

# Update on biological impacts of ocean acidification

Shallin Busch, Ph.D.

Shallin.Busch@noaa.gov, (206) 860-6782

Northwest Fisheries Science Center  
National Oceanic and Atmospheric Administration



# What is the fate of marine communities under ocean acidification?

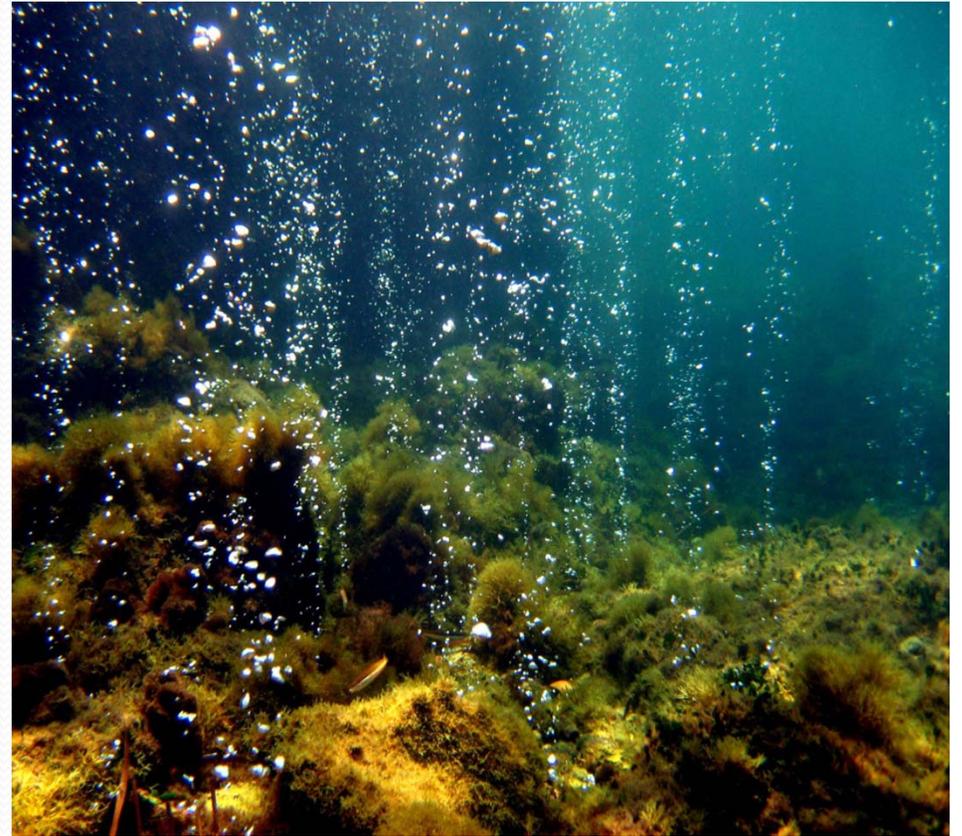


Neil Banas

# A natural experiment in Italy



Low CO<sub>2</sub>



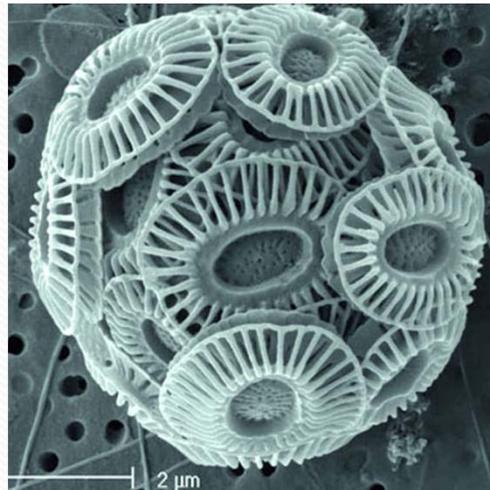
High CO<sub>2</sub>

Carbon dioxide ( $\text{CO}_2$ )

Hydrogen ions ( $\text{H}^+$ )

Carbonate ions ( $\text{CO}_3^{-2}$ )

Bicarbonate ions ( $\text{HCO}_3^-$ )



