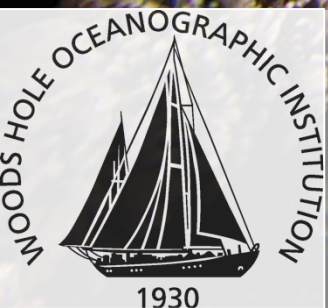


Estimating coral feeding habits from space



Michael Fox, Ph.D

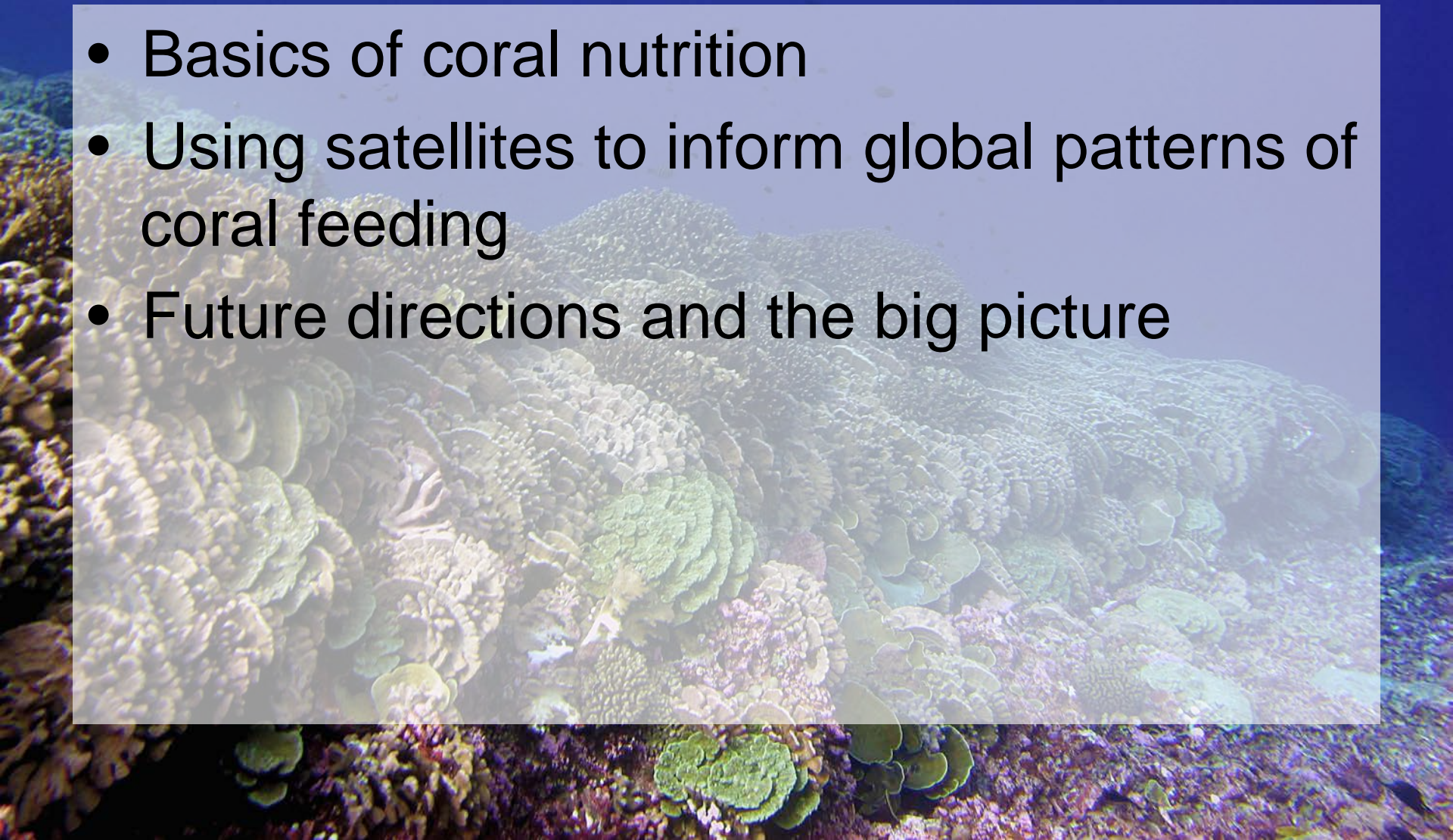
Postdoctoral Scholar

Woods Hole Oceanographic Institution



The plan for today

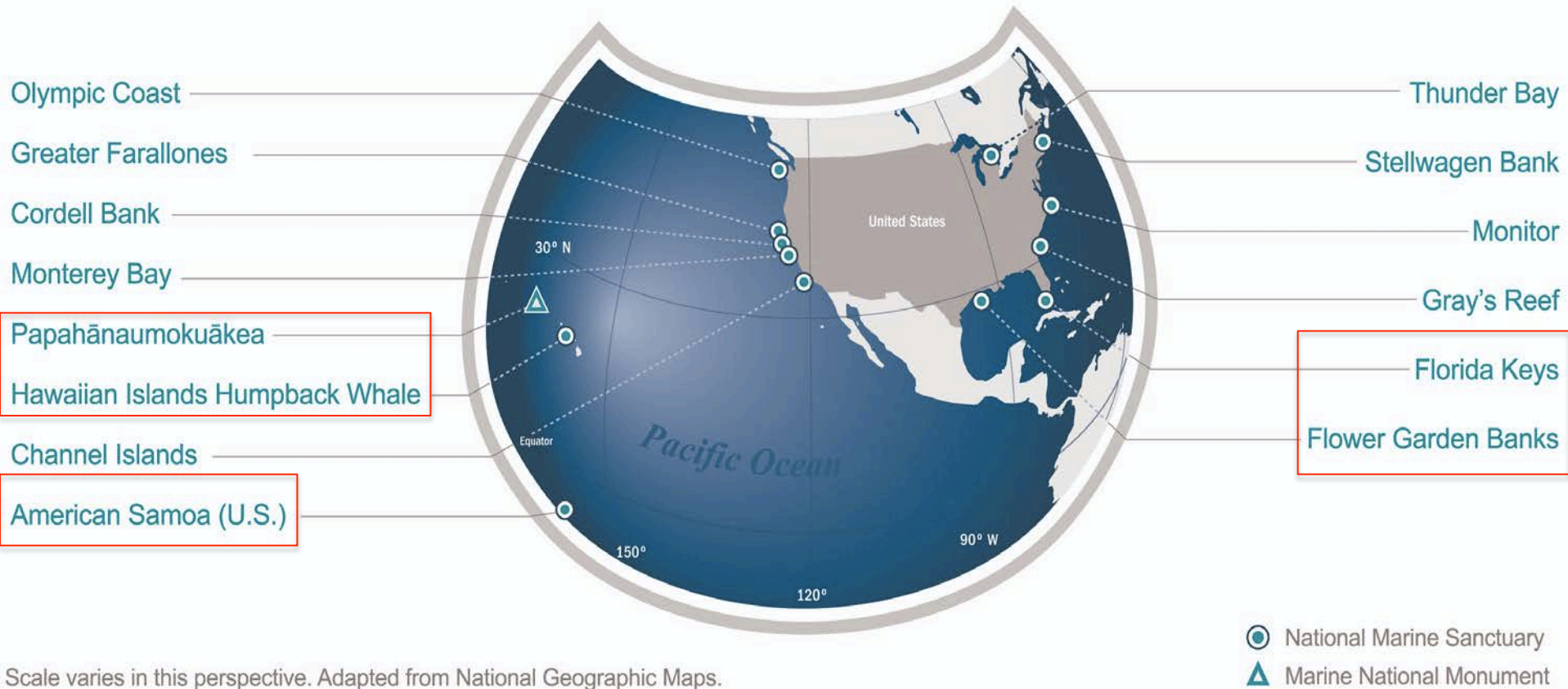
- Basics of coral nutrition
- Using satellites to inform global patterns of coral feeding
- Future directions and the big picture



The plan for today

- Basics of coral nutrition
- Using satellites to inform global patterns of coral feeding
- Future directions and the big picture
- **Goals**
- **1) Explain the importance of coral nutrition and why we need to study it more closely**
- **2) Provide some coral reef optimism!**

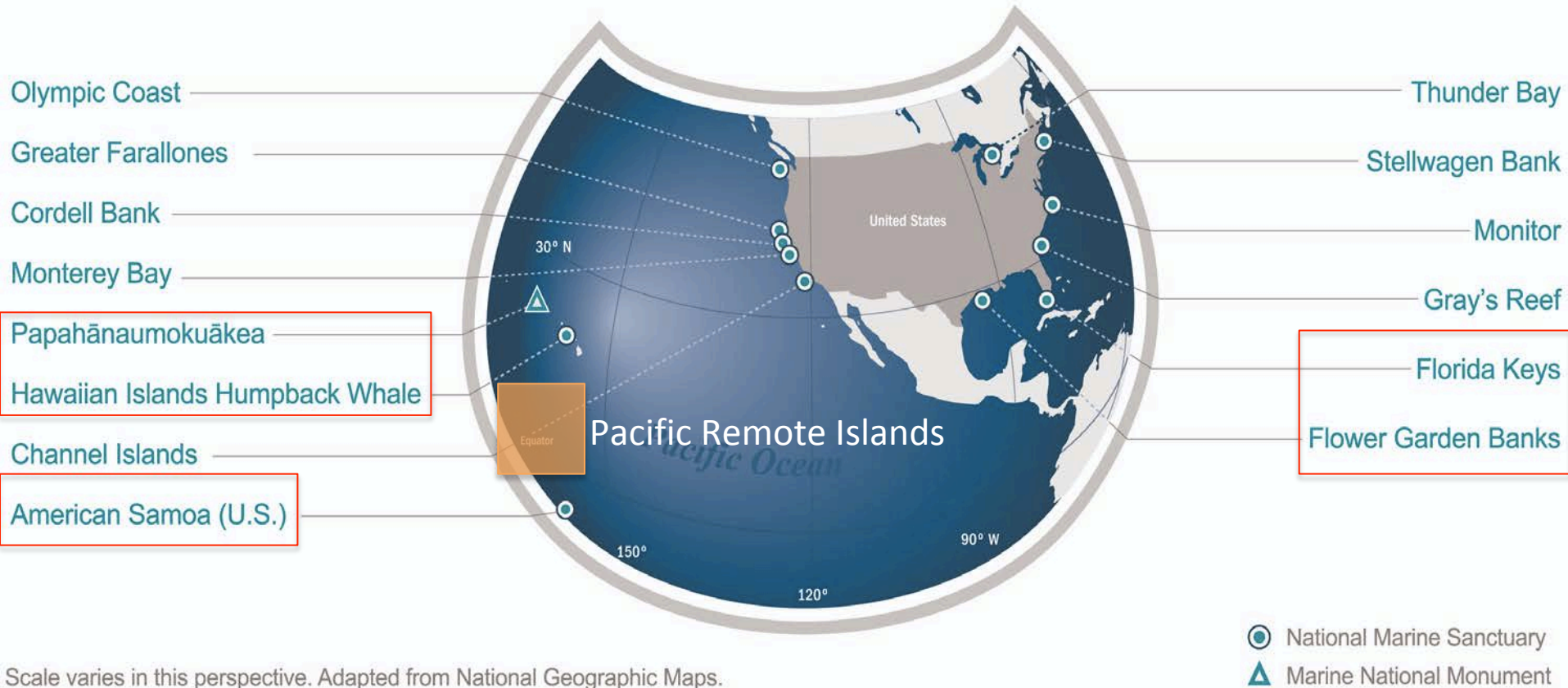
NATIONAL MARINE SANCTUARY SYSTEM



Scale varies in this perspective. Adapted from National Geographic Maps.

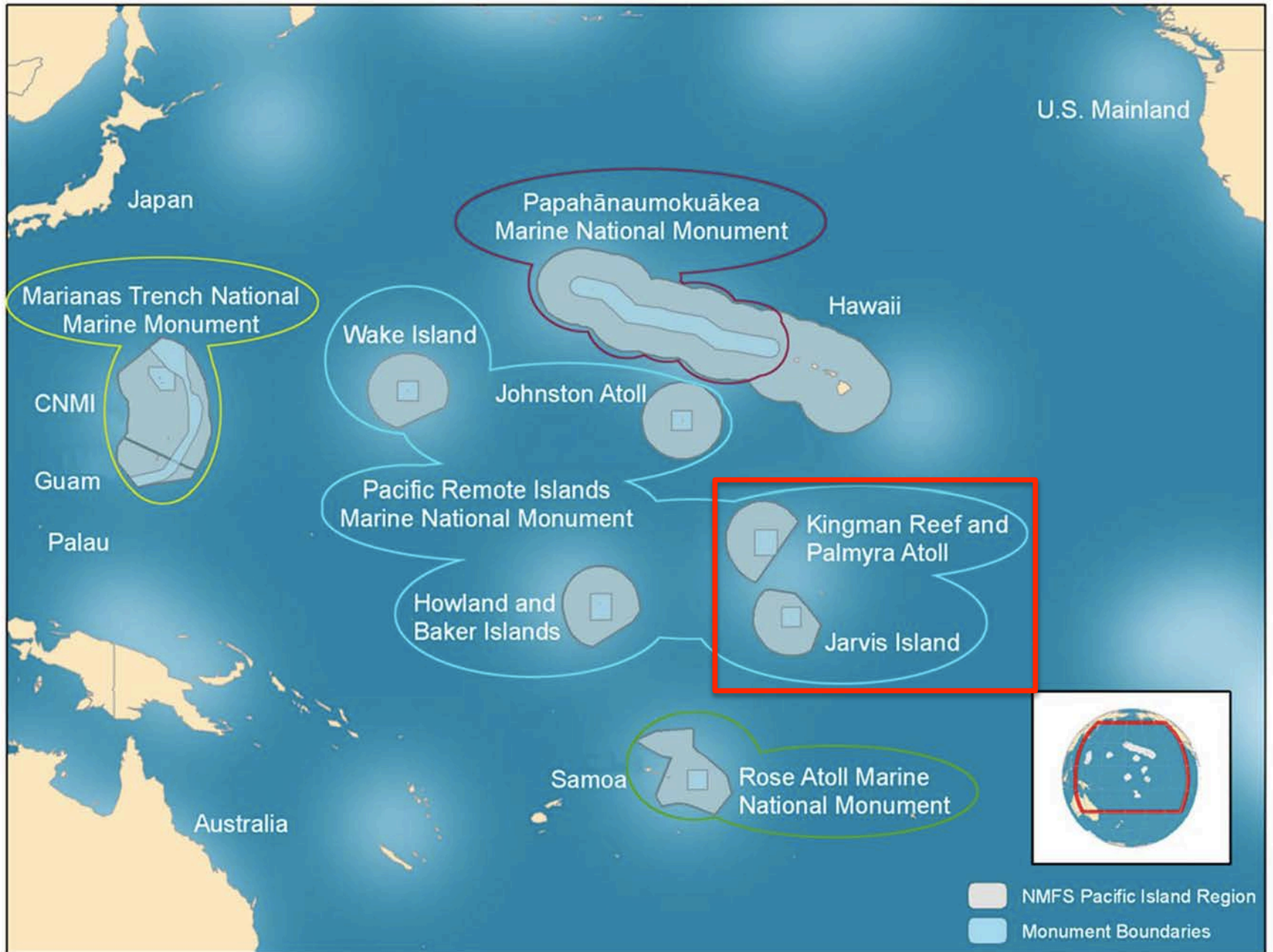
Coral reef ecosystems exist in 5 National Marine Sanctuaries

NATIONAL MARINE SANCTUARY SYSTEM

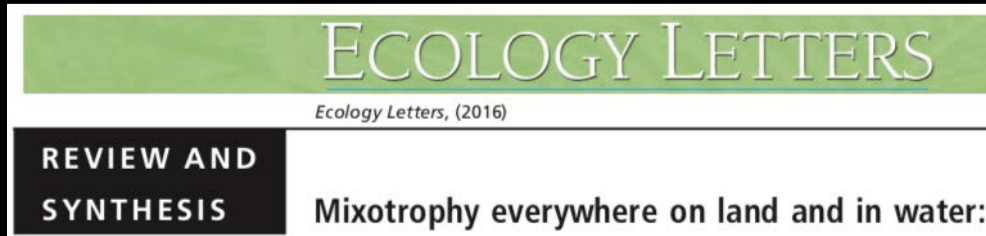


Scale varies in this perspective. Adapted from National Geographic Maps.

