Current and projected impacts on biodiversity: Ocean Acidification

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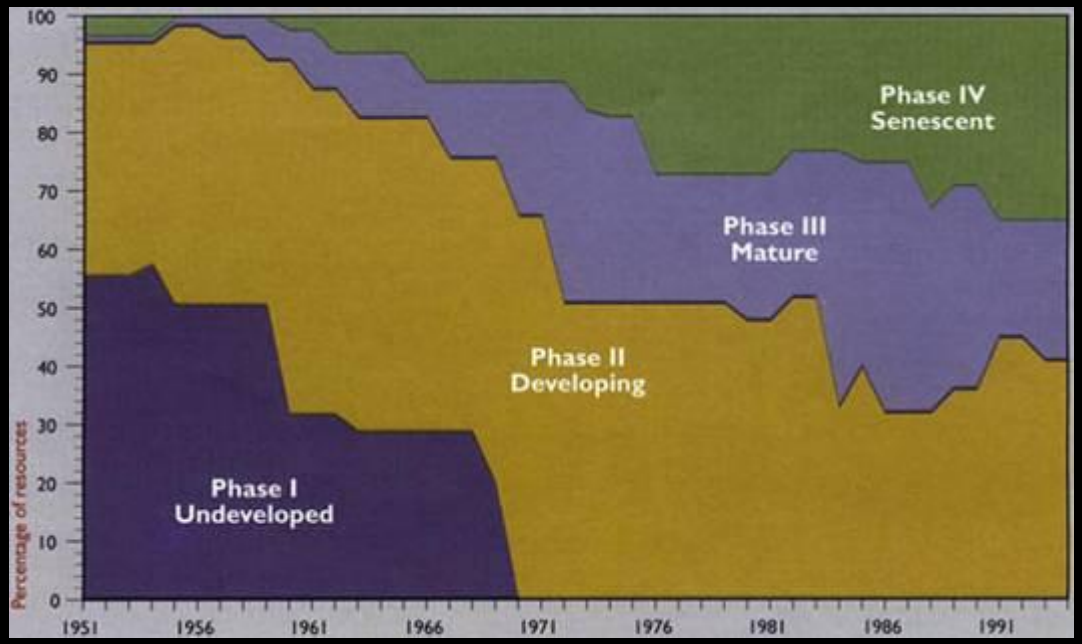
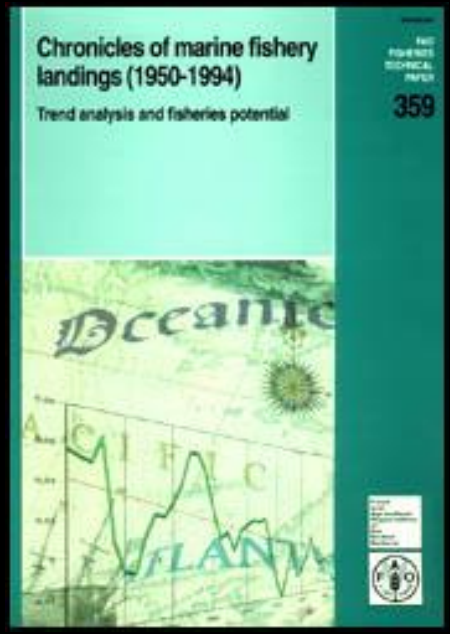
- Biodiversity loss – the big three

