ANNUAL REPORT

Marine Science Institute | UC Santa Barbara

2013 2014

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Director's Statement

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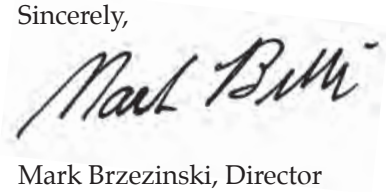
This year marks the 10th anniversary of the opening of the Marine Science Institute's Marine Science Research Building, a state-of-the-art facility located on the bluff overlooking the Pacific Ocean on the eastern edge of the University of California, Santa Barbara's campus. It is an inspiring facility and location, and it has taken the hard work of many individuals to make it a reality.
At UCSB in the 1980's and 1990's, Marine Science facilities could be described as dispersed, inadequate, and not up to the standards of a world class research institution. Long-standing efforts to get a facility approved and built had met with no success.

However, things began to change with the identification of a State of California program that provided a financing mechanism for research facilities dedicated to long-term scientific activities. After much hard work, the University of California's Office of the President in March 2000 approved the capital improvement project known as the Marine Science Research Building. A building would be built, but it would be paid for by a portion of the research dollars the UCSB Marine Science community received every year through competitive federal grant and contract awards.

In 2005 the nearly 40,000 square foot facility opened, on time and on budget. It features laboratory and office space, conference rooms and an auditorium, shared instrumentation facilities, and running sea water.

In the pages that follow, you have an opportunity to read about the many research projects administered by the Marine Science Institute. I would like to extend my thanks to the long list of researchers who contribute so much to the University of California, Santa Barbara campus, with special thanks for their vision, tenacity, and commitment that resulted in the Marine Science Research Building.

Sincerely,

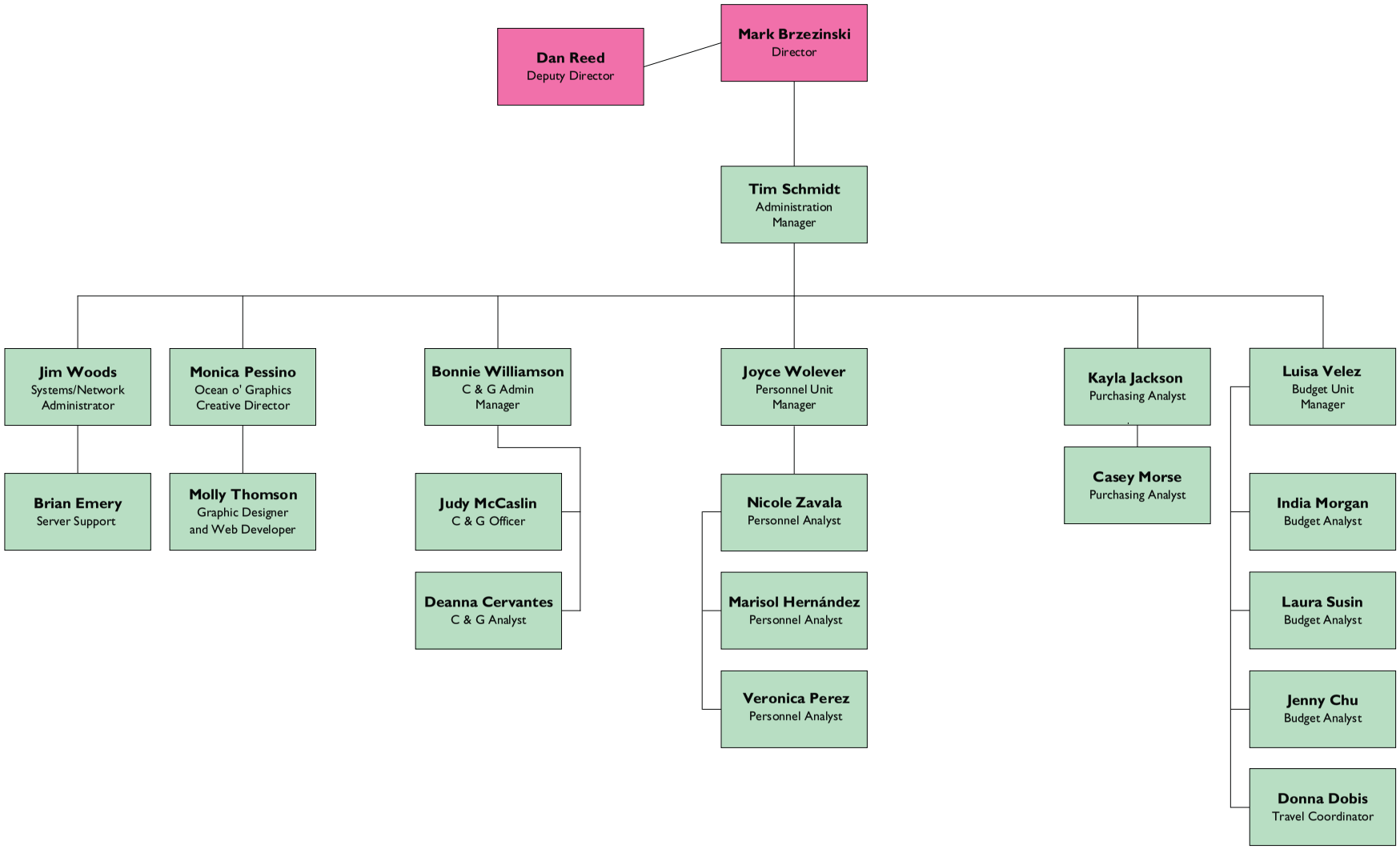


Mark Brzezinski, Director
Marine Science Institute

Organizational Charts

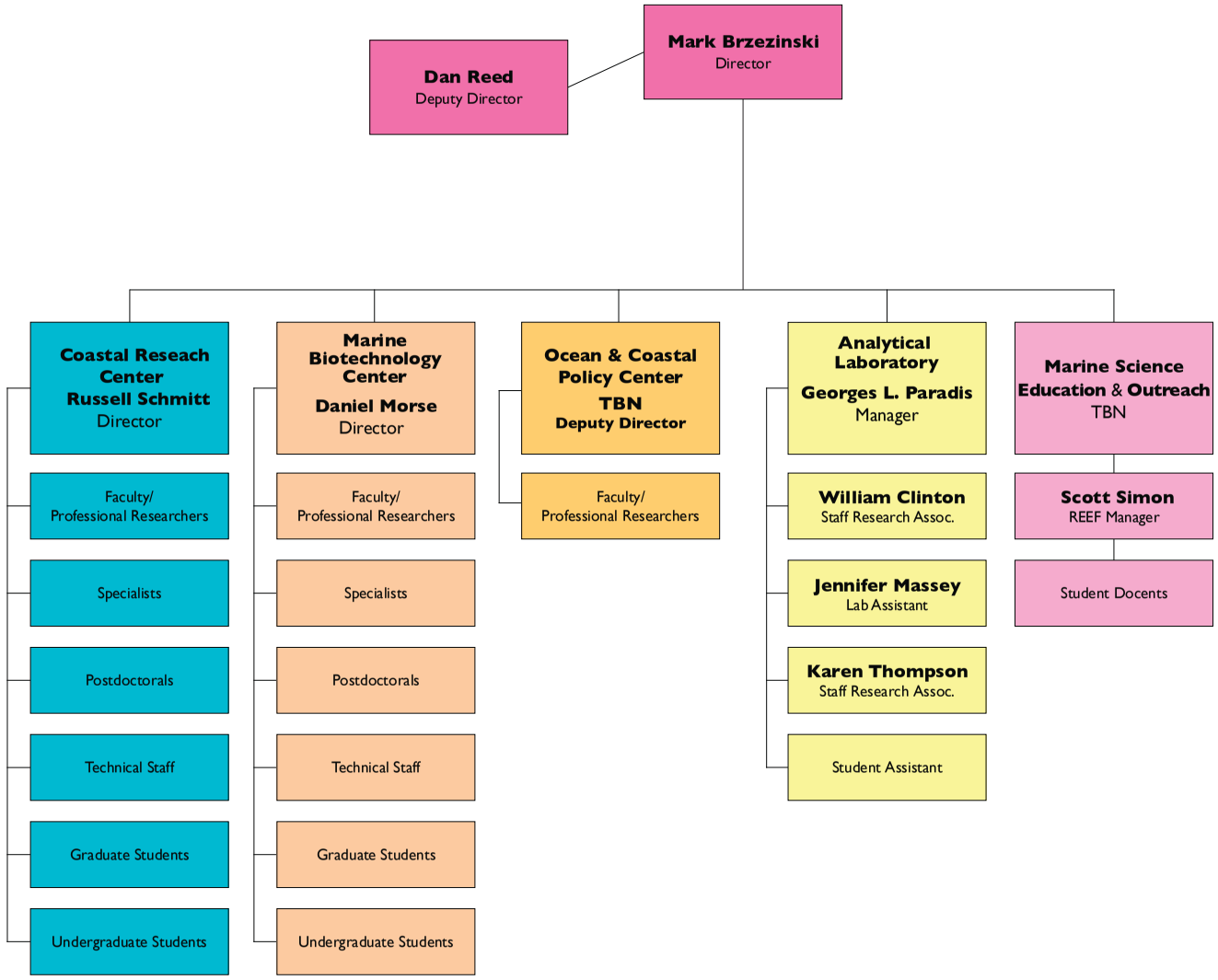
MARINE SCIENCE INSTITUTE

2013–2014 ORGANIZATIONAL CHART



MARINE SCIENCE INSTITUTE

2013–2014 ORGANIZATIONAL CHART



Other Projects & Activities

Seminars, Workshops, Conferences, and Meetings July 1, 2013–June 30, 2014

The Marine Science Institute continues to support various seminars, workshops, conferences and meetings. During the 2013-2014 fiscal year 115 events took place, in which a wide range of marine science topics were highlighted.

Dates	Coordinators	Topic
June 19–July 10, 2013	Stephanie Hampton	NCEAS Summer Institute (Training Workshop)
June 28–July 3, 2103	Chris Costello, Steve Gaines	Fish Forever Site Planning Meeting
July 1, 2013	Mark Page, Dan Reed, Steve Schroeter	San Onofre Nuclear Generating Station Mitigation Project Monitoring Scientific Advisory Panel Meeting
July 2–3, 2013	Scott Simon	Ocean for Life teacher workshop
July 12, 2013	David Marsh	Roads, toads, and nodes: Linking undergraduate ecology Courses to study the impacts of land amphibian populations (Roundtable discussion)
July 8–13, 2013	Jane Shevtsov	Synthesizing top-down and bottom-up approaches to ecological energetics (Working Group)
July 10, 2013	Carol Blanchette	Santa Barbara Educators Roundtable
July 11, 2013	Russell Schmitt	Moorea Coral Reef LTER Graduate Student Poster Session
July 19, 2013	Stephanie Hampton	Collected wisdom on great seminars (from Tewksbury Lab: http://tewksburylab.org/blog/) (Roundtable discussion)
July 24–26, 2013	Scott Simon, Carol Blanchette, Michele Johnson	Math and Science Partnership/ Santa Barbara County Teacher Professional Development workshop
July 24–26, 2013	Leah Gerber	Developing comprehensive management models for marine mammals (Working Group)
August 1, 2013	Margaret O'Brien	LTER IT working group
August 8, 2013	Margaret O'Brien	LTER IT working group

* Non-UCSB personnel

August 12, 2013	Carrie Culver	Collaborative At-Sea Sampling Program Workshop
August 13–14, 2013	Matt Jones, Mark Schildhauer	Conceptualizing an Institute for Sustainable Earth and Environmental Software (ISEES) (Workshop)
August 15, 2013	Matt Jones	Conceptualizing an Institute for Sustainable Earth and Environmental Software (ISEES steering committee)
August 20–22, 2013	Dean Urban, Patrick Comer, Lydia Olander	A standard assessment framework for ecosystem services (Working Group)
August 26, 2013	Monique Myers	Santa Barbara Area Coastal Ecosystem Vulnerability working group
August 26–28, 2013	William Andregg, Rosie Fisher, Jeffrey Hicke	Synthesizing frontiers in modeling drought- and insect-induced tree mortality with climate change (Working Group)
September–2, 2013	Eric Cardenas, David Fortson	Communicating conservation science to non-scientists: Strategies and practices (Roundtable discussion)
September 6–8, 2013	Stephen Hubbell, Richard Condit, Thorsten Wiegand, Fangliang He	Dance with neighbors: What have we learned about species coexistence in tree communities from the global stem-mapped forest plots (Working Group)
September 9–11, 2013	Leah Gerber	Developing comprehensive management models for marine mammals (Working Group)
September 9–13, 2013	Matthew Bonds, Nita Bharti, Andrew Dobson	Venture: Understanding how land-use change impacts the dynamics of vector-borne and water borne infectious disease of humans and domestic livestock (Working Group)
September 10–12, 2013	Matt Jones, Mark Schildhauer	Conceptualizing an Institute for Sustainable Earth and Environmental Software (ISEES) (Workshop)
September 12, 2013	Matt Jones, Mark Schildhauer	Conceptualizing an Institute for Sustainable Earth and Environmental Software, Visioning Meeting (ISEES steering committee)

* Non-UCSB personnel

September 12–15, 2013	Jamie Voyles, Cheryl Briggs, Marm Kilpatrick	Fungal pathogens and disease-induced extinction: Are fungal diseases different? (Working Group)
September 13, 2013	Dieter Lukas	Discussion: How to find data (Roundtable discussion)
September 18, 2013	Mark Browne	Benign by design: Fabrics with minimal impact (Roundtable discussion)
September 24, 2013	Giulia Piovan	Get a WiSE Start (Women in Science and Engineering) Meeting
September 24–26, 2013	Craig Groves, Marana Varese, Michael Goulding	SNAP: Western Amazonia: Balancing Infrastructure Development among Conservation of Waters, Wetlands and Fisheries (Working Group)
September 25, 2013	Bertrand Lemasson	Using models and data to evaluate how selective attention influences social coordination and individual risk in animal groups (Roundtable discussion)
October 1, 2013	Frank Davis, Craig Groves	The Joint TNC-NCEAS-WCS SNAP Visioning and Planning Meeting
October 7–10, 2013	Kim Selkoe, Ben Halpern, Carrie Kappel	Ocean tipping points (Working Group)
October 9, 2013	Marcello Sano	Adapting down under: Climate change and coastal management in Australia (Roundtable discussion)
October 11–12, 2013	Scott Simon, Carol Blanchette, Michele Johnson	Math and Science Partnership / Santa Barbara County Teacher Professional Development workshop
October 16, 2013	Noah Molotch	Snowpack controls on mountain forest greening and gross primary productivity in the Southwestern U.S.
October, 16, 2013	Jenny Dugan	Meeting with Bureau of Ocean Energy Management, Pacific OCS Region Environmental Studies
October 17–18, 2013	Russell Schmitt, Sally Holbrook	Moorea Coral Reef LTER All-Scientists meeting
October 23–24, 2013	Ruth Gates, Mark Schildhauer	Developing a community vision of cyberinfrastructure needs for coral reef systems science (Workshop)

* Non-UCSB personnel

October 28–30, 2013	Jane Carter Ingram, Michael Beck	SNAP: Integrating natural defenses into coastal disaster risk reduction (Working Group)
October 30, 2013	Kara Woo	Field Stories from Lake Baikal (Roundtable discussion)
November 1, 2013	Dan Reed	Santa Barbara Coastal LTER Annual All Scientists Meeting
November 5–8, 2013	Frank Davis	Marine debris: Scale and impact of trash in ocean ecosystems (Working Group)
November 5–7, 2013	Kim Selkoe, Ben Halpern, Carrie Kappel	Ocean tipping points (Working Group)
November 6, 2013	Frank Davis	From small beginnings: Linking mountain microclimates to tree species range shifts under regional climate change (Roundtable discussion)
November 12–14, 2013	Matt Jones, Mark Schildhauer	Conceptualizing an Institute for Sustainable Earth and Environmental Software (ISEES) (Working Group)
November 13, 2013	Richard Hutton, LeeAnne French	Blue Horizons: Using media to communicate vital stories of the global ocean (Roundtable discussion)
November 15, 17, 2013	Monique Myers	Research and Education for Students and Teachers about the Ormond Beach Restoration Project Teacher Workshop
November 20, 2013	Mary Hunsicker	An overview of the Ocean Tipping Points project (Roundtable discussion)
November 22, 2013	Chris Costello	West Coast Groundfish Sea Grant Project Research Symposium
December 2–5, 2013	Craig Groves, Marana Varese, Michael Goulding	SNAP: Western Amazonia: Balancing Infrastructure Development among Conservation of Waters, Wetlands and Fisheries (Working Group)
December 5–6, 2013	Paul Berkman, Frank Davis, Jean-Claude Gascard, Oran Young, Christine Provost	Arctic options: Holistic integration for arctic coastal-marine sustainability (Working Group)
December 8–12, 2013	Chris Costello, Michaela Clemence	Fish Forever Science Team Strategy and planning meeting

* Non-UCSB personnel

December 11, 2013	LeeAnne French	Telling environmental stories with (Roundtable discussion)
December 13, 2013	Gretchen Hofmann	Ocean Science Trust group meeting
December 14, 2013	Stephanie Hampton	NCEAS Summer Institute, Urban Diversity Group
December 14, 2013	Stephanie Hampton	NCEAS Summer Institute, Ocean Health Expenses
December 18, 2013	Monique Myers	Researcher and Community Meeting of the Santa Barbara Area Coastal Ecosystem Vulnerability Assessment for Local Communities Project
December 18, 2013	Steven Courtney, Frank Davis	Peer Review Process Associated with the Proposed Rule to list the Mexican Wolf as an Endangered Subspecies and Delist the Gray Wolf Elsewhere (Working Group)
December 20, 2013	Mark Page, Dan Reed, Steve Schroeter	San Onofre Nuclear Generating Station Mitigation Project Monitoring Scientific Advisory Panel Meeting
January 8, 2014	Stacy Rebich Hespanha	Discussion on the environmental ethics of research travel (Roundtable discussion)
January 10–12, 2014	Steve Gaines	Gaines Lab Retreat, Rancho Marino
January 29, 2014	Dave Valentine	Valentine Lab Annual meeting with funding agencies
January 30–31, 2014	Carol Blanchette, Jennifer Caselle	South Coast MPA (Marine Protected Area) Data Integration Workshop
February 2–3, 2014	Matt Jones, Mark Schildhauer	Conceptualizing an Institute for Sustainable Earth and Environmental Software, Visioning Meeting (ISEES steering committee)
February 4–5, 2014	Dave Valentine	Science plan collaboration meeting with ExxonMobil Scientists
February 5, 2014	Jill Murray, City of Santa Barbara Creeks Division	Applied research in the City of Santa Barbara Creeks Division (Roundtable discussion)
February 5–7, 2014	Scott Collins, Matt Jones, Corinna Gries	ABI Development: A toolbox for analysis of long-term ecological dynamics using the Kepler Workflow System (Workshop)

* Non-UCSB personnel

February 10–14, 2014	Craig Groves, Mariana Varese, Michael Goulding	SNAP: Western Amazonia: Balancing Infrastructure Development among Conservation of Waters, Wetlands and Fisheries (Working Group)
February 12, 2014	Oran Young	Arctic options: Holistic integration for Arctic coastal-marine sustainability (Roundtable discussion)
February 14, 2014	Russell Schmitt, Sally Holbrook	MCR-LTER Research Planning Group
February 19, 2014	Siddharth Narayan	More about me and the traveling engineer problem (Roundtable discussion)
February 28, 2014	Stacy Rebich Hespanha, Mary Hunsicker	Using virtual collaboration to replace or supplement carbon-intensive research travel: Barriers, best practices, and opportunities for innovation (Roundtable discussion)
February 28, 2014	Paul Berkman, Frank Davis, Jean-Claude Gascard, Oran Young, Christine Provost	Arctic options: Holistic integration for arctic coastal-marine sustainability (Polar Code Workshop)
March 27–28, 2014	Elizabeth Tellman, Joshua Goldstein	SNAP: Prioritizing investments in a green infrastructure to meet urban water security needs in Latin America
April 5–7, 2014	Mark Brzezinski	OCTOS Focus Groups and Planning
April 7–11, 2014	Craig Groves, Mariana Varese, Michael Goulding	SNAP: Western Amazonia: Balancing Infrastructure Development among Conservation of Waters, Wetlands and Fisheries (Working Group)
April 9, 2014	Jessica Couture, Morgan Visalli	Fish scraps to food: New markets in Mexican artisanal fishing communities (Roundtable discussion)
April 11–13, 2014	Stephanie Hampton, David Marsh	Toads, roads, and nodes: Collaborative course-based research on the landscape ecology of amphibian populations (Distributed Graduate Seminar)
April 12–14, 2014	Carrie Culver	Quagga Mussel Management at Lake Piru

* Non-UCSB personnel

April 18, 2014	Jono Wilson	Managing data limited fisheries for biological and economic objectives
April 19, 2014	Nancy Baron, COMPASS	Writing op-eds: Your informed argument (Roundtable discussion)
April 22, 2014	Carrie Culver	CASP Workshop on Collaborative At Sea Data Collection
April 23, 2014	Alisan Amrhein, Tinya Hoang, Rahul Madhusudanan	Offshore wind energy in the context of multiple ocean uses on the Bermuda platform (Roundtable discussion)
April 22-24, 2014	Jane Carter Ingram, Michael Beck	SNAP: Integrating natural defenses into coastal disaster risk reduction (Working Group)
April 26, 2014	Scott Simon	R.E.E.F. tours for All Gaucho Reunion
April 27–28, 2014	Carrie Culver	Quagga Mussel Management at Lake Piru
April 28-30, 2014	Chris Costello, Michaela Clemence	Fish Forever Science Team strategy and planning meeting
May 6-8, 2014	Jeremy Rude, Carmen Revenga, Jono Wilson	SNAP: Managing Data Limited Fisheries for Economic and Biological Objectives (Working Group)
May 12-14, 2014	Anne Trainor, Joseph Ryan, Sharon Baruch-Mordo, Joseph Fargione	SNAP: Impacts of hydraulic fracturing on water quantity and quality for nature and people: Are we prepared for the future? (Working Group)
May 14-15, 2014	Ben Halpern	Baltic Ocean Health Index meeting
May 20–23, 2014	Kim Selkoe, Ben Halpern, Carrie Kappel	Ocean tipping points (Working Group)
May 20, 2014	Mark Brzezinski	OCTOS Strategic Planning steering committee meeting
June 5, 2014	Daniel Reed, Lindsay Marks	Sargassum horneri Workshop
June 6–9, 2014	Carrie Culver	Quagga Mussel Management at Lake Piru
June 10–12, 2014	Kim Selkoe, Ben Halpern, Carrie Kappel	Ocean tipping points (Working Group)
June 12, 2014	Steve Gaines	Land versus sea: Do the oceans offer the most sustainable way to feed the world? (Roundtable discussion)

* Non-UCSB personnel

June 16–20, 2014	Carol Blanchette, Scott Simon, Michele Johnson	Math Science Partnership Teacher Professional Development Workshop
June 16–20, 2014	Gretchen Hofmann	CIRCAS (Cruise for Acidification Studies) working meetings
June 18, 2014	Stephanie Pau	The response of tropical forests to changes in cloud cover (Roundtable discussion)
June 25, 2014	Ben Best	Reproducible science for the Ocean Health Index (Roundtable discussion)

* Non-UCSB personnel

Coastal Research Center

The Coastal Research Center is an organizational unit within the Marine Science Institute at UCSB. The central theme of the Center is to develop scientific knowledge to gain a more complete understanding of coastal and island ecosystems, which is necessary for sound management of the natural resources within coastal and island regions. The Center links academic scientists from a wide variety of disciplines, enhancing the ability to address marine environmental issues.

While CRC scientists work in marine environments throughout the world, much effort is focused on coastal reefs found in the Santa Barbara Channel region and the coral reefs surrounding the island of Moorea, French Polynesia. These two locations provide excellent model systems for the scientific exploration of a wide range of marine issues and scientists at UCSB have long valued these environments as natural laboratories for scientific study. Both areas are enjoyed by those seeking recreation, support important local fisheries and are faced with growing conflicts amongst different user groups as human population pressures increase, a trend that is common for many marine environments. The nearshore marine environments of California and the islands of French Polynesia are used increasingly as a disposal site for waste products. Renewed exploitation of oil and natural gas reserves has augmented the number of conflicting demands placed upon the Channel resources, while issues related to global climate change have increased concerns about the sustainability of coral reef ecosystems. Local issues related to the sustainability of commercial and sport fisheries in both regions mirror global concerns regarding management of exploited stocks. The cumulative effects of human activities on the natural resources of both of these regions are just beginning to be understood. It is imperative that we learn how to balance the multiple uses of nearshore ocean waters in an environmentally sound manner. Lessons learned by scientists in the Coastal Research Center have wide implications for understanding and resolving present and future problems, and will help local, regional and national regulators develop better management policies.

Development of sound management plans for areas such as the Santa Barbara Channel or the islands of French Polynesia is hampered by scientific uncertainty about the consequences of human activities. To understand and predict natural and anthropogenic disturbances, synthesis of new and existing knowledge of many scientific aspects of coastal marine systems - including biology, ecology, genetics, geology, chemistry and oceanography - will be necessary. Further, the development of new approaches and the use of emerging technologies are needed to resolve fundamental questions, some of which have remained unanswered for many years. Only with these advances will it be possible to make reliable predictions about the consequences of various activities, to develop the ability to restore degraded habitats and conserve valuable resources, and to foster development of environmentally sound policies for use of coastal or island regions in general.

The Center has four major objectives:

- To act as a center for production and integration of basic scientific information to more fully understand coastal and island ecosystems and their natural and exploited populations.
- To evaluate and predict effects of human activities on the marine environment, and to develop measures to ameliorate lost or degraded natural resources.
- To train students in basic research on marine environmental issues that may be applicable to decision-makers.
- To facilitate and promote interdisciplinary research initiatives.

Faculty/Professional Research Participants:

Russell J. Schmitt, Director and Professor of Biology

Alice Alldredge, Professor of Biological Oceanography

Giacomo Bernardi, Professor of Molecular Ecology (UCSC)

Andrew Brooks, Associate Project Scientist

Mark Brzezinski, Professor of Biology

Alison Butler, Professor of Chemistry

Bradley Cardinale, Assistant Professor of Biology

Craig Carlson, Associate Professor of Biology

Robert C. Carpenter, Professor of Biology (CSU-Northridge)

Joseph H. Connell, Research Professor of Zoology

Jenifer E. Dugan, Associate Research Biologist

Peter J. Edmunds, Professor of Biology (CSU-Northridge)

John M. Engle, Associate Research Biologist

A. Russell Flegal, Professor of Environmental Toxicology (UCSC)

Steven D. Gaines, Professor of Biology

Ruth D. Gates, Assistant Research Biologist (University of Hawaii)

Scott Hodges, Professor of Biology

Gretchen Hofmann, Associate Professor of Biology

Sally J. Holbrook, Professor of Biology

Evelyn Hu, Professor of Electrical and Computer Engineering

Ronald Iltis, Professor of Electrical and Computer Engineering

Robert Jacobs, Professor of Biology

Ryan Kastner, Assistant Professor of Electrical and Computer Engineering

Michael I. Latz, Research Biologist, (Scripps -UCSD)

David Lea, Professor of Geology

Hua Lee, Professor of Electrical and Computer Engineering

James J. Leichter, Associate Professor of Oceanography, (Scripps -UCSD)

Hunter Lenihan, Associate Professor of Environmental Science

Milton Love, Research Biologist

Sally MacIntyre, Professor of Limnology and Oceanography

Stéphane Maritorena, Associate Researcher

John Melack, Professor of Biology

Daniel Morse, Professor of Biology

Erik Muller, Assistant Research Biologist

Roger M. Nisbet, Professor of Biology

Henry M. Page, Associate Research Biologist

Daniel C. Reed, Research Biologist

Stephen C. Schroeter, Research Biologist

Hannah Stewart, Postdoctoral Researcher (Un. Washington)

Allan Stewart-Oaten, Professor of Biology

David Valentine, Assistant Professor of Geological Sciences

Libe Washburn, Professor of Geography

Allison Whitmer, Assistant Dean (Georgetown University)

Susan Williams, Professor of Environmental Science and Policy (UCD)

Leslie Wilson, Professor of Biology

EcoInformatics Center

Extensive research directed toward identifying and understanding the natural world has been conducted, leading to the acquisition of monumental amounts of data. Yet, due to the ways in which these data are managed, only a small amount of it is readily available to researchers, including those who gathered it, after a very short period of time. The lack of ready access to information is not surprising for data collected by past generations of scientists, but access is typically impossible even for information garnered within the lifetime of the youngest ecologist, or even within the last five years. In fact, it will be true tomorrow for data gathered today. The unfortunate circumstance is that despite many years and dollars spent in pursuit of useful information about the environment, preservation and reuse of that data has not been a priority. As a consequence, environmental data are distributed widely across institutions, are not standardized in content and format, and typically undocumented. As a result, ecologists are now limited not only by a lack of information, but also by an inability to access the vast amount of data that has been collected.

The EcoInformatics Center (EIC) was established in July 2003 to address this situation by making what is already known about the environment available to potential users, from students and scientists to resource managers, regional planners, and policy makers. The EIC involves both the technical and human aspects of data acquisition, sharing, preservation, and utilization.

The EIC resides under the Marine Science Institute and is a partner Center to the National Center for Ecological Analysis and Synthesis (NCEAS). Approaches developed at NCEAS are being used to identify, develop, and test emerging concepts, technologies, and software.

The Mission of the EIC is to:

- Develop and deploy cutting edge technology to generate an Ecological Information Access System to locate and utilize the dispersed and heterogeneous information that characterizes data pertinent to ecological and environmental issues.
- Extend core data-access capabilities by developing and distributing contemporary information tools for scientists, students, conservationists, resource managers, policy makers, and planners.

To accomplish this mission, the EIC is composed of the following elements:

1. Research and software development to promote data acquisition, distributed access, and long term storage and archiving.
2. Analyses of the cultural and sociological aspects of information sharing
3. Training of students and scientists in the use of data management tools

Information is the raw material of knowledge. The research enterprise is designed to generate information – data – and facilitate its incorporation into higher order understanding and true knowledge of the system under consideration. Information has accumulated in a somewhat haphazard way for centuries. In certain focused areas, such as medicine, basic information has been turned into operational outcomes (diagnoses, treatments, pharmaceuticals) that have benefited humans. However, the geometric increase in information, and its availability in machine form, have made the amount of accessible information overwhelming; unfortunately it has not led to a commensurate increase in knowledge in most fields.

This is particularly true for ecological information, which is important for advancing the basic understanding of natural systems and for making wise management and policy decisions about natural resources. Within the universe of information, ecological data may be as dispersed and heterogeneous as any of interest to scientists and other users. Decisions commonly depend on integrating data as diverse as climatological records, spatial distributions of organisms, changes in biodiversity over space and time, responses of species to experimental manipulations, genetic structure of populations, patterns of human alterations of ecosystems, and much more. The scope of information needed to understand ecological systems is enormous.

Ecological information is inherently diverse, and it grows more diverse each day as new types of relevant information emerge. As a result, a database designed for today would be exceedingly complex, and it would be outdated long before it could ever be developed. Thus, the environment needs a different data management model that provides generic access to information in place of a uniform database structure. Rather than creating a single, fixed data schema, the solution lies in an approach analogous to the Internet that standardizes how information is characterized (through metadata, or information about the data itself). Information, once characterized with metadata, can be made accessible in context-dependent ways that are both comprehensive and efficient. The key tools are an efficient, flexible, and standardized way to describe ecological information, and a powerful information searching capability.

The primary faculty and research scientists associated with the Center include:

Dr. Richard Appelbaum, Department of Sociology and Director, Institute for Social, Behavioral, and Economic Research
Dr. Steven Gaines, Department of Ecology, Evolution, and Marine Biology and Director, Marine Science Institute
Mr. Matthew Jones, Director of Informatics Research and Development, National Center for Ecological Analysis and Synthesis
Mr. Chris Jones, Information Systems Coordinator, Marine Science Institute
Dr. Dan Reed, Research Biologist, Marine Science Institute
Dr. O. J. Reichman, Department of Ecology, Evolution, and Marine Biology and Director, National Center for Ecological Analysis and Synthesis
Dr. Mark Schildhauer, Director of Computing, National Center for Ecological Analysis and Synthesis
Dr. Robert Warner, Department of Ecology, Evolution, and Marine Biology

Marine Biotechnology Center

UCSB is recognized internationally for its leadership in Marine Biotechnology. This exciting field uses the latest breakthroughs in modern molecular biology, genetic engineering and cell science to solve basic problems in marine resource biology; to improve the production of medical, chemical, food, and energy resources from the ocean; and to develop new products and industries based on more efficient use of the ocean's resources.

The Marine Biotechnology Center is unique in the University of California system. It helps coordinate fifteen different research programs in this area at UCSB, and helps obtain funding for the vitally needed practical training of advanced students and professionals to help meet the future needs and changing requirements of the nation's marine and biotechnology industries. Close interactions with California's biotechnology, aquaculture and pharmaceutical industries provide new products and highly trained scientific personnel to the industrial sector, and provide support from industry for research and training in the University. The state-of-the-art Marine Biotechnology Laboratory Building - the first such facility of its kind in the United States - provides facilities needed to accommodate the rapid growth of research and teaching in Marine Biotechnology on the campus.

Research and training in Marine Biotechnology are focused at UCSB in three inter-related areas: (1) the development of new methods and approaches from molecular and cellular biology to investigate the basic mechanisms controlling life in the oceans and its responses to environmental change; (2) the development of new industries, resources and products from the oceans; and (3) the use of marine organisms as models for biomedical research. Recent progress in these areas is summarized below.

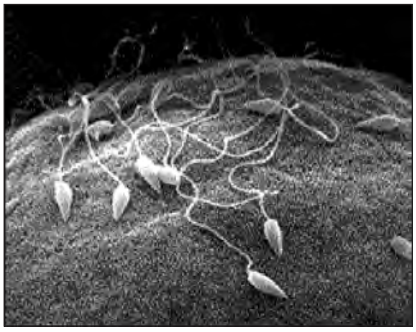
UCSB scientists are using the tools of biotechnology to unravel the ocean's mysteries in environments as diverse as the Antarctic, tropical seas and reefs, the great ocean depths, and California's resource-rich coastline. These investigations include pioneering studies of the molecular mechanisms of photosynthesis and carbon dioxide fixation by the ocean's phytoplankton, effects on these processes caused by the depletion of ozone in the Antarctic atmosphere, and effects of global warming, pollution and other environmental changes. UCSB scientists and students have discovered receptor molecules and chemical signals that control life in the ocean. The discovery of these signals, and of the receptors, transducing molecules and genes that respond to these signals, has shed new light on the underlying processes regulating the reproduction, development and growth of species ranging from tropical corals to valuable marine resources (urchins and abalones) in California waters and around the world.

Researchers in the Marine Biotechnology Center are developing the tools and techniques of molecular and cellular biology to better understand the biodiversity of marine organisms, and how they affect, and are affected by, physical, chemical and geochemical oceanic processes. Marine biota, particularly the microscopic plankton, are dominant mediators of geochemical change on Earth, yet the genetic diversity, abundance and function of these microorganisms in complex communities is still not completely understood. Researchers at the Marine Biotechnology Center are developing new ways to monitor these microscopic communities, and are discovering previously unsuspected diversity and population structure in globally distributed marine microbial populations.

Research at UCSB in the development of new products and industries from marine resources has led to the discovery of promising new diagnostic and therapeutic agents for diseases including cancer, arthritis, epilepsy and Alzheimer's disease, and the development of powerful new enzyme catalysts, novel bioadhesives, and marine microorganisms capable of degrading and detoxifying chlorinated hydrocarbons and other pollutants. Members of the Marine Biotechnology Center are working with researchers in Chemistry, Physics and Engineering through UCSB's new Army-supported Institute for Collaborative Biotechnologies, and through the NSF-sponsored National Materials Research

Laboratory, the California NanoSystems Institute, NIH's Bioengineering Consortium Program, and NASA's Biomolecular Materials program to develop valuable new materials based on the structures made by marine organisms which exhibit exceptional strength, resiliency, hardness and enhanced electrical and optical performance. With the help of the marine biotechnologists' skills in genetic and protein analysis and engineering, and close collaborations with colleagues in Chemistry, Physics and Engineering, the fundamental molecular structures and mechanisms underlying the enhanced performance of these natural materials made by marine organisms are being revealed, and translated into practical engineering solutions for the development of novel advanced materials. Teams are working with experts in the Department of Electrical and Computer Engineering to harness the mechanisms of low-temperature catalysis and molecular recognition of proteins that direct biomineralization in marine organisms to help direct the nanoscale fabrication of ultra-small crystals used for magnetic information storage and semiconductors, to help reduce the size and defect-density of electronic components, and to make new photovoltaic materials with improved efficiency to harness the sun's energy. A new generation of tough, water resistant adhesives and coatings has been inspired by sessile intertidal invertebrates, and the fangs and beaks of marine polychaetes and squids are the pointing the way to new lightweight polymeric materials with the hardness and wear resistance usually associated with ceramics. Research aimed at practical applications with economic value also has led to improvements in the economic efficiency and yield of cultivation of valuable marine fish, shellfish and plants grown for food and pharmaceuticals. These findings have led directly to the growth of new and "environmentally friendly" industries in Santa Barbara that now are producing abalones, urchins and marine algae using innovations in aquaculture technology developed at UCSB.

Research using marine organisms as model systems for biomedical research has led to a host of new and far-reaching discoveries at UCSB. Many marine invertebrates, because of their relatively simple design, and the ease of their maintenance and analysis in the laboratory, have provided a rich source of new information and serve as desirable, non-mammalian models for research. A major area of emphasis is in regard to the genetic control of normal development and of tumor formation. Professor Kathleen Foltz and her students make use of marine model systems to investigate fundamental questions of reproductive biology, cell cycle control, and early development. They discovered that the molecular recognition processes controlling oocyte maturation and fertilization are highly conserved across species; information gained from studying the eggs and embryos of many marine invertebrates (such as sea urchins, sea stars and sea squirts) can be applied to other animals, including mammals. This research group has been actively involved in the Genome Sequencing Project for the California Purple Sea Urchin, *Strongylocentrotus purpuratus*. Their team is part of an international consortium that completed the first echinoderm genome sequence. The information gained from this genome project is being used to identify and understand the gene networks that regulate early development, and to investigate the evolutionary underpinnings of animal development. The Foltz research team is using the genomic information to describe the egg "proteome" – the identification of all of the proteins present in the egg – and to study their regulation in the first few minutes of fertilization and during the egg to embryo transition. Using a functional proteomics approach, over 250 sea urchin egg proteins that undergo modifications at fertilization have been identified. Most of these proteins are conserved in mammals and thus may provide insight into fertility and contraception.



High-magnification electron micrograph of sea urchin sperm fertilizing an egg

Another important area of research is water resistant adhesion. Water is the nemesis of practical adhesive bonding, yet the rocky intertidal seashore is home to a host of organisms that spend their lives attached to solid surfaces surrounded and assaulted by water and waves. Professor Waite and his students discovered that the amino acid known as Dopa is a key to the remarkable underwater adhesion in mussels and sandcastle worms. In related studies, discoveries first made at UCSB on the biological mechanisms controlling the nanofabrication and toughness of the abalone shell have now been extended by Professor Paul Hansma and his students to human bone, with profound implications for diseases such as osteoporosis and arthritis.

National Center for Ecological Analysis and Synthesis
July 1, 2013 – June 30, 2014

The National Center for Ecological Analysis and Synthesis (NCEAS) was created in May 1995 with funding from NSF, the State of California, and UCSB. The Center focuses on the use of collaborative and synthetic approaches to solve fundamental ecological and environmental problems, and emphasizes application of up-to-date analytical and informatics tools to existing data sets and the development of new modeling approaches. NCEAS (http://www.nceas.ucsb.edu/) is associated with the Marine Science Institute and is located in downtown Santa Barbara. Frank Davis is NCEAS' Director, Stephanie Hampton is the Deputy Director, Mark Schildhauer is the Director of Computing, and Matt Jones is Director of Informatics Research and Development.

The Science Advisory Board (SAB) of 18 eminent ecologists met October 3-4, 2012 to provide guidance on the Center's mission and research directions.

Research activities focus on working groups, sabbatical fellows, postdoctoral associates, distributed graduate seminars and graduate student internships. During the 2012-2013 fiscal year, NCEAS hosted 5 meetings, 18 working group projects, and 3 training workshops. In addition, the Center hosted 3 Sabbatical Fellows, 12 Postdoctoral Associates, 8 Center Associates, 5 graduate student interns, and one undergraduate intern.

NCEAS activities involve important topics in ecology and allied disciplines such as analysis of large scale processes, complex population dynamics, ecological community dynamics, analysis of broad biogeographical patterns, development of new analytical and statistical methods, projects related to resource management, and ecological informatics. Several projects have involved areas outside the core of ecology, such as human cultural diversity, sociology of scientific collaboration, and urban ecology.

The Gordon and Betty Moore Foundation is supporting a project "Identifying Thresholds, developing key indicators, and operationalizing their use in Coastal and Marine Spatial Planning" which will support several postdocs and working groups to pursue research at NCEAS.

The David and Lucille Packard Foundation continue to fund Working Groups and postdoctoral fellows focused on a critical review of ecosystem-based management (EBM) efforts relevant to coastal-marine ecosystems and to design a longer-term program of activities to develop the scientific foundations for EBM in coastal marine systems. Packard EBM awards include a project which emphasizes making scientific results more available and useful for policymakers and also will support a summer training initiative for early-career researchers in 2013.

In summer 2012, NCEAS completed work on a project supported by The Nature Conservancy, in which we assembled Working Groups to examine the economic impacts of non-native forest pests and pathogens in North America; previous phases of the project included support for postdoctoral researchers, a distributed graduate seminar, and a graduate student.

NOAA is a co-supporter of a CAMEO (NSF-NOAA) collaboration to examine natural and human influences on coral reef community structure, diversity, and resilience, a project involving technicians who collaborate with a postdoctoral researcher.

An award from Conservation International convenes experts to develop rigorous and transparent indices of "ocean health" to guide and influence science and policy at national and international levels. Professional, postdoctoral, graduate student and high school researchers have been supported on this award.

The Ocean Conservancy supports a postdoc and working group to examine the impacts of marine

debris on ocean ecosystems, and to evaluate a suite of potential solutions.

NCEAS has become a leader in developing collaborations and technical solutions to overcome obstacles related to the dispersed and heterogeneous nature of ecological data. The Center has been involved with many collaborators to develop generic data access tools for more efficient and powerful analysis of ecological data by a broad user community, from student and resource managers to scientists. These ecoinformatics tools are reaching maturity and are being deployed in a number of settings; information about these tools can be found online at http://www.nceas.ucsb.edu/ecoinformatics.

NCEAS encourages wide dissemination of Center-related findings by providing press releases and interviews to popular media outlets, by maintaining a news feature and archive on our website, and using other web-based media, and by providing communications training for our scientists. NCEAS promotes interest in ecology and technology professions, particularly among underrepresented groups, provides outreach experiences to resident scientists, and fosters the inclusion of synthesis in ecology education.

NCEAS provides training opportunities for K-12, graduate school, and professionals. These include a successful Kids do Ecology program and bilingual website, as well as scientific computing and ecoinformatics workshops. The Center also hosted 31 Roundtable seminars this past year (formerly EcoLunch). These seminars are presented by resident and visiting scientists, and are open to the scientific community.

NCEAS relies almost exclusively on the Internet to disseminate Center-related information and findings, in addition to the usual peer-reviewed publications. The Center receives e-mail at nceas@nceas.ucsb.edu, and our website is http://www.nceas.ucsb.edu. The NCEAS home page provides interactive access to a large array of information, including summaries of current and pending research, descriptions of computing resources at NCEAS and elsewhere, funding and employment opportunities at NCEAS, ecological data archives, and NCEAS reports and publications.

Ocean and Coastal Policy Center

Ocean and coastal policy issues are becoming increasingly important in California, nationally, and internationally. The University of California, Santa Barbara is in a key position to make significant contributions in research and policy analyses of local, state, national, and international ocean management issues.

The need for programmatic attention on ocean and coastal policy in California has never been greater. California has one of the longest and most valuable coastlines in the nation. Offshore California, significant development of offshore resources takes place and the ocean and coastal zone are used, with increasing frequency, by a wide range of users - including offshore oil and gas extraction, recreation, marine transportation, fishing, and marine research. Offshore oil development and the attendant multiple-use controversies, in particular, have dramatized the need for better methods of ocean policy planning.

The Ocean and Coastal Policy Center (OCPC) is oriented toward problem-solving of significant coastal and ocean policy issues. Work at the center is interdisciplinary, involving perspectives from the different social science disciplines (broadly defined as political science, economics, law, history, anthropology, sociology, geography and aspects of environmental studies) and from the natural and physical sciences. In addition to interdisciplinary research, the Center engages in applied projects which directly relate research to specific marine policy problems. The OCPC is one of the few centers in California focusing on these issues.

Major themes of the center include:

- Coastal watershed management and ecosystem planning
- California marine and coastal policy
- Aquatic and marine biodiversity conservation policymaking
- Studies in ecological restoration

The OCPC has received support from the National Science Foundation, U.S. Department of the Interior, and other governmental agencies. The Center has also produced a "White Paper Series" that includes several essays devoted to ecological and policy-related activities of the Southern California Bight and associated coastal watersheds and wetlands. The special series is available on the center's webpage.

UC Natural Reserve System

The mission of the UC Natural Reserve System is to contribute to the understanding and wise management of the Earth and its natural systems by supporting university-level teaching, research, and public service at protected natural areas throughout California.

The University of California administers 35 natural reserves throughout the state which serve as outdoor classrooms and research laboratories for faculty, researchers, and college students in the field sciences and humanities. Community groups and K-12 classes also benefit from the reserve system through field trips and outreach programs. The reserves are natural areas that represent the ecological diversity of California. Most of the major habitats of California are included in the NRS. Each reserve is managed by a UC campus. UC Santa Barbara oversees seven of these reserve sites with habitats as diverse as coastal wetlands, coastal dunes, rocky intertidal, oak woodlands, grasslands, Monterey pine forest, island marine and terrestrial environments, and the mountain and Great Basin environments of the eastern Sierra. Unlike wilderness areas that are available for public recreation, the University reserves are devoted entirely to teaching and research. The reserves serve as "living laboratories," where researchers, teachers, and students can pose questions of the natural world that can only be answered by studying the natural environment. Access to the reserves is restricted to preserve their natural resources and provide security for long-term research and education projects.

- **Carpinteria Salt Marsh Reserve** is a significant coastal wetland reserve located 20 miles east of UCSB. It consists of 120 acres of south coast estuary, mudflats, beach and intertidal habitats, providing areas for studies on wildlife and fisheries biology, botany, and ornithology (site of several endangered species). The reserve is a part of the 230-acre Carpinteria Salt Marsh, one of the largest remaining coastal wetland habitats in southern California.

Reserve Staff
Andrew J. Brooks. Reserve Director
William Rice, Faculty Advisor

- **Coal Oil Point Natural Reserve** is located on the West Campus of UCSB and is composed of 158 acres of vulnerable and valuable coastal dunes, coastal terrace, south coastal estuarine lagoon, vernal pools, mudflats, beach and rocky intertidal habitats. It provides critical habitat for a number of endangered species including the Western Snowy Plover. This reserve is an ideal location for studies of migratory shorebirds and waterfowl, estuarine plants and animals, water quality and the impacts of human activities on coastal environments. Because of its close proximity to the main campus, the Coal Oil Point Natural Reserve provides a unique and accessible research and teaching resource.

Reserve Staff
Cristina Sandoval, Resident Reserve Director
Carla D'Antonio, Faculty Advisor

- **Kenneth S. Norris Rancho Marino Reserve** lies along the coast just south of Cambria. This 500 acre reserve offers access to offshore giant kelp forests, as well as a very diverse rocky shore. Important terrestrial natural resources include coastal terrace grassland and soft chaparral plant communities. The reserve contains the southern-most remnant of indigenous Monterey pine forest. Overnight facilities are available for research groups and university classes.

Reserve Staff
Don Canestro, Resident Reserve Director
Steven Gaines, Faculty Advisor

- **Santa Cruz Island Reserve,** located 24 miles offshore from Santa Barbara, comprises 46,020 acres of the largest and most topographically diverse of Southern California's offshore islands. Two thirds of the island is owned by The Nature Conservancy and remainder is part of the National Park Service. The island is used by the Natural Reserve System for research and environmental education under a long-term license agreement. The reserve field station is located in the center of the island and provides housing, laboratories, collections, information, a GIS database, and transportation to support research and teaching on and around Santa Cruz Island and neighboring islands in the Channel Island chain.

