Palmyra Atoll Research Consortium

Report to the

U.S. Coral Reef Task Force

August 28th, 2008

Healy Hamilton, Ph.D.

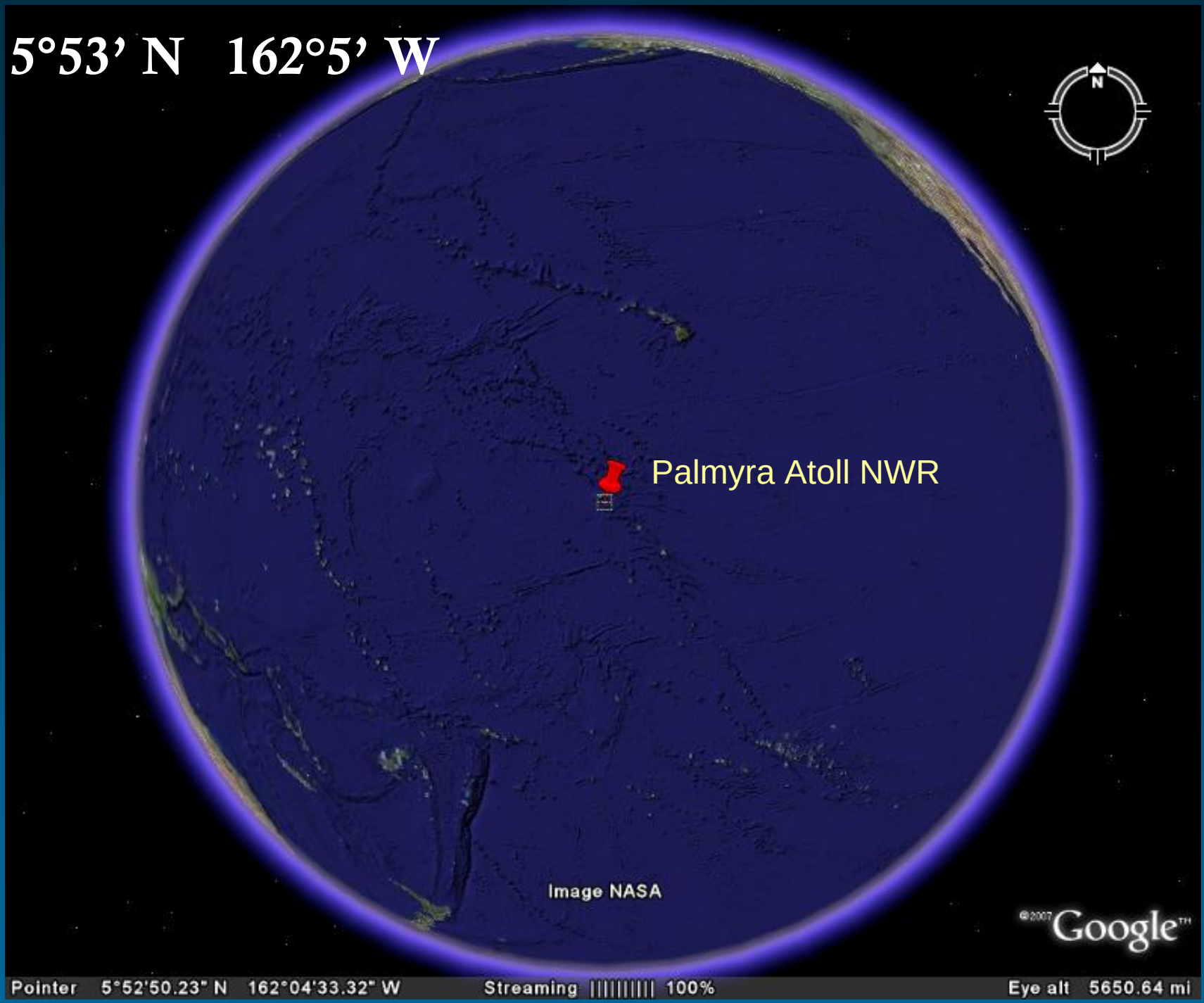
Chair, PARC Science Committee

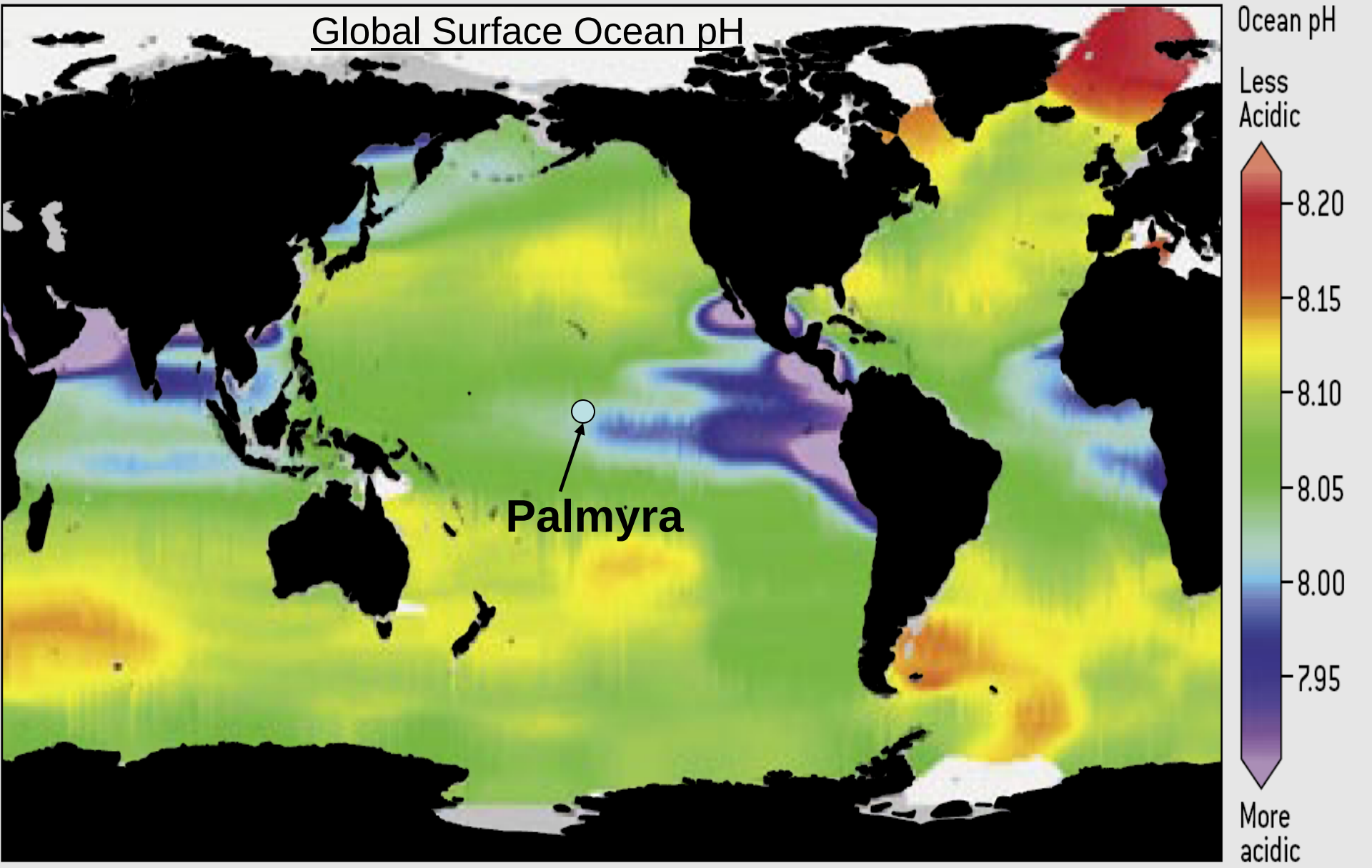
California Academy of Sciences

Outline

- Geographic orientation
- State of the coral reef ecosystems
- Partnership & Organizational Structure
- Research priorities & opportunities

