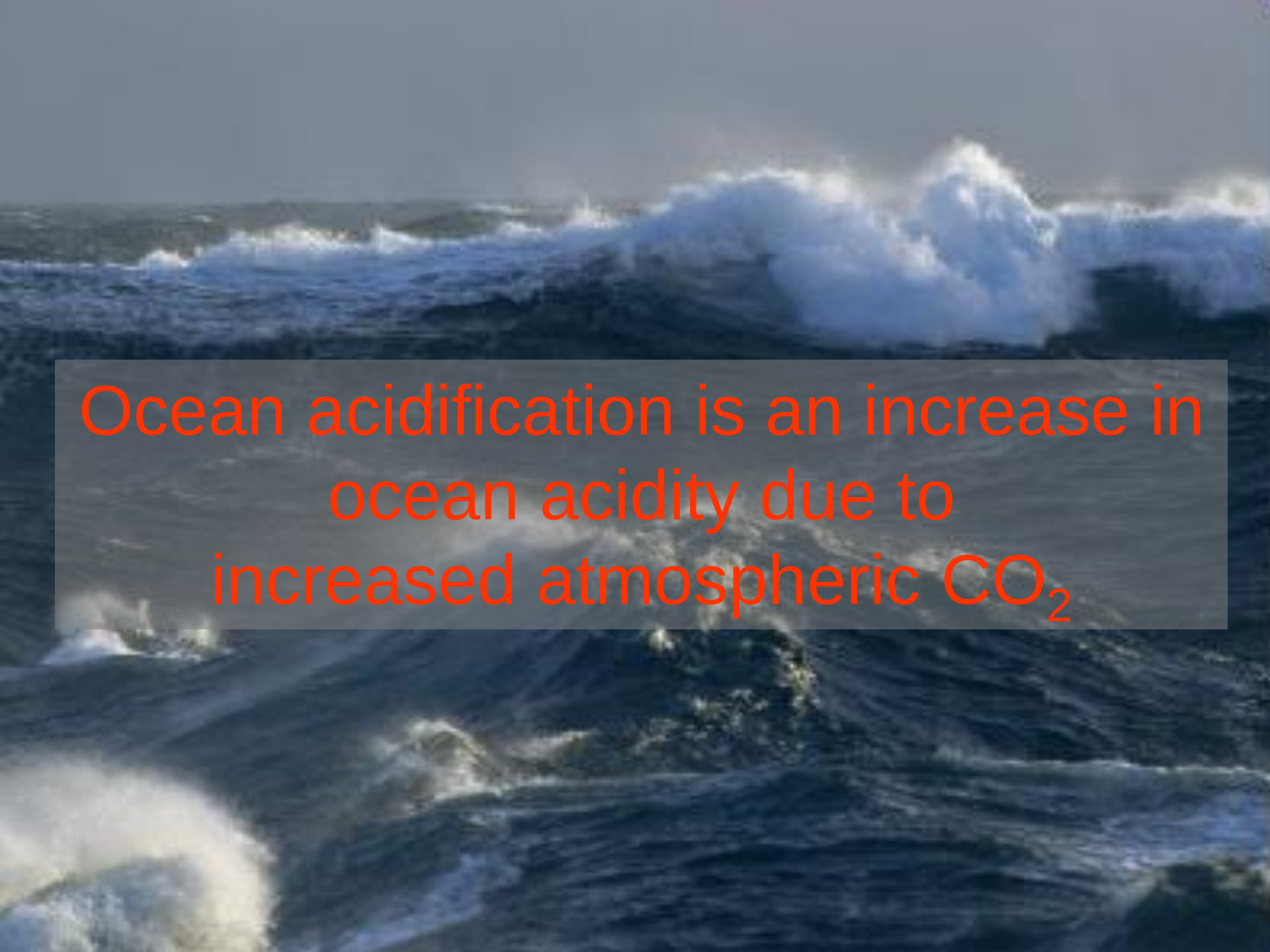
Ocean acidification and its biological impacts

Shallin Busch, Ph.D.
Northwest Fisheries Science Center
National Oceanic and Atmospheric Administration

Earth's history shows us that communities change

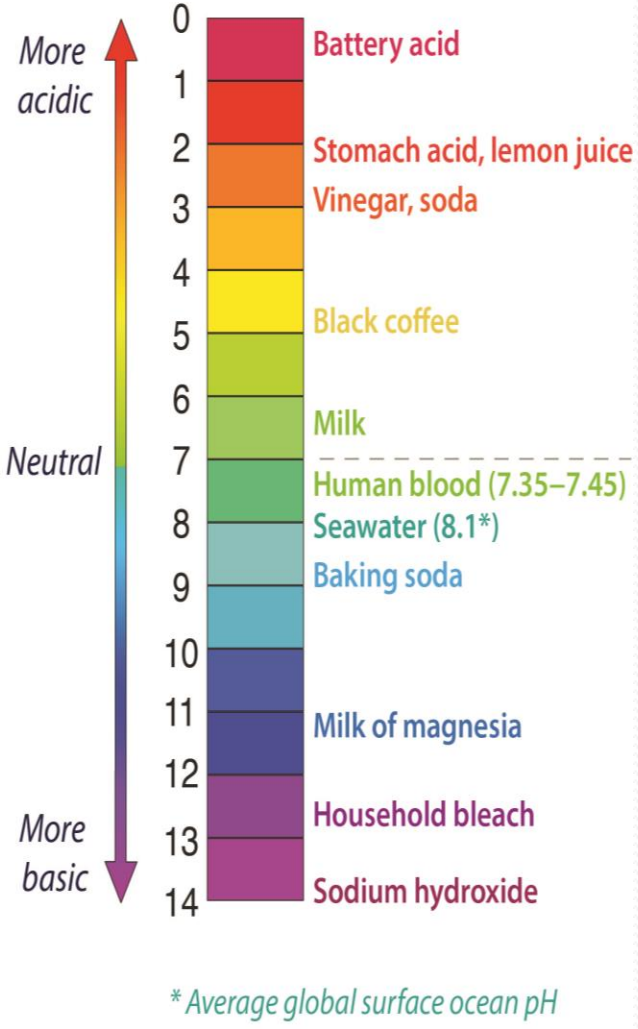
often in response to changing climatic conditions

What will ecological communities of the future look like?