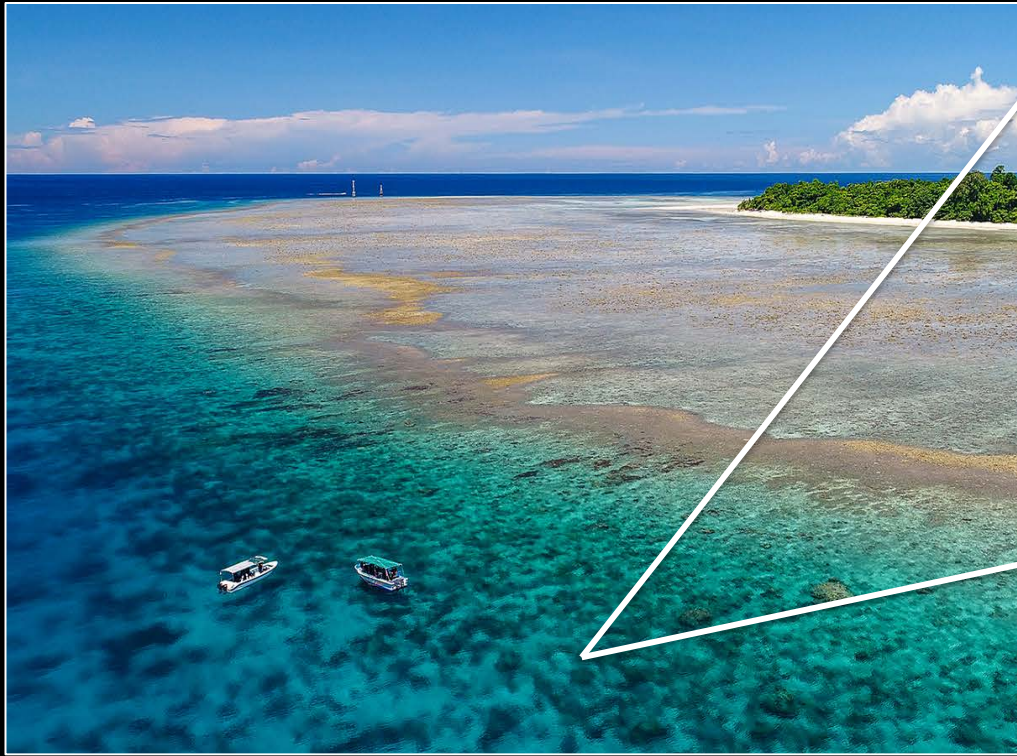
**7 Additional coral reef islands protected in the
Pacific Remote Islands Marine National Monument**



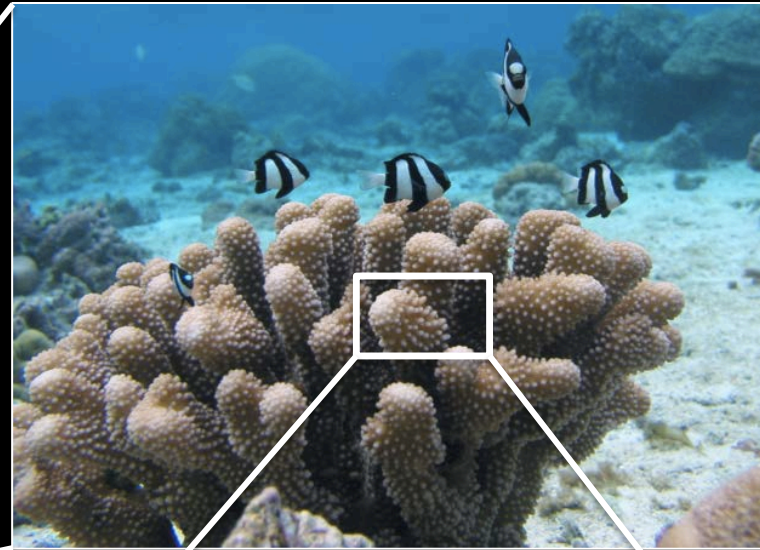
Mixotrophy is the most common nutritional strategy



Mixotrophic, reef-building corals create some of the world's largest living structures