5°53’ N 162°5’ W

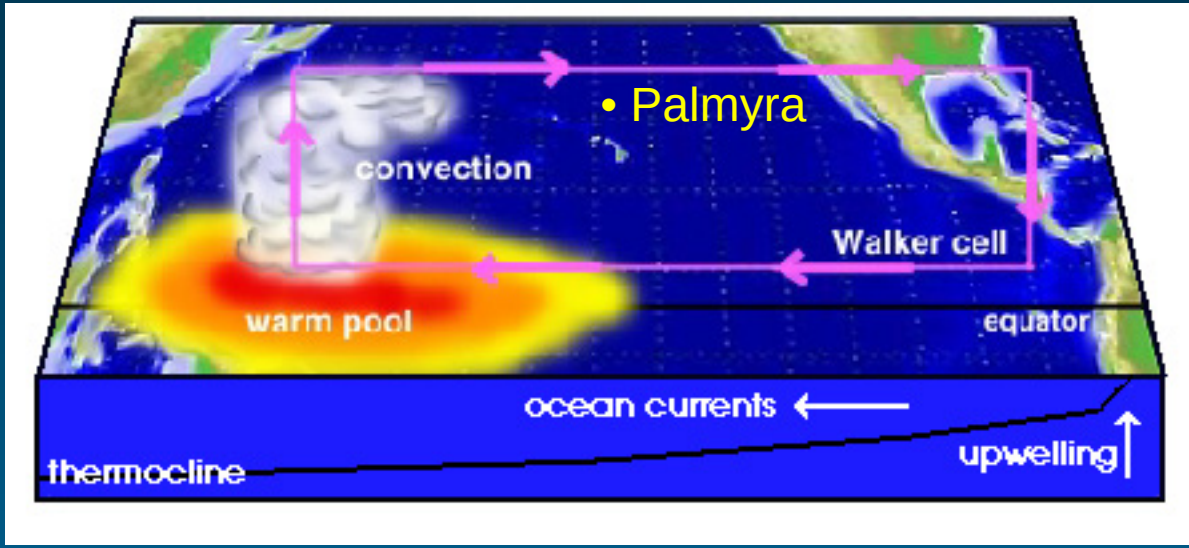

Palmyra Atoll NWR
Image NASA
©2007 Google™
Pointer 5°52'50.23" N 162°04'33.32" W
Streaming 100%
Eye alt 5650.64 mi



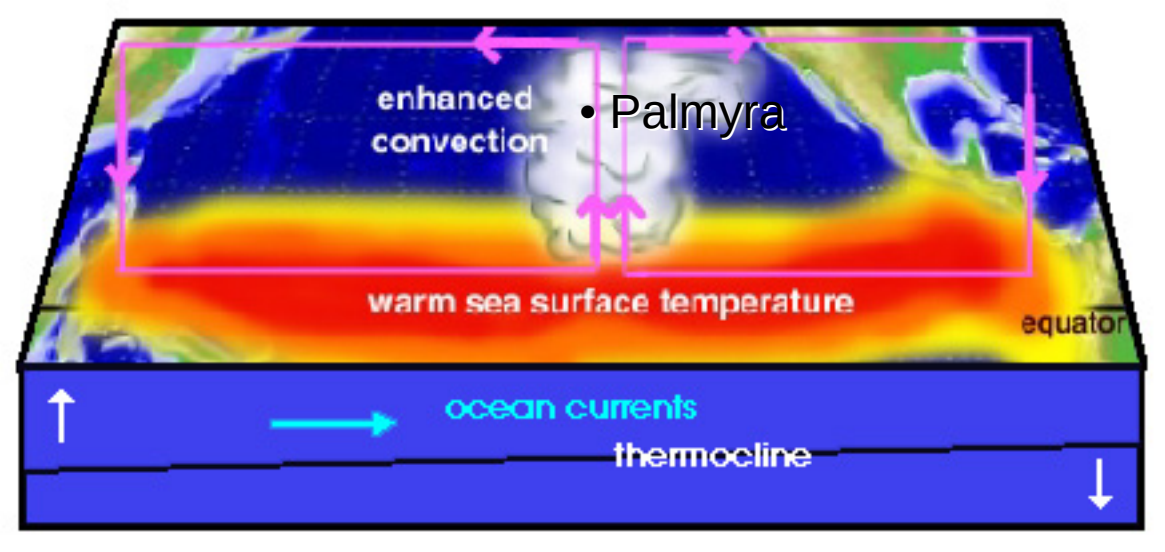
Because of its location, Palmyra experiences large decadal changes of Temp & pH, generated by El Nino/La Nina cycles

Palmyra is perfectly located to track climate changes, such as El Niño, which have been hypothesized to be changing in frequency and severity due to global warming.

"Normal"



