

Ocean acidification and its biological impacts

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Earth's history shows us that communities change



often in response to changing climatic conditions



What will ecological communities of the future look like?



Physiological processes are sensitive to carbon dioxide and pH

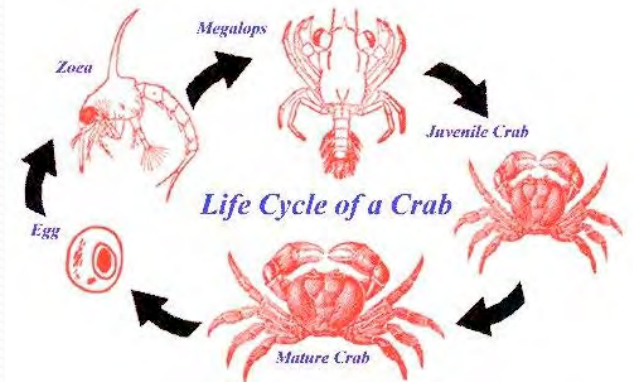


OA can have many effects

Respiration



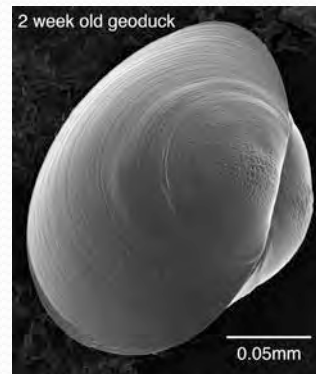
Development



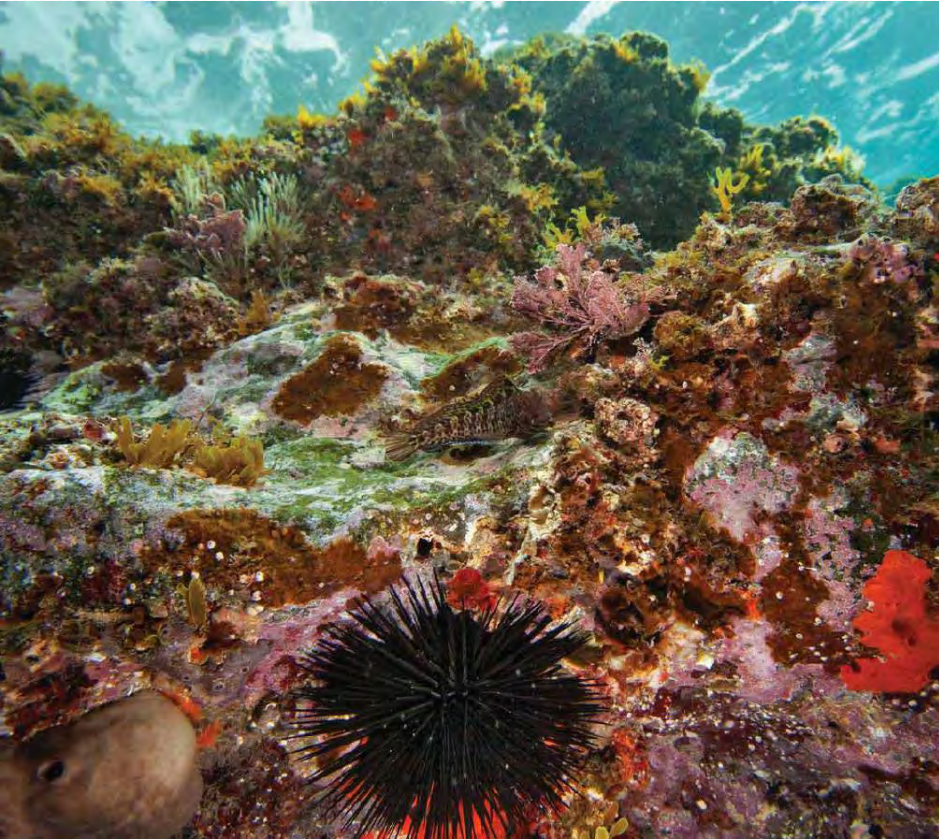
Behavior/Nervous system



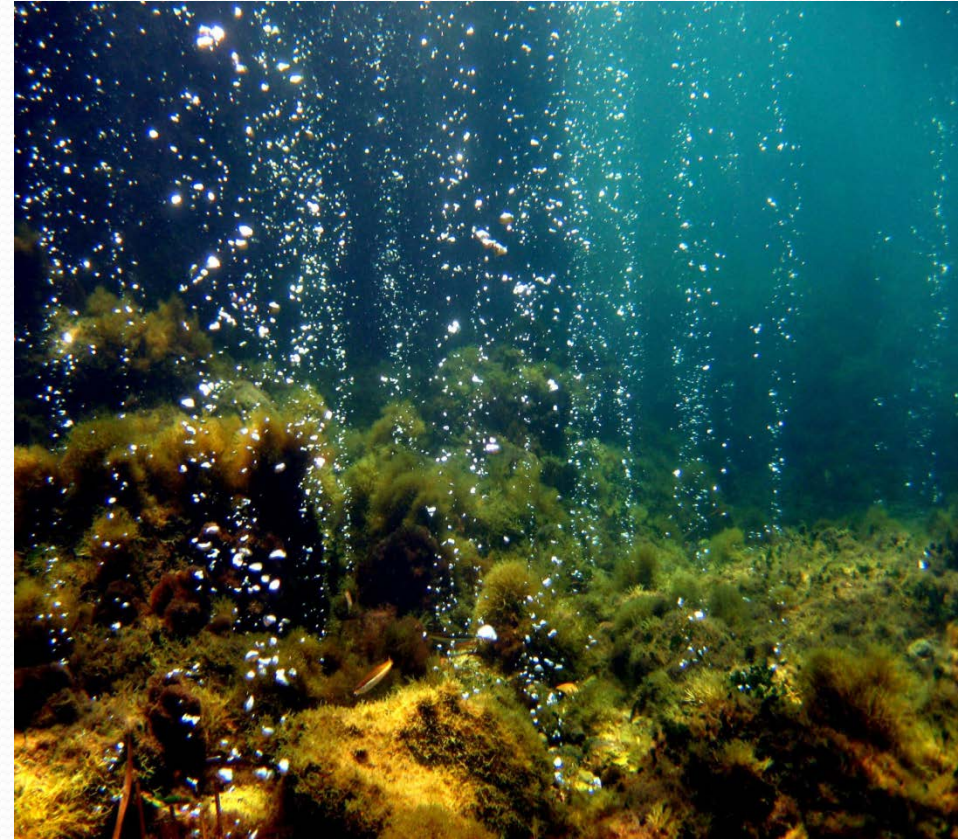
Growth



A natural experiment in Italy



Low CO₂



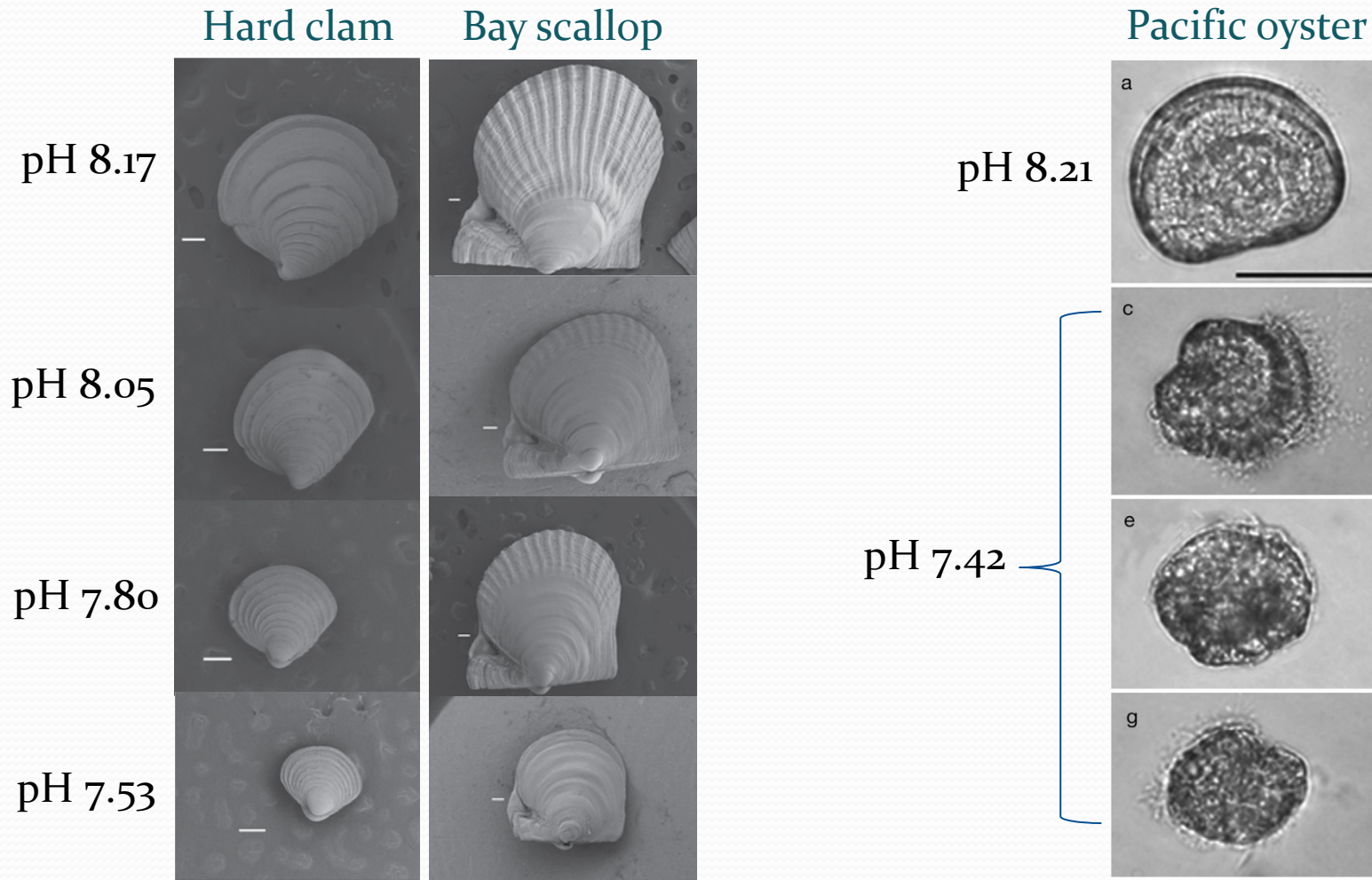
High CO₂

What we know

What we can infer

