California State University Northridge

MOOREA CORAL REEF LTER
Member of the NSF Long Term Ecological Research Network

UCSB

LTER

Studying ocean acidification at an LTER: a coral reef example from Moorea

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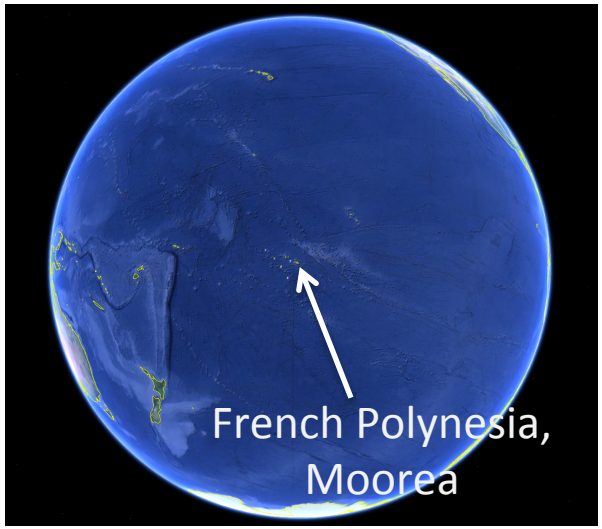
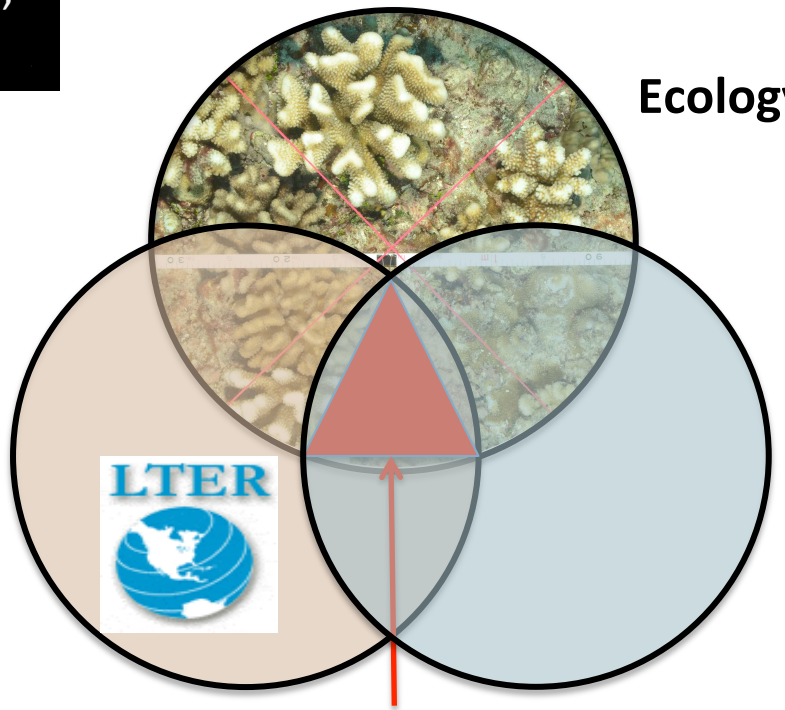
California State University, Northridge