El Niño



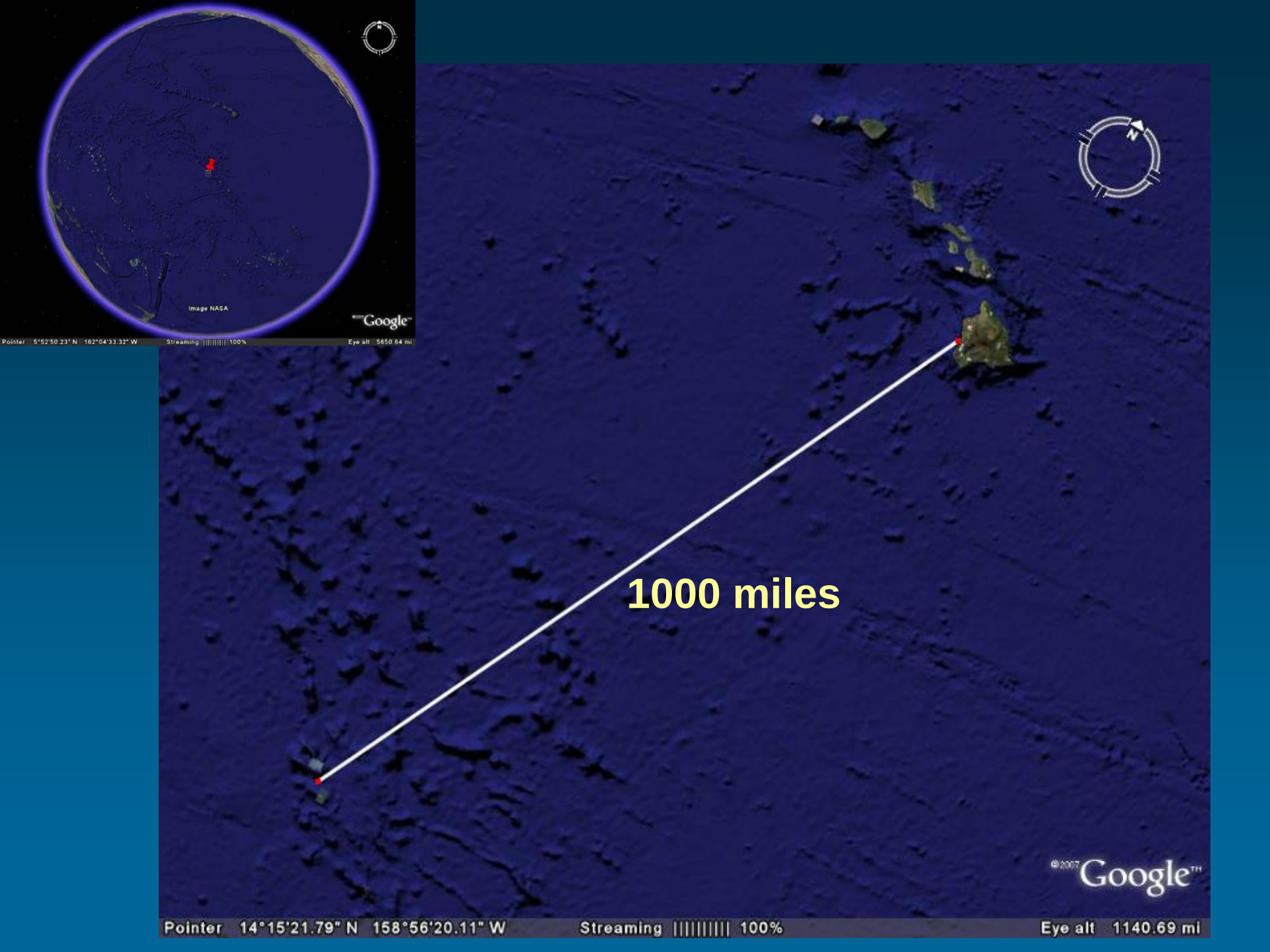


Image NASA
©Google
Pointer 5°52'50.23" N 162°04'33.32" W
Streaming 100%
Eye alt 5650.64 mi
1000 miles
©2007 Google
Pointer 14°15'21.79" N 158°56'20.11" W
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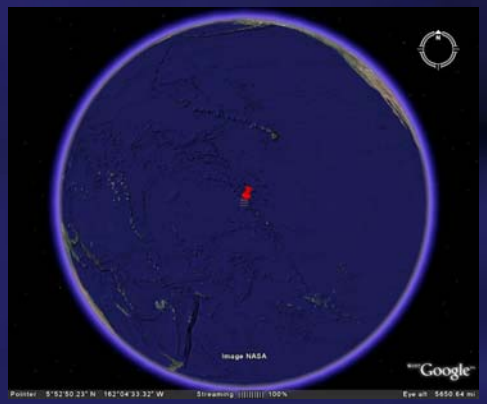
Eye alt 1140.69 mi

Kingman Reef NWR

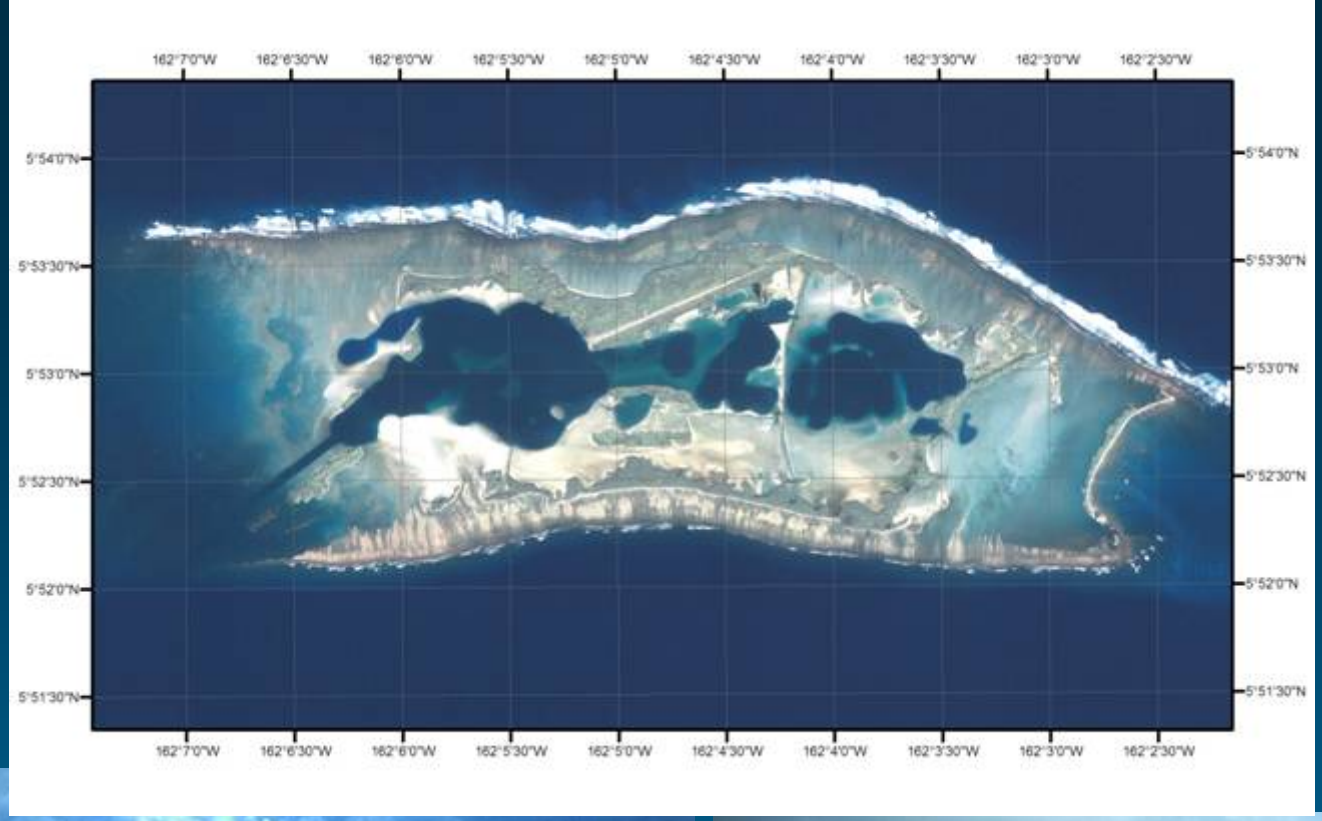
6°23’N 162°20’W

38 miles



Palmyra Atoll NWR

5°53’ N 162°04’ W


162°7'0"W
162°6'30"W
162°6'0"W
162°5'30"W
162°5'0"W
162°4'30"W
162°4'0"W
162°3'30"W
162°3'0"W
162°2'30"W
5°54'0"N
5°53'30"N
5°53'0"N
5°52'30"N
5°52'0"N
5°51'30"N

Outline

- Geographic orientation
- State of the coral reef ecosystems
- Partnership & Organizational Structure
- Research priorities & opportunities

Coral reefs globally face individual and synergistic effects of:

- Habitat destruction
- Overfishing
- Introduced species
- Warming
- Acidification
- Toxins (oil spills, plastics)
- Runoff of
  - sediments
  - pollutants
  - nutrients