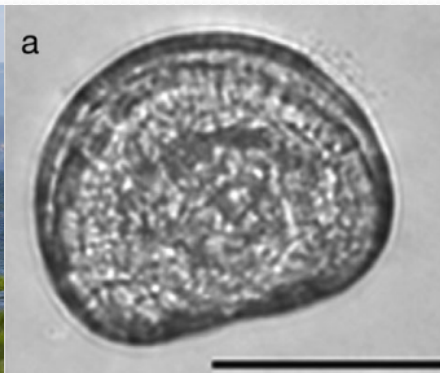


Three commercial shellfish species

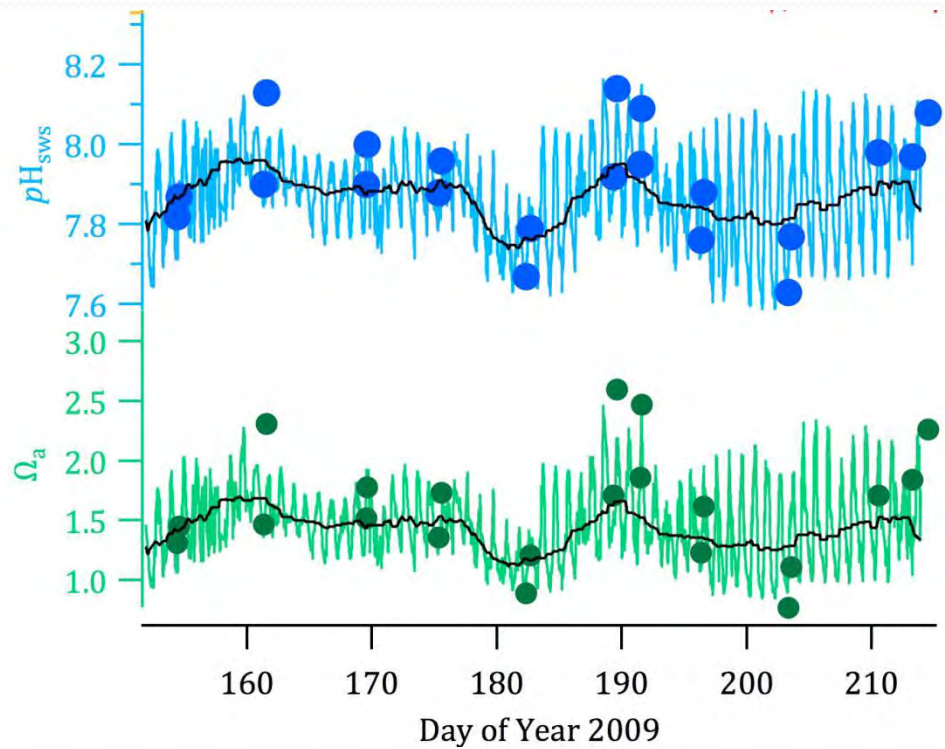
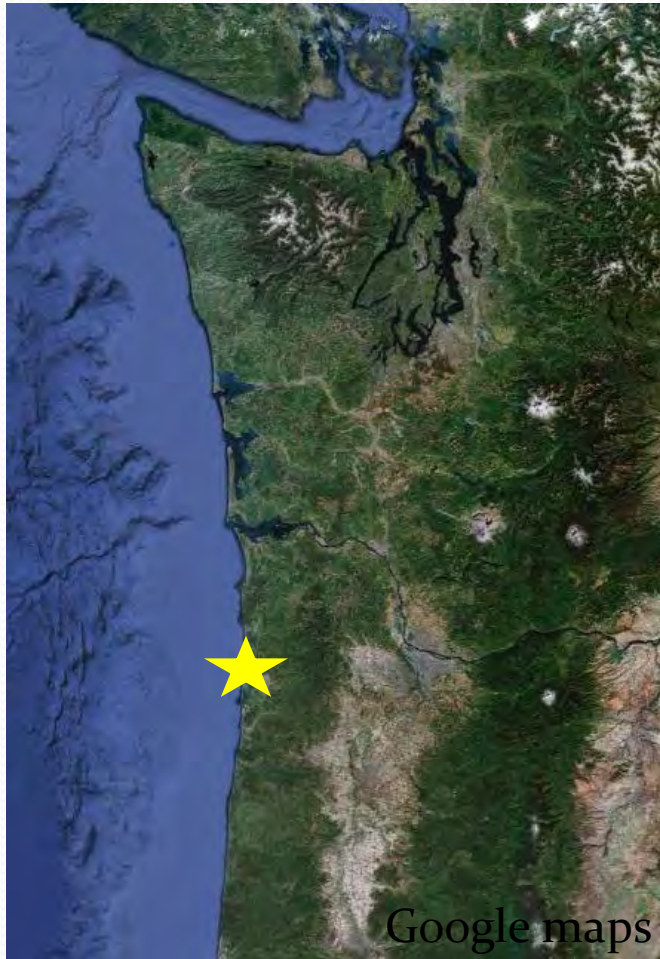


West coast oyster failure

- Willapa Bay: Wild oysters had low levels of reproduction for 7 years
- Hatcheries: Production of larvae reduced over last 6 years
- Correlations of failure with pH