1. Direct exploitation

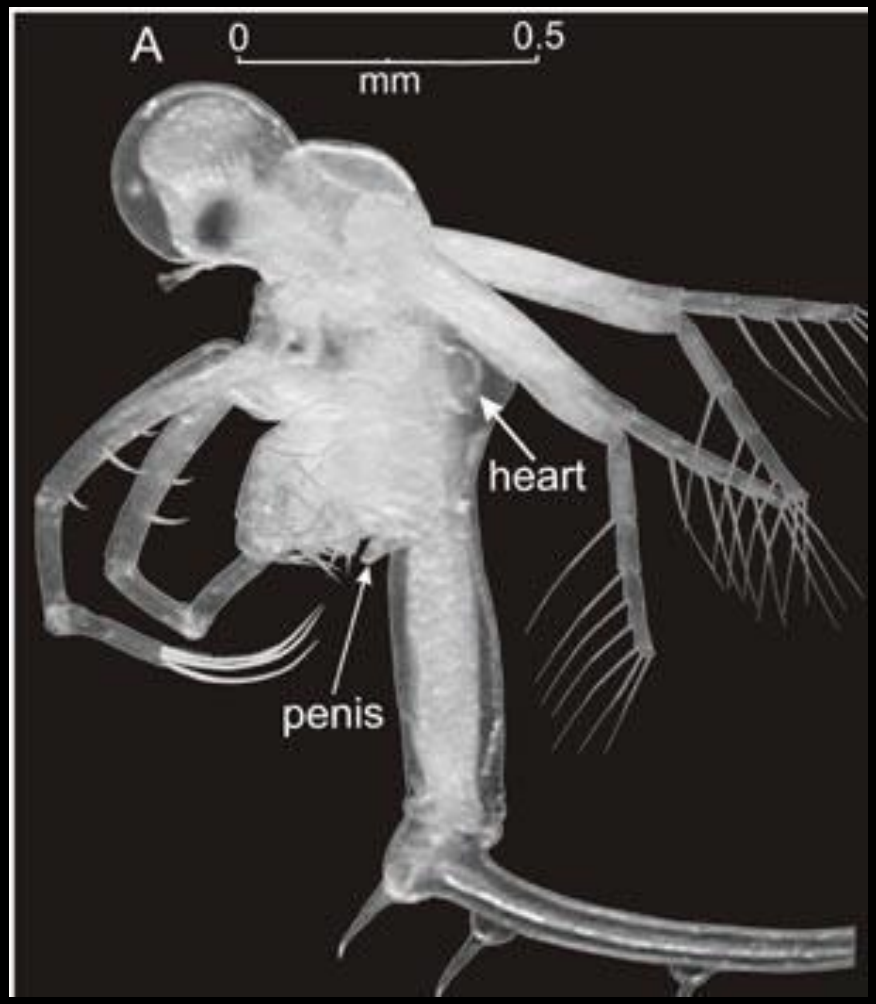




- Biodiversity loss – the big three

2. Habitat