Reserve Staff
Lyndal Laughrin, Resident Reserve Director
Sally J. Holbrook, Faculty Advisor

- **Sedgwick Reserve** is located less than one hour from the UCSB campus and is an excellent natural study area for classes in biology, botany, zoology, geography, geology, anthropology, agroecology, and environmental studies. Situated in the Santa Ynez Valley, the 5,860 acre reserve includes coast live oak forest, blue oak woodland, valley oak savannah, Ceanothus chaparral, coastal sage scrub, grassland, and willow riparian forest, plus a variety of wetland types, including vernal pools. The reserve's large size and environmental heterogeneity provide an exceptional opportunity for teaching and research on biodiversity and landscape ecology. The extensive repetition of small drainages, distinct geologic and soil regimes (including large areas of unique serpentines), and complete drainage systems make the site uniquely suitable for replicated experimental studies. At least one significant Chumash archeological site is located on the property. The reserve has active K-12 science education and public outreach programs in addition to supporting research and university instruction.

Reserve Staff
Katherine McCurdy, Resident Reserve Director
Joshua Schimel, Faculty Advisor

- **The Valentine Eastern Sierra Reserve** is composed of two reserve sites in the Mammoth Lakes area, SNARL and Valentine Camp.

The Sierra Nevada Aquatic Research Laboratory (SNARL) is located on 51 acres of the eastern slope of the Sierra Nevada and is an ideal base for field research throughout the ecologically and geologically diverse eastern Sierra and Owens Valley. The reserve offers modern housing, including dormitory accommodations for short and long-term use by researchers and classes. Office space and laboratory facilities, including wet labs, controlled-environment rooms, chemistry and radio-isotope labs, and experimental stream channels, as well as meeting and classroom facilities, are offered on a year-around basis. An extensive GIS database, a library, and a computer/communications center are also available. The reserve supports a well-attended public lecture series in the spring and early summer.

Valentine Camp encompasses 152 acres and contains one of the region's few pristine montane meadows. It provides varied habitats, including coniferous forest, chaparral, and sagebrush plains in which to conduct observational and experimental studies. The considerable ecological diversity within the reserve makes it an excellent teaching resource. The facilities include housing and laboratories which are open in the summer and early fall and, on a limited basis, in the winter. A system of foot trails provides access to all of the site's major habitats. The reserve has a very active K-12 outreach program during the summer.

Reserve Staff
Daniel R. Dawson, Resident Reserve Director
John M. Melack, Faculty Advisor
Leslie Dawson, K-12 Education Coordinator

UCSB Natural Reserve System Administration
William W. Murdoch, Director
Susan L. Swarbrick, Associate Director
Donna Moore, MSO

Analytical Laboratory

The MSI Analytical Lab is a professionally managed chemical analysis facility, with the objectives of improving the quality and efficiency of marine-related research efforts, and of providing advanced capabilities for new and expanded research programs. Originally established in 1977 to serve the needs of UCSB marine researchers, the facility is now recognized campus wide as well as nationally as a resource for high-quality analytical services, with a regular user base of over 50 faculty and professional researchers. The major capabilities of the Lab include metals analysis by Inductively Coupled Plasma Mass Spectroscopy, Flame Atomic Absorption Spectroscopy (AAS), and Furnace AAS; bulk elemental analysis of carbon, hydrogen and nitrogen (CHN) by combustion; stable isotope ratio determination of light isotopes (C, N, O, H, S) in biological and geological materials using both continuous-flow and dual inlet Isotope Ratio Mass Spectrometry; and automated determination of nutrients in natural waters using a 5-channel Flow Injection Analyzer. Most of the Lab's current instrumentation was obtained with extramural funding from grants acquired by the Lab manager in conjunction with interested faculty and researchers. The Lab operation is supported largely through user fees. There are currently five full time and three part time staff employed by the Analytical Laboratory. Please visit our Web site at analab.msi.ucsb.edu for more information.

MSI Education and Outreach

It was a year growth for MSI Oceans-To-Classrooms (O2C) Ed/Outreach Programming that included visits to the Research Experience & Education Facility (REEF) and community outreach efforts via the Mobile REEF Unit. Much of the content focused on the growing partnership with the Channel Island National Marine Sanctuary and the construction of the Outreach Center for Teaching Ocean Science (OCTOS). Up over 2,000 from the previous year, our total outreach efforts have provided marine science and ocean awareness to 17,110 (See Figure 1) people within the Tri-Counties (SLO, SB, Ventura) and beyond! This number captures our shift, this year, to capturing ALL students, both on, and off, campus. This is identified in the column P-20, to denote Preschool through Graduate school. Our Saturday, Open Door Program for the General Public had over 1,700 visitors. Our Mobile Efforts alone reached 5,119 community members). None of this would have been possible without our continued growth and collaborations with such groups both on- and off-campus. These groups include the Office of Education Partnerships, The AS Coastal Fund, Santa Barbara Channel Islands National Marine Sanctuary (CINMS) and many others.

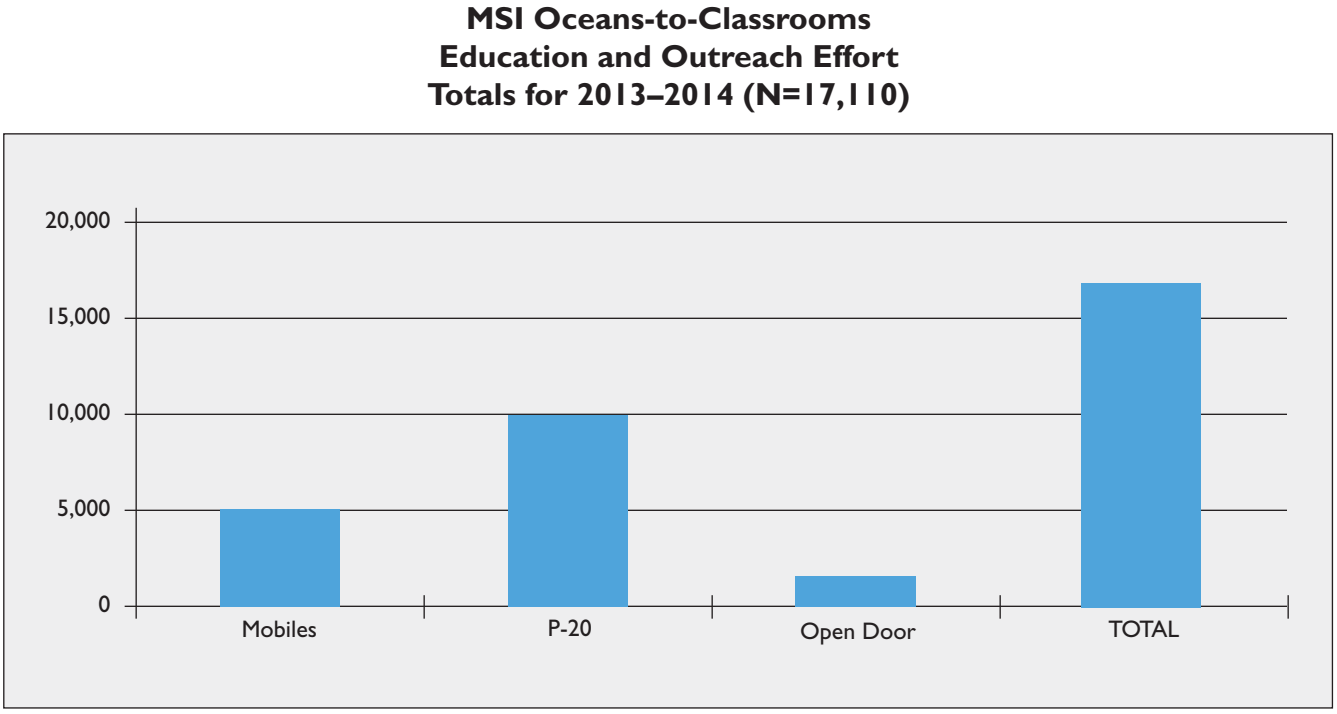


Figure 1. Graph of total number of participants served through MSI Ed/Outreach Oceans-To-Classrooms (O2C) Programming.

Awards Administered

Awards Administered 2013-2014

AUSTRALIAN MUSEUM

C. Churchill, T. Oakley	4/1/2014-3/31/15	$9,654
Interactions Between a Crustacean and an Alga: The First Marine Arthropod with Photobionts? (Ostracoda: Philomedidae)		
	Australian Museum Subtotal	**$9,654**

CALIFORNIA INSTITUTE OF TECHNOLOGY

D. Valentine	3/21/2013-3/31/2016	$109,897
Cracking the Microbial Sulfur Cycle with Novel Cell- and Metabolite-Specific Stable Isotope Approaches		
	California Institute of Technology Subtotal	**$109,897**

CALIFORNIA SEA URCHIN COMMISSION

S. Schroeter	7/1/2006-6/30/2014	$8,400
Studies of Sea Urchins Settlement in Southern and Northern California		
	California Sea Urchin Commission Subtotal	**$8,400**

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

R. Knapp	4/7/2014-3/31/2016	$295,200
Assessment of Bacterial Water Quality in the Lahontan Region: A study to provide data on bacterial indicator concentrations and sources of bacteria in surface water		
	California State Water Resources Control Board Subtotal	**$295,200**

CONSERVATION INTERNATIONAL

S. Gaines	11/1/13-10/31/15	$200,000
Marine spatial planning (MSP) and lobster fishery reform for the Galapagos		
	Conservation International Subtotal	**$200,000**

DAUPHIN ISLAND SEA LAB

M. Brzezinski	7/1/13-11/30/14	$36,219
Collaborative Research: Understanding the role of picocyanobacteria in the marine silicate cycle		
	Dauphin Island Sea Lab Subtotal	**$36,219**

DAVID AND LUCILE PACKARD FOUNDATION (THE)

C. Costello	7/1/14-4/30/15	$65,000
Global Fishery Status - Current Synthesis and Future Projections		
	David and Lucile Packard Foundation (The) Subtotal	**$65,000**

EXXON MOBIL UPSTREAM RESEARCH COMPANY

D. Valentine	7/1/13-12/31/14	$200,000

Development and Testing of Sampling Tools for the Colleciton of Microbes and Chemicals from Marine Seeps

Exxon Mobil Upstream Research Company Subtotal **$200,000**

GORDON AND BETTY MOORE FOUNDATION

F. Davis, S. Hampton 12/20/2012-8/30/2015 $32,364
NatureLab: NCEAS core support and capacity building

C. Kappel , B. Halpern, K. Selkoe 8/17/2012-10/28/2013 $1,047,242
Ecosystem Thresholds and Indicators for Marine Spatial Planning

Gordon and Betty Moore Foundation Subtotal **$1,079,606**

MARISLA FOUNDATION

J. Caselle 3/30/2012-03/30/2015 $175,000
Coral Reef Research in a Rare, Undisturbed Ecosystem: UCSB and Palmyra Atoll

Marisla Foundation Subtotal **$175,000**

MORRIS ANIMAL FOUNDATION

H. Young 6/1/14-5/30/16 $107,954
Effects of land-use on tick-burden and tick-borne diseases in wild dogs (Lycaon pictus)

Morris Animal Foundation Subtotal **$107,954**

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

C. Carlson 9/1/2012-8/31/2013 $30,000
Exploring the Role of Photobleached Dissolved Organic Matter on Bacterial Community Activity and Carbon Export Potential in Upwelling-Driven Case II Waters $30,000

National Aeronautics and Space Administration Subtotal **$60,000**

NATIONAL SCIENCE FOUNDATION

P. Berkman, F. Davis, O. Young 9/1/13-8/31/16 $1,714,176
Holistic Integration for Arctic Coastal-Marine Sustainability (HIACMS)

M. Brzezinski 12/1/2012-11/30/2015 $121,344
GEOTRACES Pacific Section: Resolving Silicon Isotope Anomalies in the Eastern Pacific $129,496

S. Hampton 9/15/2011-8/31/2015 $1,300
Dimensions: Collaborative Research: Lake Baikal Responses to Global Change: The Role of Genetic, Functional and Taxonomic Diversity in the Plankton

G. Hofmann 10/1/2013-9/30/2017 $510,394
Ocean acidification seascape: linking natural variability and anthropogenic changes in pH and temperature to performance in calcifying Antarctic marine invertebrates

G. Hofmann 9/1/2010-8/31/2016 $5,000
Synergistic Effects of Climate-Related Variables on Larval Sea Urchins: Performance to

Gene Expression, REU Supplement
S. Holbrook, A. Rassweiler 10/1/2013-9/30/2016 $247,089

Coastal SEES (Track 1), Collaborative: Adaptive Capacity, Resilience, and Coral Reef State Shifts in Socio-ecological Systems

M.D. Iglesias-Rodriguez, M. Brzezinski, C. Carlson, U. Passow, D. Valentine — 10/1/2014-12/31/2016 — $494,091
MRI: Acquisition of a Flow Sorter Cytometer to Advance Marine Research and Education

M. Jones — 1/15/2014-12/31/2014 — $13,635
Collaborative Project: Software Sustainability: an SI2 PI Workshop

T. Oakley — 10/1/2010-9/30/2014 — $10,984
Dimensions: Collaborative Research: Can Evolutionary History Predict How Changes in Biodiversity Impact the Productivity of Ecosystems?

T. Oakley, D. Speiser — 4/15/2014-3/31/2017 — $350,000
RUI: Collaborative Research: Timing and Molecular Origins of Recently Evolved Chiton Shell-Eyes: Phylogenomics of Chitonina

T. Oakley — 6/1/12-5/31/15 — $8,298
Collaborative Research: Eye Evolution in Sarsielloidea (Crustacea: Ostracoda): An Integrative Approach Based on Phylogenetics, Developmental Genetics, Behavior and Optics (REU Supplement)

D. Reed, S. Holbrook, J. Melack, D. Siegel, — 12/1/2012-11/30/2018 — (Core) $964,000; (REU Supplement) $16,000
LTER: Land/Ocean Interactions and the Dynamics of Kelp Forest Communities
SBC-LTER III

M. Schildhauer — 8/1/2013-7/31/2014 — $65,760
Collaborative Project: EarthCube Domain End-User Workshop: Developing a Community Vision of Cyberinfrastructure Needs for Coral Reef Systems Science

R. Schmitt, S. Holbrook — 9/1/2012-8/31/2016 — (Core) $956,000
LTER: MCR IIB: Long-Term Dynamics of a Coral Reef Ecosystem — (UNOLS Supplement) $125,213; (Ocean Acidification Supplement) $150,134

D. Valentine — 10/1/13-9/30/16 — $341,714
Collaborative Research: Oxygenation of Hydrocarbons in the Ocean

L. Washburn — 9/15/2010-8/31/2014 — $123,992
Collaborative Research: The Propagating Response of the Inner Shelf to Wind Relaxations in a Coastal Upwelling System

S. Weldeab, D. Lea — 7/1/13-6/30/16 — $336,594
Data synthesis and Evaluation of the Salinity Influence on Mg/Ca Paleothermometry in the Low Latitudes

National Science Foundation Subtotal **$6,684,414**

NATURE CONSERVANCY (THE)

S. Lester — 10/4/13-8/29/14 — $25,000
Economic Benefits of Proposed Marine Protected Areas in the Bahamas

The Nature Conservancy Subtotal **$25,000**

NATIONAL INSTITUTES OF HEALTH

E. Ballerini, S. Hodges — 8/1/2012-7/31/2014 — $53,942
Dissecting the Genetic Basis of Adaptive Traits in Aquilegia

C. Briggs EID disease in complex communities: multi-host multi-pathogen interactions	9/1/2013-8/31/2014	$345,701
J.H. Waite, J. Israelachvili Translating Mussel Adhesion	9/1/2013-8/31/2014	$496,954
	National Institutes of Health Subtotal	**$896,597**

OFFICE OF NAVAL RESEARCH, DOD NAVY

J.H. Waite, Kollbe Ahn	7/31/2013-7/30/2015	$117,533
Mussel-inspired Under-water Acrylic Adhesives/Coatings		$22,949
	Office of Naval Research, DOD NAVY Subtotal	**$140,482**

OREGON STATE UNIVERSITY

C. Blanchette, J. Caselle, S. Gaines, R. Warner, L. Washburn Understanding the California Current Large Marine Ecosystem under Climate Change: Delivering Sound Science for Policy	1/1/14-12/31/2014	$232,045
	Oregon State University Subtotal	**$232,045**

RARE

S. Gaines, S. Lester Fish Forever: launching pilot sites in Belize, Philippines, and Indonesia	7/1/2012-12/31/2013	$75,000
S. Lester Fish Forever	6/1/2013-5/31/2015	$83,146
	RARE Subtotal	**$158,146**

SIMPSON & SIMPSON BUSINESS AND PERSONNEL SERVICES, INC.

M. Page, D. Reed, S. Schroeter San Onofre Nuclear Generating Station Mitigation Project Monitoring Program	1/1/14-12/31/15	$4,715,399
	Simpson & Simpson Business and Personnel Services Subtotal	**$4,715,399**

UC MEXUS

D. Lea Yucatan Peninsula Hydrological Sensitivity to Radiative Forcing by Greenhouse Gases: Paleoclimate Perspective	7/1/13-12/31/14	$10,000
	UC MEXUS Subtotal	**$10,000**

UC SAN DIEGO

L. Washburn, M. Brzezinski Southern California Regional Coastal Ocean Observing System: Surface Current Mapping, Harmful Algal Bloom, and Sub-Surface Water Sections	6/1/2013-5/31/2014	$348,100
	UC San Diego Subtotal	**$348,100**

UC SANTA CRUZ

C. Blanchette	9/1/2012-8/31/2014	$39,500
Characterization of Rocky Intertidal, Kelp Forest and Deep Rocky and Sandy Ecosystems at San Clemente Island		
J. Engle	4/14/2010-4/30/2015	$8,663
Shoreline Assessment of Changes in Southern California Rocky Intertidal Communities		
A. Rassweiler	8/30/13-12/31/16	$34,000
Mediterranean Coast Network Kelp Forest Monitoring: Protocol Review and Data Synthesis		
	UC Santa Cruz Subtotal	**$82,163**

UC SEA GRANT

C. Costello, S. Gaines, R. Deacon	2/1/13-8/31/2014	(Core) $54,755
Social and Economic Effects of ITQs on the West Coast Groundfish Fishery: Solving the Weak Stock/Bycatch Problem		(Trainee) $41,148
C. Culver	2/1/2013-1/31/2014	$11,965
Sea Grant Extension Program Funds		
J. Dugan	2/1/2014-1/31/2017	$45,000
The Ecological State of Northern California's Sandy Beaches and Surf Zones: A Baseline Characterization for MPA Assessment		
S. Gaines	2/1/2014-1/31/2015	(Core) $4,416
Spatial Redistribution of Fishing Effort: Identifying Drivers and Testing Model Predictions for Informing Expectations in Marine Spatial Planning		(Trainee) $44,082
S. Lester, S. Gaines, C. Costello, L. Washburn	9/1/2012-8/31/2013	(Core) $320,587 (Trainee) $36,824
Maximizing the value of offshore aquaculture development in the context of multiple ocean uses		
D. Reed, S. Holbrook, C. Culver	2/1/2014-1/31/2015	$85,850
The Spread and Ecological Consequences of the Invasive Seaweed Sargassum homeri		
B. Walker, C. Culver, K. Selkoe	2/1/2013-1/31/2015	$91,092
Towards Resilience and Sustainable Seafood Supply: Assessing Direct Marketing Approaches for the West Coast Fishing Communities		
	UC Sea Grant Subtotal	**$735,639**

UNITED NATIONS EDUCATIONAL, SCIENTIFIC & CULTURAL ORGANIZATION (UNESCO)

B. Halpern	10/15/13-11/14/114	$36,900
GEF Transboundary Waters Assessment Programme: large marine ecosystems and open oceans		$123,233
United Nations Educational, Scientific & Cultural Organization (UNESCO) Subtotal		**$160,133**

UNITED WATER CONSERVATION DISTRICT

C. Culver	4/11/14-9/30/14	$32,400
Assisting with Quagga Mussel Management Activities at Lake Piru		
	United Water Conservation District Subtotal	**$32,400**

UNIVERSITY OF ARIZONA

M. Schildhauer	3/1/2011-12/31/2013	$61,715
iPlant/NCEAS Collaboration to Build the BIEN and Environment & Organisms Working Groups' Informatics Frameworks		
M. Schildhauer	9/1/2013-8/31/2014	$86,110
The iPlant Collaborative: Cyberinfrastructure for the Life Sciences		$79,767
	University of Arizona Subtotal	**$227,592**

UNIVERSITY OF MIAMI

C. Carlson	2/1/2009-1/31/2015	$125,187
Collaborative Research: Global Ocean Repeat Hydrography, Carbon, and Tracer Measurements, 2009-2014		
	University of Miami Subtotal	**$125,187**

UNIVERSITY OF MICHIGAN

T. Oakley	9/1/2013-8/31/2014	$206,410
EFRI-PSBR: Biodiversity & Biofuels: Finding win-win scenarios for conservation and energy production in the next century		
	University of Michigan Subtotal	**$206,410**

UNIVERSITY OF MINNESOTA

S. Mazer	10/15/2011-9/30/2014	$137,656
Project Baseline, a living plant genome reserve for the study of evolution (REU Supplement)		$7,200
	University of Minnesota Subtotal	**$144,856**

UNIVERSITY OF MISSISSIPPI

U. Passow	9/1/2011-12/31/2014	$245,599
Ecosystem Impacts of Oil and Gas Inputs to the Gulf (ECOGIG)		
	University of Mississippi Subtotal	**$245,599**

UNIVERSITY OF NEW MEXICO

M.B. Jones, S. Hampton	8/1/2009-7/31/2014	$735,267
DataNetONE: Observation Network for Earth		
	University of New Mexico Subtotal	**$735,267**

UNIVERSITY OF SOUTHERN CALIFORNIA, SOUTHERN CALIFORNIA EARTHQUAKE CENTER

C. Nicholson	2/1/2013-1/31/2014	$35,000
Updating Active 3D Fault Geometry in Special Fault Study Areas and Improving the SCEC Community Fault Model (CFM)		
	University of Southern California Subtotal	**$35,000**

US DEPARTMENT OF COMMERCE, NOAA

M. Myers	9/1/2013-8/31/2014	$178,721
Santa Barbara Area Coastal Ecosystem Vulnerability Assessment		
M. Myers	9/1/2013-8/31/2014	$99,999
Santa Barbara Area Coastal Ecosystem Vulnerability Assessment for Local Communities		
	US Department of Commerce, NOAA Subtotal	**$278,720**

USDI BUREAU OF OCEAN ENERGY MANAGEMENT

M. Love	9/22/2011-9/30/2015	$283,265
Renewable Energy in situ Power Cable Observation		
M. Love	6/4/2012-5/31/2015	$100,000
Analysis of Fish Population at Platforms off Summerland, California		$25,000
H.M. Page, J. Dugan, R. Miller	7/1/2013-6/30/2015	$230,266
Understanding the Role of Offshore Structures in Managing Potential Watersipora Invasions	$208,657	
	USDI – Bureau of Ocean Energy Management Subtotal	**$847,188**

USDI FISH & WILDLIFE SERVICE

F. Davis	11/18/2013-1/31/2014	$7,950
Peer Review Process Associated with the Proposed Rule to list the Mexican Wolf as an Endangered Subspecies and Delist the Gray Wolf Elsewhere		
T. Dudley	11/29/2010-12/20/2015	$125,000
Research and Restoration Through the Santa Clara River Reserve: A Proposal to Develop a University of California Research and Education Station		
D. Herbst	8/14/2012-6/30/2014	$60,000
Walker Lake Cooperative Research		
	USDI Fish & Wildlife Service Subtotal	**$192,950**

USDI GEOLOGICAL SURVEY

M. Brzezinski	10/1/2013-9/30/2014	$106,104
Wave Energy Sensor Development and Deployment		

R. Knapp	7/1/2013-9/30/2015	$18,000
Factors influencing the reintroduction success of the endangered mountain yellow-legged frog		$21,000
C. Nicholson	12/1/2013-11/30/2014	$49,996
Sierra Nevada Yellow-Legged Frog Genetic Analysis for Yosemite National Park		
	USDI – Geological Survey Subtotal	**$195,100**

USDI NATIONAL PARK SERVICE

J. Dugan	7/15/2013-7/25/2014	$50,000
Wave-Exposed Sandy Beach Invertebrate Staining and Mark-Recapture		
L. Laughrin	8/1/2013-8/30/2014	$6,037
Research Bibliography for Channel Islands National Park		
S. Mazer	8/30/2010-8/29/2015	$58,300
Facilitation of a Phenology Network to Assess Climate Change Response in California National Parks		
	USDI – National Park Service Subtotal	**$114,337**

WAITT FAMILY FOUNDATION

C. Costello	1/31/2014-12/31/2014	$600,000
Sustainable Ocean Solutions through Rights-Based Management, Fisheries Certification, and Marine Protected Areas		
	Waitt Family Foundation Subtotal	**$600,000**
	TOTAL 2013-2014 AWARDS	**$20,515,654**

Research Summaries
(Contracts/Grants Administered)
July 2013 – June 2014

Evangeline Ballerini **8/1/2012 to 7/31/2015** **$163,110**
Scott Hodges
NIH General Medical Sciences 5F32 GM103154

Dissecting the Genetic Basis of Adaptive Traits in Aquilegia

The ability to pinpoint the causal genetic variation and interpret the related developmental processes that lead to phenotypic variation is critical to our knowledge of how to treat and prevent human disease, improve crop yields, and to increase our understanding of evolutionary processes such as natural selection, adaptation, and speciation. Here we use several techniques to identify the genetic basis of variation in cell anisotropy affecting spur length, an adaptive trait in the genus Aquilegia. Several methods will be used to identify candidate loci for spur length variation. First, whole genome sequencing of 276 F2 progeny of a cross between the medium spurred species, Aquilegia formosa, and the long spurred species A. pubescens, will be used to map QTL for spur length. We will then use natural hybrid zones between A. formosa and A. pubescensto take advantage of increased marker recombination in advanced generation hybrids (relative to the F2 progeny used for QTL mapping) to narrow the genomic regions associated with differences in spur length. For these admixed individuals, methods of genome capture will be implemented to selectively sequence genomic regions associated with the previously identified QTL for marker genotyping and association analyses. We will also perform genome-wide scans for selection to identify regions of the genome in each species that show signs of positive selection. Combining these data will allow us to come up with a more refined list of candidate loci affecting spur length than any method independently. Gene expression and functional analyses will then be conducted on candidate genes to confirm and further comprehend their roles in the development of cell anisotropy and spur length variation. These analyses will provide basic information on the genetic basis of adaptive traits, including estimates for the number and genomic distribution of loci involved, the effect size of loci, and whether adaptive trait variation is caused by regulatory or structural genetic changes.

Paul Berkman **9/1/2013 to 8/31/2016** **$1,714,176**
Oran Young, Frank Davis
National Science Foundation PLR-12693819

Holistic Integration for Arctic Coastal-Marine Sustainability (HIACMS)

Interests are awakening globally to take advantage of extensive energy, shipping, fishing, and tourism opportunities associated with diminishing sea ice in the Arctic Ocean. Responses to this environmental state-change are generating risks of political, economic, and cultural instabilities that will affect societies at local, regional, national, and international levels. Addressing the "common arctic issues" of sustainable development and environmental protection articulated by the Arctic Council, this 3-year project will develop and demonstrate a process that will enhance the practice of governance for sustainability in Arctic coastal-marine systems, balancing national interests and common interests; environmental protection, social equity and economic prosperity, and needs of present and future generations. To achieve this project goal, we will carry out a series of tasks addressing the four ArcSEES themes (Natural and Living Environment; Built Environment; Natural Resource Development; and Governance) and including: interdisciplinary data aggregation; geospatial integration of the data to reveal plausible developmental scenarios; annual workshops to generate infrastructure and policy options, and applications of the findings to current issues of Arctic governance. This sustainability process will be elucidated and demonstrated through case-studies focusing on current 'hot spots' in the Western Arctic - Bering Strait and Beaufort-Chukchi Seas (United States, Canadian and Russian interests) – and the Eastern Arctic - Barents Sea (Norwegian and Russian interests) and West Greenland (Greenlandic, Danish, and Canadian interests). We will

engage policy makers in the process from bodies like the Convention for the Protection of the Marine Environment of the North-East Atlantic, which has a transboundary remit in the Arctic Ocean. To make the process cost effective, we have established links to the SEARCH (Study of Environmental Change: www.arcus.org/search) and ACCESS (Arctic Climate Change, Economy and Society: www.access-eu.org) projects that are supported extensively within the United States and Europe, respectively. We will leverage the capacity, networks and expertise associated with these already-funded research activities. Our international, interdisciplinary, and inclusive project also will add value through partnerships with the National Center for Ecological Analysis and Synthesis (www.nceas.ucsb.edu) in the United States and institutions in France associated with the ACCESS project as well as the Ice Atmosphere Arctic Ocean Observing System project (www.iaoos-equipex.upmc.fr). The holistic process we develop to generate and share options for Arctic coastal-marine sustainability will be memorialized through a video series involving lessons of 'science diplomacy' to further stimulate education by and for the benefit of all stakeholders (i.e., representatives of government agencies, academia, industry, non-governmental organizations, and civil society). The sustainability process we develop and demonstrate in this project focusing on the Arctic Ocean will have implications everywhere on Earth where resources, human activities, and their impacts extend across or beyond the boundaries of sovereign states.

Carol Blanchette | **9/1/2011 to 6/30/2015** | **$259,856**
California Sea Grant College Program | R/MPA-22A

Baseline Characterization and Monitoring of Rocky Intertidal Ecosystems for MPAs in the South Coast Region

The goals of this project are to produce a quantitative baseline characterization of the structure of rocky intertidal ecosystems in all of the South Coast MPAs that have accessible rocky intertidal and to provide a quantitative comparison between the rocky intertidal ecosystems in these MPAs and associated reference areas in the South coast region using a combination of biodiversity surveys and targeted species sampling. Researchers will analytically explore the baseline characterizations for potential indicators of the state of the rocky intertidal ecosystems using newly collected data along with historical and contextual data from the region, evaluate the suitability of proposed draft metrics and other metrics for long term monitoring and assess initial changes in size and abundance of targeted species across newly created MPAs, existing MPAs and reference areas.

Carol Blanchette | **9/1/2012 to 8/31/2016** | **$115,500**
UC Santa Cruz | UCSCMCA 13-004

Characterization of Rocky Intertidal, Kelp Forest and Deep Rocky and Sandy Ecosystems at San Clemente Island

Characterization of Rocky Intertidal, Kelp Forest and Deep Rocky and Sandy Ecosystems at San Clemente Island Our approach to characterizing the baseline conditions of rocky intertidal ecosystems within SCI exclusion and reference sites will be closely linked to the rocky intertidal baseline monitoring approaches used to provide baseline characterization for the California MPA network: South Coast Study Region (Blanchette and Raimondi co-PIs), Central Coast Study Region (Raimondi and Blanchette, co-PIs) and the North-Central Coast Study Region (Raimondi, PI). This tight integration of leadership, personnel, protocols and datasets with sampling programs in other California regions will ensure consistency in methods and data facilitating synthesis and analysis across study regions. Our program will be closely coordinated with the two major existing west coast regional monitoring programs for intertidal ecosystems (where Raimondi and Blanchette are also PI's). The first is MARINe (Multi Agency Rocky Intertidal Network, http://www.marine.gov/), which evolved from the monitoring program initiated by the Channel Islands National Park in the early 1980's (Davis 1985; Richards and Davis 1988). The MARINe monitoring was explicitly directed at detecting temporal changes in the intertidal communities (Raimondi et al 2005). The second is PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans, http://www.piscoweb.org/), which has supported the Coastal Biodiversity Survey program (described in detail below). These biodiversity surveys have been conducted at 130 sites from central Alaska to southern Baja, California, Mexico (Blanchette et al. 2008). While the unified MARINe protocols have proven to be

extraordinarily powerful for detecting changes in communities (Minchinton and Raimondi 2005) and particularly in separating anthropogenic from natural dynamics (Raimondi et al 1999), they were not designed to estimate biodiversity. Moreover, we found that geomorphology was tremendously important in determining communities and dynamics of communities. To address these concerns we designed a spatially explicit biodiversity monitoring program. This program has been variously called the SWAT or comprehensive surveys, but herein we will use the term biodiversity surveys. These surveys have been conducted at almost all of the MARINe sites and several non – MARINe sites. Our baseline characterization and monitoring plan will be based on the successful elements from both the MARINe and biodiversity survey programs and aimed at the assessment and understanding of ecological conditions in rocky intertidal ecosystems in this region at or near the time of MPA implementation. Our protocols will be generally aligned with those used in other study regions, and identical to those being used across the south coast study region. Based on our experiences with both the MARINe and PISCO programs, as well as leading the baseline monitoring efforts in both the central and north central regions, we propose to use two separate survey types to characterize rocky intertidal ecosystems of SCI. Both types of surveys will be done in each of the first two years to establish baseline conditions. These sites will include sites previous sampled in 2009 (Boy Scout Camp and Eel Point). Other specific locations will be determined as part of our coordinated planning meeting, which is intended to produce a joint sampling plan for all projects.

Carol Blanchette **3/22/2013 to 9/30/2015** **$232,045**
Jennifer Caselle, Steven Gaines,
Robert Warner, Libe Washburn
Oregon State University F70767A-C

Understanding the California Current Large Marine Ecosystem under Climate Change: Delivering Sound Science for Policy

The Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) requests funds for Year 4 of a 5-Year phase project (PISCO-III, 2010-2014). With these renewal funds, we will continue to apply our long-term interdisciplinary ecosystem studies to inform marine policy, improve approaches to marine conservation, and to develop adaptive strategies for climate change. Effective efforts to inform decision makers across the CCLME require a coordinated consortium, which has become the PISCO label and a national model for academic consortia informing coastal and marine policy. The generous support from DLPF provides the cohesion for our group, enables researchers to continue their high-impact roles as advisors and close collaborators with information users in various policy processes, and provides a living legacy of long-term monitoring and research that we believe will define future regional and ecosystem-based ocean science programs. In October 2009, PISCO submitted a full 5-Year proposal for the new, "PISCO-III" phase of the consortium. That proposal summarizes how PISCO's prior experience of implementing large-scale, interdisciplinary research uniquely positions the consortium to understand how ecosystems may change in the future, how these changes affect human well-being, and where effective solutions may lie. Consistent with agreements with DLPF to submit annual renewal requests for continuing funds, this renewal request summarizes our progress, highlights notable achievements as well as challenges, and proposes 2013 (Year 4) activities and budget. In general, the support requested from DLPF will enable the consortium to: · Continue key cross-disciplinary collaborations that make PISCO science particularly transformative, · Continue and further develop essential collaborations with boundary organizations, management agencies, and policy makers to ensure accurate use and support of ocean ecosystem monitoring and assessment, · Use legacy time series data and our expertise in designing and implementing monitoring programs to inform immediate and longer-term management and policy needs, · Maintain cohesion across the continuing new collections of time series data that are funded by multiple agencies, · Integrate research and monitoring to understand the dynamics of the ocean ecosystem of the US west coast in an era of changing ocean management, emerging ocean uses and climate change, and Continue to provide a model for science-to-policy in other large marine ecosystems of the United States and abroad

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Cheryl Briggs **9/1/2013 to 6/30/2016** **$1,209,186**
NIH General Medical Sciences 1R01GM109499

EID Disease in Complex Communities: Multi-host Multi-pathogen Interactions

One of the fundamental challenges facing contemporary disease ecology involves understanding infection dynamics within complex communities composed of multiple hosts and multiple pathogens. Hosts in nature are exposed to a 'cocktail' of different pathogens, therefore a central question concerns how interactions between co-occurring pathogens affect disease severity and pathogen transmission in host communities. Most research to date has been focused at a single level, examining either how multiple infections influence individual host pathology or using population surveys to identify correlations in pathogen co-occurrence within a host population. This 'disconnect' in scales (i.e., within-host vs. between- host) omits a critically important question – namely, how do pathogen interactions within hosts 'scale up' to influence between-host processes, such as transmission and disease dynamics? The primary goal of this project is to understand how interactions among three virulent pathogens at different scales of biological complexity, including within hosts, between species, and among communities, combine to influence disease dynamics in amphibians, a group of globally threatened vertebrates. This project combines cross-sectional field surveys of wetland communities with controlled laboratory and mesocosm experiments to determine (1) how amphibian pathogens covary in occurrence and intensity across multiple spatial scales (individual hosts, host species, wetland communities), (2) the individual and combined effects of each pathogen on host pathology and pathogen infection success, and (3) the net effects of variation in host and pathogen community structure for pathogen transmission and host-pathogen dynamics. A stochastic, simulation-based modeling framework uniquely focused on individual hosts will be used to interpret experimental results and link field distributions of pathogens with underlying mechanisms. This project focuses on three pathogens that have been widely implicated in causing amphibian pathology: the chytrid fungus Batrachochytrium dendrobatidis, the trematode Ribeiroia ondatrae, and the viral genus Ranavirus.

Cheryl Briggs **9/15/2007 to 8/31/2013** **$2,358,643**
Roland Knapp
National Science Foundation EF-0723563

Collaborative Research: After the Crash: Factors Allowing Host Persistence Following Outbreaks of a Highly Virulent Disease

Emerging infectious diseases can have dramatic effects on host populations. Factors such as host susceptibility and pathogen virulence can markedly alter disease outcomes, and can be the difference between host extinction or persistence. Unfortunately, such factors are often poorly understood, hampering the ability to predict the effect of emerging diseases. Chytridiomycosis is an emerging infectious disease of amphibians caused by the fungal pathogen, Batrachochytrium dendrobatidis (referred to hereafter as "Bd"). Since its discovery in 1998, chytridiomycosis has been implicated as a major cause of amphibian population declines and extinctions around the world. Many amphibians are highly susceptible to chytridiomycosis, and infection frequently results in host extinction. At the current rapid rate of global Bd spread, many amphibian populations will become infected within the next decade, and this will likely result in substantial numbers of species extinctions in this already imperiled group of organisms. The western United States is a hotspot of amphibian declines, and many of these declines are associated with chytridiomycosis. In California's Sierra Nevada mountains, Bd is rapidly spreading through previously uninfected amphibian populations. The mountain yellow-legged frog (Rana muscosa) is highly susceptible to chytridiomycosis, and has experienced hundreds of recent population extinctions due to Bd infection. Interestingly, although the majority of host populations are driven extinct following the arrival of Bd, a small fraction of populations persist with the pathogen, and disease dynamics in these persistent populations are fundamentally different from those during population crashes. The goal of the proposed research is to understand the mechanisms leading to these contrasting disease outcomes. In the proposed research, a model of the R. muscosa/Bd interaction that includes within-host Bd dynamics and host stage-structure will be parameterized and tested. In addition, four non-mutually exclusive hypotheses that could account for different disease outcomes will be tested using field and laboratory experiments. It is hypothesized that population extinction versus persistence is the result of between-population

differences in (1) density-dependent disease dynamics, (2) Bd virulence, (3) frog susceptibility, or (4) environmental conditions. A functional genomics approach that utilizes complete Bd virulence and/or frog susceptibility. The proposed research will contribute significantly to the ability to predict outcomes of future diseases on wildlife and human populations.

Cheryl Brigg, Andrea Jani **6/1/2012 to 5/31/2014** **$15,000**
National Science Foundation DEB-1210682

Dissertation Research: Associations between Symbiotic Bacterial Communities and Infection by an Emerging Fungal Pathogen: Distinguishing Cause from Correlation

Symbiotic microbial communities are increasingly recognized as important players in the development and health of multicellular organisms. Due to their relevance to human health, much research has focused on the microbiota of humans and classical animal models (e.g. mouse), and this body of work has contributed a great deal to describing community composition and understanding molecular mechanisms of microbial interactions. Less is known about the diversity and function of microbial communities symbiotic to wildlife, but the few systems recently studied (e.g. termites, corals) have fundamentally changed our understanding of the evolution and phenotypic variation of those organisms. Working in the context of a wildlife (amphibian) disease system, the proposed study combines culture-independent methods for characterizing bacterial communities with an experimental approach that will (1) examine the contribution of host background and the aquatic environment in shaping the composition of bacterial communities inhabiting amphibian skin, and (2) clarify causal links in the interactions between skin-associated microbial communities and the emerging chytrid pathogen, Batrachochytrium dendrobatidis. Preliminary data show that variation in the composition of bacterial communities found on the skin of frogs correlates with the severity of infection with B. dendrobatidis. The proposed study builds on these findings by experimentally distinguishing between cause and correlation to determine whether variation in bacterial community composition leads to differences in disease resistance, or, conversely, invasion by the pathogen perturbs the symbiotic microbial community, leading to the observed variation in microbial community composition. In addition, the study will begin to address the basic question of what factors control symbiotic bacterial community composition in the absence of the pathogen. The resulting data will advance fundamental understanding of the factors shaping symbiotic microbial communities and the contribution of those communities to host health and disease.

Mark Brzezinski **11/1/2011 to 11/1/2013** **$71,718**
Swiss Federal Inst of Technology-Dba Eth (Switzerland) SB120062

Annual Plant Coexistence at Sedgwick Reserve

• Postdoctoral Researcher Oscar Godoy del Olmo will make measurements on a field experiment with annual plants at Sedgwick reserve

• Postdoctoral Researcher Godoy will analyze the results from the experiment

• Postdoctoral Researcher Godoy will write up results for publication

• By the end of the period of this contract (November 2013), the analyses will be complete, and a manuscript draft will be produced. In addition, all fencing, plot markers and other experimental equipment will be removed at no cost to the reserve.

• Application will be appended quarterly through the NRS on-line reservation system to maintain "ACTIVE" status of the project

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Mark Brzezinski **9/1/2013 to 8/31/2016** **$484,536**
National Science Foundation OCE-1334387

Collaborative Research: Linking Physiological and Molecular Aspects of Diatom Silicification in Field Populations

Overview: Diatoms, unicellular, eukaryotic photoautotrophs, are one of the most ecologically successful and functionally diverse organisms in the ocean. Despite accounting for <1% of Earth's

biomass, diatoms are estimated to contribute ~20% of total global primary productivity. In addition to being a key component of the global carbon cycle, diatoms are also tightly connected to silicon (Si) biogeochemistry because of their obligate requirement of Si for cell wall formation and growth. It is estimated that diatoms process over 240 Teramoles of biogenic silica each year and that each molecule of silicon is cycled through a diatom 39 times before being exported to the deep ocean. This proposal seeks to understand Si regulation of diatom productivity in the sea at the molecular level through a unique combination of state of the art tracer methods and assessments of silicon transporter expression and diversity. Success will provide new insights into the physiological basis of Si limitation in the sea and the molecular mechanisms involved.

Intellectual Merit: Decades of oceanographic and field research has provided detailed insight into the dynamics of silicon uptake and silica production in natural populations, but a molecular understanding of the factors that influence silicification processes is required for further understanding the regulation of silicon and carbon fluxes in the ocean. Proposed research will build upon these studies by coupling classical measurements of silicon uptake and silica production with molecular analyses of genes and proteins involved in silicification. Characterizing the genetic potential for silicification can provide new information on the factors that regulate the distribution of diatoms and influence in situ rates of silicon uptake and silica production. Our proposed study site off the coast of California is a region where diatom dynamics are well-characterized and silica production is among the highest in the world. Episodic upwelling from May through September creates a high probability of diatom bloom conditions. Low Fe conditions also occur in this same region allowing the known linkages between Fe stress and diatom silicification to be explored at the molecular level. Our proposed cruise track will target gradients in silicic acid and Fe concentrations with the following goals: 1) Characterize the expression pattern of known genes involved in silicification (Silicification-related genes; SiRGs) 2) Correlate SiRG expression patterns to Si concentrations, silicon uptake kinetics, and silica production rates, 3) Develop a method to normalize uptake kinetics and silica production to SiRG expression levels as a more accurate measure of diatom activity and growth, and 4) Characterize the diel periodicity of silicon uptake kinetics, silica production, and SiRG expression. This research is expected to provide significant information about the molecular regulation of silicification in natural populations and improve our knowledge on the factors controlling the distribution and productivity of diatoms in the ocean.

Broader Impacts. Proposed research blends concepts in physiology, genomics, molecular biology, and biochemistry with marine ecology and oceanography, providing an opportunity for researchers with diverse interests to interact. This project provides an opportunity for a female researcher to get first time PI experience and, at the same time, provides excellent hands-on, cross-disciplinary training for a graduate student. In addition, underserved and underrepresented undergraduate students will serve as an integral component of the lab-based research and will have an opportunity to participate in the proposed oceanographic research cruises. To further facilitate outreach, students participating in field work will write a daily blog describing their experience and life at sea. In support of fostering exposure of a broad audience to Science Technology Engineering and Mathematics areas, we will leverage existing resources both at Rutgers' and UC Santa Barbara to develop novel methods for translating scientific themes and data sets generated from field work into innovative teaching materials aimed at K-12 educators, K-12 students, and undergraduates.

Mark Brzezinski | **9/15/2011 to 8/31/2015** | **$248,737**
National Science Foundation | OCE-1129227

Coupling of Silicon Isotope Distributions to Meridional Overturning Circulation of the North Atlantic

We propose to collaborate with GEOTRACES which is scheduled to sample a section across the North Atlantic in October 2011. Among the water masses sampled will be surface and mode waters, the southward flowing North Atlantic Deep Water, and it's northward flowing counterparts: Antarctic Intermediate Water and Antarctic Bottom Water. In addition, overflow waters from high latitudes may have a significant impact, as preliminary data indicate that waters from the Arctic basin have a uniquely heavy Si isotope signature.

Mark Brzezinski | **10/1/2013 to 9/30/2015** | **$106,104**
USDI Geological Survey | G13AC00397

Wave Energy Sensor Development and Deployment

The overall goal of this study is to increase our understanding of how wave energy affects nearshore environments, especially kelp forest ecosystems. This first phase will be in preparation to determine how marine communities (specifically kelp plants) respond to variation in wave exposure. The specific objectives are: Determine the distribution of wave period and amplitude across the study region, Determine how wave model predictions compare to empirical observations along a depth gradient

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Mark Brzezinski | **7/1/2013 to 11/30/2015** | **$36,219**
Dauphin Island Sea Lab | 2507JK-UCSB-01

Collaborative Research: Understanding the Role of Picocyanobacteria in the Marine Silicate Cycle

The laboratory work for this project will be conducted by PI Krause at Dauphin Island Marine Laboratory. Final field experiments are scheduled out of Bermuda during the summer of 2013. Brzezinski (Lead PI) will continue his intellectual involvement in the project through regular conference calls regarding the design and execution of those experiments. He will also be directly involved in data reduction, data analysis and publication of the results of both laboratory and field measurements of Si acquisition by Synechococcus.

Mark Brzezinski | **11/1/2012 to 10/31/2013** | **$29,325**
Swiss Federal Institute of Technology | SB130045

The Maintenance of Species Diversity

The Laboratory Assistant, Lindsey Rice, will execute field and laboratory duties for three plant ecology research projects conducted at UC Sedgwick Reserve in the Santa Ynez Mountains. The project involves examination of (1) the factors that maintain a diversity of species in ecological communities, (2) the role of small population size in influencing community change, and (3) the factors controlling the success of nonnative plant invaders. Tasks include establishing experimental plots, data collection, weeding, seed collecting, weighing, counting, recording germination, and data entry. Ms. Rice will also help set up new experiments, as necessary, and will perform seed viability testing with standard procedures.

Mark Brzezinski | **12/1/2012 to 11/30/2016** | **$349,538**
National Science Foundation | OCE-1233028

GEOTRACES Pacific Section: Resolving Silicon Isotope Anomalies in the Eastern Pacific

Intellectual Merit We propose to measure silicon isotope distributions along the US GEOTRACES section from Peru to Tahiti scheduled for the Fall of 2013. The silicon isotope proxy is increasingly being used to assess the role of diatoms and silicic acid in past shifts in ocean productivity and their implications for climate. It is becoming clear that successful application of the silicon isotope proxy for diatom productivity requires a mechanistic understanding of how the silicon isotopic composition of ventilating waters masses varies in time and space. Model results suggest control through the fractionation of isotopes of Si during silica production and during silica dissolution coupled to the movement of Si by biological pump and the meridional overturning circulation. Empirical support for model predictions is equivocal. The very few full ocean depth profiles of □30Si(OH)4reveal systematic variations among ocean basins that can be understood in terms of thermohaline circulation patterns, but in the eastern Pacific the relationship between □30Si(OH)4and [Si(OH)4] in deep waters are the opposite of what current models predict. The spatial resolution of the present data set is inadequate to resolve conflicting hypotheses regarding the mechanisms driving large-scale □30Si(OH)4distributions in this region, but we hypothesize that the North Pacific Silicic Acid Plume plays a critical role. We propose to test model predictions regarding □30Si(OH)4distributions

within key water masses in the Pacific. Among the water masses sampled will be Lower Circumpolar Deep Water flowing from the south that should each be isotopically light due to incomplete nutrient depletion in the Southern Ocean. North Pacific Deep Water that flows into the region from the North should carry the signature the North Pacific Silicic Acid Plume. We will also investigate the influence of hydrothermal inputs along the East Pacific Rise. The strong gradient in productivity within surface waters between the Peru Shelf and Tahiti is also of interest as surface waters off Peru become preferentially depleted in silicic acid relative to nitrate. This strong decoupling of N and Si use by phytoplankton should result in contrasting N and Si isotope distributions allowing an empirical test of the ability of Si and N isotopes to predict relative nutrient depletion patterns as is assumed in paleo-applications of these proxies. We also propose to expand our current modeling to construct the first numerical model that will incorporate the influence of the North Pacific Silicic Acid Plume that may account for the anomalous Si isotope patterns in the Pacific. Broader Impacts - While we can test hypotheses regarding the controls on Si isotope distributions using the proposed ocean section it is clear from anomalies in the current global □30Si(OH)4data set that a comprehensive test will require spatially resolved □30Si(OH)4data from multiple oceans basins. International GEOTRACES sections completed or planned by Canada, Great Britain, France, Germany, Sweden and India include □30Si(OH)4measurements that will compliment those proposed here. While Si isotopes are not a core GEOTRACES parameter all data collected as part of this project will be submitted to the GEOTRACES database to aid this larger global synthesis. The PI supplies both secondary standards as well as reference seawater samples to all PI's measuring Si isotopes as part of International GEOTRACES. The research will also involve undergraduates who will be trained to assist in verification of [Si(OH)4] of each sample using colorimetric methods, data entry and data management.

