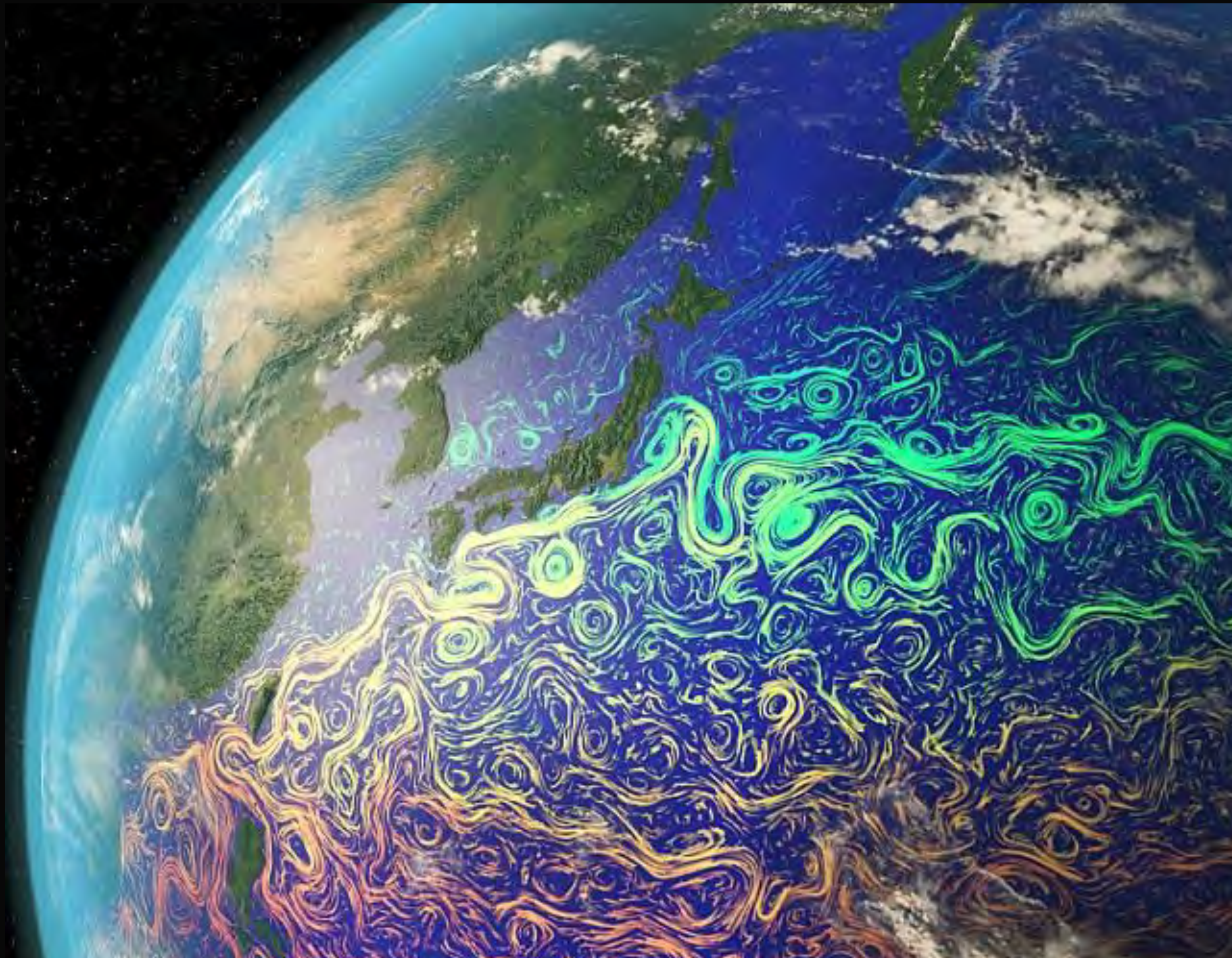
Ocean acidification drives community shifts towards simplified non-calcified habitats in a subtropical-temperate transition zone

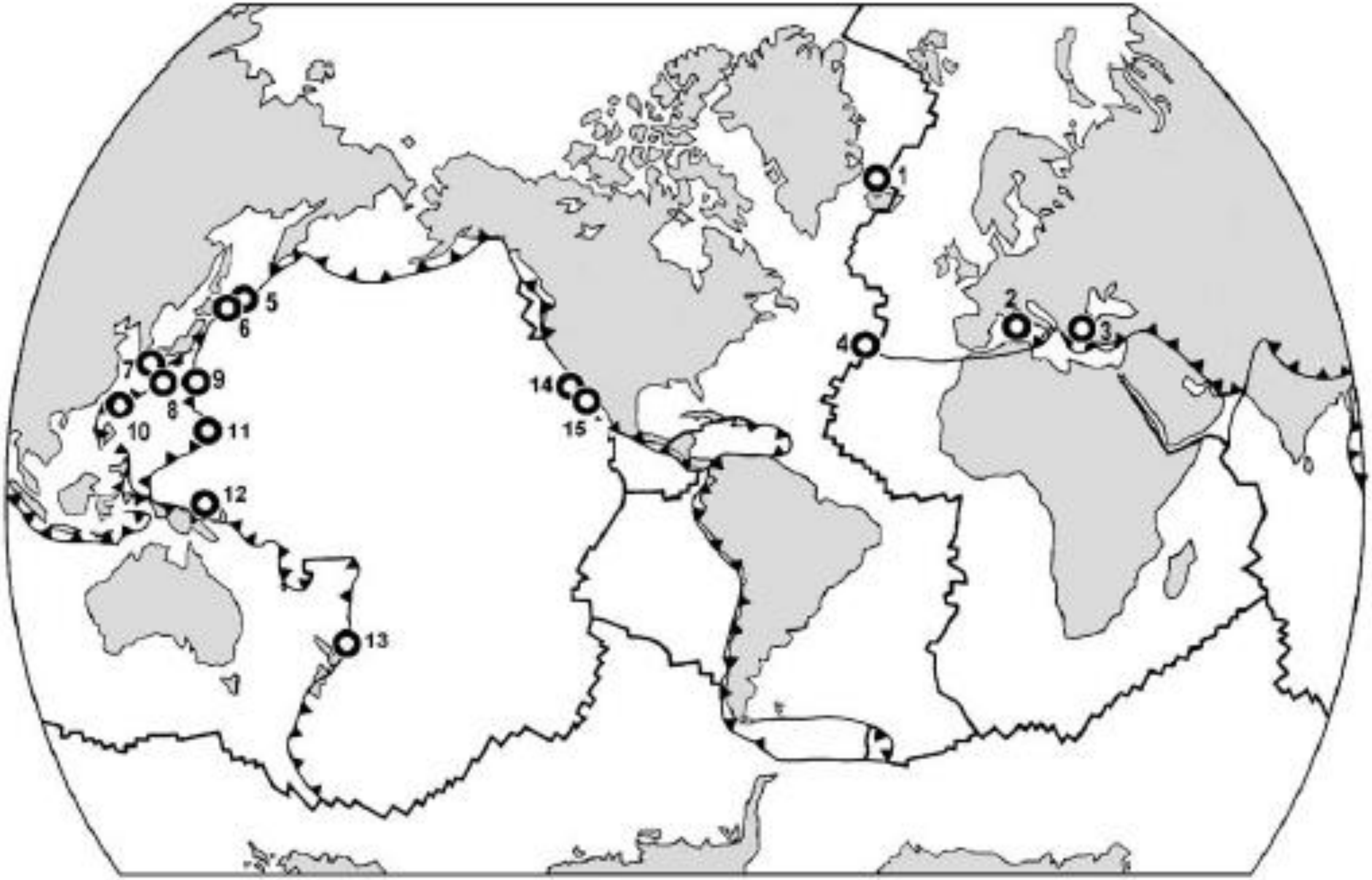
Sylvain Agostini, Ben Harvey, Shigeki Wada, Koetsu Kon, Marco Milazzo, Kazuo Inaba and Jason Hall-Spencer