loss, fragmentation & degradation

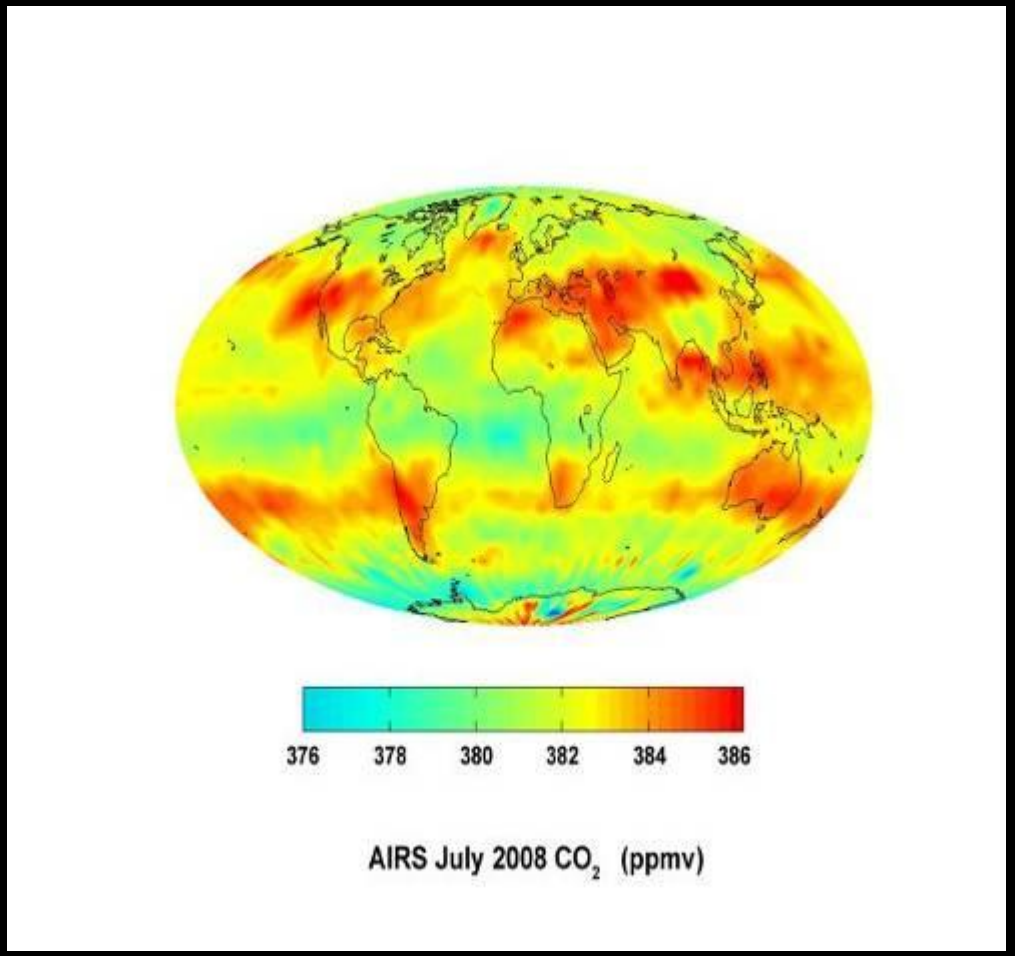
- Biodiversity loss – the big three



3. Invasive species