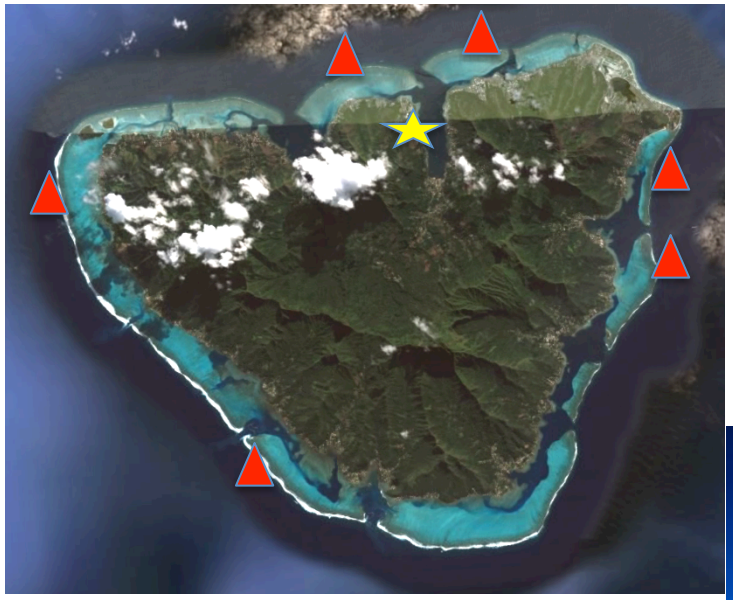
Moorea Coral Reef LTER

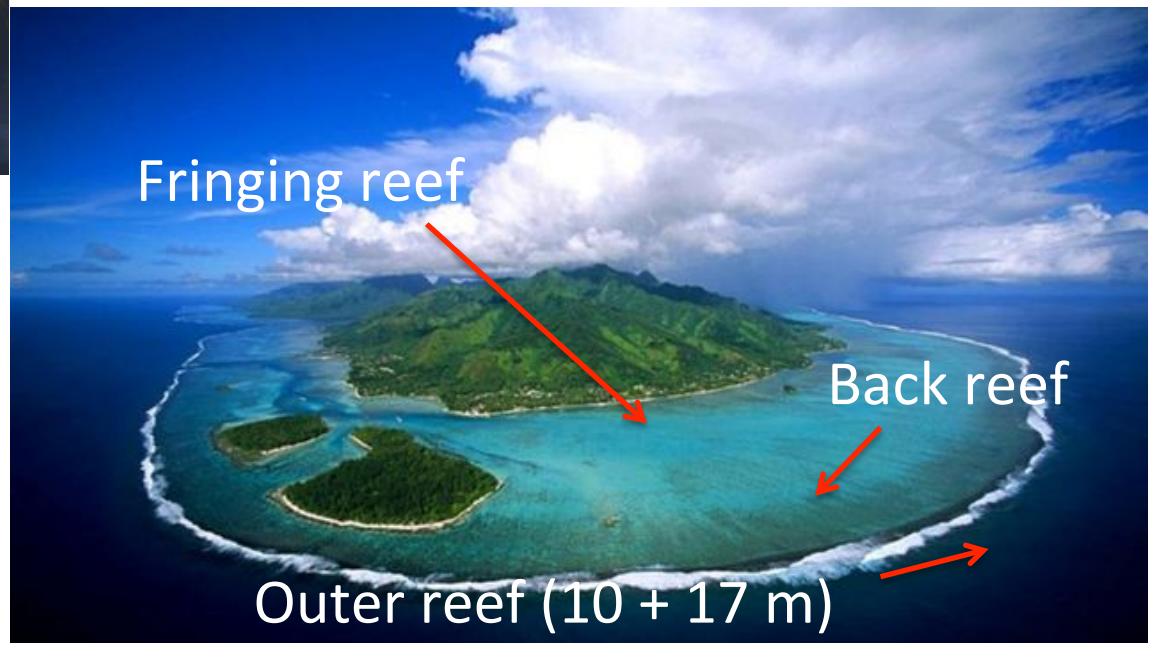




Context for, and advantages of, OA research at an LTER site

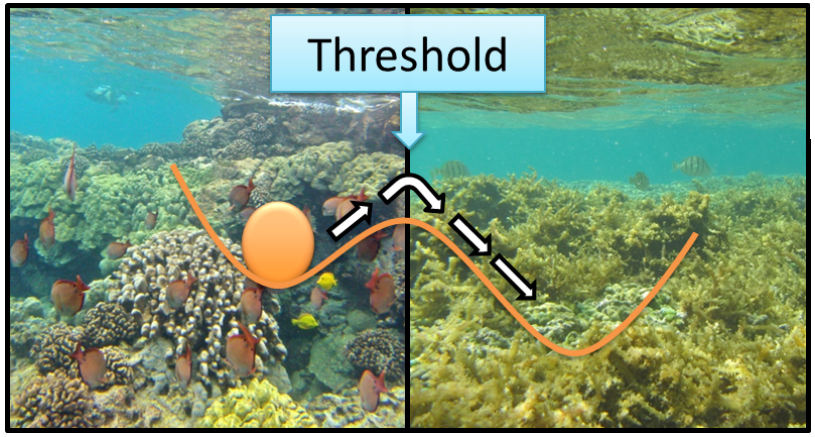
Moorea Coral Reef LTER – sampling design





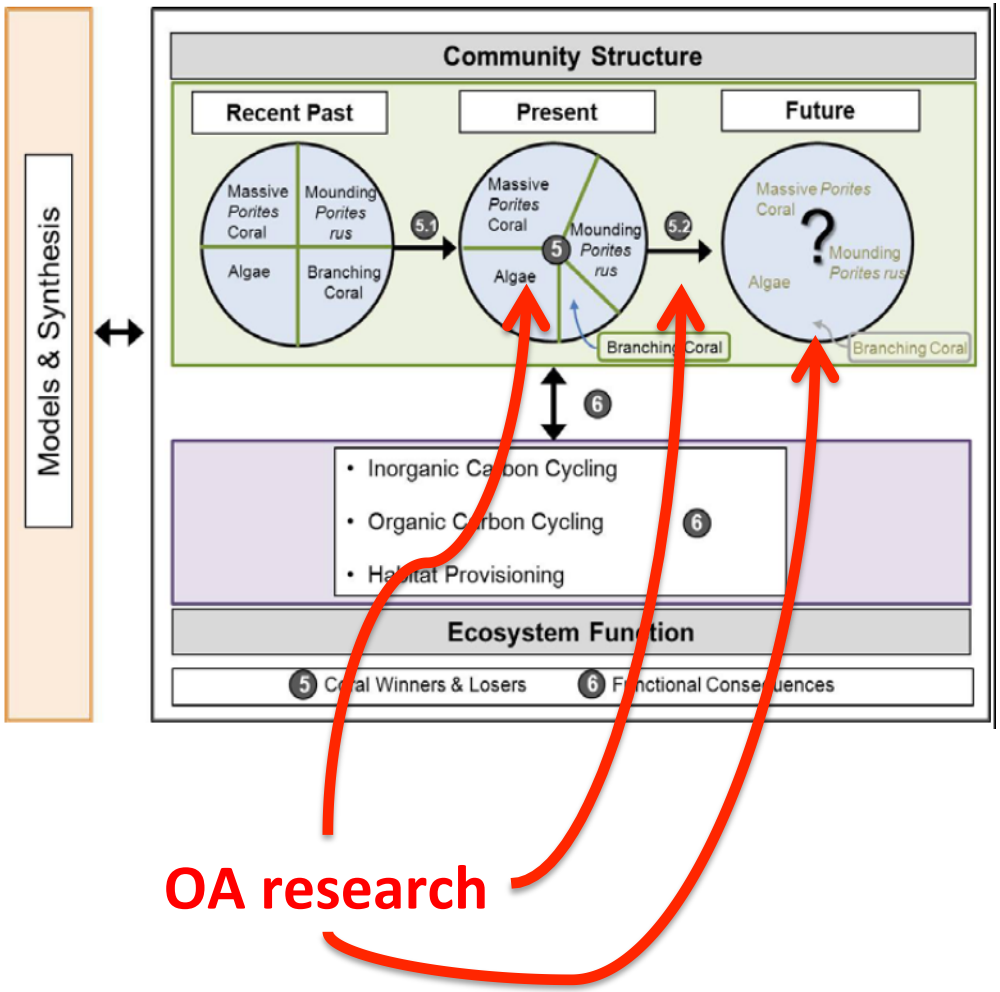
MCR research themes

1. Resilience of contemporary reefs



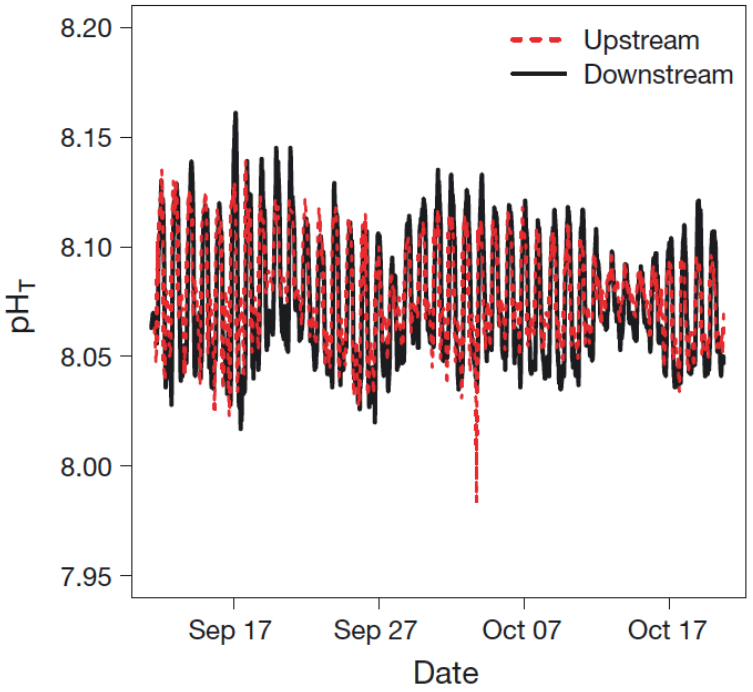
From: http://oceantippingpoints.org

2. Coral reefs of the future

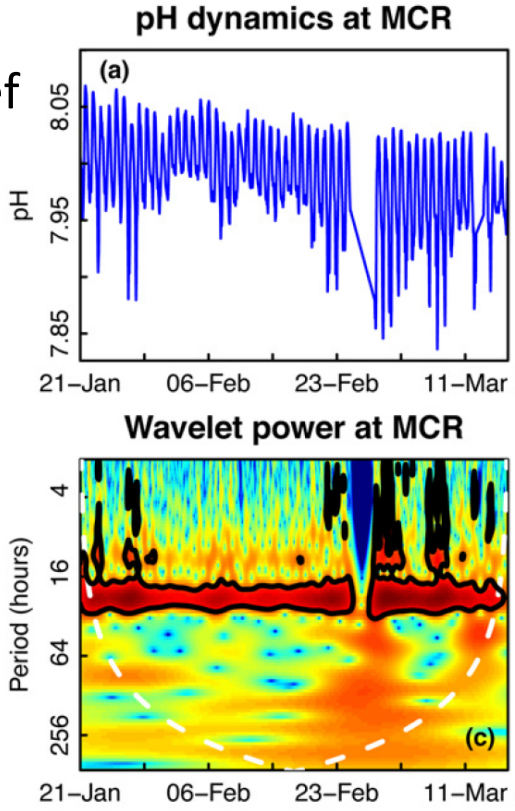


Physical measurements of pH

Upstream/downstream



Fringing reef



Offshore (2005-present)

