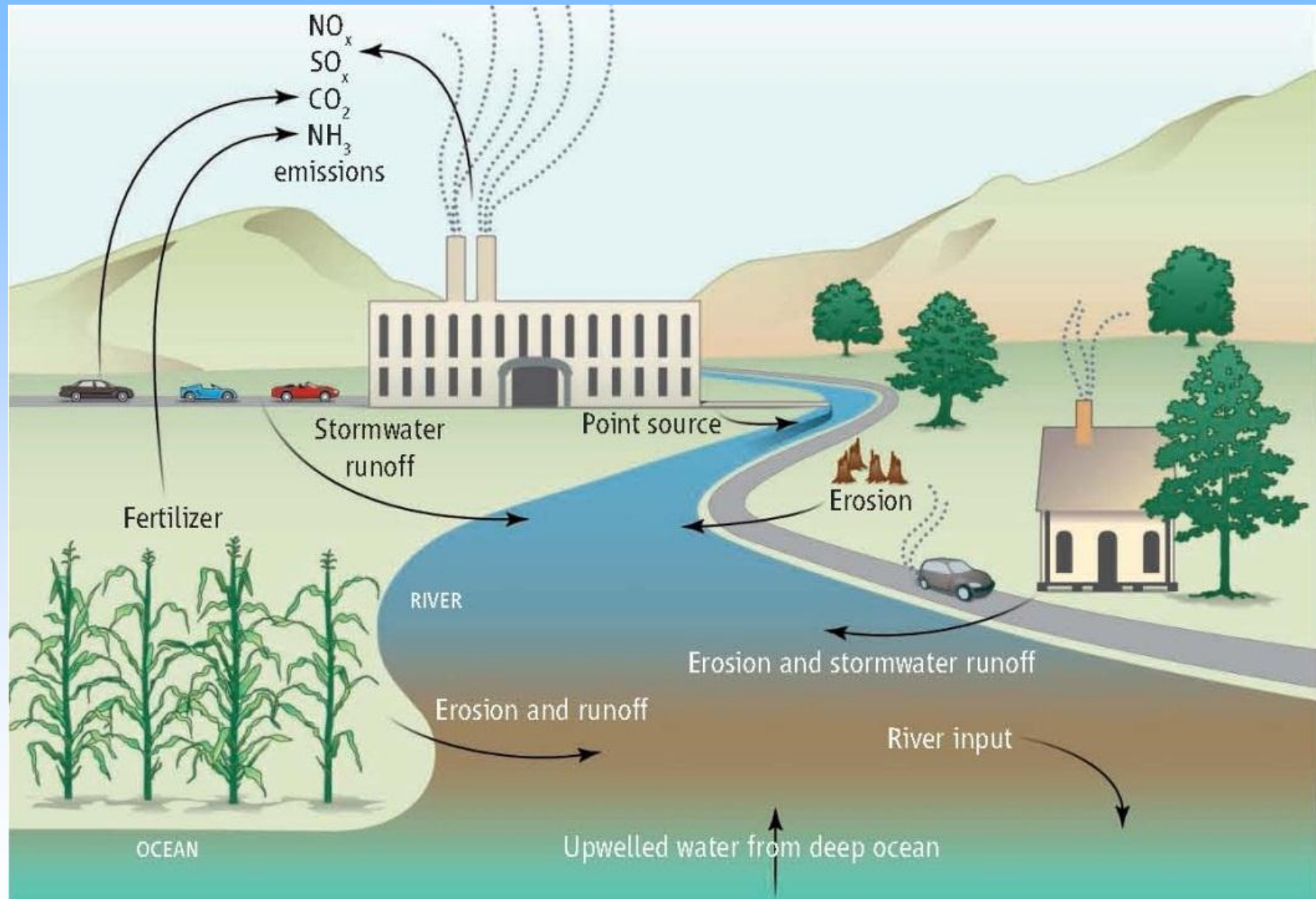


day

Hofmann et al.
PLoS 2011



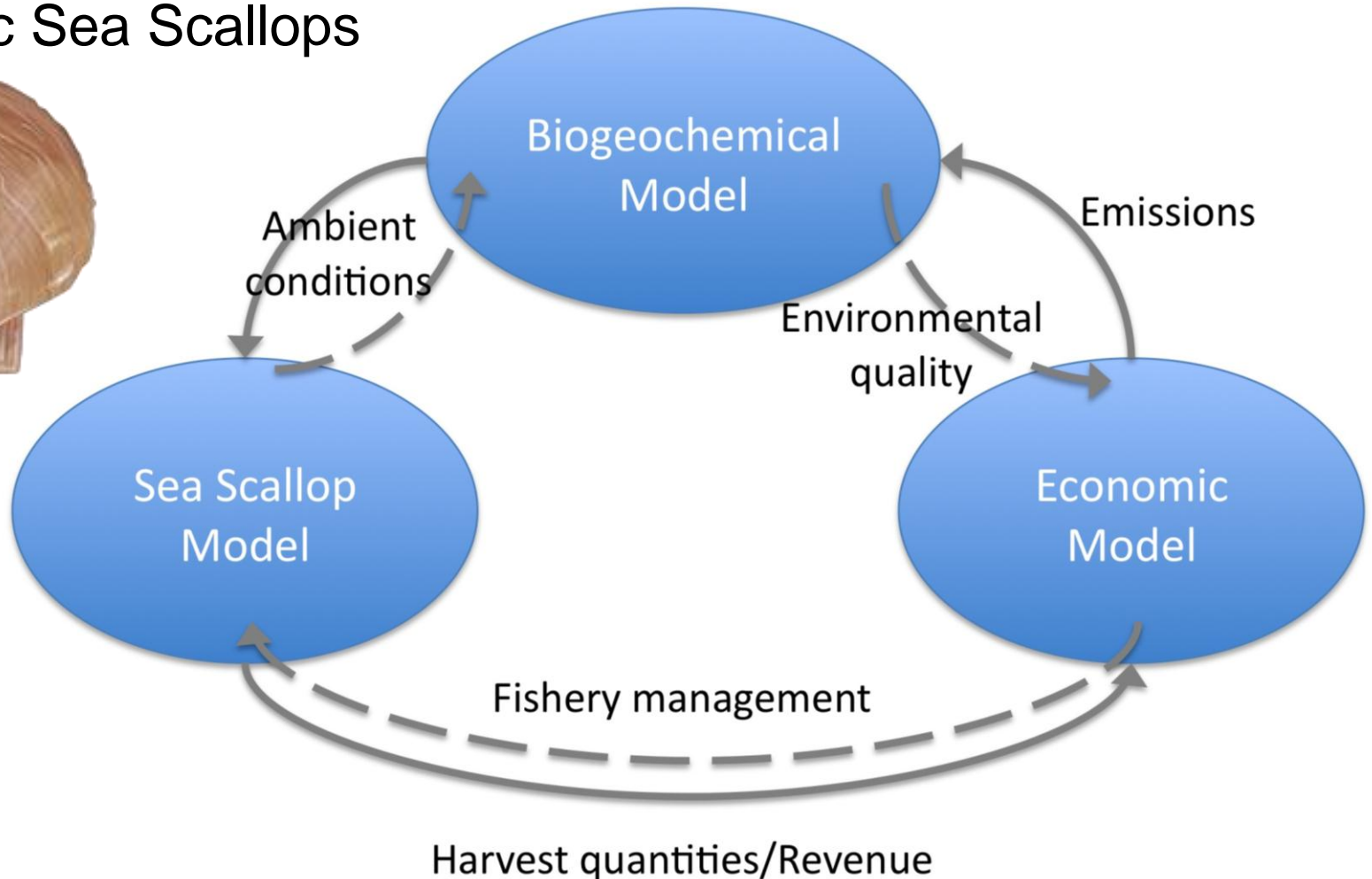