- Biodiversity loss – the big three

2. Habitat loss, fragmentation & degradation



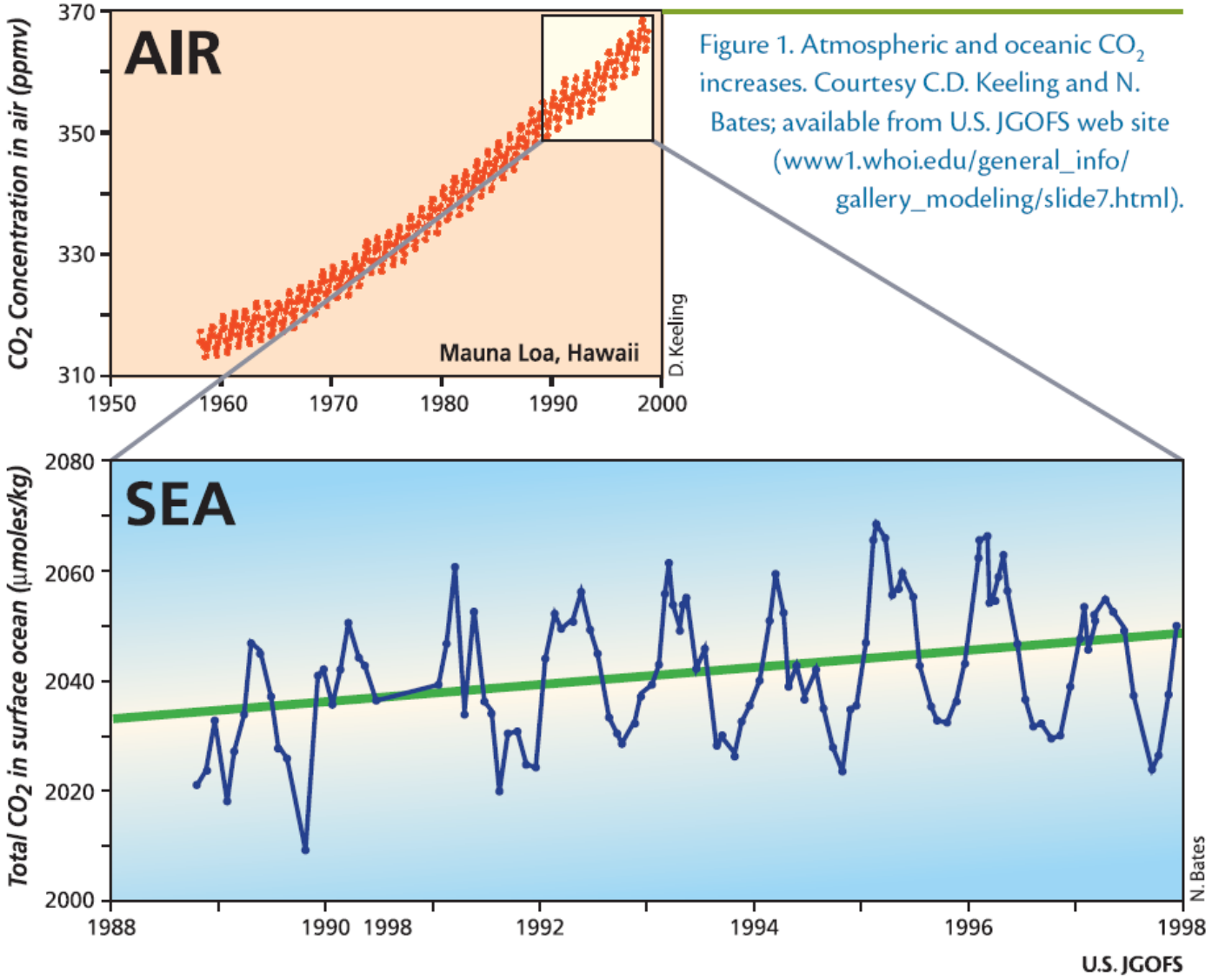