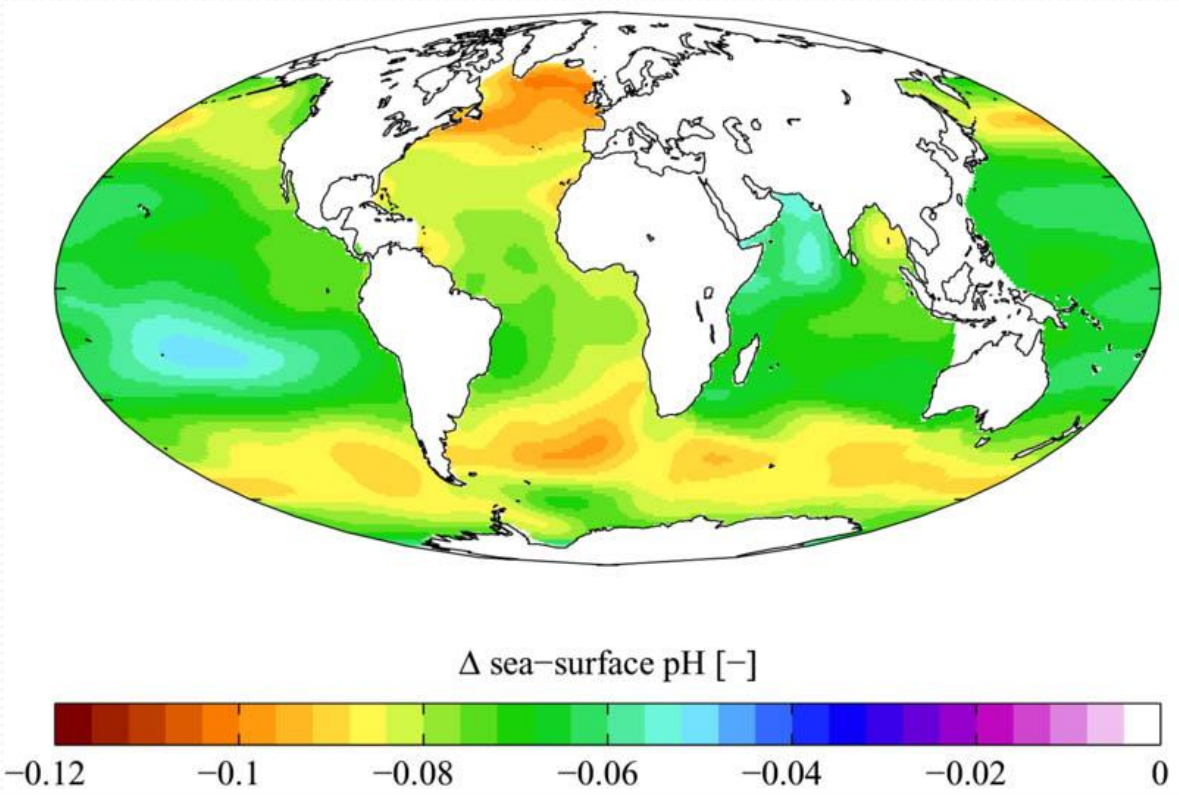

Ocean acidification is an increase in ocean acidity due to increased atmospheric CO_2

What is acidity? What is pH?

- Acidity is a measure of H^+
- pH is the scale used to measure how acidic or how basic something is
- pH is measured on the log scale
- Change in 0.1 pH unit is a 30% increase in H^+



Acidification has already occurred



Ocean acidification in Hawaii

$$CO_{2(atmos)} \leftrightarrow CO_{2(aq)} + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^- \leftrightarrow 2H^+ + CO_3^{2-}$$

Dore et al., 2009

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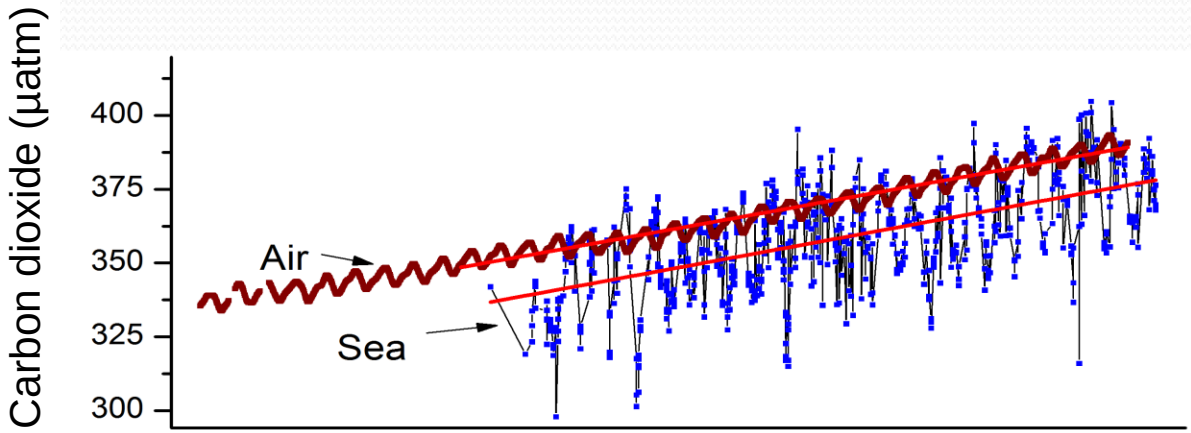

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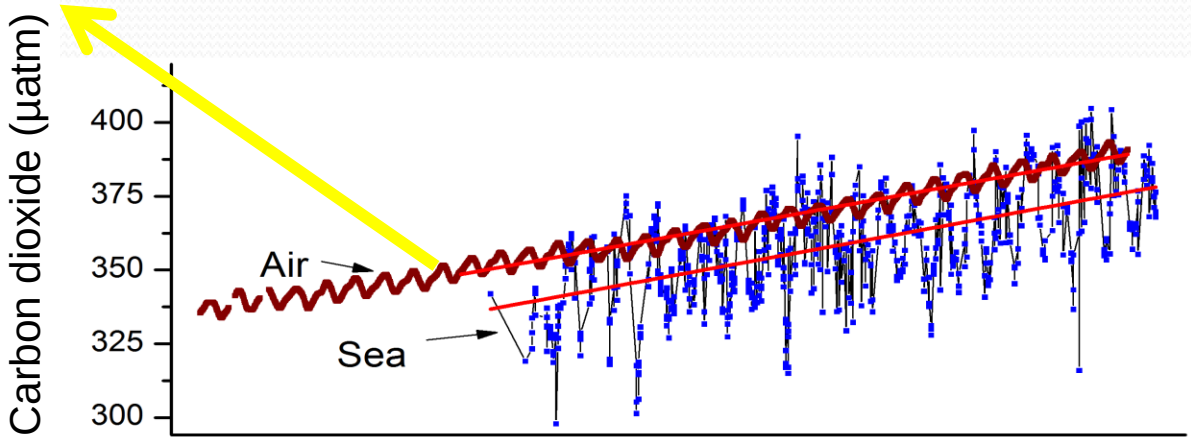

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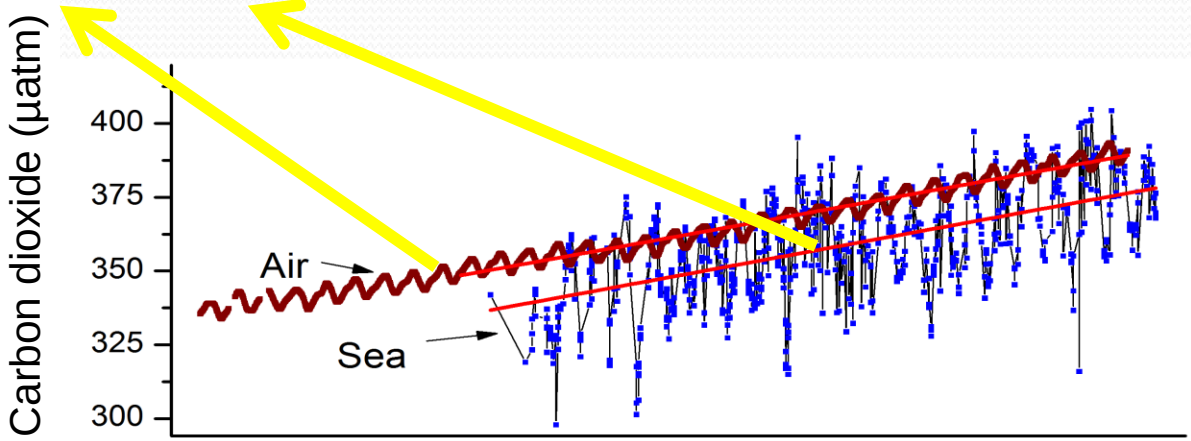