Simon Pierce/Coral Reef Image Bank



Smithsonian



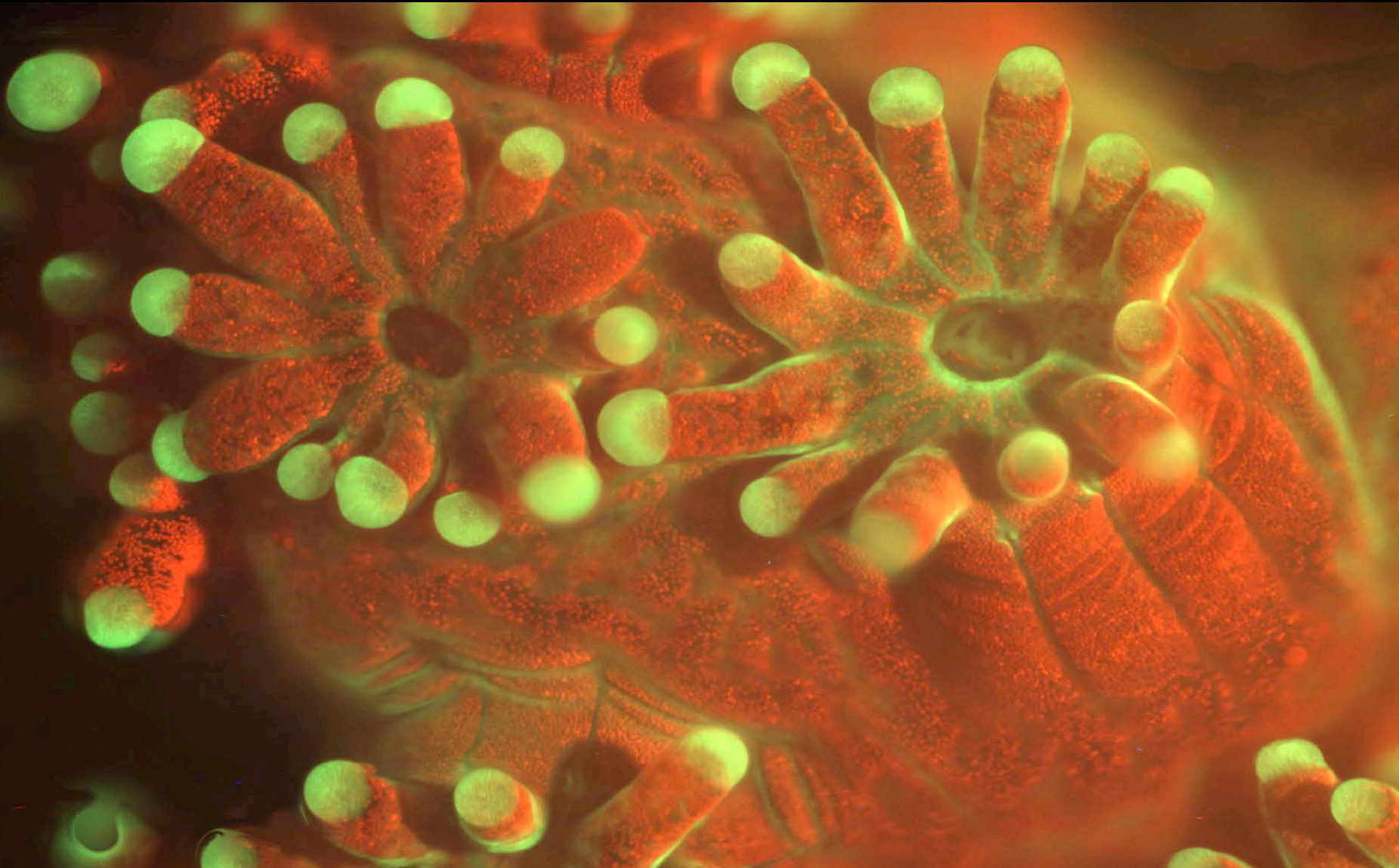
Photos: Brian Zgliczynski, Jen Smith



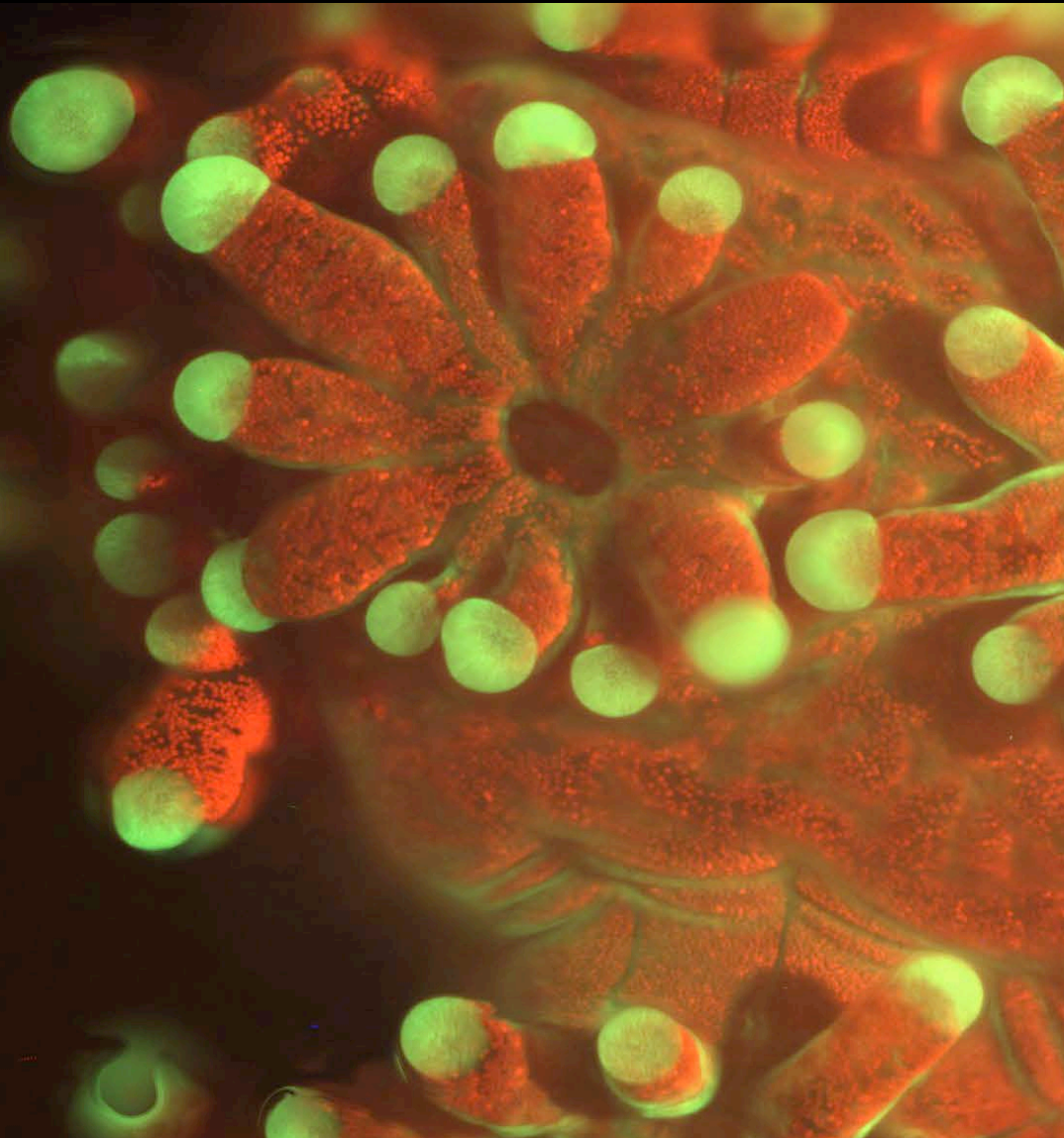


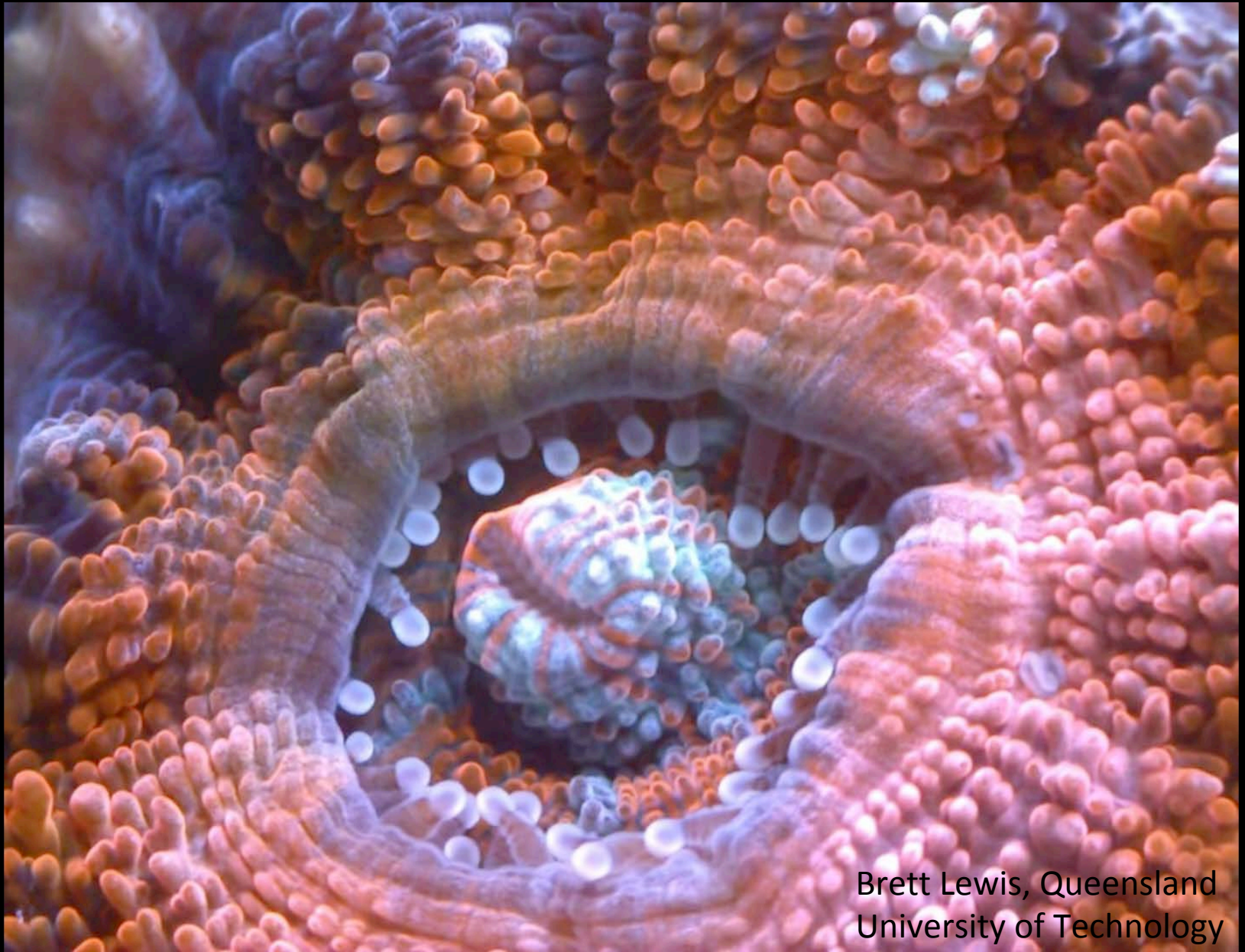
Photos: Brian Zgliczynski

**Symbiotic microalgae (endosymbionts)
are corals primary source of food**



During bleaching corals lose this important food source





Brett Lewis, Queensland
University of Technology



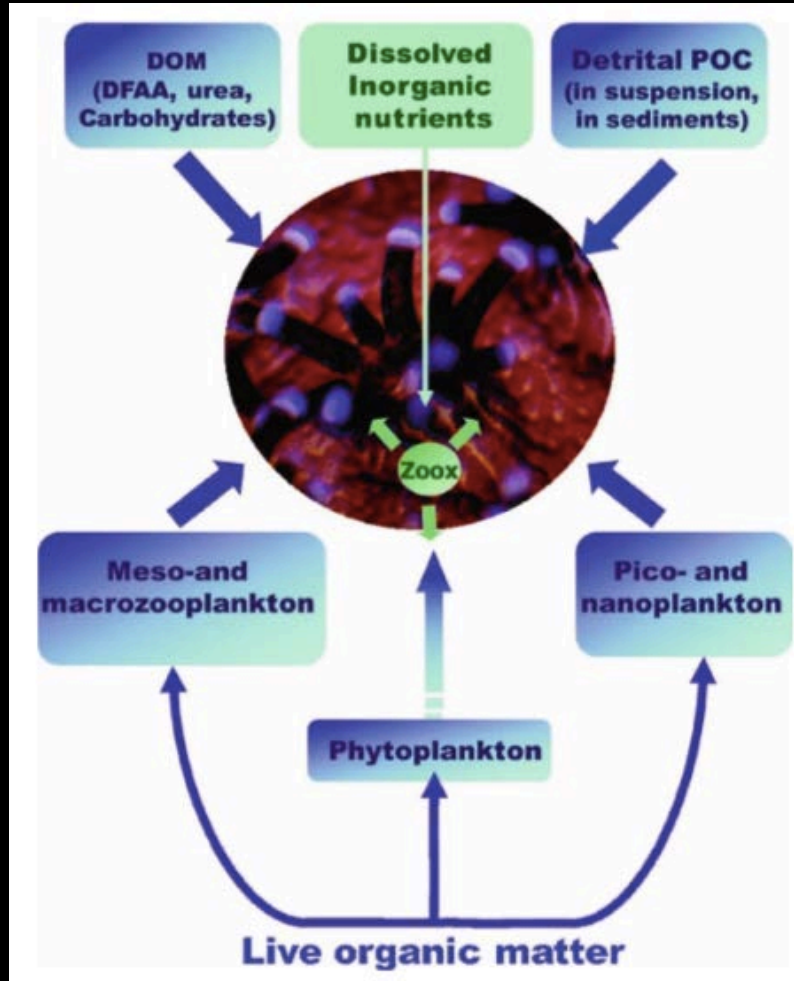
Galaxea fascicularis

Galaxy Coral

Tim Wijgerde, Coral
Publications 



Heterotrophic nutrition in reef-building corals



Heterotrophic nutrition increases

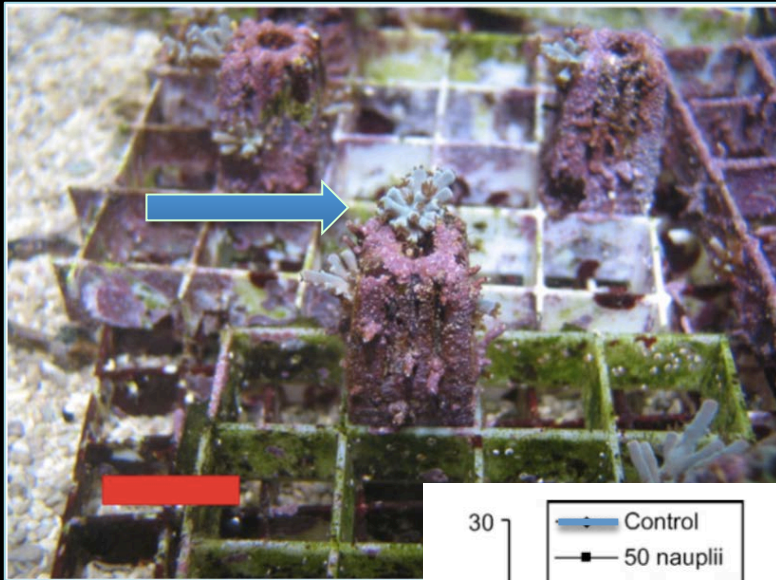
- Tissue growth
- Skeletal growth
- Energy reserves
- Symbiont density
- Fecundity (more babies)

Reduces negative impacts of

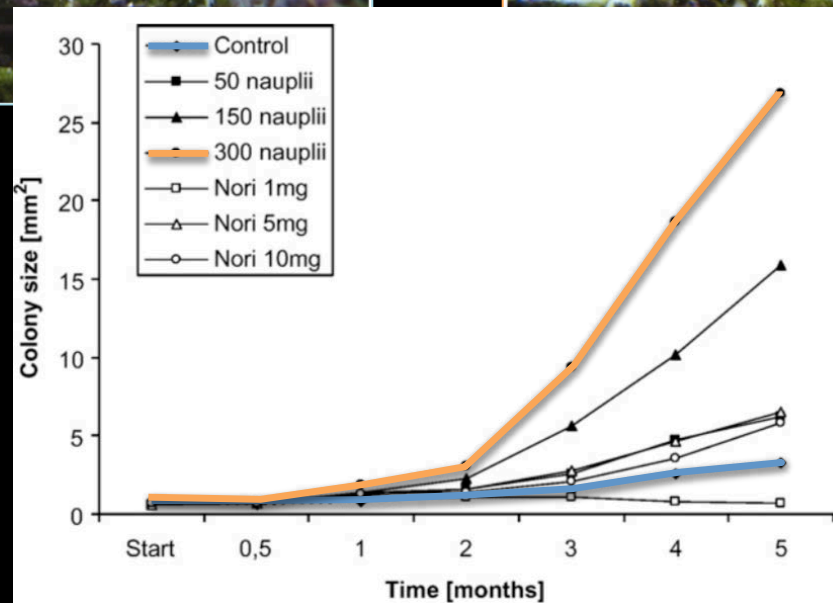
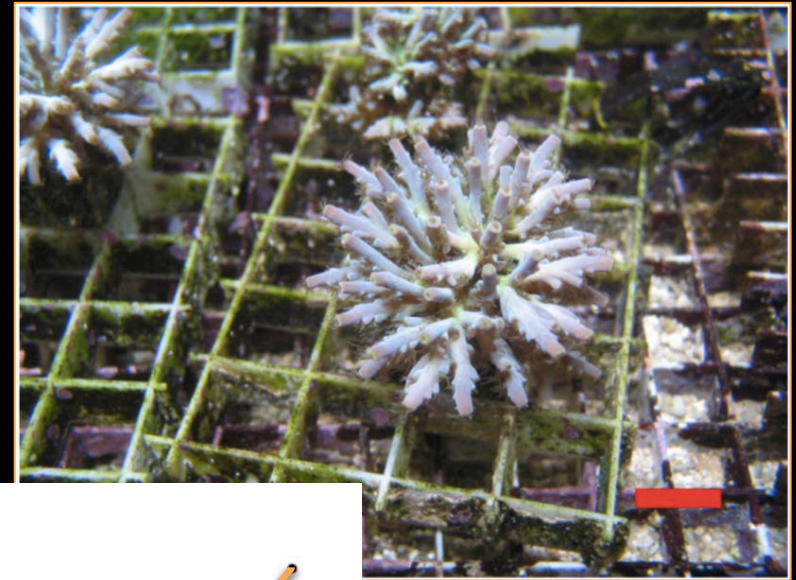
- Ocean Acidification
- Bleaching
- Nutrient Pollution
- Light limitation (turbid environments)

Coral aquaculture accelerated by food

Ambient conditions



High food supply



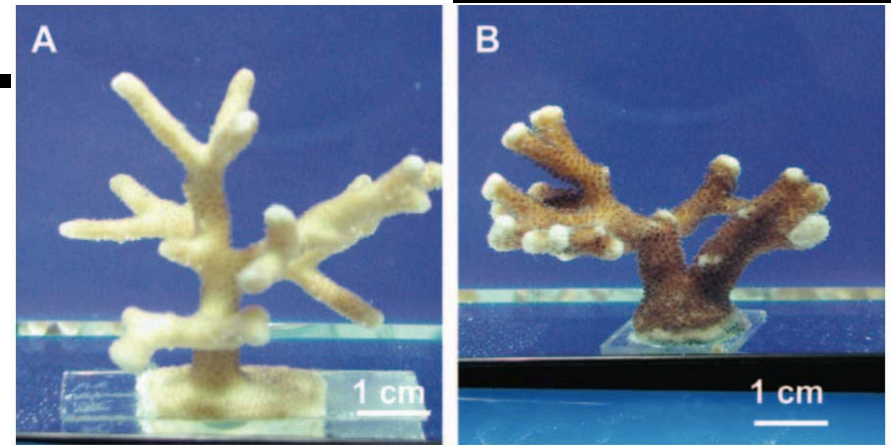
Coral survival of bleaching linked to heterotrophic nutrition

Heterotrophic plasticity and resilience in bleached corals

Andréa G. Grottoli¹, Lisa J. Rodrigues² & James E. Palardy³

Heterotrophy promotes the re-establishment of photosynthate translocation in a symbiotic coral after heat stress

Pascale Tremblay^{1,*}, Andrea Gori¹, Jean François Maguer², Mia Hoogenboom^{3,*} & Christine Ferrier-Pagès^{1,*}



Primarily studied in laboratory experiments due to logistical challenges in the field

Will all reefs suffer the same?



CNN

World » Africa | Americas | Asia | Europe | Middle East

Live TV

U.S. Edition +



Great Barrier Reef 'cooking and dying' as seas heat up, warn scientists

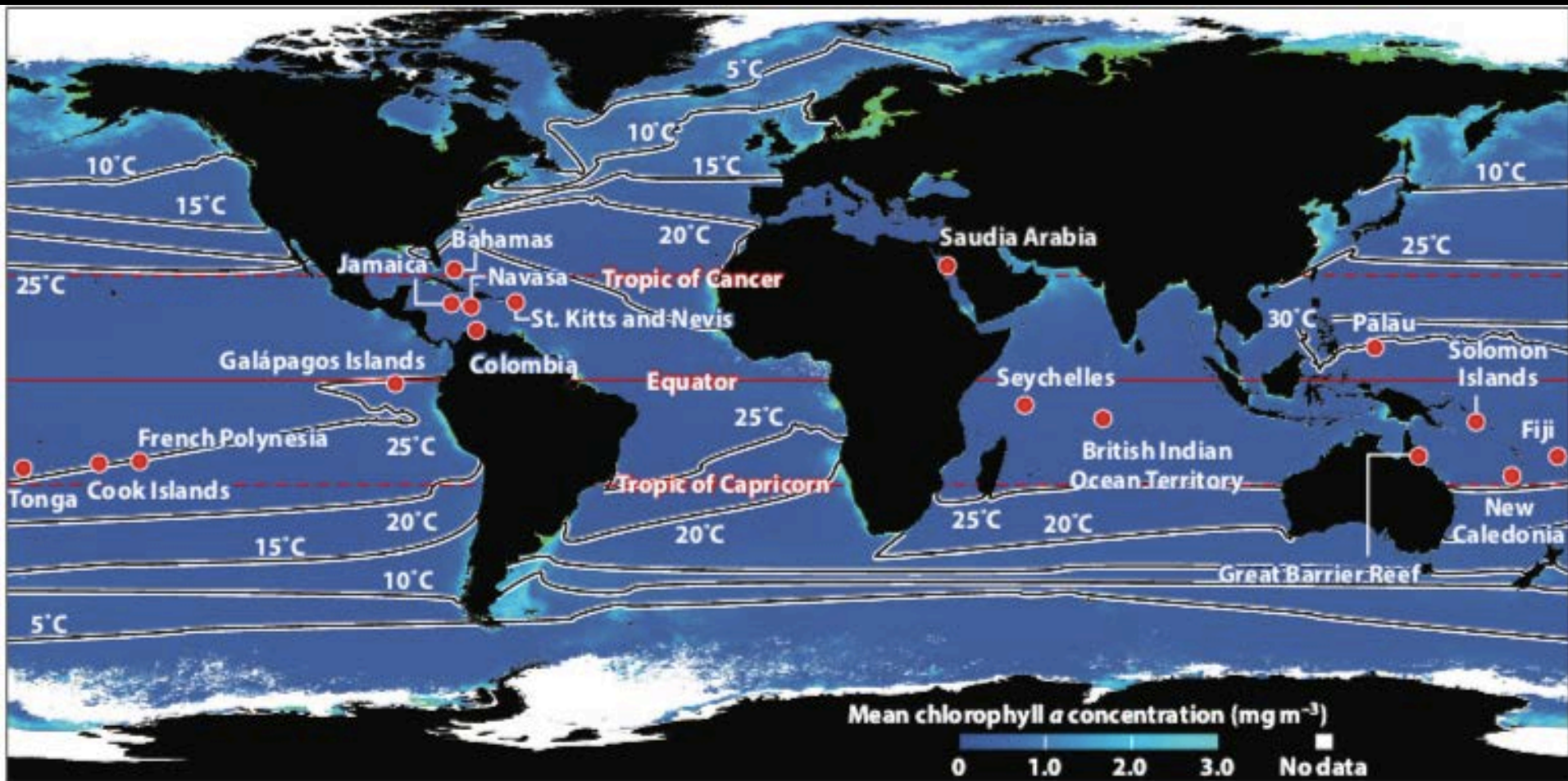
Coral sanctuary is now a 'graveyard' due to record warm oceans, scientists find

Coral reefs on Christmas Island dead after El Niño

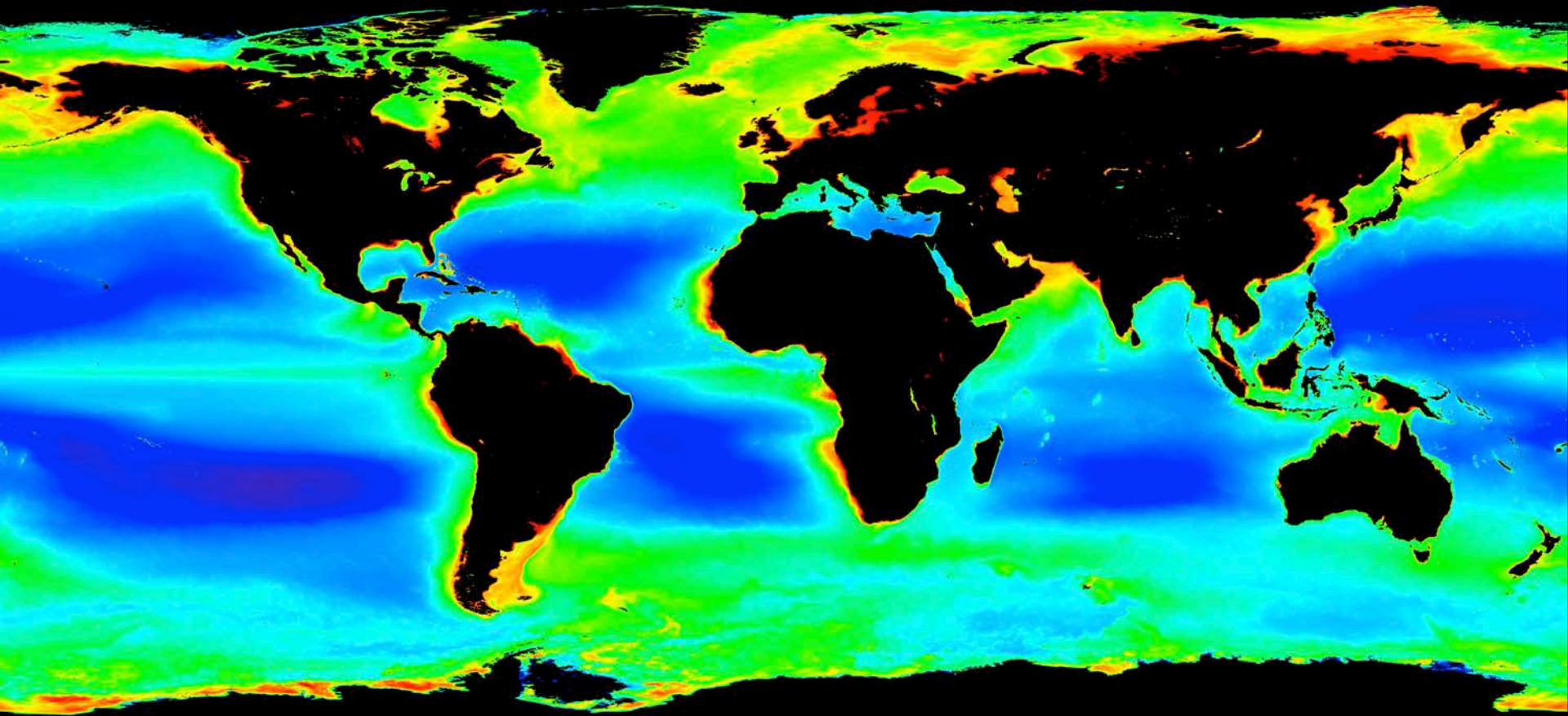
'Looks like a ghost town,' says UVic scientist after month long scuba diving expedition