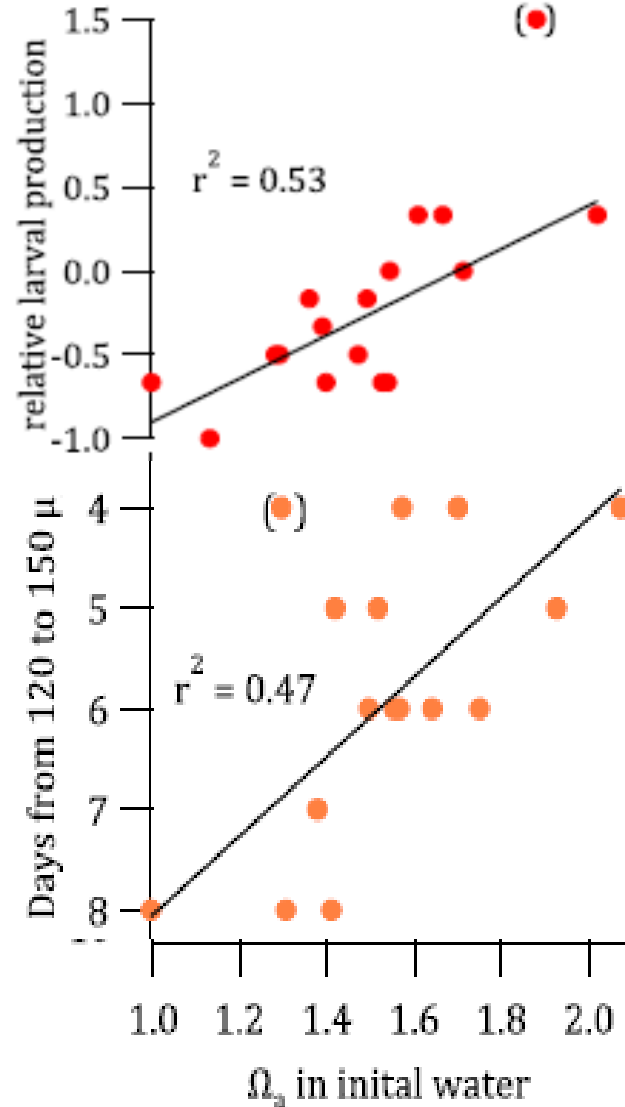


Oysters in Netart's Bay



Oysters in Netart's Bay

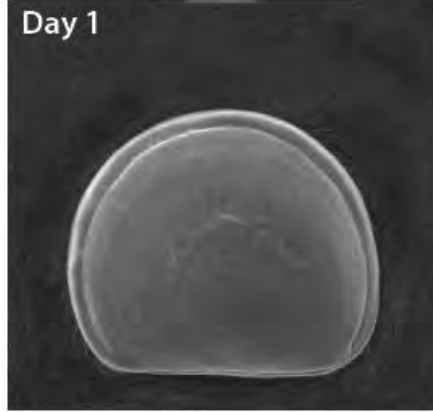
Production is lower
with lower pH



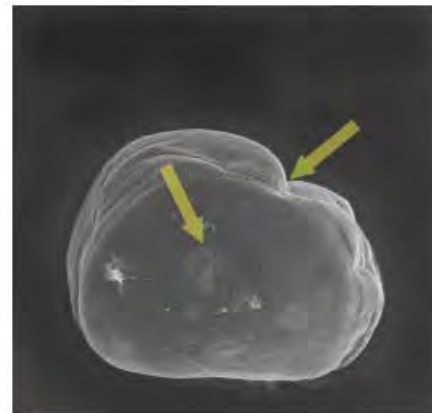
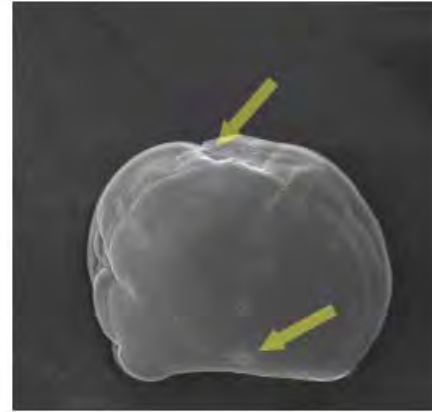
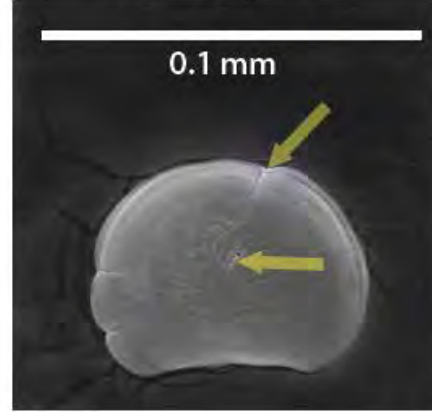
Growth in feeding stage
slower with lower pH



Low $p\text{CO}_2$
High $\Omega_{\text{Aragonite}}$



High $p\text{CO}_2$
Low $\Omega_{\text{Aragonite}}$



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

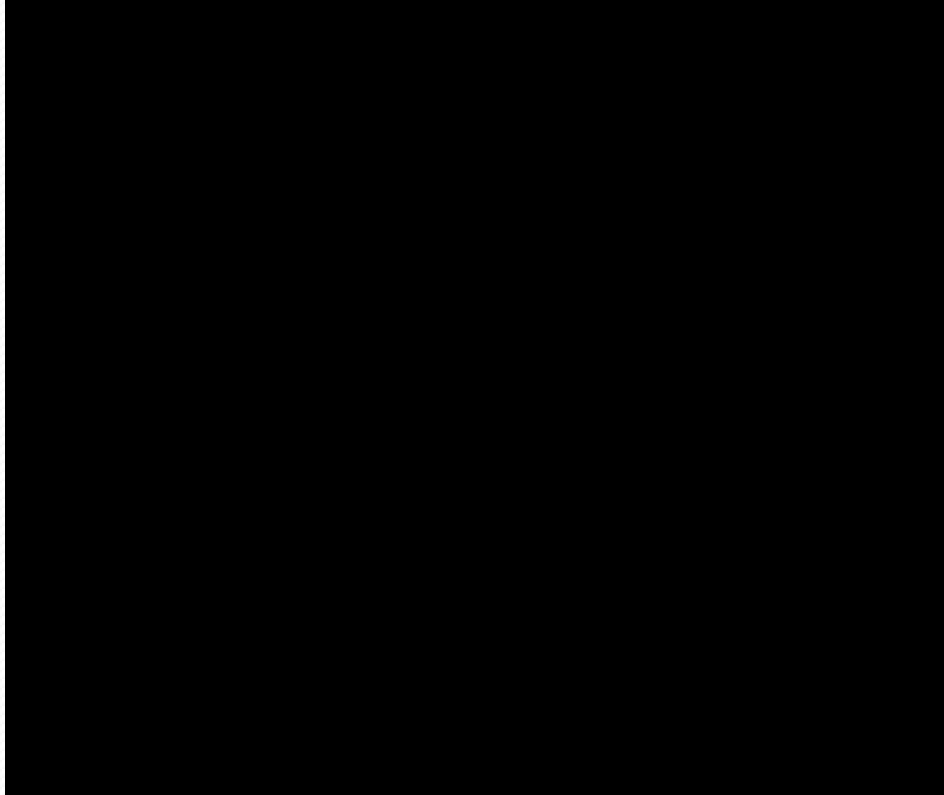
Eastern oyster



Suminoe oyster



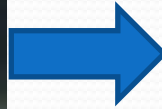
Why focus on larvae and juveniles?