Craig Carlson, Emma Wear | **9/1/2012 to 3/30/2016** | **$90,000**
NASA | NNX12AO13H

Exploring the Role of Photobleached Dissolved Organic Matter on Bacterial Community Activity and Carbon Export Potential in Upwelling-Driven Case II Waters

I will investigate the importance of photobleaching modification of dissolved organic matter (DOM) availability to heterotrophic bacterial activity in the upwelling-driven Santa Barbara Channel (SBC), an example of episodically terrestrially-influenced case II waters in which this phenomenon has not been well studied. Impacts of photobleaching will be examined across the four dominant DOM types within the SBC: terrestrially-derived sediment plumes, phytoplankton blooms, previously degraded phytoplankton DOM such as is present during summer stratification, and aged DOM brought to the surface by upwelling. I will quantify the importance of photobleaching to DOM quality in both field samples from the SBC and laboratory-produced DOM sources using remineralization bioassays. In this approach, both photobleached and non-bleached treatments are inoculated with native bacterioplankton, and changes in dissolved organic carbon concentrations, bacterial abundances, and chromophoric dissolved organic matter (CDOM) properties (both absorption and Excitation Emission Matrix spectra) are measured intensively over days to weeks. By combining these experimental results with satellite imagery analysis of the relative abundance of DOM sources in the system (derived from ocean color and sea surface temperature analyses), I will estimate the net annual importance of photoeffects in promoting heterotrophic remineralization of DOM, as opposed to sequestration in recalcitrant forms, and attempt to assign a carbon value to those effects within the Santa Barbara Channel. I will expand on the characterization of bacterial dynamics in previous studies by examining the impact of DOM photomodification on bacterial growth efficiencies (bacterial partitioning of carbon uptake between biomass and respiration) and by designing complementary experiments to track these effects into changes in bacterial community composition. This study directly addresses NASA's goals of quantifying and understanding an important component of the global carbon cycle, and in particular addresses outstanding questions on interactions between physical processes and oceanic biogeochemical cycles, and between terrestrial and marine systems, as identified in NASA's Pre-Aerosol, Clouds, and ocean Ecosystem (PACE) mission plan.

Craig Carlson | **8/15/2008 to 9/30/2014** | **$803,765**
National Science Foundation | OCE-0801991

MO: Collaborative Research: Transitions in the Surface Layer and the Role of Vertically Stratified Microbial Communities in the Carbon cycle - An Oceanic Microbial Observatory

The focus of this proposal is the role of bacterioplankton microbial community stratification in the ocean carbon cycle. Complex biological, chemical and physical processes control the efficiency of carbon transfer from the euphotic zone ocean to the deep sea, where sequestration is a possibility. Most organic carbon exported from the euphotic zone never leaves the surface 500m, with approximately ninety percent of the exported organic matter being remineralized in the mesopelagic zone (140-1000 m). Microbial communities are vertically stratified in the oceans, particularly in the surface layer (0-300m), which spans the region of deep mixing events and transition from the euphotic zone to the upper mesopelagic - the region of highest carbon remineralization activity. The premise of this proposal is that stratified bacterioplankton clades engage in specialized biogeochemical activities that can be identified by integrated oceanographic and microbiological approaches.

Craig Carlson | **2/1/2009 to 1/31/2015** | **$706,338**
University of Miami | P148822

Collaborative Research: Global Ocean Repeat: Hydrography, Carbon, and Tracer Measurements, 2009-2014

Dissolved organic matter (DOM), represents one of the largest exchangeable carbon reservoirs on earth. The global dissolved organic carbon (DOC) pool is estimated to be 685 Pg C, a value comparable to the mass of inorganic C in the atmosphere. Small perturbations in the production or sink terms of the oceanic DOC pool could strongly impact the balance between oceanic and atmospheric CO2. In this global ocean repeat hydrograph, carbon and tracer program D. Hansell (University of Miami) and C. Carlson of UCSB will be responsible for at sea sampling and analyses of dissolved organic carbon (DOC) and nitrogen (DON) measurements. The proposed program includes 18 legs 13 cruised conducted in various ocean basins from 2009-2014.

Craig Carlson, Mark Brzezinski | **4/1/2009 to 3/31/2014** | **$689,579**
National Science Foundation | OCE-0850857

Mechanisms Controlling the Production and Fate of DOM During Diatom Blooms

The residence time of DOM in surface waters of marine systems is the main factor determining its contribution to the efficiency and magnitude of the biological carbon pump. There is growing evidence that the export of DOM from the surface ocean represents a highly efficient pathway for the sequestration of organic carbon in the deep sea in some ocean regions. Current estimates are that 20% of the carbon transported to depth by the biological pump globally occurs via the export of DOC. Effective export of DOM requires that the DOM produced by phytoplankton persist in surface waters until vertical exchange processes transport the material to depth. The mechanisms controlling the time scale for the accumulation and persistence of DOM in surface waters are dominated by biological processes that both influence the amount and chemical character of the DOM produced and its consumption and decomposition by microbes. This proposal addresses these two coupled biological processes to examine controls on the accumulation of DOM during temperate diatom blooms. Diatom booms are known to produce prodigious quantities of DOM upon entering nutrient stress with a chemical composition that varies with the type of nutrient limitation (Si or N). This variable composition likely influences the nutritional value of DOM to microbes driving species successions towards functional groups of heterotrophic prokaryotes that are best able to metabolize particular forms of DOM. To date each side of this coupled system of production / consumption has been examined independently. A few studies have examined how limitation by different limiting nutrients affects the chemical character of the DOM produced by phytoplankton, while others have focused on the fate of DOM without detailed understanding of the mechanisms influencing its initial chemical composition. We propose to examine both sides of this coupled process simultaneously to see how different forms of nutrient limitation drive the chemical character of DOM and the

subsequent microbial response which together determine the fate of DOM produced during diatom blooms.

Craig Carlson | **11/1/2009 to 10/31/2013** | **$339,737**
National Science Foundation | OCE-0927411

Collaborative Research: ETBC: The coupling between DOM, algae, and microbes on coral reef platforms

The proposed research will investigate the coupling between primary producers and the utilization of dissolved organic matter (DOM) by marine heterotrophic microbes on coral reefs. Previous metagenomic studies of the microbial communities associated with near-pristine and degraded coral reefs demonstrated a shift from a microbial food web similar to the open ocean (Prochlorococcus spp. and SAR11-like bacteria) to a community dominated by "super-heterotrophs", most closely related to known pathogens like E. coli, Staphylococcus spp., Streptococcus spp., Enterobacter spp. and Vibrio spp. This shift is associated with a decline in coral cover and an increase in coral disease prevalence. Our previous research has also shown that dissolved organic carbon (DOC) concentrations are lower on coral reef platforms compared to measurements of offshore waters (60-80 μM). On degraded reefs, we have observed DOC measurements as low as 30 - 40 μM, a value similar to concentrations observed in the deep Pacific Ocean. The observation of low DOC measurements on degraded reefs is decoupled from the high abundance of macroalgae, which one might expect would raise levels of DOC through the release of photosynthate into the water column.

Craig Carlson | **2/1/2013 to 1/31/2016** | **$164,589**
National Science Foundation | OCE-1235024

Collaborative Research: Seawater Inorganic and Organic Carbon Measurements for the US GEOTRACES Eastern Pacific

Intellectual Merit: In this proposal, our collaborative effort is focused on collecting samples for inorganic and organic carbon on the U.S. GEOTRACES Eastern Pacific Zonal Transect will provide data between Peru and Tahiti in the eastern Pacific Ocean. Due to the influence of pH on redox chemistry, speciation and ligand-particle-TEI interactions, this region provides suitable ranges of marine seawater carbonate chemistry to investigate controls on the kinetics and dynamics of TEI's through the water-column. DOM found in natural waters includes humics, cellular exudates and organic colloidal material that contain carboxylic, phenolic and other functional groups that serve as binding sites that play a role in the complexation of some metals. Specifically, we will sample for dissolved inorganic carbon (DIC) and total alkalinity (TA), and DOC, with subsequent laboratory analyses of these samples. Highly precise and accurate measurements of DIC, TA and DOC will be provided that meet the high-bar criteria set for CLIVAR-Repeat hydrography program and U.S. time series efforts (i.e., BATS and HOT). These data allow calculation of pH and seawater carbonate chemistry (e.g., saturation sate for calcium carbonate minerals, W). Our contribution to the U.S. GEOTRACES Eastern Pacific Zonal Transect will comprise high-quality discrete water column observations of seawater inorganic and organic carbon, specifically: Seawater Seawater Carbonate Chemistry Measurements; Total alkalinity (TA); water-column hydrocast; Dissolved Inorganic Carbon (DIC); water-column hydrocast; pH (by calculation) Seawater Organic Carbon Measurements • Dissolved Organic Carbon (DOC); water-column hydrocast

In total, we anticipate 900 DIC and TA and up to 2000 DOC samples will be collected for this cruise with DIC and TA being analyzed at BIOS and DOC samples analyzed at UCSB. Post-analysis, the entire dataset will undergo standard QC/QA protocols, calculations of pH undertaken and subsequently entrained into the core dataset for the project. The US GEOTRACES Guidelines (http://www.usgeotraces.org/html/Proposal_Prep_Docs.html) lists a set of priority parameters to be measured in the Peru-Tahiti section. Both DIC/TA and DOC are included as essential parameters required by TEI investigators to help constrain removal, complexation and speciation of the TEIs.

Broader Impacts: It is widely agreed that the ocean biogeochemical research community needs a global view of the key and ancillary GEOTRACES properties. The major impact of this project will be its contribution to the U.S. GEOTRACES Eastern Pacific Zonal Transect through measurements of

inorganic carbon. This contributes broadly to improved understanding of the inorganic and organic carbon cycle in the Eastern Pacific Ocean. Although no graduate student is supported, this award will support improved skills of two research technicians, and data will be incorporated into a teaching module about the ocean carbon cycle for the Nippon Foundation-POGO Centre of excellence at BIOS and UCSB undergraduate and graduate curriculum.

Craig Carlson **5/1/2010 to 9/1/2013** **$392,501**
Gordon and Betty Moore Foundation 2553

Microbial Oceanography: The Biogeochemistry, Ecology, and Genomics of Oceanic Microbial Ecosystems

The Microbial Oceanography course at BIOS focuses on oligotrophic (low nutrient) marine systems, which represent approximately 70% of the world's oceans. The course offers students direct access to the historical field sites of Hydrostation S (1954) and the Bermuda Atlantic Time-series Study site (1988) and the extensive time-series data collected at these sites. These data provide students with a rich oceanographic context and are the basis for guided lectures, discussions, and student research. A cornerstone of this microbial oceanography course is the integration of genomic and metaproteomic approaches with the core disciplines of oceanography, and linking microbial activities to biogeochemical processes in the oceans is a central theme woven throughout the curriculum. To achieve these objectives, students carry out a novel oceanographic research project that includes a comprehensive microbial ecology study within the context of biogeochemical parameters measured routinely by established, long-term studies in the Sargasso Sea. Course components include sample collection during an overnight cruise on the Sargasso aboard the R.V. Atlantic Explorer, microscopic quantification, laboratory methods in metagenomics and metaproteomics, and bioinformatic analyses of genes and proteins identified in the Sargasso Sea.

Jennifer Caselle **6/24/2014 to 4/30/2016** **$85,281**
UC Santa Cruz UCSCMCA-14-009

Scientific Collecting Permits, Rockfish Dispersal, and Kelp Forest Monitoring

Background and Objectives: We propose to continue monitoring surveys of kelp forests inside and outside of a subset of MPAs in central and southern California initiated during the baseline characterization in 2007/2008 and 2012/2013, respectively. The proposed funding from CDFW will enable PISCO to maintain kelp forest surveys that are critical for informing MPA management, and detecting the impacts of major ecological events, such as a recent coast-wide sea star wasting event. In 2013-2014, an outbreak of sea star wasting syndrome of unprecedented geographic extent was observed from Alaska to the Mexican border. Since the first observations of mass wasting were made in central Oregon, in April of 2013, subsequent observations have shown the wasting syndrome to be widespread (if spatially heterogeneous) and to impact a number of different sea star species that occur in the rocky intertidal and subtidal kelp forests. There is also some anecdotal evidence that the wasting syndrome may be impacting urchin species, including the commercially important red urchin. Echinoderms can play an important role in structuring marine communities and when their abundances decrease by natural or anthropogenic causes (i.e. overfishing, disease), communities can experience phase shifts that may impact the abundance of a variety of commercially and recreationally important fish and invertebrate species. To date, most of the work on sea star wasting has occurred in the rocky intertidal. We propose to fill existing knowledge gaps by characterizing the short-term impacts of the wasting event in kelp forest ecosystems in central and southern California. The objectives of the work are twofold: 1. To fill existing knowledge gaps by characterizing the patterns of sea star decline in kelp forest systems in central and southern California. 2. To simultaneously survey the kelp forest community at existing PISCO sites to contribute to long-term monitoring of MPAs

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Jennifer Caselle **4/1/2014 to 12/31/2015** **$10,930**
National Geographic Society W311-14

Exploration of Apex Predators and Deepwater Biodiversity in an Unfished, Pristine Atoll

Northern California's coast has many long and pocket beaches located within the boundaries of the region's newly established MPAs. These ecosystem elements have regionally important ecological, cultural, recreational and commercial facets and are important indicators of coastal ecosystem health. The objective of this project is to provide a comprehensive baseline assessment of the biodiversity, structure and ecosystem state of sandy beaches and surf zones at the time of MPA implementation. We will 1) provide the first comprehensive, baseline description of the diversity and community structure of northern California's sandy beaches and surf zones (including wrack, macroinvertebrates, surf zone fishes and marine birds, as well as people and their activities); 2) collaborate with Smith River Rancheria and train tribal interns in monitoring methods and species identification to conduct baseline ecosystem assessment and long-term monitoring of culturally important species in their ancestral territories; 3) engage local environmental educators, schools and community volunteers (e.g., Mattole Restoration Council, Mattole Triple Junction High School, the Mattole Union Elementary School (grades 4-8) Mendocino High School), including recreational fishers (Humboldt Area Saltwater Anglers Association, Recreational Fishing Alliance), county / state agencies (Humboldt Bay Harbor Recreation and Conservation District, Mendocino Fish and Game Commission, California Department Fish and Wildlife), and commercial fishers (California Commercial Beach Fishermen's Association) to help with sandy beach and surf zone monitoring; and 4) interpret the important ecological links among sandy beach species for use in evaluating the effectiveness of northern California's MPAs in conserving the structure and function of sandy beach ecosystems.

Jennifer Caselle, Robert Warner | **9/24/2012 to 12/31/2015** | **$269,968**
The Coral Reef Alliance (CORAL) | SB130041

Understanding Coral Reef Resilience to Advance Science and Conservation

By developing a novel reef resilience model—based on synthesis of existing data and targeted new observations, and informed by a systematic analysis of management and conservation needs—scientists will have a critical new understanding of coral reef ecology and resource managers will be poised to apply this knowledge for improved conservation outcomes.

Jennifer Caselle, Steve Gaines | **1/8/2010 to 12/31/2013** | **$2,000,198**
Gordon and Betty Moore Foundation | 2420

Partnership for Interdisciplinary Studies of Coastal Oceans: Science to Policy, the Marine Life Protection Act

In an effort to prevent and reverse declining trends in coastal marine ecosystems, California is moving rapidly toward a new era of marine resource management that emphasizes consideration of the role of humans in and their influence on entire marine ecosystems, called Ecosystem-based Management (EBM). Marine Protected Areas (MPAs), by protecting and conserving all components of marine ecosystems in specific locations are one essential spatial tool for EBM. California's Marine Life Protection Act (MLPA) was passed in 1999 with the purpose of establishing a statewide network of MPAs. MLPA is using a regional approach, designating MPAs over time in 5 regions of the state's 1,100-mile coastline. Over the past decade, PISCO has played an integral role in California's MLPA effort in three main areas: MPA network design, MPA monitoring and evaluation, and communication at the science-policy interface. Here we propose to continue with those efforts in order to achieve the single Outcome of "A well-designed and effectively monitored network of Marine Protected Area's in California."

Jennifer Caselle | **7/15/2010 to 6/30/2014** | **$122,482**
National Science Foundation | OCE-1041489

CAMEO: Comparative Approach to Predicting the Consequences of an Impending Reinvasion: Top-Predator Effects on Californian Nearshore Fisheries

Using an integrative two-fold comparative approach, we will perform a (i) spatiotemporal empirical comparison of the structure and dynamics of central and southern Californian nearshore ecosystems in order to (ii) parameterize and compare the performance of three ecosystem-based approaches

for modeling the complex dynamics of these systems. Our goals are to develop analytical tools to facilitate ecosystem-based decision making and management, and to forecast how marine reserves and the impending reinvasion of sea otters to southern Californian waters will affect the region's valued fisheries.

Jennifer Caselle, Carol Blanchette | **9/1/2011 to 12/31/2015** | **$265,000**
UC Sea Grant College Program | R/MPA-23

Integrative Assessment of baseline ecological and socioeconomic conditions and initial changes within the South Coast MPA region

The SCSR of the Marine Life Protection Act is unique from other regions in several aspects. First, southern California marine ecosystems are among the best studied anywhere in the state (and, arguably, the West Coast). Second, the South coast study region is the third region in the MLPA process (after the central and north-central regions) and also follows the successful implementation of a network of MPAs in the northern Channel Islands in 2003 and now part of the MLPA network. More than other MLPA regions, a large body of both ecosystem monitoring data and a wealth of contextual data exist (e.g. oceanographic and water quality data, remotely sensed data, habitat maps). However, many of these datasets have yet to be analyzed outside of the context for which they were originally created and even monitoring data from similar habitats have yet to be combined into synthetic measures of ecosystem health. Here we have the opportunity to create the partnerships and data products that will be required in order to step up from single location or single habitat analyses and for the first time, move towards cross ecosystem syntheses to support measures of ecosystem health and MPA performance. We have developed a collaborative group that has committed to the goals of synthesis among our various individual projects. The key innovation of our proposed approach is the collaborative nature of the program, which should carry forward in the design, databases and analyses for a more comprehensive and integrated long-term monitoring program. The collaborative and integrated characterizations of separate ecosystem features will also facilitate outreach efforts that transcend individual features and, by including collaborations with the fishing (consumptive) and recreational (consumptive and non-consumptive) sectors, strengthen collaborations of future monitoring programs.

Jennifer Caselle | **9/1/2011 to 6/30/2015** | **$269,804**
UC Sea Grant College Program | R/MPA-27B

South Coast MPA Kelp and Shallow Rock Ecosystems: Baseline Data Collection and Long-term Trends Using Historical Data

Our approach to creating a baseline characterization of kelp and shallow (0-30m depth) ecosystems in the MLPA South Coast Study Region (SCSR) involves (1) new surveys of targeted elements of kelp forest and rocky reef ecosystems using SCUBA and (2) analysis of existing historical datasets on rocky reef communities. Sampling will address all kelp and shallow rock ecosystem Vital Signs (Ecosystem Feature Checkup) and Key Attributes (Ecosystem Feature Assessment) as designated by the Monitoring Enterprise (ME) in the Monitoring Plan for the South Coast MPA Baseline Program with the exception sea otters and predatory birds. Our proposed sampling design and protocols are a geographic extension of comparable design and protocols that are being used to generate baseline characterizations of kelp and shallow rock ecosystems in the Central Coast Study Region (CCSR) and the North Central Coast Study Region (NCCSR). Further, the study design and protocols were also employed in the network of MPAs in the Northern Channel Islands (NCI), which were implemented in 2003 and now form part of the SCSR. Results from these methods were incorporated into the successful five-year data review of the NCI MPAs (Airame and Ugoretz 2008; Hamilton et al. 2010). We propose to maintain similarities in the design and protocols to maintain standardization across the Study Regions until necessary changes in design or sampling protocols are identified.

Jennifer Caselle | **4/1/2012 to 3/31/2015** | **$212,846**
UC Santa Cruz | UCSCMCA 12-005

Regional Importance of Manmade Structures as Rockfish Nurseries

1) Assist in establishing sampling design for field surveys: Using the geodatabase developed by USGS and the recommendations obtained from the workshop on best approaches and statistical methods for geospatial analyses, the subcontractor (UCSB) will assist USGS in developing a field sampling design to determine, at the appropriate regional scale, the relative importance of nursery habitat created by offshore energy structures for commercially important rockfishes.

2) Conduct field surveys: The subcontractor (UCSB) shall oversee field surveys conducted according to the sampling design established in Task 1. The field survey data shall be incorporated into the geodatabase. The field surveys shall collect biological information, and in particular juvenile fish density, concurrent with geological data. At each sampling unit "visual vouchers" shall be collected by recording underwater site characteristics with photographic images. These images can be linked to the geodatabase and referenced at a later date to determine if geological features influence patterns or rates of long term change in biological communities.

Jennifer Caselle | **3/30/2012 to 12/31/2015** | **$525,000**
Marisla Foundation | 1-12-065/3

Coral Reef Research in a Rare, Undisturbed Ecosystem: UCSB and Palmyra Atoll

The Marine Science Institute at UCSB requests continued funding to remain a member of the Palmyra Atoll Research consortium for 2012-2014 in order to continue and expand our research programs focusing on coral reef ecosystem resilience and conservation. The major outcomes will be a better understanding of how healthy coral reef ecosystems function in the face of climate change and knowledge to inform conservation practices globally.

Celia Churchill, Todd Oakley | **4/1/2014 to 3/31/2016** | **$9,654**
Australian Museum | SB14014

Interactions Between a Crustacean and an Alga: The First Marine Arthropod with Photobionts?

Relationships between marine invertebrates and photobionts (photosynthetic endosymbionts) are not only fascinating biologically, they can comprise the energetic foundations of marine ecosystems (1, 2). Representatives of many invertebrate metazoan phyla house photobionts, yet while this evolutionary strategy appears successful over a wide taxonomic breadth, the number of times it has evolved is rare (3). Because of their often critical ecological roles and sensitivities to environmental perturbations, photosynthetic holobionts serve as ecosystem indicators (4). On a recent trip to Lizard Island Research Station, I found an undescribed philomedid ostracod (Ostracoda: Philomedidae) that appears to have photosynthetic endosymbionts (Fig. 1a). Upon initial examination, this species has an unusually colorless and translucent carapace, and a greenish hue is present both on the inner carapace membrane and on the ostracod's body. Removing one of the shells reveals that each fossa of the carapace has an associated spot of green algae on the inner carapace membrane (Fig. 1b), and that the spots on the body are not in the gut, but around the gut (Fig. 1c) and in some of the limbs (Fig. 1d). To date, there are no known photosynthetic holobionts involving a marine arthropod. A postdoctoral fellowship to conduct field work at LIRS so that I may characterize the type of algae present in this remarkable ostracod, and test whether the ostracod sources nutrition from the alga.

Christopher Costello, Steven Gaines, Robert Deacon | **2/1/2012 to 9/30/2014** | **$206,288**
Washington Sea Grant | R/SOC-01-F-1/2

Social and Economic Effects of ITQs on the West Coast Groundfish Fishery: Solving the Weak Stock/Bycatch Problem

The objectives of the proposed work dovetail with several key WSG priorities: (1) Maintain the vitality of coastal communities, particularly balancing economic growth with sustainable use of fishery resources: Our modeling analysis will examine social, economic and ecological outcomes of different management approaches to identify options that meet this important triple bottom line for fishing communities along the West Coast. (2) Identify social and economic impacts and benefits of fishing: Our empirical analyses will identify the short-term social and economic impacts and

benefits of a transition to IFQ management in the West Coast Groundfish fishery, while our modeling work will suggest likely longer term impacts and benefits of this and other key management changes (consolidation caps, spatial closures, etc.). (3) Understand ecosystem effects of fishing: Bycatch of weak stocks compromises the health of marine ecosystems and our modeling results will demonstrate the range of circumstances under which risk pools or other shifts in fleet behavior can overcome this challenge. Both our empirical and modeling work will inform effective internal rules for risk pools. This will result in a novel contribution to the scientific literature and a practical and cost-effective approach to protecting ecosystem integrity. (4) Evaluate alternative management approaches for fisheries: Our simulation modeling of "policy experiments" will inform near-term management changes for the West Coast Groundfish fishery, while also providing a framework for other US fisheries that may similarly benefit from reform. We will communicate the results of this project through numerous scientific publications and presentations to fishery managers, fishermen, and regulators. This project will also provide training in cutting-edge science at the interface of bioeconomic modeling, empirical analysis and fishery management to two graduate students.

Christopher Costello | **9/1/2011 to 8/31/2016** | **$125,705**
University of Washington | UWSC6489

CNH: Diversification, Portfolio Effects, and the Sustainability of Fishing Communities

This proposal concerns the bioeconomics of fishery management under uncertainty, a topic that Professor Costello has focused on for his past 11 years at UCSB. Costello's primary role will be to develop and implement analytical and statistical models to address the research proposal's key themes. Specifically, Costello will play a leading role in developing and implementing models of salmon fishery management strategies that explicitly cope with environmental variability, tradeoffs between ecosystem sustainability and economic performance of salmon fisheries management, and how capital investment in salmon fisheries is influenced by environmental stochasticity. What follows is a brief description of Costello's role in each of these themes: Theme 1: Salmon Management with Environmental Variability. The key research question here concerns how management decisions can influence the ecological and economic consequences of a variable environment. Alaska's salmon fisheries are notoriously variable, largely due to highly stochastic interannual and decadal-scale fluctuations in the environment that affect reproduction, recruitment and growth. Ignoring this variability in the determination of management strategies can have severe consequences to both fishermen's livelihoods and to fish stocks themselves. Costello's role will be to develop and implement dynamic stochastic optimization models that predict and inform optimal management of this bioeconomic system. These models will be parameterized with data from other aspects of the project and will be implemented in Matlab. Theme 2: Tradeoffs between sustainability and economic performance. Any given management strategy will deliver both an ecosystem outcome and an economic performance. This theme concerns the tradeoff between those two. It is sometimes argued that these two always go hand-in-hand: higher economic performance is always coupled to positive ecological outcomes. While it is widely acknowledged that a collapsed fishery cannot produce optimal economic outcomes, it is not so obvious that a fishery managed for optimal economic performance results in strong ecological condition. Costello will develop stochastic models of decision-making under uncertainty to address this theme. He will also develop a tradeoff analysis which provides a graphical depiction of the tradeoff between ecological and economic objectives for different strategies for managing salmon fisheries in Alaska. These are analytical and computation approaches, and Costello will develop both theoretical insights and practical solutions for this particular study region. Theme 3: Capital Investment in Stochastic Fisheries. Salmon fisheries are notoriously capital intensive. Processing salmon requires large plants that depreciate rapidly. These plants are expensive to build and maintain, and must be sufficiently large to handle the large volumes of fish that are landed in short periods of time. This theme addresses the question of how much harvest capacity is efficient, and how much harvest capacity would we expect from the private sector. Risk and variability in harvest size over time both influence these questions. Costello's role will be to model capacity investment in Alaska's salmon fisheries and to predict the capacity investments we would expect from the private sector under different management approaches. The results of

these models will inform management of Alaska's salmon fisheries. This work is both analytical and computer-based. Costello will work by himself to accomplish these tasks. Pending other funding sources, there may be funds to hire a PhD student or post-doc to work with Costello on these items. Costello will also be a central player in the larger research team. He will travel to Alaska annually, and will collaborate with other personnel to achieve the broader goals of this ambitious research project.

Christopher Costello **12/31/2012 to 12/31/2015** **$1,661,324**
Steven Gaines
Waitt Family Foundation SB130076

Sustainable Ocean Solutions through Rights-Based Management, Fisheries Certification, and Marine Protected Areas

The Sustainable Ocean Solutions (SOS) project, made possible by the generous support of the Waitt Foundation, combines three important tools for ocean sustainability – rights-based management reform, marine protected areas, and demand-side incentives – into novel solutions for the world's fisheries challenges. When employed individually, these three instruments can only successfully tackle a small percentage of ailing fisheries worldwide. A central challenge is to develop fisheries management systems to facilitate synergies among these approaches, thus capitalizing on their complementary strengths while overcoming their individual weaknesses. Although the necessary elements may differ across fisheries and settings, by combining changes that affect the supply of fish (such as catch shares), with conservation measures (such as MPAs), and tools that change consumer demand (such as fisheries certification), fisheries, communities, and ecosystems can simultaneously prosper. Our approach This project uses a two-pronged approach, focusing on 1) research and development, determining how and in what contexts to combine the sustainability tools of marine protected areas, property-rights based management, and demand-side incentives, and 2) demonstration projects, strategically selected as proofs of concept, which, if successful, will be scalable across the globe. The demonstration projects will link our research and development expertise with innovative partners who have proven skills at implementing reform in national and international settings.

Carolynn Culver **12/1/2011 to 9/30/2014** **$25,000**
Collaborative Fisheries Program 12-54

Developing a Collaborative Volunteer Network for Expanding Biotoxin Monitoring in California: Improving Seafood Safety

The goal of this project is to improve seafood safety of commercial and recreational fisheries in California by improving monitoring of biotoxins. Objectives are fourfold: 1) develop a coordinated network of collaborators to expand biotoxin sampling in southern California; 2) develop effective, efficient, user-friendly sampling, communication and reporting protocols, 3) train collaborators and pilot test network program, and 4) identify needs for HAB outreach materials for the fishing community. The overarching research question is: Can the existing CDPH monitoring program be expanded and enhanced through the development of a collaborative network of volunteers from fishing and coastal communities?

Carolynn Culver **8/1/2011 to 1/31/2016** **$56,806**
UC Sea Grant College Program

A/EA-14CC-F-1

Sea Grant Extension Program Funds

Culver: Sea Grant Extension Program Funds This award is in support of Dr. Culver's Sea Grant Extension program. This program is focused on discovering and transferring science-based

knowledge to help California and its residents better balance the competing needs of using and conserving coastal and marine resources for future generations. Funds will be used to support activities and operating expenses for her research, education and extension program. Some funds are allocated toward support staff that will assist Culver with program activities, including undergraduate assistance with assembling and processing of samples and office support. General operating expenses are also included for such things as telephone, duplication, IT support.

Carolynn Culver, Andrew Brooks | **9/1/2011 to 8/31/2014** | **$99,447**
USDA | 2011-34103-30856

Minimizing Impacts to Urban, Agricultural and Natural Water Systems: Evaluating Biocontrol Agents for Invasive Eurasian Mussels

This research project addresses integrated pest management for invasive quagga (Dreissena bugensis), and potentially zebra (D. polymorpha), mussels that impact agricultural, urban and natural freshwater systems throughout the Western Region. Our goal is to evaluate the feasibility of fish predators as site specific (not system-wide) biological control agents for quagga mussels. Objectives include: 1) determining whether the planktivorous threadfin shad, Dorosoma petenense, can minimize mussel infestations through predation of larval mussels and 2) evaluating whether the carnivorous Red-ear Sunfish, Lepomis microlophus, can reduce mussel infestations through predation of juvenile and adult mussels. We will contain these fishes in experimental cages with substrates and quantify mussel infestations on the substrates over time. Differing substrate orientations, water depths and mussel densities will be examined to address variability in mussel infestations in the Western Region. Commonly used mussel control methods (mechanical removal, chemical applications) are problematic for systems in the Western Region that largely serve as water sources for humans and/or are open systems. Biocontrol agents offer an ecologically sound solution for minimizing pesticide use, as well as human contact required to remove mussels mechanically. This approach supports W-RIPM program priorities by investigating methods that protect environmental quality, reduce health risks associated with application of management strategies to drinking water and irrigation systems, and provide an additional tool that targets multiple life stages of a pest through an integrated management program. It also addresses a high priority research need identified by the Western Regional Panel of the federal Aquatic Nuisance Species Task Force.

Carolynn Culver | **7/1/2012 to 3/31/2015** | **$220,907**
Stephen Schroeter
UC Sea Grant College Program | R/OPCCFRW-2A-S

Integrating Collaborative Data Collection with Management: A Lobster Fishery Test Case

This project addresses the critical need for cost-effective ways to gather essential fisheries information for managing California's fisheries. Our team of fishermen, managers and scientists will work together to test the feasibility of integrating a collaborative at-sea sampling program, where fishermen collect data at sea and are engaged in its interpretation and forming associated recommendations, with the fisheries management process. Our objectives include: 1) determining the key regulatory, administrative and operational features of established collaborative fisheries data collection programs, 2) developing a robust sampling design with associated protocols for the lobster fishery, 3) designing, testing and modifying the components of a collaborative at-sea sampling program, and 4) developing a plan for sustaining the program into the future. By addressing these objectives we will utilize established programs to inform development of a program appropriate to California; develop sampling protocols that ensure appropriate, accurate data are collected; develop data management protocols for handling and sharing the collected data; and identify ways to fund and administer the program for the long term. Such an accomplishment may move collaborative fisheries research to a new level, where it can provide continuous, high-quality information for managing diverse fisheries, not solely to address a specific management question.

Carolynn Culver | **4/11/2014 to 12/31/2014** | **$32,400**
United Water Conservation District | SB140158

Assisting with Quagga Mussel Management Activities in Lake Piru

We propose to assist with the management of quagga mussel infestation at Lake Piru using an integrated pest management (IPM) approach. While eradicating may be achieved down the line, the goal of these efforts is to greatly reduce the quagga mussel population to minimize recolonization of mussels throughout the lake.

Carla D'Antonio **9/1/2010 to 8/31/2015** **$587,453**
National Science Foundation DEB-1029168

Long Term Impacts of Grass Invasions and Fire on Community Change and Plant Soil Feedbacks

Ecologists generally lack knowledge about the long-term effects of biological invasions, and how invader-induced changes in ecosystem processes may alter the potential trajectory of a site. While it is often assumed that invasions exist in persistent alternative stable states, it may also be the case that the impacts of invaders will shift over time such that exotic species no longer reinforce their own dominance. In Hawai'i Volcanoes National Park (HAVO), exotic grasses invaded seasonally dry forests in the 1960s, altering plant communities both via direct competitive interactions with native species and by promoting a new type of disturbance, fire. In the short-term, N-limited grasses facilitate themselves by establishing higher N cycling rates and fire frequencies. Therefore, exotic grasses maintain their dominance through suppression of native species recruitment early in succession, creating a stable condition in which restoration is extremely difficult. This proposal hypothesizes, that in the long-term, a lack of native species lowers plant uptake of N, leading to overall N losses from the system, especially in the absence of fire. This scenario would lower soil nitrogen availability ultimately leading grasses to decrease their own dominance via changes in ecosystem function. In essence, positive feedbacks between invaders and ecosystem function may change to negative feedbacks. If this has occurred, it is unclear whether the lower N availability will favor recovery of native species or invasion by a new suite of invaders. The research will evaluate species composition and nitrogen cycling in burned grass-invaded sites that were studied in detail in the 1990s but which have not yet burned again. To ask how N cycling has changed over time, net soil N fluxes, as well as plant net primary productivity and N uptake, will be tracked over two years in burned and unburned sites. These data will then be compared to historical data taken between 1994 and 1996 offering a rare test of the long-term ecosystem impacts of biological invasions. Next, this proposal evaluates the long-term effects of fire and invasion on plant community composition with a set of competitor removal, fertilization, and seedling outplanting experiments. These specifically ask how changes in soil N cycling alter the ability of invaders to remain dominant, for new invaders to establish, or for native species to re-establish.

Carla D'Antonio, Nathan Emery **7/1/2013 to 12/31/2015** **$16,766**
National Science Foundation DEB-1311605

Dissertation Research: Fog and the Fire Regime in Southern California Shrublands

Research objectives: Fire is a well-studied disturbance that has had important ecological and evolutionary influences on species and environments around the world. One region with regular fire disturbance is the Mediterranean-type climate region of California. Characterized by cool, wet winters and prolonged summer drought, wildfire in these areas is typically high intensity and has dramatic ecological and economic consequences. A common climatic event along the coast of California is seasonal fog which may provide additional moisture for shrubs during the summer drought. My dissertation research will take a multi-scale approach evaluating how fog affects key variables controlling the fire regime focusing on shrubs in the Santa Barbara region and on regional scale patterns along the California coast. As part of understanding how fog influences the fire regime, the proposed research will focus on two main questions: (1) Do chaparral and coastal sage scrub species in this region use fog water? and (2) How can we improve the soil water evaporation correction applied by studies of plant water relations using stable isotopes of Hydrogen and Oxygen?

Methods and Analysis: To address the first question, I will extract water from soil and plant samples collected in 2011, 2012 and 2013 and send them to UC Berkeley for stable isotope analysis. I will chose which samples to extract and analyze based on my field data quantifying fog deposition

and live fuel moisture of the shrub species at my field sites. I will compare changes in xylem water signatures between dates with substantial versus minimal fog deposition. The isotopic data will be corrected for soil water evaporation and analyzed with a two-part mixing model to determine the proportion of fog water use for the each species. For the second question I will follow protocol of previous studies but sample from deeper into the soil profile to establish the depth at which soil evaporation fractionation occurs. This sampling will focus on three times of year, and will establish separate soil evaporation corrections based on depth and time of year. All of these samples will be extracted in a cryogenic vacuum extraction system and analyzed at the Stable Isotope Facilities at UC Berkeley. The results will be used to calculate proportional fog water use (Question 1) and determine the accuracy of this type of correction. Intellectual Merit: Understanding fire disturbance regimes in Southern California is a high priority for science and society because of the high costs of fighting and recovering from fire. My dissertation will establish the relationship between fog and fire while informing the greater scientific community about the controls on fire patterns in coastal California. This study will effectively connect changes in source water to changes in live fuel moisture content, a critical component of the National Fire Danger Rating System as well as numerous fire modeling efforts. The soil water evaporation correction is used for studies of water isotopes in semi-arid ecosystems. The proposed research will improve upon this established technique to further the field of stable isotope ecology. Lastly, this study will be the first attempt to connect a rarely studied climatic event, fog, to disturbance regimes.

Broader Impacts: (1) The results from this study will enter the scientific discourse through publications and conference presentations at the local and international scale. (2) I plan on submitting my isotopic data to the Global Network for Isotopes in Precipitation. (3) I will present my work at local and regional venues where fire managers will be present (e.g. Santa Barbara Botanic Garden lecture series and working groups on fire). (4) I have a deep commitment to involving undergraduates in research and mentoring them, especially underrepresented groups. In addition to mentoring undergraduates, I will continue to work with outreach programs offered through UCSB for mentoring young scientists including high school students. The proposed research will involve several undergraduate interns and high school mentees in the lab during the school year and in the field during the summer season.

Frank Davis, Stephanie Hampton **10/1/2006 to 9/30/2013** **$18,402,599**
National Science Foundation DBI-0553768

NCEAS: National Center for Ecological Analysis and Synthesis

The National Center for Ecological Analysis and Synthesis (NCEAS) was established in 1995 in recognition of the need for a facility where ecologists and scientists in allied disciplines could collaborate to conduct multidisciplinary research. The Center's mission is to advance the state of ecological knowledge through the use of existing information, organize and synthesize ecological information to make it useful to all users, and to influence the way in which ecological research is conducted by promoting a culture of synthesis and collaboration. The Center supports three primary modes of research – working groups (2-20 individuals interacting to address important questions), Postdoctoral Associates (15-18 per year) and Center Fellows (4-6 sabbatical visitors per year). Because research at NCEAS relies on using existing information, the Center is involved with many collaborators to develop generic data access tools for a broad user community, from student and resource managers to scientists (www.nceas.ucsb.edu/ecoinformatics).

Frank Davis **12/20/2012 to 8/31/2015** **$2,473,305**
Gordon and Betty Moore Foundation 3530

NatureLab: NCEAS core support and capacity building

The purpose of the grant is to fund NCEAS core scientific and administrative activities needed to support NatureLab, which is a joint effort by NCEAS, The Nature Conservancy and the Wildlife Conservation Society to create and operate a global center of excellence focused on knowledge generation to sustain nature and human well being. Some GBMF funds will also be used to enlarge NCEAS' capacity in development and communications to help NCEAS and NatureLab achieve long term financial viability.

Frank Davis | **11/18/2013 to 1/31/2014** | **$7,950**
USDI Fish and Wildlife Service | F14PX00095

Peer Review Process Associated with the Proposed Rule to List the Mexican Wolf as an Endangered Species and Delist the Gray Wolf Elsewhere

The US Fish and Wildlife Service (Service) has proposed changes to the status of North American wolf species and subspecies under the Endangered Species Act. Management of the various wolf taxa depends upon a clear understanding of the 'best available science' on the issue. The peer review process will be sponsored and conducted by the National Center for Ecological Analysis and Synthesis (NCEAS), University of California, Santa Barbara. Dr. Steven Courtney, a NCEAS associate, will donate his time to structure and manage the process. NCEAS will vet prospective reviewers to verify that they are able to provide an objective review and have no conflict of interest, culminating in the selection of 5-7 well-qualified scientists with professional qualifications and relevant expertise in at least one of the following areas: conservation biology, management of large carnivores, wildlife management, and mammalian taxonomy/systematics. Peer reviewers will be subject only to those basic qualifications, with particular attention to individuals with experience applying these disciplines to conservation of the gray wolf, and no scientist, including the 16 scientists who wrote to the Secretary criticizing the subject proposal, will be excluded from consideration by NCEAS. The vetting and selection of peer reviewers will occur completely outside the influence of the Service. The peer reviewers will prepare individual memoranda summarizing their opinions and conclusions; these memoranda will be incorporated into a final peer review report that will be compiled by NCEAS and submitted to the Service. The peer review report will be posted to the Service's public web site (http://www.fws.gov/home/wolfrecovery) and to www.regulations.gov during an open public comment period so that public comment on our proposed rule can also be informed by the independent scientific peer review. NCEAS will set up a peer review process that is transparent, science based, fair, and well documented. Reviewers will convene at NCEAS for a day of guided discussions on the scientific materials. They will then each write an individual review. The reviews will be collated by Dr. Courtney into a final report, with a description of the review process, and submitted to the Service. The peer review report will be posted to the Service's public web site (http://www.fws.gov/home/wolfrecovery) and to www.regulations.gov during an open public comment period so that public comment on our proposed rule can also be informed by the independent scientific peer review.

Daniel Dawson, Susan Swarbrick | **7/6/2012 to 6/30/2016** | **$1,412,000**
Department of Cal Ra Fish and Game | WC-1183CF

Infrastructure and Facility Improvements at the Sierra Nevada Aquatic Research Laboratory (SNARL)

The Sierra Nevada Aquatic Research Laboratory (SNARL) is a unit in the University of California Natural Reserve System (NRS) administered by UC Santa Barbara (UCSB) and located near Mammoth Lakes, California, along the eastern escarpment of the Sierra Nevada mountains. The station was established in 1935 and has served as an experimental site and as a base of operations for research across a large part of the Sierra Nevada, eastern California and western Nevada. Researchers from throughout the US are regular users of the facilities, and the studies range widely among the life and physical sciences. By commonly used metrics (user¬days, publications in peer-reviewed journals) the station is very well used, highly productive, and of national caliber. Facilities at SNARL are possibly the most extensive in the UC NRS and are generally in excellent or very good condition. The laboratory building, constructed in 1962 with an addition in 1987 was remodeled this year as part of this project. This $529,275 project was funded by a combination of U.S. National Science Foundation and donor funds and is part of the match for this proposal. Valentine Camp, another unit in the UC NRS is located approximately 15 miles west of SNARL adjacent to the Town of Mammoth Lakes. The two sites are jointly administered as Valentine Eastern Sierra Reserve (VESR). Dan Dawson, the Principal Investigator on this project, has been the Director of the two sites since 1979. Valentine has different attributes and habitats that make it an excellent complement to SNARL. As the facilities at SNARL support activities at Valentine, a portion of accumulated Valentine endowment funds are available for this project. With this project we propose to complete Phase 2 of our Master Plan by

replacing some aging infrastructure and constructing a single new building at SNARL. Specifically we propose to: *Replace the concrete control structures in Convict Creek that are part of our one-of-a¬ kind experimental stream system; *Grind, reshape, and repave our existing asphalt roadway and parking areas; * Install a new water line and power line under the road and parking areas; * Construct a new classroom/lecture hall adjacent to other facilities.

Anthony De Tomaso | **11/1/2009 to 10/31/2013** | **$680,872**
National Science Foundation | IOS-0842138

Evolution of Allorecognition in a Basal Chordate

Allorecognition is the ability of an individual to discriminate its own cells and tissues from those of another individual of the same species, with examples found in nearly all multicellular phyla. This phenomenon is ultimately based on the presence of highly polymorphic gene products, and is thus dependent on the creation and maintenance of genetic diversity. Polymorphisms at allorecognition loci are extraordinary and their presence is unlikely to be explained by neutral evolution. However the origins and persistence of these recognition systems are not well-understood.

Thomas Dudley | **11/29/2010 to 11/29/2015** | **$476,000**
USDI Fish and Wildlife Service | F11AC00779

Research and Restoration Through the Santa Clara River Reserve: A Proposal to Develop a University of California Research and Education Station

The objective of the Santa Clara River Reserve project is to build a multi-functional station to provide facilities, infrastructure and an institutional framework to carry out environmental studies and natural resource policy research that integrates existing information with newly acquired data to support conservation of biodiversity, ecosystem processes and agricultural sustainability in the SCR watershed. The broad mission of our University of California program in the Santa Clara watershed consists of three general objectives: Research Station Development: Build the organizational structure to locate, design and develop the financial basis for, and implement the construction of the dedicated research station and reserve; Research and Education: Develop a research program that integrates existing resource information and undertakes or facilitates new research and monitoring initiatives that promote biodiversity conservation and agro-ecosystem sustainability; Riparian Restoration: Evaluate and implement comprehensive restoration programs, in concert with regional partners, to reduce impacts of invasive species, biological pollutants, and other stressors to enhance the structure and function of floodplain ecosystems and protect habitats for native terrestrial and aquatic species.

Thomas Dudley | **11/1/2012 to 4/30/2014** | **$83,500**
Gila Watershed Partnership | SB130093

Upper Gila Watershed Riparian Restoration Project

The Colorado Basin Restoration Science Team, comprised of scientists from Stillwater Sciences, Northern Arizona University, the Desert Botanical Garden and University of California, Santa Barbara, is collaborating with the Gila Watershed Partnership (GWP) of Arizona to develop a comprehensive restoration framework for the upper Gila River watershed. The GWP requested and has received funding from the Walton Family Foundation's (WFF) Freshwater Initiative, and this Work Plan concerns the sub-award from that grant to the University of California to carry out elements of the framework as described below. The proposed restoration framework, which will be developed in anticipation of the decline of tamarisk in response to biocontrol by the tamarisk leaf beetle, will guide implementation of an Ecohydrological Restoration Action Feasibility Assessment to identify suitable restoration locations and methodologies along the flood prone, ecologically sensitive upper Gila River. We also propose to implement, in co-operation with qualified regional partners, an ecosystem monitoring program across restoration sites, including control sites (native-dominated, no-treatment tamarisk). The scientifically rigorous monitoring and evaluation program, developed in the Virgin River watershed for the WFF and Southwestern Willow Flycatcher (SWFL) Technical Advisory Committee and adapted for use in the Gila River watershed, is valuable for determining the effectiveness of restoration actions for enhancing SWFL habitat, and to document responses

of other key ecosystem functions (soil and water status, habitat for other wildlife species, reduced wildfire risk, etc.) critical to improving riparian health in Colorado Basin riparian ecosystems. The overarching goal of the Restoration Framework is to promote recovery of native riparian habitat and subsequent local increases in SWFL populations, and, ultimately, to re-establish their metapopulation structure across the greater Colorado River Basin. Satisfying this goal will enable sustained survival of this endangered species (and other sensitive riparian and aquatic wildlife) and facilitate its future de-listing. Meeting this goal will involve development of a restoration framework that maximizes the likelihood of creating sustainable native riparian vegetation in a cost-effective manner, while simultaneously building the capacity of local communities to support and participate in achieving restoration success. As with our approach currently being applied to the ecologically similar Virgin River, the primary objectives of the restoration framework program on the upper Gila River are to: 1) Conduct a restoration action feasibility assessment that identifies appropriate locations in the upper Gila River watershed for sustainable riparian restoration, based on ecological and hydrological factors. Integrate vegetation and wildlife status into the restoration framework to promote natural plant recruitment processes and enhance the capacity of SWFL and other protected species to respond based on current distributions and habitat associations. Organize plant propagation capacity for riparian restoration applications using genetically appropriate native plants. 2) Implement an ecosystem assessment protocol to evaluate progress toward program objectives and to apply adaptive management to enhance the likelihood of success in achieving those objectives. Develop a tamarisk biocontrol monitoring and evaluation program for the Gila River in anticipation of future establishment of the tamarisk leaf beetle. Secondary, but important goals for the restoration program are to improve specific watershed functions, such as enhancing groundwater resources and reducing environmental risks to property, human health, and ecosystems by minimizing potential for wildfire and flood-related erosion and sedimentation of the river channel.