PANWR + KRNWR:

Diversity & abundance

Most diverse coral faunas: >160 species in 40 genera

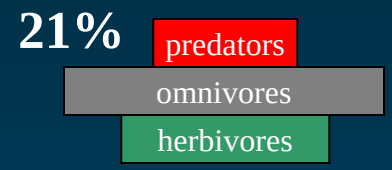
High density of top predators: trophically intact

Relatively free of confounding human influences

Near pristine state of coral reef ecosystems

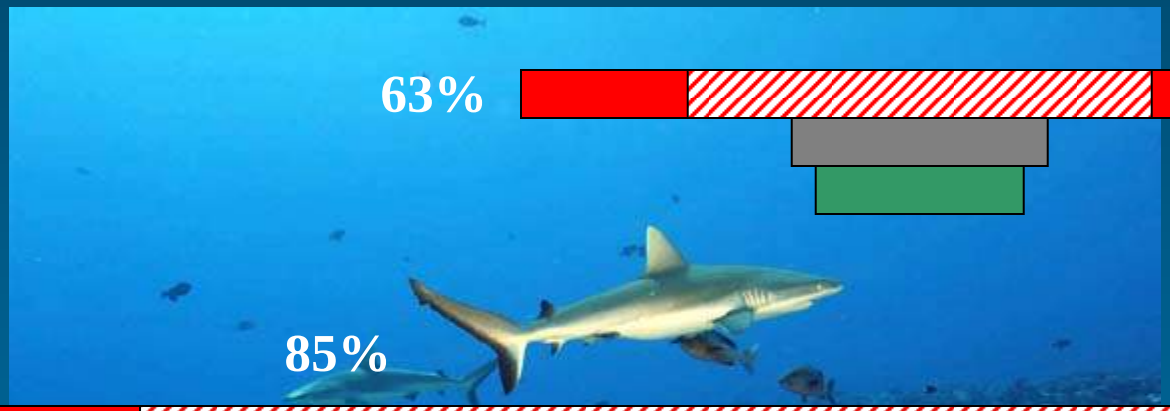
Why Palmyra?

Top predators abound. Biomass pyramids for fish become *inverted* with increasing 'health'



Kiritimati

Tabuaeran

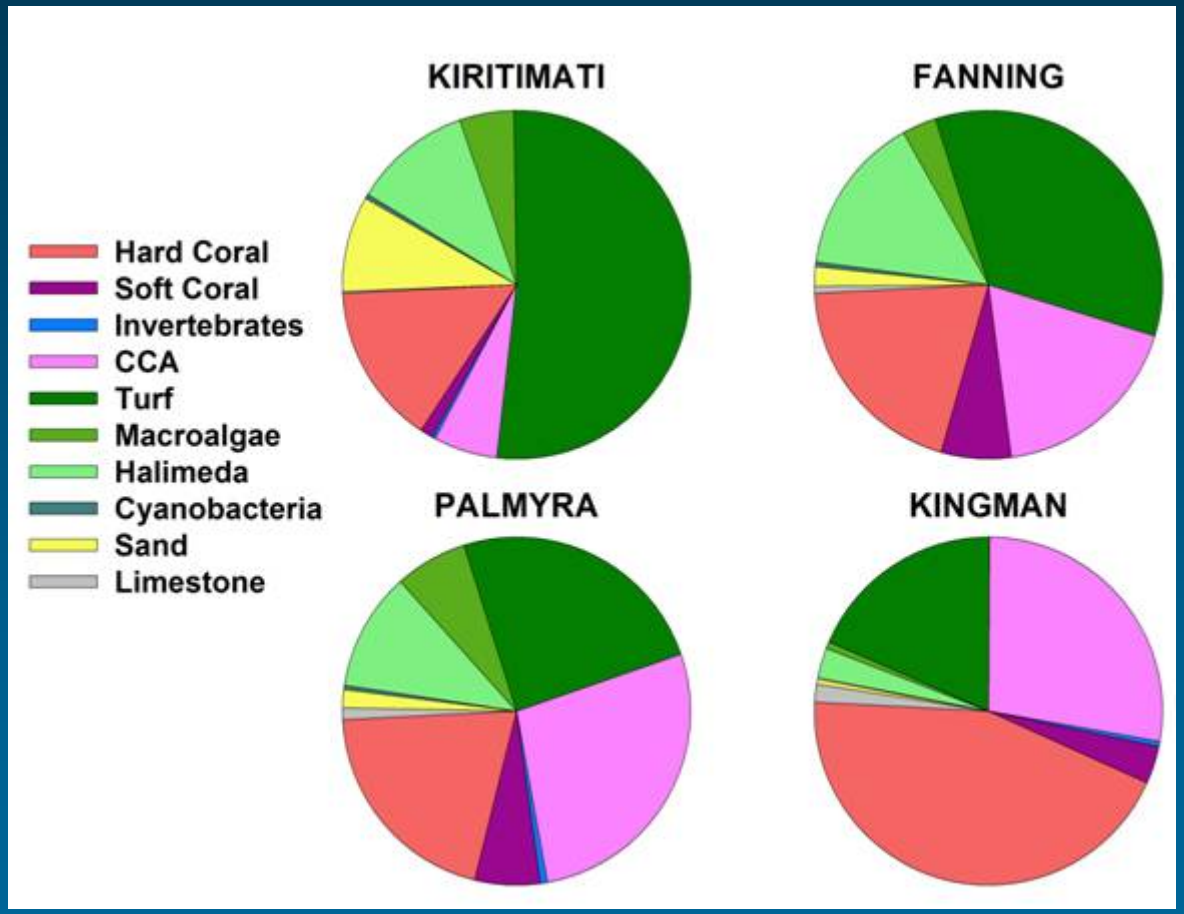


Palmyra

Kingman

Sandin *et al 2008*

Changes in species composition accompany human uses of the biosphere.



Sala et al. SIO Line Islands ‘snapshot’ benthic habitat

Palmyra offers a comparative baseline against which the changes in more altered ecosystems can be understood.

Palmyra represents unique partnership

- 2000 The Nature Conservancy purchases Palmyra Atoll from private owner
- 2001 USF&WS purchases islets and all submerged areas, designates PANWR. TNC retains ownership of Cooper Island
- 2004 Research Consortium is formed
- 2005 Research station build out
- 2006 TNC + PARC grant for PANWR manager
- 2006-08 3 field seasons (May-Nov) at full capacity

PARC current members

- American Museum of Natural History
- California Academy of Sciences
- Scripps Institution of Oceanography
- Stanford University
- University of California, Santa Barbara
- University of Hawaii
- United States Geological Survey
- Victoria University of Wellington, New Zealand

In partnership with: The Nature Conservancy and the U.S. Fish & Wildlife Service

PARC potential new members

High level of interest:

- Hawaii Pacific University
- Georgia Tech
- Long Beach State
- San Diego State
- Dalhousie

Discussions re:

Economy of scale

Island carrying capacity

Seasonal openings and closures

Moderate interest:

- Woods Hole Oceanographic Institute
- University of Washington
- Coral Reef Center of Excellence (Australia)

PARC organizational structure

Chair, Eleanor Sterling, AMNH

- Executive committee
  - Comprised of all committee chairs & TNC Palmyra program officer (Anders Lyons)
- Finance Committee
  - Chair: Rob Dunbar, Stanford University
  - Co-Chair: Jonathan Gardner, VUW
- Science Committee
  - Chair: Healy Hamilton, CAS
  - Co-Chair: Tom Suchanek, USGS
- Operations Committee
  - Chair: Stuart Sandin, SIO
  - Co-Chair: Liz Madin, UCSB

Collaborative Funding Efforts: Government

2007:

- NSF Research Coordination Network
  5 years, $500k
- NSF field station support program
  full proposal, good reviews, unsuccessful

2008:

- HURL preproposal, unsuccessful

In early development

- NSF DEB: Ecosystem Studies Program
  Jan 2009
- Palmyra as a CReefs site?