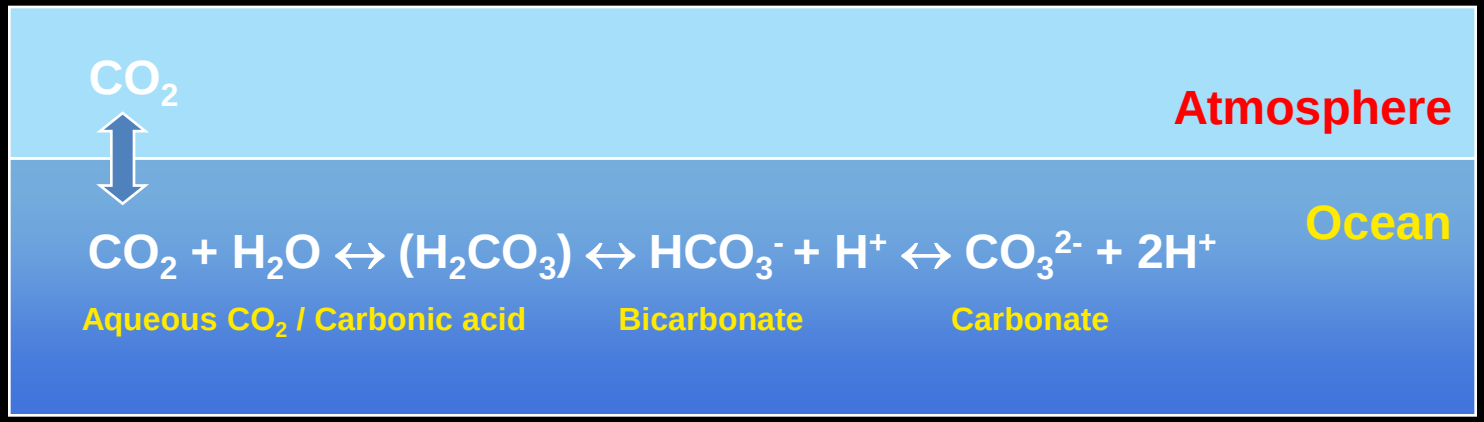
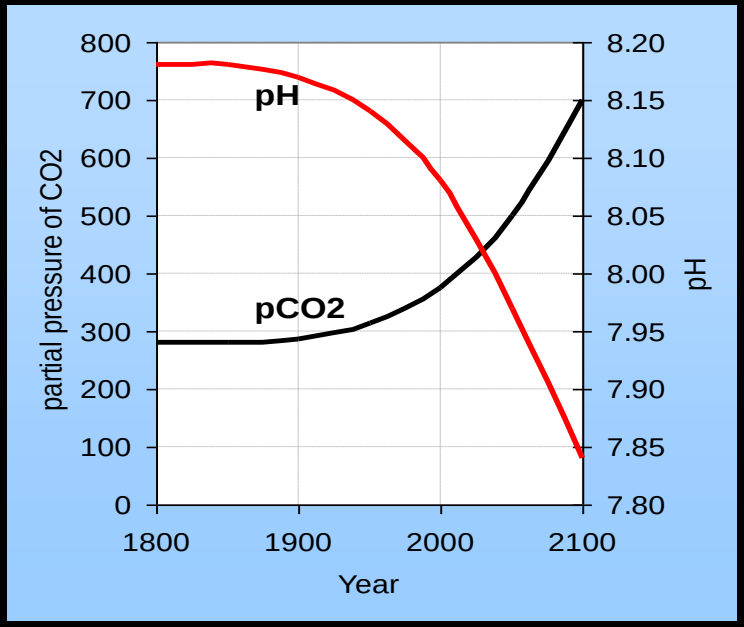
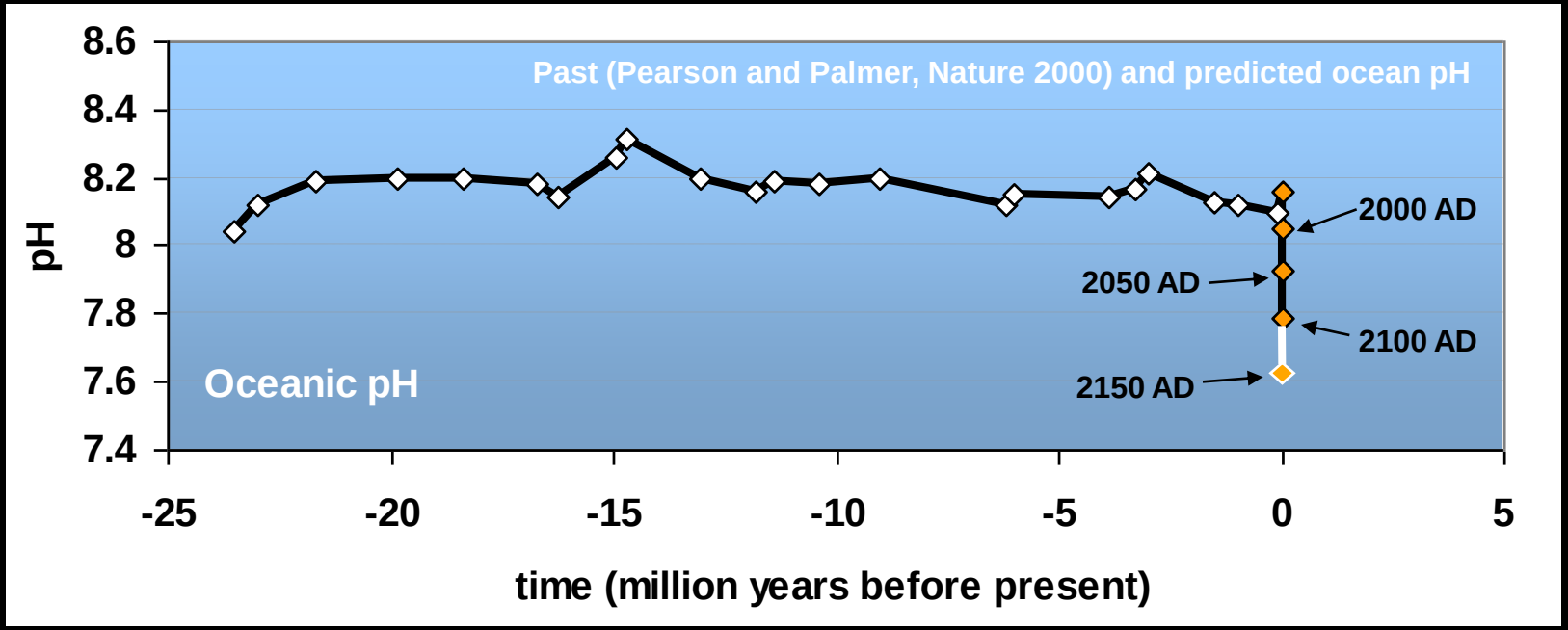