Jenifer Dugan, Mark Page **9/1/2011 to 6/30/2015** **$260,897**
UC Sea Grant College Program R/MPA-24A

Sandy Beach Ecosystems: Baseline Characterization and Evaluation of Monitoring Metrics for MPAs along the South Coast of California

Sandy beaches and adjacent surf zones are important foraging areas for shore birds and fishes that feed on intertidal invertebrates. The amount of wrack and plankton cast onto beaches is dynamically linked to adjacent ecosystem features, ocean climate and the reproductive output of invertebrates. The condition of beach ecosystems is also linked to the reproductive success of beach-nesting fishes and birds. These links are the critical pathways through which direct and indirect effects of MPA implementation and variation in ocean climate will cascade, making sandy beaches an important target for long-term monitoring to assess ecosystem condition and functioning of the SC region. Sandy beaches are also used extensively for a variety of recreational activities, including shore-based fishing, clamming and bait collection, beachcombing, dog-walking, jogging, sunbathing, surfing, swimming, volleyball and other sports, birding, and picnicking. We will: provide a comprehensive, baseline description of the biodiversity of sandy beaches of the SC region using both new and historical/existing data develop informative ecosystem indicators and a plan for long-term monitoring of the network of MPAs involving citizen scientists (e.g., students, LiMPETs, recreational fishers, members of conservation clubs) and collaborations with similar established volunteer groups in the region (e.g., Audubon etc.), and interpret the important ecological links among the components of this and other ecosystem features, including humans, for use in evaluating the effectiveness of the network of MPAs.

Jenifer Dugan **10/1/2013 to 3/31/2015** **$18,200**
San Francisco State University Foundation S13-0008

Improved Valuation of Impacts to Recreation, Public Access, and Beach Ecology from Shoreline Armoring in California

Task 1: Kick Off Meeting 1. Conduct an in person kick off meeting with all consultants and Commission staff involved in the project to discuss project objectives, deliverables, schedule, and the expectations of the consultants. Task 2: Development of Ecological Valuation Method 2.1 Conduct

a review of: a) The ecological components and features of beaches and the existing information on qualitative and quantitative responses (losses) of these ecological resources to impacts imposed by shoreline armoring. A report that identifies the ecological resources and features of beaches that respond to shoreline armoring and qualitatively describes the state of existing knowledge on impacts to (losses of) these ecological resources that occur when a shoreline is armored, identifying information gaps and needs. b) The tools/models/methods that have been or could be applied in the valuation of beach ecological resources (identified in 2.1 (a)) to account for the quantitative and qualitative impacts to (losses of) these resources that can result from shoreline armoring (identified in 2.1 (a)). The tools, models, and methods could include (but are not limited to) Natural Capital Project InVEST models, Habitat Equivalency Analysis, Standard Assessment Methodology, Compensatory Mitigation Value-Transfer, Hedonic Analysis, and Spatial Analysis. A report that describes the various tools, models, and methods that could be applied in the valuation of the beach ecological resources and the impacts to (losses of) these resources from shoreline armoring. For each method detail the analytical steps, an assessment of the data needs and feasibility of obtaining that data, describe the parameters that must be measured for use in the analysis, and describe the output that results from the method 2.2 Meeting/Consultation: Present to/consult with Commission staff on the outcomes of 2.1 (a) and (b) and the conclusions regarding the best approach to pursue for a beach ecological valuation method. Get direction from Commission staff on the feasibility and utility of the chosen approach. 2.3 Ecological Valuation Method: Based on the outcomes of 2.1 & 2.2, initiate development of an ecological valuation method to estimate the ecological value of California beaches that can be used to assess the ecological impacts/losses (as a quantifiable currency; e.g. USD, number of acres, amount of larvae, biomass) associated with specified changes to the beach resulting from shoreline armoring. Armoring changes could include direct loss of the beach from encroachment, loss of new sand to the beach and littoral cell from preventing inland erosion, or progressive loss of the beach due to sea level rise against a fixed back beach. Document the rationale supporting the chosen approach including the feasibility and utility of the proposed approach for economically valuing beach ecology. Depending on the state of the ecological method development, show application of the method through one or more case studies that are not active Coastal Commission projects A report of the ecological valuation method and rationale for the method, including the analytical steps, the parameters that must be measured for use in the analysis, how to obtain the necessary measurements, and the outputs that will result from the method. If feasible based on the state of the ecological method development, include a write-up of one or more case studies demonstrating application of the method to specific situations Write Up Final Report The team will write up a final report incorporating memos and research discussed above. The report will be thorough enough to cover clearly all issues and information required by this Scope of Work.

Jenifer Dugan | **2/1/2014 to 1/31/2016** | **$7,475**
Pepperdine University | SB150118

A New Method for Monitoring Urban Beach Ecosystems

Task 1: Develop a list of indicators suitable for use in volunteer-based beach monitoring Task 2: Develop methods and field test protocols for volunteer-based beach monitoring of selected indicators Participate in meetings of the project team during 2014 to identify and select indicators and to develop non-invasive methods and protocols for monitoring selected indicators. Participate in field testing of monitoring protocol for selected indicators: work with the project team to assess beaches using the new protocols in 2014, with comparisons and discussion of reliability for quality control. Contribute to production of overall project deliverables: List of indicator species/taxa for southern California beaches Set of field protocols suitable for use by volunteers in monitoring beaches Task 3: Develop draft field guides, protocols and materials for use by volunteers in monitoring Work with project team and a graduate student (sea grant trainee) to develop and produce materials to be incorporated in a field guide and protocol manual for beaches With project team, evaluate and test field guide and protocol manual Participate in revising and refining draft field guide and protocol manual based on feedback from field testing Contribute to production of overall project deliverables: A draft field guide and protocol manual for use by volunteers in monitoring beaches

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Jenifer Dugan **7/15/2013 to 7/28/2016** **$50,000**
USDI National Park Service P13AC00900

Wave-Exposed Sandy Beach Invertebrate Staining and Mark-Recapture

The primary objectives for the proposed study are to:

Objective 1: NPS and UCSB to conduct reconnaissance surveys of beaches near Santa Barbara to identify the locations most likely to yield invertebrates and the species of invertebrates available from these areas for use in the project. The field reconnaissance surveys will be conducted by both NPS PM and UCSB PI or their appointed representatives, likely with a small net like a 8 or 10 inch aquarium net and/or corers and mesh bags, unless NPS travel restrictions prevent NPS participation. This objective should occur during June, July or August 2013, unless NPS travel restrictions delay the travel into FY2014.

Objective 2: UCSB to perform stain trials on a variety of California sandy beach crustaceans to eliminate species that do not take up and retain the stain well and those with high mortality resulting from stain exposure; stain trials will attempt to include one (1) to three (3) species each of isopods, amphipods, mysid shrimp, and mole crabs [20 individuals per species, 20 minute stain exposure to 50 mg L-1 neutral red, stain retention and mortality evaluated against controls after 72 to 96 hours].

Objective 3: NPS and UCSB to rank the available invertebrate species as to suitability for further research based on the reconnaissance and stain trials. Ranking with include stain & mortality suitability (%), order of magnitude abundance (10x), distance-cost to location (km), simplicity to locate and sample, and ease to identify.

Objective 4: UCSB to develop a stain procedure in the laboratory that can later be tested for field mark-recapture studies of top ranked sandy beach invertebrate(s) based on staining methods of Drolet and Barbeau 2006.

Objective 5: UCSB to determine the speed and variation in burrowing time for top ranked invertebrate released onto wet native beach sand under varying submergence conditions in a laboratory setting.

Objective 6: Conduct field mark-recapture population estimates that determine how wide ranging in distance, time and invertebrate density (as indexed by CPUE) the staining can be effectively used for mark-recapture of the top ranked invertebrate. Objective 6 may require pilot studies close to the laboratory facility to test and refine field methods.

Objective 7: Make and provide rate of dispersal, population estimate and CPUE calculations and regression for top ranked invertebrate(s).

Objective 8: Compare the efficiency of size based sorting techniques for live invertebrates at beach sampling location vs. a controlled setting, specifically speed and accuracy of sorting adults from recruits in beach population samples. Objective 8 to be conducted during a time period when some recruits are present in the population. UCSB will conduct the sampling and counting; NPS will consult on sampling design and assist as requested on statistical analysis and short report. The controlled location could be a laboratory, motel room, vehicle or tent where invertebrates could be held and sorted carefully, and by dissecting microscope if necessary. Cold temperatures and anesthetics will be utilized to slow the animals for counting in preference to killing the organisms for counting.

Objective 9: Compare the efficiency of determining reproductive status in samples of live invertebrates at the beach sampling location vs. a controlled setting, specifically the speed and accuracy of determining reproductive status of the top ranked invertebrate adults in sandy beach population samples. Objective 9 to be conducted during a time when > 5% of adult females are carrying young or eggs. UCSB will conduct the sampling and counting; NPS will consult on sampling design and assist as requested on statistical analysis and short report. The controlled location could be a laboratory, motel room, vehicle or tent where invertebrates could be held and sorted carefully, and by dissecting microscope if necessary. Cold temperatures and anesthetics will be utilized to slow the animals for counting in preference to killing the organisms for counting.

Objective 10: Prepare and present a webinar on sandy beach invertebrate ecology and mark-recapture population estimates to NPS staff, academics and interested public. (Note: webinar will be posted on

NPS website for future viewing by interested parties.) Objective 10 will occur after Objectives 1-7.

Objective 11: Conduct pilot training of sampling techniques developed during this project at one NPS site. Participants in the training exercise will include project partners, NPS staff and university students. Travel to a park, likely Golden Gate National Recreation Area or Point Reyes National Seashore, and spend 12 hours demonstrating and training participants in field staining, CPUE, and mark-recapture of sandy beach organisms; size based sorting and determination of adult reproductive condition. Training would include a first attempt at participants collecting actual data in a park (i.e., CPUE and mark-recapture regression, size-sorting and reproductive data). Objective 11 will occur after objective 1- 10 unless the ATR determines otherwise. An outcome of training will be a documented training approach that can be shared with researchers, land managers and the public.

Objective 12: Share results of this project with the public, NPS units and other interested parties through the NPS Water Resources Website and the NPS Integrated Resource Management Applications (IRMA) Portal https://irma.nps.gov/App/Portal.

Jenifer Dugan **5/1/2009 to 12/31/2015** **$37,500**
California Coastal Commission SB090092

Evaluating Status and Trends in California's Sandy Beach Ecosystem

California's beaches are highly valued for recreation and tourism. Less appreciated is the role of beaches as ecosystems that support unique and rich biodiversity. The fate of California's beaches in the face of rising sea levels and continuing population growth prompts this research. This research project will investigate ecological changes in sandy beach ecosystems in southern California over the past 30 years and evaluate potential causes using comparisons of historic and modern information on ecological communities of beaches. This project will calibrate historically used and modern sampling methods, collect new data at a subset of historically sampled beach sites and archive the historic and more recent physical and ecological data needed to evaluate the status and trends in biodiversity and ecological conditions of sandy beach ecosystems in California. These comparisons will be used to provide baseline information needed for management and assessment of the impacts of climate change and human activities on sandy beach ecosystems.

Jenifer Dugan **3/1/2010 to 12/31/2013** **$60,236**
UC Sea Grant College Program R/MPA-14

Baseline Monitoring of Ecosystem and Socioeconomic Indicators for MPAs along the North Central Coast of California – Sandy Beaches

Sandy beaches and adjacent surf zones are important foraging areas for shore birds and fishes that feed on intertidal invertebrates. The amount of wrack and plankton cast onto beaches is dynamically linked to adjacent ecosystem features, ocean climate and the growth rates and reproductive output of invertebrates. These links are the critical pathways through which direct and indirect effects of MPA implementation and variation in ocean climate will cascade, making sandy beaches an important target for long-term monitoring to asses ecosystem condition and functioning of the NCC region. Sandy beaches are also used extensively for a variety of recreational activities, including shore-based fishing, bait collection, beachcombing, ATVs, surfing, birding, dog-walking and picnicking. We will 1) provide the first comprehensive, baseline description of the biodiversity of sandy beaches of the NCC region, 2) develop informative ecosystem indicators and a plan for long-term monitoring of the network of MPAs involving citizen scientists (e.g., students, recreations fishers, members of conservation clubs) and collaborations with similar established volunteer groups in the region (e.g., Gulf of the Farallones Beach Watch program), and 3) interpret the important ecological links among the components of the ecosystem, including humans, for use in evaluating the effectiveness of the network of MPAs.

Jenifer Dugan | **2/1/2014 to 1/31/2017** | **$45,000**
UC Sea Grant College Program | R/MPA-38D

The Ecological State of Northern California's Sandy Beaches and Surf Zones: A Baseline Characterization for MPA

Northern California's coast has many long and pocket beaches located within the boundaries of the region's newly established MPAs. These ecosystem elements have regionally important ecological, cultural, recreational and commercial facets and are important indicators of coastal ecosystem health. The objective of this project is to provide a comprehensive baseline assessment of the biodiversity, structure and ecosystem state of sandy beaches and surf zones at the time of MPA implementation. We will 1) provide the first comprehensive, baseline description of the diversity and community structure of northern California's sandy beaches and surf zones (including wrack, macroinvertebrates, surf zone fishes and marine birds, as well as people and their activities); 2) collaborate with Smith River Rancheria and train tribal interns in monitoring methods and species identification to conduct baseline ecosystem assessment and long-term monitoring of culturally important species in their ancestral territories; 3) engage local environmental educators, schools and community volunteers (e.g., Mattole Restoration Council, Mattole Triple Junction High School, the Mattole Union Elementary School (grades 4-8) Mendocino High School), including recreational fishers (Humboldt Area Saltwater Anglers Association, Recreational Fishing Alliance), county/state agencies (Humboldt Bay Harbor Recreation and Conservation District, Mendocino Fish and Game Commission, California Department Fish and Wildlife), and commercial fishers (California Commercial Beach Fishermen's Association) to help with sandy beach and surf zone monitoring; and 4) interpret the important ecological links among sandy beach species for use in evaluating the effectiveness of northern California's MPAs in conserving the structure and function of sandy beach ecosystems.

John Engle | **4/14/2010 to 4/30/2015** | **$186,269**
UC Santa Cruz | M10AC20000

Shoreline Assessment of changes in Southern California Rocky Intertidal Communities

This project comprises the UCSB portion of a multi-campus Bureau of Ocean Energy Management (MMS) program to assess long-term changes in rocky intertidal habitats in California. The primary Cooperative Agreement exists between MMS and UCSC, with subcontracts extended to other State of California institutions. The UCSB portion of the MMS Rocky Intertidal Program will be conducted by the Principal Investigator (PI), with help from a laboratory assistant. The work will consist of coordinating communications for the Multi-Agency Rocky Intertidal Network (MARINe), providing network information to others, maintaining standards for network protocols, overseeing network database operations and websites, and facilitating other interactions between MMS and MARINe. As the MMS/MARINe coordinator, the PI will interface with network Steering Committee, Data and Science Panels, and participating organizations to enhance productivity by organizing meetings and resolving technical issues, including species taxonomy and survey methodology. In addition to coordinating MARINe information management to promote analysis, synthesis, and publication, the PI also will maintain the network internal website, plan updates to the public website, and assist MARINe members in testing and implementing field surveys as well as laboratory, and data management procedures. The principle product of this project is coordination and facilitation of activities by others who will produce and update a variety of products including a standardized data management system, private and public internet sites, reports, publications, and oral presentations. In addition, the principal investigator will produce the following: Minutes of meetings of Steering Committee, Science Panel, and Data Panel meetings. Updated information for placement on MARINe websites. Updated summary lists of MARINe presentations, reports, and scientific publications. Updated field data entry forms for core MARINe protocols. Updated Unified Protocol Handbook for MARINe.

Melanie Fewings, Libe Washburn | **7/22/2010 to 7/21/2014** | **$634,694**
NASA | NNX10A094G

Satellite and Land-Based Remote Sensing of Atmospheric Wind Relaxations and the Oceanic Response in the California Current Large Marine Ecosystem

Along the West Coast of North America in the California Current Large Marine Ecosystem, episodic relaxation of prevailing summertime upwelling-favorable winds causes warm water to propagate northward along the coast. These wind relaxations are an important characteristic of coastal upwelling systems worldwide. Although atmospheric wind relaxations have an important influence on coastal ocean dynamics, no description exists of the regional atmospheric patterns that lead to wind relaxations in central and southern California. We will use NASA remote sensing and reanalysis products, together with existing oceanographic observations, to describe the evolution of the atmosphere and coastal ocean color, temperature, and currents during upwelling relaxation events in this region.

Erica Fleishman | **12/7/2007 to 4/15/2014** | **$1,280,807**
Gordon and Betty Moore Foundation | 1454

Prediction of Responses of Wild Pacific Salmon to Climate Change

Climate is a major driver of the geographic distribution and abundance of salmon. It is occurring globally, but there has been no organized effort to evaluate its potential effects, and potential management responses, on populations of salmon and their ecosystems. Empirical evidence shows that climate affects the viability of Pacific salmon, with cascading effects on human communities. However, predicting the effects of climate change on Pacific salmon is complicated by obstacles to downscaling coarse-grained climate models, resolving uncertainties in climate change scenarios, and understanding mechanistic responses of salmon and their resources to climate. Experts have identified high-priority research topics and developed a strategic framework for conducting targeted analyses. The National Center for Ecological Analysis and Synthesis (NCEAS) will conduct synthetic research on the following high-priority research topics: identification of mechanisms that limit the geographic range of salmon populations and exploration of how these mechanisms may adapt under projected scenarios of climate change; development of monitoring programs to identify changes in populations of Pacific salmon and attribute them to potential mechanisms, including climatic change; examination of the relative importance of evolutionary and plastic responses of Pacific salmon to climate change; and classification of salmon populations along a gradient of sensitivity or resilience to climate change, along with potential management and conservation strategies that may benefit salmon populations along that gradient under alternative future climates.

Steve Gaines | **11/1/2013 to 2/28/2016** | **$228,125**
Conservation International Foundation | 64762

Marine Spatial Planning (MSP) and Lobster Fishery Reform for the Galapagos

The purpose of this project will be to provide lasting solutions for marine spatial planning and fisheries management in the Galapagos. A key component of the marine spatial planning project will be to assess the long-term planning needs of the Galapagos and provide recommendations for the development of tools to best address these needs. Given these needs, we will help guide stakeholders towards a useful next step in the MSP process, whether though training in our own models or through exploring the development of user-friendly tools in a web-based marine spatial planning tool. Training workshops will be held as part of this product to ensure local technicians are capable of independently conducting ongoing MSP work using the tools developed through this grant. Under the fisheries management component of this project, it is unlikely that sufficient capacity exists among the local stakeholders to replicate formal stock assessments on an annual basis. As such, the goal of our data-poor assessment work will be to design fishery management tools that can feasibly be continued without SFG's ongoing involvement given local capabilities. By helping identify critical types and quantities of data required to provide science based management of the lobster fishery, this project will help make the current monitoring system more efficient and cost effective. The result will be a tool specifically intended for long-term use in fishery management by local stakeholders.

Training workshops will be held as part of this product to ensure local technicians are capable of independently conducting ongoing data-poor assessment work using the tools developed through this grant.

Steven Gaines | **5/1/2005 to 10/31/2013** | **$6,495,699**
Department of Commerce | NA05NOS4291158

Ocean Science Education Building, Phase I

As a collaboration between the Channel Islands National Marine Sanctuary (CINMS) and the University of California, Santa Barbara (UCSB) the proposed Ocean Science Education Building will function as both an Outreach Center for Teaching Ocean Science (OCTOS) and the primary administrative office for operation of the sanctuary (CINMS). The combination will be a unique learning center that brings together science process, environmental policy, and the human connection by focusing on the special marine ecosystem of the Channel Islands. OCTOS will be a state-of-the-art educational facility that connects invited participants to the Channel Islands National Marine Sanctuary and the Marine Science Institute at the University of California, Santa Barbara through compelling, hands-on programming. A goal of the project is for the building to be designed and constructed to a gold LEED standard, serving as a demonstration for sustainable design.

Steven Gaines, Robert Warner, Libe Washburn, Carol Blanchette, Jennifer Caselle | **1/1/2012 to 12/31/2013** | **$188,910**
Oregon State University | F0720A-C

Understanding the California Current Large Marine Ecosystem under Climate Change: Delivering Sound Science for Policy

Dr. Kirsten Grorud-Colvert, located at Oregon State University (OSU), will work together with Dr. Jennifer Caselle at University of California, Santa Barbara (UCSB) to analyze data from a decade-long time series of juvenile fish recruitment and adult fish population dynamics coordinated by the Partnership for the Interdisciplinary Studies of Coastal Oceans (PISCO). Dr. Grorud-Colvert will have primary responsibility for data analyses and manuscript preparation, working closely with project PI Dr. Caselle to ensure accuracy of results.

Steven Gaines, Sarah Lester | **7/1/2013 to 12/31/2013** | **$75,000**
Rare | SB140038

Fish Forever: Launching Pilot Sites in Belize, Philippines, and Indonesia

Background: Environmental Defense Fund, Rare, and the Sustainable Fisheries Group at UCSB formed the Fish Forever partnership to launch a global initiative to protect and recover nearshore fisheries, curb overfishing and safeguard the food security and economies of thousands of communities in the developing tropics. Fish Forever's theory of change is that by aligning the social and economic interests of fishermen with conservation, fishermen become agents of long-term change because they reap direct rewards. Central to our approach is the proven TURF-Reserve system that combines spatial property rights with marine reserves where fishing is off-limits. This system gives fishermen a built-in incentive to defend reserves because the reserves replenish fisheries and the rights-based system ensures that good management is in the self-interest of local communities. Fish Forever brings together three experienced organizations that are uniquely positioned to achieve lasting, scalable conservation solutions across multiple communities and countries. All have strong track records of success. Environmental Defense Fund (EDF) is a global leader in transforming fisheries through rights-based management, and provides technical expertise and practical experience in designing and launching these systems. Rare specializes in engaging developing country communities to adopt more sustainable behaviors, and builds the capacity of organizations and governments to generate support for change through Pride campaigns. University of California, Santa Barbara (UCSB) brings expertise in fisheries science and innovative biological and economic assessment and management techniques, including for data-poor stocks. Together, we are poised to begin on-the-ground work in Indonesia and the Philippines, and to launch additional pilot projects in Belize. Launching pilot sites in Belize, Philippines and Indonesia: During the second half of 2013, the Fish Forever team will create or build on TURF-reserve pilot sites in three countries (Indonesia,

Philippines, and Belize). These sites will serve as working laboratories to produce tangible results but also test a variety of new tools and approaches. They will serve as model sites where others can come to see the program in action. Learning at these sites will inform the program development and enhancements. The Sustainable Fisheries Group (SFG) at UCSB will serve a key role in providing the scientific analysis and guidance needed to make sure these pilot sites are successful. See Deliverables (Exhibit B) for specific scientific contributions that SFG will make during the launch of pilot sites in these three countries.

Steven Gaines | **2/1/2014 to 1/31/2016** | **$98,121**
UC Sea Grant College Program | R/ROC-03B-F

Spatial Redistribution of Fishing Effort: Identifying Drivers and Testing Model Predictions for Informing Expectations in Marine Spatial Planning

This project will identify and test factors affecting the redistribution of fishing effort following marine protected area (MPA) establishment at CA's Northern Channel Islands, and develop an empirically-validated model of fishing effort redistribution that can be used in calculating expectations of ecological and socioeconomic effects of MPAs, including the new MPAs in CA that are undergoing their first review process this decade. The proposed investigations will consist of the following main steps: 1. Develop hypotheses from theory and syntheses of literature for the factors affecting redistribution of fishing effort following MPA establishment. 2. Gather, organize and process data for CA Northern Channel Islands, including data for the factors hypothesized to affect distributional patterns of fishing effort (fish density and habitat data), and observed patterns of fishing effort (boat monitoring data). 3. Construct multivariate models for hypotheses developed in item 1. 4. Test the hypotheses through performance evaluation, and identify the model(s) expected to be most useful for estimating and forecasting MPA effects on fishing effort redistribution. 5. Synthesize and communicate findings with interested scientists, managers and stakeholders at conferences and meetings, and through a peer-reviewed publication.

Ben Halpern | **9/1/2012 to 6/30/2014** | **$966,737**
Conservation International Foundation | SB130035

Developing an Ocean Health Index, 2012-2013

Funding for the Ocean Health Index project for 2012-2013 is to support application of the framework developed in the previous grant for global assessment to regional cases in the USA, Brazil, and Fiji; analyses and drafting of multiple topic-specific papers that emerged from the global assessment; outreach and dissemination of results, including development of a software tool that will be used to connect the project to on-the-ground managers. The scope of work includes support for the lead scientist (Dr. Halpern), a project scientist (Dr. Longo), a computer analyst (Dr. Hardy), a tool developer (recently hired -- Dr. Best), and a research assistant (C. Scarborough).

Ben Halpern | **2/26/2014 to 11/14/2014** | **$123,323**
UNESCO | 4500231601

GEF Transboundary Waters Assessment Programme: Large Marine Ecosystems and Open Oceans

GEF Transboundary Waters Assessment Programme (TWAP): Large Marine Ecosystems and Open Ocean Components The work being conducted for the TWAP project includes the following tasks and outputs: 1. Description of Work performed by CMAP (at UCSB) i. Summarize cumulative human impact scores for individual LMEs, using primarily the existing data (to be updated where feasible); ii. Calculate area-weighted averages of country OHI scores to produce scores for each LME; iii. Update cumulative human impact scores for Open Ocean areas (dependent on how many new data layers are available), with projections where possible (physical climate projections will be available from WCRP, fish catch potential projections will be available from Sea Around Us, and other layers as possible); iv. Calculate Ocean Health Index scores for the Open Ocean (High Seas), if possible; v. Participate in working group meetings and teleconferences as required (travel for one expert will be covered under a separate budget); vi. Draft required text for the individual (LME and OO) assessment reports; and contribute to finalization of the reports based on peer review comments.

Ben Halpern **5/20/2013 to 6/30/2014** **$146,310**
Gordon and Betty Moore Foundation 3538

Evaluating Interest and Capacity to Apply the Ocean Health Index in the Moore Foundation's Conservation Initiative Focal Regions

This grant supports one year of planning activities to scope the potential for developing an Ocean Health Index (OHI) for four focal geographies in North America so that managers and stakeholders, including other grantees, can track the impacts of their work on ocean health over time. As part of this planning grant, researchers will scope data availability in each geography, evaluate the interest of stakeholders and decision-makers in the OHI, and evaluate the gaps/existing capacity/suitability of applying OHI in each region.

Benjamin Halpern **11/21/2011 to 7/31/2013** **$40,535**
Kimberly Selkoe, Carrie Kappel
Gordon and Betty Moore Foundation 2897

Identifying Thresholds, Developing Key Indicators, and Operationalizing their Use in CMSP

Coastal and marine spatial planning is emerging as a primary tool for implementing ecosystem□ based management on the west coast of North America and in other parts of the world. As decision-makers begin to develop marine spatial plans for the west coast, they are faced with the problem of how to define objectives for the ecosystem, and how to evaluate whether the management actions they take are working towards and meeting those objectives. Identifying key ecological and socio□ economic thresholds, where small changes in conditions produce large and sometimes abrupt responses in ecosystem state or function, remains a fundamental scientific and management need. In addition, knowing where such nonlinearities do not exist is as important as knowing where they do exist, as the former situations require value judgments rather than science to set a target, or desired state, for management. Relying on our team's extensive ecological, social, legal and policy experience in the region, we will use a two□phase research program (Phase 1: characterize thresholds, Phase 2: develop indicators) book□ended by participatory processes to develop a framework and tools to inform and guide nascent marine spatial plans in the California Current and British Columbia, as well as a general approach that can be applied to CMSP processes elsewhere. The planning grant is strategically designed to hone and refine the ideas and approach to be taken in a full project. Members of our team have been instrumental in developing all of the five foundational research themes listed in the RFP and have a deep familiarity with nearly all available data for the region. We are uniquely poised to rapidly and comprehensively advance the science needed for understanding ecosystem thresholds and integrating them into management decision□making.

Benjamin Halpern **10/15/2013 to 12/31/2013** **$36,900**
UNESCO 4500219162

GEF Transboundary Waters Assessment Programme: Large Marine Ecosystems and Open Oceans

IOC-UNESCO will be executing the Large Marine Ecosystem (LME) and Open Ocean components of the Global Environment Facility (GEF) full size project (FSP) of the Transboundary Waters Assessment Programme (TWAP). The objective of the FSP, which is expected to begin in January 2013 and run for two years, is to conduct a baseline, comparative global assessment of all 64 LMEs (and where possible the Pacific Warm Pool), and an assessment of the Open Ocean. These assessments will be carried out in collaboration with institutional partners identified in 2009-2011 during the TWAP Medium Size Project (MSP), and using the methodologies developed during the MSP and existing updated datasets. IOC-UNESCO will contract the institutional partners to contribute to the assessments, in line with their specific roles agreed during the MSP and the Project Preparation Grant phase. The LME assessment results are expected to be presented in a synthesis report focusing on a global comparative assessment of all LMEs based on integration of the relevant indicators, with results for individual LMEs presented on a web-based indicator platform. The Open Ocean assessment report is expected to consist of a web-based mapping and interactive indicator platform,

as well as a synthesis report and policy-focused material on global ocean-related environmental issues and their local impact. The Center for Marine Assessment and Planning (CMAP), based at University of California Santa Barbara (UCSB), is a common partner in both the LMEs and Open Ocean components and will carry out cumulative human impacts mapping and provide the Ocean Health Index (OHI) for these two components. 1. Description of Work performed by CMAP (at UCSB) i. Summarize cumulative human impact scores for individual LMEs, using primarily the existing data (to be updated where feasible); ii. Calculate area-weighted averages of country OHI scores to produce scores for each LME; iii. Update cumulative human impact scores for Open Ocean areas (dependent on how many new data layers are available), with projections where possible (physical climate projections will be available from WCRP, fish catch potential projections will be available from Sea Around Us, and other layers as possible); iv. Calculate Ocean Health Index scores for the Open Ocean (High Seas), if possible; v. Participate in working group meetings and teleconferences as required (travel for one expert will be covered under a separate budget); vi. Draft required text for the individual (LME and OO) assessment reports; and contribute to finalization of the reports based on peer review comments.

Stephanie Hampton **12/1/2011 to 1/1/2014** **$355,488**
Ocean Conservancy SB120078

Marine Debris: Scale and Impact of Trash in Ocean Ecosystems

Widespread claims of islands of trash in the middle of the ocean have received significant media attention and have stimulated strong public emotions. Legislators across the country and globe are rushing to ban plastic bags because of the threat they cause to marine life and the land-based litter problem. However, at present there is no credible science behind these large-scale public and government actions. We propose a working group from the National Center for Ecological Analysis and Synthesis (NCEAS), hosted at NCEAS but supported with external funding, to develop the scientific theory of marine debris. Marine debris is described as any manufactured object discarded, disposed of, or abandoned that enters the marine environment. In the last decade there has been an increase in the number of scientists researching marine debris and in the publication of peer-reviewed literature. However, because the discipline is still emerging, a comprehensive analysis of the large-scale ecological impacts on ocean environments and associated marine life does not exist. This proposed working group will bring together a group of leading ecologists, oceanographers, social scientists, industry market experts, behavioral economists, and plastic polymer scientists to evaluate existing data and published information and to conduct integrative modeling that will significantly advance the scientific understanding of marine debris globally. To construct the theory of marine debris incorporating the needs of nonscientific constituencies, this working group will accomplish the following goals: 1) compile and synthesize existing information to determine how much harmful debris is in our ocean; 2) compile and synthesize existing information to determine impacts of marine debris on ocean populations and ecology; 3) compile and synthesize existing information to determine impacts of marine debris on human populations; 4) identify the three most prominent sources/items of plastic debris for which behavior-oriented solutions can be implemented; and 5) analyze research regarding efficacy of policy solutions such as plastic bag bans as they relate to ocean trash items. Working group participants will include active marine debris researchers as well as academics who are leaders in their respective fields but have not yet applied their skills to the marine debris problem. The working group will collaborate with industry scientists and consultants who have access to large market data sets that have yet to be incorporated into marine debris analyses on large-scale ocean ecosystems. We have secured funds to buy these data in order to integrate them into working group models and analyses to yield unprecedented results. The working group will provide significant outreach of the scientific results to nonacademic audiences. The resources of NCEAS will make it possible to bring these experts together to ascertain a comprehensive understanding of marine debris and to create a scientifically based and solutions-oriented philosophy to address ocean trash.

Stephanie Hampton **1/1/2008 to 12/31/2013** **$1,150,000**
David and Lucile Packard Foundation 2007-31848

Development and Application of Scientific Knowledge to Ecosystem-Based Management of

Coastal Marine Systems

Ecosystem-based management typically is defined as an integrated approach to management that considers the entire ecological, physical, and socioeconomic system. Such a definition engenders little controversy but is difficult to translate into operational guidelines, explicit objectives, and clear measures of success. The National Center for Ecological Analysis and Synthesis (NCEAS) aims to develop scientific knowledge about ecological and socioeconomic processes that affect management and legislative regulation of coastal–marine ecosystems. The particular emphasis is to examine, both conceptually and via empirical evidence, how such knowledge can be transferred effectively to planning, decision-making, and implementation at different scales and in different geographic locations worldwide. This project builds on work conducted from 2004 to 2007 to advance and synthesize scientific understanding needed to support an ecosystem-based approach to managing coastal marine systems. This phase involves a portfolio of complementary activities including scoping workshops with practitioners, working groups, postgraduate training, and informatics support for working groups and the Packard Foundation's seven regional ecosystem-based management initiatives. These activities will be amenable to development and implementation of communication strategies that inform policy, management, and public behavior.

Stephanie Hampton **7/1/2012 to 6/30/2014** **$128,008**
National Science Foundation DUE-1140911

Toads, Roads, and Nodes: Collaborative Course-Based Research on the Landscape Ecology of Amphibian Populations

We propose to link networks of undergraduate ecology and conservation biology courses to study the factors that promote the persistence of amphibian populations at landscape and regional scales. Using existing data from the North American Amphibian Monitoring Program (NAAMP) and satellite imagery from Google Earth, students in 10 classes will relate the presence/absence of amphibian species in their own state or region to landscape features such as forest cover, road density, and urbanization. Representatives from each class will then bring their data to a meeting at the National Center for Ecological Analysis and Synthesis (NCEAS) to compile and analyze them at the national scale. In the first year of the project, classes will examine the effects of current landscape features on amphibian distributions. In the second year, classes will use older satellite imagery to discern the residual effects of past land use on amphibians and determine the lag time over which forest loss and road construction affect amphibians. In each project year, students will engage with a complete piece of scientific research from hypothesis to conclusion, and each year's project should result in a research publication. With respect to assessment, the multi-year, multi-class structure of our project will allow for strong inference about the impact of the project on student attitudes and abilities.

Stephanie Hampton **8/1/2010 to 7/31/2013** **$41,559**
National Science Foundation OCE-1041705

Collaborative Research: CAMEO: Comparative Analyses of Natural and Human Influences on Coral Reef Community Structure, Diversity and Resilience

Coral reefs are among the most diverse and productive marine ecosystems, but are also among the most threatened by human activities. At the local scale, fishing and land-based sources of pollution can directly alter the structure of reef communities, and at the global scale, the effects of climate change and ocean acidification are expected to impose episodic and chronic stresses to even the most remote reefs. To most effectively implement ecosystem approaches to the management of coral reefs, it is critical to understand the pathway by which reef 'health' is degraded and the functional consequences of these changes. The Pacific Islands region is NOAA's largest geographical management area, and includes much of the nation's most biologically diverse and pristine coral reef ecosystems. The Coral Reef Ecosystem Division (CRED) of NOAA PIFSC has been monitoring the coral reef ecosystems of over 50 U.S. Pacific islands in the central and western Pacific since 2000. The Pacific Reef Assessment and Monitoring Program (RAMP) provides a methodologically consistent set of data with which to use comparative approaches to address fundamental questions of the role of ecosystem organization and structure in maintaining ecosystem resilience. The sampling design spans across space, time and multiple gradients of anthropogenic disturbance allowing for replicated

tests of the effects of local versus global stressors on the current status and recovery of these systems from human disturbances. Analysis of Pacific RAMP data will provide an unprecedented view of how anthropogenic activities affect coral reef community structure, diversity, and dynamics in the U.S. Pacific.

Stephanie Hampton | **9/15/2011 to 8/31/2015** | **$348,737**
National Science Foundation | DEB-1136637

Dimensions: Collaborative Research: Lake Baikal Responses to Global Change: The Role of Genetic, Functional and Taxonomic Diversity in the Plankton

Anthropogenic global change is profoundly altering most Ecosystems on Earth. Understanding how ecological communities will re-organize under global change is one of the main challenges facing ecologists today. Responses of communities will depend on the underlying genetic and functional diversity within and across species, as well as on the taxonomic diversity within communities. Here we will characterize these different aspects of diversity in the plankton of Lake Baikal, the oldest, largest (by volume) and most diverse lake in the world. Lake Baikal's planktonic food web is dominated by endemic species that are sensitive to changing climate and other anthropogenic stressors. These organisms fuel the rest of Baikal's incredibly diverse biota making responses of the plankton crucial to understanding how Lake Baikal ecosystem will respond to global change. We will repeatedly sample Lake Baikal to characterize the spatial, seasonal and interannual variability of each of three aspects of biodiversity (taxonomic, genetic and functional). For taxonomic diversity, we will compare microscopic and molecular approaches and genetic diversity, we will assess the population structure of the ecologically important endemic and cosmopolitan species of both phytoplankton and zooplankton. We will characterize key functional traits for different species and strains (i.e., cell/body size distributions, growth rate responses to temperature, light and nutrients, grazer susceptibility and grazing rates) and compare these traits to the genetic diversity of endemic vs. cosmopolitan species. The genetic information and functional trait distributions of focal plankton species will then be used to parameterize novel mathematical models of plankton communities, allowing us to predict how they will reorganize in the future. We will explore whether, due to limited genetic and functional diversity and narrow thermal niches, endemic species will be unable to adapt to changing conditions and be replaced be cosmopolitan species, resulting in a shift in size structure and energy transfer efficiency. A unique 60-year dataset on plankton dynamics will be used to test the models, independently infer ecological preferences of species, and relate species replacements to environmental drivers and community composition. The results and approach of this project will be applicable to other systems with high diversity and endemism, as well as to other polar and subpolar aquatic environments undergoing rapid warming.

David Herbst | **5/1/2014 to 12/31/2015** | **$246,993**
Roy F. Weston, Inc. | 0087111

Bio Assessment Study Support for Leviathan Mine Superfund Site, CA

The overall Objective of this agreement is to provide technical services to support the US Army Corps of Engineers (US ACE) and the US Environmental Protection Agency Leviathan Mine Superfund project for Biological Assessment of Leviathan Creek. Tasks include supporting EPA sampling for aquatic biological assessment using stream benthic macroinvertebrates, quality assurance of laboratory enumeration of collected samples, and consulting with the government on taxonomy and field sampling. These data will form the basis for evaluating the progress and success of stream ecological recovery associated with remediation activities undertaken on the mine site and runoff from treatment facilities into Leviathan and Aspen Creeks. All reporting associated with data analysis will be performed under separate contract.

David Herbst | **8/14/2012 to 6/30/2014** | **$229,990**
USDI Fish and Wildlife Service | F12AC00654

Walker Lake Cooperative Research

Benthic and planktonic organisms have reliable protocols for their estimation, and the objectives

below provide a more comprehensive approach to understanding the food web, annual changes, and achievable ecological states.

1) Continue to track benthic community ecology to assess health, diversity and productivity of lake. Standardized monitoring program for shallow littoral habitats along 8 west shore sites at intervals timed to obtain population demography data for the benthic invertebrate community. Sublittoral Ekman surveys in deeper water zones in June and September will also be conducted.

2) Define food web interactions and changes over time. Establish primary paths of energy flow using (a) stable isotope analysis of food web: continued collections of benthic algae, detritus, different invertebrate species, phytoplankton, and fish tissue (possibly expand tissue analysis to birds and bats in conjunction with NDOW Jenni Jeffers, and continued collaboration with Karie Wright for seasonal collections of Tui Chub tissue), and (b) dissection and examination of gut contents of preserved benthic insects from previous years of sampling. Examine pelagic-benthic trophic coupling relative to role of phytoplankton-derived nutrition (using stable isotopes).

3) Follow between-year variations in thermal environment expressed as degree days of development time and altered population phenology. Temperature regime monitoring continued (using thermistor probe loggers) to contrast population dynamics under high and low inflow years.

4) Define conditions when Hyalella could recover. Hyalella amphipods were once dominant under lower salinity conditions and likely an important food source to early life stage LCT and Tui Chub under higher lake level conditions. What is their salinity tolerance and growth under acclimation? Experiments conducted using Walker River-derived population.

5) Establish patterns for the abundance of benthic algae that provide the base of the littoral food web in Walker Lake. Survey the standing crop and composition of benthic algae in seasonal samples from rocks of the processed invertebrate samples. This is the missing component thus far in tracking community productivity. Methods: Composition by depth zones within littoral, and changes in biomass by season and site using the algae removed from rocks during processing of invertebrate samples (algae biomass as grams ash-free dry mass, chlorophyll per unit area, and relative abundance of filamentous algae, diatoms, and cyanobacteria).

6) What water birds are using the nearshore lake environment at different times of the year and what feeding activity is apparent? Prior to invertebrate surveys at each sampling date, a survey of birds present within the visual radius of each site will be conducted. These will be counts by species, determined using binoculars and a spotting scope. Feeding behaviors and locations will also be noted to assess the use of the lake as a foraging ground for different birds and seasons.

David Herbst, Scott Cooper | **9/24/2012 to 12/31/2016** | **$185,000**
USDA Forest Service | 12-JV-11272139-070

Aquatic Invertebrate Research for Experimental Watersheds in the Kings River System

Samples of benthic invertebrates will be collected from the lower regions of the streams draining the experimental headwater catchments in June of 2013, using a standard D-frame collection net (30 cm wide, 250 μm mesh). This is the spring following the summer (2012) that thinning treatments will be put in place. If funding is available, we will also sample stream invertebrates in treated and control basins in June of 2014, September 2014, and June 2015, after both tree thinning and controlled burn treatments have been completed. As in previous collections, invertebrates will be gathered from riffle habitats by pooling the contents of three cross-channel D-net samples from each of three separate riffles within a defined 100-meter reach (total area = 9 square feet or 0.81 square meters), and from pool habitats by combining single D-net samples from each of 3 separate pools within the reach (total area = 3 square feet or 0.27 m2). Each square-foot (30 x 30 cm) area is sampled for a standard 60 seconds, by turning and rubbing rock and debris surfaces in riffles, with the current carrying all dislodged material and organisms into the downstream net, and by stirring bottom pool substrata and using sweeping hand motions to sweep dislodged and suspended pool material and organisms into the D-net. Each of the composited riffle and pool samples are processed in the field by rinsing, cleaning and discarding rocks, leaves, wood, moss, and lichens after collecting any clinging invertebrates, elutriating remaining material to collect invertebrates, then hand-picking the remaining sand to remove mineral-case caddisflies, mollusks, and any other heavy invertebrates.

These processed samples are preserved in 90% ethanol and stained with Rose Bengal to aid in later laboratory sample sorting. Each composited riffle and pool sample is subsampled in the laboratory using a rotating-drum sample splitter to sequentially divide the sample into fractions to obtain 500 to 1000 organisms which are then sorted, identified and counted. All invertebrates are identified to the level of genus or species (including midges and water mites) with the exception of oligochaetes (segmented worms) and ostracods (seed shrimp), which are not further distinguished. These studies are conducted in collaboration with the Pacific Southwest Research Station of the US Forest Service in Fresno (Carolyn Hunsaker, project leader). The annual and seasonal data collected over the pre-treatment period forms a baseline for establishing current, natural variability in stream invertebrate communities. These data are currently being analyzed and prepared for publication. The proposed research, then, will allow us to compare statistically these pre-treatment baseline data to post-treatment data to determine how stream invertebrate communities respond to tree thinning in their basins.

David Herbst **2/8/2013 to 12/31/2014** **$150,000**
Cal EPA Water Control Board 12-074-130

Pajaro River Contract #12-074-130

Pajaro River sediment-bioassessment study plan The goal of this project is to provide a comprehensive picture of aquatic health of the Pajaro River and its tributaries with respect to sediment loading. This will be accomplished through aquatic invertebrate bioassessments and associated measures of stream bed substrate particle distributions, sediment deposition, and embedded rock. Variations in the level of fine+sand (FS) deposition at reach- and patch-scales within 25 sites in the watershed (and adjacent drainages) will be used to provide guidance for developing numeric targets of water quality attainment. How these FS levels relate to associated benthic macroinvertebrate metrics (diversity, etc.) will be used to assess impairment of biological integrity. Selection of 25 sample sites, covering nearly all perennial tributaries and portions of the main stem river are located to cover existing monitoring areas and to represent the watershed. In addition, existing data from the San Lorenzo River and adjacent drainages can be used for reference purposes. The biological monitoring plan involves collection of 11 composited benthic macroinvertebrate samples from standard locations as a SWAMP-standard reach-wide benthos over multiple habitats within the study reach (fixed 50 m length). Quadrat grid-counts (25-point) of substrate size classes (up to cobble size) will be taken at each sampling location prior to the sampling of invertebrates. In addition, 4 patch-scale samples covering the full range of FS cover (0-25 quadrat point-counts) will be taken at each of the 25 sites, for a total of 100 of these as a finer-scale resolution of the effects of sediment deposition. These samples will allow biological effects of sediments to be evaluated between and within study sites.

David Herbst **8/25/2008 to 9/30/2013** **$73,270**
USDI Fish and Wildlife Service 14620-8-J161

Monitoring Aquatic Ecosystem Indicators of Spring Restoration on the Sheldon National Wildlife Refuge: Feral Horse Grazing Exclosures

The purpose of this study is to determine the effects of feral horse use on riparian and adjacent areas in the absence of livestock grazing. We hypothesize that springbrook channels protected from feral horse use will have different aquatic life support capacity than areas used by feral horses, and protecting streams from feral horse use will also permit geomorphic recovery of channels (decrease width and increase depth). Damages to spring habitats on the Sheldon National Wildlife Refuge in northern Nevada are associated with trampling, overgrazing, and contamination by feral horse populations. Because cattle grazing has been removed from the SNWR for over a decade, protection of select spring habitats by riparian exclosures permits examination of the independent influence of horse grazing. The success of exclosures in recovering the biological integrity of riparian and aquatic habitat of these springs will be monitored through the use of benthic macroinvertebrate bioassessment. Contrasts of the diversity of these indicator organisms inside and outside exclosures will provide a measure of the progress and extent of improved habitat conditions over time. Complementary studies of riparian and upland vegetation community recovery will also be conducted.

David Herbst **9/1/2009 to 7/30/2013** **$45,854**
USDI National Park Service J8C07090019

Evaluating Recovery of Stream Invertebrate Communities following Removal of Introduced Trout in Kings Canyon Nation Park

The Sierra Nevada Ecosystem Project identified aquatic and riparian systems as the most altered and impaired habitats of the Sierra Nevada. Sequoia and Kings Canyon National Parks (SEKI) has hundreds of miles of high elevation streams, including several Wild and Scenic Rivers, which provide critical habitat for native invertebrate communities. These habitats harbor high proportions of endemic species in insect groups such as stoneflies (25% of species in the Sierra are endemic) and caddisflies (19% endemic species), representing a significant national resource. Fishless stream environments may be critical habitat for large and vulnerable insects, such as the rare endemic mayfly Edmundsius agilis. Stream invertebrate communities are often composed of dozens of species with diverse roles in food webs are primary prey of trout, which were introduced to the high Sierra beginning in the 1860's. Recent research in Yosemite National Park (published in 2009) compared physical, chemical, and biological parameters of 22 fishless stream segments with adjacent matched streams containing trout. Results show that fishless streams contained a greater diversity of total taxa and large invertebrate predators than found in matched trout streams, while trout streams contained a greater total percentage of midges and a greater density of algae than fishless streams. These data suggest the nonnative trout cause significant changes in the ecology of high elevation streams, and thus native resources are vulnerable to direct and indirect effects of trout predation.