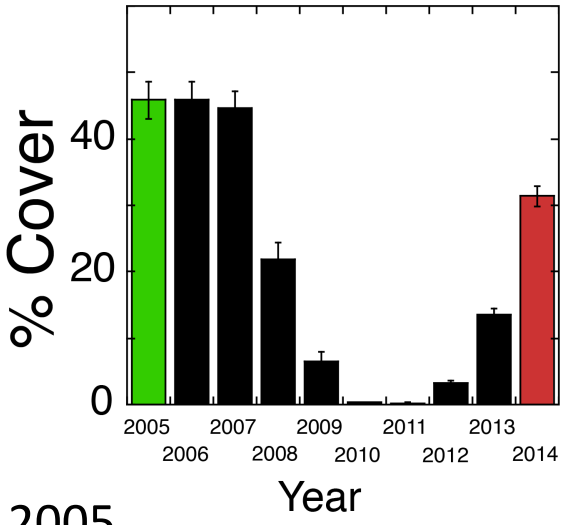
- 7 km and outer reef
- TA = 2345 ± 3 µmol/kg
- pH = 8.071 ± 0.003

Comeau et al. (2014) MEPS 501: 99-

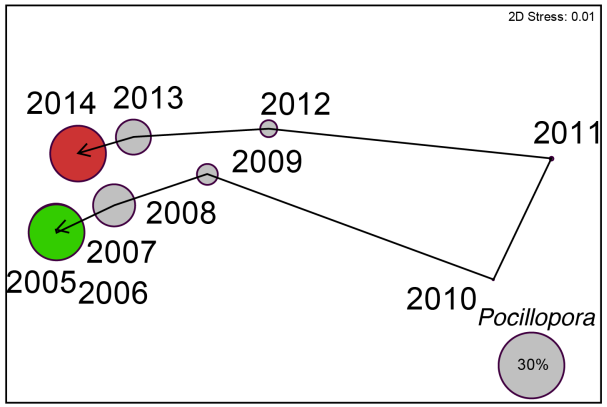
Rivest et al. (2015) PLoS ONE 10: e0121742

Biological changes on the reefs of Moorea

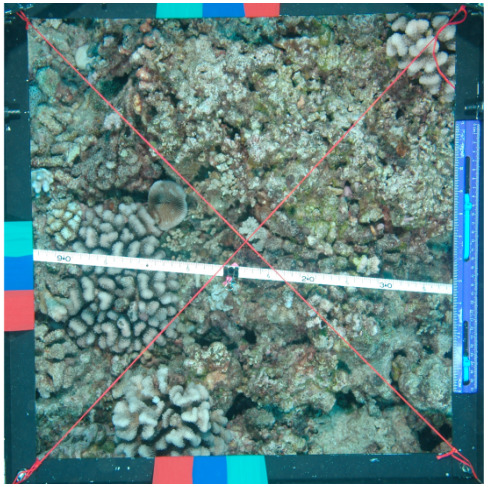
Coral cover



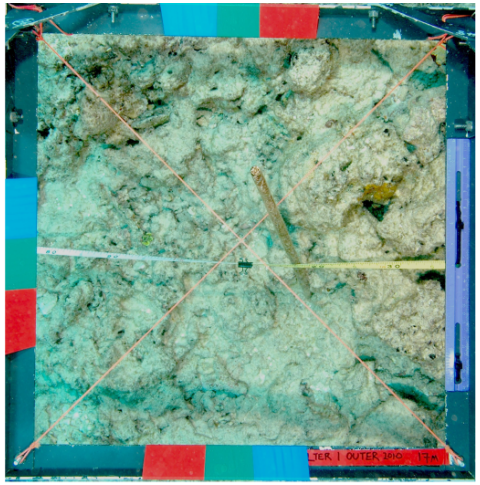
Coral genera



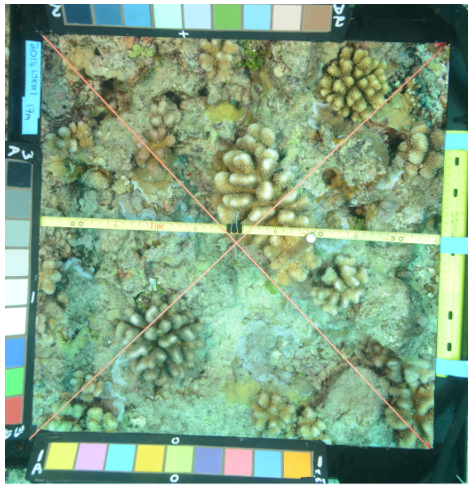
2005



2010 (after COT & Oli)



2014



Summary: Over the first decade, major changes driven by pulse disturbances (COT and cyclone)

Development of OA research theme

Cells

Organisms

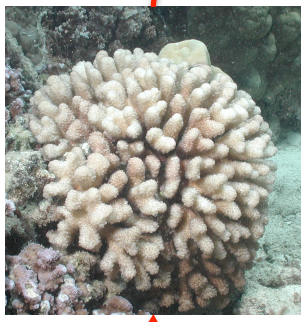
Populations

Communities

Ecosystem

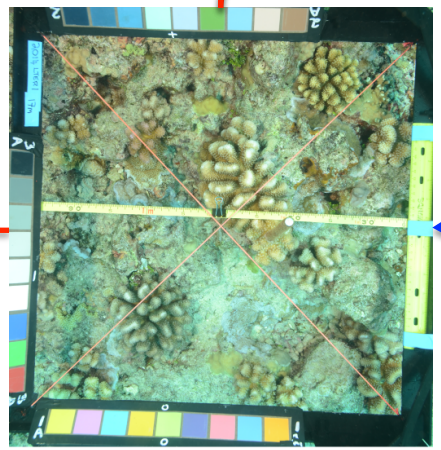
Ecologically relevant chemical and physical conditions

Revised physical sampling



Relevant ecological scenarios

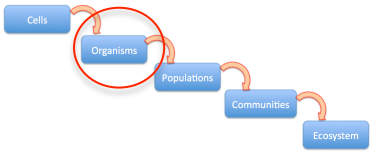
Winners & Losers



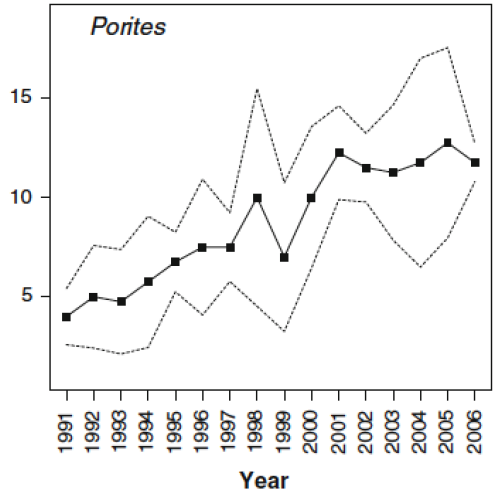
Revised ecological Sampling?