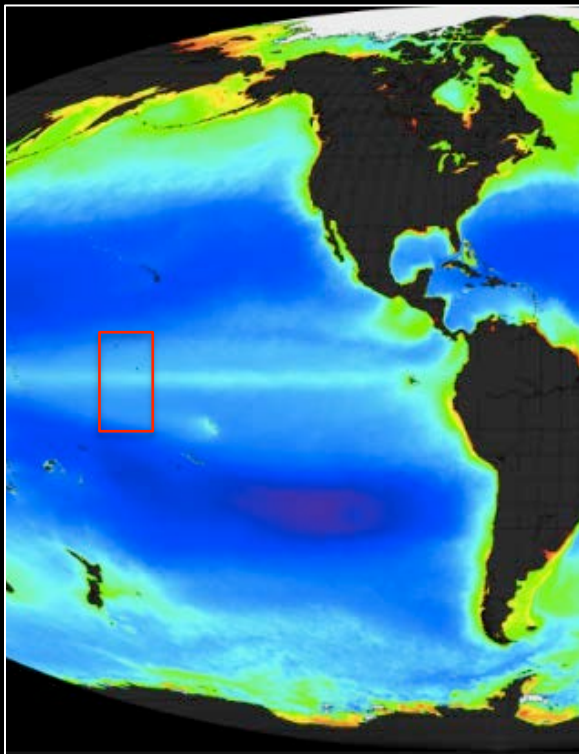
Coral reefs classically considered oceanic deserts



Primary production highly variable across the tropics

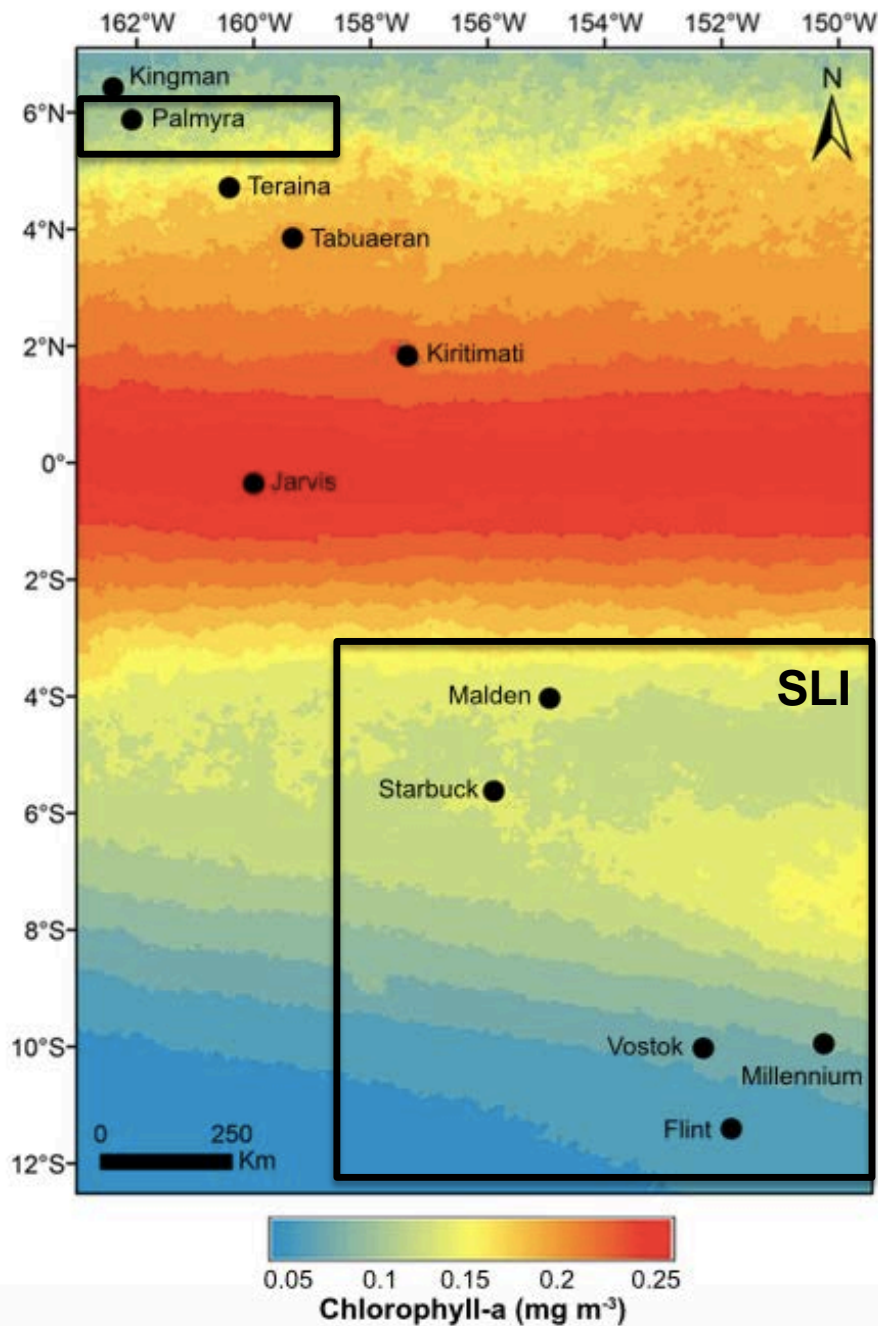


“The equatorial cold tongue”

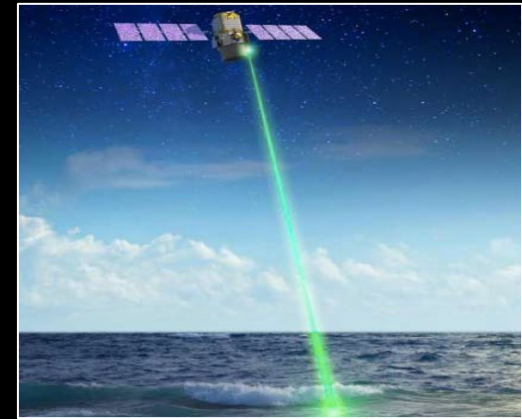
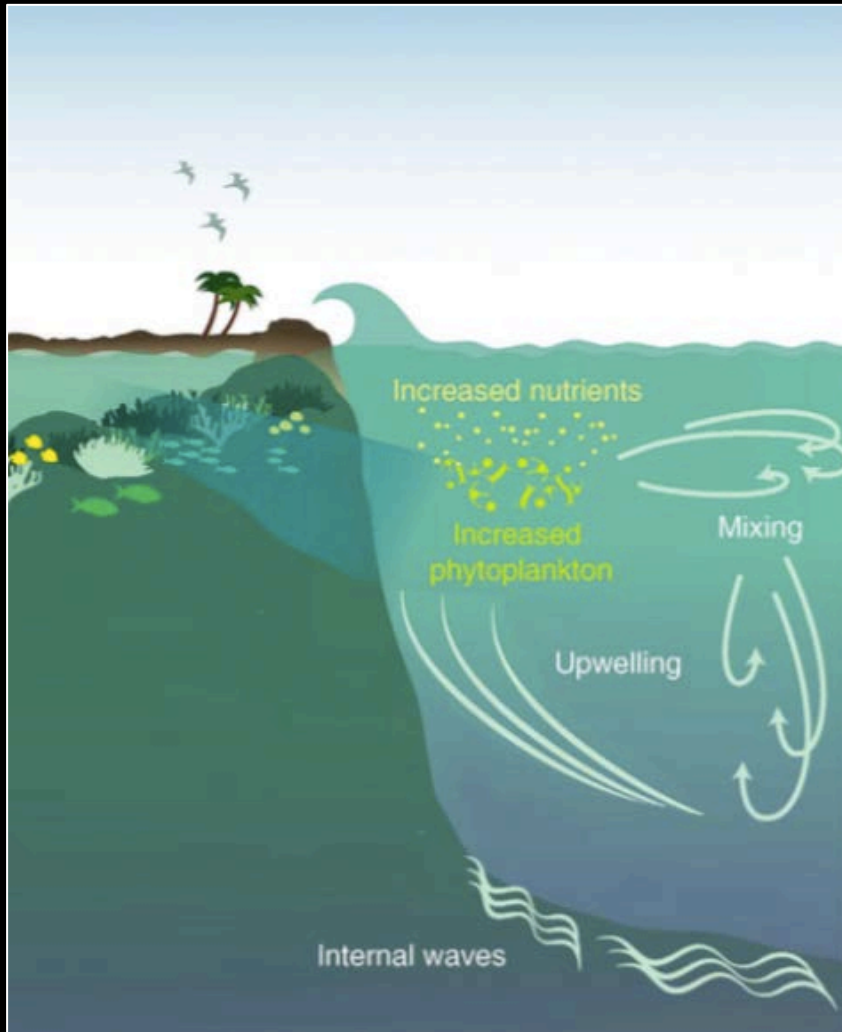


Wind and current driven
upwelling across the central
Pacific

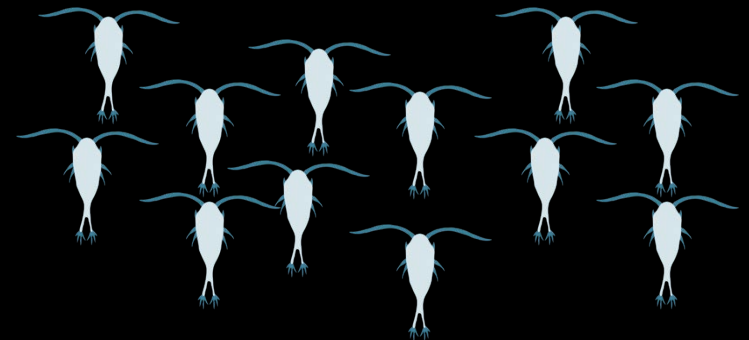
Mean chlorophyll-a concentration in the Line Islands 2005-2015



Satellite chl-*a* measurements may predict food abundance for corals

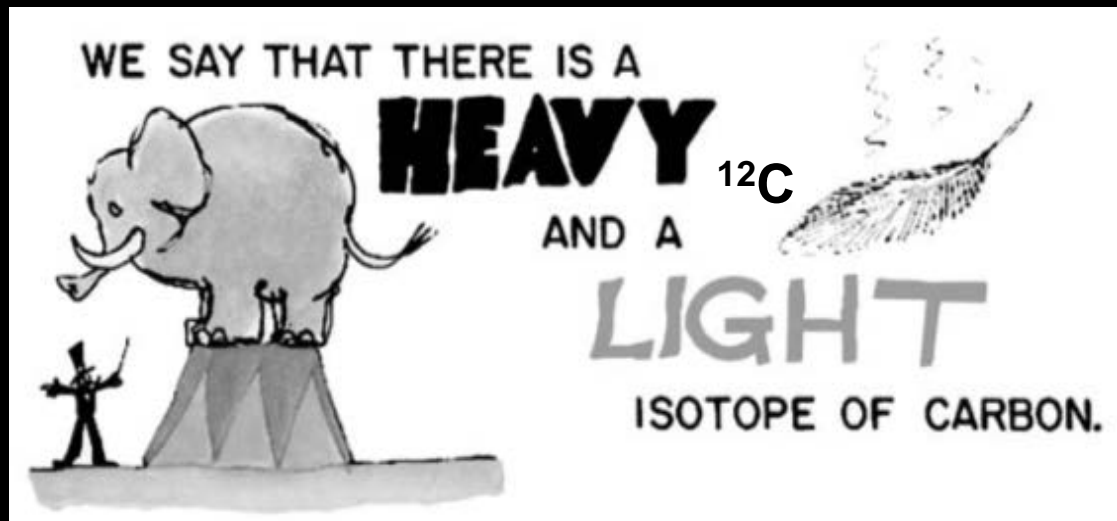
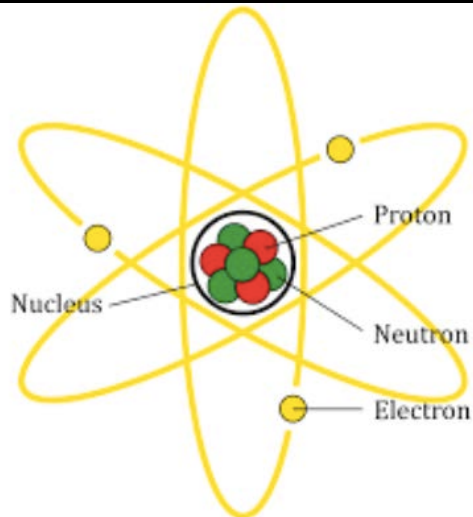
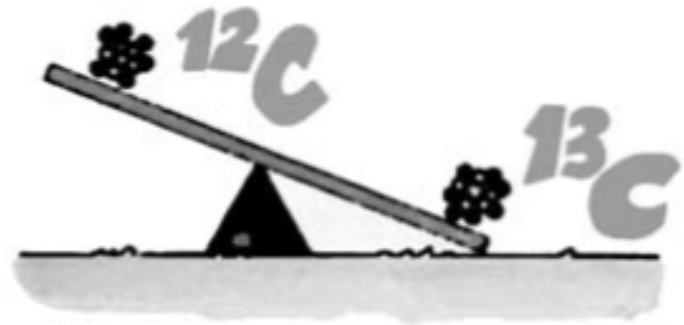