Scott Hodges **5/1/2014 to 11/2/2015** **$2,000**
Larimer County Department of Natural Resources SB150154

The Genetic Distinctiveness of Hermit Park's Aquilegia Coerulea var. Daileyae

Ever since Charles Darwin proposed that natural selection was responsible for how one species became two, scientists have been intensely interested in understanding the process. A conundrum has been that early in the process, when populations of a species just start to become different, it is not clear whether speciation will ultimately occur. Conversely, when we study two species that are clearly each others' closest relative, the process has already completed. I believe that Aquilegia coerulea var. daileyae occurring in Hermit Park may provide us with the opportunity to study the very earliest stages of the process of speciation. The purpose of our proposal is to obtain funding for preliminary genetic analysis to determine how divergent A. coerulea var. daileyae in Hermit Park is from nearby populations of the normal variety of A. coerulea and to use these findings in applying for a National Science Foundation (NSF) grant for a more comprehensive analysis.

Aquilegia coerulea var. daileyae is a striking mutant form of the Colorado columbine where the flower petals, which form the characteristic long nectar spurs, are replaced by a second set of sepals (see Fig). There is also an intermediate morphology where the normally white portion of the petals becomes blue and sepal-like and the spurs are shortened with aborted nectaries. This radical change in flower morphology likely causes a major change in how and which pollinators visit the plants and thus initiates the speciation process. This variety is usually very rare; often a single individual is found in a population of otherwise normal individuals. At Reynolds Park (Jefferson County) there is a population where the variety occurs at ~22%. However, at Hermit Park near the Homestead Meadows Parking and Connector Trail we found hundreds of individuals of var. daileyae and only a single plant with normal flowers. Similarly we found hundreds of var. daileyae individuals on the Homestead Meadow trail just outside of Hermit Park and only five normal individuals. We know of no other populations of var. daileyae where they occur in such abundance and to the near exclusion of normal-flowered plants. In striking contrast, less than two miles away we found a population of completely normal individuals. This shift from normal to mutant populations over such a short distance suggests that these populations are no longer exchanging genes (through either pollen or seed dispersal) and thus var. daileyae may be in the initial stages of becoming a new species.

We hypothesized that a mutation to a particular gene could cause the var. daileyae morphology and have now sequenced this gene from three individuals from the Hermit Park population. We found a mutation in all three individuals that would cause this gene to no longer function. We also found two different mutations to the same gene in var. daileyae individuals from Reynolds Park.

Thus, differences in this single gene could be the cause of var. daileyae. However, we do not know if mutations to other genes may also be correlated with morphology and thus whether or not var. daileyae has other important differences from normal A. coerulea. The funding we are requesting would allow us to sequence the entire genome from a set of normal and var. daileyae individuals and to identify which genes have fixed differences and thus how genetically distinct var. daileyae is from normal A. coerulea. We would then use these data to motivate a more detailed grant proposal to the NSF to study the extent of where var. daileyae occurs in abundance, the genetic basis of the change in morphology, how natural selection may be affecting its distribution, and how pollinators react to the remarkable change in flower morphology.

Currently, we have some funding that can help pay for the preliminary data I envision for an NSF grant proposal. This funding is from small UCSB funds for training undergraduate and graduate students. The SGCP would provide enough funding for us to produce compelling data for the exceptionally competitive NSF grants. Such funding would also obviously provide the opportunity to showcase this remarkable natural resource preserved through Larimer County Open Spaces.

Scott Hodges, Susan Mazer **10/1/2010 to 9/30/2013** **$1,725,740**
Ruth Finkelstein
National Science Foundation OTA-0963547

Renovation of Research Greenhouses at UC Santa Barbara for Ecological, Evolutionary and Developmental Studies

Plant scientists at the University of California, Santa Barbara (UCSB) are at the forefront of a diverse set of research areas in plant biology, including invasive species biology, controls of biodiversity, ecological & evolutionary genomics, and hormonal controls of development. Despite their many successes, plant research at UCSB has been severely hampered by a lack of modern growth facilities. The current greenhouse facilities were built nearly 50 years ago and have never had a major renovation. Numerous deficits to these facilities make growing plants difficult at best, and experimental control of environmental variables is impossible. In addition, the greenhouse facilities lack concrete flooring, drainage and the exclusion of pests and pollinators. Currently most researchers use the facility to maintain collections, make limited genetic lines, and propagate plants for field experiments. A host of new research will be possible with the complete renovation of these facilities. The proposed renovation will result in seven functional greenhouse bays comprising a total of 5,010 sq. ft. Each bay will have its own environmental controls for lighting, temperature and watering regimes. One greenhouse will have air-conditioning and structural components to allow high alpine environments to be replicated. Together, these new facilities will make possible numerous advances in plant biology, including experiments to test the specific morphological, physiological, and demographic traits responsible for the maintenance of plant diversity; identification of the genetic basis for adaptations to extreme environments and specific pollinators; tests of the how attributes of the physical environment influences plant distributions, productivity, and phenology; and an understanding of the genetic mechanisms underlying plant recognition and responses to a variety of stresses such as drought. This project will have many direct broader impacts, particularly through the training of undergraduates, graduate students and postdoctoral associates. Numerous independent research projects will be possible given the number of independent greenhouse bays and concomitant possible environments. This diversity will allow students to investigate a broad range of plant species and research questions. In addition, research questions on invasive species and their biological control will have direct societal impacts. The facility will be used to advance the development of a new model genomic system, and these resources will be available to the wider research community. Further research into the genetic mechanisms affecting seed quality and germination will have direct relevance to mitigating crop losses due to pre-harvest sprouting.

Scott Hodges, Nathan Derieg | **6/1/2013 to 5/31/2016** | **$19,890**
National Science Foundation | DEB-1311390

Dissertation Research: Causes and Consequences of Flower Color Variation in Aquilegia Coerulea

Intellectual merit: A thorough understanding of the evolution of ecologically important traits is a major goal of evolutionary biology. For any phenotype, there are three broad questions that a research program aimed at this goal should address: one, what are the relevant loci; two, are those loci experiencing natural selection; and three, what factors contribute to natural selection? Exploring these questions in the context of a geographically varied environment is particularly important, as spatially varying selection has been linked to both the maintenance of variation within species as well as the sorting of variation into diverging lineages. My dissertation research asks whether the adaptive significance of flower color variation in Rocky Mountain columbine, Aquilegia coerulea, might be determined by a trade-off between pathogen resistance and drought resistance along a geographical gradient of environmental variables including precipitation. Beyond understanding the evolutionary trajectory of a single trait, there is much interest in the relative importance of different evolutionary processes in determining the origins and fate of biodiversity. By sequencing the genomes of multiple A. coerulea individuals from across the species range, I will assess the relative importance of neutral versus adaptive processes for shaping nucleotide diversity; I will further categorize genomic regions with evidence of selection according to the kind of selection, e.g., spatially varying or positive.

Broader impacts: Understanding the evolutionary origins of adaptation and maintenance of biodiversity is a fundamental goal of evolutionary biology. My dissertation research illustrates how genomic methods can be applied to systems representing important ecological characteristics that are underrepresented in the literature; e.g., long-lived or perennial organisms in their native habitat. This work also generates and tests novel hypotheses about the potential for flower color to contribute to a trade-off between resource use and pathogen defense, a topic of broad interest. And, considering anthropogenic impacts on habitat and climate change, these questions are also highly relevant in assessing conservation concerns for species of interest and biodiversity as a whole. During the preliminary research that motivates the proposed research, I mentored several UCSB undergraduates. I am currently working with one continuing student, and will be recruiting two additional interns to work with me on the greenhouse experiment. They will work with me, but will also be encouraged to develop their own projects with the hybrid population.

Gretchen Hofmann, Carol Blanchette, Libe Washburn | **10/1/2010 to 9/30/2014** | **$473,354**
National Science Foundation | OCE-1041229

Ocean Acidification: Category 1: Collaborative Research: Acclimation and Adaptation to Ocean Acidification of Key Ecosystem Components in the California Current System

We will investigate the impacts of ocean acidification (OA) on two ecologically important, calcification-dependent marine invertebrates in relation to local-to-coastal variation in carbonate chemistry (e.g., pH and aragonite saturation) in the California Current Large Marine Ecosystem (CCLME). An interdisciplinary team of investigators with expertise in physical and chemical oceanography, marine ecology, biochemistry, molecular physiology, and molecular genetics will carry out an integrated, lab and field, multi-site investigation of the ecological, physiological, and evolutionary responses of sea urchins and mussels to spatial and temporal variation in OA. The research will take place in the context of a mosaic of variable oceanography, including recently documented latitudinal variation in carbonate chemistry along the upwelling-dominated US west coast. Variation in upwelling regimes from Washington to southern California generates spatial and temporal gradients in concentration of CO2 that shoal to surface waters during upwelling events, extending shoreward into the inner shelf region. Through well-known chemical pathways, influxes of CO2 cause present-day declines in pH in coastal ecosystems that are lower than values forecast for the ocean in general in the year 2200. Lower than "normal" pH can influence organisms by altering intracellular biochemistry, and especially, for calcification-dependent marine organisms, interfere

with formation of hard parts as the aragonite saturation state falls near or below 1.0. Because calcifiers in the upwelling-dominated CCLME have historically experienced persistent regional variation in pH, populations are likely differentially acclimatized and/or adapted to a variable carbonate chemistry environment. The new challenge to these organisms is that with global change and the resulting increase in seawater CO2, they already may be close to their acclimatization or adaptational capacity, and thus may have limited ability to respond to additional increases in CO2. It is this challenge, the mechanistic ability of calcifying invertebrates to acclimate or adapt to increasing CO2 and aragonite saturation states < 1.0 that we address here.

Gretchen Hofmann **9/1/2010 to 8/31/2016** **$604,534**
National Science Foundation IOS-1021536

Synergistic effects of climate-related variables on larval sea urchins: Performance to gene expression

The central goal is to characterize the response of larval purple sea urchins (Strongylocentrotus purpuratus) to the synergistic interaction of two climate change-related factors: ocean acidification and ocean warming. Due to increasing levels of anthropogenic carbon dioxide (CO2), ocean acidity and ocean warming are predicted to change dramatically by the end of the 21st century. Specifically, increased dissolved CO2 concentrations in the global ocean are predicted to reduce the pH of surface ocean waters from 8.1 now to ~7.8 by the year 2100 (IPCC 2007). Additionally, the average surface seawater temperatures are predicted to increase by anywhere from +1ºC to +6ºC by the year 2100. In manipulative laboratory experiments, I propose to raise cultures of larval sea urchins under varying CO2 and temperature conditions that reflect future ocean change conditions. In order to characterize the metabolic status of the larvae and the costs associated with development under varying pCO2 and temperature conditions, the following physiological processes will be measured: (1) respiration rate, (2) lipid content, (3) calcification rates, (4) total protein content, (5) tolerance of acute thermal stress and (6) morphometric analysis of the larval endoskeleton. Additionally, gene expression profiling will be performed using an oligonucleotide DNA microarray and 'next-generation' RNA sequencing (Illumina mRNA-seq) to explore transcriptome dynamics in response to a changing conditions. This transcriptomic approach will provide mechanistic understanding into how the larvae respond to environmental change in a multiple stressor scenario.

Gretchen Hofmann **8/1/2010 to 7/31/2014** **$613,812**
National Science Foundation ANT-0944201

Effect of Ocean Acidification on Early Life Stages of Antarctic Sea Urchins (Sterechinus neumayeri)

The central focus of this project is to examine the effects of ocean acidification (OA) on embryos and larvae of a contemporary calcifier in the coastal waters of Antarctica, the sea urchin Sterechinus neumayeri. Ocean acidification is the process whereby the pH of seawater is driven down by the uptake of CO2 from the atmosphere. Since the industrial revolution, anthropogenic sources of CO2 have already resulted in the lowering of ocean pH by ~0.1 units and future atmospheric and oceanic CO2 levels are predicted to further acidify surface seawater, driving ocean pH to levels well below the current day pH of ~8.1 by perhaps as much as 0.5 pH units. The effect of future ocean acidification is projected to be particularly threatening to calcifying marine organisms in coldwater, high latitude seas, making tolerance data on these organisms a critical research need in the Antarctic marine ecosystems. Due to a high magnesium (Mg) content of their calcitic hard parts, echinoderms, the focus of this proposal, are especially vulnerable to dissolution stress from OA because these organisms are already existing in seawater that is barely at the saturation level to support biogenic calcification. Thus, cold-water, high latitude species with a high Mg-content in their hard parts are considered to be the 'first responders' to chemical changes in the surface oceans. Studies in this proposal will use several metrics to examine the physiological plasticity of contemporary urchin embryos and larvae to CO2-acidified seawater, to mimic the OA scenario as defined by IPCC emission scenarios (Meehl et al. 2007) and by analyses of future acidification predicted for the Southern Ocean (McNeil & Mateur 2008). In a final study, we hope to learn about the biological consequences of developing under conditions of OA and further, whether embryos and larvae

of S. neumayeri are affected by synergistic interactions of two converging climate change-related stressors – CO2-driven ocean acidification and ocean warming. For these experiments, sea urchins will be raised in culture at the habitat temperature for S. neumayeri (-1.8 °C) at different CO2 partial pressures that are consistent with IPCC predictions of future levels of atmospheric CO2. Then, we will perform a series of measurements on the early life history stages. We will: (1) assess the effect of CO2-acidified seawater on the development of early embryos and larvae, (2) using morphometrics, examine changes in the larval endoskeleton in response to development under the high-CO2 conditions of ocean acidification, (3) using a DNA microarray, profile changes in gene expression for genes involved in biomineralization and other important physiological processes, and (4) measure costs and physiological consequences of development under conditions of ocean acidification.

Gretchen Hofmann **10/1/2012 to 9/30/2015** **$320,491**
Carol Blanchette, Libe Washburn
National Science Foundation OCE-1220359

Ocean Acidification: Collaborative Research: OMEGAS II - Linking Ecological and Organismal Responses to the Ocean Acidification Seascape in the California Current System

With one year of funding, the aspects of the overall project carried out by UCSB PIs and personnel will remain as proposed for year one in the original renewal request, and the budget will also remain unchanged. Specifically, we will: (1) continue the sensor deployments on the shore and on the PISCO moorings, thereby continuing our time series that will allow quantification of the carbonate chemistry of the upwelling transition zone spanning Point Conception. Washburn and Blanchette serve as the lead investigators of this component. A value-added aspect of this component of the project is that we have recently deployed five new pH sensors in the Santa Barbara Channel as part of the separately NSF-funded Santa Barbara Coastal Long Term Ecological Research (SBC-LTER) project; Washburn is an associate investigator on the SBC-LTER along with several other investigators not in OMEGAS. (2) PI Blanchette will collaborate with OSU PI Menge and postdoc Gouthier to develop an ecological model to examine the community-level effects of geographic variation in OA conditions. (3) Blanchette and the UCSB field team will collaborate with PIs Sanford, Gaylord, Menge, and Raimondi to carry out the Year 1 deployment of juvenile mussel outplant experiments aimed at testing how mussel growth, shell thickness and strength, and anti-predator defense is affected by differing regimes of ocean acidification. (4) PIs Hofmann and Blanchette will lead a separate set of physiological assessments aimed at understanding the mechanisms underlying differences in performance in juvenile mussels (harvested from field transplants) using an array of physiological techniques (respiration rates, lipid microanalysis, calcification rates, enzyme assays and thermotolerance trials). (5) PI Hofmann will lead the exploration of how patterns of gene expression are affected by temporal variability and high frequency variation in seawater chemistry, and (6) all USCB PIs will actively engage in public outreach efforts with a variety of state and national partners and they will continue outreach efforts through public presentations, workshops and professional development experiences for teachers.

Gretchen Hofmann **10/1/2013 to 9/30/2016** **$510,394**
National Science Foundation PLR-1246202

Ocean Acidification Seascape: Linking Natural Variability and Anthropogenic Changes in pH and Temperature to Performance in Calcifying Antarctic Marine Invertebrates

Intellectual Merit: Ocean acidification (OA) has emerged as a major research area in the study of marine ecosystems and ocean change. From an organismal perspective, the goal of the research community has been to identify the physiological tolerances and/or vulnerabilities of key calcifying marine organisms. However, in most cases, the present-day pH/pCO2 dynamics that most marine organisms experience in their respective habitats are relatively unknown. This is a significant data gap as the resilience of organisms is closely related to the physical conditions to which they are adapted. Thus, data regarding the 'OA seascape" would greatly facilitate organismal research; laboratory experiments could be performed in an environmental context and investigators would have a better baseline from which to project pH dynamic changes in the future that are driven by anthropogenic ocean acidification. The central focus of the current proposal is to better frame the

study of the response of Antarctic marine organisms to OA conditions by measuring the annual pH dynamics in Antarctic coastal waters and performing organismal experiments that are parameterized using these field observations. The project has two main activities: (1) we will deploy autonomous pH sensors called SeaFETs in four sites in McMurdo Sound and at a nearshore Palmer site (the Palmer LTER Station A) in order to continuously record pH time series data; the sensors can be programmed to record all year and can be deployed on the benthos, below the sea ice and will not be interfered with by changes in sea ice coverage; (2) using these field observations of annual variation in pH dynamics, we will perform lab experiments using environmentally relevant pHs and pCO2 to study the resilience and tolerance of a key marine invertebrate, the Antarctic pteropod Limacina helicina antarctica. In these lab experiments, we will also examine the interaction of ocean warming and ocean acidification, two potentially interacting anthropogenic stressors that could drive ocean change in the future. For the pteropod exposure studies and temperature x CO2 combinations, we will measure the following: (1) examination of shell morphology using calcein staining, (2) oxygen consumption via respirometry as an indirect measure of metabolic rate, (3) organismal thermotolerance, and (4) gene expression patterns 454 pyrosequencing to obtain a normalized and annotated library of sequences following by the use of custom microarrays that are prepared using sequence data from the pteropod 454 sequence data. Importantly, the proposed research represents a new development in 'biophysical coupling' studies in Antarctic ecosystems research, and brings relatively new ocean sensor technology to Antarctic marine ecosystem science. The project also provides multidisciplinary training for postdoctoral researchers and graduate students in the study of global change biology of the Antarctic marine ecosystem. Broader Impacts: In addition to supporting the training of undergraduates, graduate students and postdoctoral researchers, we plan to have a significant informal public education element in this project. In collaboration with the Aquarium of the Pacific (AOP) in Long Beach, California, we plan to contribute to their education and outreach activities. The AOP recently opened an exhibit on polar ecosystems -entitled "Arctic & Antarctic: Our Polar Regions in Peril" and we plan to contribute to the development of materials for the Antarctic portion of the exhibit. The major focus of the polar exhibit is climate change and the public audience for the materials is large. In addition, in 2010, the Aquarium staff served 219,000 students in outreach classroom activities; these are on-site classroom activities for visiting K-12 students from the Los Angeles metro area. We will work to engage these students via live feeds, guest teaching and lectures by lab members, and by using our research results to create teaching materials for these on-site teaching events.

Gretchen Hofmann **1/1/2010 to 12/31/2013** **$2,469,005**
UC Office of the President 142997

Ocean Acidification: A Research & Training Consortium

The goal is to form a multidisciplinary collaboration to study ocean acidification (OA) and its impacts on the coastal marine ecosystems of California. As the need to forecast the impacts of ocean acidification on marine ecosystems has become more urgent, it is clear that sound science and contributions to strategies will only be found through multidisciplinary collaborations within the broad marine science community. Thus, we propose a consortium to integrate and strengthen our research programs to work on critical questions about how ocean acidification will impact marine communities. In addition, we propose to focus especially on designing and implementing multidisciplinary training for graduate students and postdoctoral fellows, and a major part of the budget will be used for traineeship support. These efforts will position UC to compete more effectively for upcoming federal funds to study ocean acidification, and train the next generation of scientists who will contribute to knowledge on ocean acidification and impacts on the California coast. The activities of this proposal will fulfill three goals that are central to the UC MRU program. (1) The studies described here will directly address the impacts of climate change on coastal marine ecosystems, a critical issue for California, (2) this proposal strategically prepares a research team within UC that can compete for external research funds for the study of ocean acidification, and (3) support for this group will build a multidisciplinary team that takes advantage of complementary expertise among graduate students and postdoctoral fellows in the UC system. Ultimately, this program will serve as an outstanding recruitment tool to attract high quality graduate students to the UC campuses.

Gretchen Hofmann | **12/1/2010 to 12/31/2013** | **$48,000**
UC Sea Grant College Program | R/OPCENV-09-S

Ocean Acidification Exacerbated by Coastal Upwelling: Monitoring of CO2 and O2 on the California Shelf and Effects on Red Sea Urchins, Abalone, and Oysters

The project will be conducted by a multidisciplinary team of experts in physical chemistry, biological oceanography, molecular ecology, and management of marine resources. Team members include: Victoria Fabry, Professor, CSUSM, biological and ecological impacts of ocean acidification Andrew Dickson, Professor-in-Residence, UCSD, inorganic carbon system in seawater Gretchen Hofmann, Professor, UCSB, use of genomic tools in assessing affects of climate change Jeffrey Abell, Assistant Professor, Humboldt State University, carbon, oxygen and nitrogen cycling in oceans Richard Feely and Chris Sabine, Chemical oceanographers, NOAA's Pacific Environmental Marine Laboratory, field observations of oceanic uptake of anthropogenic CO2, pCO2 sensors Deborah Aseltine-Neilson, Senior Biologist Specialist (Marine/Fisheries), Department of Fish and Game, research and data partnerships 3 Sea Grant Interns (1 each at CSUSM, UCSD, and UCSB) Fabry will be responsible for overall coordination of the project. Drs. Feely and Sabine will manufacturer a pCO2 sensor to be deployed on a moored buoy off the northern coast of California. The project will use Humboldt State University's ship, the R/V Coral Sea to deploy the system. Dr. Abell will supervise regular sampling of seawater for dissolved inorganic carbon, alkalinity, oxygen and nutrients. Drs. Fabry and Dickson will design and build the experimental system for CO2-perturbation experiments and will conduct manipulative experiments in which red sea urchins, California mussels, and abalone are exposed to different pCO2 concentrations in seawater. Dr. Fabry will conduct measurements of calcification rates of larval, juvenile and adult stages of these species. Dr. Dickson will analyze seawater samples for dissolved inorganic carbon and total alkalinity and calculate all the parameters of the seawater CO2 system in both perturbation experiments and at the mooring site in northern California. Dr. Hofmann will use different genomic tools to link Fabry's calcification rates measurements with gene expression. Aseltine-Neilson will provide input to experimental design and development of useful tools to assess the impacts of ocean acidification on selected important marine resources. The three trainees will work together with the investigators on the three major research areas: CO2 chemistry, calcification rates, and genomics.

Gretchen Hofmann | **2/1/2012 to 1/31/2016** | **$12,090**
National Science Foundation | OISE-1219542

International: The Energetic Cost of an Acidic, Warm Environment: Changes in Lipid Consumption of Pocillopora damicornis Larvae

Emily Rivest, a graduate student advised by Dr. Gretchen Hofmann at the University of California Santa Barbara, will collaborate with Dr. Peter Edmunds (CSUN) to incubate larvae of the coral Pocillopora damicornis in seawater of combinations of CO2¬ concentration and temperature. The treatment levels used in this experiment approximate current and end-of-the-century conditions experienced by these larvae in the surface ocean. Emily will collaborate with Drs. Chii-Shiarng Chen and Hsing-Hui Li at the National Museum of Marine Biology and Aquarium, who will provide access to the necessary equipment and training to perform analyses to analyze the lipid content and composition of these larvae. From the data, we can then better understand how elevated CO2 and temperature interact to challenge the energy budget of these larvae, facilitating predictions of effects on planktonic duration and settlement success. Emily will also use a SeaFET pH sensor to measure the variation of pH on the natal reef of the coral used in this study, working with Dr. Tung-Yung Fan at NMMBA.

Sally Holbrook, Andrew Rassweiler | **10/1/2013 to 9/30/2016** | **$247,089**
National Science Foundation | OCE-1325652

Coastal SEES (Track 1) Collaborative: Adaptive Capacity, Resilience, and Coral Reef State Shifts in Socio-Ecological Systems

This project presents an unparalleled opportunity to assess resilience in a coral reef social-ecological

system (SES). Over the last several decades members of our research team associated with the Moorea Coral Reef Long-Term Ecological Research site have documented how reefs around the Pacific island of Mo'orea, French Polynesia, have been impacted by major perturbations but have consistently reassembled to coral dominance. This resilience to disturbance is a key component of coastal sustainability, as it maintains the reefs in a state capable of providing critical ecosystem services. The resilience of reefs in Mo'orea is particularly striking, given that coral reefs in many regions have experienced abrupt and potentially irreversible shifts from a coral dominated state, with complex structure and a rich fish community, to a macroalgae dominated state with fewer fish. The central aim of this proposal is to better understand the adaptive capacities of Mo'orea's SES that enable the coral reefs to return to coral dominance following large-scale disturbances. To do this, an integrative social and natural science approach will be employed that addresses place-based questions about resilience, sustainability and adaptive capacity of coastal systems, while developing a framework for addressing more complex questions about the Mo'orea SES, as well as providing a model for the integration of ecology and social science in other coastal systems. The dynamics of state shifts are fundamental to understanding the resilience and long-term sustainability of coral-reef social-ecological systems, yet the interplay between anthropogenic and ecological feedbacks are poorly understood in these systems. SESs with high population densities, widespread coastal development and intense resource exploitation typically show declines in the critical adaptive capacities that underpin resilience to local environmental variability, but Mo'orea has maintained its resilience despite rapid development. This project will explore how the complex feedbacks in a coral reef SES maintain its capacity to withstand large-scale ecological disturbances. By its very nature, this study requires substantial interdisciplinary collaboration between social and natural scientists. Anthropological fieldwork focusing on the human dimensions of coral reef use, traditional governance, and indigenous ecological knowledge, will document how local communities perceive, respond to, and manage changes in ecosystem state. Ecological models will describe the dynamics of coral, algal and fish communities, including the feedbacks that make these communities susceptible to abrupt shifts in ecosystem state. These components will be integrated in a systems modeling framework that includes feedbacks both within and between the human and natural communities, quantitatively modeling how humans change their behavior as a function of ecosystem state and how the ecosystem is affected in turn by human activities. A key objective is to bridge the gap between the data collected by social scientists and the dynamic ecosystem models developed by ecologists, as this is crucial to understanding the resilience and long-term sustainability of coastal SESs worldwide. This project will contribute to more sustainable management of coral reefs by identifying pathways that confer resilience, highlighting emerging vulnerabilities, and suggesting policy initiatives in areas such as integrated coastal zone management and sustainable development planning. We will simulate possible future scenarios, providing information about ways resilience might be maintained or eroded by potential changes in management and fishing practices. Finally, this research will evaluate the effects of specific current management actions such as MPAs on resilience, and compare the effectiveness of these actions to alternative strategies. Collaborative science and learning and stakeholder workshops will 1) ensure that local communities, NGOs, and government agencies have access to our findings, 2) improve local awareness of environmental feedbacks, and 3) foster interaction between local Mo'orea institutions and between local institutions and others at higher levels. This project will promote interdisciplinary research into coastal sustainability around the globe. The framework for bridging anthropology and ecology developed here will have applicability in a broad range of coastal SESs. We will train an interdisciplinary work force through workshops and the involvement of graduate students in all its phases.

Sally Holbrook | **1/1/2011 to 12/31/2013** | **$60,000**
University of California San Diego | SB110067

Re-Deployable CI for Environmental Observing Systems

Task 1. Assist in the benchtop testing of OA instruments, particularly in regard to development of middleware for real-time data collection (50% UCSB, 50% CSUN). Task 2. Conduct test field deployments of the OA instruments on the existing real-time mooring in Moorea (60% UCSB, 40% CSUN). This will include deployment and retrieval of instruments, data download and sensor maintenance and calibration as needed, maintenance and troubleshooting of the data transmission hardware on Moorea, maintenance of the existing real-time mooring (buoy, cable, power supplies,

etc.). Task 3. Evaluation of data streams from the real-time deployments, including QA/QC, comparisons between sensors, and assessments of spatial and temporal variation in measured variables (40% UCSB, 60% CSUN). Task 4. Preparation of the report document that will present a justification and design of an expanded real-time sensor network to address research issues on ocean acidification in Moorea (50% UCSB, 50% CSUN).

Debora Iglesias-Rodriguez, **1/1/2014 to 12/31/2016** **$494,091**
Mark Brzezinski, Craig Carlson, Uta Passow, David Valentine
National Science Foundation OCE-1337400

MRI: Acquisition of a Flow Sorter Cytometer to Advance Marine Research and Education

Intellectual Merit. The MRI requested is a BD Influx sorter cytometer that enables the identification, enumeration and sorting of cells with subtle differences in their optical signatures. The novelty of this state-of-the-art instrument is its unparalleled modular system, sensitivity and sorting power, provided by its manual adjustment of detectors to distinguish varying ranges of spectral bands, fluorescence intensities and other optical parameters (e.g., polarized forward scatter). This instrument will revolutionize marine research and education at UCSB for the following reasons: Pushing the frontiers of microbial oceanography. Acquiring this instrument will enable building a flow cytometry facility (FCF) to test hypotheses where adaptable manual control of parameters (e.g., alignment of laser beams, detectors and filters) is required to (1) identify cells with subtle differences in their optical properties; and (2) sort cells/viruses for further genotyping/phenotyping. The PI has successfully used this approach to distinguish degrees of biomineralization between strains of the same species[1] that are differentially selected under climate stress. The Influx will make it possible to diagnose and forecast shifts in biogeochemically important functional types, by studying populations in a dynamic context. Synergy between disciplines. The broad range of questions and applications, using different cell types and diagnostic tools will stimulate cross-fertilization of ideas across UCSB and extended community. The FCF will be of tremendous benefit to seven research groups located in the Marine Science Institute, and the Depts. of Earth Science and Ecology, Evolution and Marine Biology (EEMB). The PIs and broader teams will use the FCF extensively to pursue research on phytoplankton and bacterioplankton population physiology, ecology, biogeochemistry, genetics and evolution as well as host-virus interactions. Training the next generation of UCSB marine scientists. Iglesias-Rodriguez has funding for a technician, who will be trained to use and manage the FCF. The PI and two more EEMB technicians will also be trained by BD to coach the next generation of marine scientists. The FCF will represent a tremendous benefit to UCSB and its maximized use is guaranteed from the start given the large number of marine science programs, students and interested teams within and outside the UCSB marine community. Long-term maintenance of FCF state-of-the-art features. To guarantee the FCF success, it must benefit from new technological advances. Firstly, its modular system is ideally designed to incorporate new technology. Secondly, a close collaboration with Prof van den Engh, the inventor of the instrument, will ensure that its utility and development are maximized. He will work closely with the team in the research implementation or instrument development and the PI will submit regular feedback to BD.

Broader Impacts. A series of research and teaching programs are planned or underway to investigate single-cell responses to their environment to quantitatively study microbial ecosystems. Acquiring the BD Influx will profit from the Iglesias-Rodriguez's lab success in distinguishing degrees of calcification between/within species that are key to marine carbon sequestration. Biomineralization will also be studied in silicate-producing phytoplankton using fluorescent probes. The BD Influx will also assist in elucidating the role of viral infections on microbial evolution and partitioning of organic carbon. Promoting state-of-the-art technology in research, teaching and training the broader community. As a research-lead institution, UCSB promotes bringing research into the classroom. A new undergraduate and postgraduate course: "Flow Cytometry Applications in Modern Microbial Oceanography" will be at the interface between bio-optics, microbial ecology and molecular biology and will equip the next generation of oceanographers with the modern tools to ask molecular, physiological, ecological, biogeochemical and evolutionary questions. We anticipate that 100 undergraduates, 20 postgraduates and 12 postdoctoral scientists will use the flow cytometry facility every year. Induction courses and a two-day workshop will be offered to UCSB and other Californian research institutions and industry. This program will impact directly on evolutionary biologists,

biogeochemists, chemical and biological oceanographers and climate scientists, as well as providing advance to biomedical, marine biotechnology, private and public sectors and in outreach programs.

Matthew Jones | **1/15/2014 to 12/31/2014** | **$13,635**
National Science Foundation | ACI-1419139

Collaborative Project: Software Sustainability: An SI2 PI Workshop

Software is an integral enabler of computation, experiment and theory and a primary modality for realizing the Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21) vision. Software is directly responsible for increased scientific productivity and significant enhancement of researchers' capabilities. The SI2 program has the overarching goal of transforming innovations in research and education into sustained software resources that are an integral part of the cyberinfrastructure. A goal of SI2 is the development of sustainable software communities that transcend scientific and geographical boundaries and are vibrant partnerships among academia, government laboratories, and industry, including international entities. It further recognizes that integrated education activities will play a key role in sustaining the cyberinfrastructure over time. In this workshop we propose to focus on several related topics. The topics serve to inform the attendees of emerging best practices, and stimulate thinking on new ways of achieving sustainability and of ensuring that the foundation laid by SI2 is preserved into the future. An objective of the workshop is to gather experiences and shared sense of best practice and for the PIs, Plale, Thain, and Jones to write a report from the workshop for broader dissemination of results. To facilitate full participation, we propose to use a shared document for live annotation and note-taking.

Matthew Jones | **10/1/2012 to 9/30/2014** | **$582,660**
Mark Schildhauer
National Science Foundation | OCI-1216894

Conceptualizing an Institute for Sustainable Earth and Environmental Software (ISEES)

Planning Process: The project will undertake a one-year community-driven process to develop a strategic plan for the creation and operation of ISEES. Our diverse research constituency includes earth, life, and environmental scientists and experts from software engineering, computer science, informatics, and library sciences. A series of design workshops that use proven, formal planning and assessment methods will meet in three topical clusters to conceptualize and articulate a grand vision and strategy for how ISEES will transform the software lifecycle and galvanize the research community. A Science Cluster collates and articulates grand challenges within earth observational sciences that focus and drive ISEES' software activities and define exemplary collaborative science activities that support detailed requirements analysis. A Software Cluster analyzes requirements for scientific software and proposes approaches for ISEES to address these via improvements across the full science software lifecycle. And, a Sustainability and Adoption Cluster examines sustainability and governance challenges, and proposes models for engaging the research community, governing ISEES, and developing an effective workforce that can sustain the portfolio of science software curated through ISEES. Community experts lead each working group and collectively comprise a Steering Committee that synthesizes recommendations, presents these results and gathers feedback at a Town Hall co-located at a major science conference, and combines this with recommendations from an open call for comments on the Internet to create the final Strategic Plan describing the mission, design, and impact of ISEES.

Intellectual Merit: The strategic planning process will define a mission for ISEES that spans the creation, interoperability, and sustainability of a compelling suite of software systems that will transform earth and environmental scientific research. The strategic plan will articulate and compare the strengths of various organizational models and activities in terms of their ability to resolve issues that are prevalent in scientific software, such as code complexity and opacity, lack of scalability, lack of openness and interoperability, and lack of formal versioning and management of software evolution for sustainability. In addition, the strategic plan will provide a compelling framework for workforce development, creation of community software frameworks, and community governance of ISEES.

Broader Impacts: Results from software lifecycle modeling and sustainability and governance modeling will be broadly applicable to software ecosystems outside of the earth and environmental sciences. The diverse community of participants engaged in the planning process will have a strong impact on the views of multiple science communities about critical issues in the scientific software lifecycle. ISEES workforce development plans will significantly advance the training and education agenda outlined under NSF's CIF21 agenda, and create a pathway for software careers for underrepresented groups. Finally, many diverse participants, students, and postdocs will participate in planning workshops and activities, thus improving their use of complex software to conduct science.

Matthew Jones | **4/1/2013 to 3/31/2016** | **$472,188**
National Science Foundation | DBI-1262463

Collaborative Research: ABI Development: A Toolbox for Analysis of Long-term Ecological Dynamics using the Kepler Workflow System

Ecological communities are highly dynamic in space and time. Analysis of spatial variability has a long history in ecology, yet because of the historical dearth of long-term, well-documented, on-line datasets we know comparatively little about rates and patterns of temporal change in ecological communities. Fortunately, an expanding array of long-term datasets is now available through sources such as the LTER Network and LTREB program. This growing availability of high-resolution (annual) temporal data sets creates new opportunities to address questions about how ecological communities change over time in response to global environmental change. Although, several metrics for analyzing long-term change in biotic communities have been developed, most are used in one-off approaches, frequently involving calculations, modeling, and visualization in spreadsheets or custom programs (e.g., Rank Clocks). Most of these indices are not available in common statistical packages. We propose to combine two open source programs, the statistical package R and the Kepler workflow system, to make long-term community change analysis more accessible. Taking the extra step and encoding complete workflows for community analysis in Kepler will provide the option of re-running analyses whenever new data are available. The output, a value added data product, may be used for purposes well beyond detecting and interpreting community change. We will improve Kepler's workflow sharing subsystems to grow an enthusiastic group of ecological researchers that create and share temporal community analyses to accelerate the study of community change. And finally, we will refactor Kepler's data handling subsystems to be compatible with the emergent DataONE repository federation. Intellectual merit: As ecologists continue to gather long-term data at site, regional, continental and global scales, there will be an increasing need for tools to measure the pattern and rate of change in plant and animal communities in response to multiple environmental drivers. Gathering together multiple metrics of ecological dynamics into one toolbox will provide ecologists with a new set of tools for quantifying how communities change over time. Our proposed approach builds upon many recent eco-informatics developments (EML, DataONE, LTER NIS, PASTA, Kepler) to advance ecological research. Long-term data sets collected by LTER sites and others will be used to demonstrate data and system accessibility and interoperability, and through implementation of new metrics we will gain insights into community change on a continental scale. Data will be accessed via the DataONE portal and the LTER Network Information System using metadata encoded in the Ecological Metadata Language and analyzed with R routines in Kepler workflows. Broader Impacts: The toolbox will make community analysis more accessible and in turn expose a variety of indices to wider use, thorough testing, and open discussion of applicability for quantifying and visualizing ecological dynamics. Existing workflows will help reduce effort in data preparation and foster unprecedented potential for collaboration. Value added data products of community change indices across habitats are particularly valuable for education and outreach, and in broader synthetic activities related to environmental health, management, and dynamics at larger scales. Through the LTER Schoolyard program these data and understanding of environmental change will reach a large number and diversity of schoolchildren.

Matthew Jones, Mark Schildhauer, Joshua Madin, Margaret O'Brien | **8/1/2008 to 7/31/2014** | **$599,999**

National Science Foundation | DBI-0743429

Semantic Enhancements for Ecological Data Management

The wide range of relevant data and the lack of standard methods used in ecological studies hinder current techniques for managing ecological data. This data heterogeneity creates several major informatics challenges that impede the sharing of data collected by individuals, institutions, and scientific communities. While current data management approaches include the use of structured metadata (e.g., EML - the Ecological Metadata Language) and community-wide data networks (e.g., KNB - the Knowledge Network for Biocomplexity), software tools are still needed that address the often-subtle and implicit semantics of ecological data. Such tools in particular must encode and utilize the semantics of scientific observations to directly confront issues impending broad-scale discovery, access, interpretation, and synthesis of data by ecologists. The development and use of formal ontologies has become more prevalent within ecology and the environmental sciences. However, efforts towards ontology standardization and development of production software systems to leverage these advances and facilitate adoption by the broader community are still needed, especially when compared to the benefits gained by similar efforts in other scientific disciplines such as molecular biology and biomedicine. The investigators propose to reduce this gap by leveraging existing ontology standardization efforts within the community , developing reference implementations of these standards, and incorporating these implementations into existing production systems for managing ecological data.

Matthew Jones, Stephanie Hampton | **8/1/2009 to 10/31/2014** | **$3,023,094**

University of New Mexico | 63014-873R

DataNetONE: Observation Network for Earth

NCEAS hosts the second Coordinating Node and supports three of the ten Working Groups. Co-PI Stephanie Hampton initially co-leads the DataNetONE community engagement and outreach activities until the AD CE&O is hired and, thereafter, serves as a co-leader of the Community Engagement and Education Working Group. She also will oversee integration of Best Practices modules into existing informatics presentations to all NCEAS working groups, reaching hundreds of scientists and students during the first phase of DataNetONE. Co-I Matthew Jones serves on the Core CI Team and acts as co-leader of the research and development activities during year 1 until the AD D&O is hired. UC Santa Barbara and NCEAS, as part of their commitment to DataNetONE, provide the 24/7 operational environment for the Coordinating Node and high-speed bandwidth access, as well as furnishing office space and conference facilities for the Node staff, students, and three Working Groups. NCEAS, through the leadership of Deputy Director Hampton and Director of Informatics Research and Development Jones, has extensive experience facilitating training, outreach, and interdisciplinary collaborative research by hundreds of scientists each year in its world class facilities. Furthermore, Co-I Jones provides leadership in earth observational science metadata standards, data management software, and scientific workflow systems.

Carrie Kappel, Benjamin Halpern, Kim Selkoe | **8/17/2012 to 10/28/2016** | **$1,883,774**

Gordon and Betty Moore Foundation | 2897.01

Ecosystem Thresholds and Indicators for Marine Spatial Planning

Marine spatial planning is emerging as a primary tool for implementing ecosystem-based management and an important directive of US National Ocean Policy. As decision-makers begin to develop marine spatial plans they face the problems of how to define management targets at the ecosystem level, how to understand the cumulative effect of human activities within the ecosystem, and how to evaluate whether the management actions they take are working towards their objectives.

They confront these tasks with the knowledge that marine ecosystems can exhibit complex behaviors, including the possibility of crossing thresholds and changing rapidly into a new set of conditions. Our research goals are to (1) identify thresholds in marine ecosystems by synthesizing existing data, (2) examine possible indicators of pending transformation within the ecological system and coupled social systems, (3) develop analytical tools to allow for marine spatial planning based on knowledge of ecosystem thresholds, (4) identify and demonstrate regulatory and policy vehicles that could apply ecosystem thresholds and indicators to marine management, and (5) communicate our results clearly and effectively to managers and policymakers. In Phase One of the project (September 2012-September 2014) we will focus on reviewing and analyzing existing data on the application of ecosystem thresholds in management, examples of thresholds in coastal and marine ecosystems, and nonlinear responses of ecosystem components to key stressors relevant to our case study locations. We will analyze single sector case examples where an understanding of thresholds could lead to better management and begin to build models of tradeoffs in ecosystem services that take into account ecosystem thresholds. In Phase Two (September 2014-September 2016), a suite of research activities will develop the science needed to apply ecosystem thresholds and indicators to single and multi-sector problems in our case study locations: Haida Gwaii, British Columbia and the Humpback Whale National Marine Sanctuary in Hawaii. During this phase we will conduct the legal and policy analysis needed to reveal the most likely routes for these concepts, results and tools to make it into management decision-making. We will tie together the results of Phase One and Two into a toolbox and general framework for setting target multi-sector activity levels within the context of ecosystem thresholds.

Lydia Kapsenberg, Gretchen Hofmann | **6/1/2011 to 8/31/2015** | **$19,987**

University of Washington | SB110188

Assessment of Ocean Acidification in the Channel Islands National Park and its Impact on Local Marine Species

Ocean acidification (OA), the decline in surface seawater pH as a direct result of anthropogenic CO2 dissolving into surface oceans, is expected to affect many marine species, especially calcifying organisms. The result of these biological impacts will likely alter community structure of key marine ecosystems. Upwelling systems, such as the California Current Large Marine Ecosystem, already experience periods of low pH that were not expected for several decades and may therefore be sensitive to further OA. The Channel Islands National Park (CINP) spans a temperature gradient associated with the California Current Large Marine Ecosystem seasonal upwelling, however, there are no data regarding the local near-shore carbonate chemistry. This research proposal involves (1) the assessment of current pH conditions and (2) its effect on marine species in the CINP along an upwelling gradient. Deployment of two autonomous pH sensors at Santa Cruz Island pier and Anacapa Island pier will assess current pH in the CINP, for the first time. Using these data and the CO2-mixing system in the Hofmann lab that was designed to study OA, I will test the effect of OA on fertilization of two sea urchins species (Strongylocentrotus purpuratus and S. franciscanus) from each island and evaluate the variation in tolerance with respect to pH. The results of this research will provide insight into the evolutionary history of sea urchins and their potential to tolerate or adapt to future OA. This project will advance CINP resource management by initiating a pH monitoring program within the Park's waters and by documenting near-shore carbon chemistry for the first time as well as advancing understanding of the effects of OA on local marine organisms. This project will help provide information that may focus climate change management efforts, in order to preserve and protect the CINP for future generations.

Amanda Kelly **8/26/2013 to** **$10,000**
Gretchen Hofmann
National Science Foundation

The Physiologic Response of Larvae of the Antarctic Sea Urchin, Sterechinus Neumayeri, to Multi-Stressor Environment Predicted under Global Climate Change

The main thrust of this proposal is to measure the physiologic response to environmental change in the larvae of Sterechinus neumayeri, the Antarctic sea urchin with a focus on understanding the emerging response of Antarctic benthic calcifiers to conditions of ocean acidification. The experiments presented here will delve into the physiological mechanisms employed by this highly endemic, benthically abundant, stenothermal echinoid in response to ocean acidification, as well as elevated temperatures, and variations in salinity, all factors associated with ocean change. A burgeoning field, global change biology endeavors to gain insight into the biological processes organisms use to mitigate these changes. A comprehensive physiologic assessment including organismal, proteomic and transcriptomic analyses on developing larvae will be made to investigate the biological consequences of global climate change (GCC). Together, the proposed research objectives will not only continue to advance our understanding of the physiologic effects of GCC, but will build on previous research in an effort to elucidate the physiological processes that result in a reduction of larval size in S. neumayeri under hypercapnia conditions. The principal research objectives of this proposal are: 1) To measure changes in pHi, cell size, cell-cycle regulation/proliferation/apoptosis in response to elevated pCO2 levels with the aim of identifying the mechanistic underpinnings that generate a reduction in larval size during maturation 2) To characterize the synergistic effects of increased pCO2, temperature, and variations in salinity on metabolism, growth and the transcriptional response.

James Kennett **9/15/2008 to 8/31/2013** **$495,175**
National Science Foundation OCE-0825322

Collaborative Research: Co-Evolution of Submillennial and Orbital Scale Climate and Ocean Behavior During the Last 700 kyrs: The Unique Santa Barbara Basin Record

The proposed research will investigate abrupt and high-frequency climate change at an ultra-high resolution previously unobtainable before 150 ka, but here spanning most of the 100-kyr climate regime back to ~700 ka. Resolving short-term climate behavior before ~150 ka is critical for understanding processes, thresholds, and feedbacks that contribute to abrupt climate change. Millennial-scale climate oscillations (Dansgaard/Oeshger cycles) reflect major abrupt shifts in the ocean-atmosphere system, yet knowledge of this important behavior is largely confined to the last glacial cycle, owing to the unavailability of suitable older sequences. This study will extend our understanding of these events and processes for the first time by analysis of a superb suite of 32 high-sedimentation rate (~80-120 cm/kyr) cores taken in 2005 on the Santa Barbara Mid-Channel anticlinal trend, where older, uplifted stratigraphic sequences crop out on the ocean floor. Our preliminary work confirms that Santa Barbara Basin can reveal climate history in unprecedented resolution for this time span, clearly recording earlier D/O-like cycles and abrupt climate change on decadal time scales. The cores provide ultra-high resolution windows into climatic-oceanographic behavior of the north Pacific through much of the interval dominated by the 100 kyr glacial-interglacial cycles, an interval not previously studied at this resolution.

Roland Knapp **7/1/2013 to 9/30/2016** **$59,000**
USDI Geological Survey G13AC00154

Factors Influencing the Reintroduction Success of the Endangered Mountain Yellow-Legged Frog

Objectives: Six reintroductions of MYL frogs are proposed within SEKI and YOSE using methods that will allow the detailed quantification of temporal patterns of Bd infection intensity, survival rates, and fates of individual frogs. By combining information from this study with that collected during a previous reintroduction study (Knapp et al. 2011) we will also be able to evaluate the role of habitat conditions on the outcome of reintroductions. Collectively, this information will allow us to assess the importance of disease, stochasticity, and habitat in influencing the success of reintroductions.