Time series

Organism scale effects



Long-term change on the N shore



Winners in Moorea

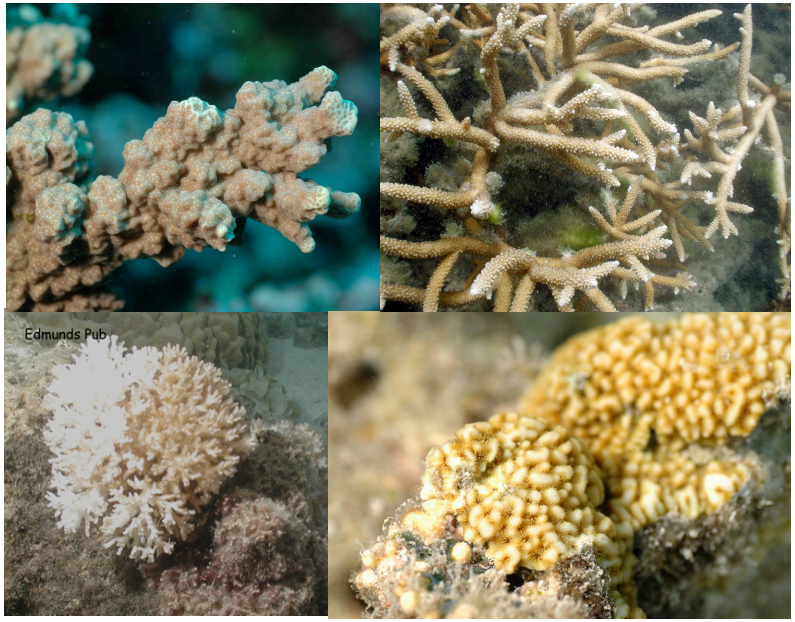
Porites

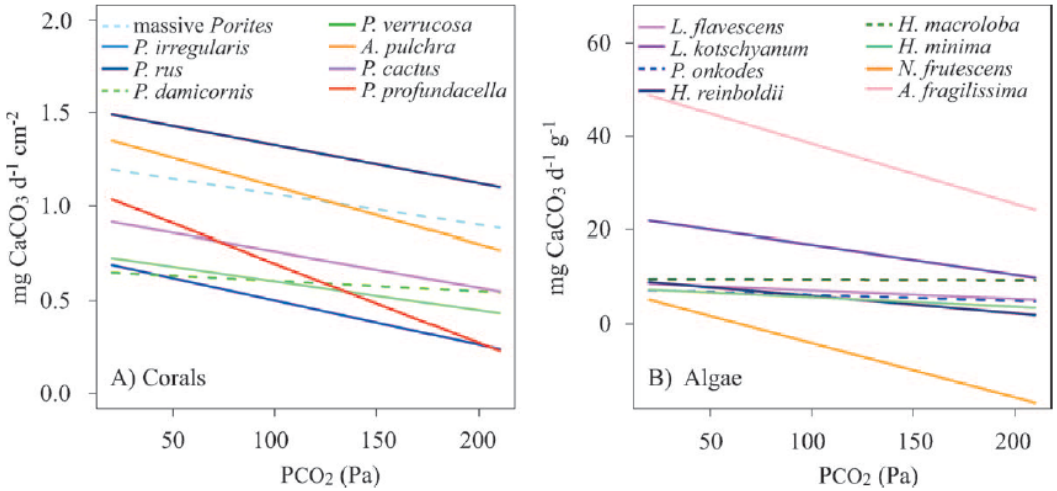
Pocillopora

Losers in Moorea

Acropora

Montipora



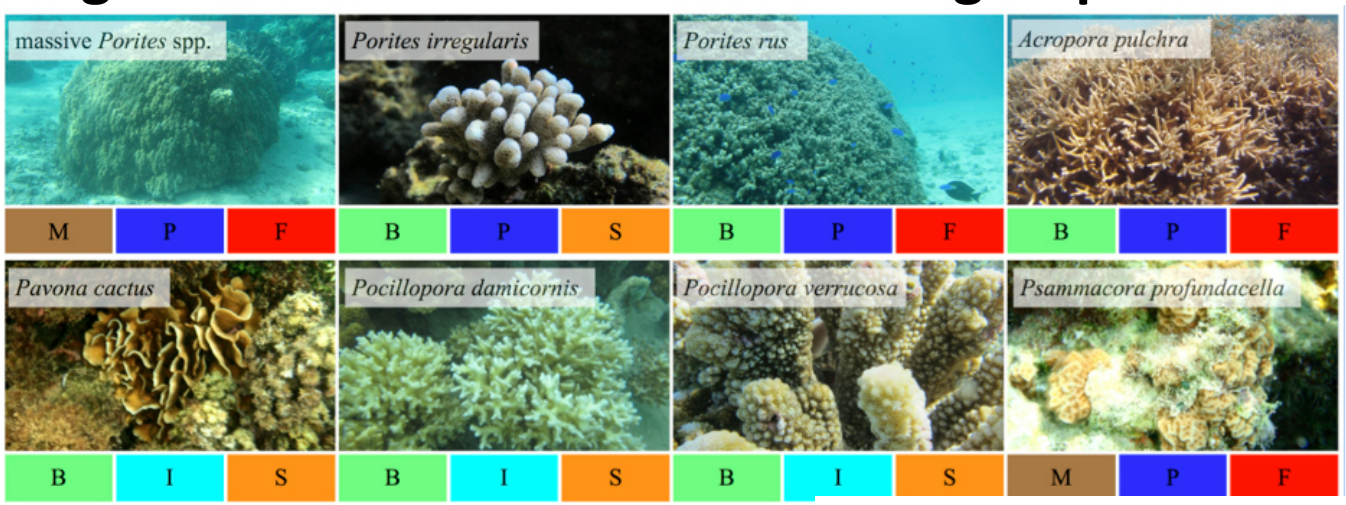


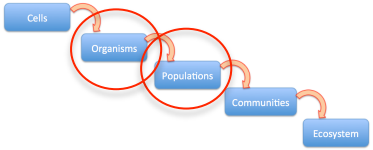
Solid lines, $P < 0.05$, dashed $P > 0.05$

Variety of species contrasts differ in their response to OA, and show no tipping point against pCO_2

