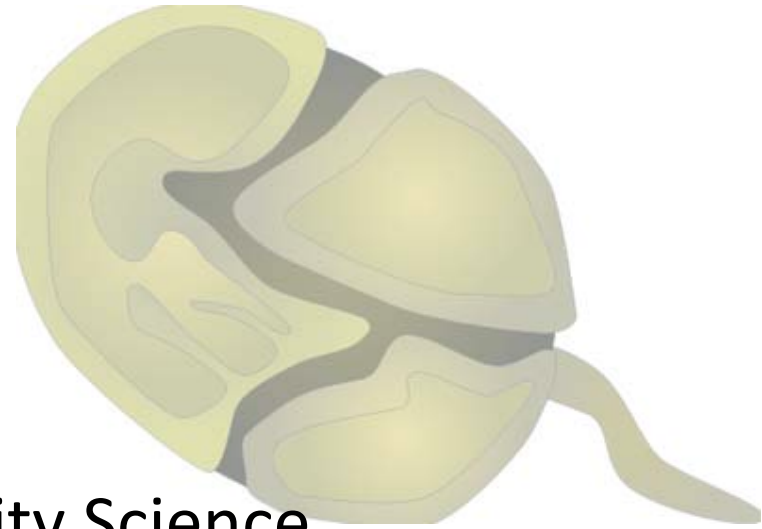
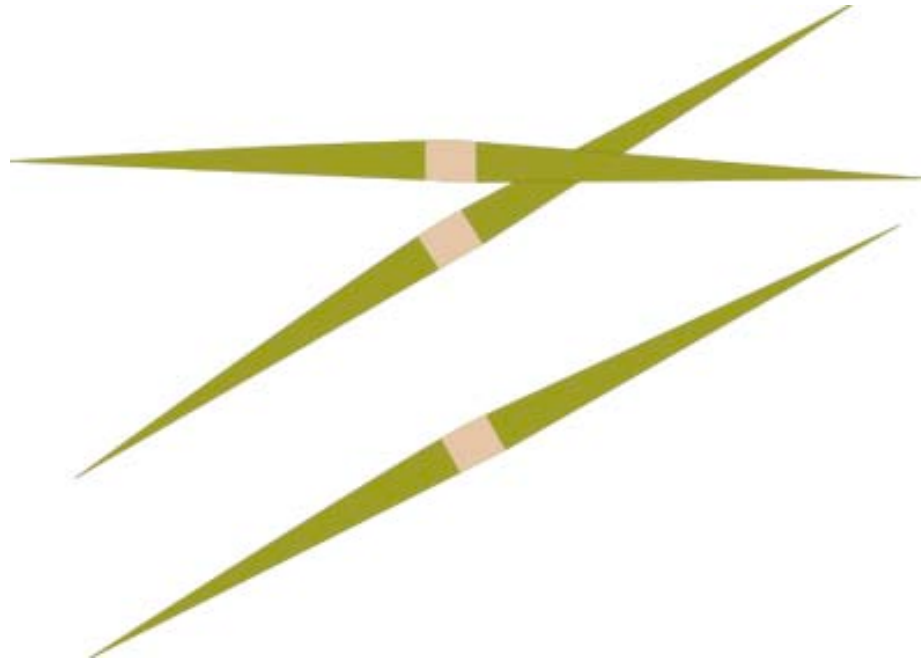


Big Challenges in OA Research



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Image credit: IAN Image Library (ian.umces.edu/imagelibrary/)

Three Big Challenges in OA Research

1. *Characterize spatial and temporal variation in carbonate chemistry and saturation state*
2. *Characterize biological responses and project ecological impacts*
3. *Identify and mitigate societal impacts*