Museum of Comparative Zoology, Harvard University

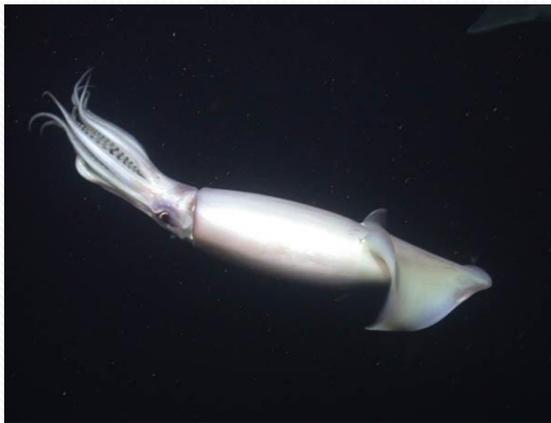
opacity

# Physiological processes are sensitive to carbon dioxide and pH

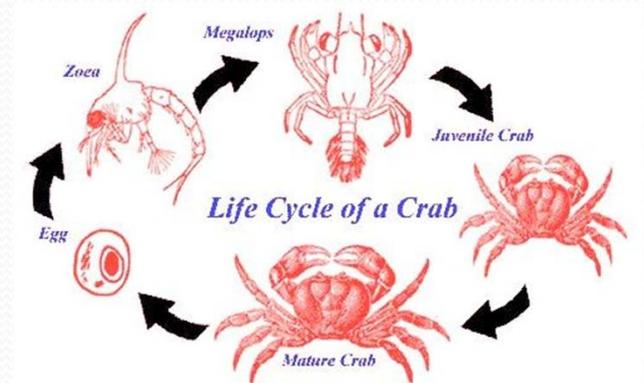


# OA can have many effects

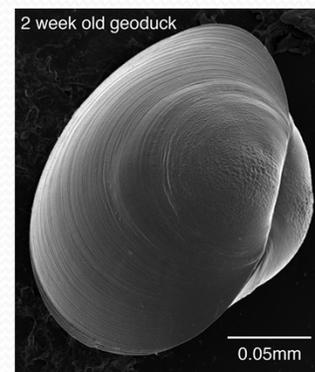
## Respiration/Photosynthesis



## Development



## Behavior



## Growth

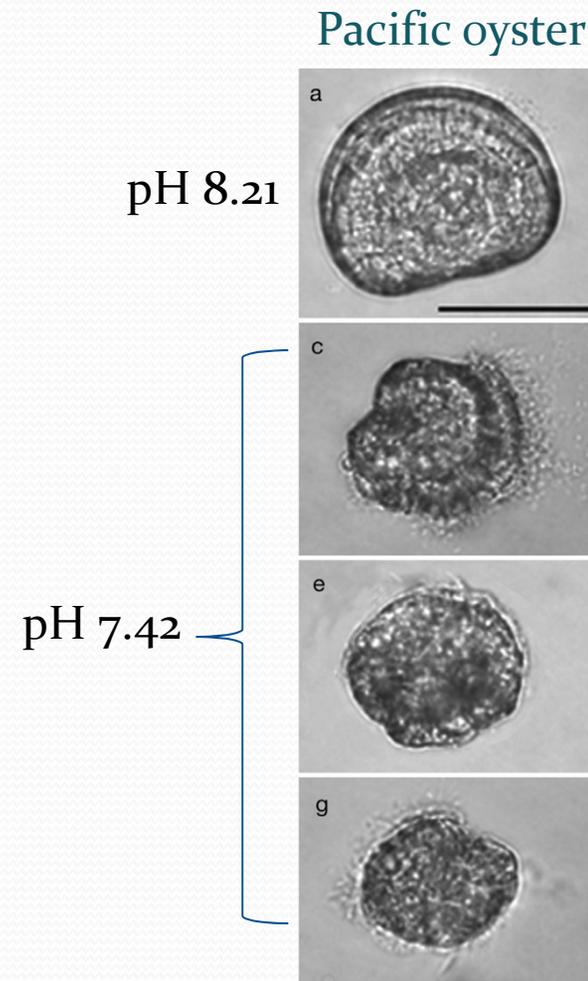
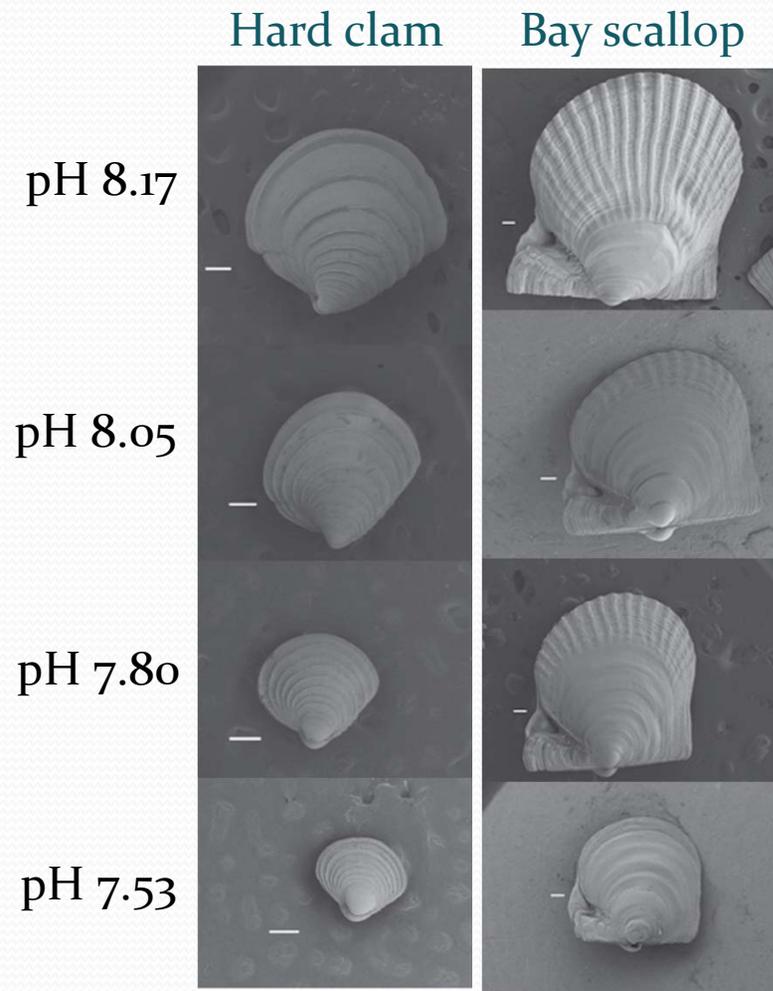