Other Local Sources of Acidification



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>



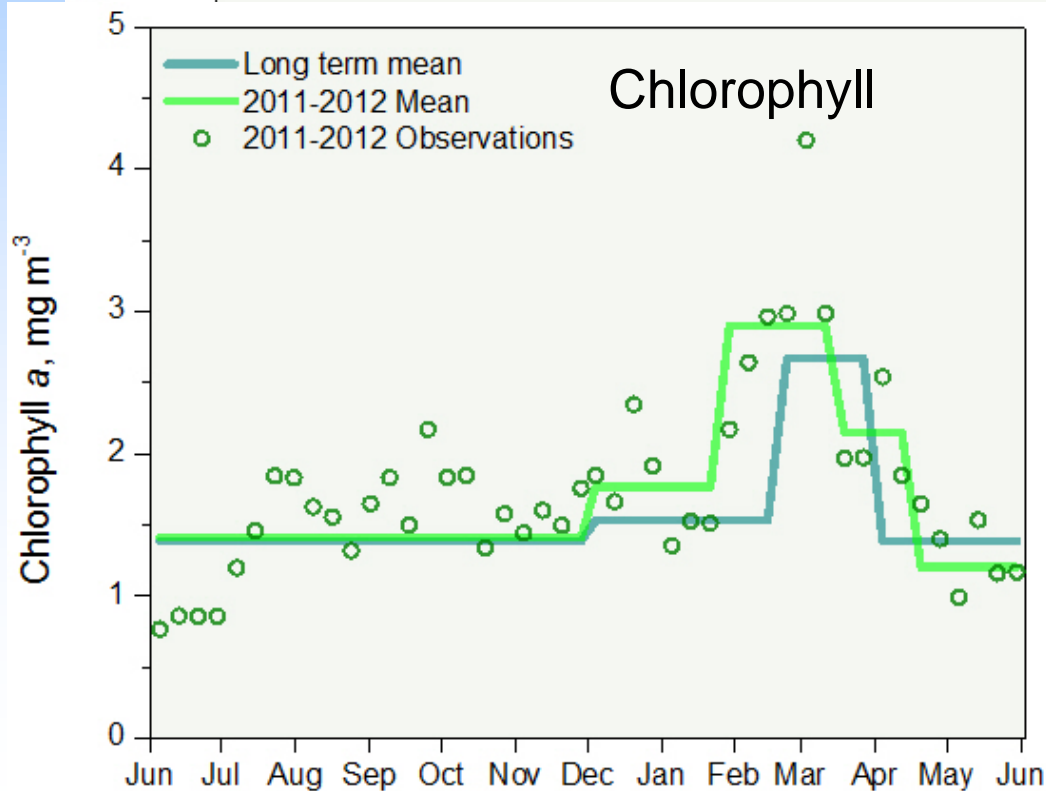
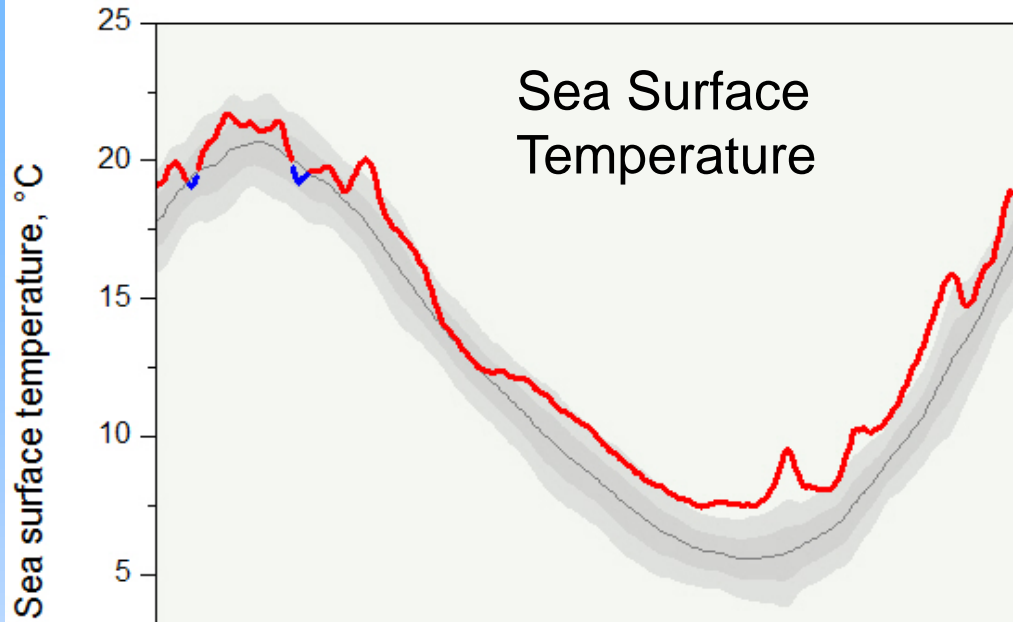
November 2012