Comeau et al. (2013) L&O 58, 388- , (2014) L&O 59: 1081-

Organism scale effects – functional groups

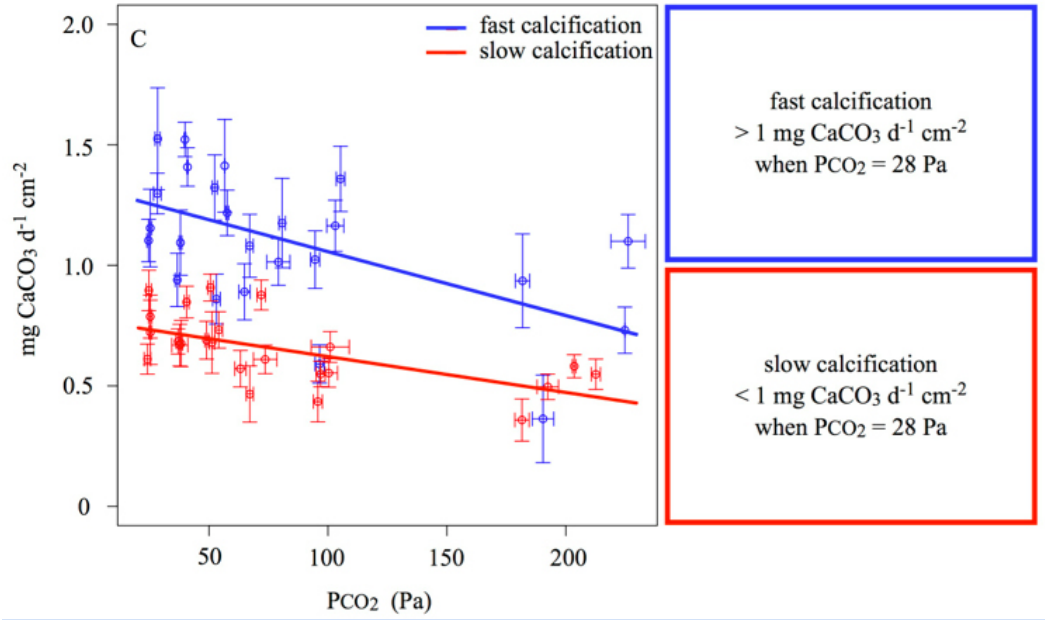




ANCOVA, slopes: P = 0.042

Corals

Morphology:	M	mounding vs.	B	branching
Skeleton:	P	perforate vs.	I	imperforate
Calcification:	F	fast vs.	S	slow



Do coral reef calcifiers differ among functional groups in response to OA?

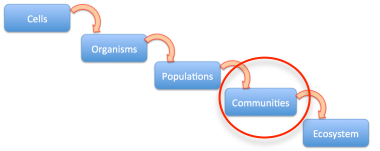
- fast vs slow

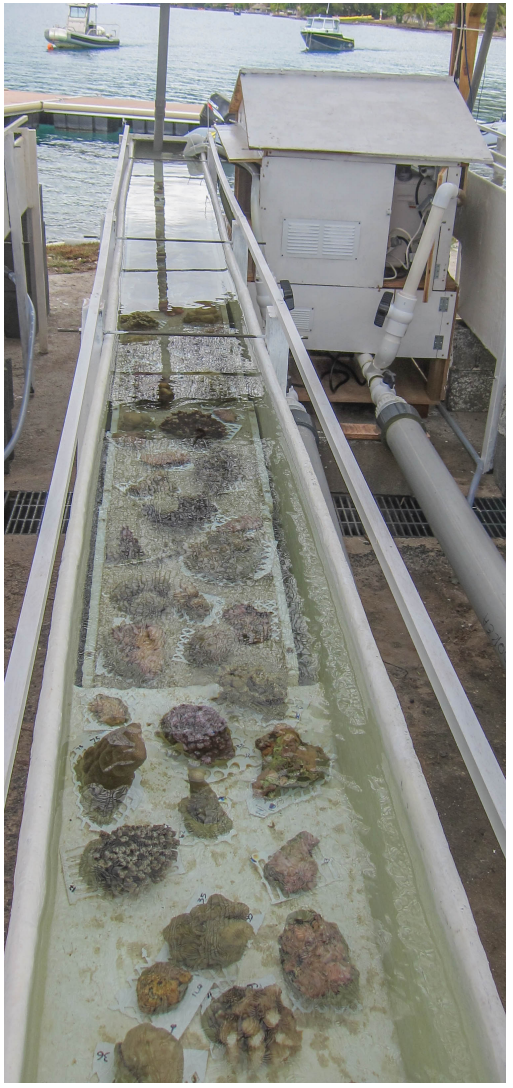
Summary: Functional groups differ, fast are more sensitive than slow calcifiers

Comeau et al. (2014) L&O 59, 1081-

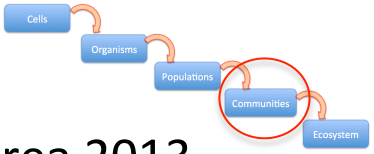
Community scale effects – flume experiments