High Chlorophyll

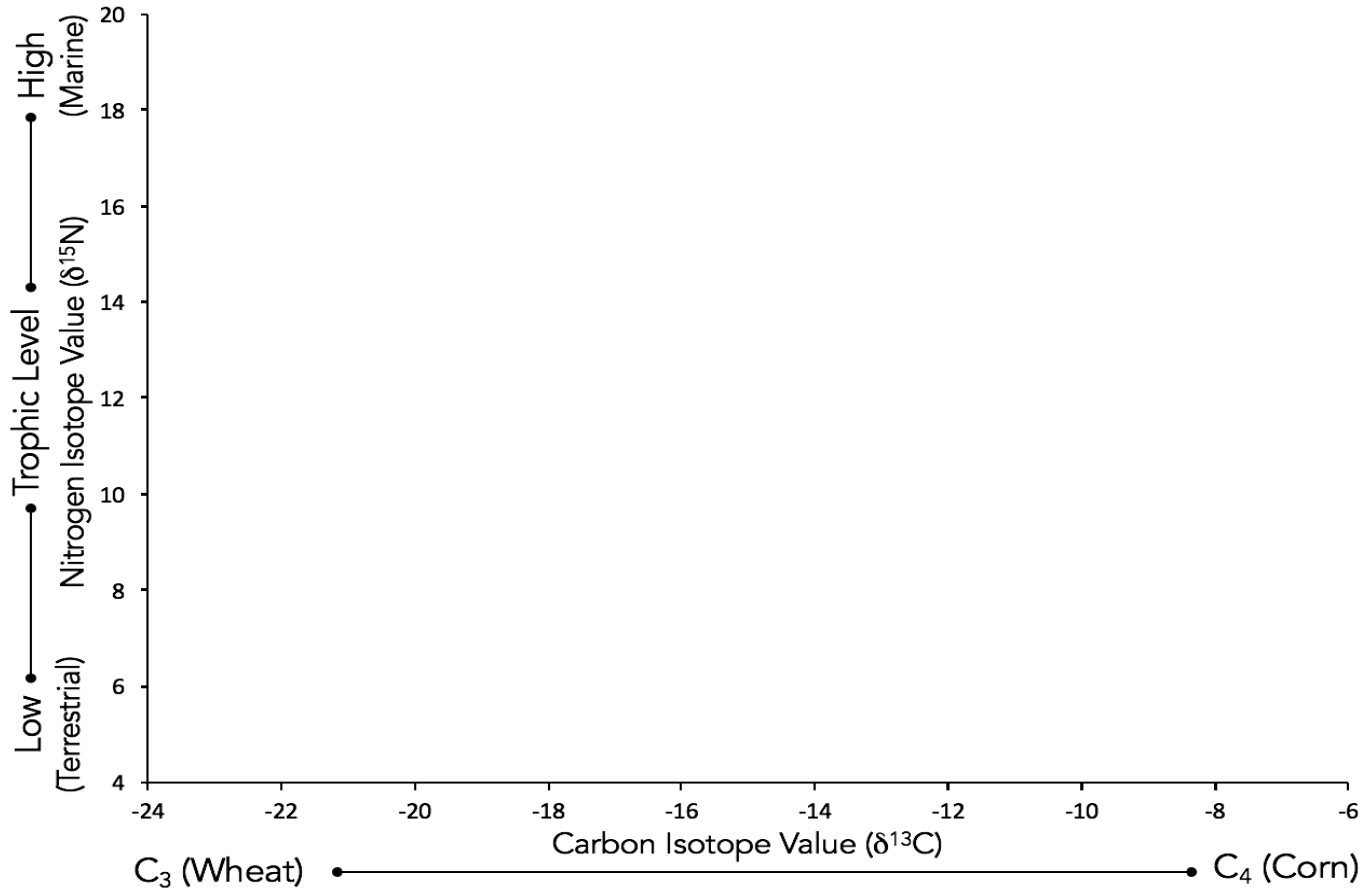


Animal diets can be studied using stable isotopes

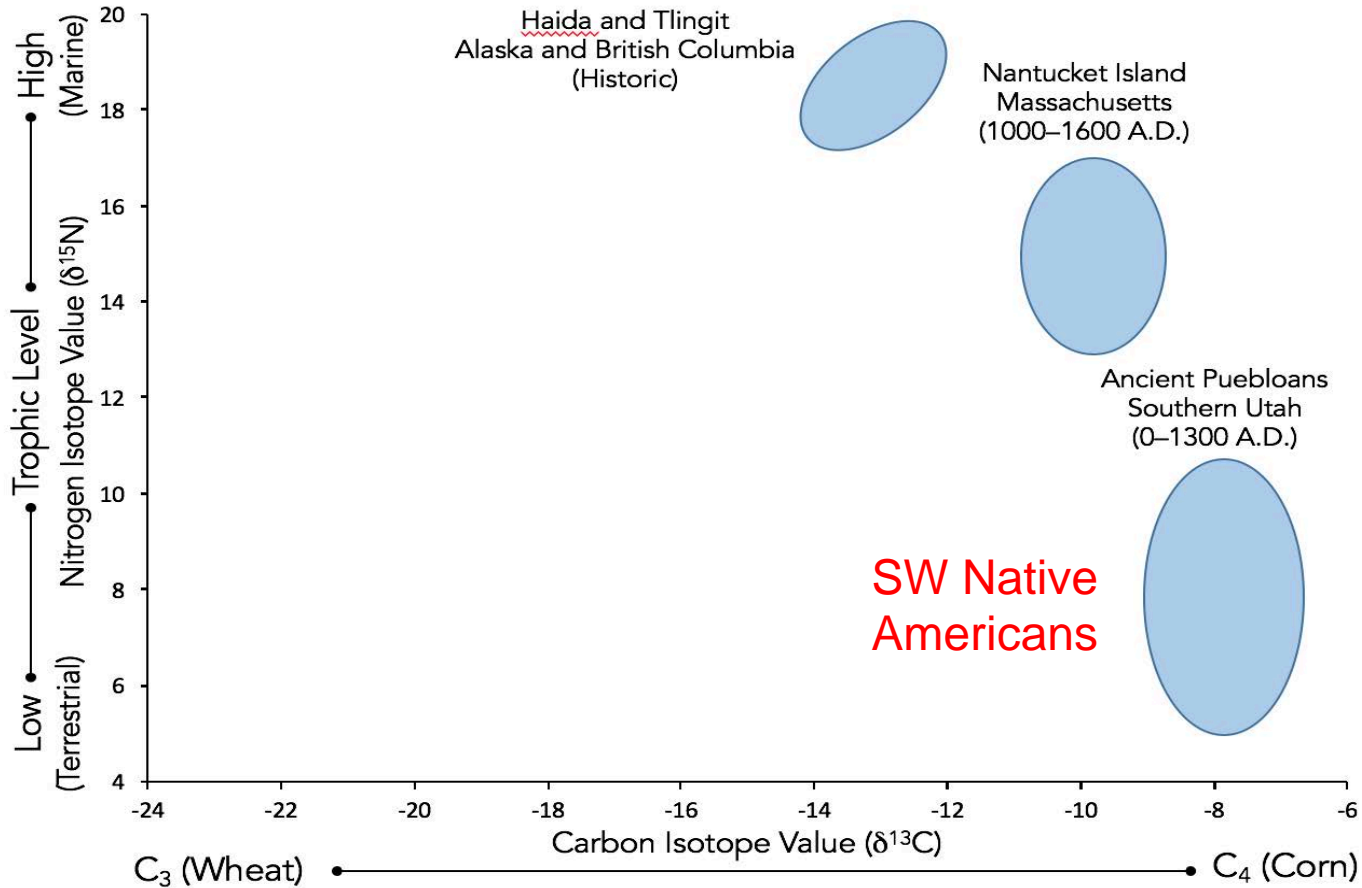
^{13}C CARBON HAS ONE MORE NEUTRON THAN ^{12}C CARBON IN ITS NUCLEUS.



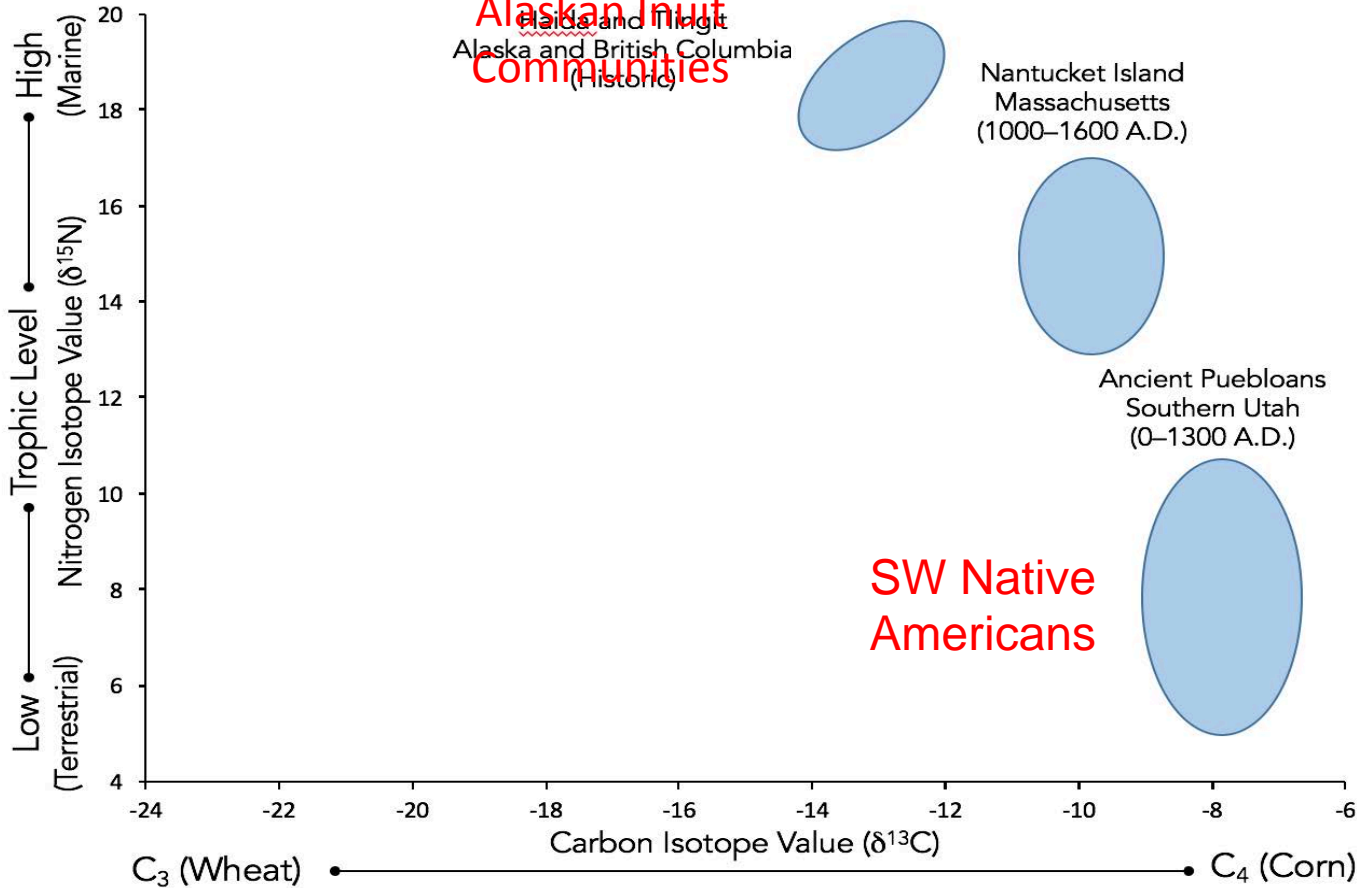
You are what you eat...



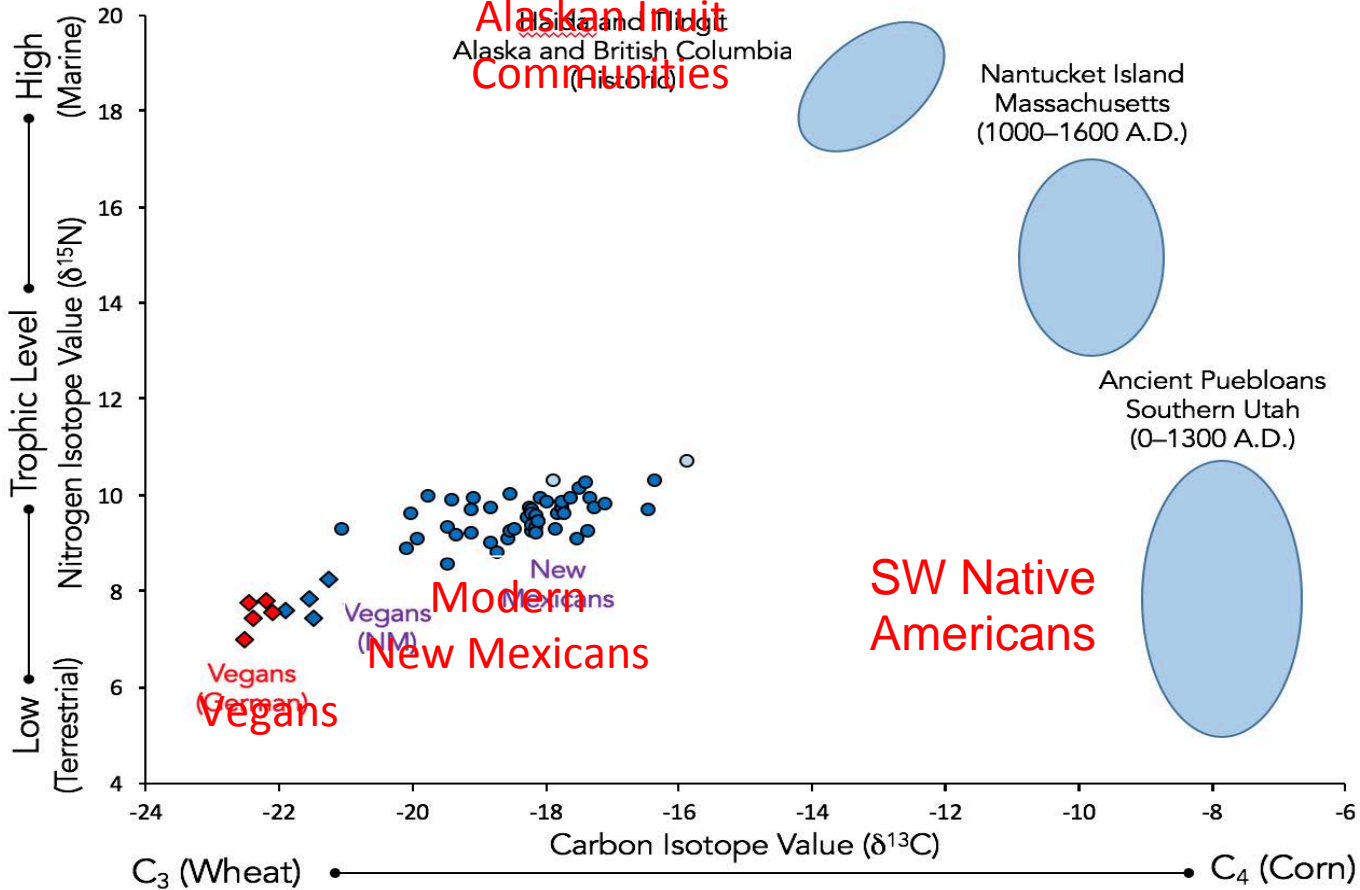
You are what you eat...



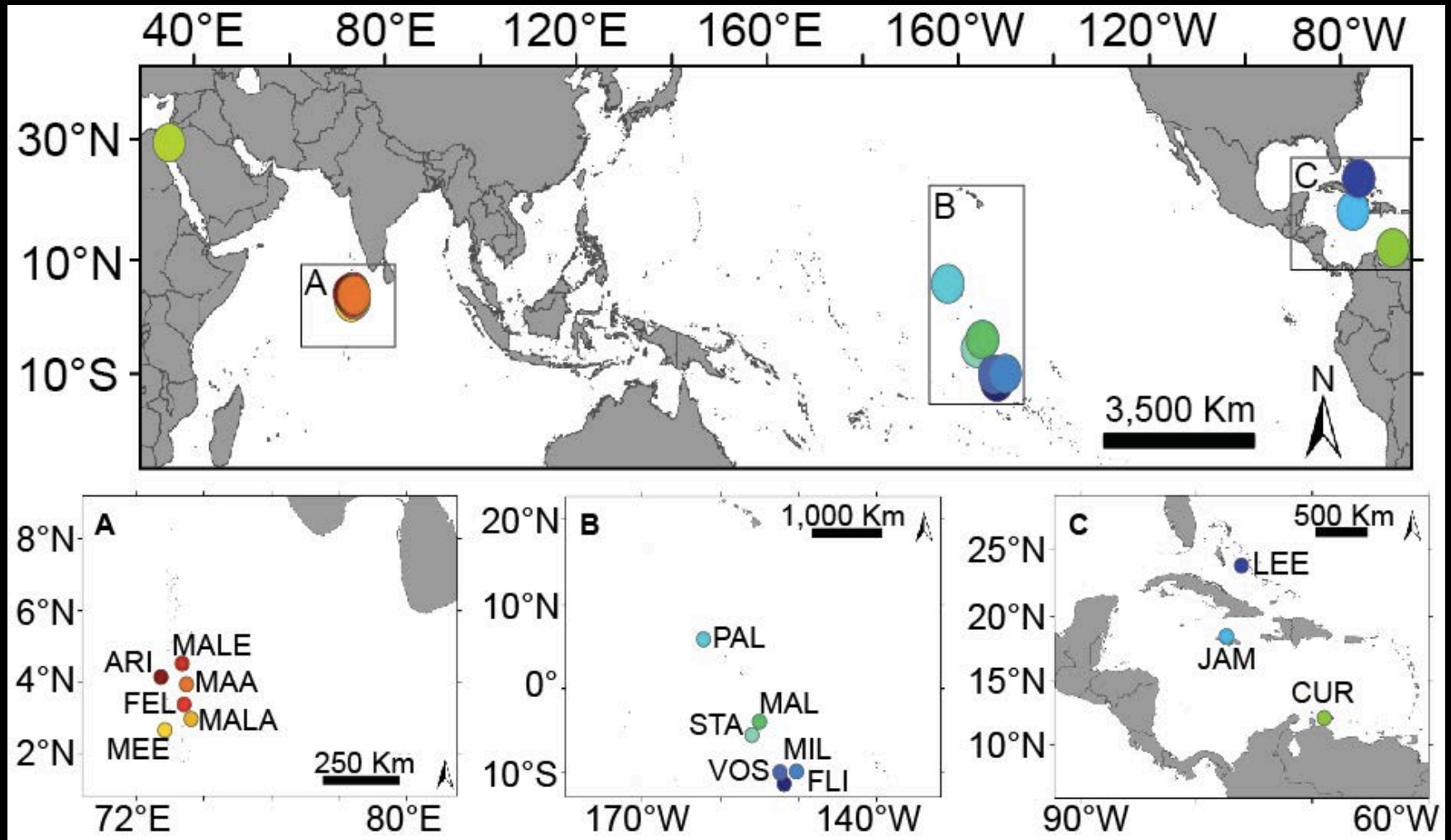
You are what you eat...