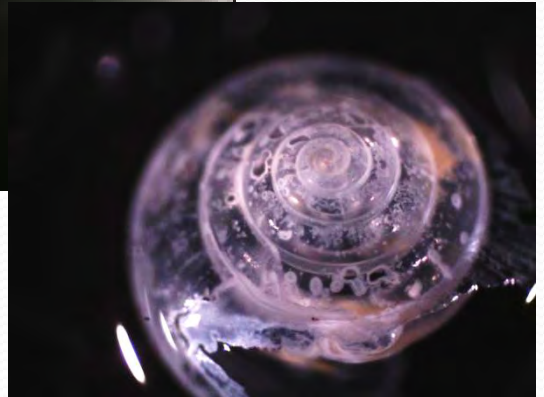
Research on commercial shellfish



Crab development sensitive to OA



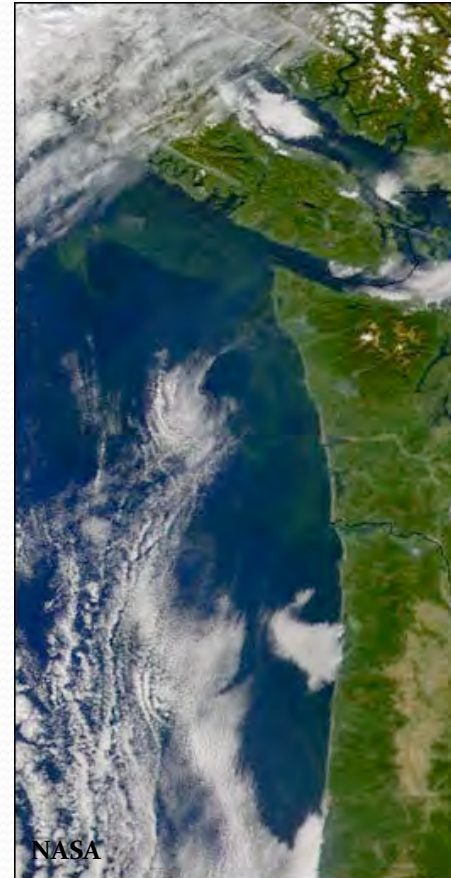
Shelled pteropods: planktonic snails



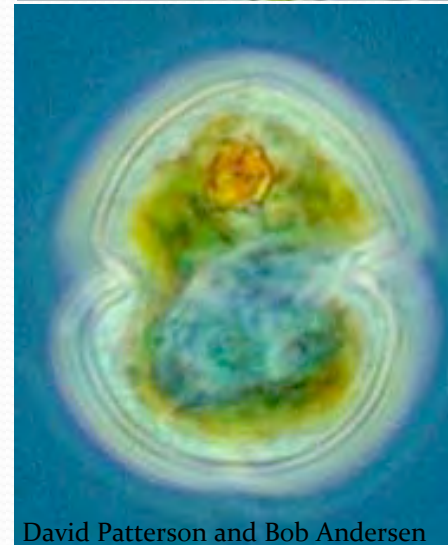
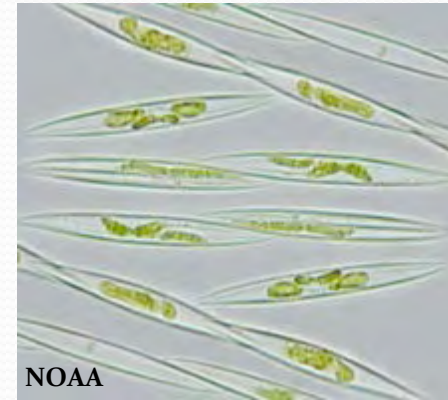
Sensitivity of other zooplankton?



There will be surprises!