Collaborative Funding Efforts: Foundations

Gordon & Betty Moore Foundation

Marisla Foundation

Packard Foundation

Collaborative Funding Efforts: Corporations

Mitsubishi
Canon
BP

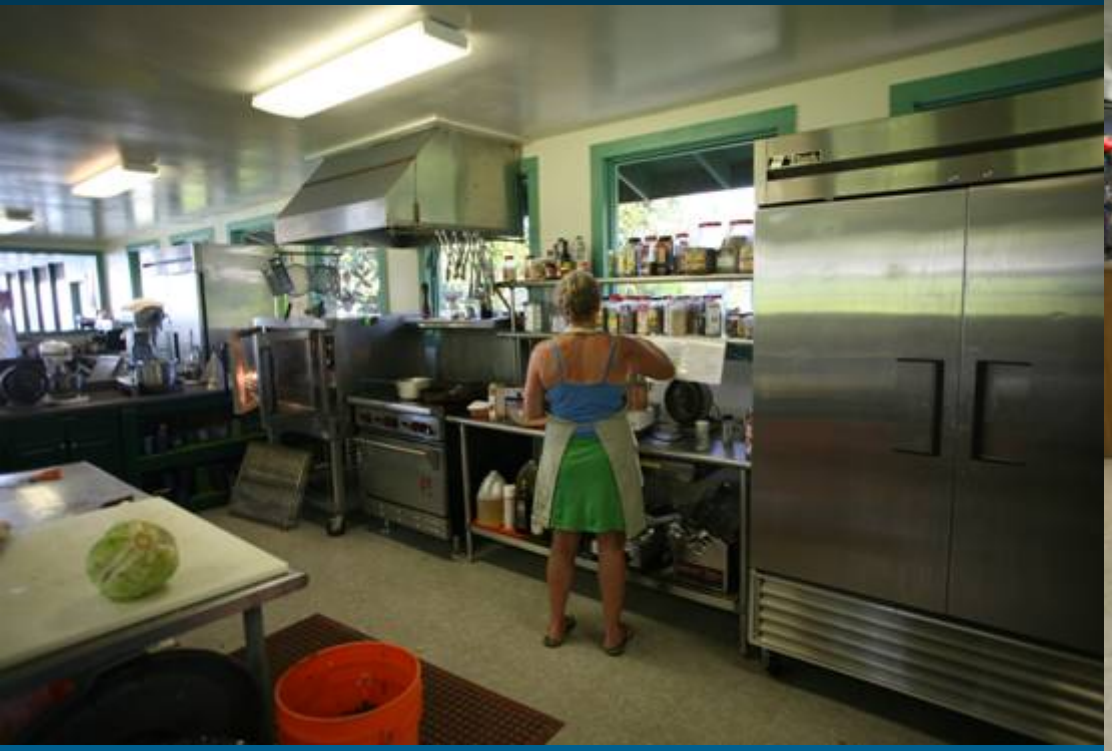

Palmyra
Boats Work


SCUBA SHACK


4A


3A
4A


FIRST AID
P.A.R.C.
DRY LAB




PALMYRA
YACHT CLUB

PALMYRA ATOLL RESEARCH CONSORTIUM

Navigation

- About
  - Where Is Palmyra Atoll?
  - What Is PARC?
  - PARC's Mission
  - PARC Member Institutions
  - In the News
- Research
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PARC Login

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About

Credit: E. Madin

Palmyra Atoll is among the most isolated island systems in the world. This tiny central Pacific atoll is a complex of small islands and islets encircling a system of three lagoons and surrounded by more than 16,000 acres of coral reef systems. Although the islands have never supported any permanent settlements, Palmyra's terrestrial and lagoonal habitats have been dramatically modified by people, especially during the Second World War. Even so, the combination of its location, isolation, rich biological systems, and lack of persistent human pressures make Palmyra Atoll an exceptional and unique location for a wide range of research pertaining to biodiversity, conservation, natural history, ecosystem restoration, marine ecosystem dynamics, biogeochemistry, climate dynamics, and atmospheric processes. Scientists and institutions interested in studying the natural systems of Palmyra Atoll and its surrounding region have united to form a partnership, the Palmyra Atoll Research Consortium (PARC).

To learn more about the interesting history of Palmyra Atoll, visit The Nature Conservancy's, Living Archipelagos, or Wikipedia's pages on Palmyra Atoll.

www.palmyraresearch.org

Recent publications

2 Biology and Ecology of the Recreational Bonefish Fishery at Palmyra Atoll National Wildlife Refuge with Comparisons to Other Pacific Islands

Alan M. Friedlander, Jennifer E. Caselle, Jim Beets, [illegible] V. Bowen, [illegible] ley, Todd Calitri,

PACIFIC SCIENCE · October 2007

OPEN ACCESS Freely available online PLoS one

Baselines and Degradation of Coral Reefs in the Northern Line Islands

Stuart A. Sandin[1], Jennifer E. Smith[2], Edward E. DeMartini[3], Elizabeth A. Dinsdale[4], Simon D. Donner[5], Alan M. Friedlander[6], Talina Konotchick[1], Machel Malay[7], James E. Maragos[8], David Obura[9], Olga Pantos[4], Gustav Paulay[7], Morgan Richie[1], Forest Rohwer[4], Robert E. Schroeder[10], Sheila Walsh[1], Jeremy B. C. Jackson[1,11], Nancy Knowlton[1,11], Enric Sala[1,12]*

1 Center for Marine Biodiversity and Conservation, Scripps Institution of Oceanography, La Jolla, California, United States of America, 2 National Center for Ecological Analysis and Synthesis, University of California Santa Barbara, Santa Barbara, California, United States of America, 3 National Oceanic and Atmospheric Administration (NOAA) Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, Hawaii, United States of America, 4 Department of Biology, San Diego State University, San Diego, California, United States of America, 5 Woodrow Wilson School, Princeton University, Princeton, New Jersey, United States of America, 6 National Oceanic and Atmospheric Administration (NOAA), National Ocean Service, National Centers for Coastal Ocean Science-Biogeography Team and The Oceanic Institute, Waimanalo, Hawaii, United States of America, 7 Florida Museum of Natural History, University of Florida, Gainesville, Florida, United States of America, 8 Pacific/Remote Islands National Wildlife Refuge Complex, U.S. Fish and Wildlife Service, Honolulu, Hawaii, United States of America, 9 CORDIO East Africa, Mombasa, Kenya, 10 National Oceanic and Atmospheric Adm[illegible] Honolulu, Hawaii, Unil[illegible] Superior de Investigac[illegible]

Arthropod Surveys on Palmyra Atoll, Line Islands, and Insights into the Decline of the Native Tree *Pisonia grandis* (Nyctaginaceae)[1]