The results will be used to develop a reintroduction protocol to guide future reintroduction efforts conducted throughout the range of the MYL frog. Methods Site selection During a five-year period starting in 1997, my research group surveyed all aquatic habitats in SEKI and YOSE for amphibians, fish, and habitat attributes (Knapp et al. 2003, Knapp 2005). Since this initial survey, I have conducted repeated resurveys of all MYL frog populations in both parks to describe the distribution and spread of Bd, and its impact on these populations (Rachowicz et al. 2006, Vredenburg et al. 2010, Knapp et al. 2011). The resulting data set provides a detailed view of the status and trend of MYL frog populations at an unprecedented spatial scale. For the proposed reintroduction research, we used this data set to identify six MYL frog source populations (three in SEKI and three in YOSE) that experienced Bd-caused population die-offs during the past 5-15 years but that have at least partially recovered despite ongoing chytridiomycosis. All six populations are large enough (≥200 adult frogs) to allow the removal of small numbers of adult frogs for reintroductions without negatively affecting their viability. Results from previous reintroductions in YOSE indicate that removal of approximately 20% of the adult frogs from the source population resulted in a large pulse of recruitment in subsequent years that compensated for the removals (Knapp et al. 2011). The six proposed reintroduction sites are paired with the six source sites (i.e., each pair contains one source and one reintroduction site), and sites in each pair are located within 10 km of each other. Until recently, each of the proposed reintroduction sites contained a robust MYL frog population, but all six of these populations were extirpated following the arrival of Bd. The reintroduction sites are all lakes predicted to be of very high habitat suitability (Knapp et al. 2003). Reintroductions The six reintroductions will be conducted in mid-summer of FY13 using methods proven to be effective in previous reintroductions of MYL frogs (Knapp et al. 2011). We will collect twenty adult MYL frogs from each source population (10 males, 10 females) using hand nets. All frogs will be tagged with 8mm PIT tags, measured, weighed, and sexed. PIT tagging was successfully used in numerous previous studies of MYL frogs and does not affect frog survival (Briggs et al. 2010). To characterize the Bd infection intensity of individual frogs, we will collect a skin swab from each frog using standard methods (Hyatt et al. 2007, Vredenburg et al. 2010) and analyze them using real-time quantitative PCR (qPCR; Boyle et al. 2004). Following capture at the source sites, frogs will be held individually in small plastic containers (with ventilation holes), and transported to each reintroduction site via helicopter (Knapp et al. 2011). Prior to release at the reintroduction site, each frog will be fitted with a miniature radio-transmitter (Matthews and Pope 1999). Given the general rule that transmitters not exceed 10% of body mass (Heyer et al. 1994), only frogs weighing more than 10 g will be used. Radio-telemetry was successfully used on MYL frogs in several previous studies and the associated techniques are well-developed (Matthews and Pope 1999; Knapp, unpublished data). The use of radio-transmitters provides a means to overcome a major limitation of past reintroductions by facilitating the recapture of every live frog and retrieval of dead frogs during each site visit, thereby allowing accurate determination of frog status (alive or dead) and regular quantification of Bd infection intensity. To allow direct comparison between frogs at the reintroduction and source sites, we will also attach radio-transmitters to ten frogs in each source population. Population monitoring Following release of transmittered frogs, we will revisit each source and reintroduced population once per week for one month (i.e., the battery life of the transmitter). During each visit, all frogs will be located using radio-telemetry. The status of each frog will be determined (alive or dead), and live frogs will be measured, weighed, and swabbed. Frogs will be released at the site of capture. Just prior to battery failure, all transmitters will be removed from frogs. Subsequent monitoring in FY 13 will rely solely on periodic recapture of frogs, identifiable via their PIT tags. This monitoring will be conducted during twice-monthly site visits, during which as many frogs as possible will be captured, identified, measured, weighted, swabbed, and released. In the two years following the reintroduction (FY 14, 15) we will again visit each reintroduction and source population approximately every two weeks throughout the summer active season, and will monitor each population using only capture-recapture methods based on PIT-tagged frogs (Knapp et al. 2011). Although the capture-recapture methods will not provide the detailed information on infection intensities and fates of individual frogs possible using radio-telemetry, they will allow estimation of site-specific detection and survival rates and measurement of infection intensities on recaptured frogs (Knapp et al. 2011). During each visit we will conduct shoreline visual encounter surveys of all life stages. Any adults observed will be captured, identified via their PIT tag, measured, weighed, swabbed, and released. The presence of tadpoles or juveniles at the reintroduction sites in FY 14 and/or 15 would provide evidence of successful reproduction, and these life stages will also be measured, weighed, and swabbed at both the reintroduction and source sites.

Roland Knapp **5/1/2014 to 5/30/2015** **$17,592**
National Park Foundation SB150003

Facilitating Recovery of the Endangered Sierra Nevada Yellow-legged Frog (Rana sierrae) in Yosemite National Park Through Identification of Critical Habitats and Movement Corridors

The Sierra Nevada yellow-legged frog (Rana sierrae) was once the most abundant vertebrate in the mountains of California, but steep population declines during the past century have pushed this species to the brink of extinction. To improve the effectiveness of conservation actions undertaken to recover this frog, including habitat restoration and frog reintroductions, we propose a frog tagging and radio-tracking study in Yosemite National Park designed to identify critical habitats and migration corridors used by R. sierrae. The proposed project will provide youth and college students with hands-on experience in conservation research, and the study results will be essential for the design and implementation of future conservation actions in Yosemite and across the range of this iconic species.

Roland Knapp, Cheryl Briggs **8/1/2012 to 12/31/2014** **$121,077**
National Science Foundation IOS-1244804

Collaborative Research (RAPID): Testing Intervention Strategies to Change the Outcome of Disease-caused Mass-mortality Events in a Declining Amphibian

During summer 2012, the largest remaining mountain yellow-legged frog population will suffer a mass-mortality event caused by the recent arrival in the area of the amphibian chytrid fungus, Batrachochytrium dendrobatidis (Bd). In mountain yellow-legged frog populations the arrival of Bd in a naïve population typically results in frog population extirpation, and the goal of the proposed study is to change the outcome to long-term persistence. This disease intervention will take the form of a field experiment in which the effectiveness of antifungal drug and bacterial augmentation treatments are quantified at the scale of an entire frog population. This large-scale experiment will provide a unique opportunity to also test several specific hypotheses regarding the mechanisms underlying treatment effectiveness, including the role of the adaptive immune system, effect of the microbiome present on the skin of frogs, and rapid evolution in frogs during Bd epizootics. To initiate the experiment, frogs will be treated with Itraconazole, the symbiotic skin bacterium Janthinobacterium lividum, or both. Untreated control frogs will also be included. Following treatment, frogs will be released into the study lake and the Bd load and frog survival quantified during the remainder of the summer and fall using frog skin swabs and frog capture-recapture techniques. The effect of the frog microbiome on frog susceptibility to Bd will be investigated by quantifying relationships between microbiome composition (determined by pyrosequencing) and frog Bd load over the course of the experiment. The dynamics of natural selection in the frogs will be described using genomic tools applied to frog tissue samples collected from frogs in all treatments before and after the frog mass-mortality event.

Roland Knapp, Craig Nelson **10/19/2012 to 3/31/2015** **$130,000**
Cal EPA Water Control Board 12-067-160

Assessment of Bacterial Water Quality in the Lahontan Region: A study to provide data on bacterial indicator concentrations and sources of bacteria in surface waters

The project will be performed primarily at the Sierra Nevada Aquatic Research Laboratory and at UCSB, with field collection of samples to occur throughout the eastern Sierra Nevada and other possible locations around the Lahontan Region. The State Water Board and the Lahontan Regional Water Quality Control Board regulate the quality of California's surface waters, in part via the adoption and enforcement of water quality standards for bacterial indicators. The Water Boards' current bacterial indicators and standards are decades old. The Water Boards need modern tools and information regarding bacterial indicators in order to amend and update existing water quality standards for bacteria, to adopt new or complementary water quality standards for bacterial indicators, to develop appropriate numeric targets for Total Maximum Daily Loads (TMDLs) for bacteria and pathogens, and to list or de-list water bodies as impaired pursuant to Section 303(d) of

the Clean Water Act, as appropriate. This study will examine the relative concentrations of various bacterial indicators in surface waters of the Lahontan Region, using modern as well as traditional methods. The UCSB principal investigators will conduct field sampling and analysis of water samples using quality control methods and processes approved by the State Water Board's Contract Manager. 1. At not fewer than eight watersheds, the UCSB research team will conduct longitudinal stream surveys for bacterial indicators. At each selected watershed, not fewer than ten water samples will be collected and transported to the appropriate laboratory (SNARL and/or UCSB) for analysis. Records of the sampling sites will be maintained, including date and time of sampling and GPS coordinates for latitude and longitude. 2. Using USEPA-approved methods, not fewer than 80 water samples will be analyzed in the laboratory for fecal coliform bacteria and Escherichia coli. In addition to the standard membrane filter methods for fecal coliform bacteria and E. coli, a preliminary source tracking assessment will be conducted (on not fewer than 50 samples, from a range of potential bacterial exposures) using newly developed qPCR probe/primer sets for differentiating human and bovine sources of Bacteriodales. Specificity of widely used assays of Bacteroides spp. and Enterococcus spp. will be contrasted to develop ratio-based metrics of relative source levels (human vs. bovine). The PIs will submit all bacteria and laboratory metadata to SWAMP and/or CEDEN databases and will prepare quarterly and final reports for the State Water Resources Control Board.

Roland Knapp | **11/15/2012 to 5/31/2016** | **$275,003**
USDA Forest Service | 13-DG-11272170-002

Effectiveness of Reintroductions and Probiotic Treatment as Tools to Restore the Endangered Sierra Nevada Yellow-legged Frog (Rana sierrae) to the Lake Tahoe Basin

The Sierra Nevada yellow-legged frog (Rana sierrae) was until recently a common inhabitant of the central and northern Sierra Nevada, including the Lake Tahoe Basin. Because of its abundance, R. sierrae played an important role in structuring aquatic and adjacent terrestrial ecosystems, with strong effects on nutrient cycling and food web dynamics. Unfortunately, due primarily to the introduction of non-native fish and a novel (but widespread) amphibian pathogen (Batrachochytrium dendrobatidis), R. sierrae is now absent from more than 90% of its historical range and may be extirpated from the Lake Tahoe Basin. Reversing this decline will depend critically on the removal of introduced fish from key habitats and on frog reintroductions. B. dendrobatidis infection has limited the success of previous R. sierrae reintroduction efforts, but a recently developed probiotic treatment against B. dendrobatidis may provide an effective method of minimizing disease impacts. In this study, we propose to test the effectiveness of reintroductions and probiotic treatment as tools to restore R. sierrae to the Lake Tahoe Basin. The frog treatment will involve augmenting the microbial community that inhabits the skin of R. sierrae with Janthinobacterium lividum, a bacterium that in recent laboratory and field trials was found to strongly inhibit the growth of B. dendrobatidis on amphibians, including R. sierrae. J. lividum is common in soil and water, and is found naturally at low density on the skin of R. sierrae. In the first year of the project, 10 adults and 160 juveniles will be translocated from source populations on the Eldorado National Forest to two lakes on the adjacent Lake Tahoe Basin Management Unit. The reintroduction lakes were recently returned to their natural fishless condition and contain high-quality habitat for R. sierrae. Prior to release at the reintroduction sites, some of the frogs will be treated with J. lividum and the remainder will serve as untreated controls. An additional 160 juveniles will be treated and translocated during the second year of the project. Following frog treatment and release, the effect of J. lividum treatment on disease status and survival of frogs will be quantified over a two year period using capture-recapture methods and radio-telemetry. This research will provide critical insights into the effectiveness of J. lividum treatment in increasing the survival of R. sierrae. If the treatment is effective, the study results could markedly increase the success of future R. sierrae reintroduction efforts and have broad implications for the recovery of this declining species in the Lake Tahoe Basin and throughout the Sierra Nevada. Project justification This proposal addresses issues in the Watershed, Water Quality, and Habitat Restoration theme, and specifically in Subtheme 2c: Increase our understanding of special status species and communities. The Sierra Nevada yellow-legged frog (Rana sierrae) is a special status species that was historically abundant in the central and northern Sierra Nevada, including the Lake Tahoe Basin. As a consequence of its precipitous decline, it is increasingly the focus of conservation and restoration efforts led by both federal and state agencies. These include (1) an ongoing multi-agency effort led by the U.S. Fish and Wildlife Service (USFWS) to develop a Conservation Strategy

for R. sierrae, (2) the pending listing of R. sierrae under the U.S. and California Endangered Species Acts, (3) ongoing efforts by the California Department of Fish and Game (CDFG) to develop Aquatic Biodiversity Management Plans for watersheds throughout the Sierra Nevada (including a recently completed plan for the Desolation Wilderness) that identify restoration opportunities for R. sierrae and other native amphibians, and (4) efforts by the National Park Service (NPS), U.S. Forest Service (USFS), and CDFG to remove non-native fish populations from key habitats to recover R. sierrae populations. This latter effort includes recent fish removal projects in the Desolation Wilderness portion of the Lake Tahoe Basin Management Unit (LTBMU). The proposed project would provide critical information and guidance on the effectiveness of frog reintroductions as a means to reestablishing R. sierrae populations in areas from which they were previously extirpated.

Roland Knapp | **6/4/2012 to 7/30/2014** | **$116,146**
USDI National Park Service | P12AC10522

Preventing the Extirpation of Mountain Yellow-legged Frog Populations in Sequoia and Kings Canyon National Parks Following Disease-caused Mass-mortality Events

Mountain yellow-legged frogs (Rana muscosa and Rana sierrae) are highly susceptible to amphibian chytrid fungus (Batrachochytrium dendrobatidis; "Bd"), and most populations are extirpated following Bd arrival at a site. Skin swabs collected from Spur Basin in Sequoia and Kings Canyon National Parks on two occasions in 2011 indicated the onset of Bd and increasing prevalence and infection intensity. These patterns indicate that a frog die-off is likely sometime during 2012. Field trials using anti-fungal treatment and augmentation of beneficial bacteria both show promise in changing the outcome of Bd outbreaks from frog population extinction to persistence. With the impending Bd outbreak in Spur Basin, we have an opportunity to markedly increase the chances of frog population persistence, and be able to compare the relative effectiveness of different Bd treatments. We will treat hundreds of frogs in several adjacent populations, thereby potentially changing the outcome from likely extirpation of these populations to long-term coexistence between frogs and Bd. This study will have important implications for future disease interventions that will be important in conserving the remaining mountain yellow-legged frog populations across their respective ranges.

Roland Knapp | **4/8/2013 to 6/30/2015** | **$50,000**
USDI National Park Service | P13AC00124

Sierra Nevada Yellow-Legged Frog Genetic Analysis for Yosemite National Park

This collaborative project between investigators at the University of California, Santa Barbara-Sierra Nevada Aquatic Research Laboratory (UCSB) and National Park Service (NPS) staff at Yosemite National Park (YOSE) is designed to support efforts to recover the Sierra Nevada yellow-legged frog (Rana sierrae) by conducting genetic analysis of frog tissue samples. Approximately 93% of the Sierra Nevada yellow-legged frog populations have been extirpated over the past 100 years, with declines escalating since the late-70s (Phillips 1994; Vredenburg et al. 2010). Most of remaining populations are much smaller and more isolated than those that occurred historically (Knapp 2005).Consequently, this species is listed as Threatened by the State of California, and it is proposed for listing as Endangered by the U.S. Fish and Wildlife Service (USFWS). YOSE, US Fish and Wildlife Service (FWS), U.S. Forest Service (USFS), Sequoia and Kings Canyon National Park (SEKI), and the California Department of Fish and Wildlife (CDFW) are collaborating to develop a range-wide conservation strategy to "ensure self-sustaining, long-term viability, and evolution of mountain yellow-legged frog populations in perpetuity that represent their historic geographical range and genetic and ecological diversity". This multi-agency group has identified translocations as one of the primary tools for bringing the Sierra Nevada yellow-legged frog back from the brink of extinction and for protecting genetic diversity as a key component of frog recovery. However, our knowledge of the genetic structure of Sierra Nevada yellow-legged frog populations is limited, and much more detailed information is needed to guide future translocation efforts. Results from this genetic project at YOSE will be integrated into the range-wide conservation strategy for the Sierra Nevada yellow-legged frog.

Roland Knapp | **4/7/2014 to 3/31/2016** | **$295,200**
Cal EPA Water Control Board | 13-054-160

Assessment of Bacterial Water Quality in the Lahontan Region: A Study to Provide Data on Bacterial Indicator Concentrations and Sources of Bacteria in Surface Waters

The Water Boards regulate the quality of California's surface waters in part via the adoption and enforcement of water quality standards for bacterial indicators. Numerous water bodies within the jurisdiction of the Lahontan Region have been determined to be impaired due to bacteria and/or pathogens. The Water Boards must identify the source(s) of the bacteria in impaired surface waters before they can develop effective remedial strategies to address these impairments. This project will collect information and assist the Water Boards in identifying the source(s) of bacteria in surface water bodies that have been shown to exceed standards for fecal indicator bacteria.

Jeffrey Krause | **4/1/2012 to 3/31/2016** | **$453,487**
National Science Foundation | OCE-1155663

Group-Specific Diatom Silica Production in a Coastal Upwelling System

This project seeks support to understand the variability in the contribution of individual diatom groups to total silica production in a field diatom population as a function of dissolved silicon availability. The value of the ecological and biogeochemical insights that would be gained from knowledge of the performance of individual groups has inspired several attempts, but the partitioning of silica production among different diatom groups has never been done in the field. Bulk measures of silica production have been made in all types of marine environments. When silica production studies also have taxonomic data, the lack of information on the performance of individual species makes it impossible to allocate the measured rates among cells. The assignment of the most numerically abundant diatom as the highest contributor to bulk silica production potentially leads to erroneous conclusions given interspecific differences in cell size and Si uptake kinetics. Quantitative estimates of the contribution of individual diatom taxa to total silica production would improve our understanding of the major biological and ecological drivers of silica production and identify key diatom species for inclusion in food-web and biogeochemical models. The proposed work will test hypotheses related to the general theme of using species-specific data to improve our understanding of the factors regulating diatoms' role in elemental cycles and marine food webs. By combining bulk measures of silica production using the radioisotope 32Si with measures of silicon deposition rates by individual cells using the fluorescent probe 2-(4-pyridyl)-5((4-(2-dimethylaminoethyl-aminocarbamoyl)-methoxy)phenyl)oxazole or PDMPO, quantitative estimates of the contribution of individual diatom taxa to total silica production will be determined for the first time. This study will assess differences in the distribution of silica production among diatom species along gradients in dissolved silicon concentration in a coastal upwelling system, evaluate the role of cell size, abundance and Si uptake capacity in determining the contribution of individual diatom taxa to total silica production, and determine species-specific kinetic parameters for Si uptake which govern the ability of individual species to compete for dissolved silicon.

Jeffrey Krause, Mark Brzezinski | **1/1/2012 to 12/31/2014** | **$256,128**
National Science Foundation | OCE-1131788

Collaborative Research: Understanding the Role of Picocyanobacteria in the Marine Silicate Cycle

We propose to pursue our discovery of significant accumulation of silicon by marine picocyanobacteria of the genus Synechococcus to assess the contribution of these organisms to the cycling of biogenic silica in the ocean. Oceanographers have long assumed that diatoms are the dominant marine organisms controlling the cycling of silica in the ocean. Si cycling by diatoms is coupled to their processing of other nutrient elements with consequences for the sequestration of carbon in the deep sea. Recently, however, single-cell analyses of picocyanobacterial cells from field samples surprisingly revealed the presence of substantial amounts of silicon within Synechococcus. The contribution of Synechococcus to biogenic silica often rivaled that of living diatoms in the two systems examined. Moreover, size fractionation of biogenic silica indicates that up to 25% of biogenic silica can exist in the picoplanktonic size fraction. Given that picocyanobacteria dominate

phytoplankton biomass and primary production over much of the world's ocean, these findings raise significant questions about the factors controlling the marine silica cycle globally, as well as the proper interpretation of biogenic silica measurements, Si:N ratios in particulate matter, and ratios of silicate and nitrate depletion. It also suggests that picocyanobacterial populations may be subject to previously unknown constraints on their productivity. The proposed work will have both laboratory and field components. Because cellular Si varies substantially among the field-collected samples and laboratory strains so far analyzed, the laboratory component will document variability in Si uptake and cellular Si concentrations, while determining what role physiological and phylogenetic factors play in this variability. We propose using strains of the cyanobacterium Synechococcus for which there are existing genomes. Three separate laboratory components will 1) use 32Si radiotracer uptake experiments to assess the degree of variability in Si content and Si uptake kinetics among strains of Synechococcus acclimated to different levels of silicate , 2) characterize the intracellular distribution and chemistry of silicon within cells using fractionation techniques, density centrifugation, electron microscopy and x-ray absorption spectroscopy, and 3) use bioinformatic analyses of published genomes to determine whether uptake of Si can be predicted based on phylogenetic relationships, to identify candidate genes for inactivation and to develop probes for community structure that can be related to cellular Si content. Field work at the Bermuda Atlantic Time Series (BATS) site will assess the contribution of Synechococcus and diatoms to total biogenic silica in surface waters at times of the year when the former are typically dominant. Field measurements will include size fractionation of biogenic silica biomass and Si uptake, and synchrotron-based x-ray fluorescence microscopy. We will also attempt to characterize Synechococcus communities using various molecular approaches to help explain the substantial spatial and temporal variation in expression of this trait.

Armand Kuris **8/1/2011 to 7/31/2016** **$2,149,227**
Ryan Hechinger, Kevin Lafferty
National Science Foundation OCE-1115965

Collaborative Research: Modeling Infectious Diseases: How much Ecological Complexity Must We Address?

This project focuses on how ecological complexity influences infectious disease dynamics and how we should best go about predicting disease dynamics. Ecological systems are undeniably complex and to fully understand their dynamics we must first take their complexity into consideration. One of the most complex aspects of ecology is how biodiversity interacts in ecological networks. Ecologists have been making strides toward describing and analyzing complex ecological networks, but are only very recently considering the role of infectious diseases. Particularly challenging is that infectious diseases affect ecological networks while ecological networks affect infectious diseases. The research will not only increase our understanding of infectious disease dynamics, but also illuminate the general role of infectious processes in ecological systems, helping ecological science better address the fundamental and overlooked implications of parasitism.

Armand Kuris, Kevin Lafferty **6/1/2012 to 5/31/2015** **$36,000**
University of Tromso SB120155

The Role of Parasites in Food-Web Topology and Dynamics of Subarctic Lakes

UCSB will give assistance in the project work with field sampling of parasites from the Norwegian lake sites involved in the study, taxonomical analyses of sampled parasites, and quantitative analyses of collected data on food-web topology and functioning (June 2012 – Dec. 2014); host the postdoc candidate during a research visit at UCSB (Sept. 2013 – May 2014); and participate in the dissemination and publication of findings from the Project (June 2012 – May 2015).

Adam Lambert, Tom Dudley **9/1/2012 to 12/31/2014** **$99,930**
USDA National Institute for Food and Agriculture 2012-34103-20193

Evaluating the Efficacy and Impacts of Tetramesa romana, a Wasp Introduced for Biological Control of Arundo donax (Giant Reed)

Arundo donax (giant reed) is a large invasive grass in riparian areas across the southern United

States, especially in the arid Southwest. A biological control program is being implemented using specialist herbivores of European origin, and several of these insects have been released or are already present in the US. However, field evaluation of their impacts has not yet been conducted. Our work is intended to complement and facilitate the ongoing USDA biocontrol program by providing additional and unique information about the impacts of herbivores released for biocontrol, as well as new techniques for large-scale development and implementation. Our proposed research addresses multiple program priorities and integrates basic scientific investigations and outreach activities. We propose to document the impacts of Arundo IPM adoption by measuring the effects of herbivorous wasps and other insects on Arundo growth and architecture in field populations in California [priority (a)]. Further, we propose to develop and fine tune methods for mass rearing wasp biocontrol agents [priority (g)] and evaluate whether insects can be redistributed over a greater range where Arundo is problematic [priorty (e)], including multiple states (CA, NV, and AZ). We will work to promote understanding and acceptance of this program by the public by disseminating information about Arundo biocontrol through our website and informational materials provided to cooperative extensions, land managers, and weed management areas. Our ultimate goals are to evaluate the risks associated with and facilitate large-scale implementation of the Arundo biocontrol program.

Lyndal Laughrin, Susan Swarbrick | **8/1/2013 to 8/30/2015** | **$13,581**
USDI National Park Service | P13AC01131

Research Bibliography for Channel Islands National Park

In this project, the National Park Service (NPS) and University of California, Santa Barbara (UCSB) will collaborate on compiling and updating bibliographic references for natural and cultural resource research studies within and in the vicinity of Channel Islands National Park (CHIS). The compiled park research bibliographies will provide a variety of users, from park staff to students, teachers, and scientists, with useful references for understanding the scope of previous research and as a baseline for understanding where to direct future research efforts. This project is planned for multiple phases. Phase 1 will focus on compiling easily sourced natural resource related references for CHIS in an electronic database and completing an assessment of information gaps for planning future project phases. A longer term goal of this project is to provide public access to park bibliographic information through an easy to use web interface and one that consolidates information across jurisdictions. Project partners will explore the possibility of working jointly with the University of California, Natural Reserve System in the development of a web-based research portal for parks, natural reserves and other protected areas in the state. Future phases of this project would be implemented through modification of this Task Agreement and are dependent upon the availability of funding and need.

David Lea | **7/1/2013 to 12/31/2014** | **$10,000**
UC MEXUS | SB140018

Yucatan Peninsula Hydrological Sensitivity to Radiative Forcing by Greenhouse Gases: Paleoclimate Perspective

We propose to extend the climate record of the Yucatan Peninsula (YP), which currently goes back 10 thousand years before present (BP), to at least 320 thousand years BP, by analyzing the chemical composition of stalagmite deposits found in underground caverns from this region. By exploiting recently developed tools for paleo-rainfall reconstruction, we aim to provide a regional view of past climate variability in the YP region, investigate the role of climate in shaping the history of the Maya civilization, and offer quantitative estimates of the sensitivity of regional rainfall variability to changes in the atmospheric content of greenhouse gases. The problems that we propose to address here are particularly important considering recent model estimates suggesting regional rainfall reductions of up to 50% by the end of this century, and the considerable impact that drought has on the livelihood of local populations.

Ira Leifer, Bruce Luyendyk | **8/1/2008 to 7/31/2013** | **$236,742**
University of Mississippi | 09-08-015

Spatio-Temporal Measurement of Seep Emissions by Multibeam Sonar

By their nature, seeps are spatially and temporally variable and episodic; thus, effective emissions quantification presents significant challenges because measurements at any one time and location likely are unrepresentative. Moreover, Leifer et al. (2006) showed that large transient emissions are critical for allowing methane sequestered in deep-sea hydrates to reach the winter mixed-layer and thus the atmosphere. Thus, we propose to measure seep emissions including transient events over a wide spatial domain using a seabed-deployed, scanning multibeam sonar system. The system will use a low–cost and low power model, several of which are commercially available. We propose a two stage proposal, a pilot stage (described herein) to demonstrate the principle, followed by a second stage to optimize the approach and determine system limitations in distance, resolution, discrimination of fish, signal to noise, and optimum frequency: Stage 1 Phase 1: Laboratory calibration Phase 2: Mapping in seep field Phase 3: Field seabed, boat-based deployments (scuba accessible) Stage 2 Phase 4: Scanning seabed multibeam sonar construction Phase 5: Field seabed long-term deployment (i.e., seabed power) Phase 6: Field data analysis

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Ira Leifer | **9/1/2010 to 8/31/2014** | **$224,088**
National Science Foundation | ARC-1023600

Collaborative Research: The East Siberian Arctic Shelf as a source of Atmospheric Methane: First Approach to Quantitative Assessment

We propose to study methane (CH4) release over the East Siberian Arctic shelf (ESAS), the largest (~10% of the world ocean shelf area) and the shallowest shelf (mean depth <50 m) of the world ocean. Until recently, the ESAS was not considered a CH4 source due to subsea permafrost's impermeability, which completely isolated it from modern biogeochemical cycles. The ESAS stores the world's largest hydrocarbon stocks, mostly as shallow Arctic hydrates, and thus represents an enormous potential CH4 atmospheric source that could result from global warming-triggered permafrost degradation. Increased CH4 fluxes could occur as numerous weak seeps or strong bubble plumes over large areas. Due to the shallow nature of the ESAS, the majority of ESAS CH4 likely avoids oxidation and escapes to the atmosphere. To assess whether sudden, large-scale CH4 release occurs or is likely to occur in the future, we will investigate the migration pathway characteristics and identify the controlling factors of CH4 flux from the seabed, in the water column, and to the atmosphere.

Ira Leifer | **8/1/2010 to 7/31/2013** | **$110,711**
Dar Roberts, Bruce Luyendyk
National Science Foundation | AGS-1042894

Fossil-Fuel Extraction Industry Methane Emission Ground Reference Measurements during the AVIRIS Response to the Gulf

Methane emissions from fossil fuel production are estimated as one of the major sources of the greenhouse gas CH4, estimated responsible for ~30% the radiative transfer impact of CO2 (Shindell et al 2005), yet, virtually no peer-reviewed studies have field-evaluated these emissions, which EPA estimates are the largest non-anthropogenic US CH4 source. As such, refinement of this key part of the global carbon cycle would greatly reduce uncertainty in natural global budgets. The current state of knowledge is in part because of the need for imaging spectrometric remote sensing, recently first demonstrated with AVIRIS (Airborne Visual Infrared Imaging Spectrometer) for a marine geologic source and sunglint (Roberts et al 2010).

Hunter Lenihan, Laura Urbisci | **6/1/2014 to 5/31/2017** | **$96,249**
UC Sea Grant College Program | E/PD-13-F-R

Developing a New Ecosystem-Based Management Approach: Using Ecosystem Models to Calculate a Better Estimate of Population Scale for Single-Species Models

Exploitation of renewable marine resources provides for many of the world's human needs, and this dependence is unlikely to change in the future. Exploited fish stocks are especially important in providing sources of protein as well as employment to millions of people world-wide. Without

appropriate management that is based on high quality science and adequate enforcement, sustainable fishing is difficult to maintain (Hutchings and Myers 1994). Most managed stocks rely on single-species stock assessments to provide the necessary information to support sustainable harvest. Dynamic stock assessment models range from simple biomass dynamics models to complex age and sex-structured models (Pope and Shepherd 1985; R. Methot 1989; Hilborn 1990; R. D. Methot 1990). Modern integrated stock assessment models are capable of utilizing a wide range of data types from traditional fisheries monitoring (e.g. catches, surveys, composition) in addition to environmental data. In a statistical framework, population level processes (i.e. recruitment, mortality) are used to govern the estimation of dynamics (i.e. changes in abundance through time), which in turn are then used to compare the model predications to the data. However, single-species models stop short of understanding broader ecosystem concepts, because they do not adequately incorporate energy transfer through food-webs and species interactions. Ecosystem models on the other hand can generate critical information that so far has limited the power of single species stock assessments. To meet the needs of more comprehensive management and assure sustainable fishing, integrated ecosystem models are being developed to address broader ecosystem level processes, such as the total fish biomass that can be produced for a given level of primary production. We use single-species models to manage quotas for individual stocks. These models rely heavily on estimates of population "scale", another term for population abundance used by stock managers. Population scale is a critical metric because it used to estimate the virgin stock biomass, against which sustainable removals through fishing, as stipulated in annual quotas, are calculated. As such, sustainable fishing is heavily reliant on good estimates of population scale that was present prior to the initiation of the fishery. Of course, actual scale measures are not possible, so are backed out of the available stock biomass data generated from catches through time. For apex predators, such as tunas, sharks, and swordfish, estimates of virgin stock biomass are difficult to generate because their population scale is heavily dependent on the state of the ecosystem, specifically in terms of prey availability (i.e., biomass in low trophic levels) and thus primary Laura Urbisci NMFS Fellowship Application: Project Proposal production, as well as environmental features, especially temperature, which helps determine their spatial distribution. My project is designed to utilize information from ecosystem models, specifically potential secondary production of apex predators and environmental conditions, to generate more robust estimates of population scale for use in single species stock assessment. This project will therefore make a very important contribution to ecosystem-based fishery management. Sharks and other chondrichthyan species are apex predators that we fish heavily in many fisheries worldwide. However, as apex predators sharks appear to be highly susceptible to overfishing due primarily to their low reproductive rate (i.e. slow growth, late maturity and low fecundity)(Holden 1974; Holden 1977). In low production species, only a relatively small portion of the population can be removed annually if the catches and populations are to remain sustainable. Populations of sharks are therefore difficult to manage in single-species stock assessments because the estimate of virgin biomass, "population scale", is so critical in estimating sustainable catches. Apex predators are also of major importance in ecosystem-based fishery theory because of their role in controlling the abundance of prey species that are also fished or are utilized by other species as prey. Thus overfishing of apex predators can lead to the destabilization of food web dynamics (Friedlander and DeMartini 2002).Destabilization of food web dynamics may alter the relationship between the apex predator and the trophic system through poorly understood ecosystem feedback mechanisms. As such, developing a more sustainable approach to managing apex predators is of major concern to fishery managers at NMFS and elsewhere. Shortfin mako sharks (Isurus oxyrinchus) are a highly migratory apex predators that are widely distributed in tropical and subtropical waters and are commercially fished across the globe (Compagno 2001). Despite their importance to both fisheries and trophic dynamics, considerable uncertainty remains in their stock status, productivity and resilience to heavy fishing and natural disturbance, as well as the influence of ecosystem changes (biological and environment) on their population dynamics and regulatory mechanisms. The focus of my research will be on integrating alternative estimates of population scale size from ecosystem models into single-species models to improve the reliability and reduce uncertainty of the current stock assessment models. The objectives of my proposed study are to compare results of two different theoretical approaches to modeling shortfin mako population dynamics. In the first approach, I will

create a traditional fisheries single-species dynamic model. In the second approach, I will develop an alternative ecosystem model that includes non-traditional data and ecological process allowing for understanding of alternative and higher level population regulation mechanisms. I plan on comparing both the model performance and key drivers of population dynamics from the two approaches. I intend to focus on the strengths and shortcoming of both methods as well as how to use our ecosystem level understanding to improve shortcomings in the single-species approach (i.e. calculating population scale size)

Sarah Lester, Steve Gaines	**10/4/2013 to 8/29/2014**	**$25,000**
The Nature Conservancy	FY13-G-BH-Waitt-UCSB	

Economic Benefits of Proposed Marine Protected Areas in the Bahamas

1) Background: The economic, cultural, and political variables that shape individual behavior ultimately structure the development, management and performance of Marine Protected Areas (MPAs). TNC is interested in evaluating the economic contribution of natural resources (and the associated environmental goods and services they provide) to the economy and people in the Bahamas. 2) Objective of the Study: The overall objective of the grant is to document the economic contribution of the natural resources within proposed marine protected areas to the Bahamian economy and to the social development of its population. The results of the economic valuations are expected to form the basis for mobilizing support for natural resource conservation and sea use planning from political leaders, decision-makers, the private sector and the general public. 3) Specific Objectives for the evaluation of 5 proposed priority MPAs in the Bahamas: 1. Construct a conceptual model of all existing interactions between natural resources in currently proposed MPAs and the national economy of The Bahamas (preferably divided along productive sectors). The model should be concise and descriptive rather than analytical or mathematical. In particular, emphasis should be put on differentiating indirect and direct benefits from goods and services generated by ecosystems in the proposed areas, as well as direct and indirect uses in those ecosystems. 2. Based on the conceptual model, identify actual and potential environmental benefits that the natural resources of proposed MPAs specifically provide to the Bahamian economy. This analysis should be divided by sector and place special emphasis on the economic sectors associated with the ecosystems services selected. 3. Again based on the conceptual framework, identify actual and potential environmental goods and services that the proposed areas provide to humans, such as natural disaster protection, water supply, property values, recreation, and overall social welfare effects not covered by sectorial analysis of the previous specific objective. 4. Prepare a set of simple and strong economic and political messages which are backed up by credible data and the results from the above analysis.

Sarah Lester,	**1/1/2014 to 12/31/2018**	**$100,000**
Christopher Costello		
Rare	SB150042	

Fish Forever (Waitt Foundation)

Statement of Work During the grant period, the Sustainable Fisheries Group at UCSB (SFG), under the direction of Project PIs Lester and Costello, will design and refine analytical tools and provide technical support to improve project implementation and capture learning on how to adapt and improve future strategies and tactics across Fish Forever sites in the Philippines, Indonesia, Belize and Brazil. Specifically, SFG will be responsible for: · Providing scientific guidance on site assessment and selection, including assisting with the application of a Rapid Site Assessment tool. · Providing technical support in the development of global and regional monitoring and evaluation plans and baseline assessments, including data collection protocols and guidance on the development of a data management platform. · Performing data analysis and modeling to inform implementation decisions such as TURF-reserve design and adaptive fisheries management, including the use and development of new data-limited fisheries assessment methods; assistance with setting harvest controls; tracking and evaluating progress towards our stated goals for the program; and providing technical expertise on barrier removal strategies. · Writing scientific papers, to be submitted to peer-reviewed journals, based on research related to Fish Forever, when appropriate. · Participating in the Fish Forever Science and Design team, including attending regular meetings. · Assisting with the development

of Fish Forever curriculum on technical/scientific topics, including attending Fish Forever Training Team meetings. · Participating in the development of strategic plans for Fish Forever.

Sarah Lester, Steven Gaines,	**9/1/2012 to 8/31/2014**	**$414,420**
Chris Costello, Libe Washburn		**$72,123**
NOAA Sea Grant	R/AQ-134-F-R-1/2	

Maximizing the Value of Offshore Aquaculture Development in the Context of Multiple Ocean Uses

The overarching goal of the proposed project is to develop a framework to inform marine spatial planning for offshore or open ocean aquaculture such that the value and success of aquaculture development is optimized in the context of a suite of ocean uses and environmental impacts. Planning for aquaculture without consideration for other competing uses (e.g., fisheries, shipping) is likely to result in conflicts and stakeholder and political opposition, and could preclude this new avenue for sustainable seafood and coastal economic development. We assert that strategic marine spatial planning can significantly reduce impacts from aquaculture and increase its value and compatibility with other ocean uses. Furthermore, successful planning requires an explicit consideration for how dynamic processes in marine ecosystems, such as oceanographic currents and human response patterns, drive interactions among aquaculture, other competing uses, and the environment. Therefore, we will develop an innovative dynamic spatial analysis framework for examining economic and environmental tradeoffs among aquaculture and other ocean uses in order to identify spatial plans that achieve a diversity of objectives and minimize environmental impacts. We hypothesize that our dynamic spatial analysis approach will out-perform static spatial siting models (i.e., that do not account for dynamic processes) and single sector planning decisions (i.e., that focus on maximizing a single use). This will allow us to assess if and how value is added by our approach and the losses that are likely to be incurred by moving forward with aquaculture development in its absence.

Sarah Lester	**6/1/2013 to 5/31/2015**	**$83,146**
Rare	SB140049	

Fish Forever: Subaward from MacArthur Foundation

Background: Environmental Defense Fund, Rare, and the Sustainable Fisheries Group at UCSB formed the Fish Forever partnership to launch a global initiative to protect and recover nearshore fisheries, curb overfishing and safeguard the food security and economies of thousands of communities in the developing tropics. Fish Forever's theory of change is that by aligning the social and economic interests of fishermen with conservation, fishermen become agents of long-term change because they reap direct rewards. Central to our approach is the proven TURF-Reserve system that combines spatial property rights with marine reserves where fishing is off-limits. This system gives fishermen a built-in incentive to defend reserves because the reserves replenish fisheries and the rights-based system ensures that good management is in the self-interest of local communities. Fish Forever brings together three experienced organizations that are uniquely positioned to achieve lasting, scalable conservation solutions across multiple communities and countries. All have strong track records of success. Environmental Defense Fund (EDF) is a global leader in transforming fisheries through rights-based management, and provides technical expertise and practical experience in designing and launching these systems. Rare specializes in engaging developing country communities to adopt more sustainable behaviors, and builds the capacity of organizations and governments to generate support for change through Pride campaigns. University of California, Santa Barbara (UCSB) brings expertise in fisheries science and innovative biological and economic assessment and management techniques, including for data-poor stocks. Together, we are poised to begin on-the-ground work in Indonesia and the Philippines, and to launch additional pilot projects in Belize. Launching pilot sites in Belize, Philippines and Indonesia: During the grant period of June 2013- May 2015, the Fish Forever team will create or build on TURF-reserve pilot sites in three countries (Indonesia, Philippines, and Belize) and assess these R&D sites in order to adapt, analyze and document lessons learned from this initial phase. These sites will serve as working laboratories to produce tangible results but also test a variety of new tools and approaches. They will serve as model

sites where others can come to see the program in action. Learning at these sites will inform the program development and enhancements. The Sustainable Fisheries Group (SFG) at UCSB will serve a key role in providing the scientific analysis and guidance needed to make sure these pilot sites are successful. See Deliverables (Exhibit B) for specific scientific contributions that SFG will make during the launch of pilot sites in these three countries.

Jonathan Levine **10/21/2004 to 9/30/2014** **$675,000**
David and Lucile Packard Foundation 2004-27672

Understanding Biological Invasions from Introduction through Impact

Biological invasions are a leading threat to natural ecosystems and cost the American economy tens of billions of dollars annually. At the same time, invasions can be regarded as large scale perturbations to ecological communities, providing unique opportunities to understand how these systems are structured. This proposal outlines a research program applying principles of population, community, and ecosystem ecology to understand the factors controlling the success and impacts of biological invasions. The proposed research couples mathematical models with field experiments to understand such fundamental questions as how many new invaders we should expect over the coming decades, and what factors regulate the impact of invaders once they have established. By examining key questions at the introduction, establishment, spread, and impact stages, the proposed research aggressively pursues a rigorous understanding of the entire invasion process.

Jonathan Levine, Erin Mordecai **5/1/2012 to 4/30/2014** **$12,654**
National Science Foundation DEB-1210378

Dissertation Research: Climate-Mediated effects of pathogens on plant communities

Although the effects of pathogens and parasites are known to cascade through foodwebs, this widespread group of species is among the least studied by ecologists. In plant communities, pathogens are often thought to regulate populations and maintain diversity, but theory also shows that pathogens can promote competitive exclusion via processes such as pathogen spillover from tolerant to intolerant hosts. Better understanding when these different alternatives arise in natural systems is of particular importance because climate change will likely alter pathogen dynamics, which may in turn, affect host population regulation and community composition. Motivated by this concern, the proposed research will address (1) how a shared pathogen influences the outcome of competition between plant species and (2) how climatic conditions influence pathogen effects on plant community dynamics. To accomplish this, the research will integrate field parameterized mathematical models of pathogen impacts on plant populations with a direct manipulation of climate conditions hypothesized to mediate disease risk in this system. Although pathogen spillover is an important transmission mechanism for wildlife disease, its consequences for host community dynamics are rarely investigated. This research will examine the impact of spillover of a widespread fungal seed pathogen from an invasive annual grass to a native bunchgrass in the Great Basin of North America. The effect of the pathogen on the outcome of competition between invasive and native hosts will be quantified by parameterizing population growth models with field-collected data. Field plots will track competition and seed bank dynamics throughout the growing season, yielding demographic parameters for the models. The key within and between species transmission parameters influencing host population dynamics will be quantified by experimental manipulations of seed density in controlled settings. Finally, a field manipulation of fall rainfall conditions hypothesized to affect disease risk will examine the influence of climate variability on pathogen-mediated host community dynamics. The study will show how pathogen attack influences cheatgrass invasion and dominance, and how this influence depends on the pattern of precipitation in the region.

Lorraine Lisiecki **9/1/2009 to 8/31/2013** **$317,113**
National Science Foundation OCE-0926735

Climate forcing of Atlantic overturning over the last 3 Myr

Atlantic overturning experiences dramatic changes over glacial cycles with potentially dramatic

effects on climate. However, its pre-LGM spatial and temporal variability and its primary forcing are poorly understood. The SPECMAP project [Imbrie et al.,1992] proposed that summer insolation at 65N, i.e., Milankovitch forcing, drives the same sequence of climate responses (including Atlantic overturning) over 100-kyr eccentricity cycles, 41-kyr obliquity cycles, and 23-kyr precession cycles. The implication of this hypothesis is that global climate is extremely sensitive to changes in the North Atlantic and that all other climate changes (e.g., in the tropics and Southern Ocean) are only responses or feedbacks to changes in Atlantic overturning or northern hemisphere ice volume.

Lorraine Lisiecki | **10/1/2010 to 9/30/2014** | **$157,017**
National Science Foundation | OCE-1025444

CMG Collaborative Research: Probabilistic stratigraphic alignment and dating of paleoclimate data

Stratigraphic alignment is the primary way in which long marine climate records (105 – 107 years) are placed on a common age model. However, currently there are no techniques for quantifying the uncertainty associated with these alignments. We propose to build probabilistic models of an automated stratigraphic alignment algorithm for paleoclimate records [Lisiecki & Lisiecki, 2002] as a means of characterizing this uncertainty. The development of this uncertainty analysis is important because the relative timing of climate responses (derived from stratigraphic alignment) is frequently used to evaluate causal relationships within the climate system. Therefore, we will also assess the effects of alignment uncertainty on these evaluations. Additionally, we will develop a probabilistic algorithm for age model development through orbital tuning. The improved accuracy and error estimates for paleoclimate age models that result from this work will improve estimates of the climate system's sensitivity to changes in radiative forcing [e.g., Hansen et al., 2007; Meyers et al., 2008].. The original software developed by PI L. Lisiecki uses dynamic programming to find the optimal alignment of paleoclimate records based on user-defined parameter settings and produces one best-fit alignment with no uncertainty analysis. The new version will provide users with alignments sampled in proportion to their probability and will provide error bars for the estimated relative ages at each point in the alignment. Specifically, we will develop two probabilistic versions of the alignment algorithm (pairwise and multiple) in the form of (pair and profile) Hidden Markov models (HMM) and develop a probabilistic HMM for creating orbitally tuned age models for paleoclimate data. The algorithm for age model development will incorporate knowledge gained about sedimentation rate variability from the pair and profile HMM algorithms. All three algorithms will be applied to create a new stack model of benthic □18O records (a proxy for global climate) with uncertainty estimates which include data noise, alignment uncertainty and age model uncertainty. This "probabilistic stack" is scientifically important because it will yield uncertainty estimates for a widely used measure of past climate change. For example, the deterministic □18O stack of Lisiecki & Raymo (2005) has >300 citations. We also propose to develop statistical methods to characterize the shapes of the posterior distributions of stratigraphic alignments and orbital tuning. This alignment problem is in a large class of discrete high dimensional problems that often have complex multimodal solution spaces which are difficult to characterize. To date the characterization of these spaces has been limited to a point estimate(s) and Bayesian confidence limits around these high-D estimates. In this project we propose to develop novel methods for the identification of clusters from multiple modes in these high-D spaces and characterize them as specific probabilistic models using both direct samples from the posterior distribution and the probabilities of each sampled value. Given the limited utility of point estimates and confidence limits in such high-D spaces, these probabilistic characterizations of posterior spaces will greatly improve our ability to describe such posterior spaces.

Lorraine Lisiecki | **9/1/2011 to 8/31/2016** | **$303,207**
National Science Foundation | OIA-1125181

CDI-Type II: Collaborative Research – 4 Dimensional Visualization of Past Ocean Circulation from Paleoceanographic Data

One of the fundamental challenges in the study of climate change is how to combine models of past oceanographic circulation (as reconstructed from sparse geochemical data taken from deep sea sedimentary cores) with modern ocean circulation models (as constructed from modern

oceanographic observations and computer simulations) to yield insight into the processes governing ocean circulation throughout the last glacial cycle from 150,000 years ago to the present. Similarly, a major challenge in computational data analysis and visualization is how to extract topological/structural information from sparse, time-varying 4D datasets, and how to effectively combine human-in-the-loop analysis of data (computational thinking) with automated data analysis, to extract new knowledge about features and processes. Our multidisciplinary and multi-institutional project will bring together computer scientists, physical oceanographers, paleoceanographers, and computational geophysicists to develop an innovative suite of visualization and analytical tools to explore fundamental questions about changes in global ocean circulation. This project will merge innovations in flow-dependent data approximation and reconstruction and topology-based analysis of ocean flow with 40 years of paleoceanographically relevant geochemical data from deep sea sedimentary cores in order to gain new insights into features of past ocean circulation change that were not previously possible. Our research will take advantage of the unique analytical resources and unique interdisciplinary collaboration provided by the UC Davis KeckCAVES (W.M. Keck Center for Active Visualization in the Earth Sciences). The KeckCAVES provides a visualization instrument and collaborative environment that exploits the human capacity to visually identify meaningful patterns in complex datasets and to interact with the data through pattern recognition, change detection algorithms, human-in-the-loop computing, and computational thinking. In this unique collaborative environment, we will develop methods based on flow fields that improve data interpolation, develop techniques to automatically extract flow patterns and detect changes in flow over time, and develop interactive means of visualizing and interacting with those large and time-dependent datasets.

Milton Love **10/1/2010 to 9/30/2013** **$100,372**
UC Santa Cruz NA100AR4320156

Investigations in Fisheries Ecology

We will conduct biological and ecological research on the deepwater corals and sponges of California. This research will include 1) underwater surveys of coral and sponge habitats, 2) the relationship of fishes with these structure-forming invertebrates and 3) taxonomic and genetic studies of corals and sponges.

Milton Love **9/22/2011 to 12/31/2015** **$1,232,660**
USDI Bureau of Ocean Energy Managemen M11AC00008

Renewable Energy in situ Power Cable Observation

The BOEM requires information concerning the level of impacts of electromagnetic field (EMF) on some marine species. Submarine transmission cables that power offshore oil platforms in the Pacific Region provide an opportunity to assess potential behavior and reaction of electromagnetic sensitive species to industry activities. By comparing the fishes and invertebrates that associate with 1) an energized power cable, 2) an unenergized power cable, and 3) nearby seafloor, it will be possible to determine how some marine organisms relate to an EMF. The information will be applicable to all renewable energy power cable EMF considerations and will determine effectiveness of the commonly proposed mitigation of cable burial.