Specific Challenges: Pacific Northwest

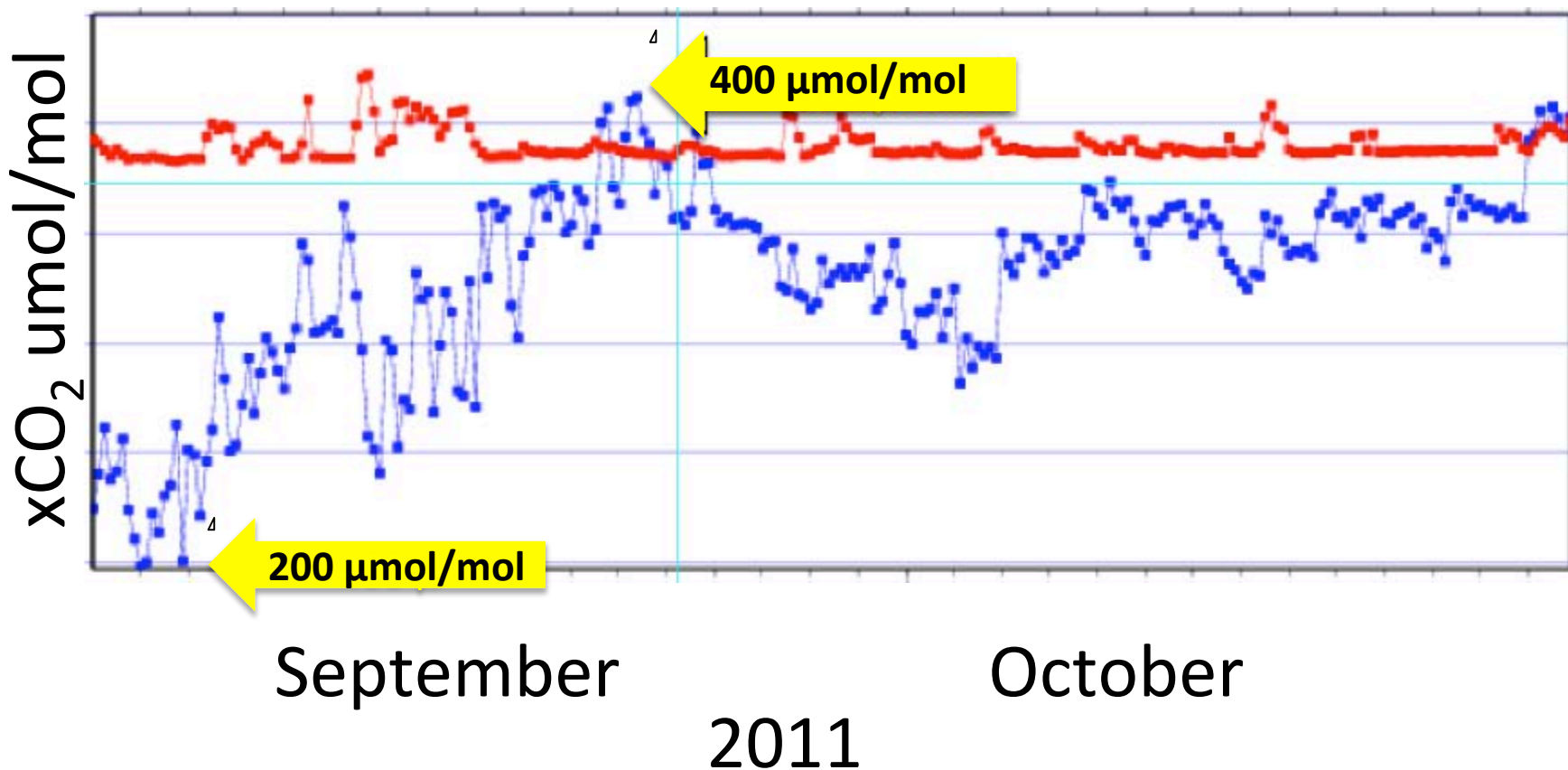
Substantial variation exists in carbonate chemistry and saturation state in space and time