Alex T. Handler,[2,3,7] Daniel S. Gruner,[3,4] William P. Haines,[5] Matthew W. Lange,[6] and Kenneth Y. Kaneshiro[3]

Abstract: Palmyra Atoll, in the Line Islands of the equatorial Pacific, supports one of the largest remaining native stands of *Pisonia grandis* forest in the tropical Pacific Ocean. In 2003, we surveyed terrestrial arthropods to document extant native and introduced species richness, compare these lists with historical records, and assess potential threats to native species and ecosystem integrity. In total, 115 arthropod taxa were collected, bringing the total number of taxa recorded since 1913 to 162. Few native species were collected; most taxa were accidental introductions also recorded from the Hawaiian Islands, the presumed main source of introductions to Palmyra. The overlap with previous historical surveys in 1913 and 1948 was low (<40%), and new species continue to establish, with one species of whitefly reaching pest status between 2003 and 2005. We observed numerous dead or dying large *Pisonia grandis*, and the green scale *Pulvinaria urbicola* (Coccidae) was particularly abundant on trees of poor health. Abundant introduced ants, particularly *Pheidole megacephala*, tended this and other hemipterans feeding on both native and introduced plants. We hypothesize that the *Pheidole-Pulvinaria* facultative mutualism is causing the decline of *Pisonia grandis*. Because of the unique properties of *Pisonia grandis* forest on oceanic atolls, its importance for nesting seabirds, and its alarming global decline, im-

OPEN ACCESS Freely available online PLoS one

Microbial Ecology of Four Coral Atolls in the Northern Line Islands

Elizabeth A. Dinsdale[1,2]*, Olga Pantos[1]*, Steven Smriga[3], Robert A. Edwards[4,5], Florent Angly[1], Linda Wegley[1], Mark Hatay[1], Dana Hall[1], Elysa Brown[1], Matthew Haynes[1], Lutz Krause[6], Enric Sala[3], Stuart A. Sandin[3], Rebecca Vega Thurber[1], Bette L. Willis[7], Farooq Azam[3], Nancy Knowlton[3], Forest Rohwer[1,4]*

1 Department of Biology, San Diego State University, San Diego, California, United States of America, 2 School of Biological Sciences, Flinders University, Adelaide, South Australia, Australia, 3 Center for Marine Biodiversity and Conservation, Scripps Institution of Oceanography, University of California San Diego, La Jolla, California, United States of America, 4 Center for Microbial Sciences, San Diego State University, San Diego, California, United States of America, 5 Fellowship for Interpretation of Genomes, Burr Ridge, Illinois, United States of America, 6 Center for Biotechnology (CeBiTec), Bielefeld University, Bielefeld, Germany, 7 Australian Research Council (ARC) Centre of Excellence for Coral Reef Studies, School of Marine and Tropical Biology, James Cook University, Townsville, Queensland, Australia

Abstract

Microbes are key players in both healthy and degraded coral reefs. A combination of metagenomics, microscopy, culturing, and water chemistry were used to characterize microbial communities on four coral atolls in the Northern Line Islands, central Pacific. Kingman, a small uninhabited atoll which lies most northerly in the chain, had microbial and water chemistry characteristic of an open ocean ecosystem. On this atoll the microbial community was equally divided between autotrophs (mostly *Prochlorococcus* spp.) and heterotrophs. In contrast, Kiritimati, a large and populated (~5500 people) atoll, which is most southerly in the chain, had microbial and water chemistry characteristic of a near-shore environment. On Kiritimati, there were 10 times more microbial cells and virus-like particles in the water column and these microbes were dominated by heterotrophs, including a large percentage of potential pathogens. Culturable *Vibrios* were common only on Kiritimati. The benthic community on Kiritimati had the highest prevalence of coral disease and lowest coral cover. The middle atolls, Palmyra and Tabuaeran, had intermediate densities of microbes and viruses and higher percentages of autotrophic microbes than either Kingman or Kiritimati. The differences in microbial communities across atolls could reflect variation in 1) oceanographic and/or hydrographic conditions or 2) human impacts associated with land-use and fishing. The fact that historically Kingman and Kiritimati did not differ strongly in their fish or benthic communities (both had large numbers of sharks and high coral cover) suggest an anthropogenic component in the differences in the microbial communities. Kingman is one of the world's most pristine coral reefs, and this dataset should serve as a baseline for future studies of coral reef microbes. Obtaining the microbial data set, from atolls is particularly important given the association of microbes in the ongoing degradation of coral reef ecosystems worldwide.

Recent coverage in popular press

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Host Dan Rather presents hard-edged field reports, in-depth interviews and accuracy, fairness and guts in their reporting. The program will cover topics environment, the global economy, and international affairs and conflicts.

OCEAN VIEW

Original Air Date: Tuesday, June 17th, 2008

Palmyra Atoll is a natural paradise - 1000 miles south of Ha world's most spectacular coral reefs and is protected by th American evangelist tries to spread Christianity in China. A

npr

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24-hour Program Stream | Schedule

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August 25, 2008

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CLIMATE CONNECTIONS: PROFILES

Living in Paradise on the Palmyra Atoll

by Alex Chadwick

Listen Now *[7 min 46 sec]* + add to playlist

Enlarge Steve Proffitt, NPR

The galley where the staff and scientists at the research center take their meals and socialize.

Day to Day, October 25, 2007 · Palmyra Atoll, a lagoon surrounded by coral reefs in the middle of the Pacific Ocean, is about 1,000 miles from the closest inhabited land — Hawaii.

This remoteness makes it a truly remarkable place, allowing for scientific research that would not be possible in other places with human populations.

Palmyra is uninhabited for the most part — it has no indigenous population, with only a small staff to support the 15 or 20 researchers who come for a week or a month at a time.