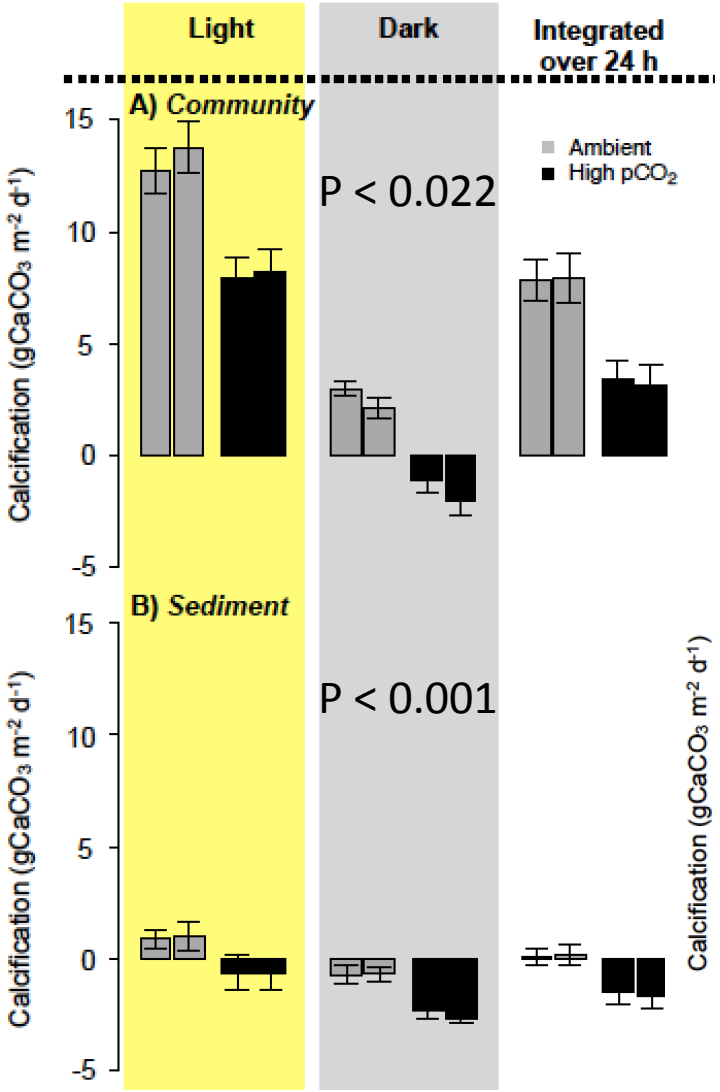
Back reef



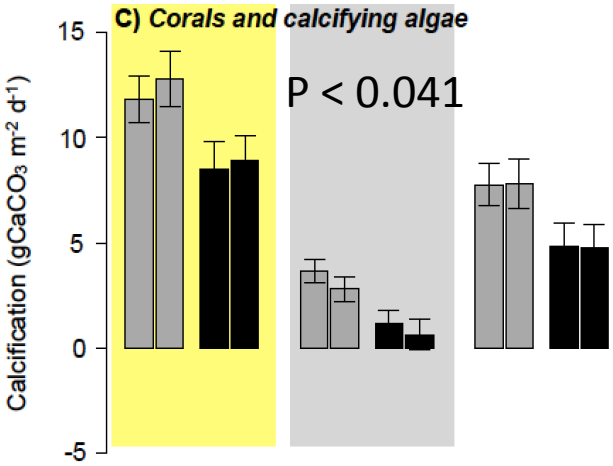


Community scale effects – back reef





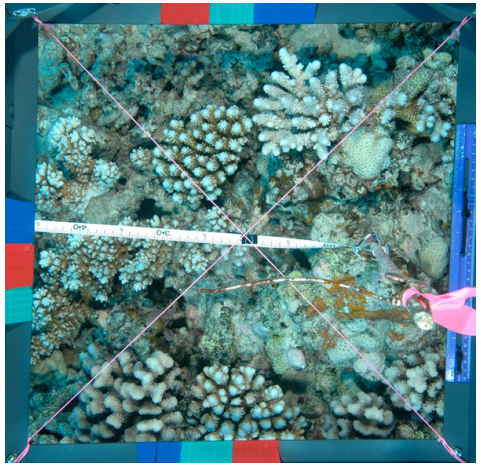
Community matched to Moorea 2013

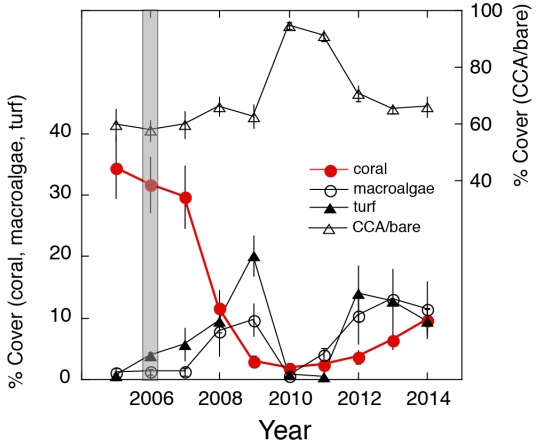


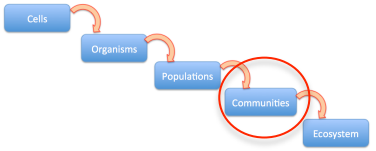
Summary: community calcification reduced 59% at high pCO2, with 50% of this due to sediment dissolution; corals and calcified algae reduced 29%

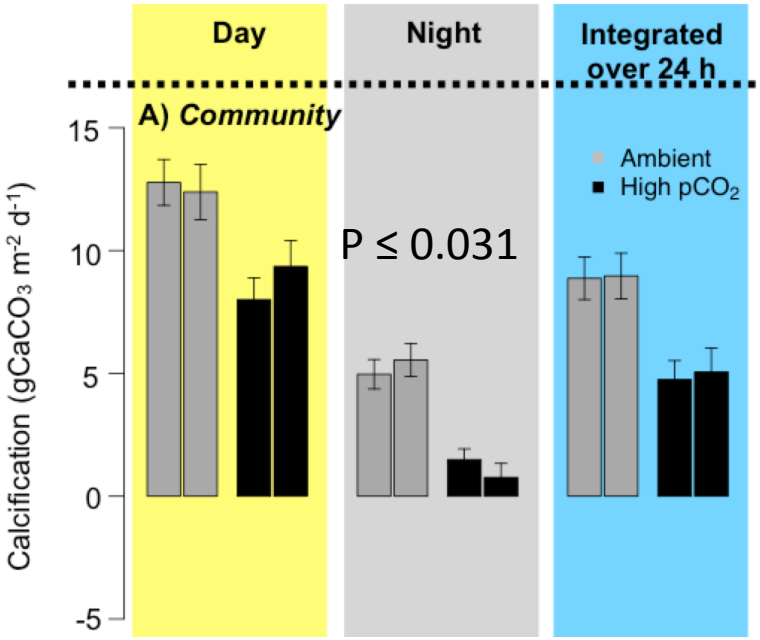
Comeau et al. (2015) Biogeosciences 12: 365-

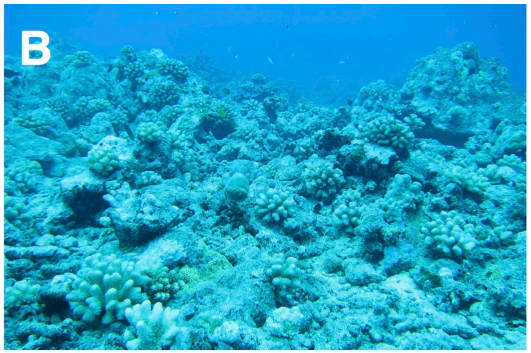
Community-scale effects – 17 m, outer reef

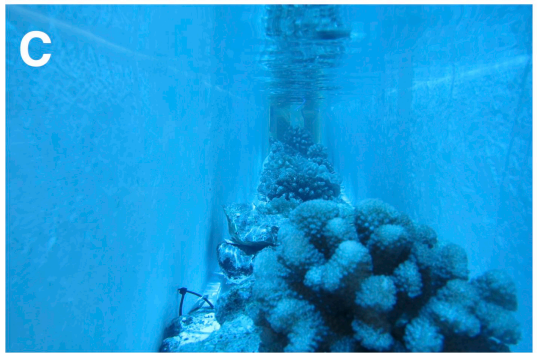


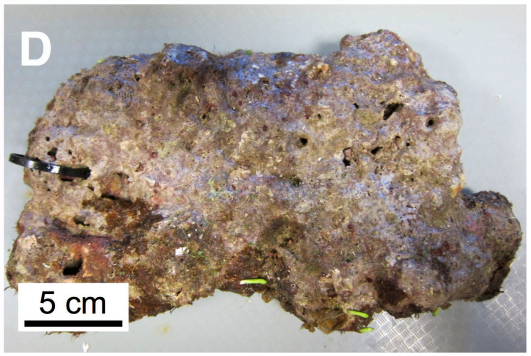








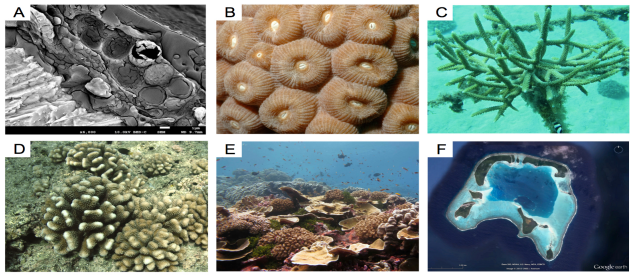




Summary: pCO_2 (1200 µatm) depressed Community calcification 45% when Integrated over 24 h, largely due to pavement dissolution

Comeau et al. (2015) GCB (in press)

Scaling-up OA effects

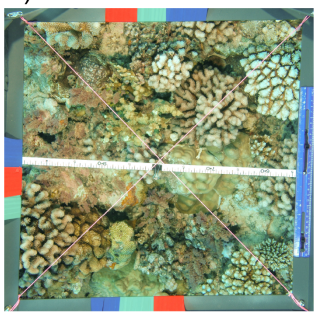


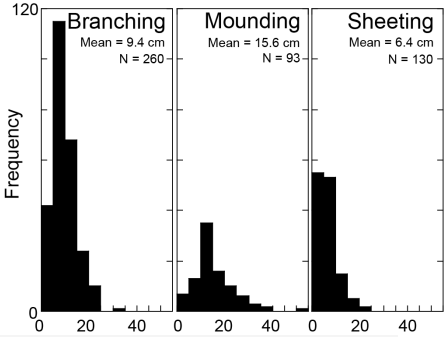
Cells → Organisms → Populations → Communities → Ecosystem