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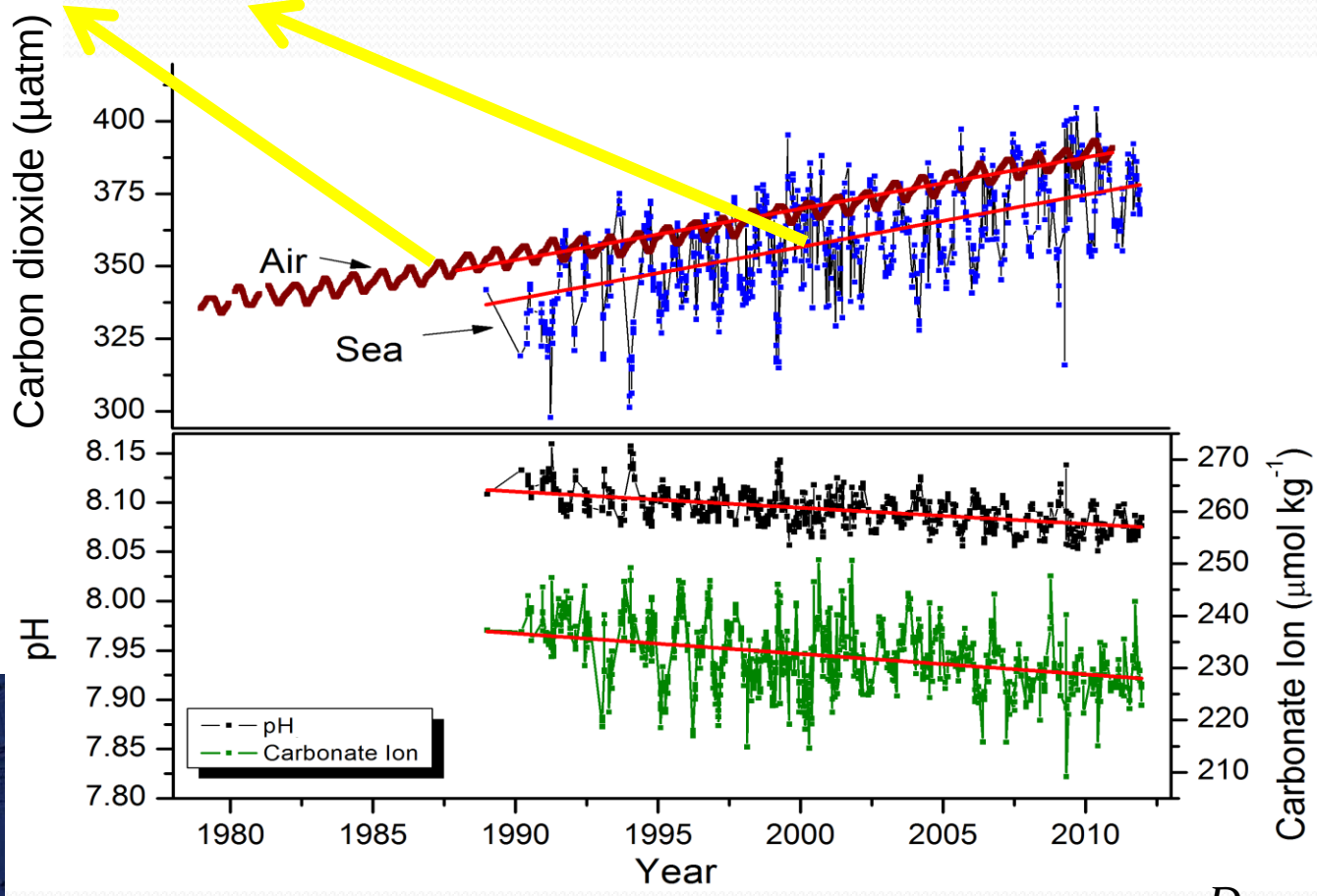

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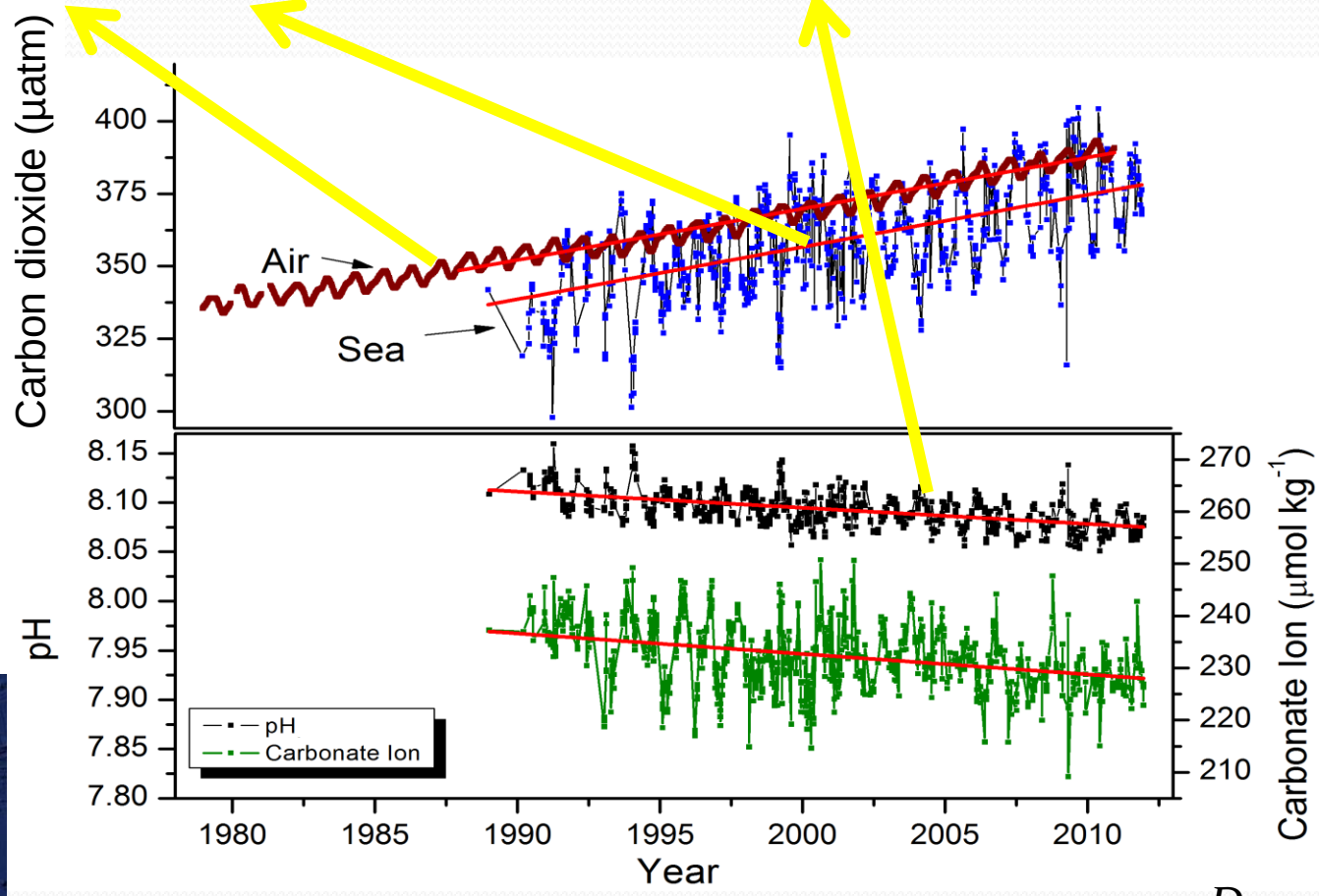