Figure 1. Atmospheric and oceanic CO_2 increases. Courtesy C.D. Keeling and N. Bates; available from U.S. JGOFS web site (www1.whoi.edu/general_info/gallery_modeling/slide7.html).

48% (over 650 Gt) of all the anthropogenic CO_2 produced in the past 200 years has been absorbed by the oceans:



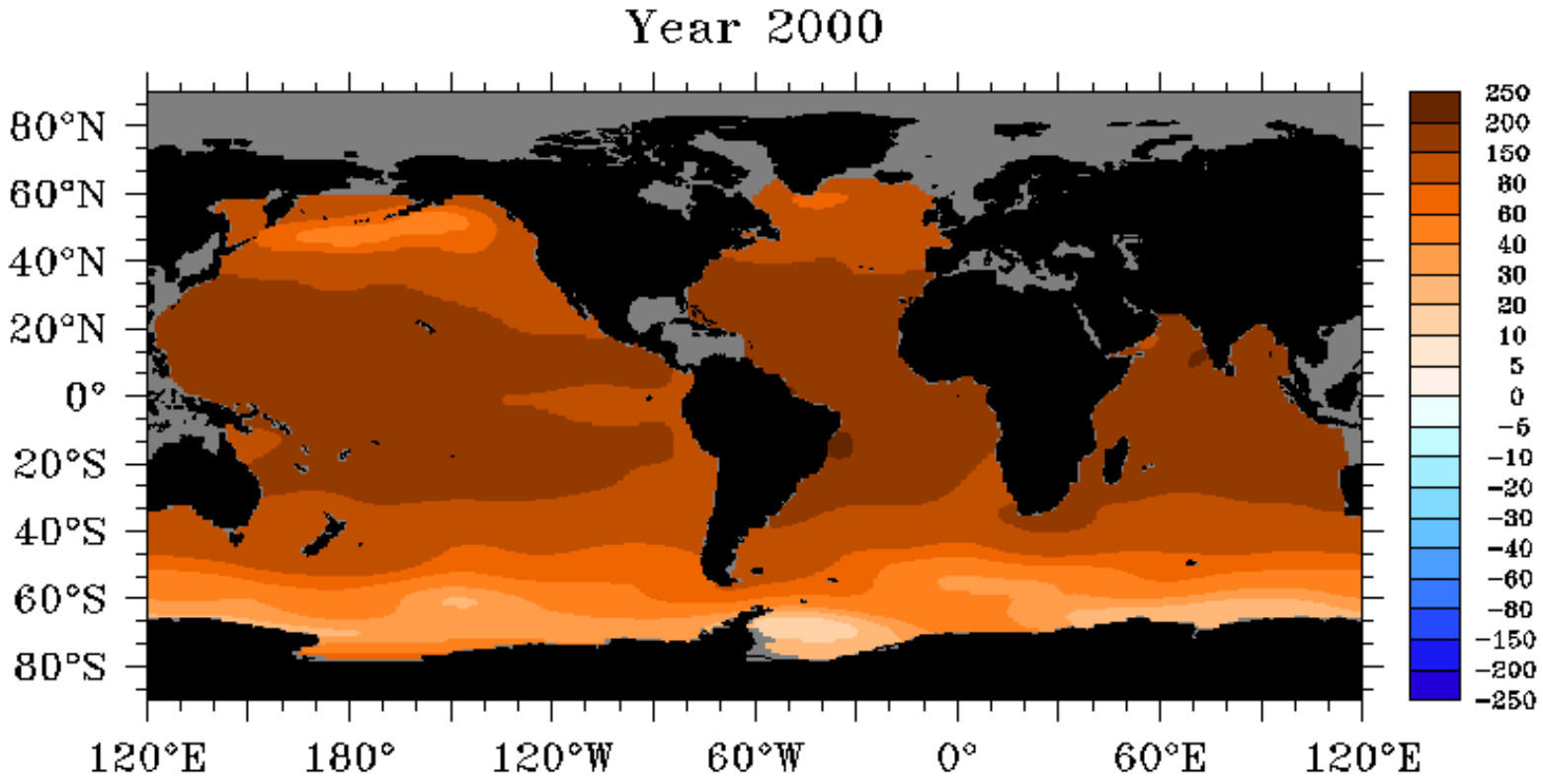




From: Blackford JC & Gilbert F (2007). pH variability and CO_2 induced acidification in the North Sea. J Mar Sys 64: 229-241

approximate date	atmospheric pCO_2	marine pH	pH change	% increase in H^+ ions.
1800	260	8.20		
1900	285	8.17	0.03	7%
1950	315	8.14	0.06	15%
2000	375	8.08	0.12	32%
2050	500	7.97	0.23	70%
2100	700	7.84	0.36	130%
2150	1000	7.70	0.50	216%

Aragonite ($CaCO_3$) saturation state of surface waters



Will OA selectively remove species from particular taxonomic or functional groups?

Can we predict an organism's sensitivity to OA related by:

- *phylogeny?*
- *environment (deep v shallow; infaunal v epifauna)?*
- *reliance on calcium carbonate?*

Sensitivity predicted by phylogeny?

- Maintenance of extracellular pH important for intracellular pH and the function of respiratory pigments.
- pH sensitivity may predicted by an organisms ability to compensate extracellular acidosis.
- Could be an underlying phylogenetic pattern in compensatory ability.
- But pattern not clear cut – complicating ecological factors?

Good or complete compensation




No or partial compensation





Sensitivity predicted by environment ?

Infaunal v epifaunal

- CO_2 in sediment invariably higher than in the overlying water
- *Callianassa* - pH in its burrows as low as 6.3 (Torres et al 1977)
- CO_2 in *Arenicola* burrows as high as 4000ppm after 4 hours of tidal exposure (Toulmond 1973)
- Assumption than infaunal animals more tolerant than epifaunal
- Most studies conducted on epifaunal species
- No impact observed on the burrowing polychaete *Nereis virens* (Widdicombe & Needham 2007)
- *Amphiura* was seen to be affected by exposure to high CO_2 (Wood et al 2008)

- Need more data from comparative experiments on survival of hypercapnia by infaunal and epifaunal benthos

Sensitivity be predicted by enivorment?