Photo: George Grall

Examples of Local Variation

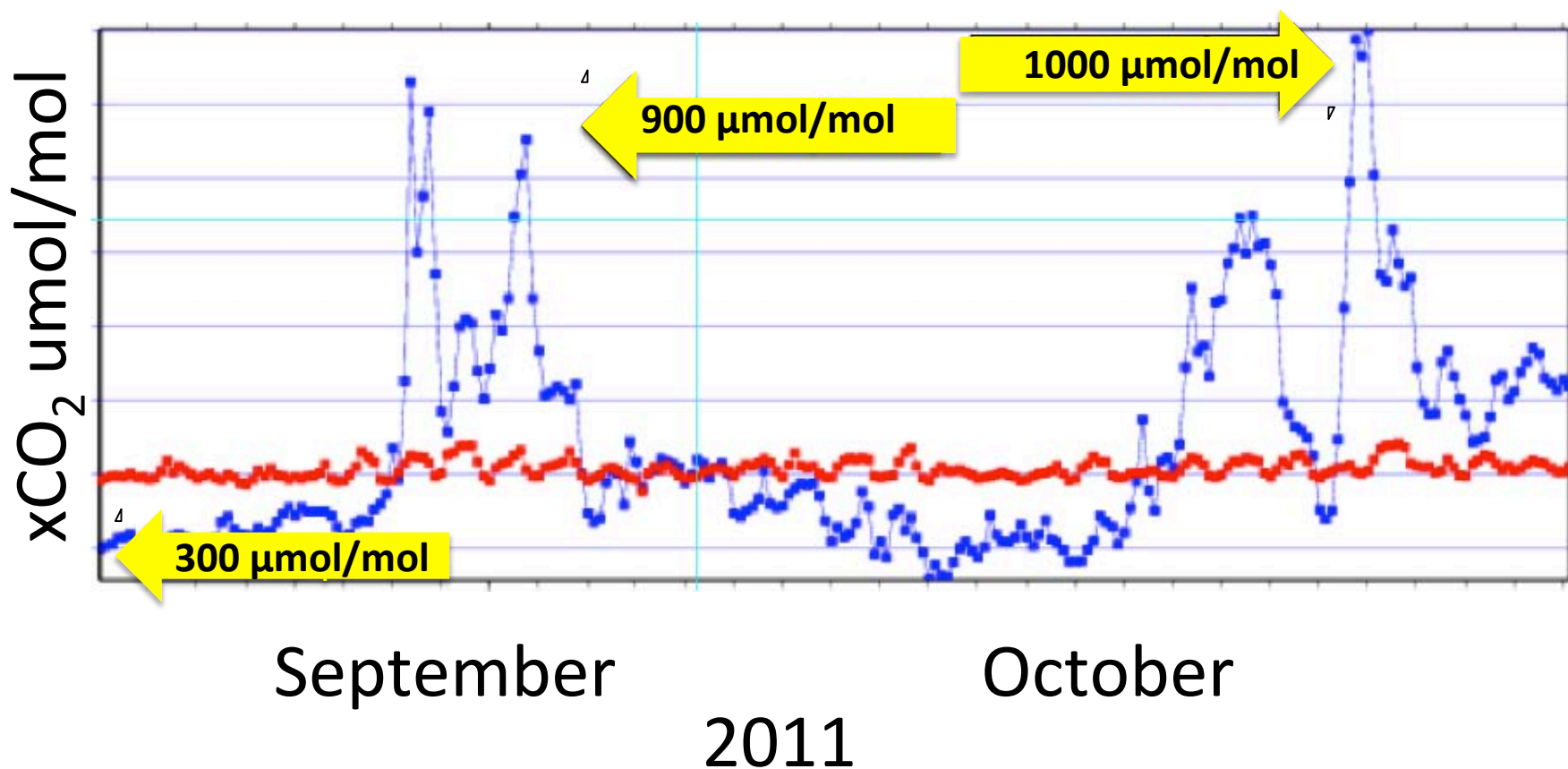
pCO₂ in **Air** and **Seawater** at La Push