# What we know

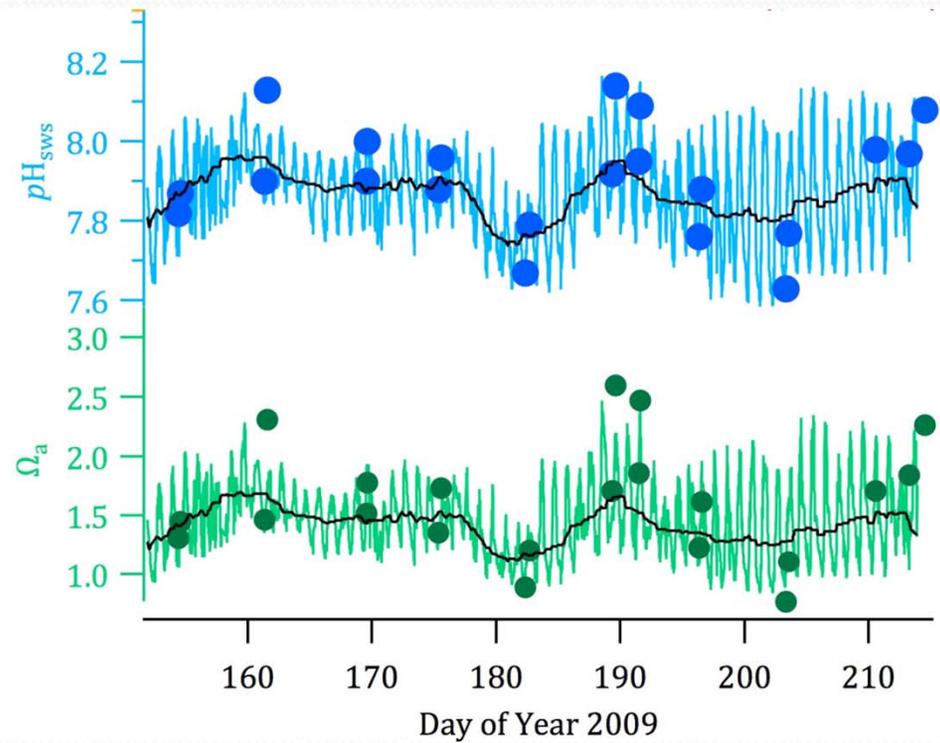
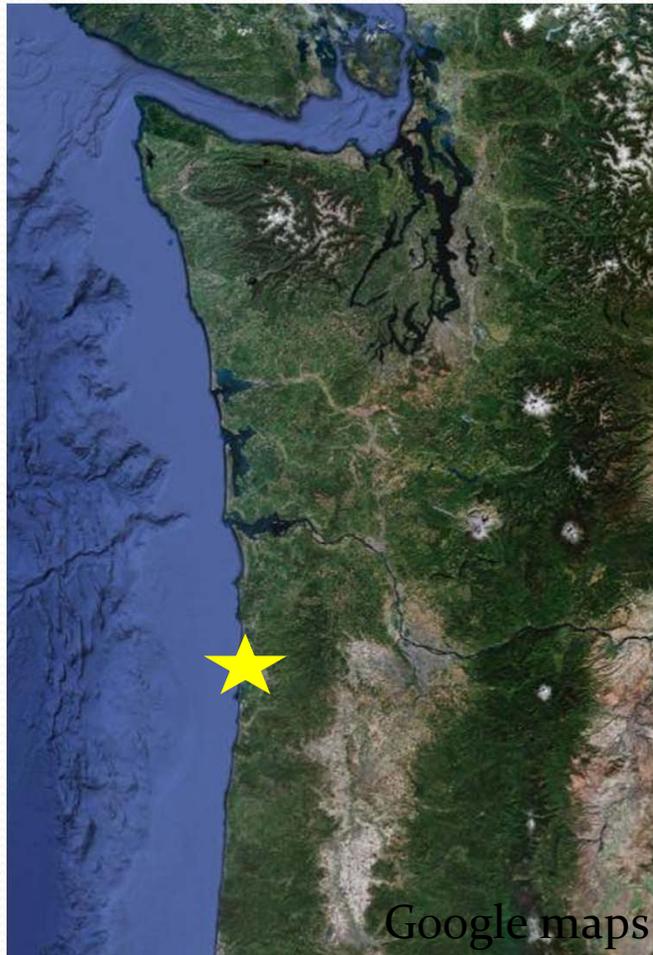
# What we can infer