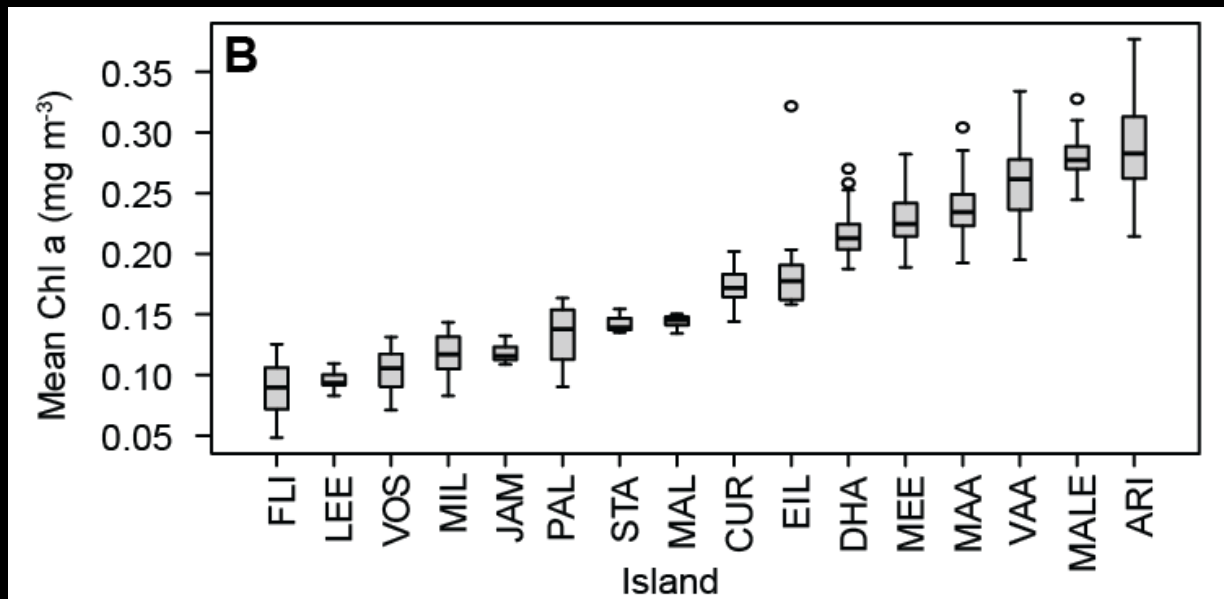
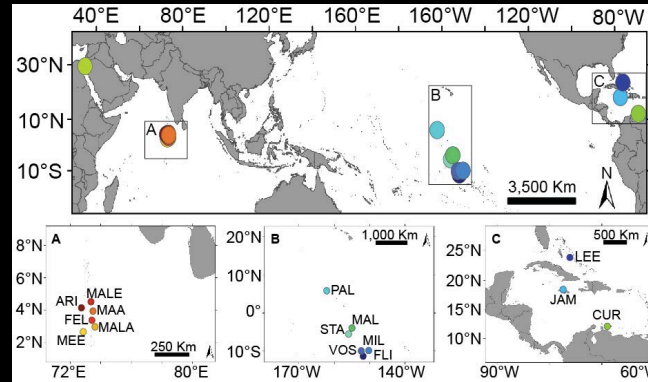
You are what you eat...



15 species of coral from 16 locations across 3 ocean basins



A three-fold gradient in Chl-*a*



Increasing Chl-*a*

Water along this gradient still clear

This study = 0.09 – 0.35 μ Chl-*a*



Photo: Brian Zgliczynski

Water along this gradient is still clear

This study = 0.09 – 0.35 μ Chl-*a*



Photo: Brian Zgliczynski

CA Kelp forest = 3.0 – 10.0 μ Chl-*a*

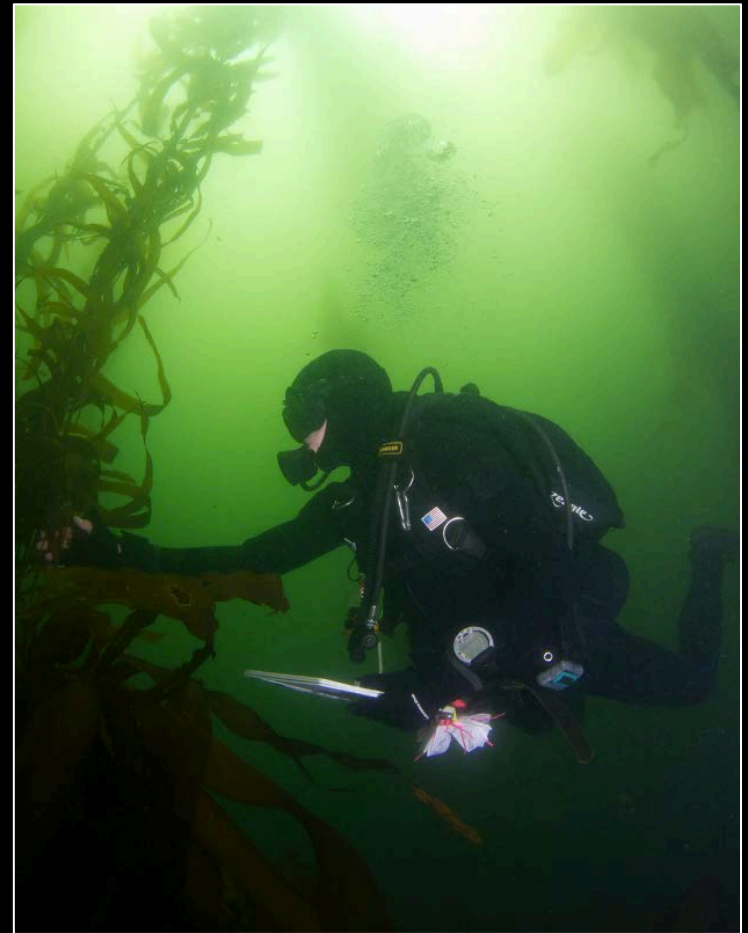
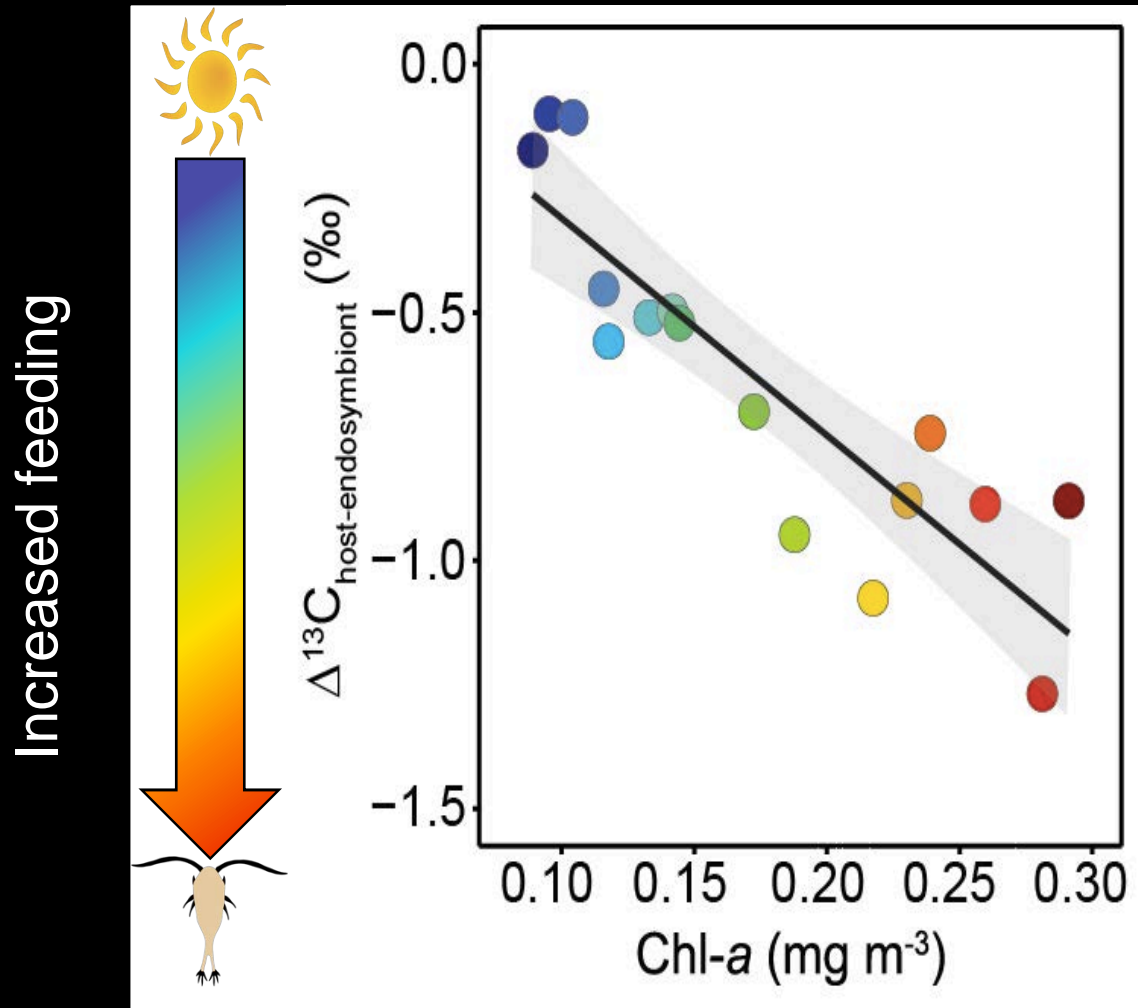
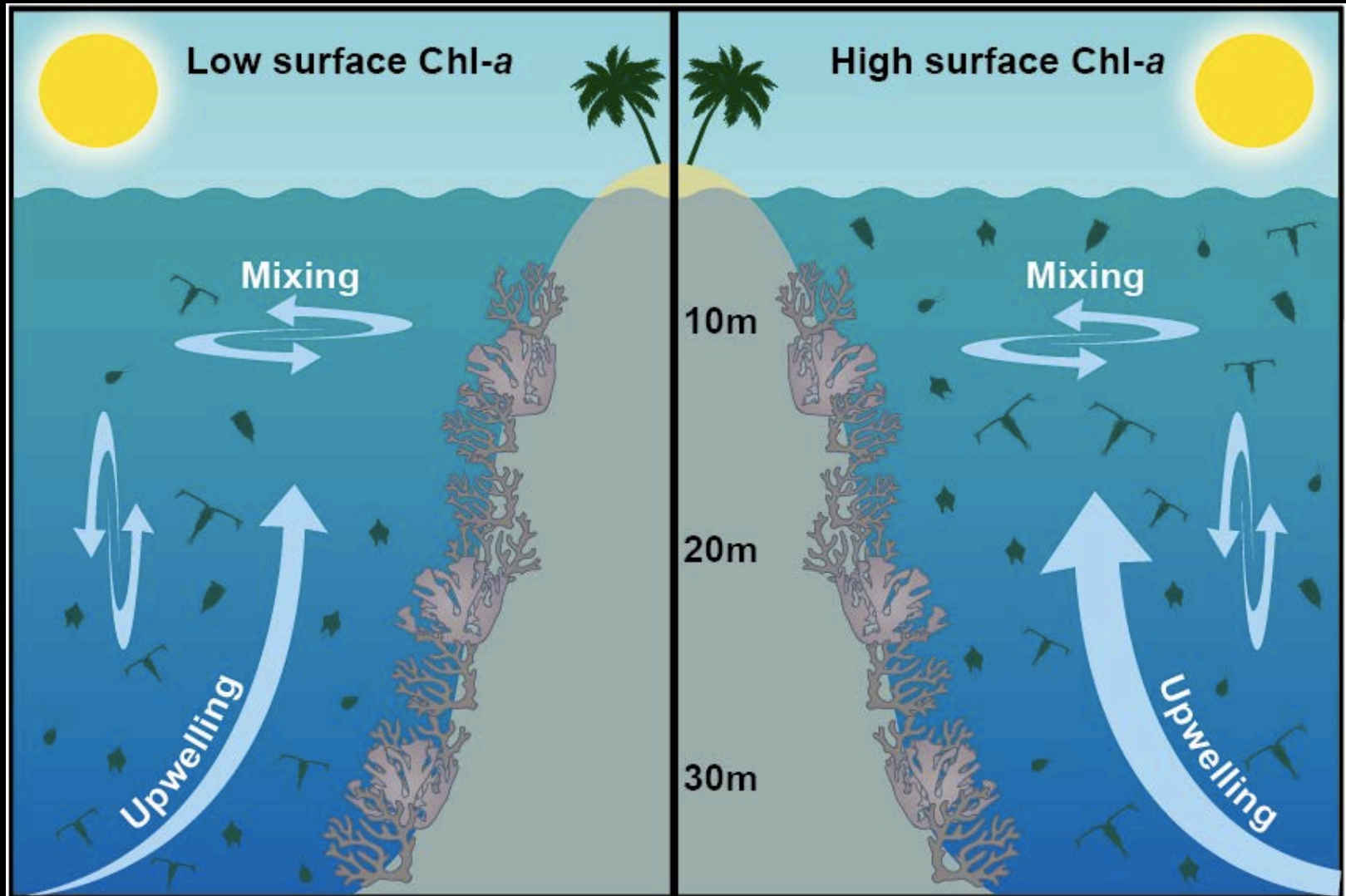


Photo: Scott Gabara

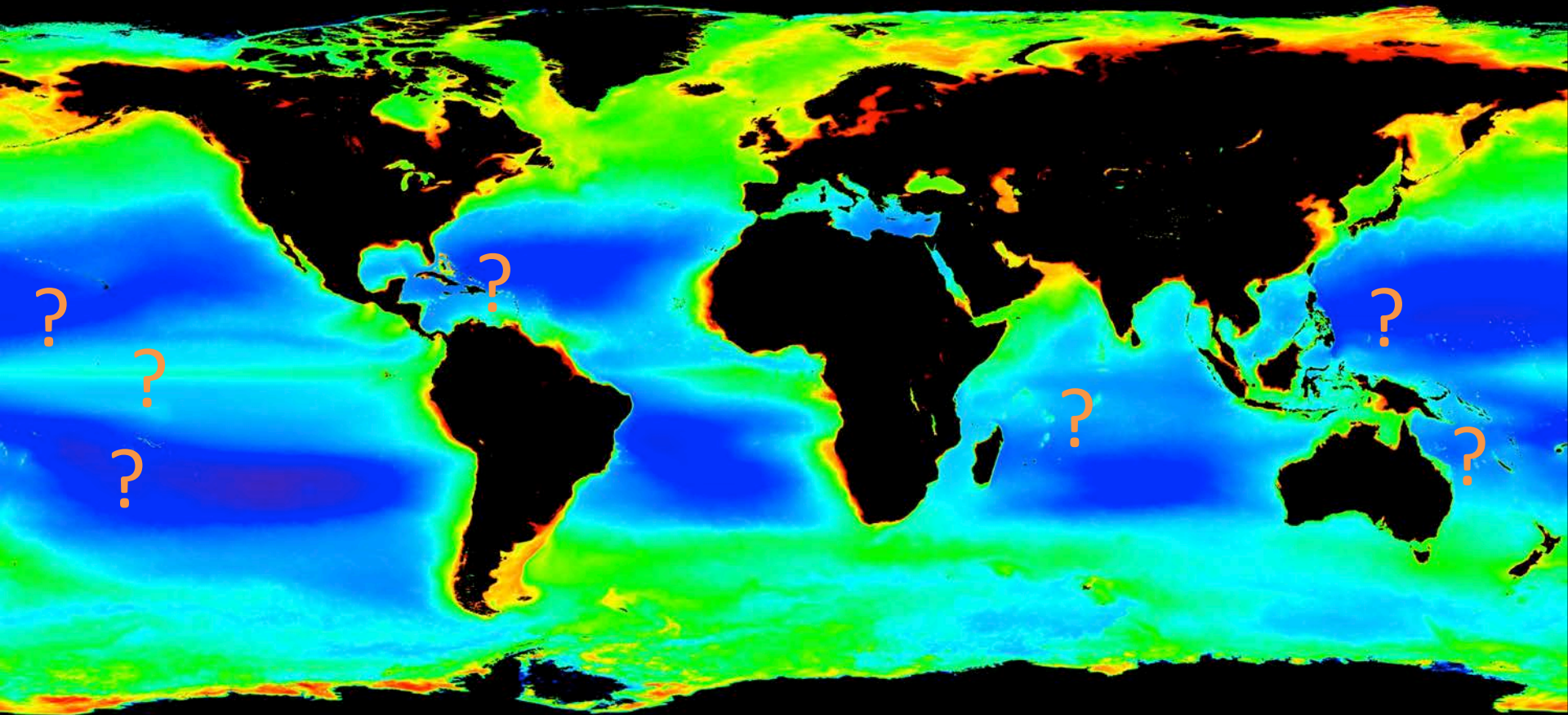
Global patterns in Chl-*a* predict how much coral are likely to eat