A non-profit group, the Nature Conservancy, bought Palmyra

More in the Series

» Oct. 24, 2007 Researchers Track Boobies for Climate Change Data

» Oct. 23, 2007 Scientists Track Shark Behavior in Palmyra Atoll

Outline

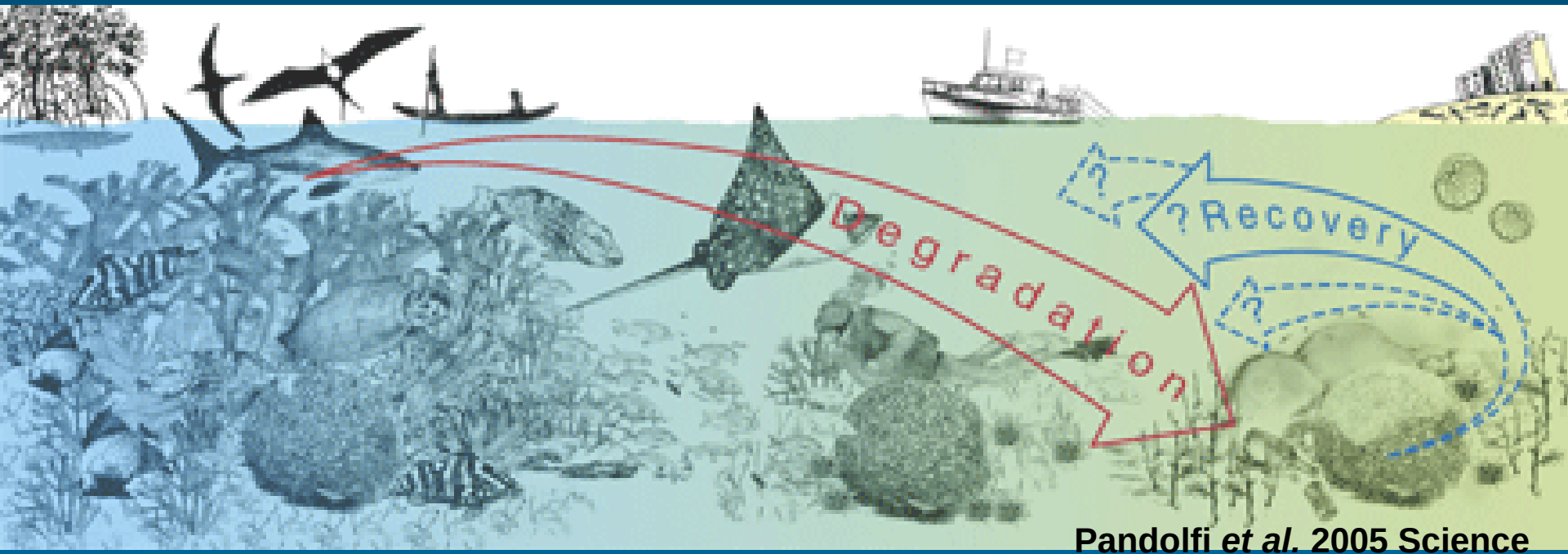
- Geographic orientation
- State of the coral reef ecosystems
- Partnership & Organizational Structure
- Research priorities & opportunities

Biodiversity composition & regional connectivity

What are the current patterns of biodiversity composition and marine connectivity between Palmyra and the greater IndoPacific?

Biodiversity structure and function

What are the physiological, ecological, and evolutionary mechanisms of ecosystem resilience in healthy, intact coral reefs?



Pandolfi *et al.* 2005 Science

Intact coral reefs with more complete trophic structures may recover more quickly and completely from environmental disturbances.

What are the dynamics contributing to this increased resilience?

Outcomes of biodiversity research on PA




- Identify the constituents of healthy reef diversity
- Construct data-based models of energy flow through the reef community
- Describe ecological dynamics responsible for coral reef resiliency
- Identify geographic and genetic connectivity
- Monitor these properties and processes into the future

Biogeochemistry and Climate Change

- Question #1: **What are the mechanisms that elevate coral reef productivity to levels far exceeding that of the surrounding blue water ocean?**

- Question #2: **What does Palmyra teach us about the trajectory of change in the tropics due to global warming and ocean acidification?**

POLICYFORUM

OCEAN SCIENCE

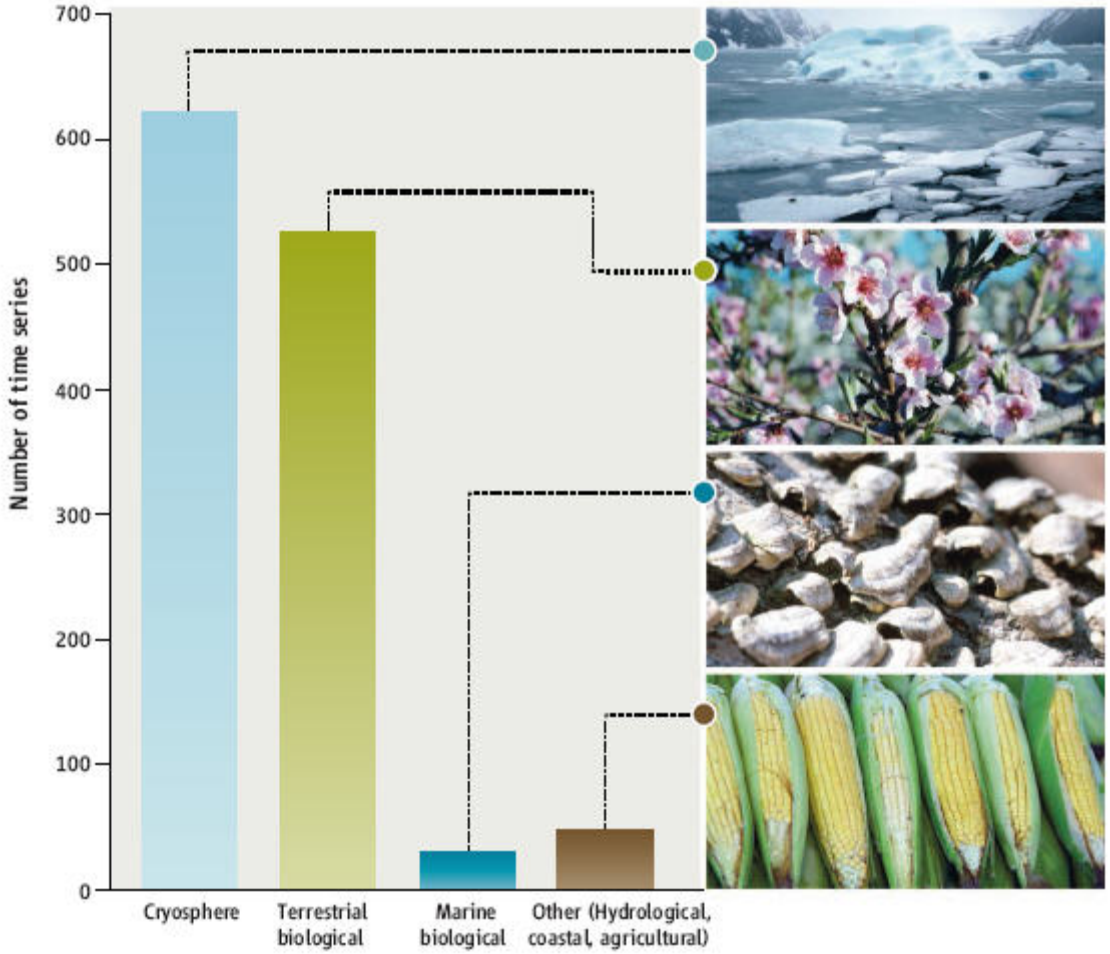
Under-Resourced, Under Threat

Anthony J. Richardson[1,2] and Elvira S. Poloczanska[3]