SHIMODA MARINE RESEARCH CENTER
UNIVERSITY OF TSUKUBA



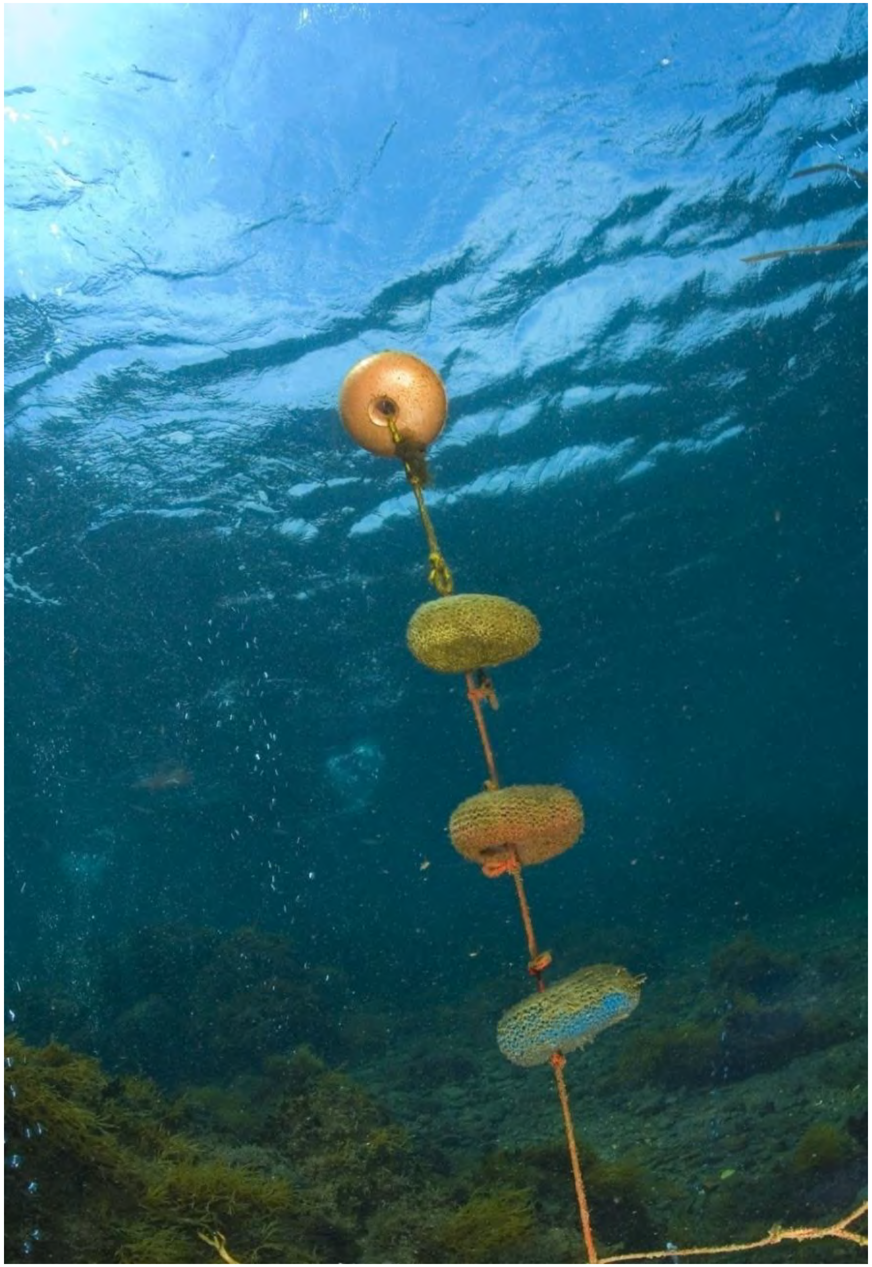
1 November 2018

Coastal CO_2 seeps worldwide



CO_2 seeps can show ecosystem responses to ocean acidification but careful site selection needed

OA has direct effects e.g. recruitment severely disrupted



Cigliano et al. (2010) Marine Biology,
Smith et al. (2016) Nature Climate Change
Allen et al. (2017) Mar. Poll. Bull.
Brown et al. (2018) Global Change Biology