Examples of Local Variation

pCO₂ in **Air** and **Seawater** at Dabob Bay

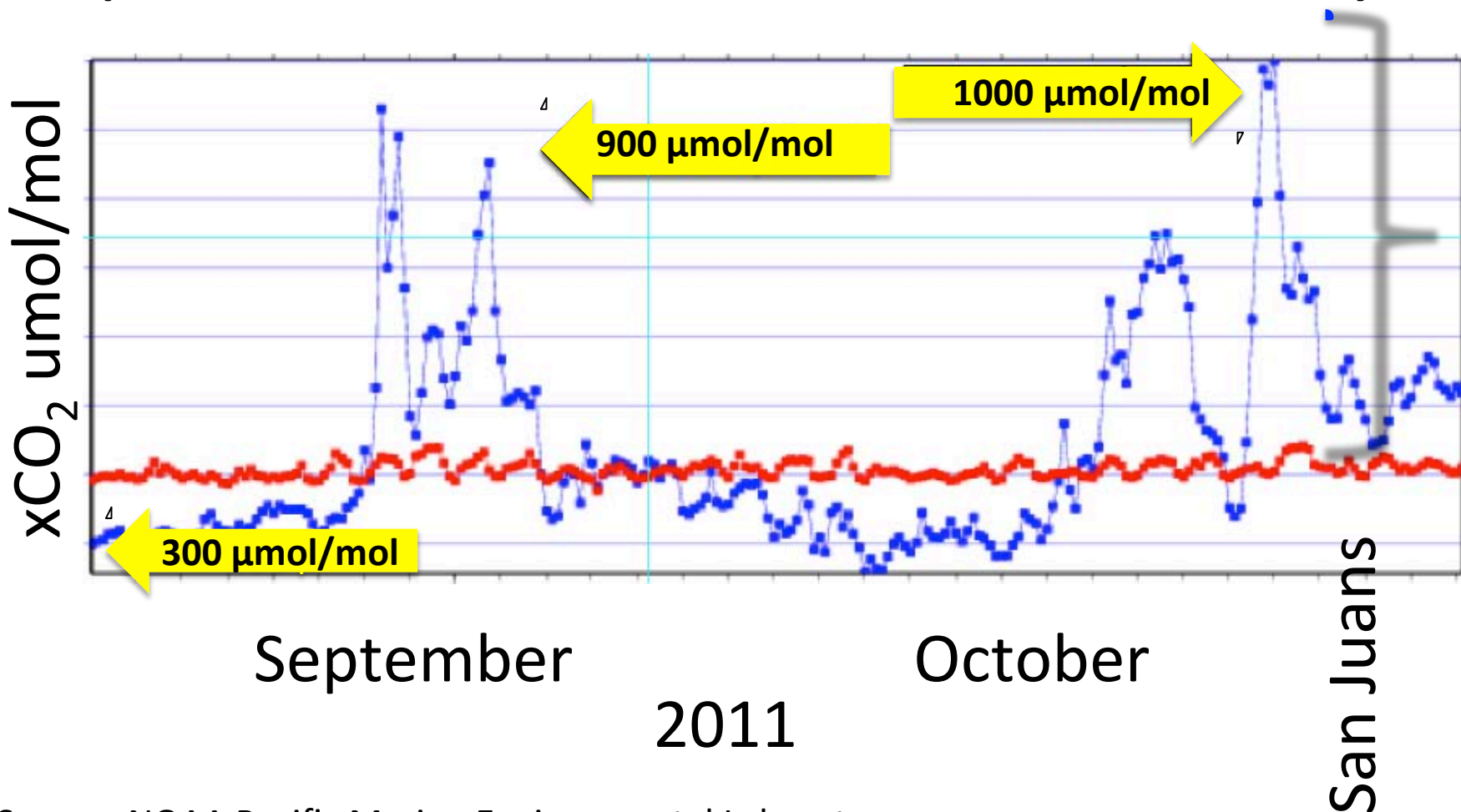
Challenge: Variation



Examples of Local Variation

pCO₂ in **Air** and **Seawater** at Dabob Bay

Challenge: Variation



Consequences of Local Variation

- 1. Variation causes difficulties in estimation, representation, and interpretation of carbonate chemistry in local systems*
- 2. Observations and monitoring will help address this issue*