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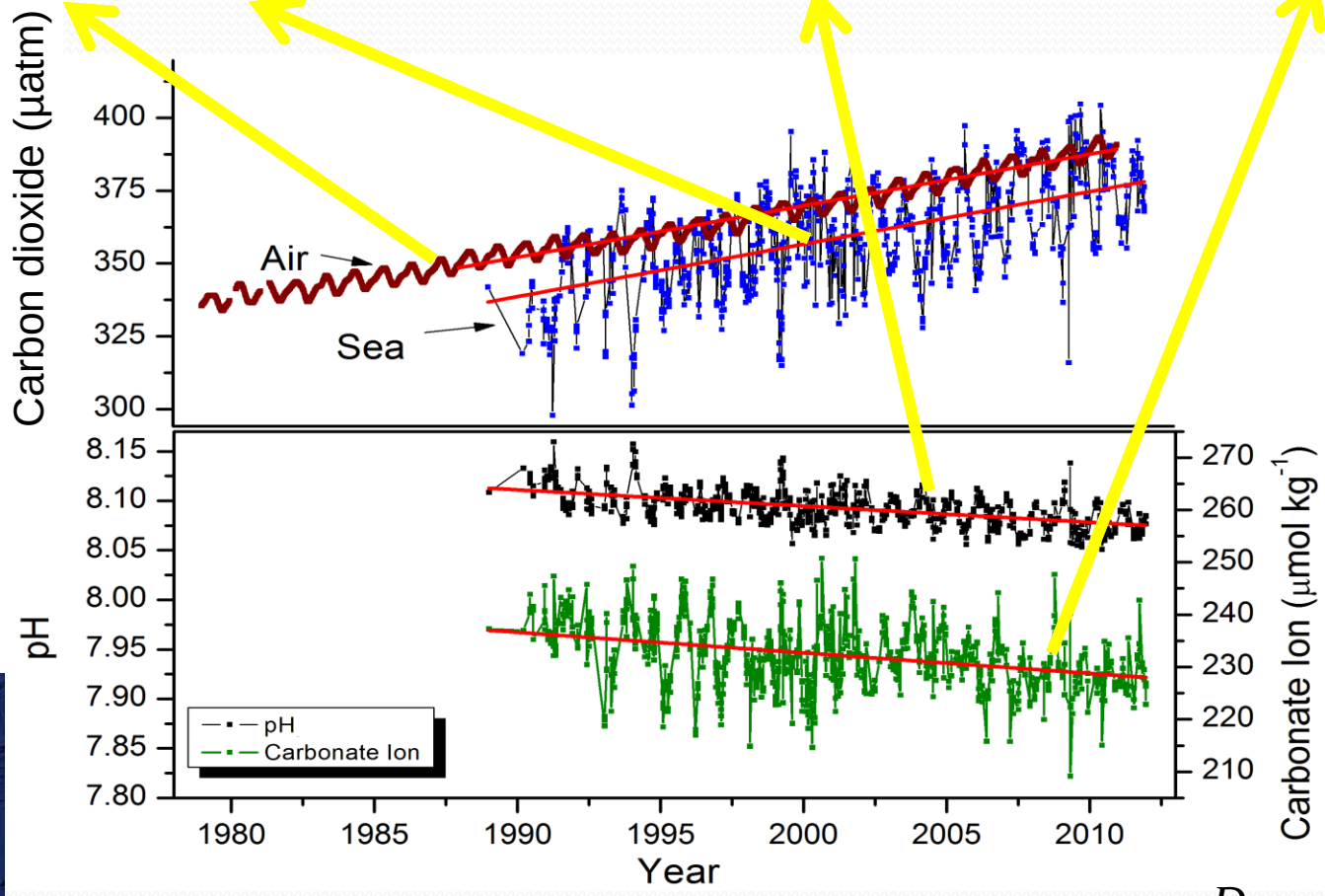
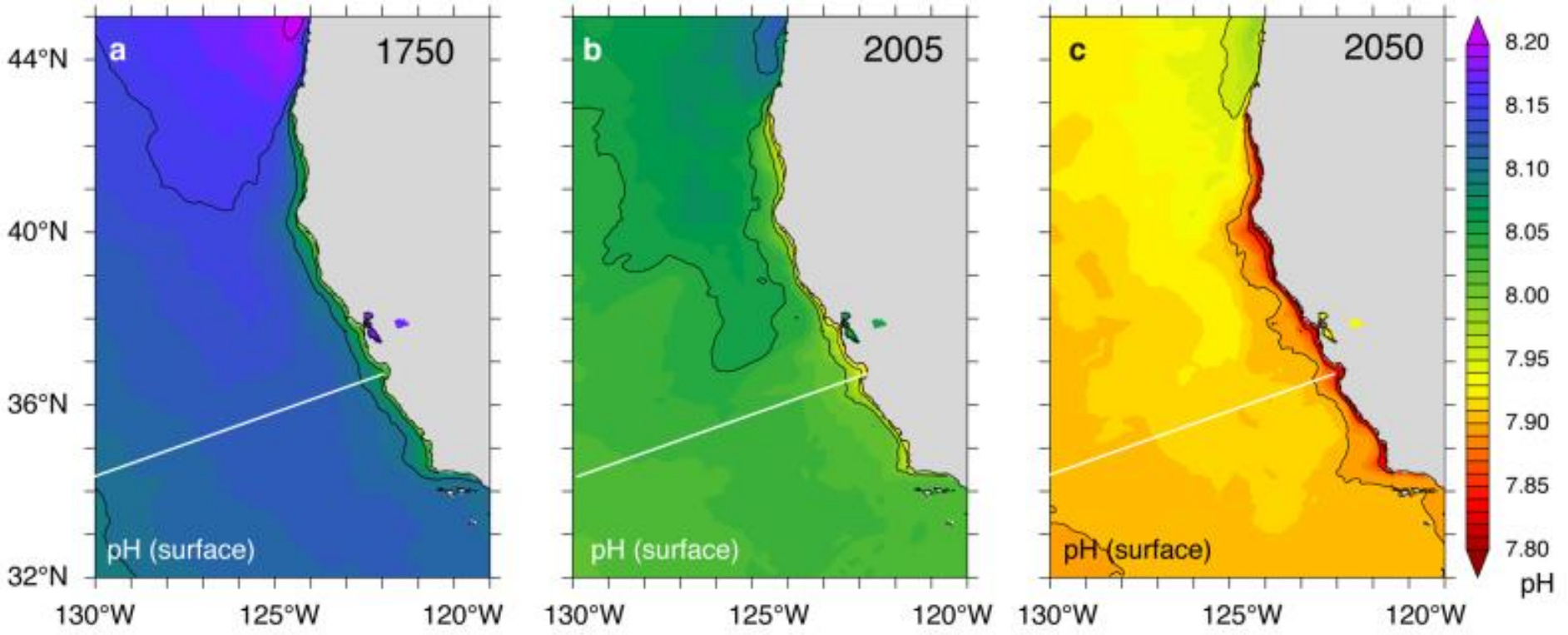