OA also has indirect effects e.g. due to biogenic habitat modifications

Sunday et al. (2017) Nature Climate Change

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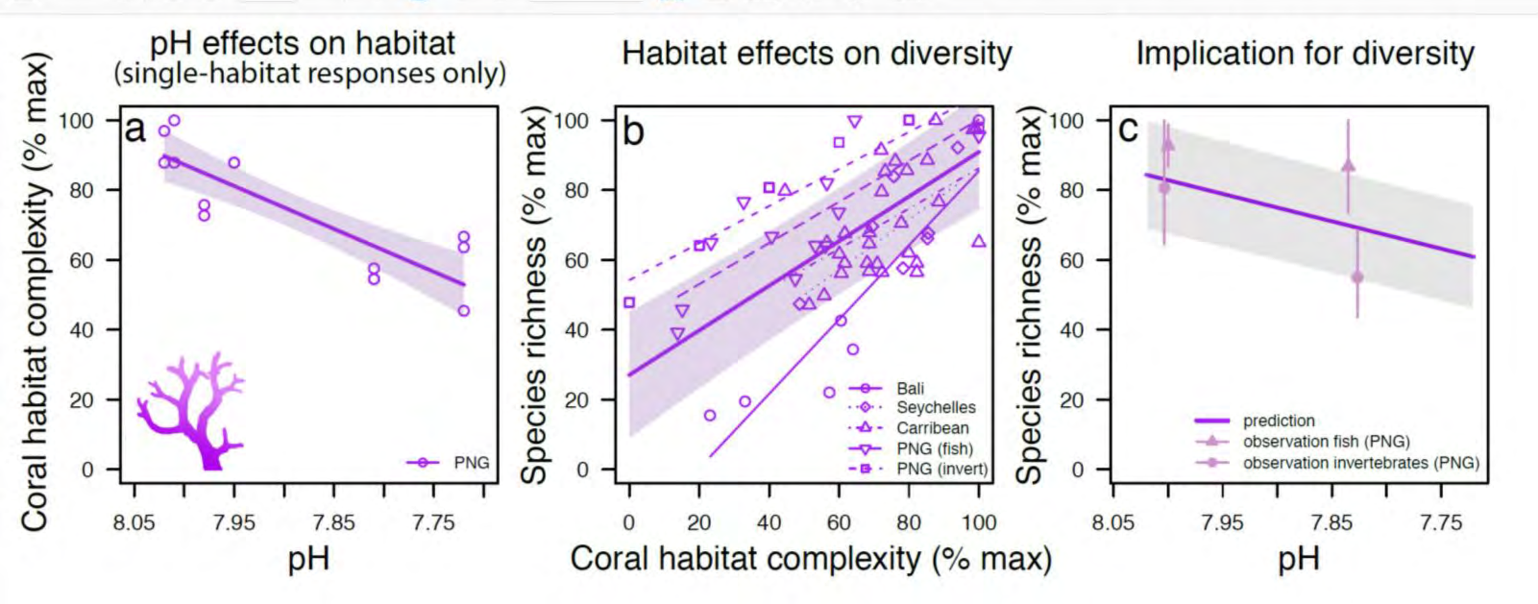
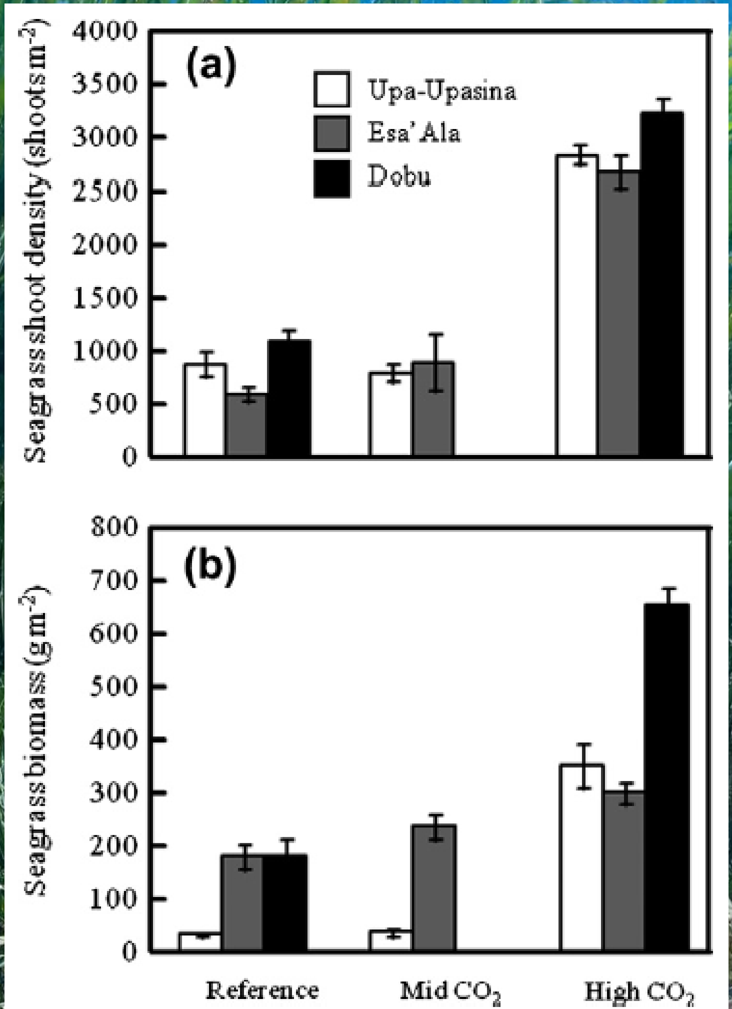
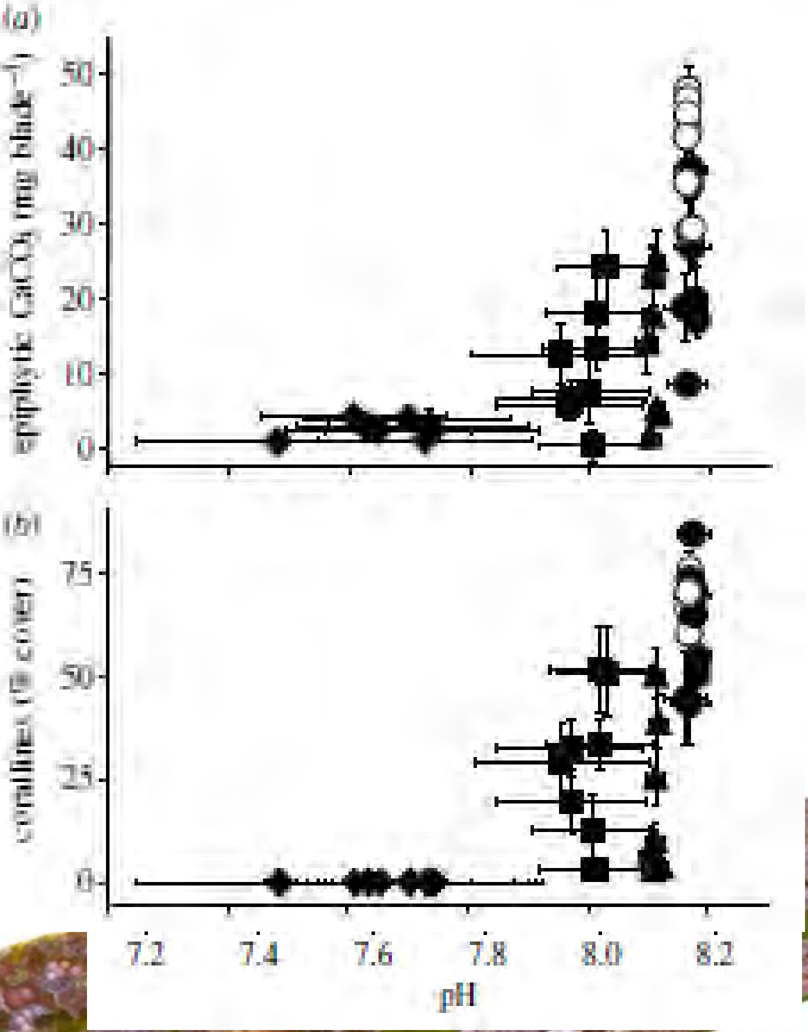


Sunday et al. 2017 *Nature Climate Change*

Seagrass is carbon limited; it grows well at CO_2 seeps



Russell BD et al. (2013) Marine Pollution Bulletin 73, 463-469.