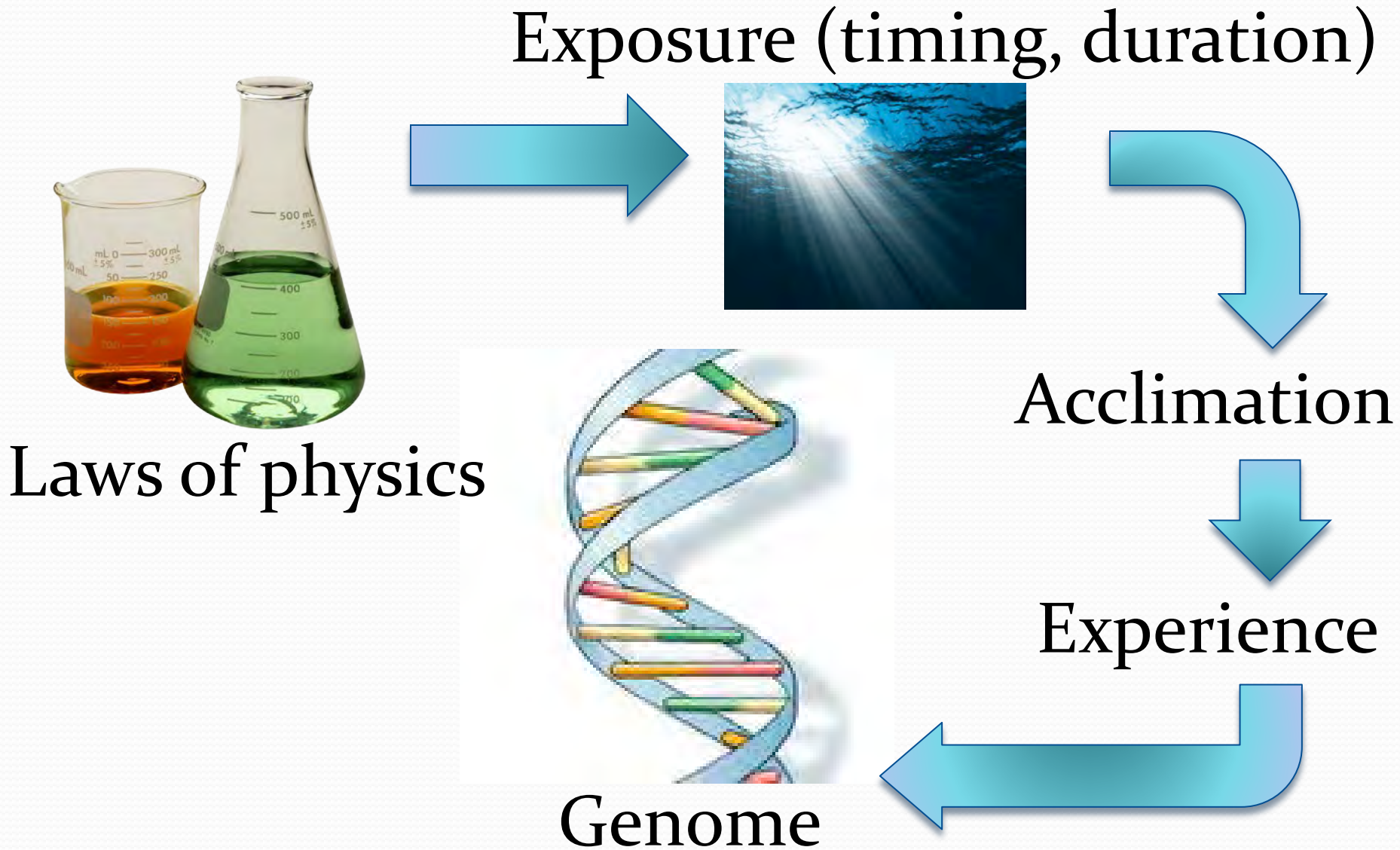
September 24, 2004



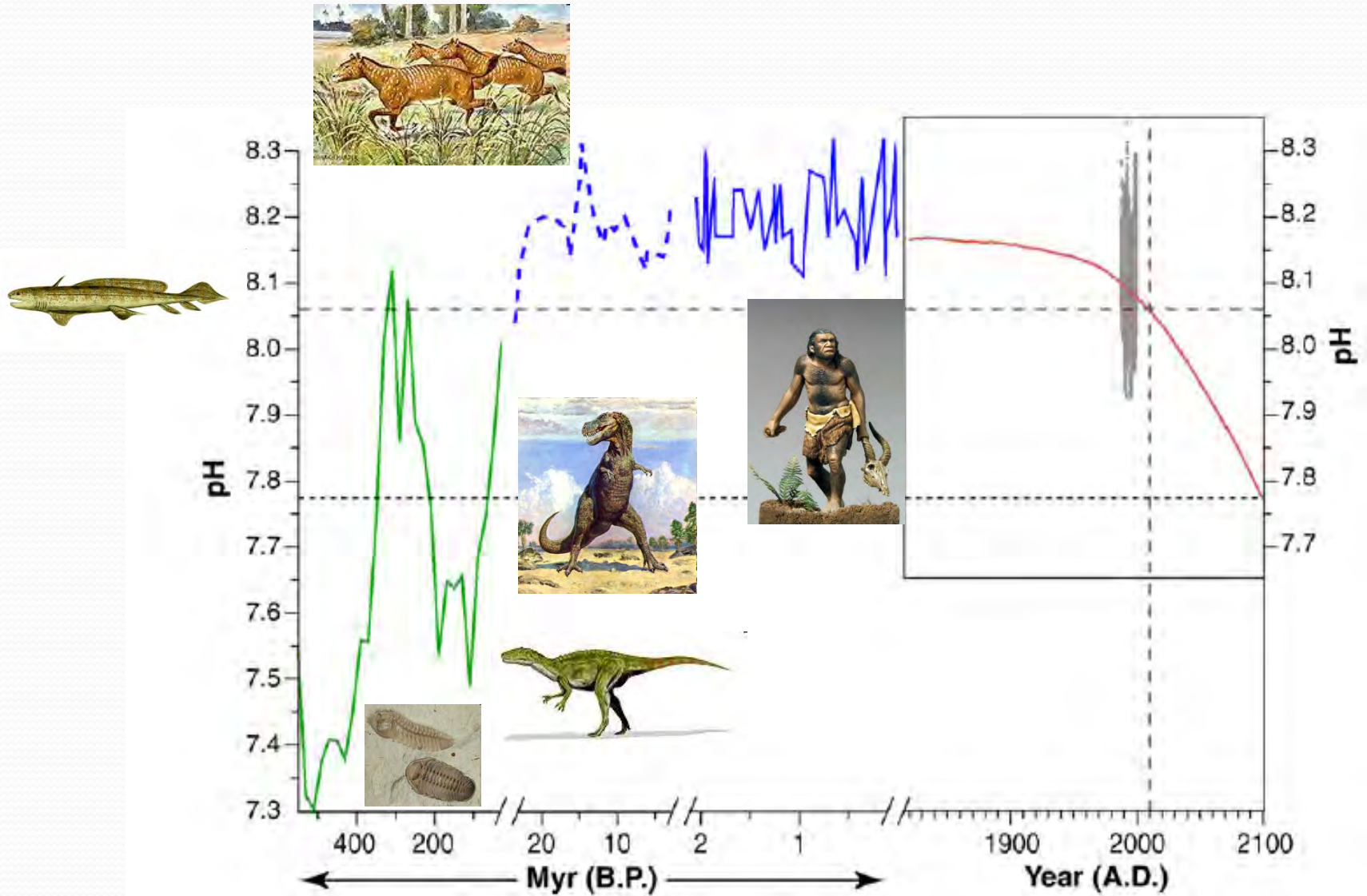
Munday et al. 2009, 2010;
Simpson et al. 2011; Nilsson et al. 2012

Sun et al. 2011, Fu et al. 2010

From chemistry to biology...