Dore et al., 2009

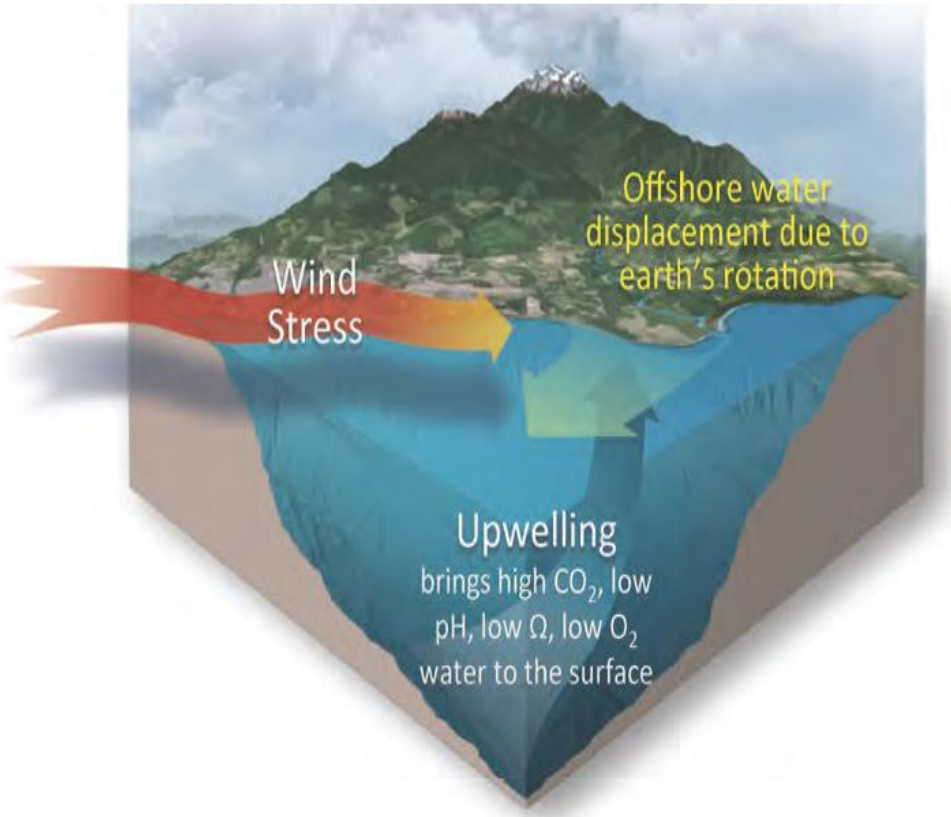
Ocean acidity could increase 100-150% by the year 2100.

Ocean acidification on the West Coast



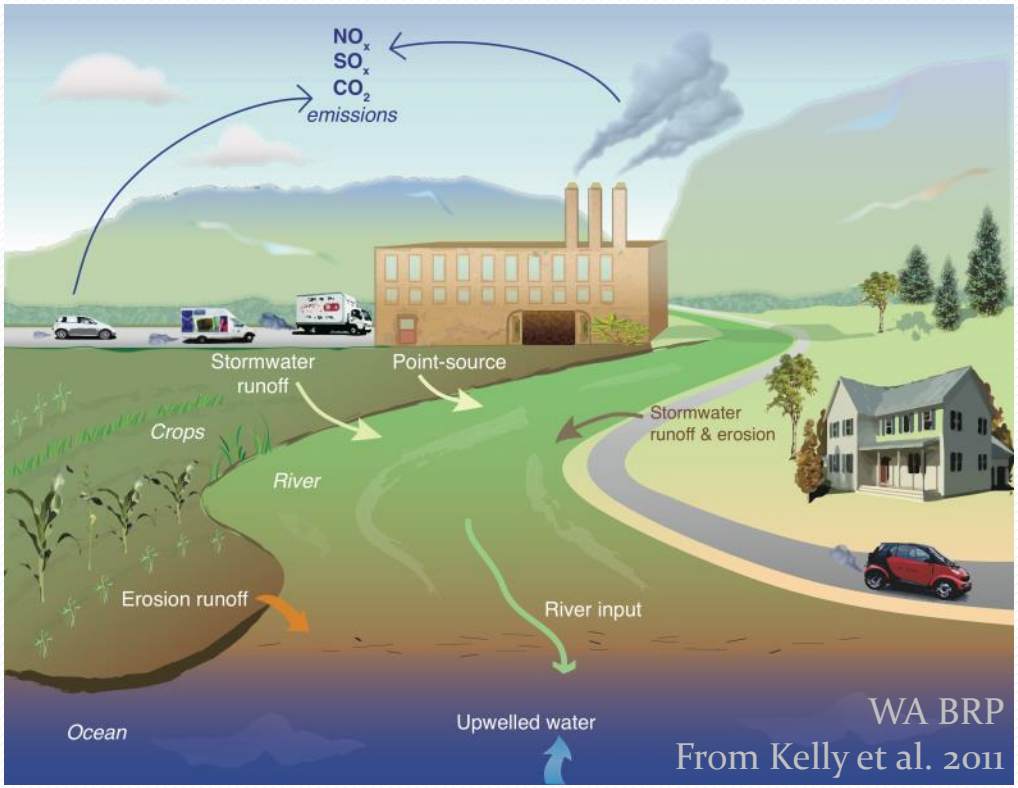
Gruber et al. 2012

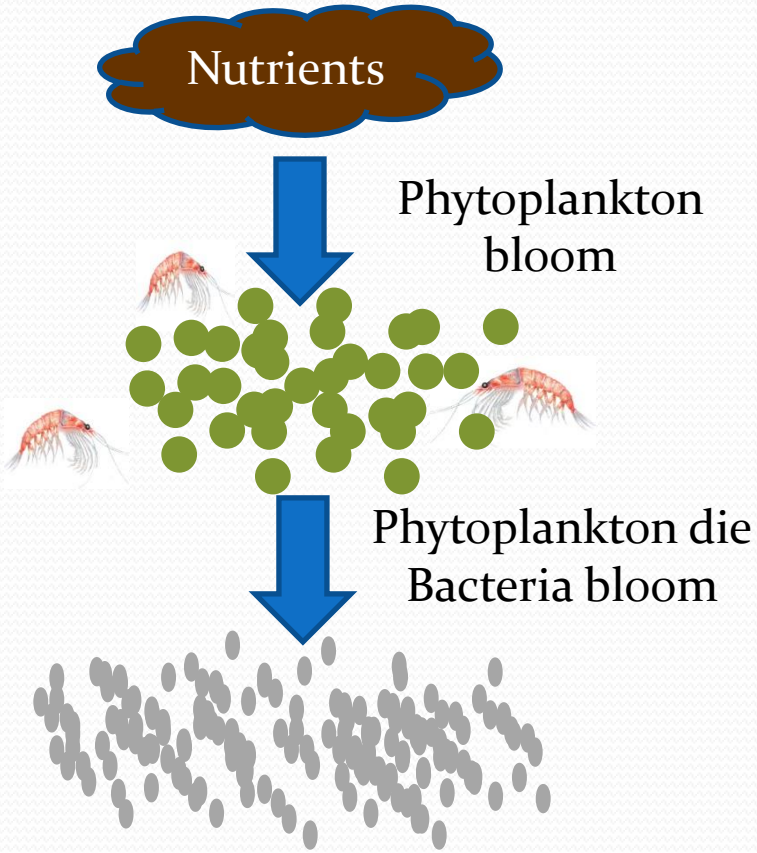
Local oceanography



NOAA PMEL

Nutrients and acidification





Bacteria consume oxygen, respire carbon dioxide

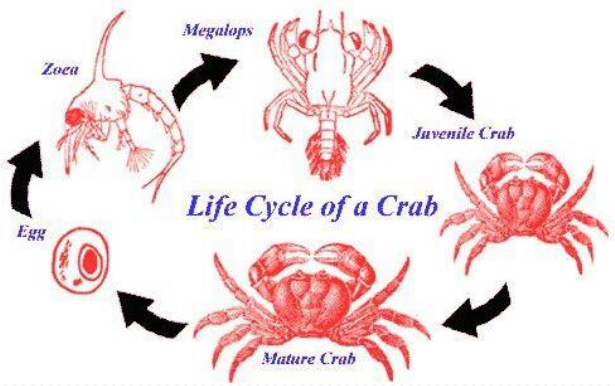
What is the fate of marine communities under ocean acidification?