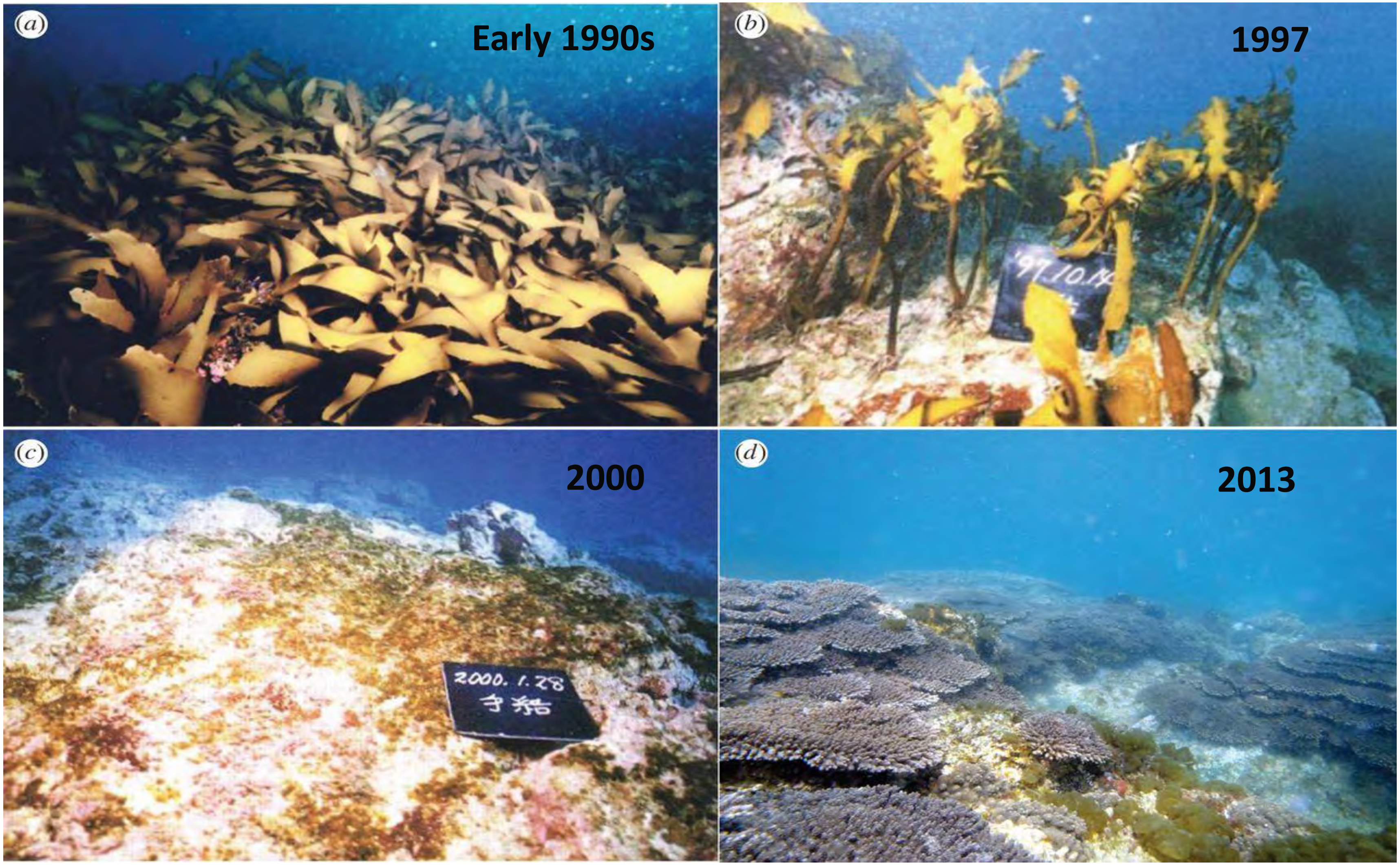
Martin et al. (2008) Biology Letters


JAPAN
BY: IOZUAN

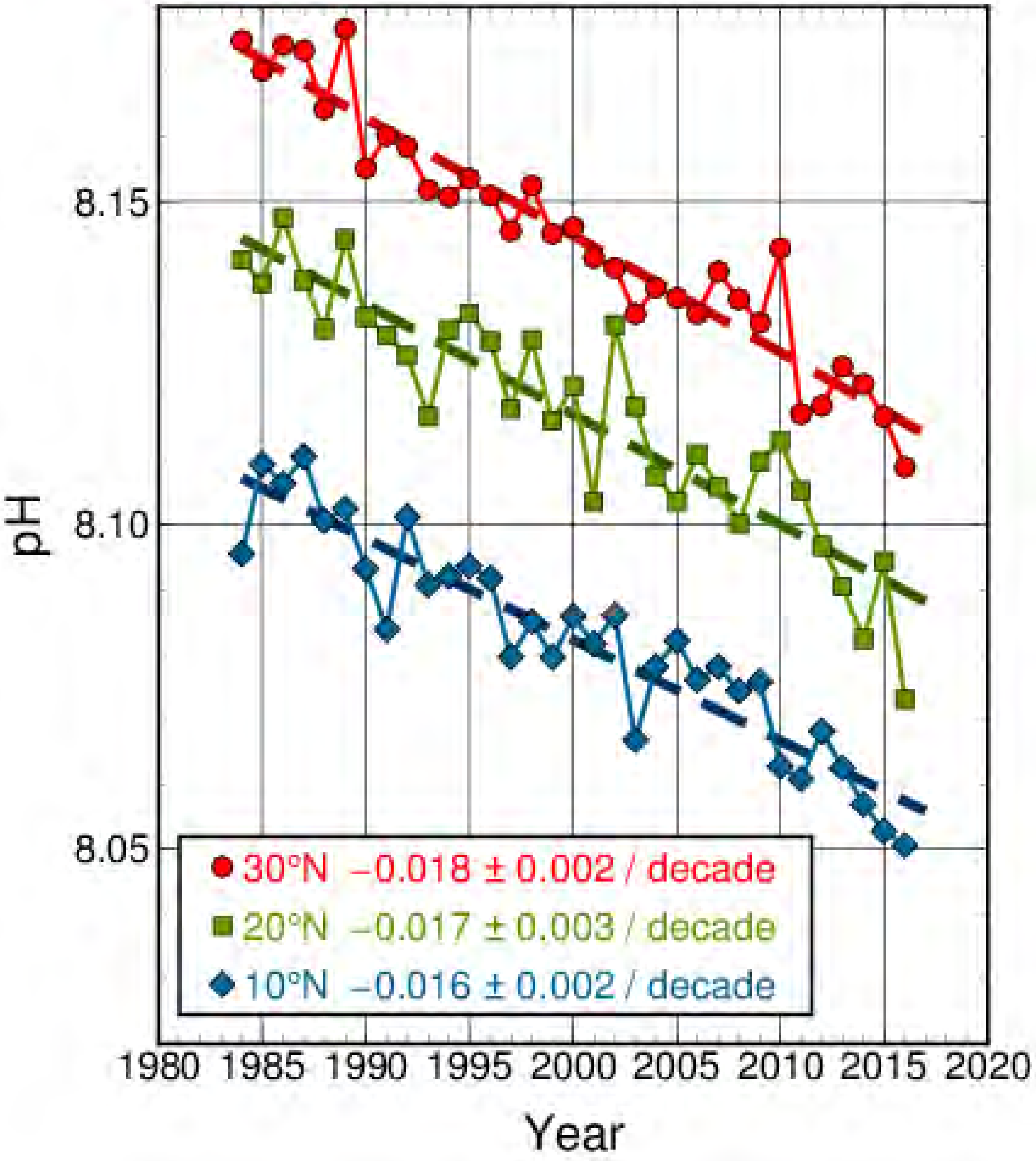
JAPAN

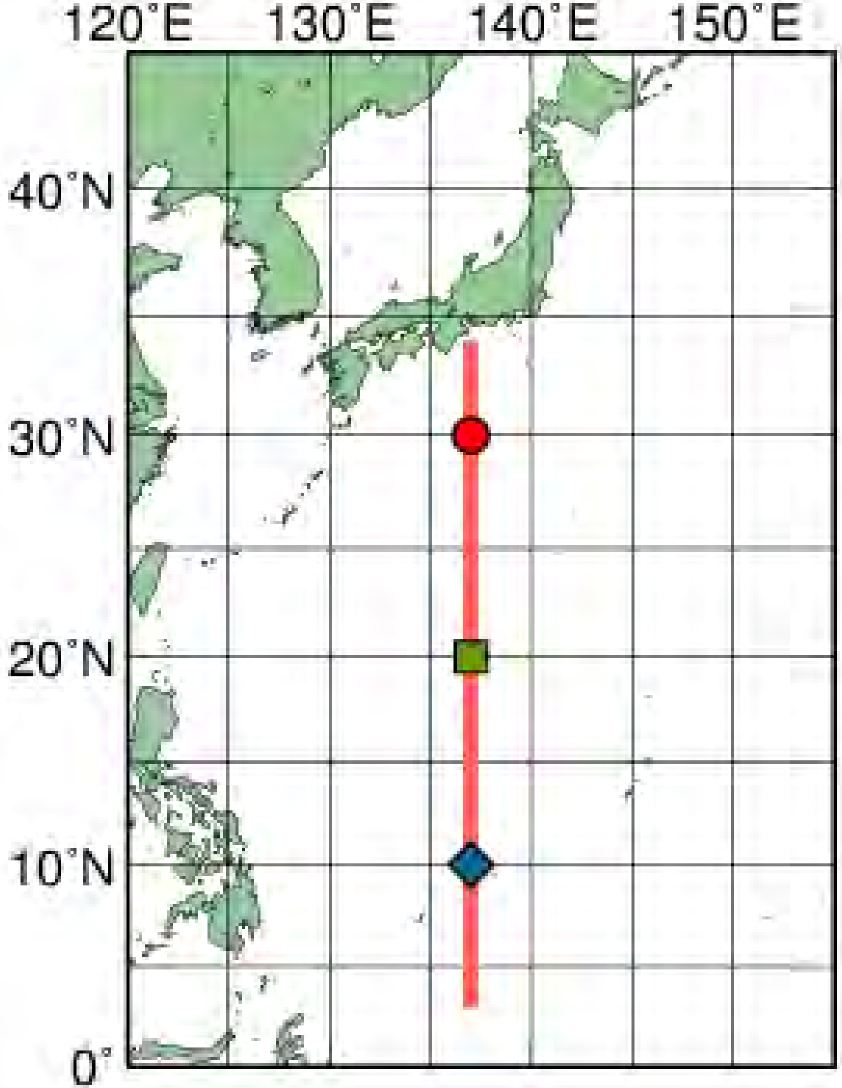
Shifting communities

(a) well-developed Ecklonia cava bed in the early 1990s; (b) overgrazed E. cava bed in October 1997; (c) rocky barren area in January 2000; (d) coral communities present in January 2013 Serisawa *et al.*