# Three commercial shellfish species



# Oysters in Netart's Bay

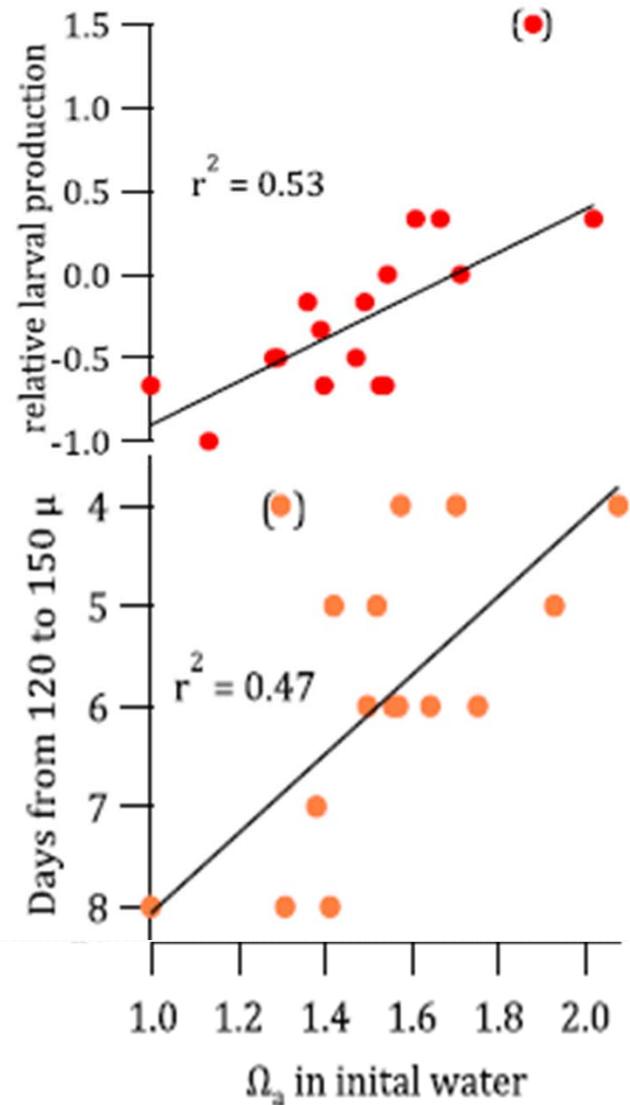


# Oysters in Netart's Bay

Production is lower with lower pH



Growth in feeding stage slower with lower pH



# Species response to $p\text{CO}_2$ can vary

Eastern oyster

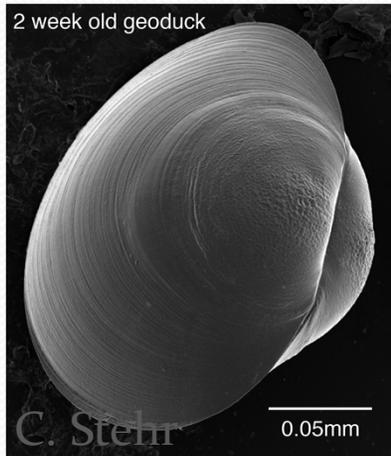


Suminoe oyster



Miller et al 2009, photos from National Geographic

# Research on commercial shellfish



# Shelled pteropods: planktonic snails

*Click on title to  
watch movie*

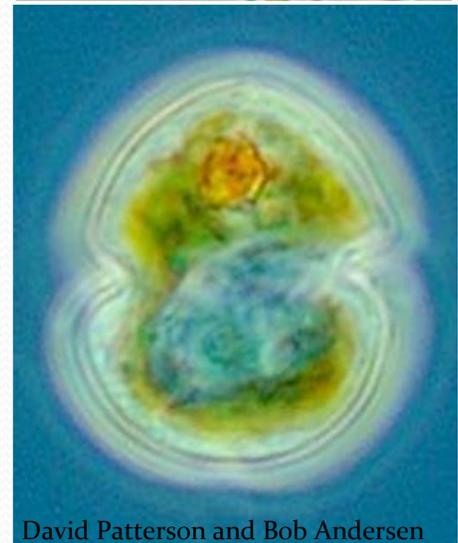
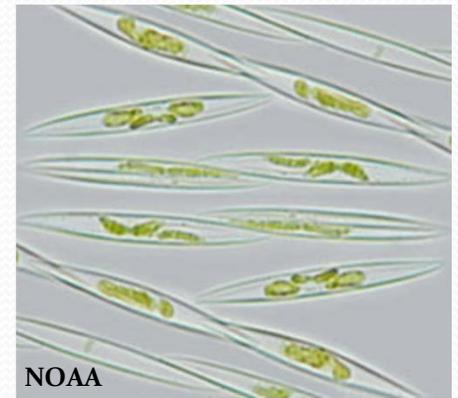


*Limacina helicina* fresh shell

*Limacina helicina* in OA experiment  
Incubation at 1100  $\mu\text{atm}$   $\text{pCO}_2$ , 3°C for 29 days.