Physiological processes are sensitive to carbon dioxide and pH

OA can have many effects

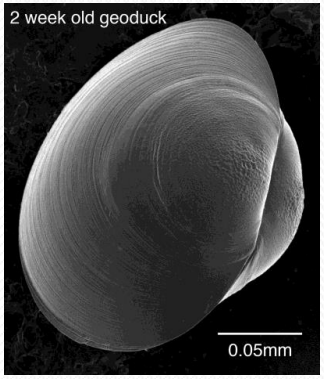
Respiration

Development



Behavior/Nervous system

Growth

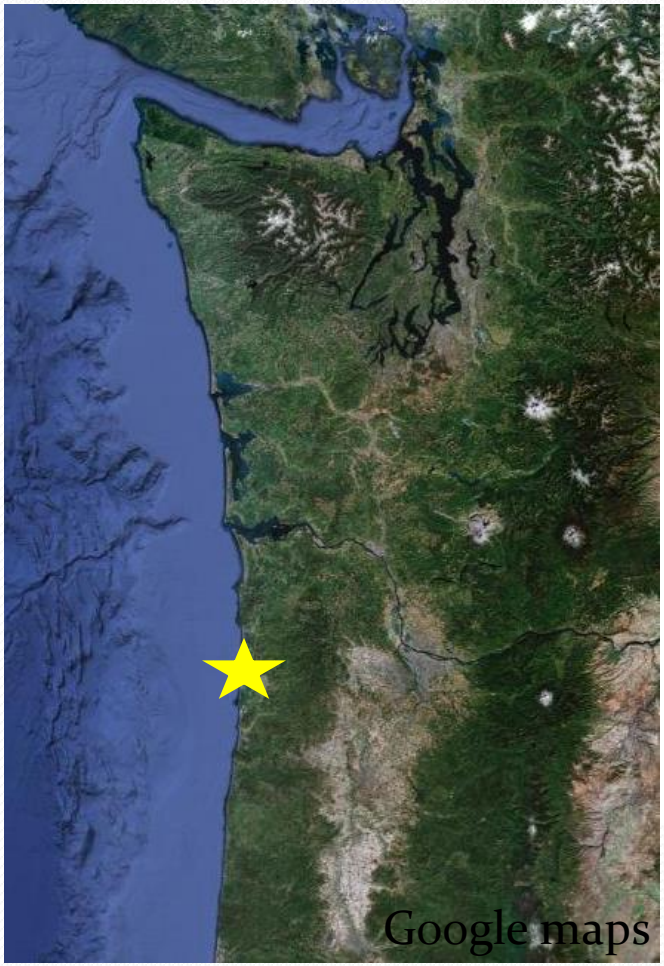


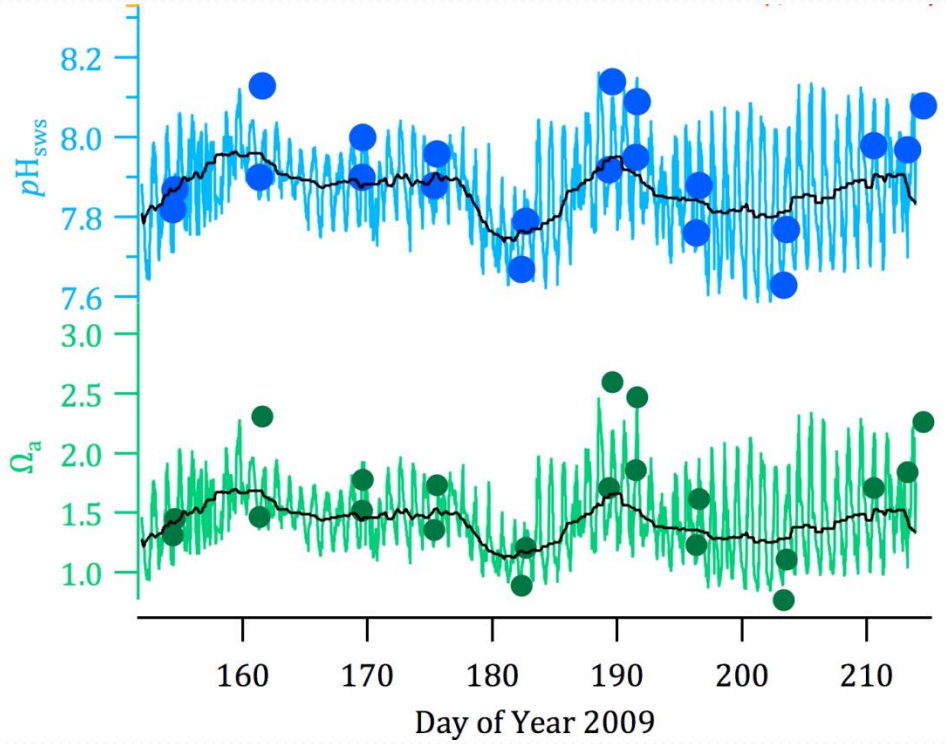
What we know

What we can infer


Benjamin Drummond / basjs.com

Oysters in Netart's Bay



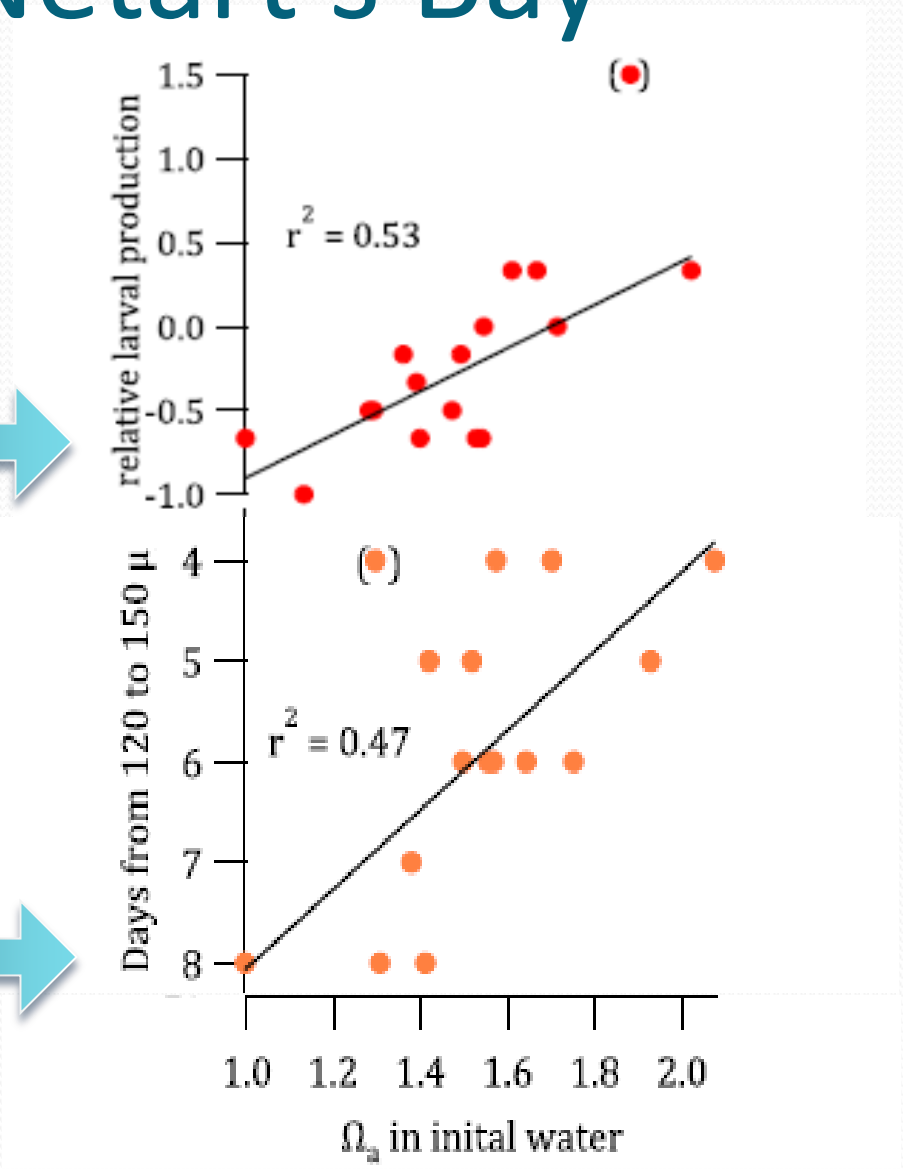


Barton et al. 2012

Oysters in Netart's Bay

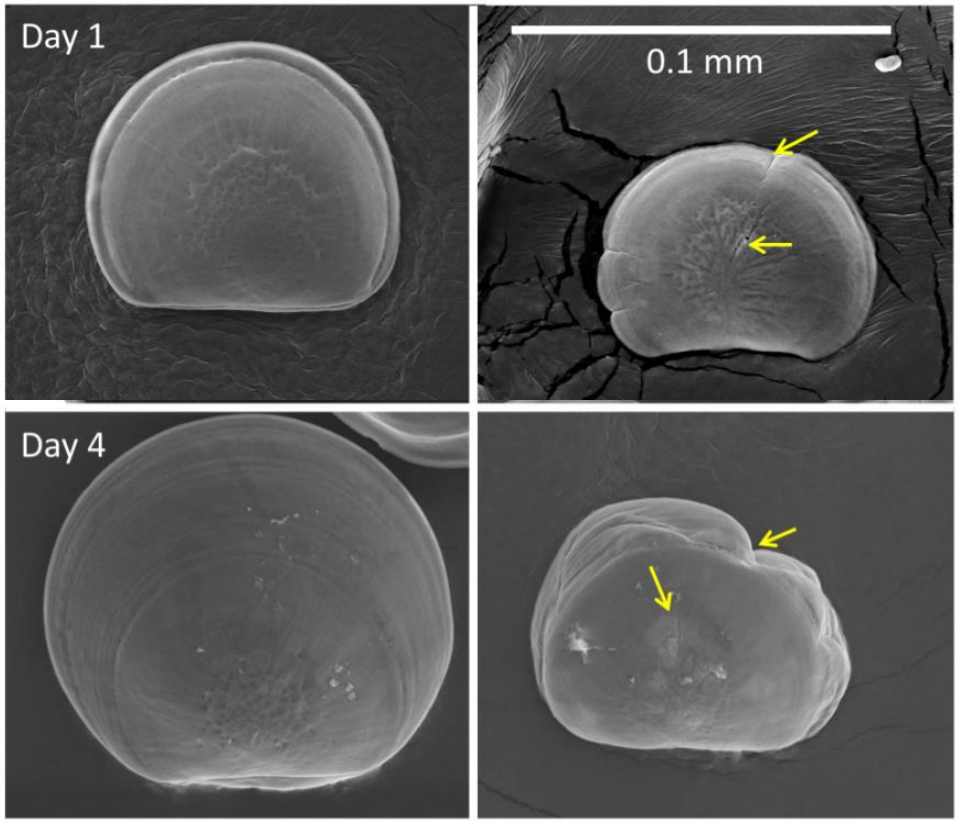
Production is lower with lower pH

Growth in feeding stage slower with lower pH



Barton et al. 2012