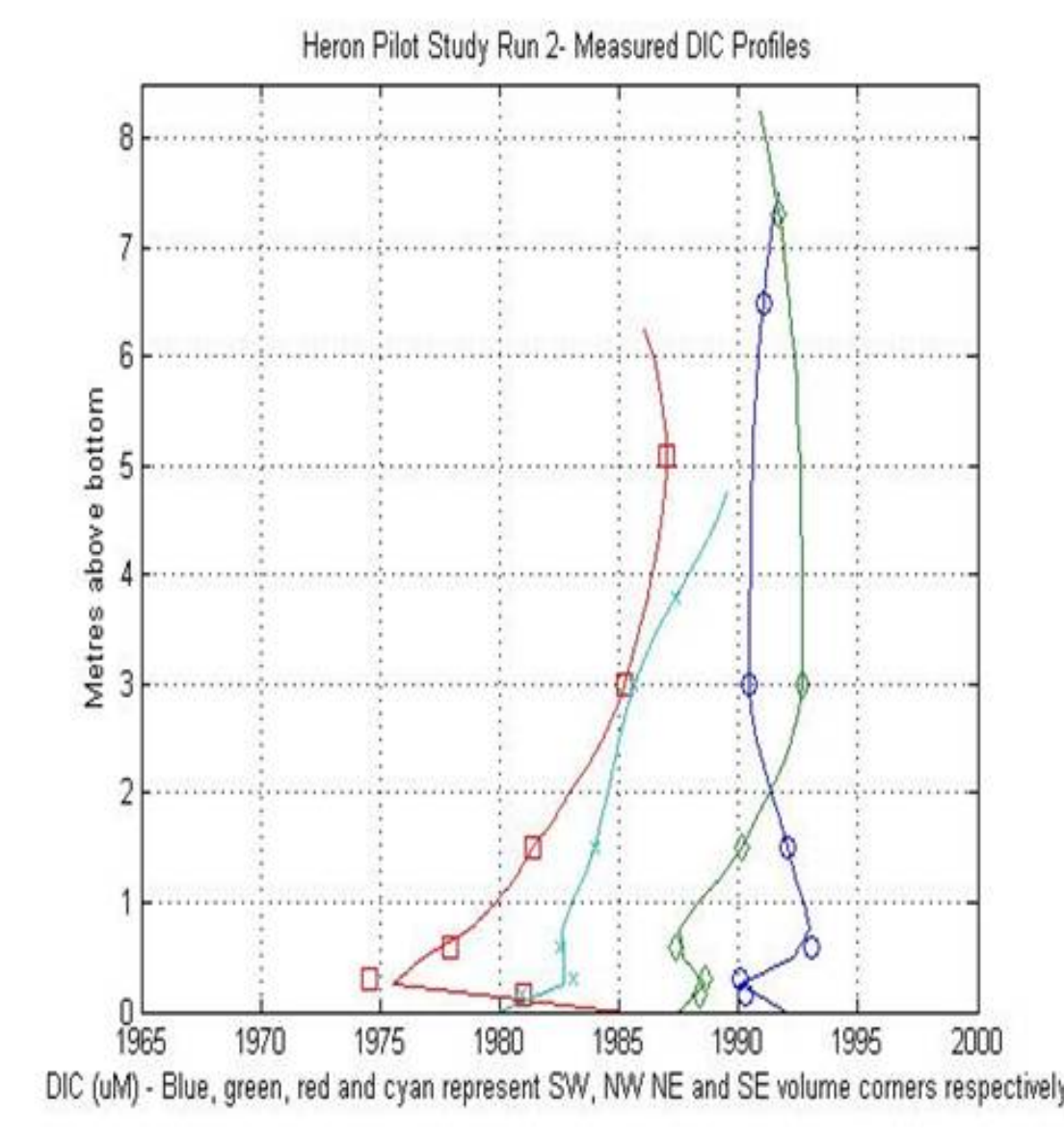
A coherent global vision is needed to better determine the impacts of climate change on marine systems.

Palmyra & Kingman:

Key places to study the effects of climate change on marine systems



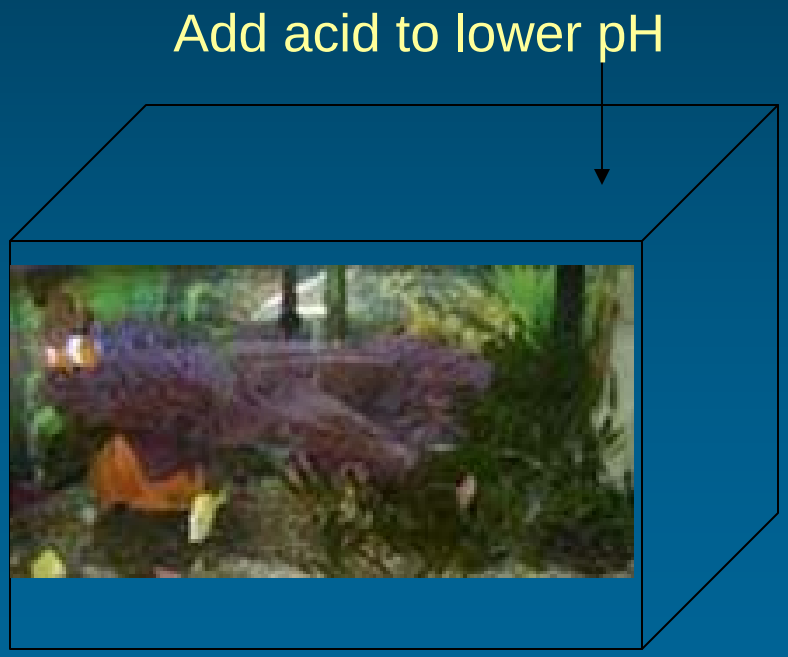
Marine undersampling. The number of time series from different environments included in the recent IPCC (Intergovernmental Panel on Climate Change) Fourth Assessment Report differ widely. Marine systems are vastly underrepresented compared with terrestrial systems (*1*).



This method can measure carbon flux between the reef and the seawater

Free Ocean CO_2 Enrichment (FOCE)

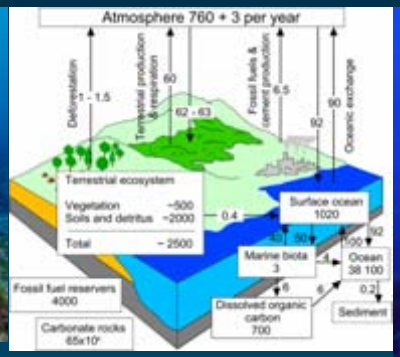
- Mesocosms will be set up in the lab on Palmyra to study the sensitivity of organisms and materials to large changes in pH.

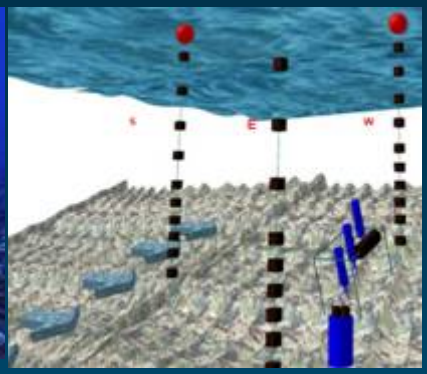


- Monitor nutrients, DIC, Alkalinity, pH.

- Observe organismal responses including health, productivity and dissolution of $CaCO_3$ in corals, forams, pteropods, coccoliths, etc.

Outcomes of Biogeochemistry research on PA





- Quantify the flow of energy, food, and nutrients from the physical to the biological realm in a system relatively free from confounding human influences
- Identify components of the system that limit or enhance overall new and/or recycled productivity
- Development of a novel in-situ method for measuring oceanic buffering capacity (FOCE), producing critical data on how a natural system responds to elevated levels of CO_2
- Produce empirical data that will support modeling and prediction research on the effects of global climate and chemical changes on coral reefs

Terrestrial and Lagoon Ecology & Restoration

Species/guild composition and function

Invasive species management

Local and regional connectivity

Biogeochemical cycles

Lagoon sediment and hydrologic dynamics

Pisonia forest restoration & management

T & E species (seabirds, turtles, coconut crabs)

PARC Mission statement

PARC undertakes collaborative research to understand terrestrial, marine, and climate systems of Palmyra Atoll and the central Pacific that advances the conservation of island and coastal systems worldwide




http://www.palmyraresearch.org