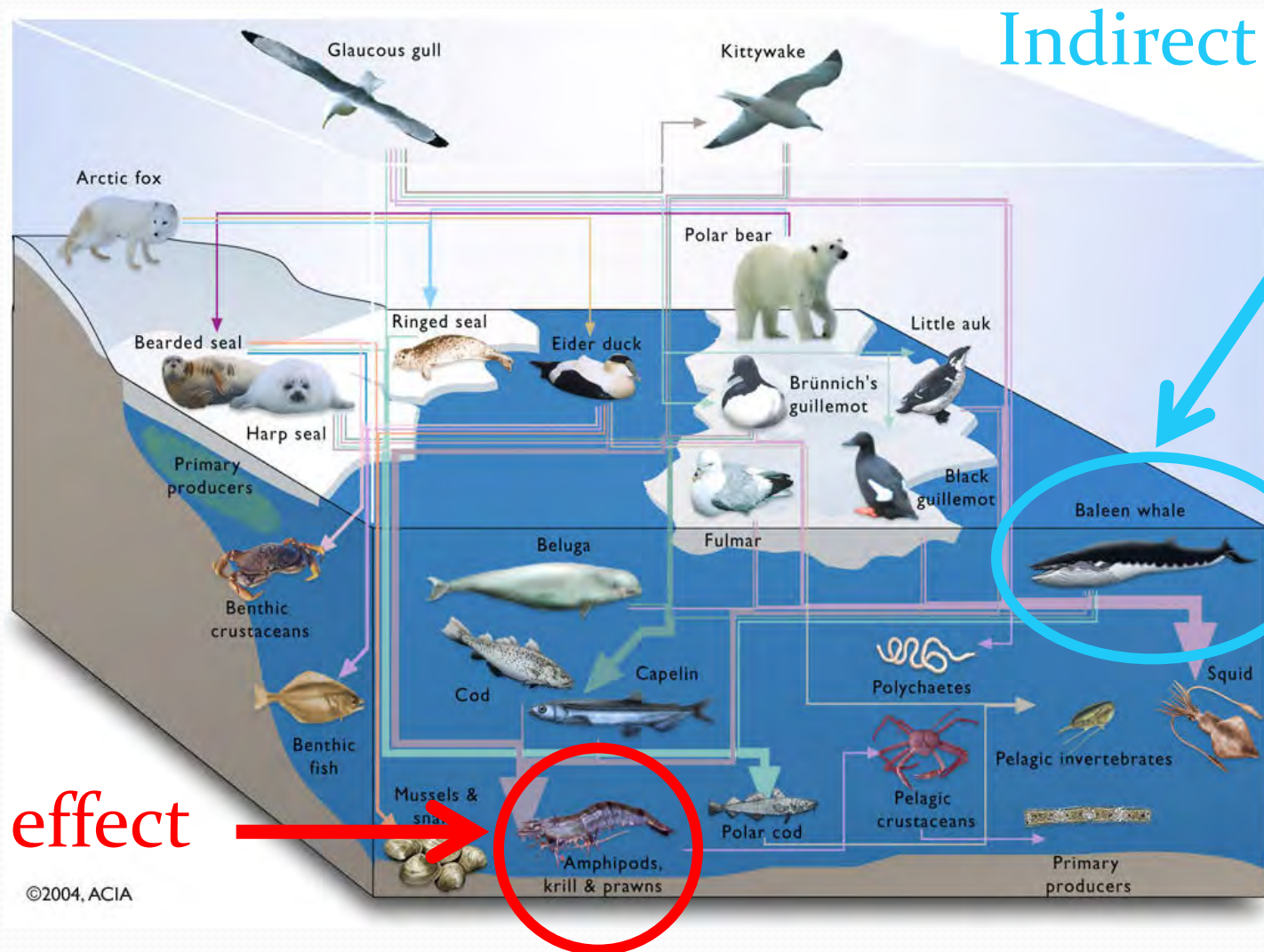
Seawater pH is changing very quickly



What is the fate of marine communities under ocean acidification?



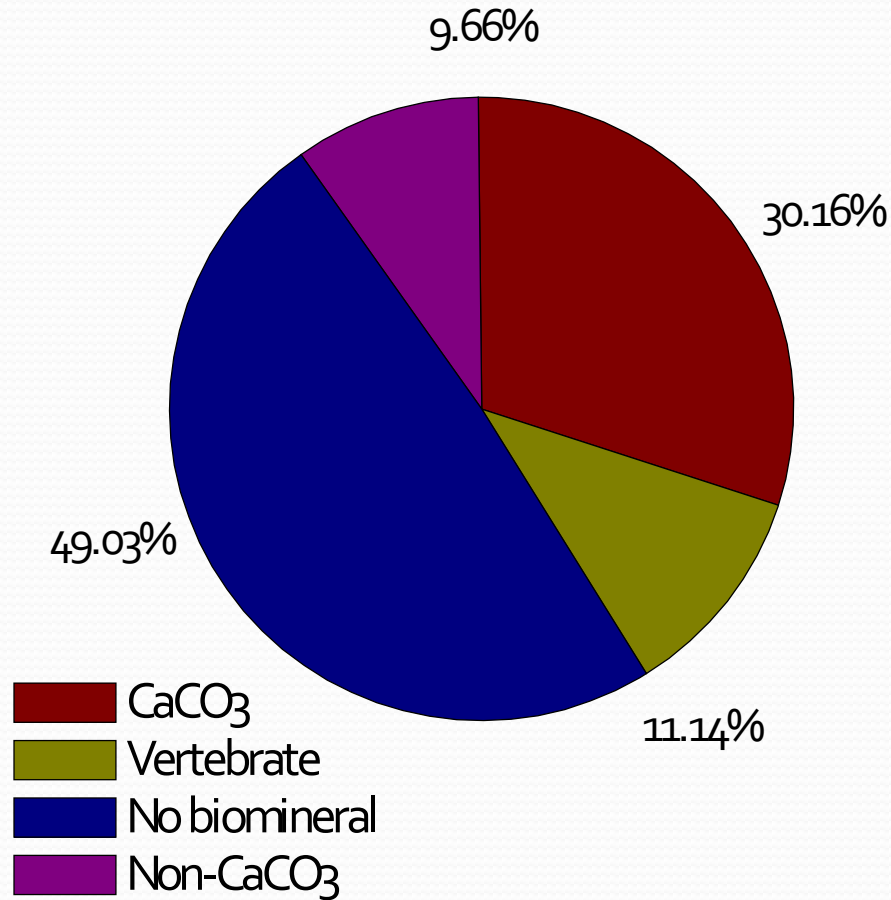
Complex systems have complex responses



Indirect effect?