Lischka et al. 2011

# There will be surprises!

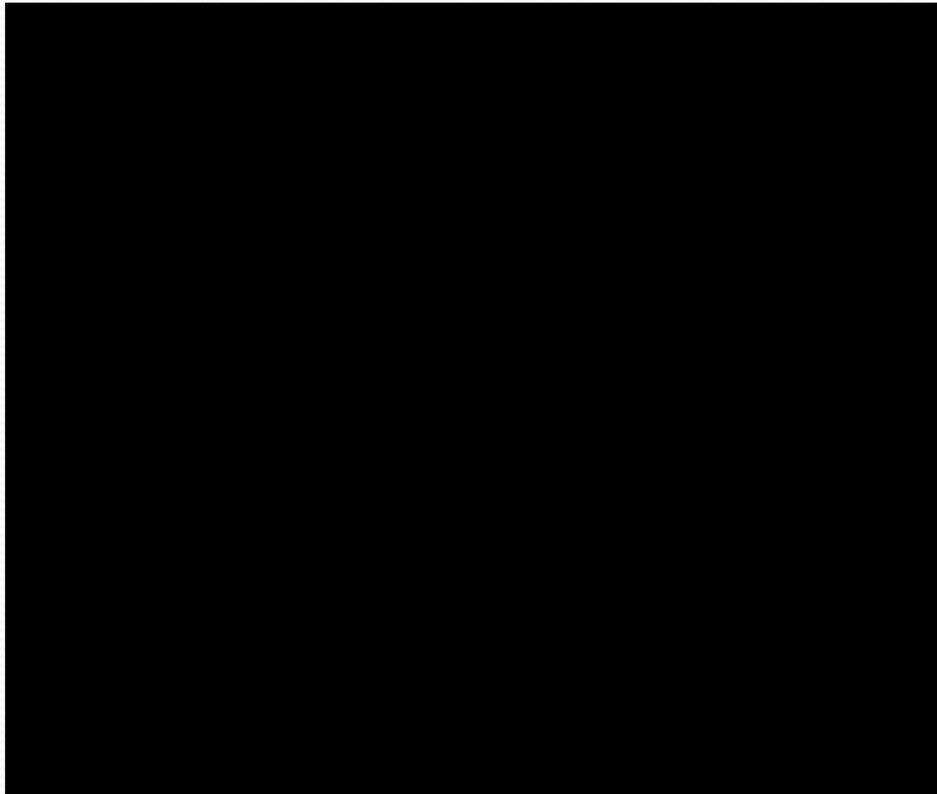


Munday et al. 2009, 2010;  
Simpson et al. 2011; Nilsson et al. 2012

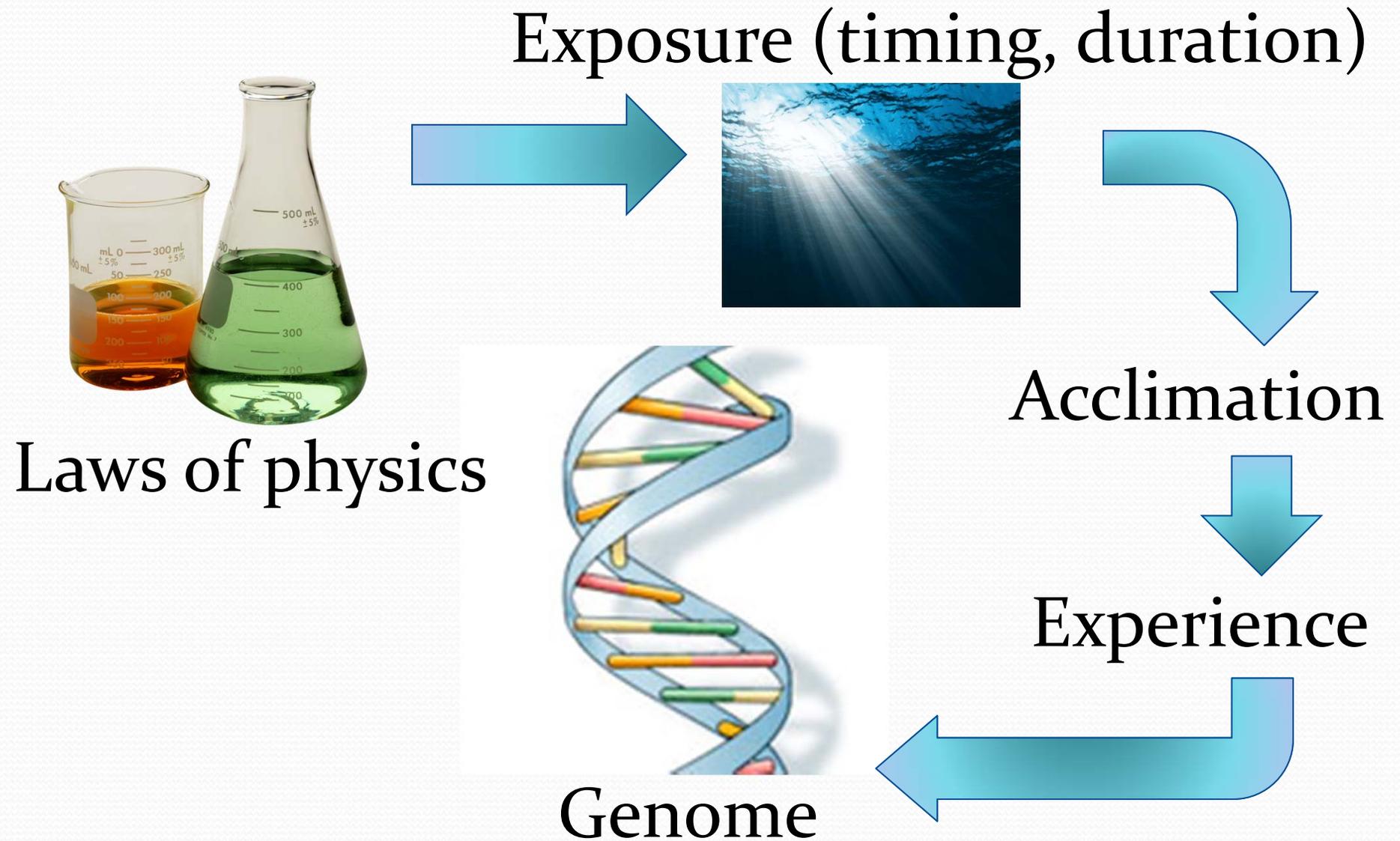
Sun et al. 2011, Fu et al. 2010

# Why focus on larvae and juveniles?

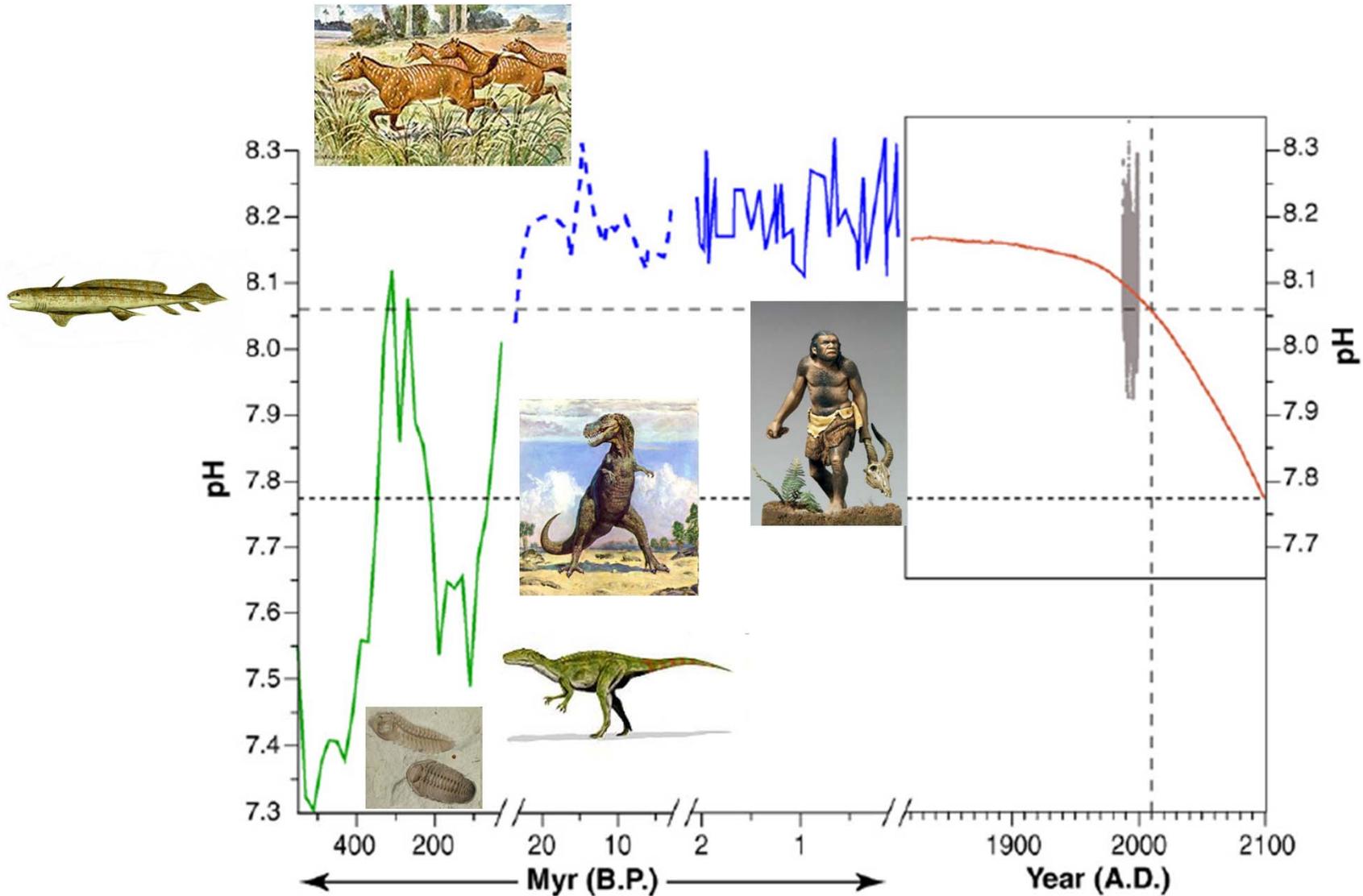