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

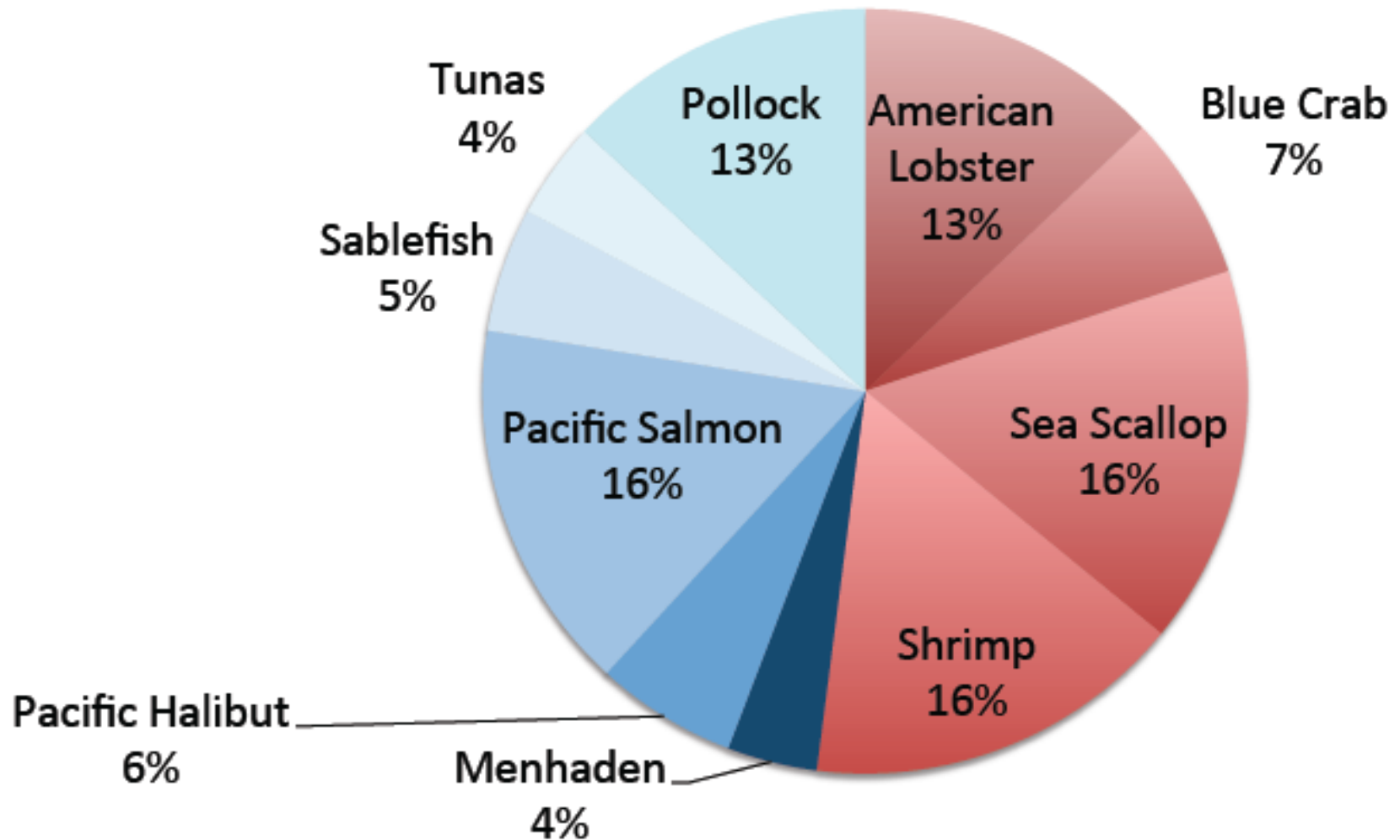


Northeast Shelf Warming (2011-2012)