Direct effect

30% of Puget Sound species calcify



Busch et al., in revision



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

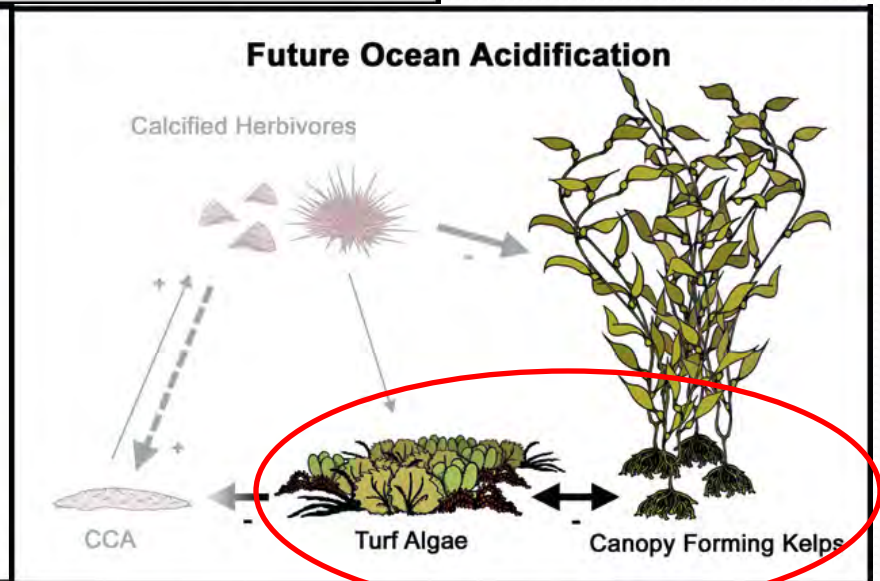
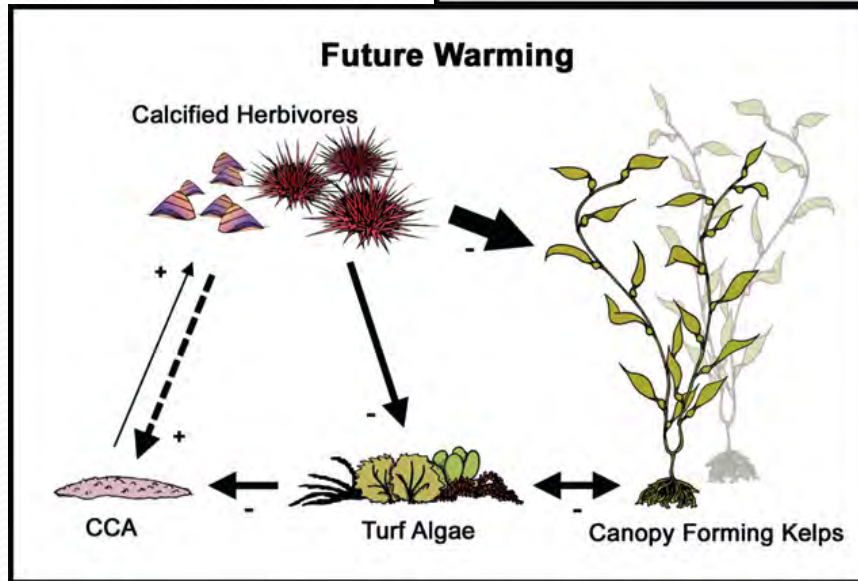
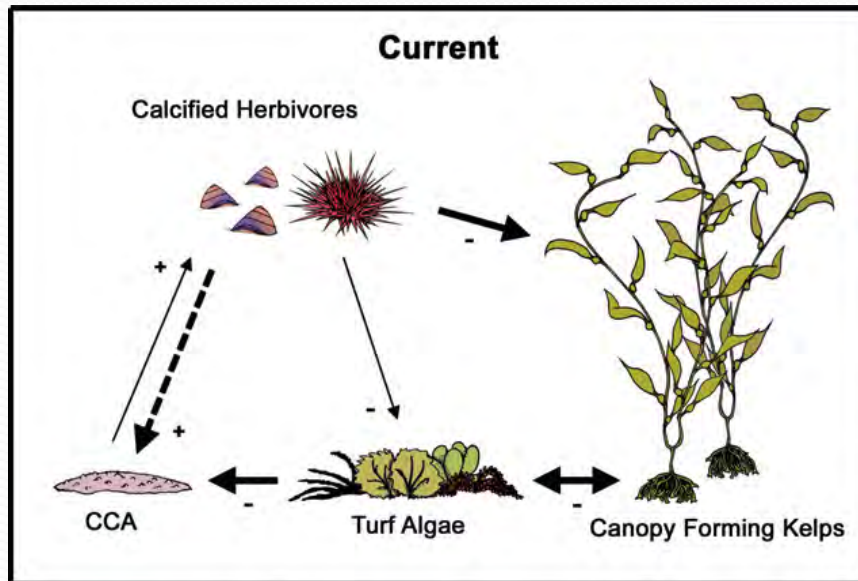


System responses



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 response to OA