*Click in box to watch movie*

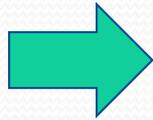


# From chemistry to biology...

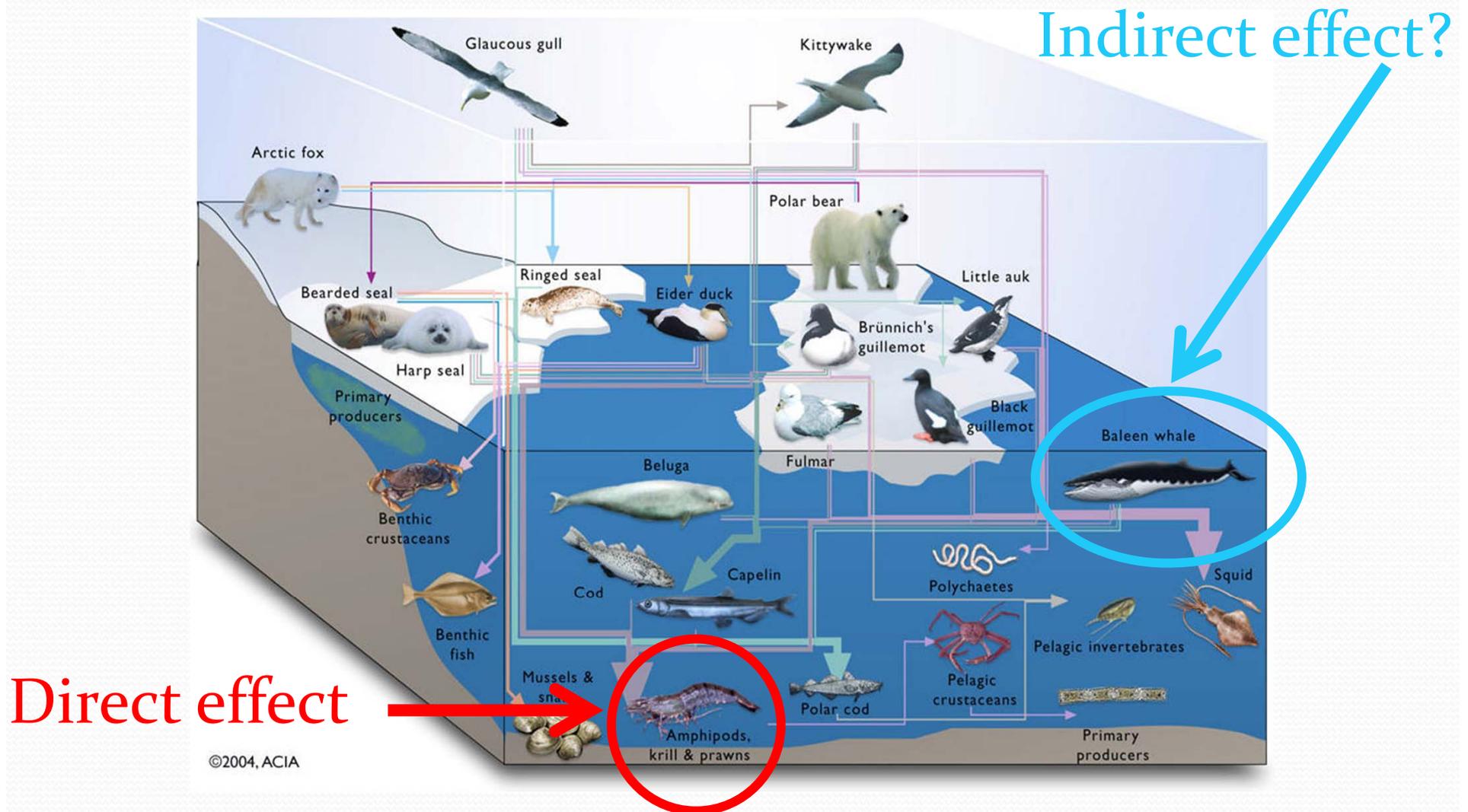


# Seawater pH is changing very quickly

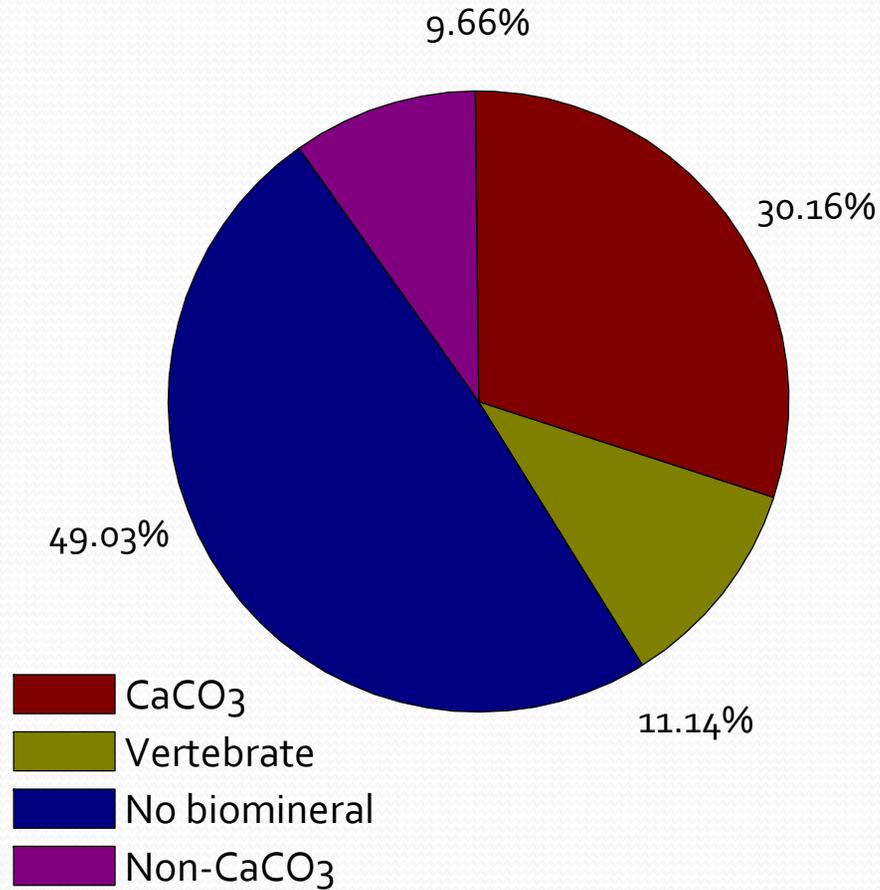