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

Valuable Commercial Shellfish Fisheries

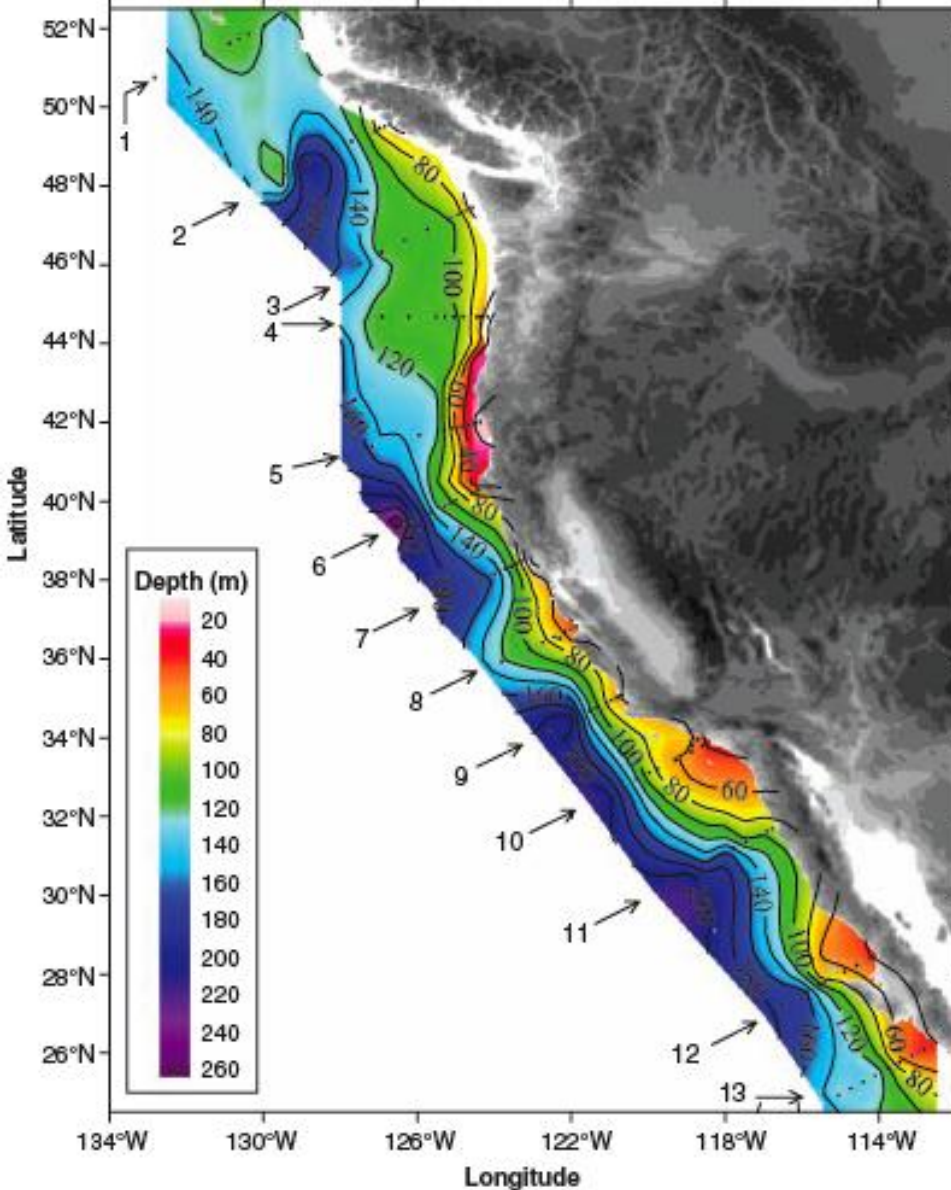


U.S. ex-vessel revenue ~\$4 Billion/year
NOAA NMFS; Cooley & Doney ERL 2009

Collapse of Pacific NW Oyster Hatcheries