More dining options for corals on productive reefs



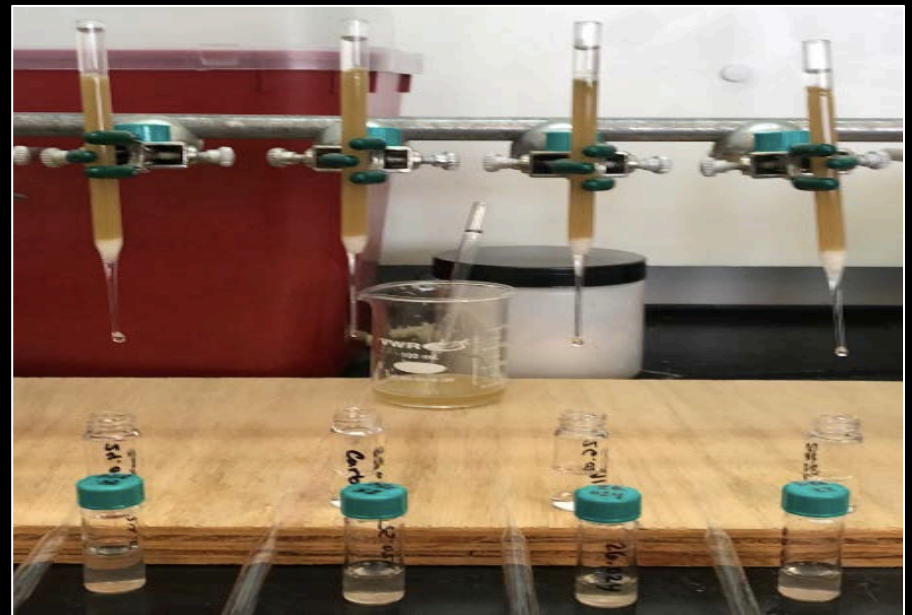
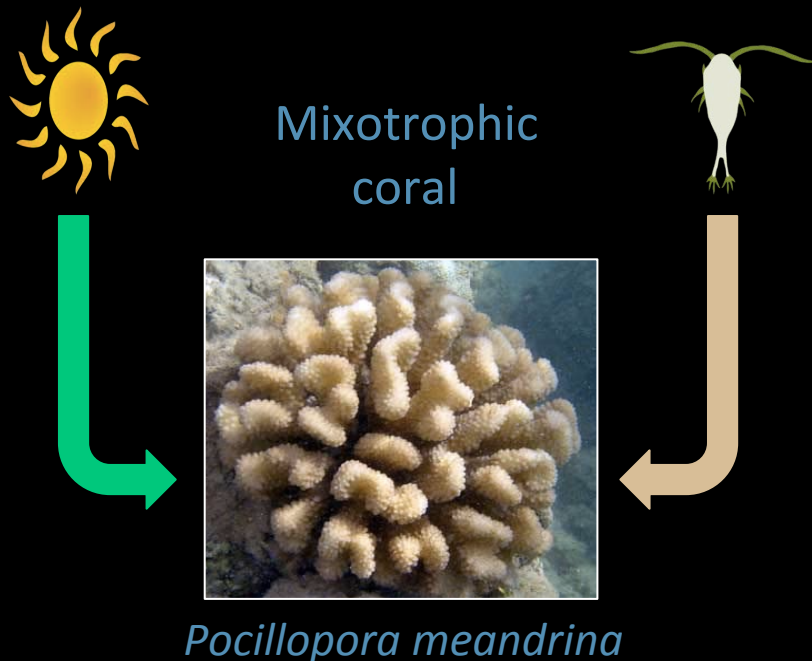
Can we use this information to understand where corals are most likely to survive?

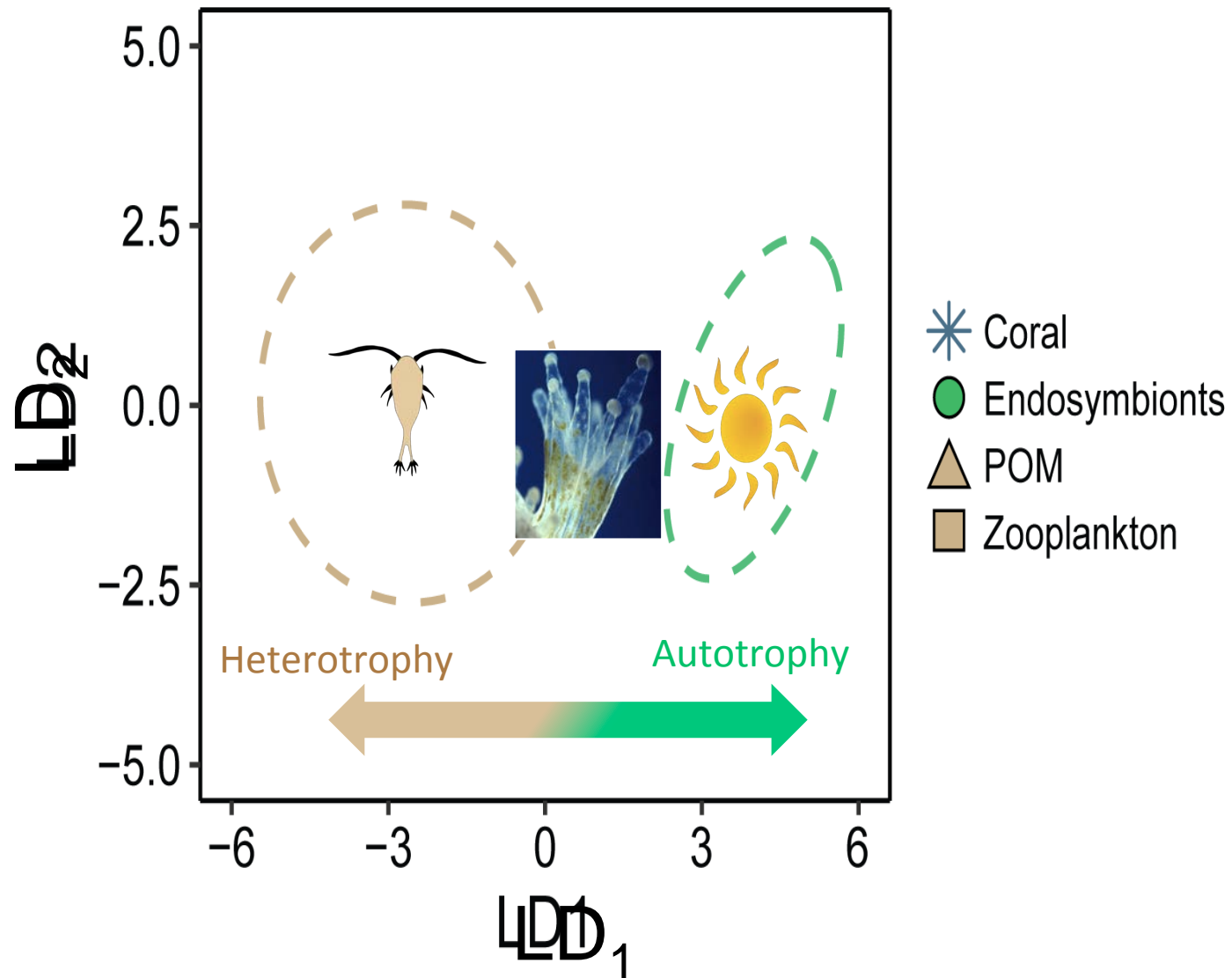


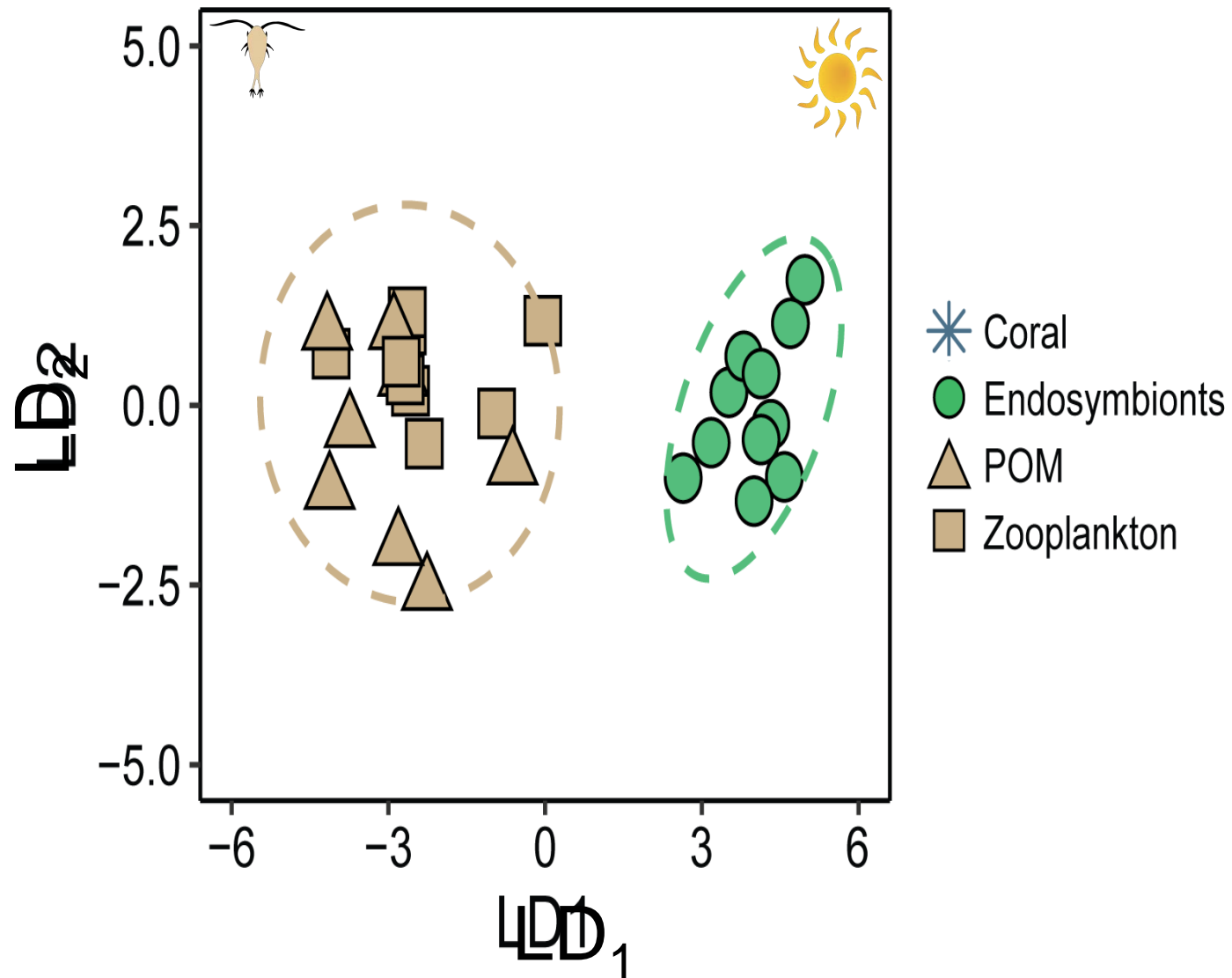
Current understanding of coral nutrition isn't good enough...we need better tools

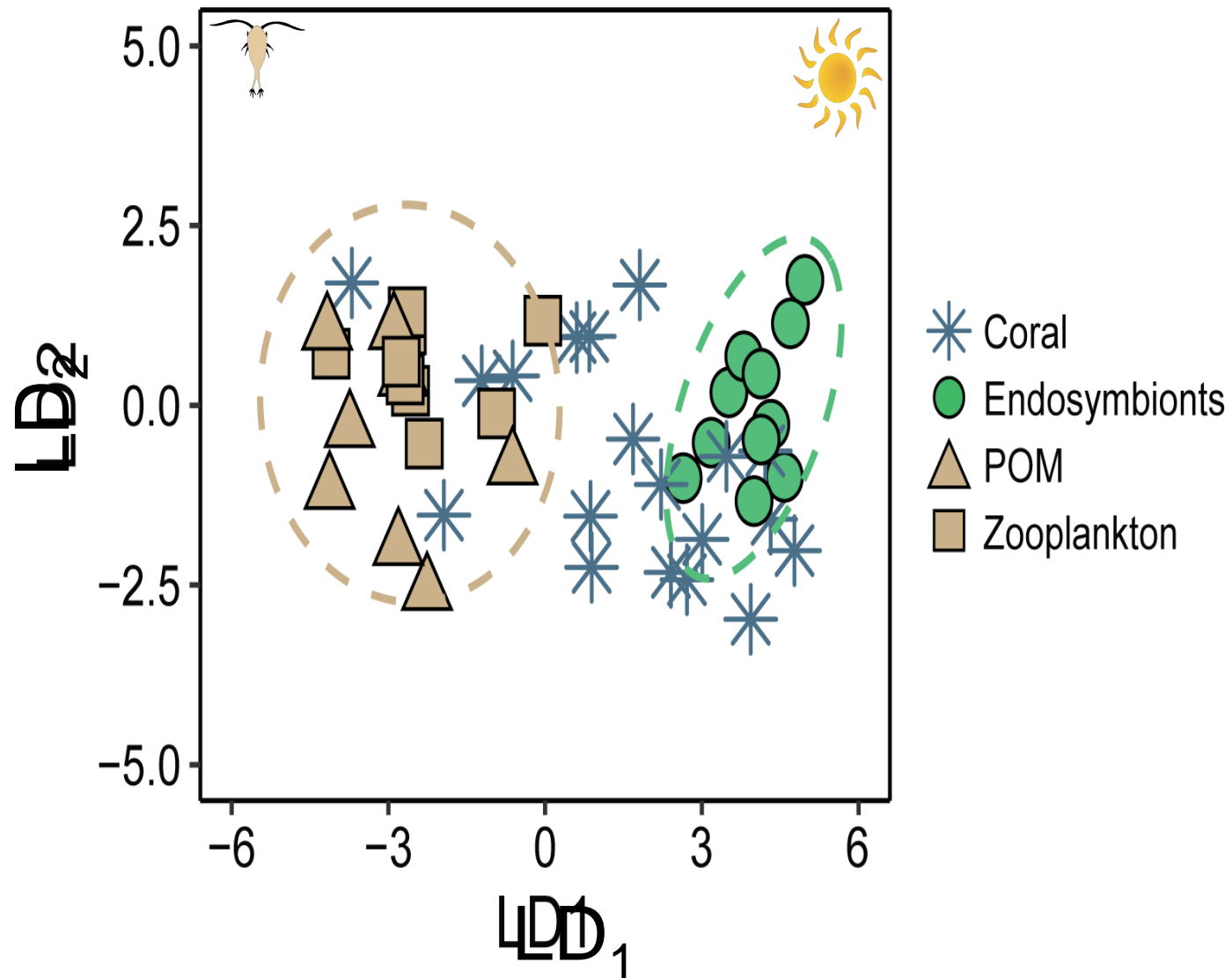


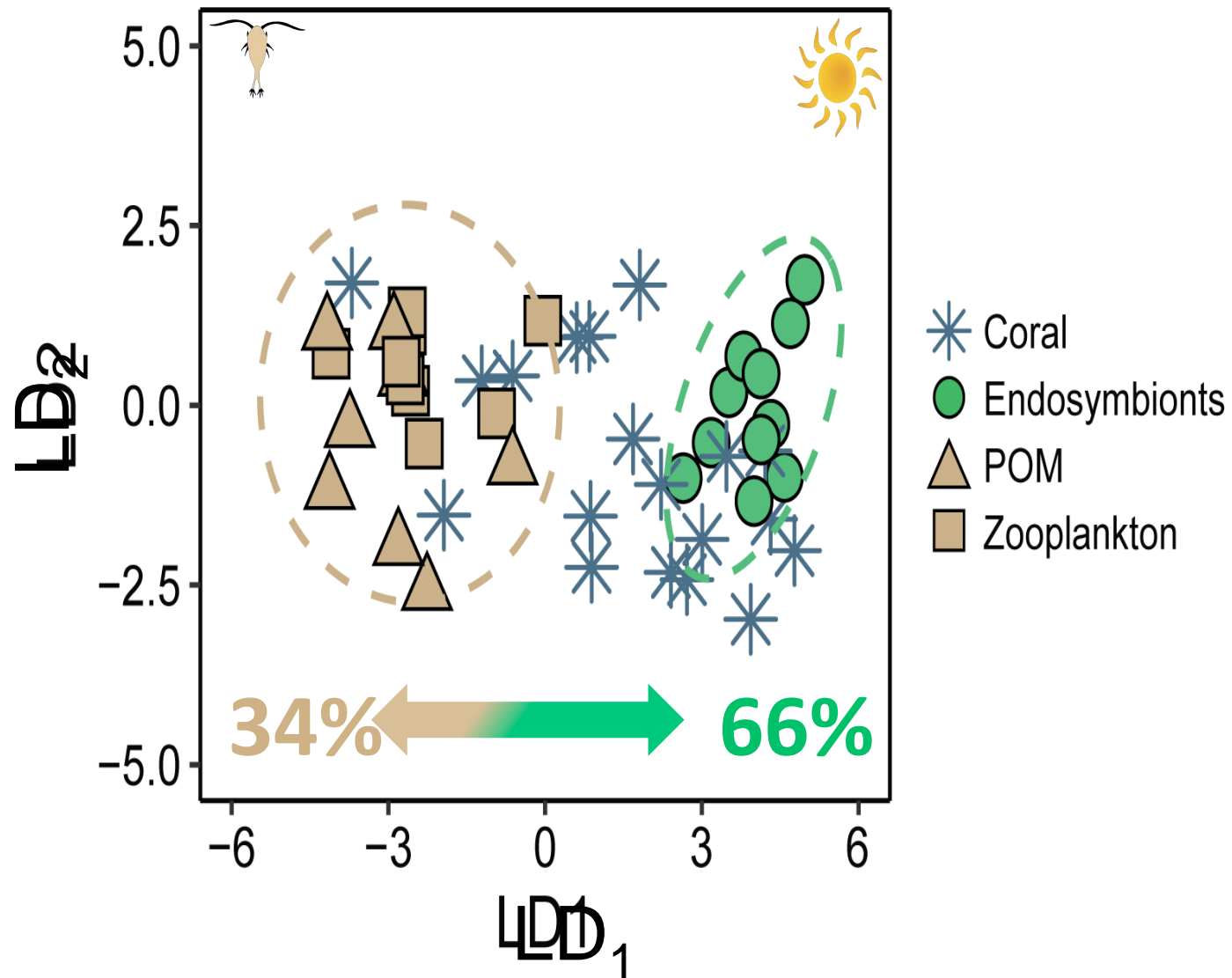
Stable isotope analysis of individual amino acids