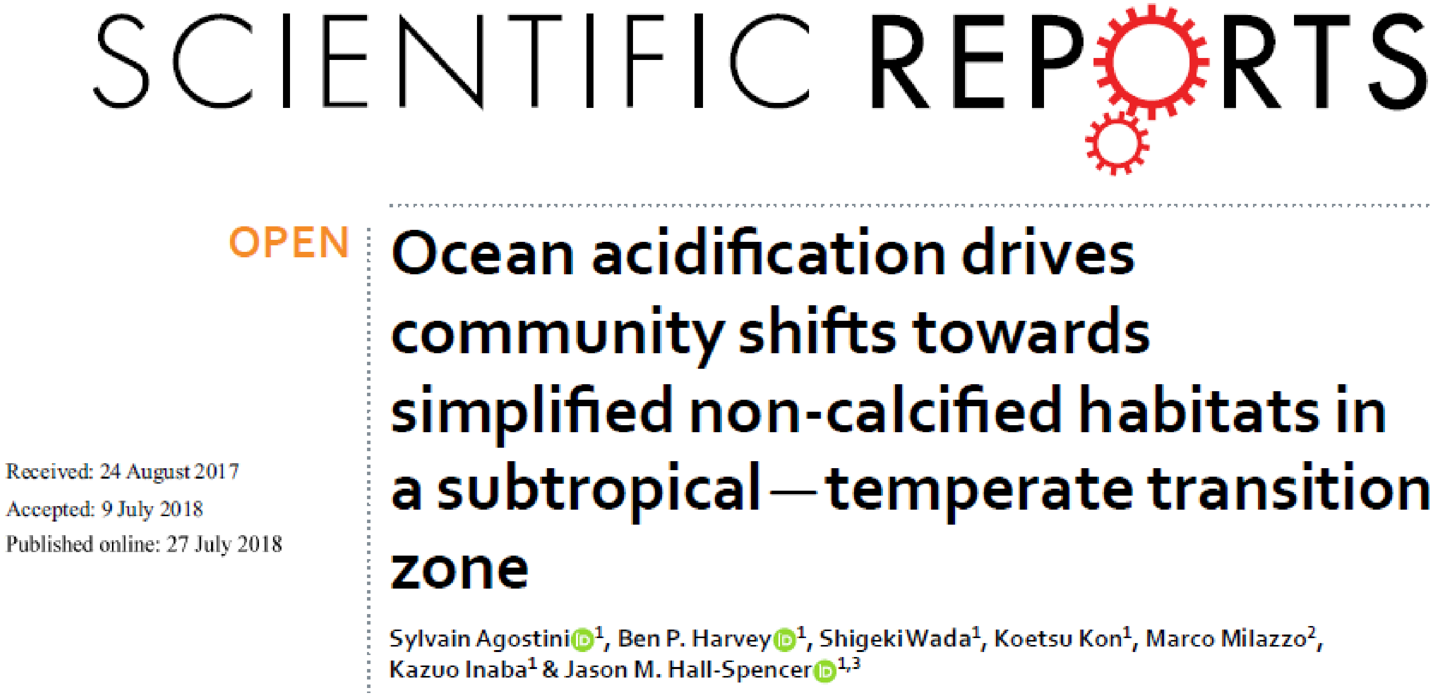
We know that seawater pH is falling rapidly off Japan. Our CO_2 seep data indicates that this will limit the northern spread of corals





Midorikawa (2010)

We have new data on 100s of species including Bacteria, Cyanobacteria, Diatoms, Seaweeds, Sponges, Corals, Polychaetes, Crustaceans, Molluscs, Echinoderms & Fish