# Complex systems have complex responses



# 30% of Puget Sound species calcify



Busch et al., in review



# OA will affect marine food webs

Species affected by OA will also be affected by predator-prey interactions



# OA will affect marine food webs

OA will impact species unaffected by changes in pH via predator-prey interactions



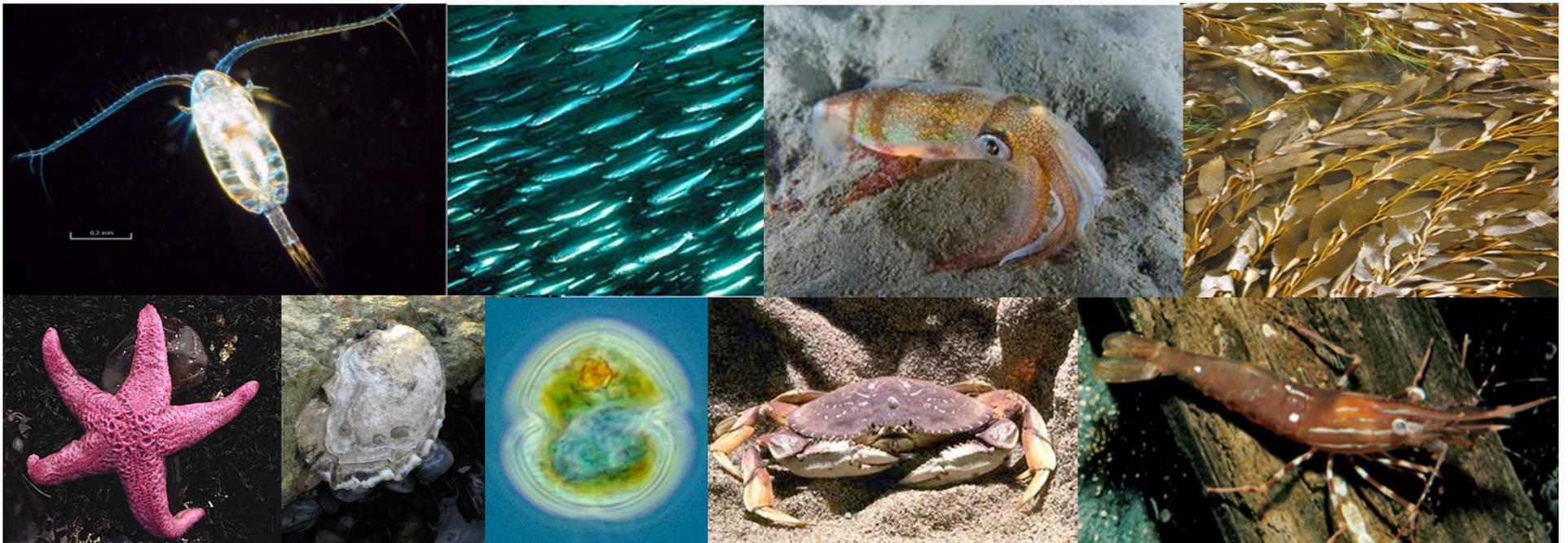
# OA will affect marine food webs

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



brewbooks

Soil Science



Walter Siegmund



Eutrophication&hypoxia



# 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 response to OA