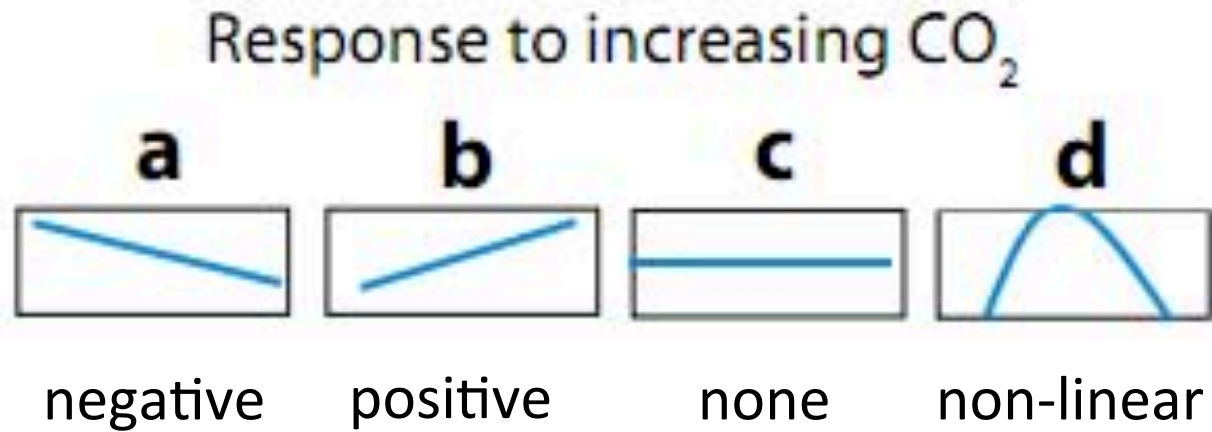
Big Challenge Two

Characterize biological responses and project ecological impacts

Big Challenge Two



Biological Response Varies by Species



Biological response variables include calcification, photosynthesis, growth, reproduction

Source: Doney et al 2009

Biological Response Varies by Species

Response to increasing CO₂



oysters

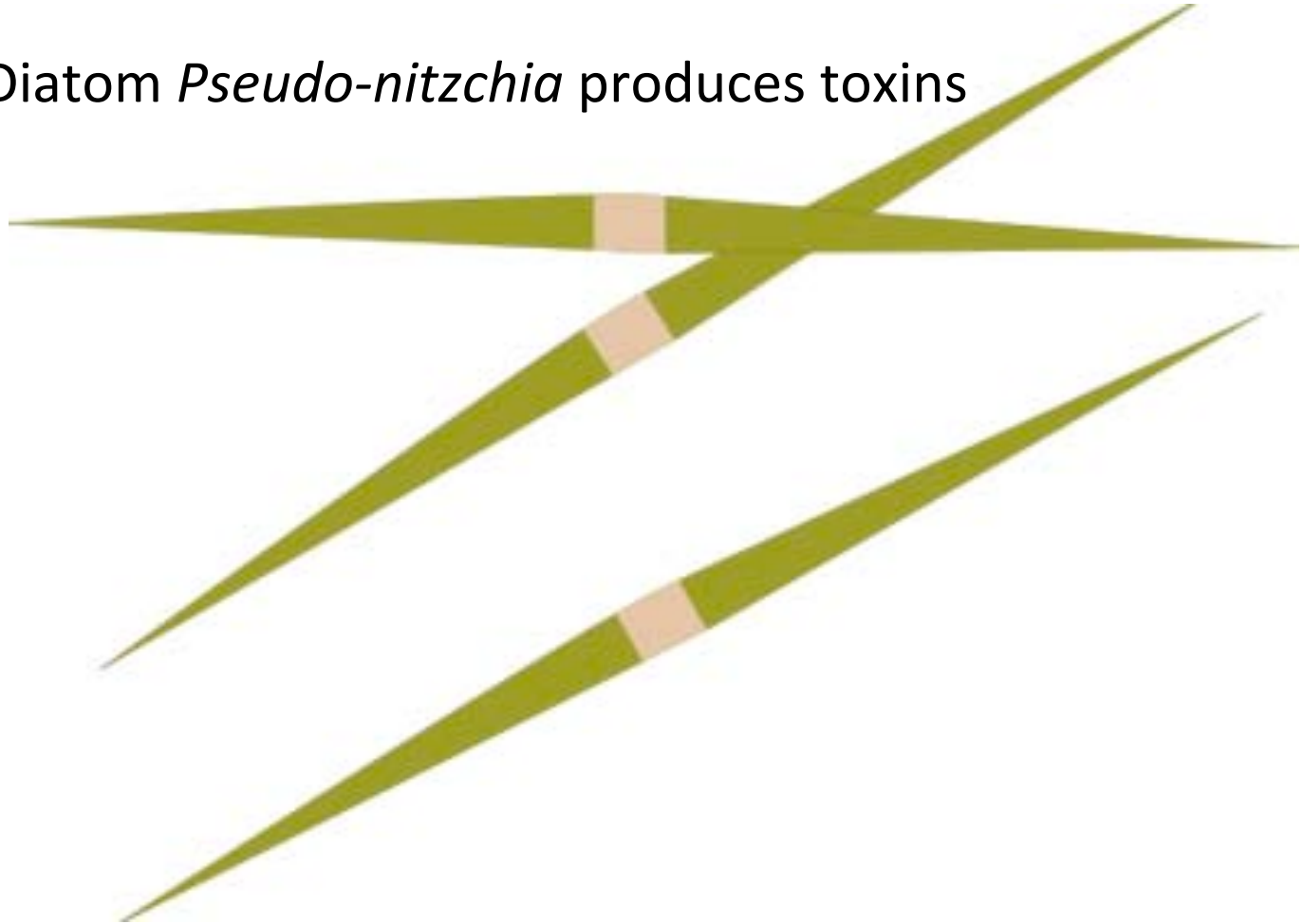
seagrass,
algae (?)