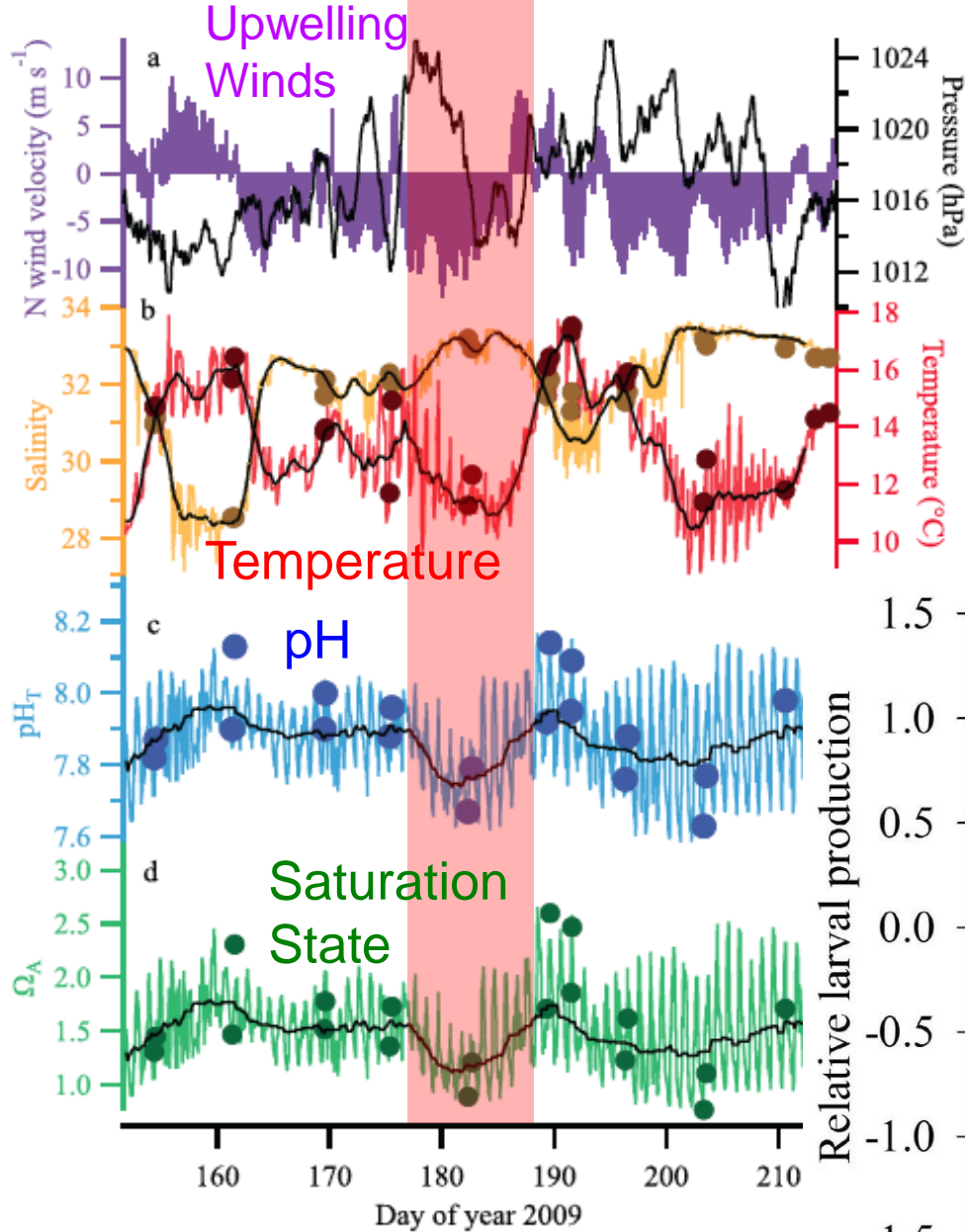
The Seattle Times

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



STEVE RINGMAN / THE SEATTLE TIMES

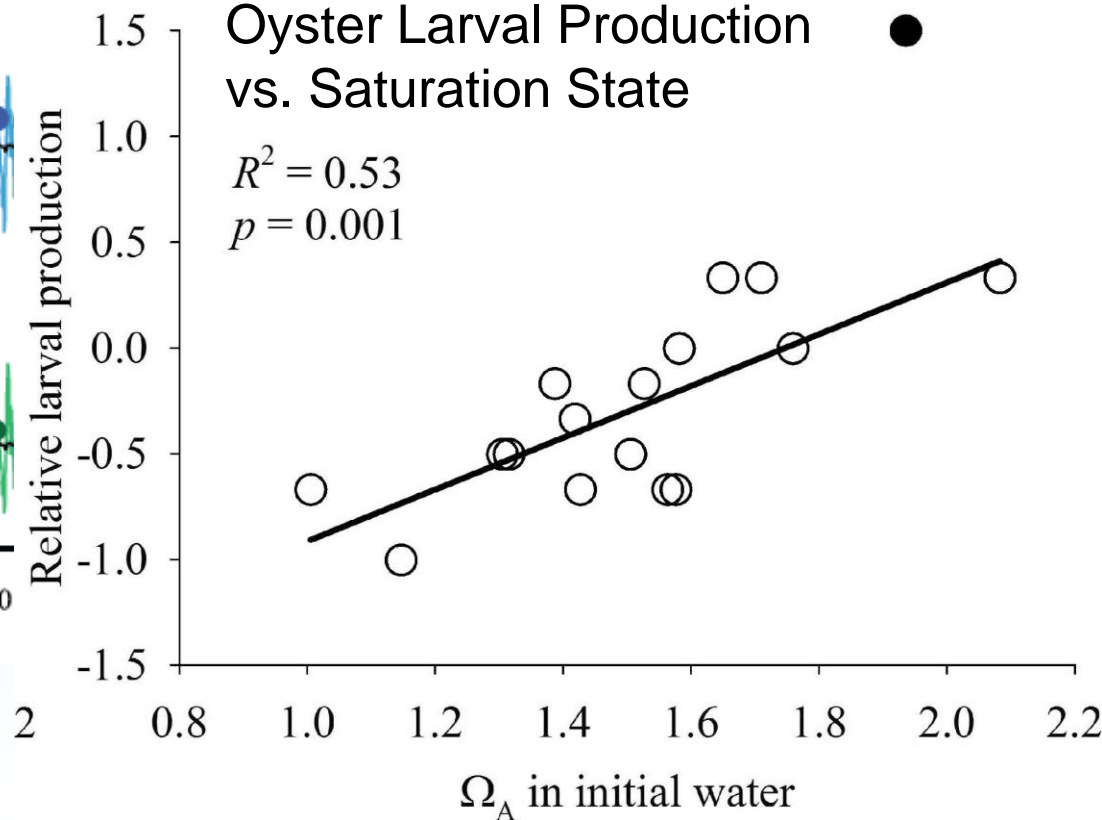
Reduced Larval Production During Upwelling Events