Low CO_2 High CO_2



nfcc

Oregon State University OSU College of Earth, Ocean, and Atmospheric Sciences

Taylor Shellfish Farms

E. Brunner, G. Waldbusser

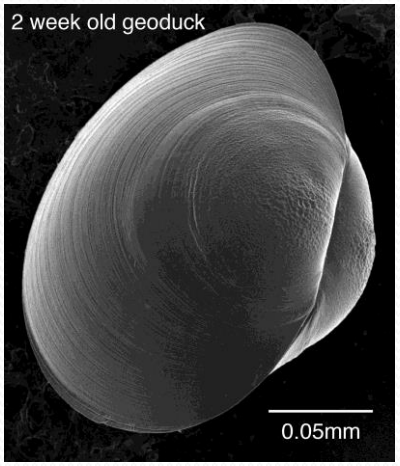
Species response to pCO_2 can vary

Eastern oyster

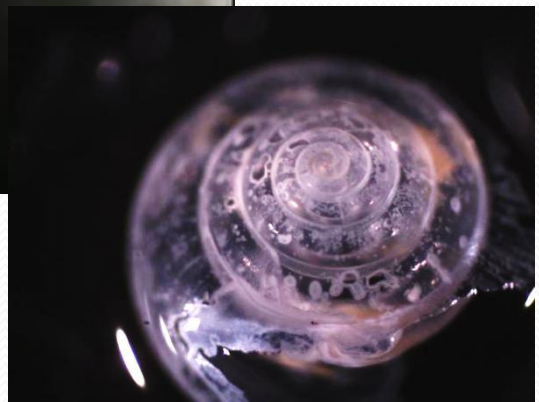
Suminoe oyster

Miller et al 2009, photos from National Geographic

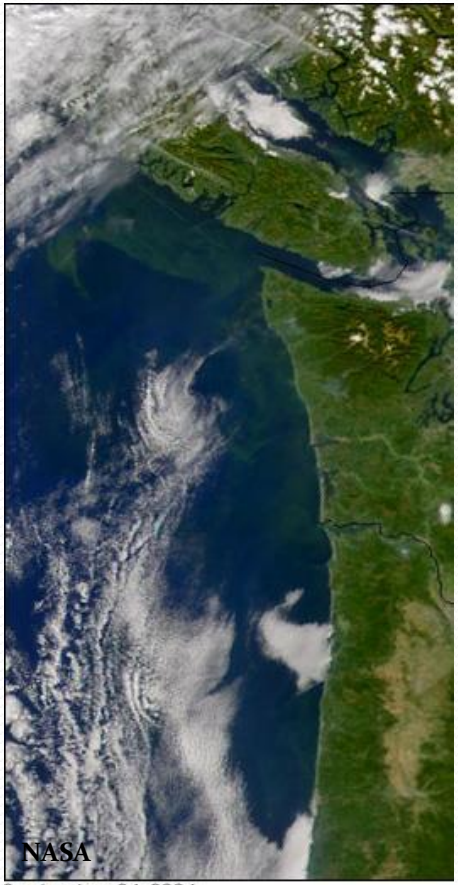
Research on commercial shellfish

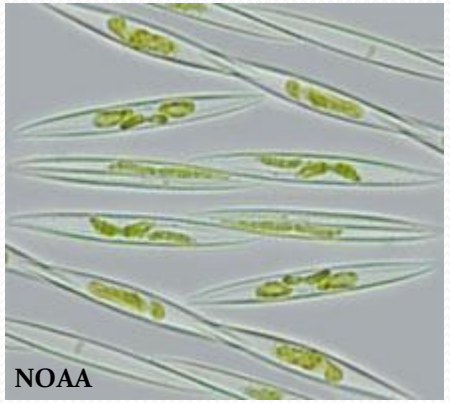


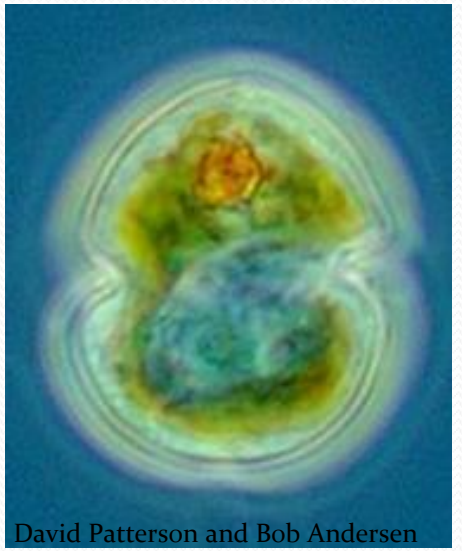
OA negatively affects pteropods



There will be surprises!