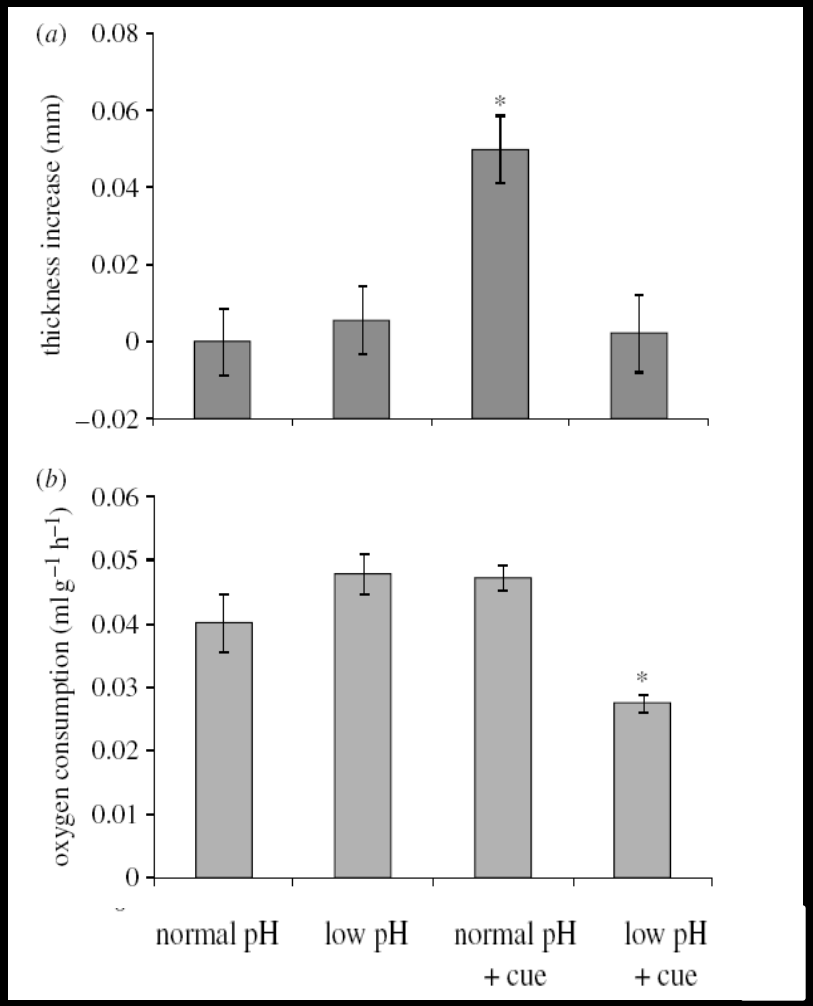



Deep water v shallow water species

- Pane & Barry (2007) compared deep sea Tanner crab with shallow water Dungeness crab.
- Dungeness crab displayed compensated acidosis

  Tanner crab was largely uncompensated.
- Supports idea that deep sea animals could be more vulnerable than shallow water animals.
- BUT, whilst a study of *Necora puber* (Spicer et al, 2007) supports this idea, data from a number of studies on the shallow water species *Callinectes sapidus* showed a considerable decrease in haemolymph pH.
  - Other shallow water organisms also show poor compensation.
  - More studies needed.


Sensitivity predicted by reliance on calcium carbonate?



Bibby, Cleall-Harding, Rundle, Widdicombe & Spicer (2007) *Biology Letters* *(Royal Society)* **3**, 699-701

Will OA selectively remove species from particular taxonomic or functional groups?

Is an organism's sensitivity to OA related to its:

Underlying pattern

- phylogeny?

Likely

- environment (deep v shallow; infaunal v epifauna)?

Almost certainly

- reliance on calcium carbonate?

Ocean Acidification Expertise in Plymouth

Ecophysiology

Adaption and Evolution

Paleo-ecology

Animal Behaviour

Scientific Discussion

Joint Student Supervision

Sharing Equipment and Facilities

Animal – Environment Interactions

Microbial Ecology

Biogeochemical Cycles

Biodiversity & Ecosystem Function

Ecosystem Modelling

Socioeconomics

Understand and predict the impact of ocean acidification on marine ecosystems and the consequences for society