Oyster Larval Production vs. Saturation State

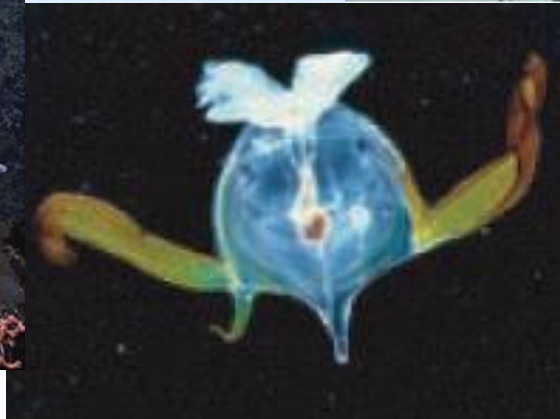
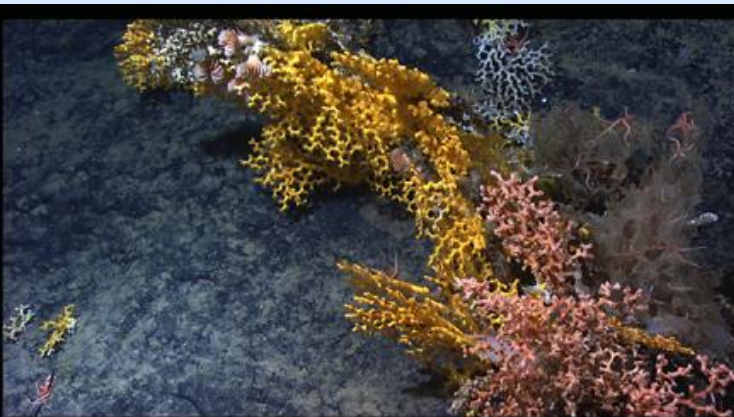
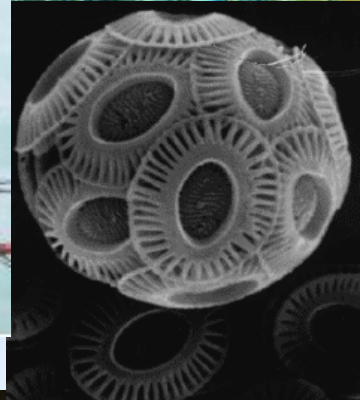
$$R^2 = 0.53$$