Milton Love **6/4/2012 to 9/30/2015** **$625,000**
USDI Bureau of Ocean Energy Management M12AC00004

Analysis of Fish Population at Platforms off Summerland, California

The purpose of this award is to use BOEM-funded pre-existing methodology, applied through SCUBA and Remotely Operated Vehicle (ROV) surveys, to obtain observations of fish assemblages at eight very closely grouped platforms, within the Dos Cuadras oil field, off Summerland, Santa Barbara County, California. The detailed purpose is to characterize the fish assemblages around the platforms, describe the spatial and temporal patterns of fish diversity, density and size distribution among platform habitat types, complete analyses and synthesis documents for the eight platforms themselves and within the context of the manned submersible data from other Pacific platforms and natural reefs, complete standing stock (biomass) and fish productivity modeling for each platform

when compared to other nearby natural reefs for which similar production estimates are readily available, and compare production estimates in the literature of other marine ecosystems. The issue of platform decommissioning and decisions related to decommissioning and possible reefing will be decided on a platform by platform basis with each of the platforms judged on its own merits as far as ecological value is concerned. The eight platforms off Summerland California, Platforms C, B, A, Hillhouse, Henry, Houchin, Hogan and Habitat have been in operation for over four decades and are expected to be some of the first to be in line for decommissioning. Information is needed as soon as possible for the use by the State of California to consider for decommissioning options under the California legislation AB 2503 (the California Marine Resources Legacy Act). The Act requires California to consider reefing OCS oil and gas platforms, if their ecological value warrants, before decommissioning and potential removal. This study will also extend the application of the methodology to develop results applicable specifically for BOEM management decisions so that BOEM can specify requirements to industry or other interested parties when decommissioning occurs. Using the results, BOEM can ensure that specified criteria can be properly evaluated during the decommissioning process pursuant to the federal regulations at 30 CFR 250.1730 and the State of California can ensure proper evaluation under the California Rigs-to-Reefs Program law AB 2503 (the California Marine Resources Legacy Act). Thus, the overarching purpose of this research is to provide those responsible for making decommissioning decisions with a much more detailed assessment of the fish assemblages of these eight platforms (and by extension a more accurate picture of their ecological importance) than is currently available.

Milton Love **4/23/2012 to 9/30/2013** **$100,000**
USDI Bureau of Ocean Energy Management M12AC00003

Biological Productivity of Fish Associated with Offshore Oil and Gas Structures on the Pacific OCS

Understanding the similarities and differences in the biological characteristics of the fish communities associated with manmade structures and natural reef habitats in the Southern California Bight is important to evaluating the potential biological effects of oil platform decommissioning options. Since decommissioning these platforms is an unavoidable issue that will face California's ocean managers in the near future, understanding the environmental consequences of the two decommissioning alternatives being considered in this region, partial and complete removal, on local and regional fish populations will be important information to consider. The proposed project will use a biological model to produce estimates of the standing stock and annual production of fishes on platforms in the Southern California Bight based on existing empirical studies and compare these metrics to nearby natural reefs and other marine and terrestrial ecosystems. We have developed a preliminary model that starts with the current standing stock on a given platform, defined as the total biomass of each species, and then calculates the future production and standing stock based upon various platform decommissioning options. We are requesting additional funds to refine, improve and publish the model in a peer reviewed journal. Publication of this model will provide foundational information from which specified criteria can be properly evaluated during the decommissioning process associated with Bill AB 2503 (the California Marine Resources Legacy Act). Additionally, this study will provide further background from which to evaluate the potential of new habitat created by proposed installations by alternative energy projects, on the Pacific OCS, to contribute to local and regional fish standing stock and production.

Sally MacIntyre **8/1/2012 to 7/31/2017** **$943,094**
National Science Foundation ARC-12045267

Circulation and Respiration in Ice-covered Arctic Lakes

For approximately nine months of each year, the waters of arctic lakes are under ice. Although wind no longer acts directly on the water surface setting it in motion, the waters of arctic lakes are not still. Respiration occurs in the water column and within the sediments with rates temperature dependent. Classical studies have demonstrated circulation is induced by sediments heating the overlying water and by decomposition processes which create localized increases in salt content which further modify density. Gravity currents flow to deeper depths and an overall convective circulation results. The

lower water column may become anoxic and greenhouse gases accumulate. A large fraction of snow melt waters exits lakes without mixing. Spring heating induces vertical convective mixing. Over the last several years we have collected a unique time series of under ice temperature and conductivity data from arctic lakes of different sizes. These data show departures and extensions of the classical picture described above which warrant further investigation both by analysis of the existing data and by studies which link the hydrodynamics under the ice, during melting, and just after ice off to biogeochemistry. Based on these observations, we hypothesize that lake morphometry and geological setting cause between lake differences in the magnitude of cryoconcentration, respiration and sediment temperatures and thus differences in resistance to the convective mixing induced by spring time heating with consequences for persistence of anoxia and evasion of greenhouse gases. Internal waves contribute to mixing of snowmelt water with its high concentrations of CO2, labile organic matter, and nutrients so important for a lake's productivity in spring and summer. We propose time series studies to 1) quantify physical controls on under ice thermal structure and circulation, mixing of snow melt waters, mixing during spring and fall, 2) to quantify respiration rates in arctic lakes of differing morphology and on different geological substrates, and 3) to illustrate the linkages and feedbacks between these physical and biogeochemical processes. Measurements will include temperature and conductivity, meteorology, sediment temperatures, ice thickness, snow cover, and respiration with newly developed oxygen and pCO2sensors. Winter limnological studies are rare, and rarer still in the Arctic with its harsh environment. The proposed research, with its goals of better understanding physical limnology under the ice and controls on winter respiration and spring time gas evasion will fill a major gap in limnological understanding of high latitude lakes.

Susan Mazer | **12/8/2011 to 9/30/2013** | **$77,674**
University of St. Thomas | 260068

Collaborative RUI: The Evolution of Life History, Physiological, and Floral Traits in Clarkia: Do Genetic Correlations Affect Mating System Evolution?

The transfer of Clarkia unguiculata seed lineages from UST to UCSB: The UCSB team will cultivate and conduct the final episode of artificial selection on one of the three wild populations of Clarkia unguiculata that are the subject of this study. These seeds include 60 maternal lineages produced by the selective breeding of four selection regimes (Early-flowering; High autogamy; and two Control groups [self-fertilized and outcrossed]). The UCSB team will cultivate these 60 maternal lineages and enforce selective breeding as planned in the original grant proposal while also completing the cultivation and selective breeding of the three populations of Clarkia xantiana ssp. xantiana that have been the focus of UCSB's breeding program to date. March 2012 – September 2012: PIs Mazer and Dudley will analyze data from completed greenhouse experiments to prepare lineages for the upcoming 2012-2013 field experiments. October 2012 – July 2013: PIs Mazer and Dudley will raise the selected lineages in natural habitats off-campus in the southern Sierra Nevada, as described in the original grant proposal. A field assistant will accompany us in the field. February 2012 – July 2013: The UCSB team will monitor (in the southern Sierra Nevada) field-raised genetic lineages of Clarkia unguiculata and Clarkia xantiana ssp. xantiana prior to and during flowering to: 1) Determine whether phenotypes of lineages selected in the greenhouse (Early-Flowering and High-Autogamy, relative to the Control groups) through our artificial selection regime are also expressed in the field; 2) Measure the selected lineages' physiological rates and parameters under field conditions, including photosynthetic rate, transpiration rate, water use efficiency, water potential, and chlorophyll fluorescence; 3) Conduct phenotypic selection analysis in field-raised genetic lineages to estimate the direction and magnitude of natural selection (estimating both linear selection gradients and selection differentials) on the above-mentioned physiological rates and parameters; 4) Evaluate whether genetic correlations between flowering date and floral traits associated with self-fertilization are expressed in the field such that selection favoring early flowering may drive or promote the evolution of self-fertilization. 5) Collect seeds from field-raised plants to estimate fitness under natural conditions. July 2013 – August 2013: PIs Mazer and Dudley will prepare data sets and analyze data from the field component of this research.

Susan Mazer | **10/15/2011 to 9/30/2016** | **$317,917**
University of Minnesota | D002520602

Project Baseline, a Living Plant Genome Reserve for the Study of Evolution

The goal of this project is to collect seeds from multiple populations of each of 30-40 wild species of plants native to or introduced to California; these seeds will then be archived in the National Germplasm Resources Lab in Fort Collins, Colorado. In the future, these seeds will be distributed to evolutionary biologists so that they can compare them to seeds obtained from the same populations in order to assess the degree and kind of evolutionary change that has occurred due to environmental change. Dr. Susan Mazer will direct all field components of this project that will be based in California and coordinate UCSB's research activities with collaborators in Minnesota and New York. The other collaborators (Dr. Julie Etterson [University of Minnesota-Duluth] and Dr. Steve Franks [Fordham University, New York]) will direct the field components to be performed in parallel in the Midwest and in New England. In addition, the activities of all collaborators will be integrated by a Project Director who will be based in Duluth. Susan Mazer's responsibilities include a variety of tasks that will require 1.5-2.0 months of activity per year, including: Recruitment of Assistant Specialist, who will perform many of the day-to-day activities of this project; assisting with species selection and the choice of collection locations in California; coordinating with the Project Director at UMN-Duluth and the Assistant Specialist at UCSB to plan the annual collecting route and collection sites; designing the most efficient collection schedule for the selected taxa; soliciting, writing, editing, and disseminating contributions to Project Baseline eNewsletter that reports each region's progress in the collection of seeds and provides communication among teachers, park staff, reserve docents, and citizen scientists about educational programs involving seed collection, seed preservation, and phenology; supervising the Assistant Specialist's adherence to Project Baseline protocols and data management plant; collation and organization of environmental data to be transmitted to the Project Director; designing and participating in training workshops to introduce the public, graduate students, and other scientists to the principles and methods of Project Baseline.

Susan Mazer | **8/15/2007 to 9/30/2013** | **$579,608**
National Science Foundation | IOS-0718253

Collaborative Research: The Evolution of Life History, Physiological, and Floral Traits in Clarkia: do Genetic Correlations Affect Mating System Evolution?

Mating system is among the most evolutionarily labile of plant traits. To date, the primary explanations for the evolution of selfing in angiosperms are adaptive ones, focusing on the genetic and ecological consequences of selfing independent of other traits. For example, natural selection may strongly favor autogamous (within-flower) self-fertilization where pollinators are scarce or unreliable, or where short growing seasons favor rapid reproduction (which is facilitated by selfing). Self-fertilization in plants, however, often evolves along with a suite of physiological, morphological, and life history traits. This joint evolution of multiple traits raises the possibility that the evolution of selfing is influenced by selection on other traits with which it may be developmentally, physiologically, or genetically correlated.

Susan Mazer | **8/30/2010 to 8/29/2015** | **$430,436**
USDI National Park Service | P10AC00487

Facilitation of a phenology network to assess climate change response in California National Parks

In this project, investigators from the University of California, Santa Barbara (UCSB) will collaborate with National Park Service (NPS) staff and the director and staff of the National Coordinating Office of the USA-National Phenology Network to develop a phenological monitoring network emphasizing NPS units in California. The activities to be developed include: (1) identifying compelling scientific questions that can be addressed by park-based phenological monitoring programs, that apply to multiple California parks and nearby state or federal landholdings and preserves, and that may apply to national parks across the United States (a particular focus will be on using phenology to assess climate change response); (2) selecting charismatic, ecologically important, and/or keystone species, that address scientific questions of interest, for phenological monitoring within and across California

national parks; (3) designing and testing park-specific as well as park-wide species-sampling schemes and monitoring protocols; (4) designing, testing and evaluating activities to engage national park visitors, including families, institutional groups, and school groups in conducting phenological observations; (5) developing in collaboration with park-based educators informal science education programs and curricula for the public that can be implemented in each of the California national parks and with nearby schools; (6) developing a monitoring framework for all NPS units in CA in which species and protocols are identified and packaged; (7) training park staff to implement phenological monitoring and educational programs; (8) developing written materials and manuals that can be used by park staff to engage the public and to maintain consistent and high standards for phenological data acquisition; (9) creating a CA phenology network website for information and reference materials to be readily accessible to project participants and the public; (10) developing protocols to assure high quality data accumulation, archiving, and accessibility; and (11) assessing programmatic success with follow-up visits to participating parks, participating staff and members of the public. Partnerships will also be developed with the directors and staff of the University of California Natural Reserve system's field stations and sister federal agencies who wish to participate in the design and implementation of a statewide phenological monitoring network. Depending upon future needs and funding availability this task agreement may be modified in future years.

Robert Miller, Mark Page | **7/1/2013 to 6/30/2016** | **$58,354**
National Science Foundation | IIA-1318469

Sources of Particulate Organic Matter and Their Use by Suspension-feeders in New Zealand Kelp Forests

Understanding trophic connections and the effect of resource variability on consumers is necessary to predict how food webs may shift in the face of environmental change. Macroalgae and phytoplankton support highly productive marine ecosystems on shallow coastal reefs. The objectives of our proposed research is to determine: 1) the contribution of phytoplankton and kelp detritus to the pool of suspended particulate organic matter (POM) available to reef consumers, and 2) how different components of the POM are used as food by reef suspension feeders. Our work in giant kelp (Macrocystis) forests off California thus far suggests that phytoplankton dominates POM composition and suspension feeder diets. Nevertheless, work done in other regions suggests that other species of kelp degrade differently and may provide a more significant source of detritus. Ecklonia radiata is an excellent example of a highly productive understory kelp that is common throughout the temperate southern hemisphere, including Africa, Australia, and New Zealand. We propose to extend our work to examine the role of kelp detritus in this very different kelp forest system. We will use stable isotopes and polyunsaturated fatty acids (PUFA) to trace kelp carbon through the food web, and test the hypothesis that kelp detritus represents a significant source of carbon to suspension feeders living in the extensive Ecklonia kelp forests of New Zealand. New Zealand has an older more extensive network of marine reserves in place compared to California, which provides a gradient in kelp abundance that is a perfect natural experiment we can use to address this hypothesis. Like Macrocystis, Ecklonia abundance and primary production is predicted to decline with continued climate change. Collaborations with southern hemisphere scientists will be needed to achieve a general understanding of the effects of climate change on temperate reef ecosystems. Nicholas Shears, a Lecturer at the University of Auckland, would be our partner in this work. Dr. Shears has the intellectual background and field experience that will make the work possible. He is an international leader in the science of marine reserves, and has demonstrated top-down effects on Ecklonia through his work across the network of marine reserves in New Zealand. Superimposed on these reserve effects are gradients in sedimentation and light levels that shape the productivity of New Zealand kelp forests, and this topic is a major area of Dr. Shears' present research. Our collaboration would make use of the knowledge and technical expertise obtained from our NSF funded work in southern California to connect his work on Ecklonia to consumers in the kelp forest, with the primary goal of determining the extent to which variability in Ecklonia production affects the reef food web. We will benefit from Dr. Shears' expertise in the use of reserves and physical gradients to examine top-down versus bottom-up effects on the kelp forest food web, while Dr. Shears and his graduate students will benefit from our perspective on the role of kelp in the food web and our expertise in the use of stable isotopes and other tracers of material transfer. This interchange would continue from the fieldwork to data analysis and writing. A major benefit of this project to our research program, and

one that we will continue by seeking further funding, is a new focus on the trophic consequences of marine reserves. This focus will be particularly timely with the recent (Jan 2012) establishment of a large network of marine reserves off southern California, where research is needed to inform natural resource managers of the community-level consequences of reserves. We intend to continue working with Dr. Shears to continue comparative work on marine reserve ecology between our regions. Without CNIC catalysis this collaboration will most likely not develop. Broader impacts of this project will also include educational benefits to our graduate student, Christie Yorke, who is the first person in her family to attend college. The project will serve to expand her research and perspective to include a very different kelp forest system and introduce her to the value of international collaborations through mentoring by Dr. Shears and his group. Results of this research will be disseminated widely through scientific publications but also through our undergraduate teaching and public lectures at venues such as the Santa Barbara Museum of Natural History.

William Murdoch, Susan Swarbrick **8/26/2010 to 12/31/2014** **$960,000**
Dept of California Fish and Game WC-1014CF

Sedgwick Reserve Infrastructure and Facilities Project: Phase 2

Sedgwick Reserve has all the attributes of a world-class field site for university research and teaching, except that its facilities are wholly inadequate. This proposal is for the development of basic infrastructure. It follows an initial phase and is prelude to a subsequent phase. The three phases, collectively, will create the needed facilities. The aim of the entire project is to create the facilities and infrastructure needed to serve Sedgwick's current and projected needs and to turn it into a world-class natural reserve and field station. The Reserve currently supports 40 research projects including a number of long-term externally-funded programs investigating environmental problems important to preserving and managing California's natural living resources. About 400 students in 20 university courses use the reserve each year. The reserve has vigorous K-12 educational programs, including field trips for more than 700 students (many from under-served groups) from 23 schools and an environmental science program for 150 4th and 5th graders. There is a very active and large docent program, and partnerships with many local agencies. Our aim is to greatly increase research use and to fill out the teaching and outreach programs. The major facilities to be added over the entire project include the following: fully adequate infrastructure housing for the reserve director and the reserve steward a research center with accommodation for several researchers, kitchen, dining room, offices and wet/dry lab (remodel of existing Ranch House) a 12-bed dormitory for researchers and students a meeting house (capacity 75) with offices for the NRS staff an astronomical observatory with 1-meter telescope linked to a global telescope array a workshop, storage facilities, and a heritage center (refurbished existing hay barn) an upgrade of the existing Art Studio (capacity 30) for meetings and conferences. In preparation for the project, in 2004 through 2006 we developed a Master Plan and completed an EIR, improved the mile-long entrance road and repaired the Ranch House roof. In Phase 1, during the past few years, we constructed a solar-power-generating system, a pipeline that brings potable water into the reserve from the adjacent Woodstock community, an electronically-controlled entrance gate (essential for security), and an outdoor meeting area. Funding for 99% of this development came from private donors (total value $1,088,472). The current proposal (implementation of Phase 2) will create the basic infrastructure needed for future facilities plus one emergency renovation. Infrastructure development includes: construction of the wastewater system distribution of a potable water supply upgrade of the electrical supply and distribution system and communications repair of fencing for controlled grazing & vehicle traffic emergency renovation of the Art Studio roof construction of a maintenance shop removal of 2 existing buildings. During the final phase, Phase 3, we will construct the two residences, the dormitory, the meeting house, and the astronomical observatory renovate the Ranch House (to create the research center), the Art Studio and the Heritage Barn. The complete project will increase both the quantity and quality of research and teaching at Sedgwick Reserve. Regarding quantity, we will triple the number of researchers and students that the reserve can accommodate overnight. The increase in student numbers will come mainly from University level classes. Regarding quality, the main changes will be increased quality of life for overnight-users, reserve staff and others working on the reserve, the ability of university classes to stay for longer periods, and, most important, the ability of researchers both to stay for long periods and to have the security to carry out long-term projects lasting a decade and more.

Monique Myers **6/1/2014 to 4/30/2016** **$28,000**
California Coastal Commission WT-13-36

Community Research Education for Students and Teachers about the Ormond Beach Restoration (RESTOR) Project

The RESTOR Project is a year-long watershed education project based on the Ormond Beach restoration for low-income, multicultural 6th-12th grade students and their teachers. It involves a tiered mentoring approach and promotes social-ecological resilience by including City Corps youth, CSUCI students, local non-profit organizations, university researchers and volunteers.

Monique Myer, Daniel Reed, Jenifer Dugan, Mark Page **7/1/2013 to 1/31/2016** **$99,999**
National Oceanic and Atmospheric Administration NA13OAR4170155

Santa Barbara Area Coastal Ecosystem Vulnerability Assessment for Local Communities

Project Abstract The Santa Barbara Area Coastal Ecosystem Vulnerability Assessment for Local Communities (SBA CEVALC) has both local and far-reaching goals. We will create a vulnerability assessment of coastal ecosystems (beaches, wetlands and watersheds) for southern Santa Barbara County to assist the Cities of Santa Barbara, Carpinteria, and Goleta and the County of Santa Barbara in planning for adaptation to climate change. The SBA CEVALC will be developed from the work of three of the state's leading ecological and climatological research programs: UCSB's Santa Barbara Coastal Long-Term Ecological Research (LTER) Program, the UCSD Scripps Institution of Oceanography's (SIO) California and Nevada Applications Program Regional Integrated Science and Assessment (CNAP RISA) Program, and USGS Coastal Storm Modeling System (CoSMoS) and accompanying coastal change monitoring program. The SBA CEVALC document will be developed in close collaboration with the three cities and County. Community input will be integral to the project and coordinated, along with all other aspects of the project by California Sea Grant Extension Program (CASGEP). To ensure the project results are useful to decision-makers' needs, staff from all relevant city/county departments will participate in project workshops and draft document review. CASG will guide development of the SBA CEVALC planning guidance document, work with community partners to distribute results locally and ensure wide distribution outside the Santa Barbara area. This work is novel: while some coastal states and cities or counties are developing climate change vulnerability assessments, most focus on impacts to physical and built environments; they do not provide a comprehensive assessment of impacts to ecological resources. Incorporating ecosystems in local climate vulnerability planning is important since the majority of land-use planning decisions are made at the local level. Local governments regulate general land use and development activity for the majority of the land in California, where over half the land is owned privately. Local planning that does not consider ecosystems can result in fragmentation and degradation of ecosystem services. The SBA CEVALC is an important step toward ecosystem-based adaptation planning at the local level. Specifically, project results may be incorporated in new Climate Action Plans (CAPs) for the City of Goleta, City of Goleta and Santa Barbara County; the Gaviota Coast Plan; the City of Carpinteria's Coastal Land Use Plan; the Goleta Slough Management Plan, as well as General Plan and CAP updates. Our work will bring together the best available climate and ecological research resources to provide a sophisticated coastal ecosystem vulnerability assessment, aimed at informing local land-use decisions. A broad archive of ecological, climatic and physical coastal data is available for the Santa Barbara region allowing for a detailed assessment of climatological impacts to coastal ecosystems. The team has an unusual breadth of expertise that spans from upland watersheds to the shore zones. Beaches constitute the majority of the coastline in the Santa Barbara area and, along with wetlands and watersheds, are a critical component to the vulnerability assessment. Key historical climate patterns and possible climatic changes and other impacts to the Santa Barbara area will be evaluated (e.g. temperature, precipitation, sea level rise, wave action, sediment movement). Downscaled climate data, to monthly and daily time scales, will be employed. As well as multi-decadal variability, extreme events are a particularly important driver of physical and biological elements in these ecosystems—the project will include hydrologic models to simulate effects of drought and floods, as well as fire and coastal physical impact models. When possible we will leverage the work of the USGS Coastal Storm Modeling System (CoSMoS), which predicts inundation/flooding, wave height, beach erosion and cliff failure and is useful for

informing climate impacts to beach ecosystems. The proposed SBA CEVALC will address California Sea Grant's Strategic Plan focus areas 'Effective Response to Climate Change' and 'Resilient Coastal Communities' as well as NOAA's Next Generation Strategic Plan mission to enhance sustainability and resilience of ecosystems, communities and economies by providing information that coastal communities can use to plan for climate change impacts to ecosystems (as well as the physical components of the coastline). Practical information detailing how to create a coastal ecosystem vulnerability assessment for a city/county also will be incorporated in the final SBA CEVALC document. We anticipate study results will have broad implications since the SBA CEVALC is an important and novel step toward implementing ecosystem-based adaptation planning. This work should serve as a model for other coastal cities/counties in California, the United States and, potentially, other countries.

Monique Myers | **9/1/2012 to 8/31/2015** | **$109,996**
Department of Commerce | NA12NOS4290040

Research and Education for Students and Teachers about the Ormond Beach Restoration (RESTOR) Project

Fifteen teachers, 500 predominantly multicultural middle and high school students, 15 City Corps youth and five local university students will learn about their local watershed and wetland through classroom activities and meaningful outdoor experiences in their local wetland. The focus of the project is the Ormond Beach wetland restoration, the largest wetland restoration project in southern California. Teachers, university students and City Corps youth volunteers will collect base-line scientific water quality monitoring data for the restoration and act as mentors for students and each other. Participation of students of different ages and academic levels, all mostly from multicultural heritage, will allow for student-student mentoring. The diverse partners participating in the project and importance of the project to the quality of life of local residents make this an exciting educational effort that reaches beyond the classroom. In 2012-2015 the project will shift to serve older students than previous years with an emphasis on middle and high school students. New components of the program this year include the tiered mentoring approach, which allows broader community impact, a new emphasis on climate change and marine debris, and an end-of-the-year external sharing community event. To complete their understanding of how activities in watersheds can affect the ocean, students will participate in an essay contest and winners will travel to the Channel Islands.

Monique Myers, Jenifer Dugan, Mark Page, John Melack | **9/1/2013 to 8/31/2016** | **$178,721**
Department of Commerce, NOAA | NA13OAR4310235

Santa Barbara Area Coastal Ecosystem Vulnerability Assessment

Abstract: NOAA CSI Coastal and Ocean Climate Applications (COCA) The Santa Barbara area coastal ecosystem vulnerability assessment (SBA CEVA) has both local and far-reaching goals. We will create a vulnerability assessment of coastal ecosystems(beaches, wetlands and watersheds) for southern Santa Barbara County to assist the Cities of Santa Barbara, Carpinteria, and Goleta and the County of Santa Barbara in planning for adaptation to climate change. The SBA CEVA will be developed from the work of three of the state's leading ecological and climatological research programs: UCSB's Santa Barbara Coastal Long-Term Ecological Research (LTER) Program, the UCSD Scripps Institution of Oceanography's (SIO) California and Nevada Applications Program Regional Integrated Science and Assessment (CNAP RISA) Program, and USGS Coastal Storm Modeling System (CoSMoS) and accompanying coastal change monitoring program. All project components will be coordinated and results compiled into a planning guidance document by the California Sea Grant (CASG) Extension program. This work is novel: while some coastal states and municipalities are developing climate change vulnerability assessments, most focus on impacts to physical and built environments; they do not provide a comprehensive assessment of impacts to ecological resources. Incorporating ecosystems in local climate vulnerability planning is important since the majority of land-use planning decisions are made at the local level. Local governments regulate general land use and development activity for the majority of the land in California, where over half the land is owned privately. Local planning that does not consider ecosystems can result in fragmentation and degradation of ecosystem services.

The SBA CEVA is an important step toward ecosystem-based adaptation planning. Our work will bring together the best available climate and ecological research resources to provide a sophisticated coastal ecosystem vulnerability assessment, aimed at informing local land-use decisions. A broad archive of ecological, climatic and physical coastal data is available for the Santa Barbara region that will allow for a detailed assessment of climatological impacts to coastal ecosystems. The team has an unusual breadth of expertise that spans from upland watersheds to the shore zones. Beaches constitute the majority of the coastline in the Santa Barbara area and, along with wetlands and watersheds, are a critical component to the vulnerability assessment. Key historical climate patterns and possible climatic changes and other impacts to the Santa Barbara area will be evaluated (e.g. temperature, precipitation, sea level rise, wave action, sediment movement). Downscaled climate data, to monthly and daily time scales, will be employed. As well as lower frequency multi-decadal variability, extreme events are a particularly important driver of physical and biological elements in these ecosystems—the project will include hydrologic models to simulate effects of drought and floods, as well as fire and coastal physical impact models. Particularly important to the immediate coastal zone is the CoSMoS model, which predicts inundation/flooding, wave height, beach erosion and cliff failure. NOAA's Next Generation Strategic Plan includes a mission to create enhanced resilience in ecosystems, communities and economies. The proposed SBA CEVA, will contribute to resilient and sustainable ecosystems by providing information that coastal communities can use to plan for climate change impacts to ecosystems. As a decision support process and instrument aimed at enhancing coastal ecosystem resilience and coastal decision-maker's understanding of ecosystem vulnerability to climate change, the SBA CEVA is directly relevant to the objectives of the COCA program. Furthermore, because this work focuses on coastal ecosystems, it will be innovative, broadly applicable, and transferable not only within southern California but elsewhere in California, the US and, potentially, abroad.

Craig Nelson, Roland Knapp | **9/1/2012 to 3/31/2016** | **$56,000**
Sierra Business Council | SB130011

Grazing Management Practice Implementation and Assessment in One or More Targeted Watersheds in the Lahontan Region

Task 1. Project Administration and Management 1.1 Provide all technical and administrative services as needed for Contract completion; monitor, supervise, and review all work performed; coordinate budget, and schedule, to assure that the Contract is completed within budget, on schedule, and in accordance with approved procedures, applicable laws and regulations. 1.2 Ensure that contract requirements are being met through completion of progress reports submitted to the Sierra Business Council's Contract Manager by the tenth (10th) of the month following the end of the calendar quarter. Task 2. Prepare a Quality Assurance Plan Prepare a quality assurance plan that specifies the quality assurance and quality control (QA/QC) methods and processes to be used for the field and laboratory elements of the project. Field sampling shall not commence until the quality assurance plan has been accepted by the Sierra Business Council's Contract Manager in consultation with Lahontan Water Board staff. Task 3. Conduct Field Sampling & Laboratory Analysis of Water Samples 3.1 Receive water samples delivered to the Sierra Nevada Aquatic Research Laboratory (SNARL) by Lahontan Water Board staff. Following the procedures specified in the quality assurance plan, analyze 125 water samples collected under Task 3.1 for fecal coliform bacteria (membrane filter method) and Escherichia coli (membrane filter method).

Craig Nelson, Roland Knapp | **6/1/2012 to 3/31/2014** | **$40,000**
Cal EPA Water Control Board | 11-167-160

Assessment of Bacterial Water Quality at Targeted Streams in the Eastern Sierra

The State Water Board and the Lahontan Regional Water Quality Control Board regulate the quality of California's surface waters in part via the adoption and enforcement of water quality standards for bacterial indicators. The Water Boards' current bacterial indicators and standards are decades old. The Water Boards need modern tools and information regarding bacterial indicators in order to amend and update existing water quality standards for bacteria, to adopt new or complementary water quality standards for bacterial indicators, and to develop appropriate Total Maximum Daily

Loads (TMDLs) for bacteria and pathogens. This study shall examine the relative concentrations of various bacterial indicators at streams in California's eastern Sierra Nevada (Lahontan Region), using modern as well as traditional methods.

Craig Nicholson | **2/1/2012 to 1/31/2016** | **$152,000**
University of Southern California | Y81716

Updating Active 3D Fault Geometry in Special Fault Study Areas and to Improve the SCEC Community Fault Model (CFM)

I propose to continue conducting detailed studies of active faults along major fault zones in southern California. The primary focus would be to generate new and improved 3D fault models of principal slip surfaces, especially in designated or soon-to-be-designated Special Fault Study Areas, and to incorporate these new fault representations into CFM in collaboration with Andreas, John, Egill and other members of the SCEC CFM Working Group. This includes evaluating earthquake hypocenters and focal mechanisms, developing new digital 3D fault surfaces for inclusion in CFM, and evaluating existing alternative fault representations. In 2011, we made substantial progress in developing revised 3D fault models for the San Andreas, San Jacinto, Elsinore-Laguna Salada and other fault systems [Nicholson et al., 2011]. For 2012,we plan to largely focus on revising 3D models for other complex fault areas within the Transverse Ranges region and in specific Special Fault Study Area's to insure greater compatibility and consistency with the Q-fault database and the relocated seismicity at depth. In addition, Andreas and I will complete the re-organization of the CFM-v.4.0 fault database to allow for a more systematic naming, numbering and database search system that can account for the increasing variety and complexity of multi-stranded principal slip surfaces, adjacent secondary faults, and alternative fault representations that have been, or are now currently being developed for CFM. Nominal travel funds have been included in the budget to allow Andreas and I to collaborate on and complete this CFM re-organization project.

Craig Nicholson | **12/1/2013 to 5/31/2015** | **$49,996**
USDI Geological Survey | G14AP00006

Continuing to Map the 3D Geometry of Active Faults in Southern California

Proposal Abstract: Accurate assessment of the earthquake hazard in southern California requires an accurate and complete description of the active faults in three dimensions. Dynamic rupture behavior, realistic rupture scenarios, fault segmentation, and the accurate prediction of fault interactions and strong ground motion all strongly depend on the location, sense of slip, and 3D geometry of these active fault surfaces [Shi and Day, 2010; Lozos and Oglesby, 2012]. Improved earthquake catalogs of relocated hypocenters and focal mechanisms are now available for southern California [e.g., Hauksson et al.,2012; Hardebeck and Shearer,2003]. These catalogs comprise over 500,000 earthquake hypocenters since 1981, and over 200,000 well-determined focal mechanisms. These extensive catalogs need to carefully examined and analyzed, not only for the accuracy and resolution of the earthquake hypocenters, but also for the kinematic consistency and spatial pattern of fault slip, and for the orientation and 3D geometry of active fault surfaces at seismogenic depths. Active faults in southern California have a high probability of generating a major damaging earthquake in the near future. How big, when and where such an event will be generated will depend in part on subtle, complex variations in stress, strength and fault geometry, such as bends, offsets, changes in fault dip or fault strike, or other fault discontinuities that control fault segmentation and rupture behavior. As demonstrated by the 2010 El Mayor-Cucapah earthquake and other previous events, rupture along major through-going faults in southern California can be complex and strongly affected by the interaction with adjacent secondary structures, including sub-parallel fault strands, left-lateral cross faults, tear faults, and basal detachments [e.g., Nicholson et al.,1986; Hudnut et al., 1989; Seeber and Armbruster,1995; Nicholson, 1996; Carena et al.,2004; Lin et al.,2007; Nicholson et al.,2009; Hudnut et al., 2010]. Identification of these features prior to a major earthquake rupture, especially at seismogenic depths, often depends on a careful kinematic analysis of microearthquake hypocenters and focal mechanisms in three dimensions. I propose to continue various ongoing studies of seismicity in both space and time to help identify and map active subsurface 3D fault surfaces accommodating crustal deformation in southern California. The current project, which just began, will focus on active structures in and around San Gorgonio Pass and the principal strands of the southern San Andreas and San Jacinto fault zones. This project will extend this work

farther west along the Transverse Ranges towards Los Angeles, Ventura and Santa Barbara, and will largely consist of detailed kinematic analysis of accurate relocated earthquake hypocenters and focal mechanisms to resolve active 3D fault geometry and patterns of strain accommodation. Where available, other sets of geologic and geophysical data, including surface topography, seismic reflection, well, and geologic mapping data will be used. The resulting digital 3D fault surfaces will be incorporated into both the Southern California Earthquake Center (SCEC) Community Fault Model (CFM) and the USGS Quaternary Fault database, and thus accessible as inputs for dynamic rupture propagation models, for improved predictions of strong ground motion, and for ultimately upgrading the USGS National Earthquake Hazard Maps. This effort is directly related to specific goals, objectives, and research priorities of Program Elements I and III for Southern California, as specified in the USGS FY2013NEHRP Announcement. These include:

•Determine the activity of faults in southern California. Of particular interest are investigations of the San Andreas and San Jacinto faults, fault zones in the Transverse Ranges, and fault zones whose role in regional tectonics is not well understoodor that could host earthquakes large enough to contribute to hazard in urban regions

•Develop new, improved, or alternative models of 3D fault representations and seismic velocity. These models may be refinements or extensions of the existing SCEC Community Fault and Velocity Models;

•Use seismic data to determine earthquake source parameters and crustal structure, ...including further development and testing of 2-and 3D structural models;

•Develop regional models of active deformation and of fault and earthquake interactions

•Characterize the behavior of active fault segments and evaluate seismogenic thickness. Results from this project will help improve earthquake hazard assessments (and thus reduce expected earthquake losses) in southern California by improving our understanding of the location, orientation, 3D geometry and sense of slip of active subsurface faults, and thus the accuracy of rupture propagation and ground motion predictions for potential earthquakes these faults may produce.

Results from this project will help improve earthquake hazard assessments (and thus reduce expected earthquake losses) in southern California by improving our understanding of the location, orientation, 3D geometry and sense of slip of active subsurface faults, and thus the accuracy of rupture propagation and ground motion predictions for potential earthquakes these faults may produce.

Todd Oakley | **4/1/2007 to 3/31/2014** | **$636,797**
National Science Foundation | DEB-0643840

CAREER: Exploring Congruence of Fossil and Molecular Estimates of Macroevolutionary Divergence Times in Ostracoda (Crustacea)

The PI proposes an empirical study of origination times of numerous lineages of Ostracoda (Crustacea). This study will have broad implications for understanding the controversies surrounding divergence time estimation by investigating hypotheses to explain observed incongruities between fossil and molecular divergence time estimates in Ostracoda. A primary goal is to examine in detail causes of incongruence observed in preliminary data; considering molecular, statistical and paleontological explanations. To ensure a balanced approach, the PI proposes to collaborate with two postdoctoral researchers (sequentially) with primary training in morphology/taxonomy and paleontology. In addition to detailed inquiries into the causes of molecular/fossil incongruence, the lineage divergence times in question have direct bearing on several important evolutionary hypotheses that are a focus in the lab of the PI, such as the recent origin of compound eyes in myodocopid ostracods. A primary goal is to examine the sensitivity of character evolution hypotheses to different possible divergence time estimates.

Todd Oakley | **10/1/2010 to 9/30/2015** | **$682,498**
National Science Foundation | DEB-1046307

Dimensions: Collaborative Research: Can evolutionary history predict how changes in biodiversity impact the productivity of ecosystems?

While a spectacular variety of life is perhaps the most defining feature of our planet, loss of this biological diversity is one of the most pronounced forms of environmental change in the modern era. Researchers have made great strides in understand how changes in biodiversity impact essential biological processes, such as the efficiency by which ecological communities capture limited resources and produce new biomass. However, we still do not understand the mechanisms by which diversity affects the productivity and sustainability of ecosystems, or which dimensions of biodiversity matter most. We believe this is partly due to the fact that most prior work has been preoccupied with variation among species as our primary measure of biodiversity. But 'species' are little more than a form of packing for all the genetic, functional, and trait variation that influence the efficiency and metabolism of an organism, and these differences are themselves shaped by patterns of evolutionary history and common ancestry. If we want to understand the functional consequences of diversity loss, we must first understand the evolutionary processes that generate and maintain diversity at levels spanning genes to communities. Here we propose a collaboration that will integrate phylogenetics, genomics, and community ecology to test the hypothesis: Evolution leads to genetic differentiation among species that controls the strength of niche partitioning and, in turn, how efficiently communities capture the limited resources needed to produce biomass. Using a group of algae that are among the most widespread and ecologically important in lakes throughout North America, we will: Create a new molecular phylogeny that can be used to test whether assemblages of freshwater planktonic green algae are more genetically diverse than predicted by chance. Experimentally manipulate the evolutionary and genetic divergence of species to assess how these aspects of biological diversity control niche differences and community productivity. Conduct transcriptome analyses to identify the genetic basis of niche differentiation among species, and relate these to the production of biomass by phytoplankton communities.

Todd Oakley | **9/1/2013 to 8/31/2016** | **$424,787**
University of Michigan | 3002735491

EFRI-PSBR: Biodiversity & Biofuels: Finding Win-Win Scenarios for Conservation and Energy Production in the Next Century

UCSB researchers in Oakley's lab will complete Objective 3 described in the preproposal. Oakley, a postdoctoral researcher, and laboratory technician will measure genetic complementarity of biofuel synthesis in multi-species combinations. They will extract RNA from algae growing in co-cultures, prepare libraries for high throughput sequencing, and perform data analysis to quantify expression levels of genes in the cultures. They will be involved in scientific publication of the results.

Todd Oakley, Daniel Speiser | **1/15/2014 to 3/31/2017** | **$350,000**
National Science Foundation | DEB-1354831

RUI: Collaborative Research: Timing and Molecular Origins of Recently Evolved Chiton Shell-Eyes: Phylogenomics of Chitonia

Overview: To establish how many times, when, where, and how 'shell' eyes evolved in chitons (Mollusca: Polyplacophora), the following proposal will reconstruct a data rich phylogeny of Chitonina using fossil calibrations, preliminary 16S/COI data, new transcriptomes, and new sequences of conserved gDNA. Chitons are the target for study because most species have photosensory organs (known as aesthetes) yet ancestrally lack image-forming eyes. Nevertheless, at least one lineage within Chitonina contains species that have hundreds of eyes embedded in their dorsal shell plates. These 'shell' eyes provide spatial vision and are the only eyes known to focus light using lenses made of aragonite. Chitons are an excellent system in which to study the origins of eyes because eyes evolved recently in this group, behavioral and molecular experiments are tractable, and certain extant taxa may act as morphological intermediates that link species with and without eyes. Using dense molecular and taxonomic sampling, combined with divergence time estimates of nodes using fossil and molecular clock calibrations, the following proposal will test the prediction that the eyes of chitons originated within the last 56 mya. The proposal seeks three years of funding to: (1) Produce an unparalleled dataset for resolving relationships within Chitonina by adding to existing 16S/COI data for 126 estimated species: a) transcriptome data for 17 species of chitons (9 already completed) and b) gDNA Target Enrichment (gTE)regions from 126

species across Chitonina; (2) Combine 16S/COI, transcriptomes, and gDNA sequences from gTE to achieve dense taxon sampling and produce a robust phylogeny of Chitonina; (3) Estimate divergence times for Chitonina using fossil and biogeographic records; (4) Analyze transcriptome data to find the ancestral source(s) of genes employed by chiton eyes; (5) Implement existing tools and new analysis scripts in Galaxy, an open source bioinformatics platform. Intellectual Merit: Establishing a data rich phylogeny for Chitonina (the group of chitons that includes species with 'shell' eyes) will be important to systematisists, evolutionists, paleontologists, and other scientists who are using a phylogenetically-informed approach to study non-model organisms. Co-PI Oakley will develop new scripts for bioinformatics and implement existing tools for estimates of divergence time in Galaxy (an open source bioinformatic platform). PI Eernisse and Co-PI Oakley will also develop methods for using transcriptome data to design probes for the multi-gene sampling of genomic DNA through gTE. Additionally, Co-PI Speiser will refine methods for assigning specific identities to the gene fragments produced by assembly programs, a necessary step in the study of the origin of complex traits. Current annotation methods depend on BLAST similarity scores, which do not necessarily correspond to phylogenetic relatedness. Instead, Co-PI Speiser will develop a tree-based framework for annotating transcriptomes that is more specific, informative, flexible and objective than current methods. Broader Impacts: Research on the 'shell' eyes of chitons will benefit society by advancing the field of biomaterials. To learn more about how mollusks build precisely shaped structures through biomineralization, Co-PI Speiser and Senior Collaborator Brooker are using transcriptome data to identify genes in chitons that are associated with the development of their aragonite lenses. Studying the origins of chiton eyes will help counter popular misconceptions about evolution by demonstrating how complex traits evolve through stepwise processes. Therefore, all of the PIs will continue to engage the public by submitting articles to popular publications such as Scientific American, contributing to biodiversity websites like iNaturalist, and collaborating with science blogs such as EarthSky, Wired, and Discover Magazine. To help develop a diverse, globally competitive STEM workforce, PI Eernisse will train three undergraduate students from CSUF (at 15-20 hours per week for 2.5 years) who will curate voucher specimens and use cutting-edge molecular techniques to sequence conserved segments of gDNA from chitons. These students will present their work at the Society for the Study of Evolution and will co-author publications. With 33% of its students self-identifying as Hispanic, CSUF has been a noted Hispanic-Serving Institution since 2004; CSUF ranks No. 1 in California and fourth in the nation among top colleges and universities awarding bachelor's degrees to Hispanics.

Todd Oakley, Molly Pankey | **6/1/2012 to 5/31/2014** | **$14,991**
National Science Foundation | DEB-1210673

Dissertation Research: Transcriptomic Basis of Convergent Evolution in Bioluminescent Squid

The phenomenon of convergent phenotypic evolution fascinates biologists. Yet, the extent to which convergent molecular processes drive convergence at the phenotypic level remains unclear. Natural selection is frequently invoked to explain how taxa facing similar biotic or abiotic pressures may arrive at similar phenotypic solutions. I seek to understand if the possibilities of 'molecular solutions' for a favored phenotype are similarly limited. Is the combined power of selection and developmental/genetic constraints sufficient to give rise to traits convergent at both molecular and phenotypic levels? The recent feasibility of generating multiple transcriptomes with next-generation sequencing permits the examination of the genetic signature of convergence in study systems for which complex phenotypes are hypothesized to have evolved multiple times. Convergent forms of bioluminescence have originated often in diverse forms of life. Cephalopod molluscs include two distinct clades of squid which harbor closely related strains of luminous bacterial symbionts within elaborate, optically enhanced organs called "photophores". I am interested in understanding how the molecular profiles that underlie phenotypically similar traits relate to morphological and functional similarity by investigating 1) the phylogenetic origins of light-emitting organs ('photophores') in cephalopods; 2) the transcriptomic similarities among these phylogenetically convergent organs; and 3) the transcriptomic similarity among selected homologous traits for the same species.

Todd Oakley | **6/1/2012 to 5/31/2015** | **$353,629**
National Science Foundation | DEB-1146337

Collaborative Research: Eye Evolution in Sarsielloidea (Crustacea: Ostracoda): An Integrative Approach Based on Philogenetics, Developmental Genetics, Behavior, and Optics

The genetic basis of phenotypic evolution is a topic of long-standing interest that has become approachable with new genomic technologies. We propose to resolve a species-level phylogeny for Sarsielloidea (Crustacea: Ostracoda), which will enable us to understand both the functional and genetic bases of an evolutionarily convergent phenotype. Multiple sarsielloid ostracods exhibit an amazing sexual dimorphism where only males have image forming eyes. Preliminary phylogenies indicate the dimorphism evolved at least twice. Further resolving the phylogeny likely will point to additional convergent evolution. Preliminary manipulative experiments show that differential reproductive roles drive this dimorphism: Males use eyes to evade predators, which they are more likely to encounter than females because males leave the sediment more often in search of mates. In addition, the genetics of eye development is well understood in model arthropods, indicating candidate genes for the developmental control of eye dimorphisms in sarsielloids. By resolving sarsielloid phylogeny, two collaborating labs will be in a position to establish a foundation for a valuable and integrative research program to understand the genetic and functional bases of convergent characters. Therefore, we will be able to address fundamental evolutionary questions, such as whether the same ecological functions drive convergent phenotypes, and whether convergent developmental genetics underlie those phenotypes.

Todd Oakley | **6/1/2012 to 5/31/2016** | **REU Supplement $8,298**
National Science Foundation | DEB-1146337

Collaborative Research: Eye Evolution in Sarsielloidea (Crustacea:Ostracoda): An Integrative Approach Based on Phylogenetics, Developmental Genetics, Behavior and Optics

Intellectual Merit: This proposal seeks supplemental funding for one undergraduate to assist with a two-week international collecting expedition targeting a remarkable unidentified species of philomedid ostracod crustacean that appears to harbor photosynthetic algae. Specimens will be collected at Lizard Island Research Station, Queensland, Australia, where they were discovered during a previous trip for the phylogenetic component of this grant. Following the collecting trip, funding is requested for eight weeks of academic-year support for the undergraduate to learn confocal microscopy and stable isotope analysis preparation techniques to investigate the nature of the algal-ostracod relationship, and test the hypothesis that the algae are symbiotic. If they are, this would be the first known photosymbiosis involving a marine arthropod host. The undergraduate will be accompanied and mentored individually through field work and lab work by PI Todd Oakley and postdoc Celia Churchill.

Broader Impacts The requested funds will be used to enhance the educational experiences of one undergraduate in both field and laboratory techniques that are new to the student. The student will be encouraged to present his results at a local meeting (WEB = Western Evolutionary Biologists) in fall of 2014. In addition, he will be encouraged to write about his experience as an REU student (both in the field and in the lab) on PI Oakley's scientific blog, Evolutionary Novelties (evolutionarynovelty.blogspot.com).

Todd Oakley | **9/1/2010 to 8/31/2013** | **$200,000**
National Science Foundation | IOS-1045257

Collaborative Research: Developing Genomic Tools for Integrative Biology Research

Biologists seek an integrated understanding of biological systems that ranges from genotype to phenotype. However, species amenable to phenotypic study were not always the same species that are amenable to genotypic study. Yet new technologies allow the development of genomic tools for most any organism, opening the door for genotypic studies in species and systems that are well-studied phenotypically. We propose to capitalize on new technologies and develop general protocols for sequencing the suite of genes expressed in a tissue. Specifically we will develop bioinformatic tools and tutorials for transcriptome analyses, including assembly, annotation, and evolutionary analyses. To illustrate the utility of these tools, we propose to apply them to organisms that are well-studied and/or well-suited to vision research, but that are not traditional genomic model organisms.

We will make available in public databases the sequences of genes expressed in eyes of multiple invertebrate organisms. These data can be used to test important hypotheses in vision research, integrating across levels of organization from genes to phenotype, and further elevating animal vision as a 'model phenotype' for integrative systems biology research.