limpets

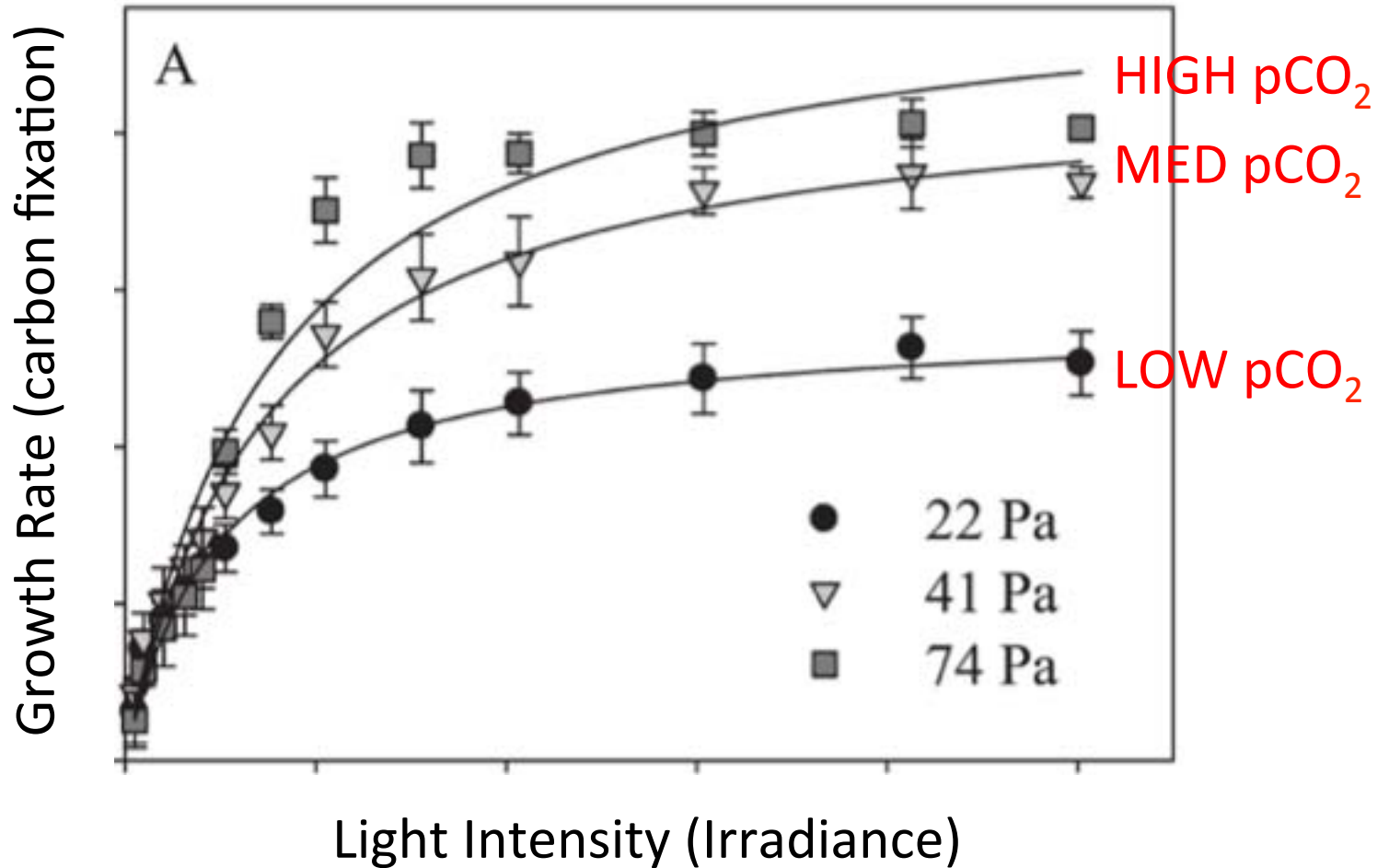
phytoplankton?
seaweeds?