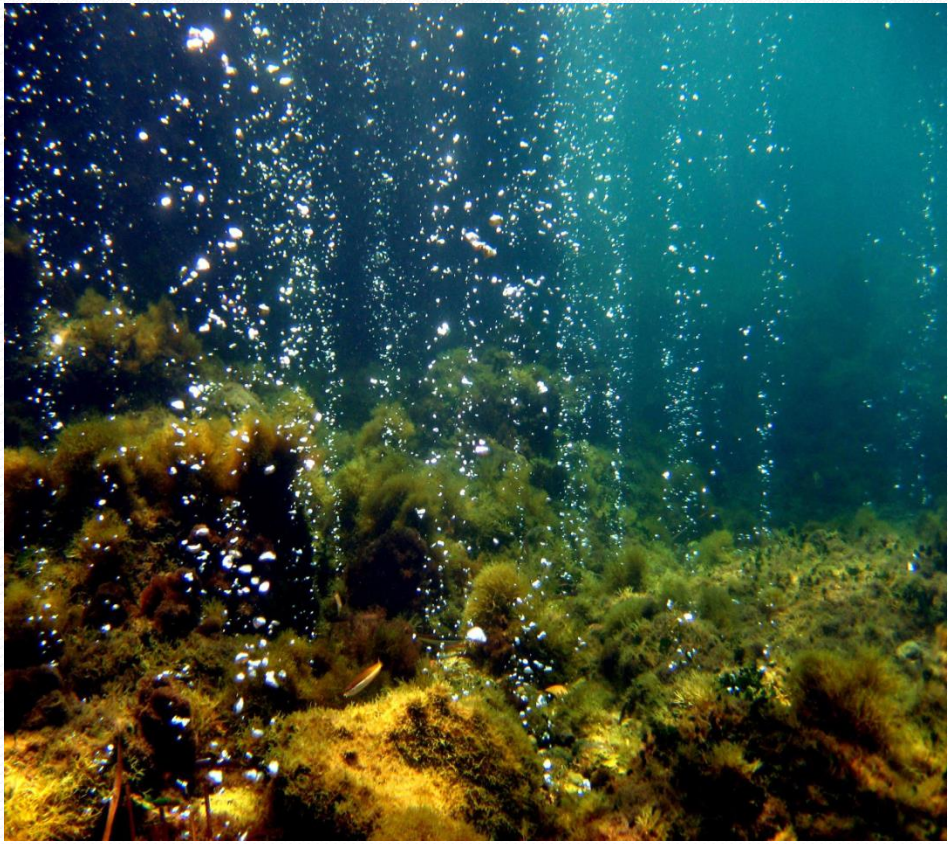


Munday et al. 2009, 2010;
Simpson et al. 2011; Nilsson et al. 2012

Sun et al. 2011, Fu et al. 2010

A natural experiment in Italy

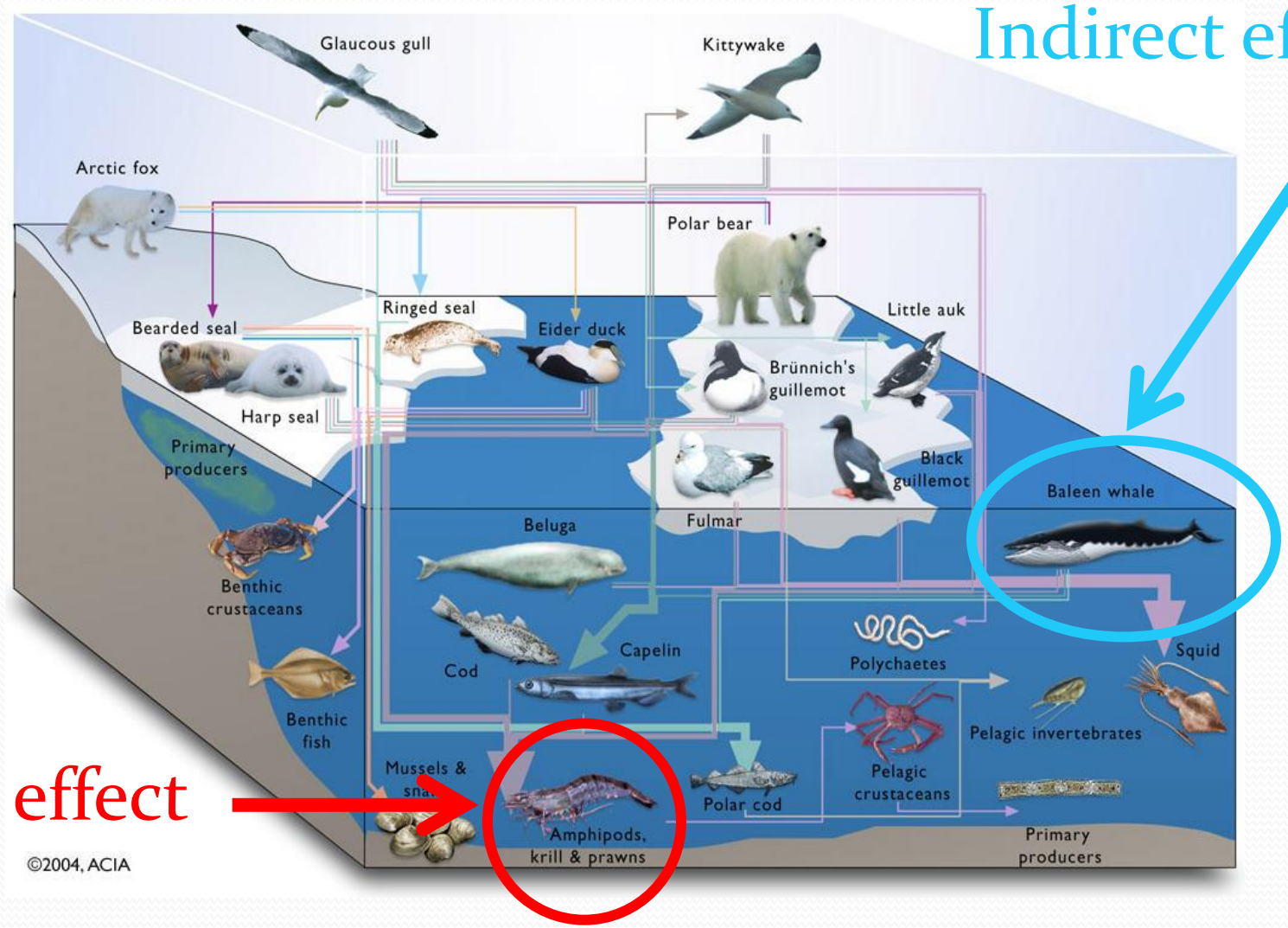
Low CO_2



High CO_2

J. Hall-Spencer

Complex systems have complex responses



http://marinebio.org/Oceans/Biotic-Structure.asp

OA will affect marine food webs

Which species are affected by OA will drive the nature of the food web response

OA will affect marine food webs

OA impacts on just one or a few species can have big effects on the food web and ecosystem services

Impacts of multiple stressors

What we know

- The ocean is acidifying rapidly
- Some local species will be sensitive to OA
- Biological responses to OA are variable
- Impacts of OA will ripple through food webs
- Other stressors can exacerbate species response