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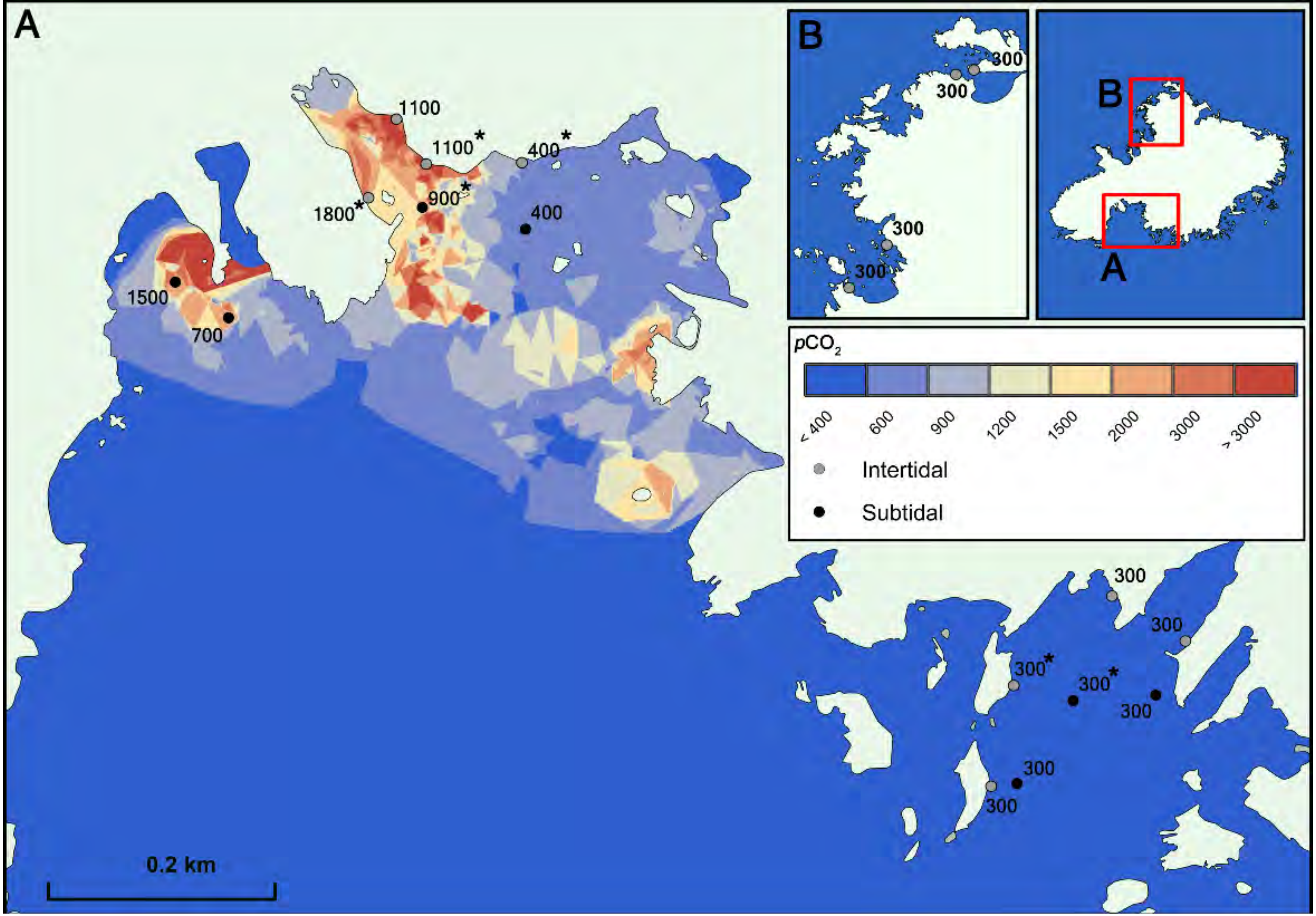
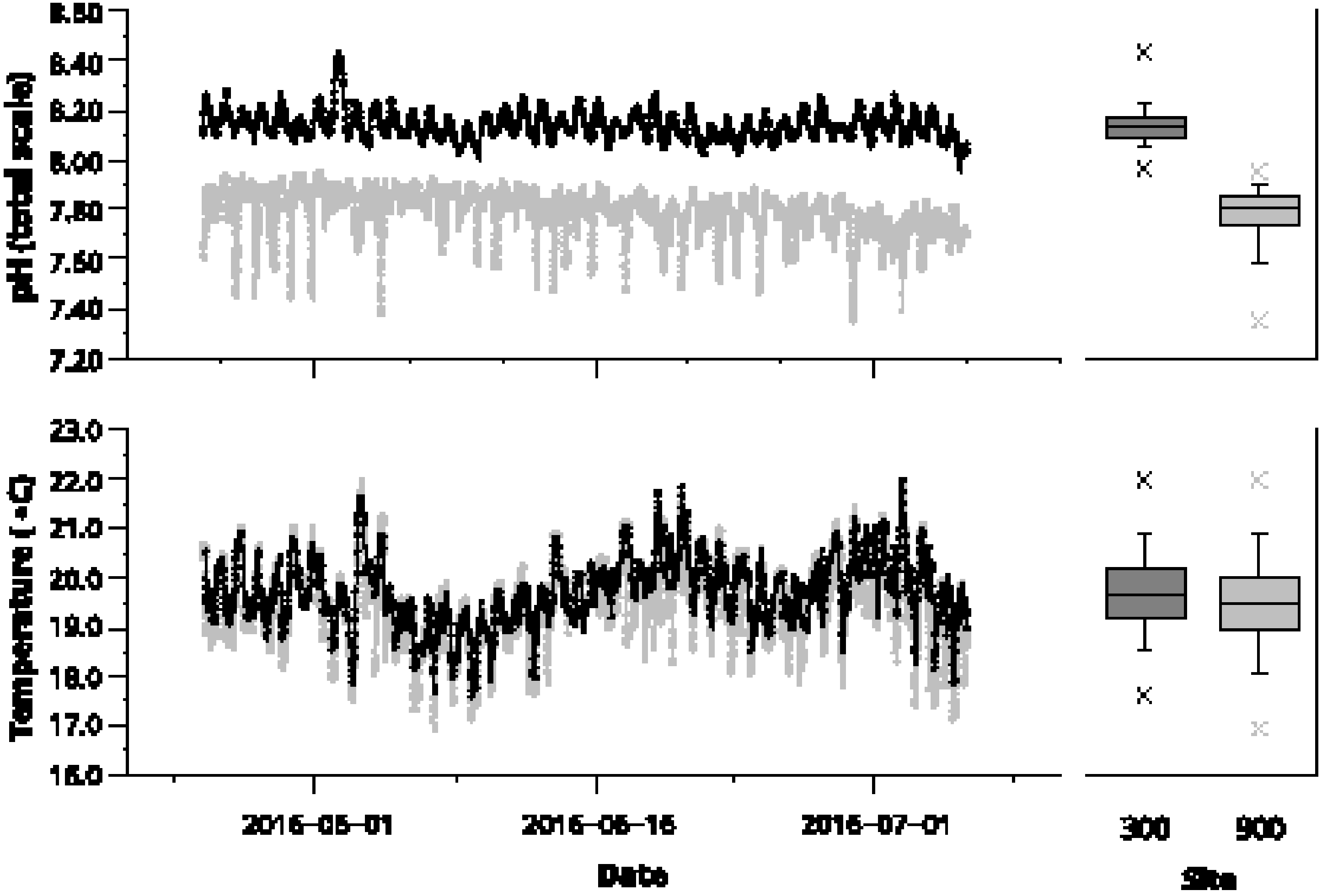
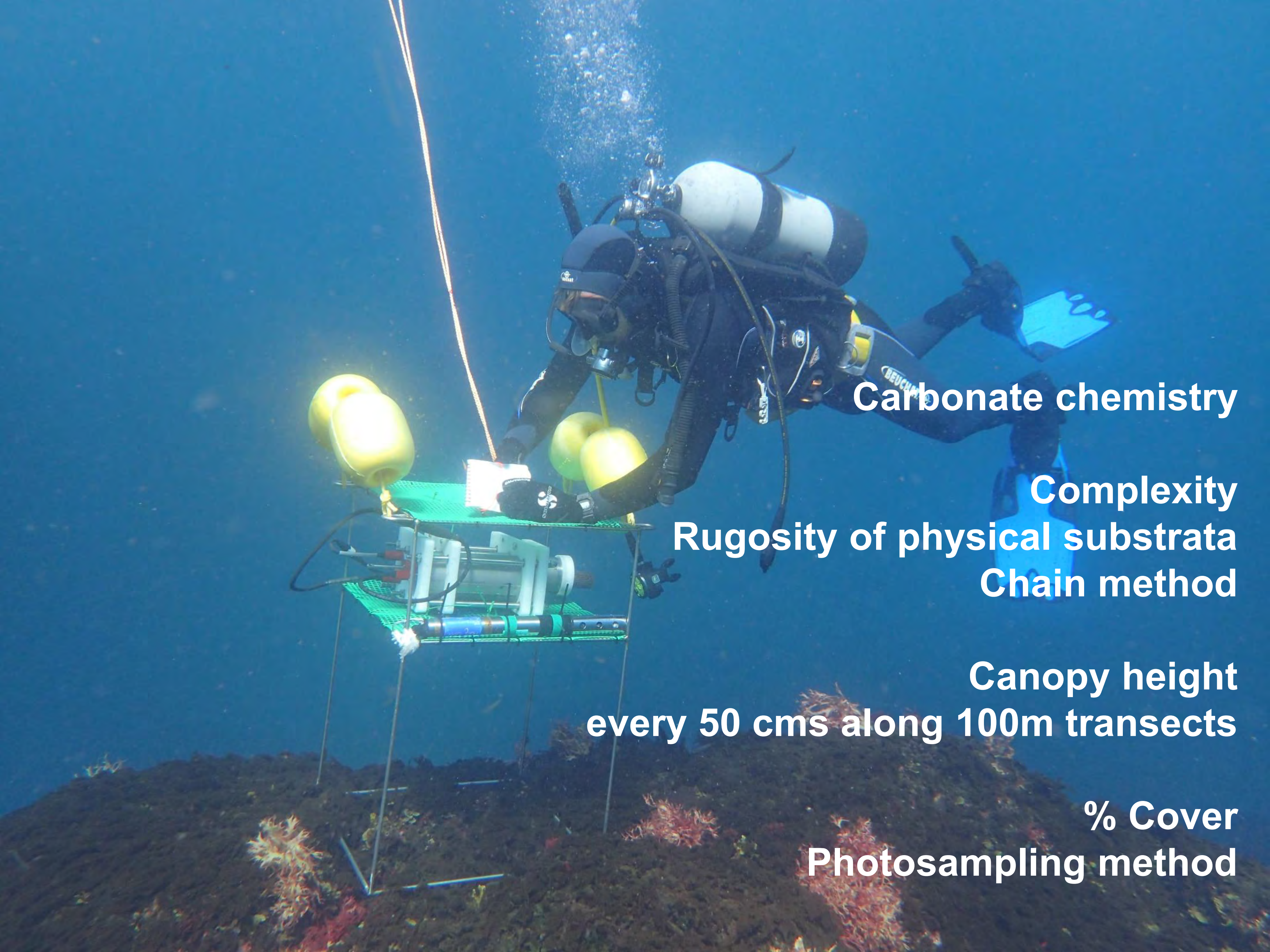
Shikine-jima



Study area (Shikine-Jima, Japan) showing intertidal and subtidal stations, and the spatial variability in *p*CO_2. The spatial distribution of *p*CO_2 was computed using the nearest neighbour algorithm in ArcGIS '*' indicates sites where 24-hour measurements of carbonate chemistry were taken.



Variation of temperature and pH (total scale) in June 2016 at a subtidal control site ('300 µatm') and a subtidal elevated CO_2 site ('900 µatm'), both 3 m deep. Measurements were carried out with SeaFET sensors deployed just above the seafloor.