$$p = 0.001$$

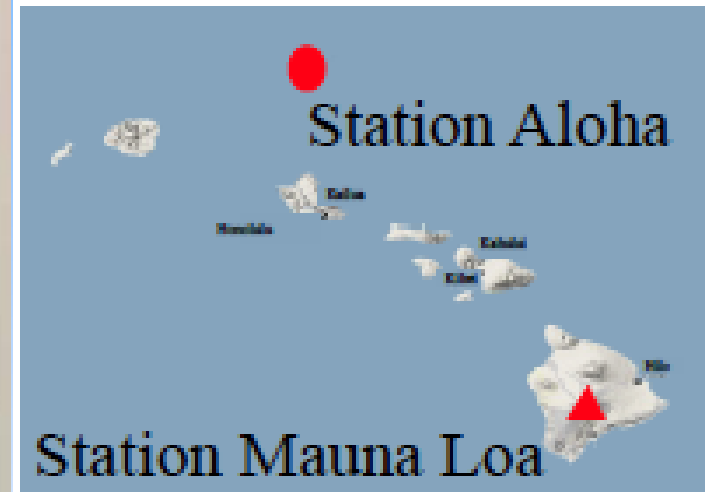
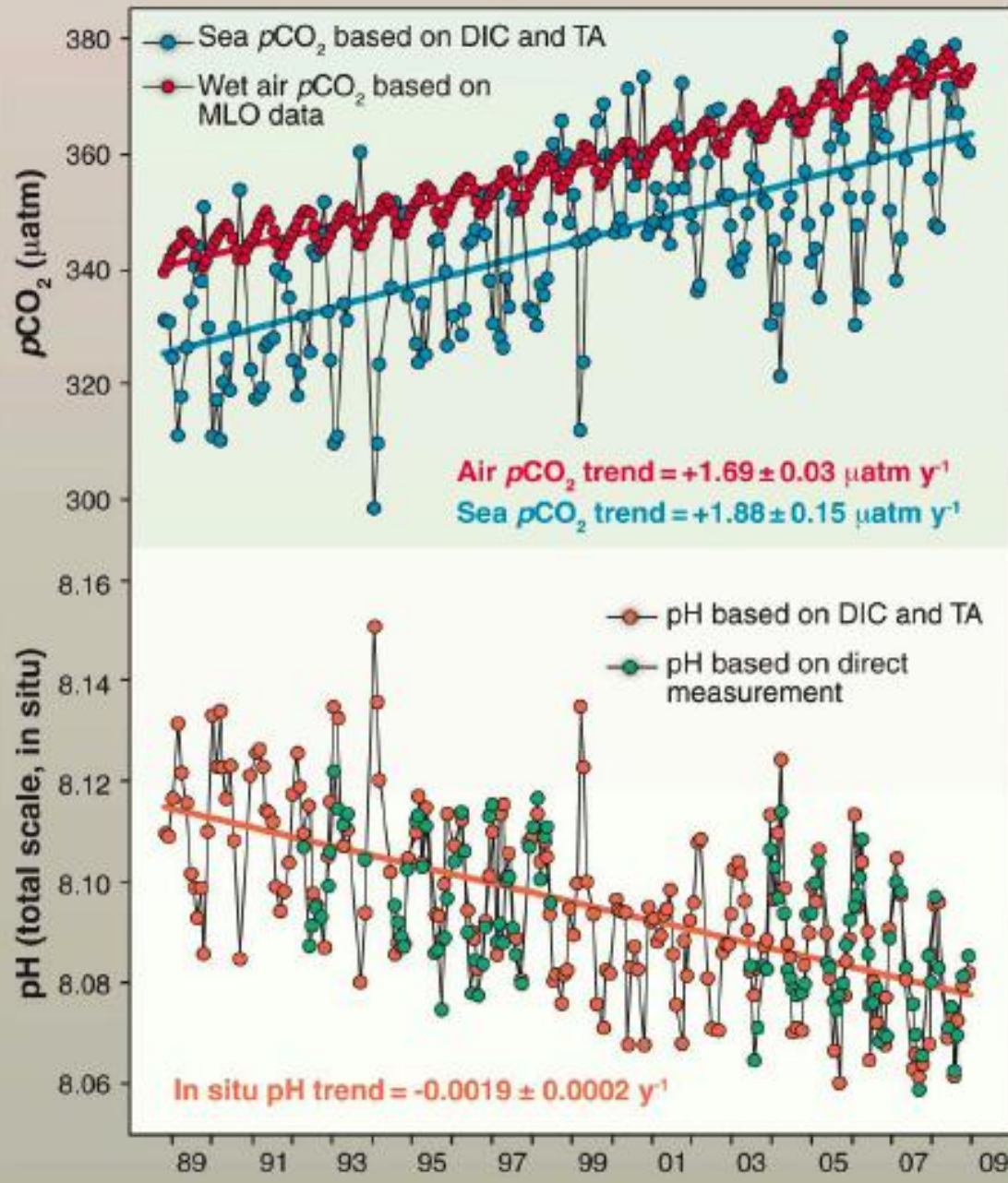


Marine Life Susceptible to Ocean Acidification

- Reduced shell formation
- Habitat loss
- Less available prey



Changing Seawater Chemistry



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