NATIONAL SCIENCE FOUNDATION AWARDS

- Documenting Bleaching Susceptibility and Resilience in Guam, Micronesia
- The Impact of an Empty Forest on Tree Recruitment and Community Structure
- Toward Predicting the Impact of Ocean Acidification on Net Calcification by a Broad Range of Coral Reef Ecosystems: Identifying Patterns and Underlying Causes

Award Abstract #1418673

RAPID: Documenting bleaching susceptibility and resilience in Guam, Micronesia

NSF Org: OCE
Division of Ocean Sciences

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Award Instrument: Standard Grant

Program Manager: Michael Sieracki
OCE Division of Ocean Sciences
GEO Directorate for Geosciences

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Sponsor: American University
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NSF Program(s): BIOLOGICAL OCEANOGRAPHY

Program Reference Code(s): 1195, 7914, 9169

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ABSTRACT - Documenting Bleaching Susceptibility and Resilience in Guam, Micronesia

Coral reef ecosystems are experiencing unprecedented levels of environmental stress. Guam, Micronesia is currently experiencing an island-wide coral bleaching event unprecedented in recent decades. The available evidence suggests that the severity and extent of this event is

linked to extended high sea surface temperature and a delay in the onset of the rainy season. Initial surveys of coral reefs around the island indicate that the impacts are broad in both geographic extent and the number of coral species affected. This project will support a quantitative examination of the patterns of mortality and recovery of corals from this event in the context of reef resilience, or their ability to recover. Specifically, the project will examine whether: (a) exposure differences between the east and west sides of the island result in differential recovery, and (b) do sites that showed lower bleaching severity during initial surveys show higher recovery post-bleaching? It is predicted that differential bleaching is due, in part, to genetic differences in both the coral host and its symbiotic algae and identifying unique host-symbiont combinations that are less sensitive to extreme temperature anomalies will be a primary goal of this project. These hypotheses and predictions will be addressed by returning to a select subset of reef sites over time by a rapid response team using survey methods as employed at the NSF funded Moorea Coral Reef Long Term Ecological Research (LTER) site which includes permanent transects and fixed quadrats, and computer software to document changes in the percent cover of corals over time. Additionally, long-term monitoring of tagged colonies in the genera Acropora and Pocillopora, specifically for their recovery, and for detailed genetic analyses to examine host and symbiont genetic diversity, will help determine which combinations of host-symbiont genotypes are exhibiting recovery versus mortality.

The proposed work will reveal which specific sites, environmental conditions, and genotypes are associated with resilience to coral bleaching and will allow establishment of a system whereby long-term recovery can be documented and also compared to the Moorea LTER data on coral reef resilience. Such data sets are rare or non-existent in Micronesia and the ability to identify resilient populations can provide information to help prioritize management efforts and evaluate the performance of existing marine parks and preserves.

Award Abstract #1257433

Collaborative Research: The impact of an empty forest on tree recruitment and community structure

NSF Org:	DEB Division of Environmental Biology
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Award Number:	1257433
Award Instrument:	Continuing grant
Program Manager:	Peter Alpert DEB Division of Environmental Biology BIO Directorate for Biological Sciences
Start Date:	May 1, 2013
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Awarded Amount to Date:	$204,831.00
Investigator(s):	Ross Miller rmiller@uguam.uog.edu (Principal Investigator)
Sponsor:	University of Guam UOG Station Mangilao, GU 96913-1800 (671)735-2994
NSF Program(s):	POP & COMMUNITY ECOL PROG
Program Reference Code(s):	9169,
Program Element Code(s):	1182

ABSTRACT - The Impact of an Empty Forest on Tree Recruitment and Community Structure

Fruit-eating vertebrates have experienced steep declines in abundance and diversity in many of the tropical forests in Asia, Africa, and South America. Many of the tropical trees that need high light to grow from seeds to adults depend largely on these vertebrates to carry their seeds to new openings, or gaps, in the forest created by treefalls. This project will investigate whether the disappearance of fruit-eating vertebrates is reducing the abundance of these trees and causing forest gaps to persist and accumulate. To test this, researchers will compare forests on the island of Guam, which has lost nearly all its fruit-eating vertebrates due to the introduction of a predatory snake, and on three nearby islands that retain native, fruit-eating, forest birds and, in one case, a native, fruit-eating bat. Studies will measure the dynamics of forest gaps on the islands, compare the light requirements of 16 common tree species, and test the effects of experimentally preventing dispersal of seeds on islands that do have birds.

This research will directly aid state and federal agencies to manage and restore tropical forests on Guam. Results should also be of use to managers of other tropical forests, since many pioneer species in the tropics are dispersed by vertebrates, and enlarge our understanding of the potential environmental consequences of introducing species to new areas. The project will provide scientific training for Pacific Islanders and run a special, three-week course in island ecology for students from local colleges.