Surprises Will Occur

Local Diatom *Pseudo-nitzschia* produces toxins

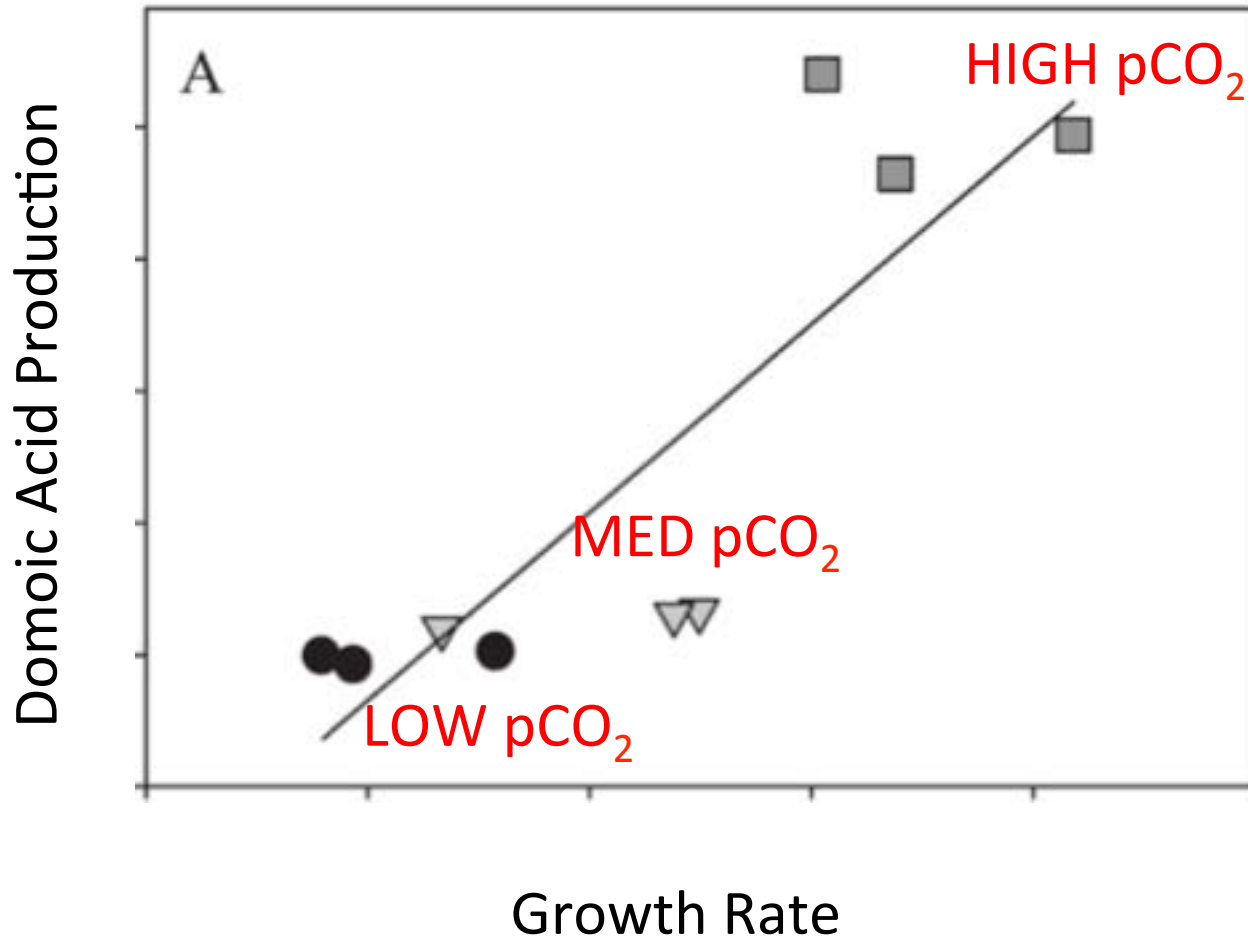


Growth Rates Highest at High pCO₂



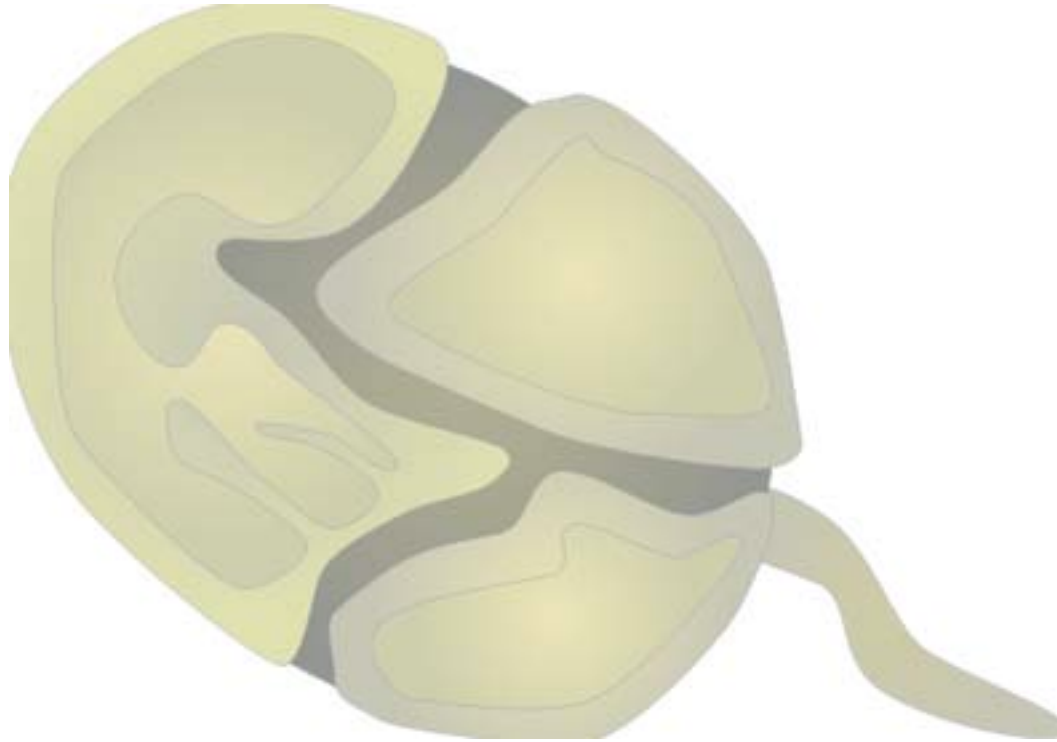
Source: Sun et al. 2011 (modified)

Toxin Production Highest at High pCO₂



Source: Sun et al. 2011 (modified)

Toxin Production Highest at High $p\text{CO}_2$



Similar result for dinoflagellate species

See: Fu et al. 2010

Image credit: Saxby, IAN Image Library (ian.umces.edu/imagelibrary/)

Consequences of Biological Variation

1. *Biological variation causes difficulties in predicting impacts to local ecosystems*
2. *“Response diversity” will favor some species over others*
3. *Unanticipated responses will cause surprises*

Understanding Variation

- 1. Physical system varies in space and time*
need to understand the scales of variation
- 2. Biological responses vary within and among species, and are influenced by other factors*
need to understand the scope of biological variation and the nature of interactions
- 3. Biological and ecological surprises will occur*
need to prepare for surprises by increasing ecological and social resilience

Education Promotes Social Resilience