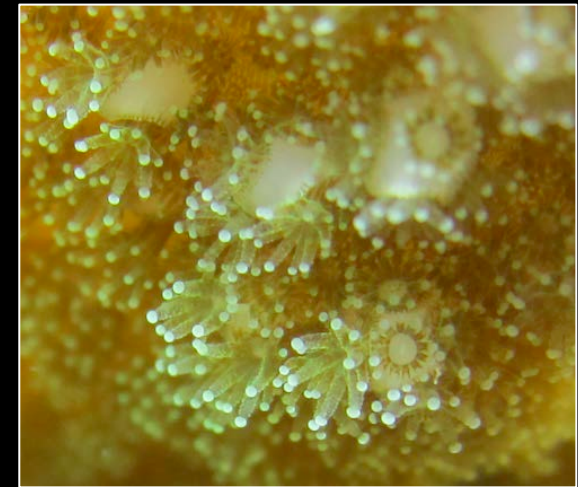
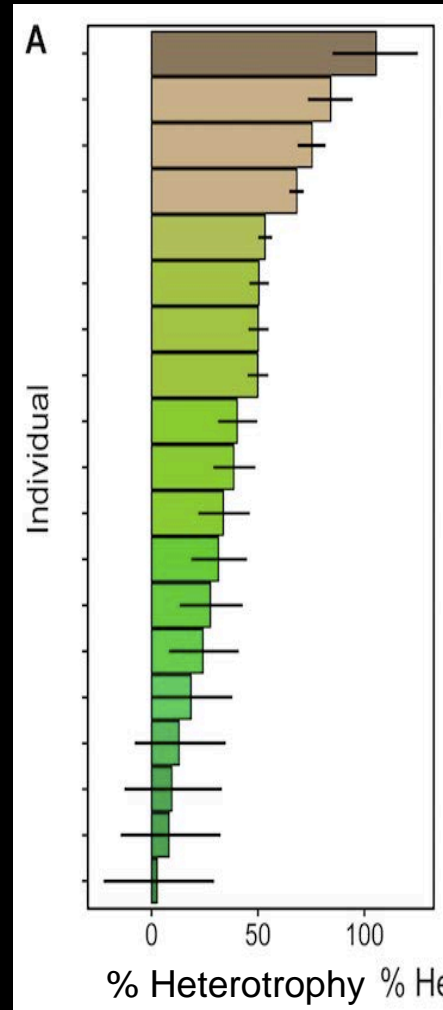
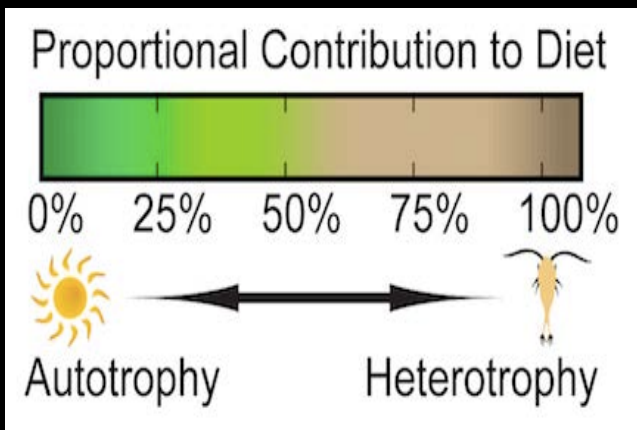
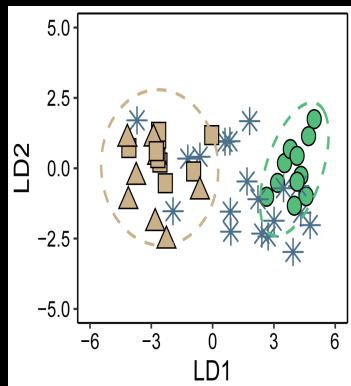








High variability in feeding among individual coral colonies



Key take home messages

- Corals feed more on reefs that have more food

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- Food availability can vary widely from reef to reef

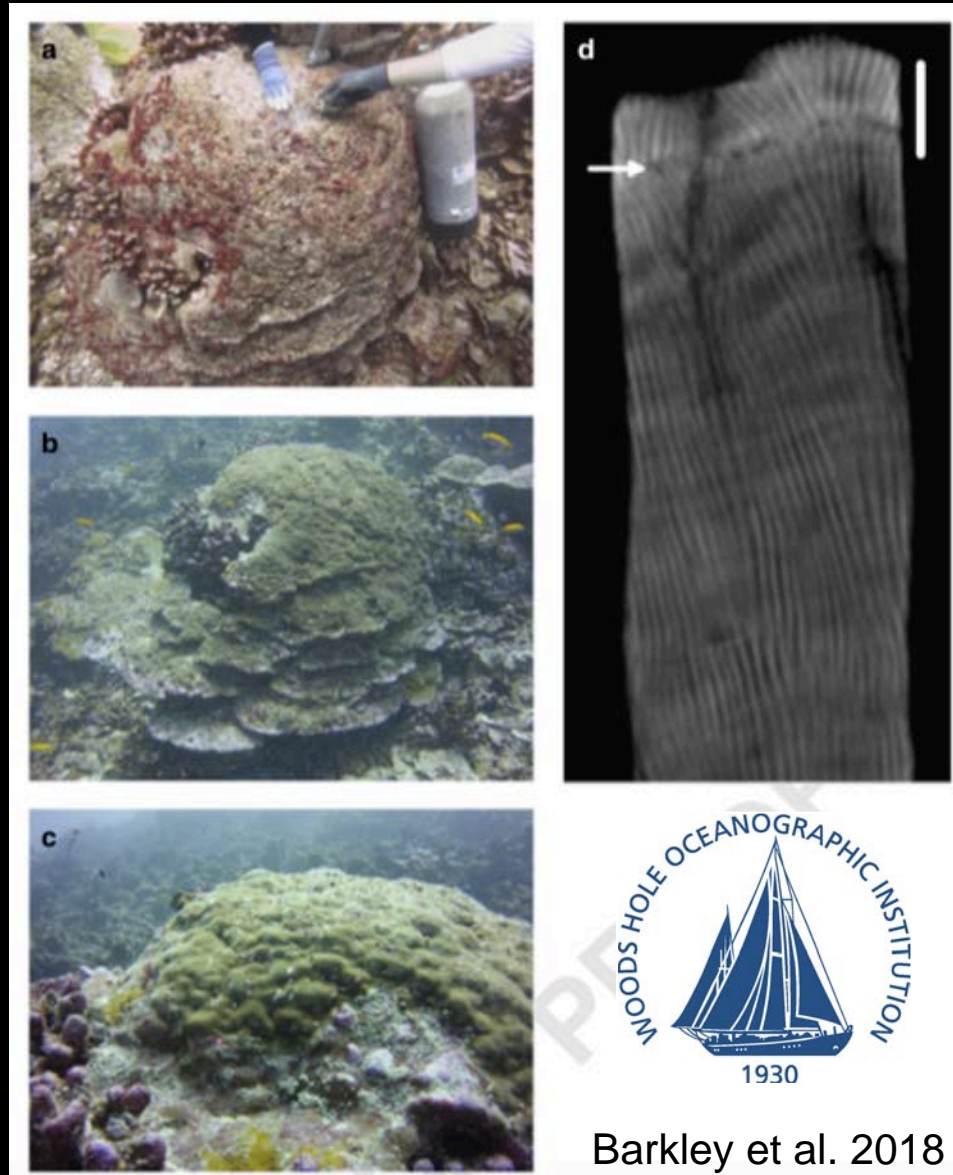
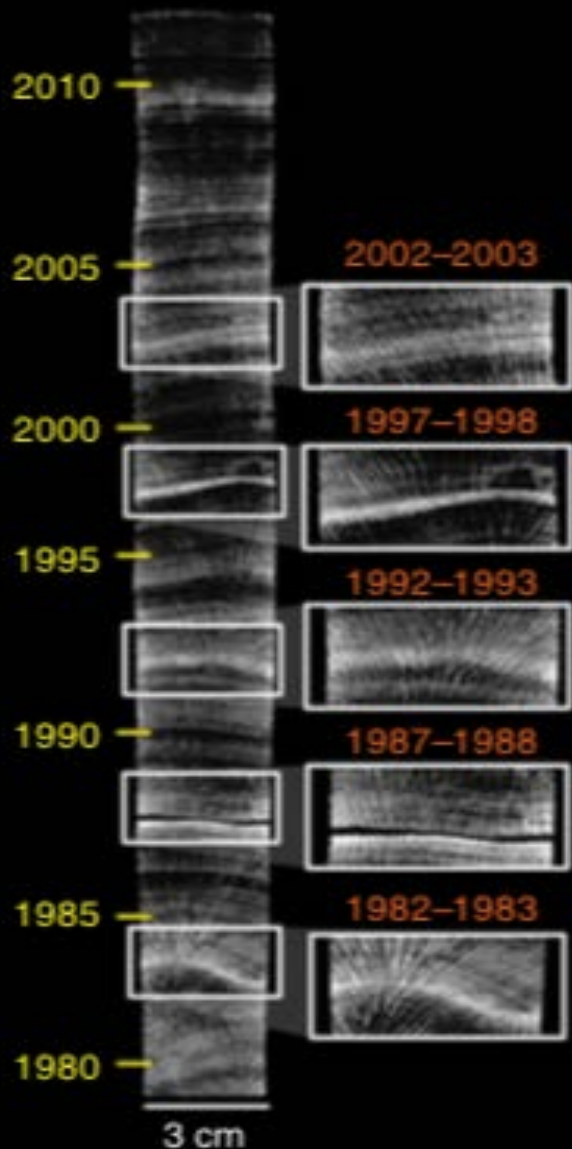
Key take home messages

- Corals feed more on reefs that have more food
- Food availability can vary widely from reef to reef
- New techniques and technologies are providing insights to coral nutrition at scales previously impossible

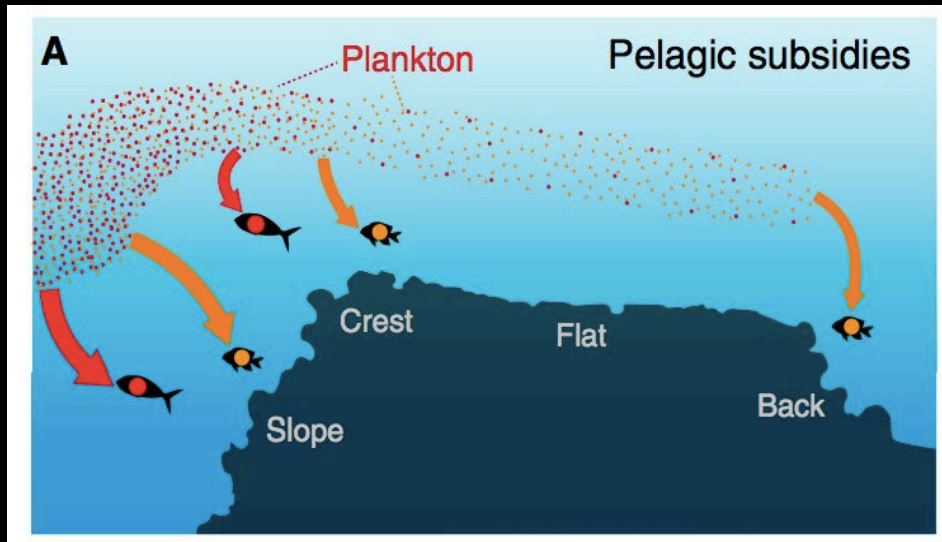
Key take home messages

- Corals likely feed more on reefs with more food
- Food availability can vary widely from reef to reef
- New techniques and technologies are providing insights to coral nutrition at scales previously impossible
- Understanding how coral feeding varies may provide important information about reef survival

Can feeding help corals survive repeat bleaching?

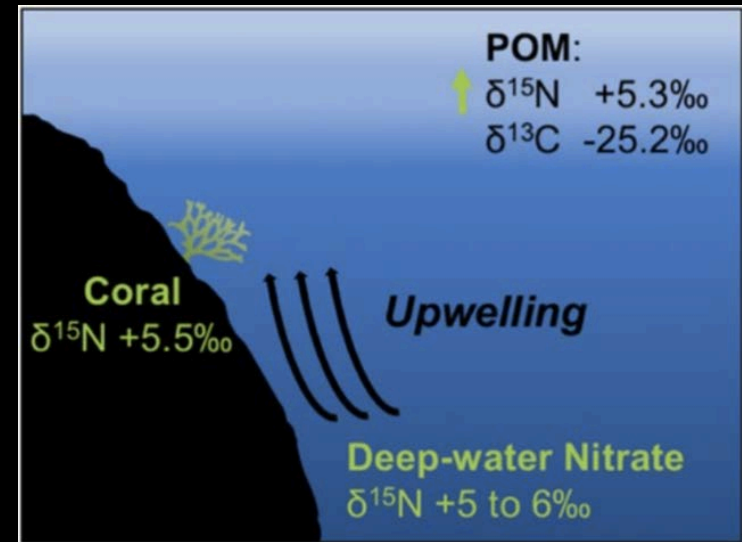


Continually uncovering the importance of oceanic production



Morais and Bellwood 2019 *Current Biology*

Sustains fish biomass following mass coral mortality on the Great Barrier Reef



Radice et al. 2019 *Functional Ecology*

Upwelling provides nitrogen to corals in the Maldives

Acknowledgements

Funding and Support

- NOAA Dr. Nancy Foster Scholarship
- Achievement Rewards for College Scientists (ARCS)
- SIO Grad. Division
- Lewis and Clark Exploration Fund
- Lerner-Gray Marine Research Grant
- Woods Hole Postdoctoral Scholarship

Logistical Support

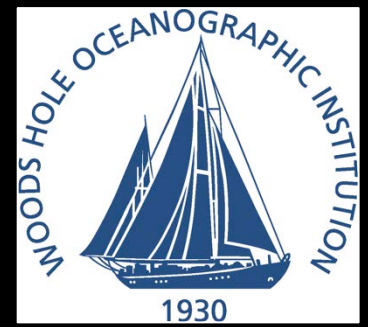
- Palmyra Atoll Research Consortium
- US Fish and Wildlife Service
- The Nature Conservancy
- 100 Island Challenge

Collaborators

Gareth Williams, Jennifer Smith, Stuart Sandin, Forest Rohwer, Seth Newsome, Emma Elliott Smith, Maggie Johnson, Brian Zgliczynski, Clint Edwards, Amanda Carter, Emily Kelly

Lab Assistance

Jess Glanz, Ellis Juhlin, Spencer Brenning-Aday, Annika Vawter





Thank you!

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