Award Abstract #1220529

Toward Predicting the Impact of Ocean Acidification on Net Calcification by a Bro

NSF Org:	OCE Division of Ocean Sciences
Initial Amendment Date:	September 20, 2012
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Award Number:	1220529
Award Instrument:	Standard Grant
Program Manager:	David L. Garrison OCE Division of Ocean Sciences GEO Directorate for Geosciences
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Expires:	August 31, 2015 (Estimated)
Awarded Amount to Date:	$695,322.00
Investigator(s):	Anne Cohen acohen@whoi.edu (Principal Investigator) Steven Lentz (Co-Principal Investigator) Kathryn Shamberger (Co-Principal Investigator)
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NSF Program(s):	CRI-OA
Program Reference Code(s):	1382, 4444, 9169
Program Element Code(s):	8001

ABSTRACT - Toward Predicting the Impact of Ocean Acidification on Net Calcification by a Broad Range of Coral Reef Ecosystems: Identifying Patterns and Underlying Causes

Intellectual Merit: Much of our understanding of the impact of ocean acidification on coral reef calcification comes from laboratory manipulation experiments in which reef organisms are removed from their natural habitat and reared under conditions of calcium carbonate saturation (Omega) predicted for the tropical oceans at the end of this century. By comparison, there is a paucity of in situ data describing the sensitivity of coral reef ecosystems to changes in calcium carbonate saturation. Yet emerging evidence suggests there may be critical differences between the calcification response of organisms in culture and the net calcification response of a coral reef ecosystem, to the same degree of change in calcium carbonate saturation. In the majority of cases, the sensitivity of net reef calcification to changing calcium carbonate saturation is more severe than laboratory manipulation experiments predict. Clearly, accurate predictions of the response of coral reef ecosystems to 21st century ocean acidification will

depend on a robust characterization of ecosystem-scale responses and an understanding of the fundamental processes that shape them. Using existing data, the investigators show that the sensitivity of coral reef ecosystem calcification to Delta calcium carbonate saturation conforms to the empirical rate equation R=k(Aragonite saturation state -1)n, which also describes the relationship between the rate of net abiogenic CaCO3 precipitation (R) and the degree of aragonite supersaturation (Aragonite saturation state-1). By implication, the net ecosystem calcification (NEC) response to ocean acidification is governed by fundamental laws of physical chemistry and is potentially predictable across space and time. When viewed this way, the existing, albeit sparse, dataset of NEC reveals distinct patterns that, if verified, have important implications for how different coral reef ecosystems will respond to 21st century ocean acidification. The investigators have outlined a research program designed to build on this proposition. The project expands the currently sparse dataset of ecosystem-scale observations at four strategically placed reef sites, enabling us to test the following hypotheses: 1. The sensitivity ("n" in the rate equation) of coral reef ecosystem calcification to Delta Aragonite saturation state decreases with decreasing Aragonite saturation state. By implication, the rate at which reef calcification declines will slow as ocean acidification progresses over the course of this century. 2. The energetic status of the calcifying community is a key determinant of absolute rates of net ecosystem calcification ("k" in the rate equation), which, combined with n, defines the Aragonite saturation state value at which NEC approaches zero. By implication, the shift from net calcification to net dissolution will be delayed in healthy, energetically replete coral reef ecosystems and accelerated in perturbed, energetically depleted ecosystems. 3. The calcification response of individual colonies of dominant reef calcifiers (corals and algae) is weaker than the measured ecosystem-scale response to the same change in Aragonite saturation state. By implication, processes not adequately captured in laboratory experiments, such as bioerosion and dissolution, will play an important role in the coral reef response to ocean acidification.

Broader Impacts: Ocean acidification threatens the livelihoods of 500 million people worldwide who depend on coral reefs to provide habitable and agricultural land, food, building materials, coastal protection and income from tourism. Yet data emerging from ocean acidification (OA) studies point to critical gaps in our knowledge of reef ecosystem-scale responses to OA that currently limit our ability to predict the timing and severity of its impact on different reefs in different parts of the world. Using existing data generated by the investigators and others, this project will address a series of related hypotheses, which, if verified by the research, will have an immediate, direct impact on predictions of coral reef resilience in a high CO2 world. This project brings together expertise in coral reef biogeochemistry, chemical oceanography and physical oceanography to focus on a problem that has enormous societal, economic and conservation relevance. Support is provided for a young investigator, undergraduate and minority student will participate in research through the WHOI Summer Fellowship Program, the Woods Hole Sea Education Association and PEP programs, and a burgeoning collaboration will be enhanced between the PIs and Pacific Island conservation groups and stakeholders whose goal it is to ensure that conservation decisions are grounded in scientific data. Results of the study will be presented at national and international meetings and workshops and disseminated in a timely manner through peer-reviewed publications. All data produced through this program will be archived in the Biological and Chemical Oceanographic Data Management Office (BCO-DMO) and the Pangaea Open Access library.