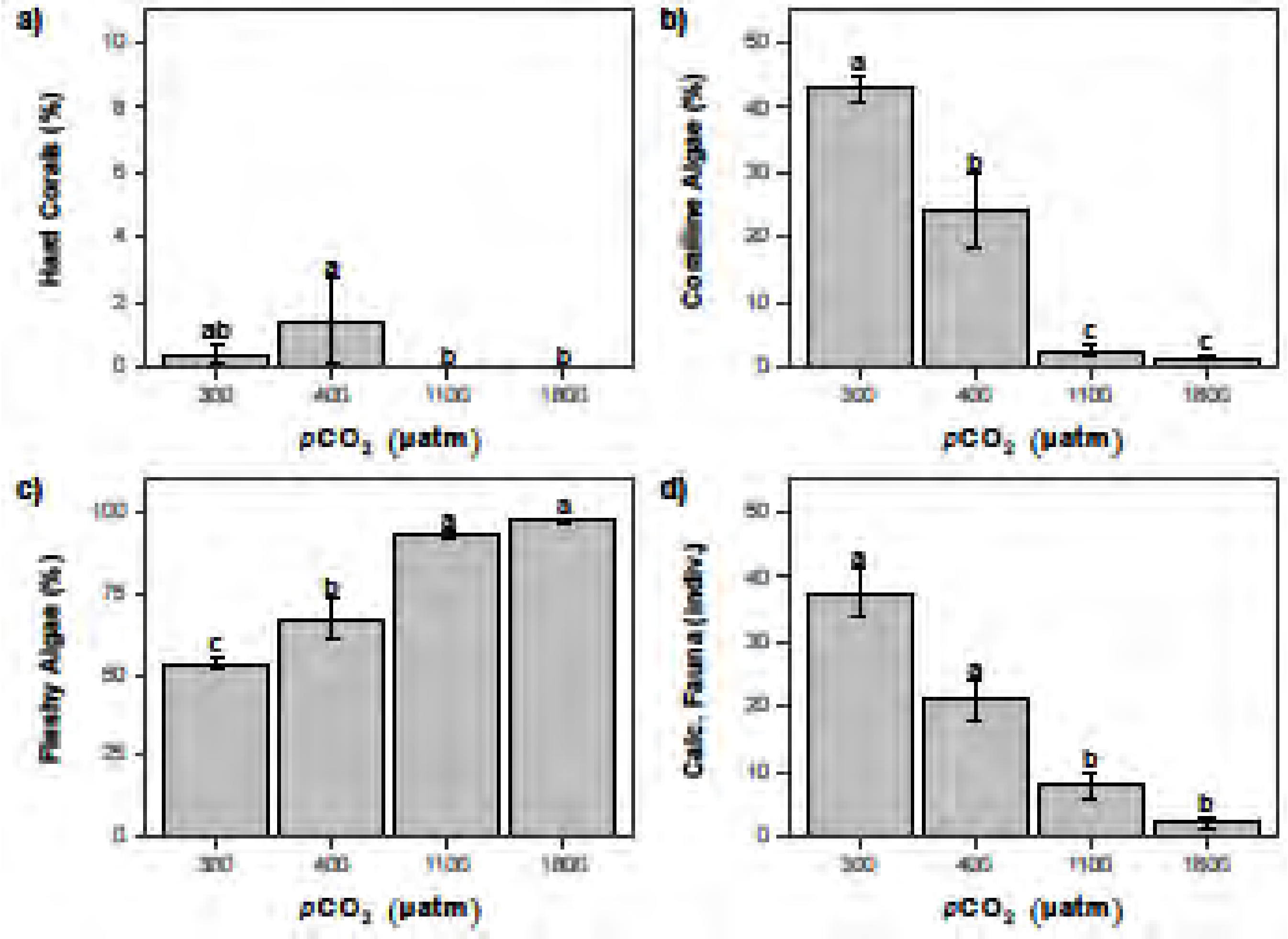


Carbonate chemistry

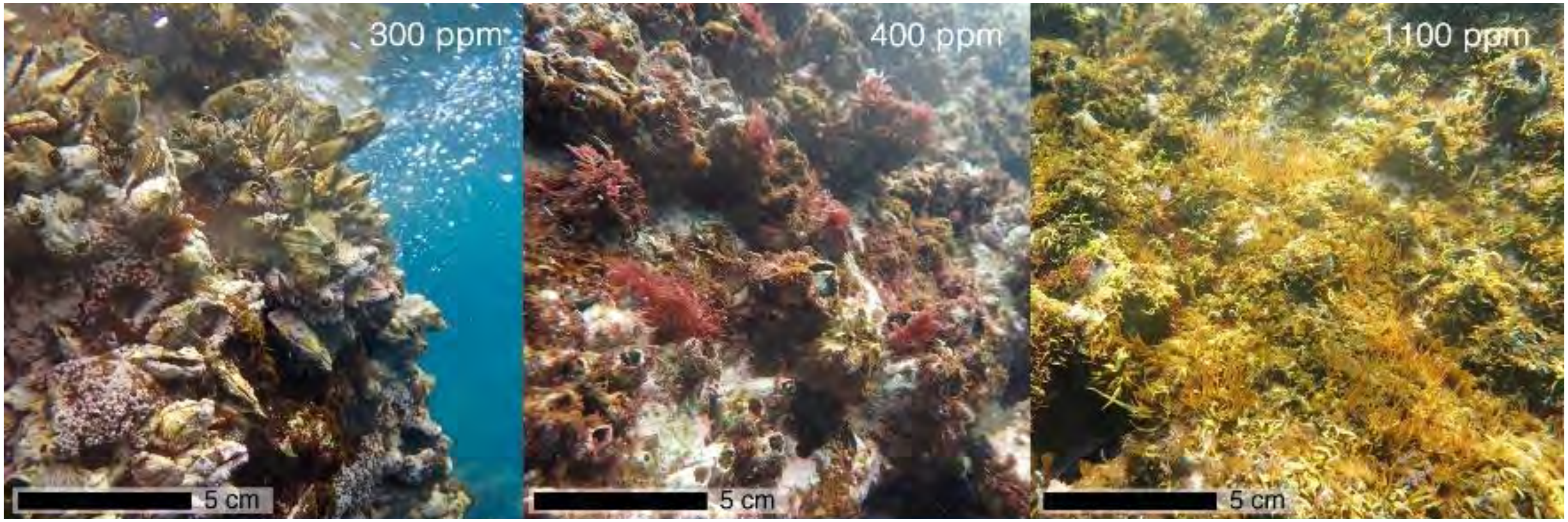
Complexity
Rugosity of physical substrata
Chain method

Canopy height
every 50 cms along 100m transects

% Cover
Photosampling method

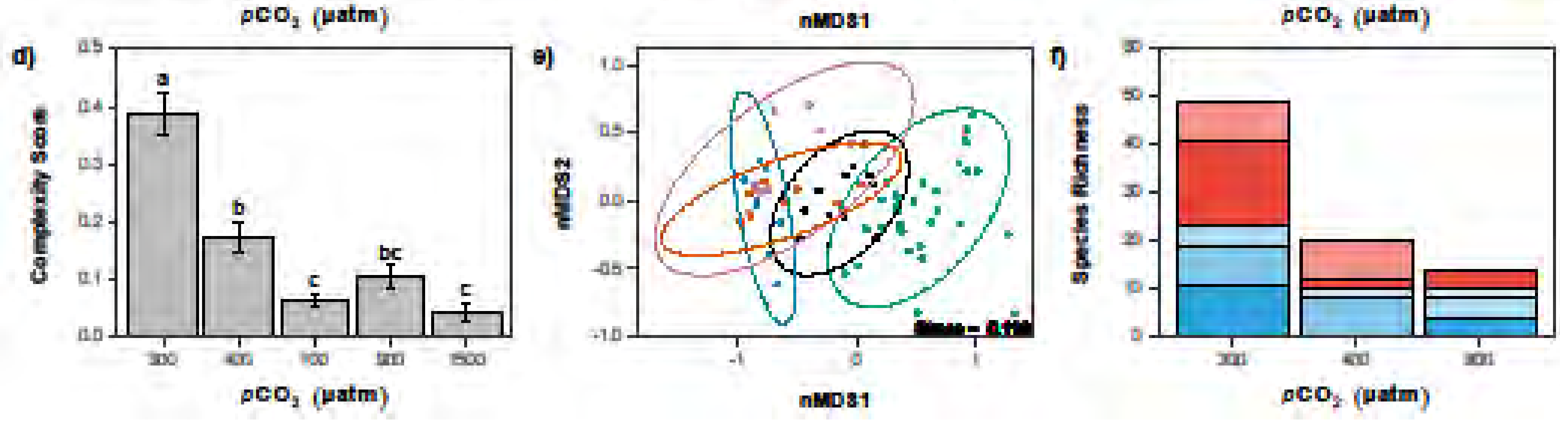


Changes in abundance (mean ± SE) of taxa (mean ± SE) with increasing $p\mathrm{CO}_2$ for intertidal habitat. a, coralline algae. **b**, hard corals. **c**, low-profile fleshy algae. **d,** calcified fauna. A significant difference between $p\mathrm{CO}_2$ groups is indicated with a different letter.