Modeling approaches:

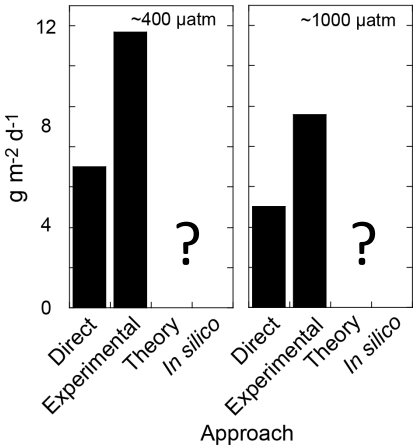
- Dynamic energy budgets (DEB)
- integral projection models (IPM)
- Metabolic theory of ecology (MTE)

A) Direct calculation



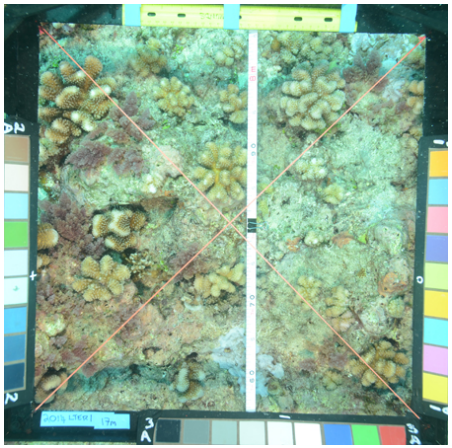


D) Community calcification



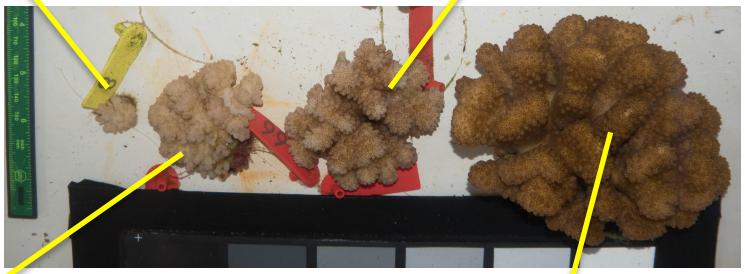
Edmunds (+ 15 others) BioSciences (in prep.)

Integral projection models – *Pocillopora verrucosa* example



Size 1 = 2.6 ± 0.1 cm

Size III = 7.9 ± 0.1 cm



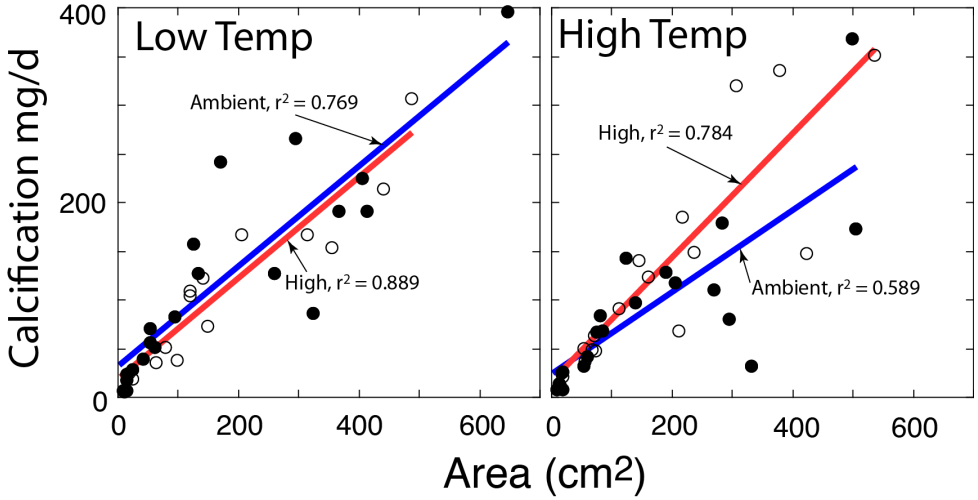
Size II = 5.6 ± 0.4 cm

Size IV = 12.0 ± 0.3 cm

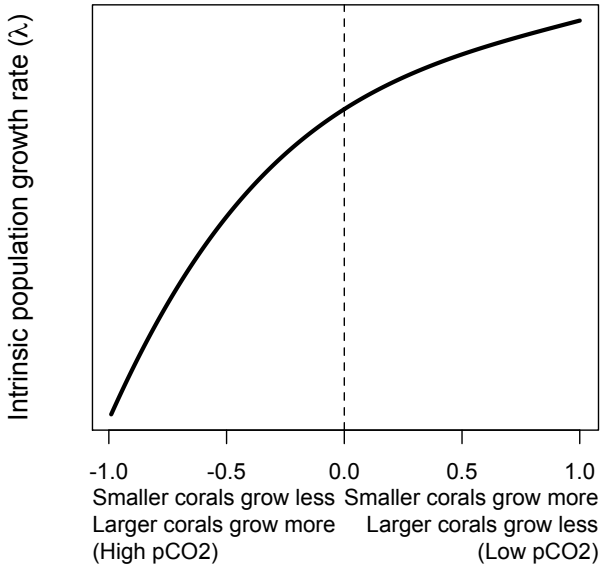
Factorial experiment

(Trial 1, 2014; Trial 2, 2015)

ANCOVA: Temp x pCO2 x Size, P = 0.009



Integral projection model (IPM)

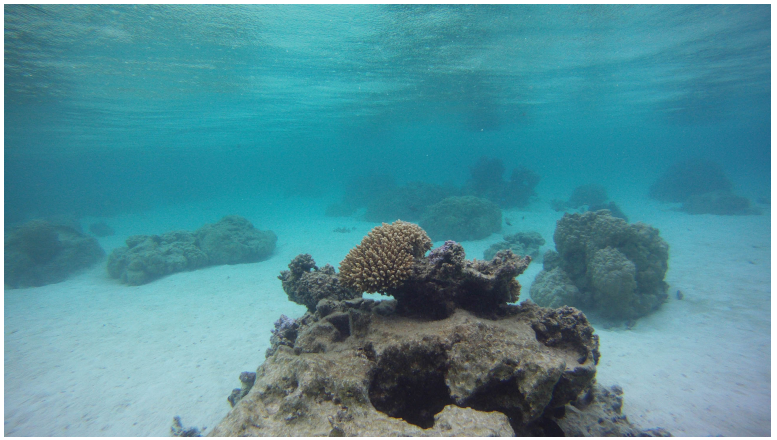


Summary: *Preliminary work* reveals complex ways by which OA translates to population growth

Edmunds PJ + Burgess S (in prep)

Future OA plans in Moorea

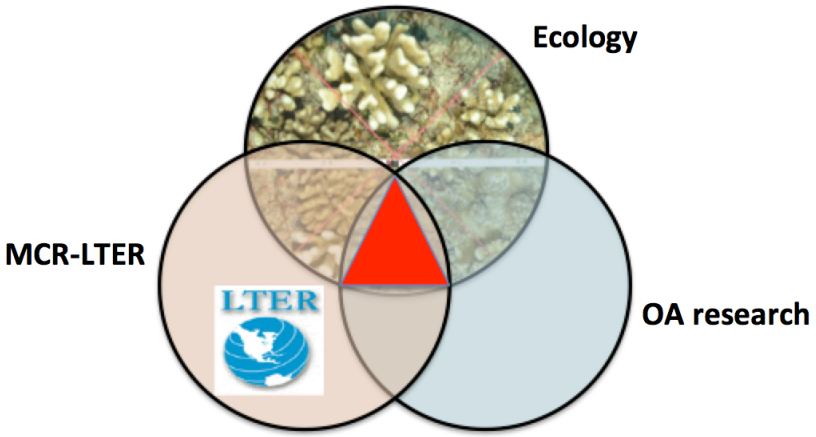
1. In situ flume work to better match to conditions affecting reefs in the LTER