Representative intertidal communities at increasing pCO_2 levels.

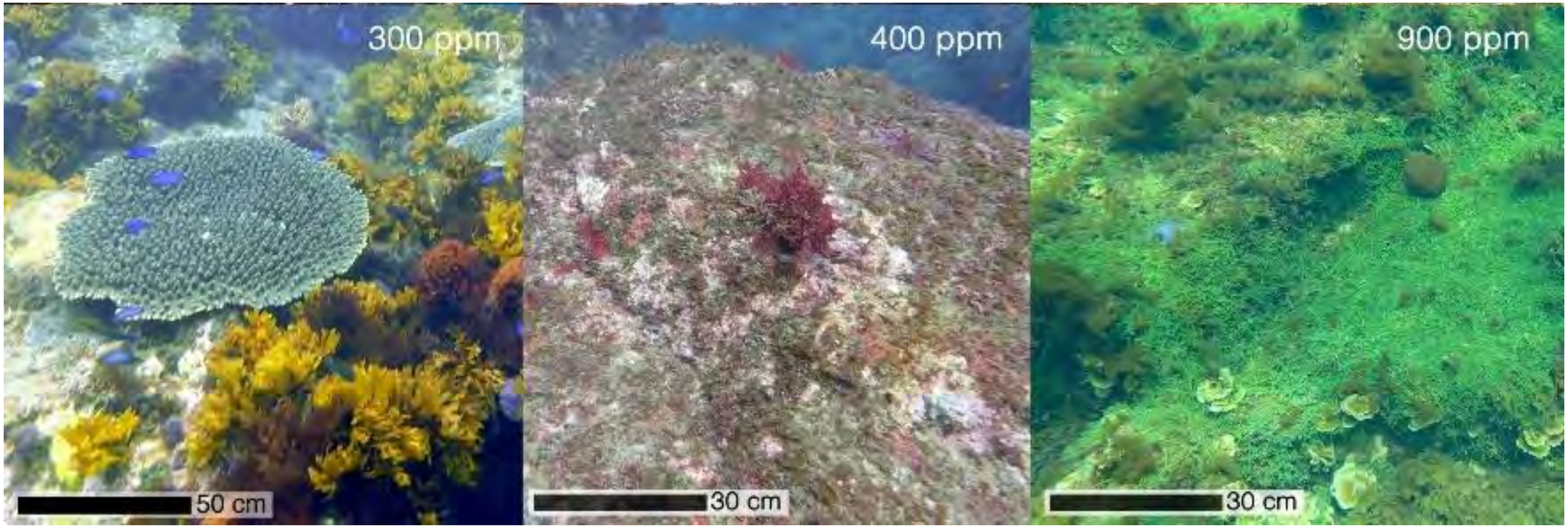
Marine communities exposed to mean levels of pCO_2 predicted by 2050 experienced periods of low aragonite saturation and high dissolved inorganic carbon. These two factors combined to cause marked community shifts.



Changes in habitat complexity (mean ± SE), communities, and species richness with increasing $p\text{CO}_2$ for subtidal (d, e and f) habitats.

e) The colour of each point represents the $p\text{CO}_2$: green: ‘300 µatm’, black: ‘400 µatm’, light blue: ‘1100 µatm’ and orange: ‘1800 µatm’ for the intertidal and green: ‘300 µatm’, black: ‘400 µatm’, blue: ‘700 µatm’, red: ‘900 µatm’ and pink: ‘1500 µatm’ for the subtidal.

f) Algal (blue) and faunal (red) species richness are shown



Representative subtidal communities at increasing $p\mathrm{CO}_2$ levels.

A major decline in biodiversity, including the loss of key habitat-forming species, with even more community changes expected by 2100

In areas with pre-Industrial levels of CO_2 the coast has an impressive amount of calcified organisms such as corals and oysters.

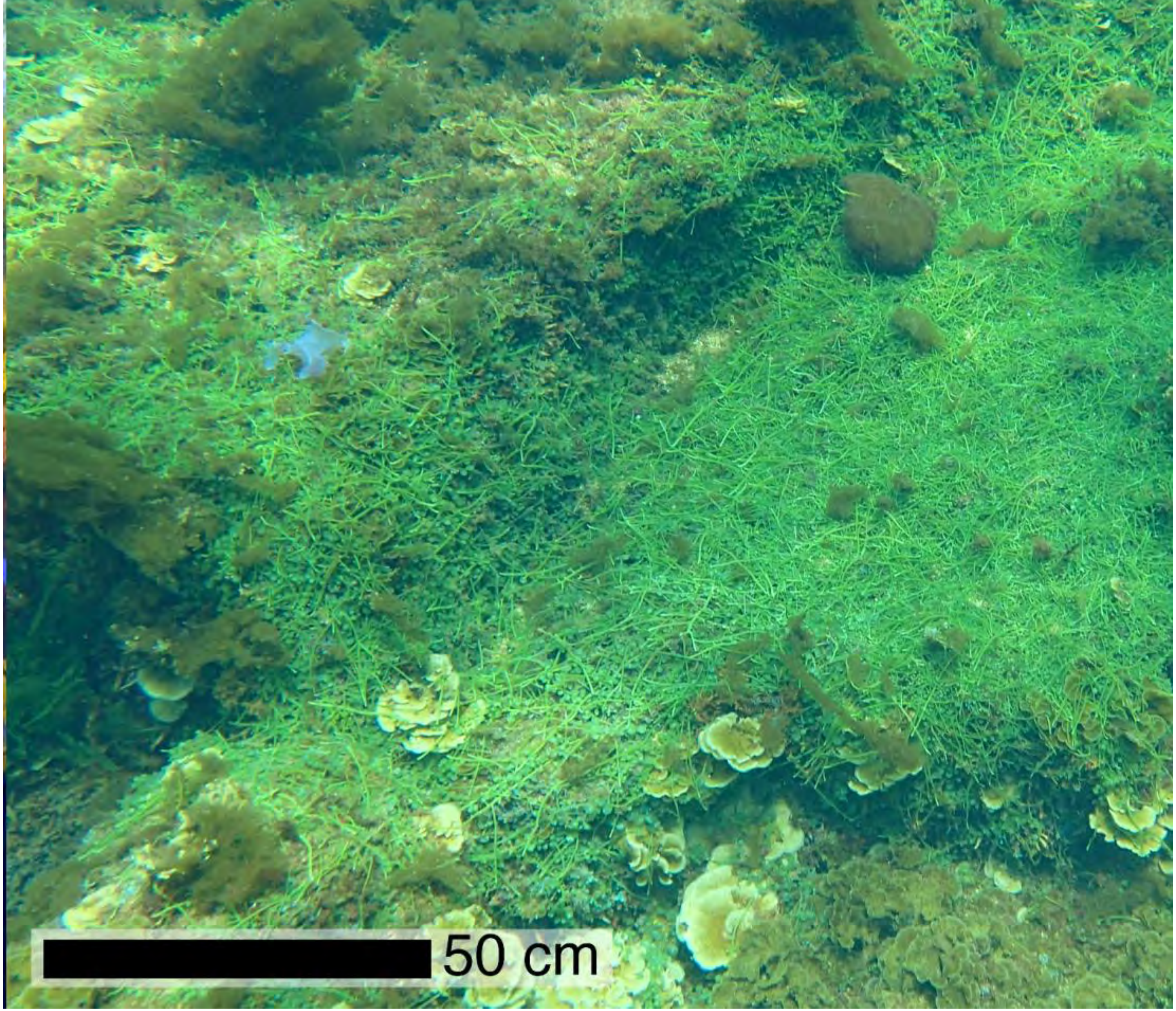
In areas with present-day average levels of surface seawater CO_2we found far fewer corals and other calcified life, and so there was less biodiversity.

This shows the effects of CO_2 emissions over the past 300 years

300 ppm CO_2

- ↑ Canopy
- ↑ Corals

- ↑ Fish diversity
- ↑ Fish abundance



CO_2 levels 900 ppm in 2090 BAU

Thanks for your attention

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