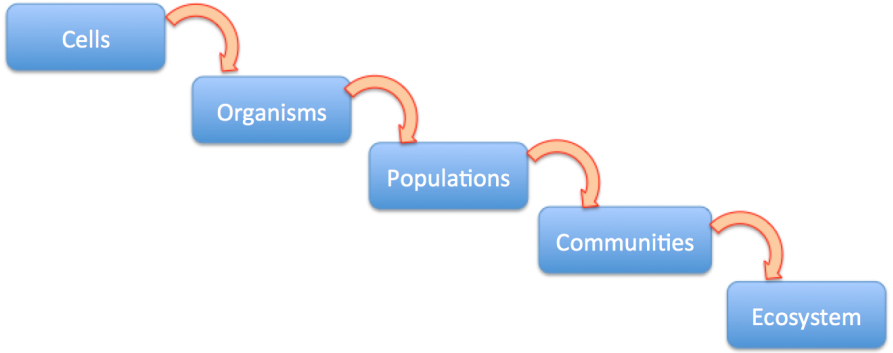
2. Extend duration of experiments to 12 months

3. Common gardens to explore within- and among- genotype capacity to respond to OA

Summary points



Research context



Scales and scale-dependency

1. MCR-LTER supplies information infrastructure for contextualizing OA research and for providing added value to this research
2. Long-term (decades+) aspect of LTER is critical to providing:
   (a) a means to evaluate effects of press disturbances (like OA)
   (b) test hypotheses emerging from OA research
   (c) framework for year+ OA experiments
3. Intellectual, data, and technology infrastructure is well suited to one of the next major challenges: integrating effects across scales.

Acknowledgements

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Graduate students

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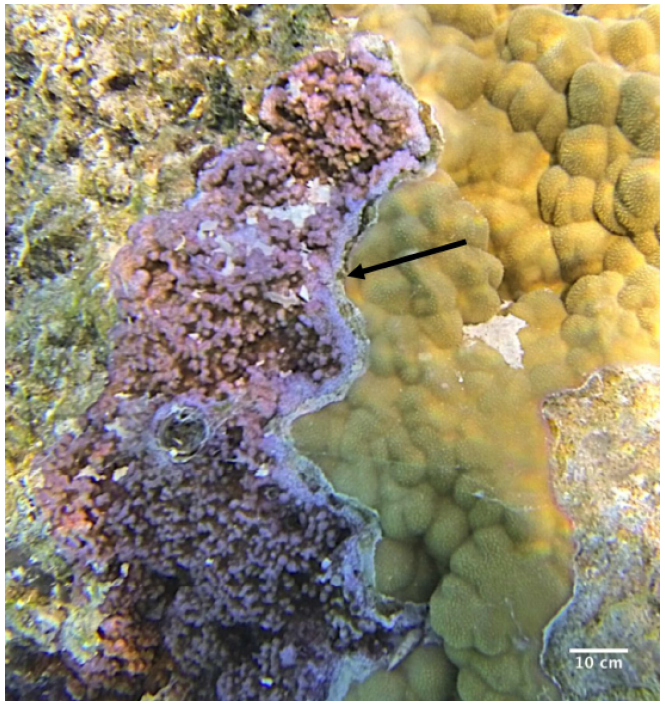
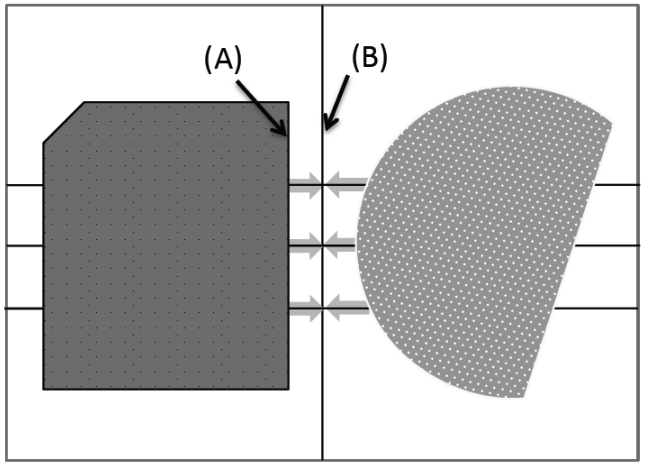
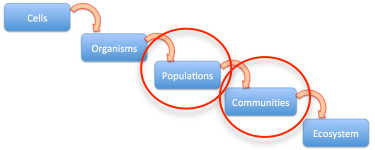
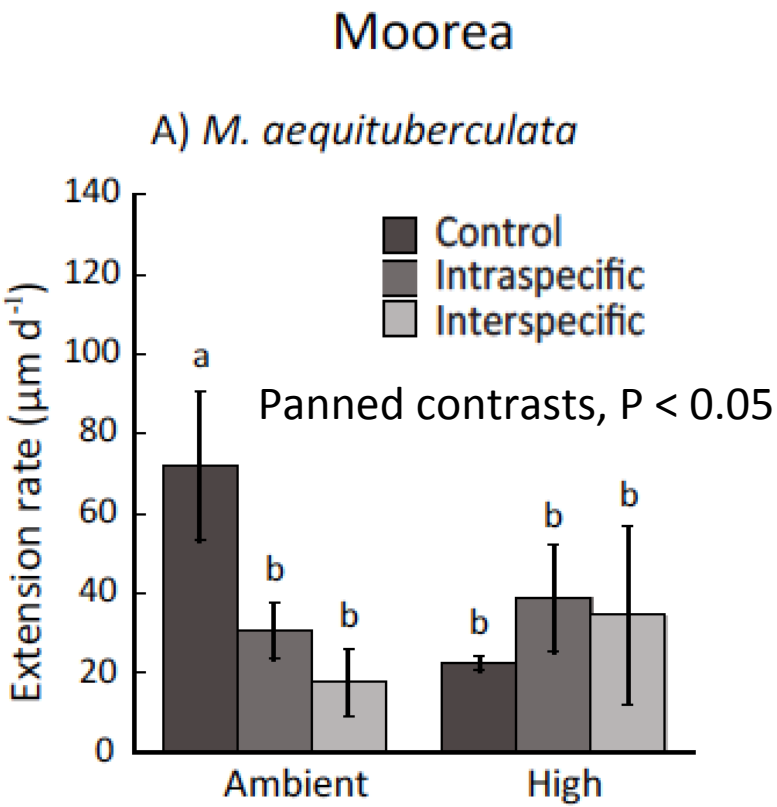
Population/community scale effects – ecological processes





Competitive encounters among corals
Montipora vs *Porites*





Summary: Growth depressed by OA, but competitive encounters reduced negative effects

Evensen, Edmunds, Sakai. MEPS (in review)