Mark Page, Jenifer Dugan, Robert Miller | **7/1/2013 to 5/31/2018** | **$738,710**

USDI Bureau of Ocean Energy Management M13AC00007

Understanding the Role of Offshore Structures in Managing Potential Watersipora Invasions

The purpose of this award is to survey offshore oil and gas platforms in the Santa Barbara Channel/ Santa Maria Basin and San Pedro Basin, other artificial structures, and natural reefs for the non-indigenous species (NIS) Watersipora subtorquata, measure the reproductive seasonality of this species and identify potential vectors for dispersal among platforms and between platforms and natural habitat, propose mitigation measure(s) that may be employed to manage Watersipora, and to incorporate this information into environmental reviews regarding managing the spread of Watersipora at ongoing operations, during decommissioning of oil and gas platforms, and at potential renewable energy facilities. The need for this information is to elucidate the role that offshore artificial structures may have in affecting biological communities. Information is needed for use by the State of California to consider for decommissioning options under the California legislation AB 2503 (the California Marine Resources Legacy Act). The Act requires California to consider reefing OCS oil and gas platforms, if their ecological value warrants, before decommissioning and potential removal. The information is also needed to comply with the duties of Federal agencies that are outlined in Section 2 of Executive Order 13112 (Invasive Species). BOEM will use study results for environmental reviews concerning ongoing operations and decommissioning alternatives of offshore oil and gas platforms and potential marine renewable energy facilities. The issue of platform decommissioning and decisions related to decommissioning and possible reefing will be decided on a platform by platform basis with each of the platforms judged on its own merits as far as ecological value is concerned. This study will also extend the application of existing methodology to develop results applicable specifically for Bureau of Safety and Environmental Enforcement (BSEE) management decisions so that BSEE can specify requirements to industry or other interested parties when decommissioning occurs. Using the results, the State of California can ensure proper evaluation under the California Rigs-to-Reefs Program law AB 2503 (the California Marine Resources Legacy Act), and BSEE can ensure that specified criteria can be properly evaluated during the decommissioning process pursuant to the federal regulations at 30 CFR 250.1730 . Thus, the overarching purpose of this research is to collect information on Watersipora for environmental reviews regarding managing the spread of Watersipora during decommissioning of oil and gas platforms for the State of California.

Mark Page, Robert Miller | **4/1/2010 to 3/31/2016** | **$899,463**

National Science Foundation OCE-0962306

Sources of Particulate Organic Matter and Their use by Benthic Suspension-Feeders in the Coastal California Ecosystem

Understanding trophic connections and how resource variability affects consumers is necessary if we are to predict how food webs may shift in the face of environmental change. Macroalgae and phytoplankton support highly productive marine ecosystems. Research based on stable isotope analyses has supported the idea that macroalgal detritus, especially that of giant kelp Macrocystis, is a major source of dietary carbon to benthic suspension-feeders. However, our recent findings from a four-year stable isotope study suggest that phytoplankton, not kelp, are the main food resource for benthic suspension-feeders on reefs in the Santa Barbara Channel, and that variation in phytoplankton abundance, combined with feeding selectivity and the scale of consumer tissue turnover times, may drive variability in consumer isotope values. Our results suggest that a key assumption made in 'snapshot' isotope studies of coastal ecosystems over the past 20 years, that the isotope signature of coastal phytoplankton can be represented by that of offshore phytoplankton, could be incorrect. This assumption has been made because of the difficulty in separating

phytoplankton from detritus to obtain an uncontaminated isotope signature, a problem in freshwater systems also. Our objectives are to 1) determine the contribution of phytoplankton and giant kelp detritus to the pool of suspended reef POM and whether POM composition varies with distance from kelp forests, and 2) evaluate how different components of the POM are used as food by reef suspension feeders. We propose to explore the contribution of phytoplankton and kelp detritus to POM in coastal waters using two complementary approaches: an advanced flow cytometry and cell-sorting system to separate phytoplankton from bulk POM, and analysis of essential polyunsaturated fatty acids (PUFA) in POM and consumers. We have obtained preliminary data that demonstrate the feasibility of both of these methods. Isotope values of isolated inshore phytoplankton and kelp, and compound-specific PUFA, will be used in mixing models to estimate contributions of these two major primary producers to suspension feeder diets. We will also test two hypothesized mechanisms that may influence isotopic composition of consumers: selective feeding on particular fractions of POM, and tissue turnover times. This project will provide new insights into the trophic support of benthic suspension feeders, an ecologically and economically important guild in coastal ecosystems. Our results will test the general hypothesis that giant kelp detritus is an important source of carbon to suspension feeders, a commonly accepted idea that needs re-evaluation in light of key assumptions that have been made in its support. Stable isotope analyses are an ideal tool for testing this hypothesis given the spatial and temporal scales of variability that exist in the abundance of phytoplankton and giant kelp at our study sites. Our proposal sampling scheme combined with longer-term data on producer biomass provided by the Santa Barbara Coastal LTER will enable us to capture this variability, which is generally missed by studies based on 'snapshot' stable isotope analyses.

Mark Page, Dan Reed **1/1/2014 to 12/31/2015** **$4,715,399**
Stephen Schroeter
Simpson and Simpson SB140086

San Onofre Nuclear Generating Station Mitigation Project Monitoring Program

Background Condition D of coastal development permit for the operation of SONGS Units 2 & 3 requires the permittee (SCE) to fund scientific and support staff retained by the California Coastal Commission to oversee the site assessments, project design and implementation, and monitoring activities for the mitigation projects designed to compensate for the past and ongoing adverse effects of .SONGS operations on coastal marine resources. Implementation Structure Scientific expertise is provided to the Commission by a small technical oversight team hired under contract. The technical oversight team members include three Research Biologists from UC Santa Barbara (Principal Scientists): Stephen Schroeter, Ph.D., marine ecologist, Mark Page, Ph.D., wetlands ecologist (half time), and Daniel Reed, Ph.D., kelp forest ecologist (half-time). A part-time senior administrator (Lane Yee) completes the core contract program staff. In addition, a science advisory panel advises the Commission on the design, implementation, monitoring, and remediation of the mitigation projects. Current science advisory panel members include Richard Ambrose, Ph.D., Professor, UCLA, Peter Raimondi, Ph.D., Professor, UC Santa Cruz, and Russell Schmitt, Ph.D., Professor, UC Santa Barbara.

Dorothy Pak **9/1/2008 to 8/31/2013** **$90,915**
National Science Foundation OCE-0751803

Collaborative Research: An Ultra-High Resolution, Multiproxy Study of the Past 2,000 Years of Climate Change in Southern California

Santa Barbara Basin (SBB) is the only location in the northeast Pacific that can provide quality, high-resolution paleoclimate reconstructions due to suboxic bottom waters (minimal bioturbation), high biogenic sediment input (including sufficient foraminiferal carbonate for dating, etc.) and extremely high sedimentation rates (hence high resolution). The study must be high resolution to capture information about specific climate events such as the Little Ice Age (LIA), MCA and the rapid warming of the 20th-21st centuries. Furthermore, the study must be multiproxy to capture short duration events that may only be reflecting specific environmental conditions in the basin and therefore be recorded by specific proxies. The location of the SBB in the subtropics makes it sensitive

to record variability associated with strong expressions of the El Nino Southern Oscillation (ENSO) as well as indices of extratropical climate state, i.e. the Pacific Decadal Oscillations (PDO). Both ENSO and PDO variability have been linked to western US drought patterns [Cook et al., 2007; MacDonald and Case, 2005]. Finally, a multiproxy annual to decadal surface ocean reconstruction will enormously benefit the prediction of drought in the western US by providing tests for causal relationships.

Uta Passow, Allice Alldredge **9/1/2009 to 8/31/2013** **$705,703**
National Science Foundation OCE-0926711

Will Ocean Acidification Diminish Particle Aggregation and Mineral Scavenging, Thus Weakening the Biological Pump?

The pH of the ocean is predicted to decrease by 0.2-0.5 pH units in the next 50 to100 years as a result of increasing atmospheric CO2. To date almost all the research on impending ocean acidification has focused on the impacts to calcifying organisms and the carbonate system. However, ocean acidification will also affect other significant marine processes that are pH dependent. In this proposal we investigate the impact of ocean acidification on the organic carbon or "soft tissue" biological pump. We predict that a decline in oceanic pH will result in an increase in the protonation of negatively charged substances, especially of Transparent Exopolymer Particles (TEP), the gel-like particles that provide the matrix of aggregates and bind particles together. A decreased polarity of these highly surface-active particles may reduce their "stickiness" resulting in decreased aggregation of organic-rich particles and a decreased ability of aggregates to scavenge and retain heavy ballast minerals. A reduction in aggregation will lower the fraction of POC enclosed in fast-sinking aggregates. Decreased scavenging of minerals by aggregates will result in reduced sinking velocities and consequently a decline in the fraction of material escaping degradation in the water column. Both processes ultimately reduce carbon flux to depth. The resulting weakening of the biological pump will alter pelagic ecology and potentially produce a positive feed-back pathway that further increases atmospheric CO2 concentrations.

Uta Passow **10/1/2010 to 9/30/2016** **$971,524**
Mark Brzezinski, Craig Carlson
National Science Foundation OCE-1041038

Will high CO2 conditions affect production, partitioning and fate in organic matter?

The ocean has taken up ~30% of anthropogenic carbon, and future changes in marine biogeochemical cycling of carbon, and especially in the functioning of the biological carbon pump, will determine whether or not the ocean continues to be a strong sink for carbon. IPCC scenarios assume continued uptake of CO2 by the ocean, but currently even the direction of change in the biological pump in response to increases in CO2 is unresolved and controversial. Coastal waters are already experiencing episodic exposure to carbonate conditions that were not expected until the end of the century making understanding the response to these episodic events as important as understanding the long-term mean response. Among the most striking examples are those associated with coastal upwelling along the west coast of the US, where the pH of surface waters may drop to 7.6 and pCO2 can reach 1100 μatm. Upwelling systems are responsible for a significant fraction of global carbon export making them prime targets for investigations on how ocean acidification is already affecting the biological pump today. It is the goal of this proposal to investigate the potential effects of ocean acidification on the strength of the biological pump under the transient increases in CO2 experienced due to upwelling. Increases in CO2 are expected to alter the path and processing of carbon through marine food webs thereby strengthening the biological pump. Increases in inorganic carbon without proportional increases in nutrients result in carbon overconsumption by phytoplankton. How carbon overconsumption affects the strength of the biological pump will depend on the fate of the extra carbon that is either incorporated into phytoplankton cells forming particulate organic matter (POM), or is excreted as dissolved organic matter (DOM). POM and DOM follow very different paths through the pelagic ecosystem. POM is exported primarily through gravitational sinking. DOM can either form exopolymer particles that facilitate aggregation accelerating sedimentation rates of POM, or, in its dissolved form DOM export occurs when DOM that has accumulated in surface waters is carried to depth by physical processes. There is evidence that carbon overproduction leads to more carbon rich POM and to a rise in exopolymer formation, increasing particle aggregation and

export. Carbon overconsumption may additionally enhance the production of low quality (high C: N) exudates that resist microbial degradation allowing a greater fraction of DOM produced under high CO2 to accumulate in surface waters and eventually be transported to depth. Thus, ocean acidification may enhance the export of both POM and DOM strengthening the biological pump and accelerating the rate at which increases in atmospheric CO2 are transferred to the deep ocean. Results from mesocosm experiments demonstrate that the mechanisms controlling the partitioning of fixed carbon between the particulate and dissolved phases, and the processing of those materials, are obscured when both processes operate simultaneously under natural or semi-natural conditions. Here, POM and DOM production and the heterotrophic processing of these materials will be separated experimentally across a range of CO2 concentrations by conducting basic laboratory culture experiments. In this way the mechanisms whereby elevated CO2 alters the flow of carbon along these paths can be elucidated and better understood for use in mechanistic forecasting models.

Uta Passow | **9/1/2011 to 12/31/2015** | **$822,745**
University of Mississippi | SB120113

Ecosystems Impacts of Oil and Gas Inputs to the Gulf (ECOGIG)

Together with collaborators Asper and Diercks we will deploy 4 deep times series sediment traps to collect time integrated samples throughout the year. The deployments must be put together, currently only 1 trap deployment exists. These traps will be deployed at strategic positions at the main sampling sites and will be turned at least around annually. Trap samples (20 per year per trap) will be analyzed for particle composition (microscopically), POC, PON, TEP, dry weight, PO13C, PO15N, oil (PAH) and corexit (doss). Biogenic minerals and Al or a different marker for resuspended material will also be measured. At the time of deployment and retrieval of traps the water column parameters, especially the distribution of marine snow will also be analyzed. This data will be put into context of sediment and water column data, which will also be collected within the project. Moreover, a series of experiments on the formation of marine snow in the presence of oil and/ or dispersant and on the characteristics of this snow will be performed. Natural material and fresh oil, or aged oil with or without dispersant etc. will be incubated and the formation of flocks monitored. This series of experiment will test all the different parameters potentially affecting flock formation – e.g. the aging of oil bacterially or by light. Sinking velocity of flocks, as well as composition, size and density will be characterized. The hypothesis that these flocks do not form by aggregation or from feeding structures is to be tested. In collaboration with Arnosti I will investigate the fate of such flocks, and the role of specific bacteria and changes in the bacterial community composition. During aging the change s in carbon, nitrogen, TEP etc. will be monitored and the partitioning between phases tracked. Bacterial activity and turnover will be assessed. For this in situ and experimental work, we will be working at different sites, representing different types of releases of oil and gas. The above described measurements will be conducted at the different site to compare the impact of the release on flock formation and sedimentation.

Stephen Proulx | **9/1/2011 to 8/31/2016** | **$608,274**
Joao Hespanha
National Science Foundation | EF-1137835

The Evolution of Dynamic Response Strategies: Optimal Control and Evolutionary Dynamics

Organisms are constantly responding to change. The abiotic environment fluctuates, physiological processes are noisy, and other individuals behave unpredictably. The dynamic changes in conditions over time contain information that can be sensed, remembered, processed, and acted upon. We define the dynamic response strategy of a genotype as the dynam¬ical system they use to produce a response given a time series of sensed inputs. This project will develop theoretical approaches based on optimal control theory and population genetics to understand biological scenarios involving sensed environmental input and a dynamic response. Specific focus will be given to determining how the reliability of sensory input and the tempo of environmental variation relate to the optimal strategies for gathering, processing, and responding to information. The focus is on cellular dynamic response systems including simple gene regula-tion, regulation of interacting genes in a network, cellular sensory mechanisms, and competitive foraging. For each biological system, the mechanistic

details of the dynamic response will be mod¬eled and population genetic techniques will be used to determine the evolutionary outcomes. The optimal control solutions define an upper bound to fitness and can be compared to the biologically constrained evolved strategies. This comparison will show how well biological systems can ap¬proximate the optimal solutions, explain the general principles behind the evolution of dynamic response strategies, and address whether the optimal solutions are evolutionarily achievable. This project has the potential to be transformative because our methods apply equally well to single cell responses, developmental responses, physiological responses, and behavioral responses.

Langdon Quetin **4/1/2011 to 3/31/2016** **$445,002**
Robin Ross
National Science Foundation ANT-1010688

Palmer LTER Zooplankton 1993-2008: Synthesis and Integration of Time-Series Data, Zooplankton Aggregation Structure and Secondary Production of Antarctic Krill

The Palmer Long-Term Ecological Research (LTER) program is focused on the marine pelagic ecosystem west of the Antarctic Peninsula, one of most rapidly warming regions on the planet. The study region is composed of coastal, shelf and slope regions midway down the Antarctic Peninsula, in an area influenced by the Antarctic Circumpolar Current with warm Upper Circumpolar Deep Water flooding the shelf. Changes in seasonal sea ice dynamics, the heat content of the shelf and populations of a key predator, Adélie penguins, have been documented. Although the phytoplankton and zooplankton community have shown some changes in composition and production during the time series, most are not yet significant. The sampling design included an annual summer cruise (large spatial, short temporal scale) and seasonal sampling within 3.7 km of Palmer Station on Anvers Island (small spatial, long temporal scale). In the Southern Ocean, larger mesozooplankton and micronekton, particularly Antarctic krill (Euphausia superba) form the primary link between primary producers and upper-level predators, serving as both a grazer and prey. The overall goal of this proposal is to undertake a synthesis of zooplankton and micronekton data collected from 1991 through 2008 as part of this multi-disciplinary program, specifically to investigate spatio-temporal variability on multiple scales and to test hypotheses on the underlying causes of the variability documented. Data include community composition, abundance and biomass, from net tows and bioacoustic transects, and life history information for both Antarctic krill and the salp (Salpa thompsoni), the biomass dominants for zooplankon > 2 mm. Net and bioacoustic data are complimentary, and should be integrated. Net data yield samples for community composition, population demography and experiments, and serve for target identification of sound scatterers. Bioacoustic data yield data on smaller scales relevant to the ecology of the different sound scatterers and their predators, both biomass and aggregation characteristics. In addition, in situ rates of secondary production (growth, spawning and egg production) were measured experimentally for the key species Antarctic krill in order to estimate secondary production. This zooplankton data set combined with the coherent multi-disciplinary data sets collected by the Palmer LTER is uniquely suited for studies of spatio-temporal variability and mechanisms underlying that variability, partially due to the fact that the time period spans three full cycles of recruitment in Antarctic krill and variability in primary production. Focus areas for the data synthesis proposed include: (1) A Principal Components Analysis and Canonical Correlation Analysis (PCA-CCA) approach, as recently used to document zooplankton abundance and distribution patterns, will be used for analysis of the time-series 1993-2008 of zooplankton and the biological-biological and biological-physical linkages. Three workshops will be convened with colleagues with complimentary hydrographic, sea ice and phytoplankton data to test hypotheses and produce manuscripts. (2) After full restoration, the bioacoustic data will be analyzed for patterns and/or trends in biomass and aggregation characteristics, and relationships to environmental factors and ecosystem function. With the British Antarctic Survey (BAS), zooplankton (Antarctic krill and other sound scatterers) biomass and aggregation characteristics within the Palmer LTER study region will be compared to the South Georgia region. These data will be archived in a format easily used by future investigators as a consensus on such variables as target strength emerges. (3) Secondary production experimental data will be modeled as a function of environmental variables such as food quantity and quality and individual size and sexual maturity, then integrated with acoustic biomass data to estimate secondary production rates and production:biomass ratios (turnover) and their spatio-temporal variability

throughout the study region. In addition funds will bring to fruition separate collaborative efforts on somatic growth and life cycle timing for salps in this region (P. Kremer), and the use of Antarctic krill length frequency data to explore linkages among populations around the continent (BAS). Included are resources for multiple data base activities: completion of sample analysis and data submittal for the 0708 field season, interactions with the Palmer LTER information manager, and submittal to the LTER data directory of completed derived products as described above.

Andrew Rassweiler **8/30/2013 to 12/31/2016** **$34,000**
UC Santa Cruz UCSCMCA-14-006

Mediterranean Coast Network Kelp Forest Monitoring: Protocol Review and Data Synthesis

Channel Islands National Park (CHIS) initiated kelp forest (KF) monitoring in 1982 to better understand the long-term dynamics of these important ecosystems. Monitoring data have been collected continuously for 31 years with a total of 33 sites currently being sampled annually. The purpose of the KF monitoring program is to understand the natural variation within these communities and collect baseline data for comparing resources inside and outside of marine protected areas, and to better understand the dynamic nature of these communities so that it can be properly conserved for current and future generations. In 1994, a detailed review of the CHIS KF monitoring program was conducted by a scientific panel (Schroeter and Dixon 1994). Several adjustments were made to the monitoring protocols following the 1994 review. With the establishment of new marine protected areas in 2003, KF monitoring at CHIS was extended to several new locations resulting in a greatly expanded monitoring effort. This resulted in an increase in monitoring from 16 original sites in 1982 to 33 sites in 2005 in order to monitor and assess the new marine protected areas. As a result of these changes an in-depth review of monitoring protocols and sampling design is needed to identify recommendations for prioritizing monitoring efforts, streamlining protocols, and evaluate the monitoring effectiveness for marine protected area evaluation. In addition, an updated synthesis and interpretation of the long-term KF monitoring dataset is needed to support the protocol review and to share KF monitoring results with scientists, resource managers and the interested public. KF monitoring data are currently available on the web at http://pyrifera.marinemap.org. CHIS staff and others have authored a data paper for Ecology (Kushner et al. In Press) that summarizes the KF methodology and data set. These KF data resources will be updated as part of this project.

Daniel Reed, Steven Gaines, **12/1/2006 to 11/30/2013** **$6,058,895**
John Melack, David Siegel, Sally Holbrook
National Science Foundation OCE-0620276

LTER: Land/Ocean Interactions and the Dynamics of Kelp Forest Communities

The Santa Barbara Coastal LTER (SBC LTER) is an interdisciplinary research and education program investigating the relative importance of land and ocean processes in structuring ecosystems at the land-sea margin. Our principal study area is the Santa Barbara Channel and the coastal watersheds that drain into it, and our focal ecosystem is giant kelp forests, which occur on shallow rocky reefs at the interface of the land-sea margin throughout our study area and other temperate coasts throughout the world. The major focus of the work proposed here is developing a predictive understanding of the structural and functional responses of giant kelp forest ecosystems to environmental forcing from the land and the sea. The amount of nutrients and organic matter delivered to the kelp forest from land and the surrounding ocean varies in response to short- and long-term changes in climate, ocean conditions and land use. Variation in the supply of these commodities interacts with physical disturbance to influence the abundance and species composition of the forest inhabitants and the ecological services that they provide.

Daniel C. Reed, Sally Holbrook, **12/1/2012 to 11/30/2018** **$3,281,158**
John Melack, David Siegel
National Science Foundation OCE-1232779

LTER: Land/Ocean Interactions and the Dynamics of Kelp Forest Communities

Intellectual Merit: The Santa Barbara Coastal LTER (SBC) is an interdisciplinary research and education program established in April, 2000 to investigate the role of land and ocean processes in structuring ecosystems at the land-sea margin. Our study main area is the Santa Barbara Channel and the steep coastal watersheds, small estuaries and sandy beaches that drain into it. The focal ecosystem of our research is giant kelp forests, a diverse and highly productive marine ecosystem that occurs on shallow rocky reefs at the interface of the land-sea margin in the Santa Barbara Channel and other temperate regions throughout the world. The major emphasis of our proposed work is developing a predictive understanding of the structural and functional responses of giant kelp forest ecosystems to environmental forcing from the land and the sea. The amount of nutrients and organic matter delivered to the kelp forest from land and the surrounding ocean varies in response to changes in climate, ocean conditions and land use. Variation in the supply of these commodities interacts with physical disturbance to influence the abundance and species composition of kelp forest inhabitants and the ecological services that they provide. The overarching question motivating our proposed research is: How are the structure and function of kelp forests and their material exchange with adjacent land and ocean ecosystems altered by disturbance and climate? To address this question our research will focus on three themes: (1) biotic and abiotic drivers of kelp forest structure and function, (2) material exchange at the land-ocean margin, and (3) movement and fluxes of inorganic and organic matter in the coastal ocean. The relevance of our research is far reaching as we address fundamental questions pertaining to biodiversity and ecosystem function, vulnerability and resilience of communities to climate change and fishing, the roles of land use and fire on landscape change and watershed hydrology, and the physics of dispersal in the little studied coastal waters of the inner continental shelf. The dynamic nature of kelp forests, including their frequent disturbance and rapid regeneration coupled with high productivity and diverse food webs make them ideal systems for investigating ecological questions that require decades to centuries to address in other ecosystems. Our research will utilize a variety of approaches including: (1) coordinated long-term measurements, (2) manipulative field experiments, (3) measurement-intensive process studies, and (4) integrated synthetic analyses and modeling that allow for predictions beyond the spatial and temporal scope of our measurements, and help guide future research. SBC's information management system, which focuses on data organization, integrity, preservation and web-based public access geared for a variety of end users will facilitate these efforts.

Broader Impacts: Education and training are tightly integrated into all aspects of our research. We have successfully developed a multifaceted, interdisciplinary approach to education and outreach that highlights research interests of SBC investigators, students, and the general public. Our programs include active links with K-12 students and teachers that target historically under-represented groups from underserving, low-achieving schools. We are also very proactive in undergraduate and graduate student training, direct public outreach, and productive interactions with the media, government agencies and local industries. We will continue these outreach and education programs and maintain our efforts to attract additional funding to support them. We are committed to sharing our research results with resource managers, decision makers, stakeholders, and the general public who are interested in applying our findings to policy issues concerning natural resources, coastal management, and land use.

Daniel C. Reed, Sally Holbrook, Carolynn Culver	**2/1/2014 to 1/31/2016**	**$172,360**
UC Sea Grant	R/HCME-07-F	

The Spread and Ecological Consequences of the Invasive Seaweed Sargassum homeri

Sargassum horneriis is a fast growing brown alga native to shallow reefs of Japan and Korea. It has spread aggressively in southern California since first being discovered in 2003 and poses a major threat to the sustainability of native marine ecosystems in this region. While numerous groups collect data on S. hornerias part of their routine monitoring, the ecology and impact of this invader in southern California are poorly known. Of particular note is the manner in which the spread of S.

horneriis influenced by the recent increase in Marine Protected Areas (MPAs), which were established to harbor protected assemblages of native species that may offer biotic resistance to invasion. We propose quantitative surveys and experiments inside and outside of MPAs aimed at determining the causes and ecological consequences of the invasion of this recently introduced seaweed. Our objectives are to: (1) identify the physical and biological factors that promote characteristics of habitats that promote the growth and reproduction of S. horneri and thus its potential to spread, (2) determine the consequences of S. horneri invasion on the structure and diversity of native communities, and (3) determine the mechanisms by which MPAs might confer biotic resistance to invasion by S. horneri. These objectives directly address two of the three Strategic Focus Areas identified in California Sea Grant's 2014 call for proposals: Healthy Coastal Marine Ecosystems (Goals 1& 2) and Resilient Coastal Communities (Goal 1). Moreover, our research will support the common mission of both the state and national Sea Grant organizations to provide integrated research on coastal ecosystems that informs and fosters the responsible use and conservation of marine resources.

Daniel Reed **9/22/2011 to 3/31/2017** **$449,927**
USDI Bureau of Ocean Energy Management M11AC00012

DOI Partnership: Distinguishing Between Human and Natural Causes of Changes in Kelp Forests Using Long-term Data from DOI Monitoring Programs

Monitoring and predicting the potential impacts of outer continental shelf (OCS) energy production on nearshore ecosystems requires an ability to distinguish between changes caused by natural processes and those caused by human activities. This ability is often hampered by the lack of long-term data to describe natural variation. Offshore southern California, two Department of the Interior (DOI) monitoring programs that focus on kelp forest communities have the potential to provide considerable insight into the patterns and causes of change in kelp forest ecosystems. Analysis of these data sets (which span 25+ years) will enable scientists and managers to evaluate possible impacts from offshore oil and gas and renewable energy activities and develop options to mitigate these impacts. This is especially important in light of global climate change and the need to understand the cumulative impacts of multiple projects on the OCS.

Daniel Reed **9/1/2012 to 8/31/2016** **$264,575**
National Science Foundation OCE-1233283

Collaborative Research: The Effect of Inbreeding on Metapopulation Dynamics of the Giant Kelp, Macrocystis pyrifera

Understanding the causes for populations to fluctuate in space and time is of great interest to ecologists and knowledge on this topic has widespread application for conservation and environmental management. The recognition that many species live in highly fragmented landscapes led to the development of metapopulation theory, which is widely applicable to both terrestrial and marine systems. In its simplest form the concept of a metapopulation represents the idea that habitat patches suitable for local populations are either occupied or not and that connectivity among patches acts to "rescue" extinct local populations. Several recent studies on inbreeding have challenged the traditional belief that ecological factors are the primary causes of local population reduction and eventual extinction. However, to date there have been few investigations of the extent to which inbreeding depression drives local population dynamics in a metapopulation. The giant kelp, Macrocystis pyrifera, is an ideal system for testing metapopulation theory because it occurs in discrete patches that undergo frequent local extinctions and recolonizations on time scales of a few years. Here we propose to test five related hypotheses aimed at determining whether the metapopulation of the giant kelp in the Southern California Bight is regulated at least in part by repeated and asynchronous episodes of inbreeding depression. Our proposed research is motivated by our previous findings on patterns of local population extinction and recolonization with respect to patch size and degree of isolation, patterns of spore dispersal and genetic connectivity, and the adverse consequences of inbreeding depression to kelp reproduction. In the proposed research we will: (1) Assess the extent and pattern of inbreeding in populations of giant kelp in the Southern California Bight, and (2) Determine the extent that inbreeding depression via decreased reproduction contributes to the pattern of metapopulation patch dynamics of giant kelp in the Southern California

Bight. Our research will be greatly facilitated by our recent developments of: (1) highly polymorphic microsatellite markers for characterizing the population genetics of giant kelp, and (2) a novel method for estimating effective population size for all discrete patches of giant kelp in the Southern California Bight using Landsat satellite imagery.

Cristina Sandoval	**6/29/2011 to 6/30/2015**	**$250,000**
Susan Swarbrick		
Cal Coastal Conservancy	10-112	

Access Improvements and Restoration at Coal Oil Point Reserve

Staff is recommending that the Conservancy provide up to $250,000 to the Regents of the University of California ('grantee") for coastal access improvements (the "COPR Access Project" or "the project") at the Coal Oil Point Reserve ("the Reserve" or "COPR") adjacent to Devereux Slough and owned by the Regents of the University of California("Regents"), and managed by the University of California, Santa Barbara ("UCSB"), whose campus is nearby. The proposed COPR Access Project is a Tier One project on the Southern California Wetlands Recovery Project Work Plan and is recommended for priority funding. It is also the first project to implement the vision of the Ellwood-Devereux Open Space Management Plan to create a large coastal open space to serve the community and protect sensitive habitats. The project will enhance the quality of public access within the Reserve while providing increased protection for its natural resources. The Reserve is located near a large population center and the UCSB campus, is known for its scenic and ecological values, and is heavily used for recreation. The Reserve and surrounding open spaces are among the few natural coastal sites in Santa Barbara County that offer public access for recreation while simultaneously managing for protection of threatened and endangered plants and wildlife. Access improvements are needed to protect fragile habitats and ensure human activity occurs only in appropriate areas within the Reserve. The project will encourage visitors to stay on authorized trails and to avoid sensitive habitat areas using various approaches such as improving access points, closing and restoring unapproved trails, making improvements to the interpretive Pond Trail, replacing old fences and gates, and installing fencing and no-horse barriers in specified areas to reduce human impacts to sensitive areas. Trespassing has been successfully reduced on the northern and eastern perimeter of the Reserve by creating a "green fence". All of the green fencing planted and planned for this project is on disturbed habitat and will replace exotic vegetation with native vegetation typical of the habitat. Thus the green fence serves as habitat restoration in addition to encouraging appropriate access. The proposed access improvements will be further enhanced by other improvements being implemented at the Reserve including the installation of 20 interpretive signs and development of a downloadable podcast to provide self-guided tours along Reserve trails. In addition, fundraising has begun to create an interpretive nature center on a nearby site recently acquired by the University and to take over management of the Cliff House. Collectively, these projects will provide unique and important opportunities to enjoy and learn about this special area. The Reserve proposes to construct access improvements at four sites within the Reserve and at one site outside the Reserve boundary on adjacent land owned by the University. Access improvements will be constructed at the public access way at Sands beach (see Exhibit 2, Figure 4, Access B). An existing gate and 86 feet of aging chain-link fence will be replaced by a three-rail Woodcrete fence. The fence will be built in exactly the same position as the existing fence and the access way through the fence will mimic the shape and location of the existing access way to allow only pedestrian access to the beach. In addition, a six foot gate will be installed but kept locked to be used for emergencies, such as removing injured people and marine mammals from the beach. The proposed project also includes several improvements along the Pond Trail (Exhibit 1). The Pond Trail follows the western edge of the Devereux Slough mouth (Access C) to the Reserve's northern access point, where it meets the Coastal Trail and the De Anza Trail. The main Pond Trail will remain in its current location, but other existing informal branching trails will be closed to protect sensitive habitat areas. To keep hikers on the designated Pond Trail wood log borders will be laid along each side of the trail. Shrubs and other native plants appropriate for the habitat will be planted outside of the log borders to eventually create a green fence around the trail. If the logs are removed or vandalized by people at any specific location along the trail, a post-and cable fence will be installed. At the northern boundary of the Pond Trail, an L-shaped trail entrance (similar in design to the entrance for Access B, described above) will be installed where none currently exists to allow pedestrians but prevent horses and bicycles from entering the trail. A 32-foot section of Woodcrete fencing will be installed on each side of the entrance. The southern end of the

Pond Trail bisects the dune swale that connects the dune pond to the slough. During the rainy season this portion of the trail can flood. To allow continued access through this area during the rainy season a roll-out boardwalk will be laid out over the flooded section of the trail. This temporary boardwalk will not prevent people from stepping on water when the area is flooded but it will encourage people to stay on the path rather than walking on wetland vegetation. In addition, approximately six inches of fill on the trail will be removed to restore the hydrological connection of the dune swales on each side of the trail. The westernmost access point (Access D) is located on UC Santa Barbara's South Parcel on North Campus, just outside the western boundary of the Reserve. At this access point, the trail from the bluff to the beach will be regraded to remove existing erosion ditches and control future erosion. In addition, the iceplant around this access point will be removed. The beach and bluffs will be revegetated with locally sourced native plants. A 760-foot long Woodcrete three-rail fence will be installed on the Reserve side of the western trail access to reduce unauthorized access to the dunes and wetlands from this area. Coal Oil Point Natural Reserve is owned and managed by the University of California as part of its Natural Reserve System ("The NRS"). The Coal Oil Point Reserve Director lives on the site and coordinates all Reserve activities. The Director will be responsible for supervising this project. The Reserve is unique among the NRS sites because of its proximity to a large urban population, requiring a significantly higher level of management. Active habitat restoration at the Reserve has been carried out for over ten years and all projects have had successful outcomes. A large number of students and community members participate in restoration on the Reserve. In 2009, 900 volunteers participated in restoration workdays. Utilizing volunteers is cost-effective and helps the Reserve achieve its outreach and education goals.

Mark Schildhauer | **8/1/2013 to 7/31/2015** | **$65,760**
National Science Foundation | OCE-1344385

Collaborative Project: EarthCube Domain End-User Workshop: Developing a Community Vision of Cyberinfrastructure Needs for Coral Reef Systems Science

Overview: The NSF EarthCube initiative (http://www.nsf.gov/geo/earthcube/) encompasses "transformative concepts and approaches to create integrated data management infrastructures across the Geosciences." To accomplish this, the program recognizes the importance of aligning activities with the needs of end user research communities. To that end, NSF EarthCube is soliciting input from these communities and this workshop proposal is a response to this call. We propose to convene 50-70 members of the coral reef community in two workshops, one held at the University of Hawaii (HIMB) and the other at the University of California Santa Barbara (NCEAS). The specific objectives of the workshop are to: 1. Define current and future (5-15 years) scientific challenges in the field 2. Summarize data and cyber-infrastructure constraints that prevent these challenges being met 3. Collate current community data and modeling resources and their locations 4. Identify and recommend data infrastructure that could facilitate rapidly addressing the scientific challenges in the field Intellectual Merit : The coral reef research community is multidisciplinary and the data on reefs is diverse and complex, crossing biological scales from genes to ecosystems, temporal scales from nanoseconds to millennia, and spatial scales from nanometers to kilometers. The challenge is to integrate across these data sources to identify patterns and relationships that rapidly forward our understanding of coral reefs systems. This effort has been hindered to date by the lack of tools to accomplish this and a fractured and overly competitive community that is not effectively sharing data or collaborating. These workshops will engage the coral reef community to 1) develop a common vision of the grand science challenges in the field 2) highlight how data infrastructure and tools could integrate the complex datasets and potentially facilitate rapid forward momentum in key areas of coral reefs systems science and 3) emphasize the value of collaboration and data sharing as a first step to changing and improving the way coral reef scientists support each other and advance the field. Broader Impacts : As ecosystem engineers, corals provide the nutritional, economic, and structural basis of an ecosystem worth billions of dollars annually1,2. This effort convenes the coral reef community and articulates how cyberinfrastructure can inform coral reef systems science. The latter will ultimately accelerate understanding of reef ecosystems, broaden the scope of the questions that can be asked and build capacity to predict how these societally relevant and fragile ecosystems will face the challenges of climate change and human development. The explicit mandate of developing common vision for a way forward will promote collegiality and foster relationships in early to mid stage career academics that will have important downstream implications for how coral reef science moves forward in the future. The workshops will be attended by at least 4 postdocs and represents a significant professional development opportunity for these individuals. Results will be disseminated

on the EarthCube website, the NCEAS website, and the Gates Lab and HIMB website making them broadly accessible to the science, education and lay communities. The product from the proposed endeavor will be a report to NSF EarthCube summarizing the discussion for each of these objectives that will serve to define and align the needs across the Geosciences and help prioritize EarthCube activities. There is also an opportunity to use the results to develop a white paper or manuscript that articulates how data-infrastructure can address the science challenges facing the coral reef community and facilitate a systems level science agenda. Such a product could have high value in both the science funding and policy realm.

Mark Schildhauer | **3/1/2011 to 12/31/2013** | **$343,198**
University of Arizona | Y562553

iPlant/NCEAS Collaboration to Build the BIEN and Environment & Organisms Working Groups' Informatics Frameworks

The geospatial analyst will develop a set of global raster environmental layers to meet the needs of plant biologists and ecologists seeking to understand the interaction between plants and their broad, geospatial environmental context. Attention will be paid to making this data product and the technologies supporting it extensible to accommodate analyses relevant to the marine environment and non-plant organisms. Key deliverables will include: developing an integrated information resource merging daily ground-based weather station data with satellite based measurements of weather; creating select, derived products based on the above, that provide climate, extreme temperature and moisture events (such as return times or 50 year extreme temperatures), and bioagricultural variables such as growing degree days and AET; producing a global, high-resolution terrain model that uses a digital elevation model and derives variables that are biologically relevant such as slope, aspect, slope position, soil moisture and insulation; incorporating some additional layers to be determined, relating to land cover, vegetation and soils. The GA's focus will be to develop a usable, initial version of these integrated layers, while keeping careful track of the workflows used in their creation. The GA will then coordinate with developers based at iPlant to make these workflows scalable and repeatable as a resilient part of CI (cyberinfrastructure) for plant biology. The GA will work most closely with Drs. Brian McGill, Rob Guralnick, and Walter Jetz for scientific guidelines and deliverables tasking. Drs. Mark Schildhauer and James Regetz at NCEAS will provide direct supervision of the GA, and oversight of his/her activities relative to the collaboration among the iPlant and NCEAS technologists, and related Working Group activities (Environments & Organisms with McGill et al.; and BIEN with Enquist et al.). The GA will be a member of the geospatial infrastructure (GSI) group at iPlant and will be expected to participate in team meetings and work towards delivering the environmental layers specified in use cases developed by the GSI group headed by Brian Enquist and Nirav Merchant. The database developer will work in close collaboration with scientists associated with the NCEAS' BIEN Working Group, as well as iPlant and NCEAS' technical personnel, to create a web-accessible database in support of the Botanical Information and Ecology Network project. The envisioned database must accommodate multiple-millions of records of plant biodiversity data, including information about their taxonomic identity, geospatial location, time of sampling, as well as potentially related information regarding co-occurrence with other taxa, sampling methodologies, functional traits, and associated environmental measurements. Key deliverables will include: developing an integrated information resource by merging several well-established plant occurrence information resources, including specimen data from various natural history and botanical museums, as well as plots data; creating useful and appealing web interfaces and services for uploading and accessing these data for quantitative investigations of plant biodiversity; merging this information resource with other services and tools under development within the iPlant cyberinfrastructure, such as for taxonomic name resolution or geospatial quality control, as well as related efforts; planning for the architecture of this framework to be compatible with emerging data confederations in the earth and life sciences, such as DataONE and/or the Data Conservancy enabling this resource to be extensible to accommodate the growing array of relevant information useful for biodiversity research, including but not limited to information about geospatial and environmental context, plant phylogenies, and associated genomic and functional trait data. The DBD will work most closely with Drs. Brian Enquist, Brad Boyle, Rick Condit, Bob Peet, James Regetz, and Mark Schildhauer for scientific guidelines and deliverables tasking. Drs Jim Regetz and Mark Schildhauer at NCEAS will provide direct supervision of the DBD, and oversight of his/her activities relative to the collaboration among the iPlant and NCEAS technologists. The DBD activities will also coordinate activities with the complementary activities in

plant sciences, including especially developments in geospatial intelligence technologies underway through the Environments & Organisms Working Group collaboration between iPlant and NCEAS.

Mark Schildhauer | **8/1/2008 to 7/31/2014** | **$750,000**
National Science Foundation | DBI-0753144

INTEROP: A Community-Driven Scientific Observations Network to Achieve Interoperability of Environmental and Ecological Data

Advances in environmental science increasingly depend on information from multiple disciplines to tackle broader and more complex questions about the natural world. Such advances, however, are hindered by data heterogeneity, which impedes the ability of researchers to discover, interpret, and integrate relevant data that have been collected by oth¬ers. A recent NSF-funded workshop on multi-disciplinary data management concluded that interoperability can be significantly improved by better describing data at the level of observa¬tion and measurement, rather than the traditional focus at the level of the data set. That is, for systems to interoperate effectively, the scientific community must unify the various existing ap¬proaches for representing and describing observational data. A community-sanctioned, unified data model for observational data is thus needed to enable interoperability among existing data resources, which will in turn provide the necessary foundation to support cross-disciplinary synthetic research in the environmental sciences. The investigators propose the Scientific Obser¬vations Network to initiate a multi-disciplinary, community-driven effort to define and develop the necessary specifications and technologies to facilitate semantic interpretation and integra¬tion of observational data. The technological approaches will derive from recent advances in knowledge representation that have demonstrated practical utility in enhancing scientific com¬munication and data interoperability within the genomics community. This effort will consti¬tute a community of experts consisting of environmental science researchers, computer scien¬tists, and information managers, to develop open-source, standards-based approaches to the semantic modeling of observational data. Subgroups of Network experts will also engage in extending this core data model to include a broad range of specific measurements collected by the representative set of disciplines, and a series of demonstration projects will illustrate the ca¬pabilities of the approaches to confederate data for reuse in broader and unanticipated contexts.

Mark Schildhauer | **9/1/2013 to 8/31/2014** | **$165,877**
University of Arizona | 155005

The iPlant Collaborative: Cyberinfrastructure for the Life Sciences

The geospatial analyst will develop a set of global raster environmental layers to meet the needs of plant biologists and ecologists seeking to understand the interaction between plants and their broad, geospatial environmental context. Attention will be paid to making this data product and the technologies supporting it extensible to accommodate analyses relevant to the marine environment and non-plant organisms. Key deliverables will include: 1) developing an integrated information resource merging daily ground-based weather station data with satellite based measurements of weather; 2) creating select, derived products based on the above, that provide climate, extreme temperature and moisture events (such as return times or 50 year extreme temperatures), and bioagricultural variables such as growing degree days and AET; 3) producing a global, high-resolution terrain model that uses a digital elevation model and derives variables that are biologically relevant such as slope, aspect, slope position, soil moisture and insulation; 4) incorporating some additional layers to be determined, relating to land cover, vegetation and soils. The GA's focus will be to develop a usable, initial version of these integrated layers, while keeping careful track of the workflows used in their creation. The GA will then coordinate with developers based at iPlant to make these workflows scalable and repeatable as a resilient part of CI (cyberinfrastructure) for plant biology.

Joshua Schimel | **9/1/2008 to 8/31/2013** | **$254,239**
National Science Foundation | ARC-0806451

Collaborative Research: Spatial and Temporal Influences of Thermokarst Features on Surface Processes in Arctic Landscapes

Recent summaries of international research clearly document the past and future extent of climate

warming in the Arctic. These summaries suggest that in the future, rising temperatures will be accompanied by increased precipitation, mostly as rain: 20% more over the Arctic as a whole and up to 30% more in coastal areas during the winter and autumn. These climate changes will have important impacts on Arctic Systems. Of direct interest to the research we propose here is the likelihood that warming will promote permafrost degradation and thaw. Formerly frozen soils may be further destabilized by increased precipitation, leading to hillslope thermkarst failures. We have recently documented that thermokarst failures are abundant and appear to have become more numerous around Toolik Lake on the eastern North Slope and in the western Noatak River Basin in Alaska. We hypothesize that a widespread and long-term increase in the incidence of thermokarst failures will have important impacts on the structure and function of arctic headwater landscapes. We propose to use a systems approach to address hypotheses about how thermokarst failures influence the structure and function of the arctic landscape. Specifically we will focus on the composition of vegetation, the distribution and processing of soil nutrients, and exports of sediments and nutrients to stream and lake ecosystems. We further propose to line results obtained at this hillslope scale to patterns observed at the landscape scale to test hypotheses about the spatial distribution of thermokarst failures in the arctic foothills.

Russell Schmitt	**9/1/2010 to 8/31/2013**	**$2,010,161**
Sally Holbrook		**$99,989**
National Science Foundation	OCE-1026851	$87,126

LTER: MCR II - Long - Term Dynamics of a Coral Reef Ecosystem **$27,000**

The Moorea Coral Reef (MCR) LTER is an interdisciplinary research and education program that was established in 2004, to explore the joint effects of climate and disturbance on the structure and function of coral reefs. Our study area is the reef complex that surrounds the island of Moorea in French Polynesia. Our initial focus (MCR I) was to advance understanding of major controls of processes that modulate ecosystem function, shape community structure and diversity, and determine abundance and dynamics of constituent populations. We build on this foundation by adapting a unifying conceptual framework (US LTER 2007) and developing a set of research themes to organize the MCR II research program and facilitate cross-site collaboration. Coral reef ecosystems appear especially vulnerable to changes in abiotic drivers associated with Global Climate Change (GCC). These arise from two mechanisms related to increasing concentrations of atmospheric CO2: rising seawater temperature due to greenhouse warming, and changing seawater chemistry known as Ocean Acidification (OA). A paradigm shift occurred within the past decade regarding the relative importance of these climate-related drivers to coral reefs. The focus initially was on rising seawater temperature because it triggered several large-scale, conspicuous coral bleaching (i.e., loss of the endosymbiont Symbiodinium) events. There now is widespread recognition that OA and its interaction with rising temperature have the potential to cause even more sweeping changes. These drivers occur against a backdrop of other press (e.g., fishing) and pulse (e.g., storms) perturbations. During MCR I, a brief outbreak of crown-of-thorns seastars (COTS) resulted in the death of virtually all coral on the fore reef of Moorea, bringing issues related to state change, resilience (recovery), interactive effects and indirect cascades to the forefront. The fundamental question that we address in MCR II is: How do drivers that operate over different spatial and temporal scales interact to influence the structure and function of coral reef ecosystems? Our three organizing themes are: (i) interactive effects among drivers, (ii) indirect effects arising from structure – function linkages, and (iii) resilience and resistance in relation to structure – function feedbacks. The six goals of MCR II are to: (a) continue our long-term datasets on physical drivers, community dynamics and ecosystem processes; (b) maintain a long-term resilience experiment; (c) contribute to understanding of how Global Climate Change drivers will affect coral reefs and what factors influence resistance and resilience; (d) develop and test general ecological theory; (e) continue to improve our information management system to more fully meet the needs of the LTER network and broader scientific community; and (f) enhance our outreach components.

Russell Schmitt	**9/1/2012 to 8/31/2016**	**$4,632,747**
Sally Holbrook		**$16,000**
National Science Foundation	OCE-1236905	$125,213

LTER: MCR IIB: Long-Term Dynamics of a Coral Reef Ecosystem **$194,040** $2,145
$150,134

Intellectual Merit: The Moorea Coral Reef (MCR) LTER is an interdisciplinary research and education program that was established in 2004, to explore the joint effects of climate and disturbance on the structure and function of coral reefs. Our study area is the reef complex that surrounds the island of Moorea in French Polynesia. Our initial focus (MCR I) was to advance understanding of major controls of processes that modulate ecosystem function, shape community structure and diversity, and determine abundance and dynamics of constituent populations. We build on this foundation by adapting a unifying conceptual framework (US LTER 2007) and developing a set of research themes to organize the MCR II research program and facilitate cross-site collaboration. Coral reef ecosystems appear especially vulnerable to changes in abiotic drivers associated with Global Climate Change (GCC). These arise from two mechanisms related to increasing concentrations of atmospheric CO2: rising seawater temperature due to greenhouse warming, and changing seawater chemistry known as Ocean Acidification (OA). A paradigm shift occurred within the past decade regarding the relative importance of these climate-related drivers to coral reefs. The focus initially was on rising seawater temperature because it triggered several large-scale, conspicuous coral bleaching (i.e., loss of the endosymbiont Symbiodinium) events. There now is widespread recognition that OA and its interaction with rising temperature have the potential to cause even more sweeping changes. These drivers occur against a backdrop of other press (e.g., fishing) and pulse (e.g., storms) perturbations. During MCR I, a brief outbreak of crown-of-thorns seastars (COTS) resulted in the death of virtually all coral on the fore reef of Moorea, bringing issues related to state change, resilience (recovery), interactive effects and indirect cascades to the forefront. The fundamental question that we address in MCR II is: How do drivers that operate over different spatial and temporal scales interact to influence the structure and function of coral reef ecosystems? Our three organizing themes are: (i) interactive effects among drivers, (ii) indirect effects arising from structure – function linkages, and (iii) resilience and resistance in relation to structure – function feedbacks. The six goals of MCR II are to: (a) continue our long-term datasets on physical drivers, community dynamics and ecosystem processes; (b) maintain a long-term resilience experiment; (c) contribute to understanding of how Global Climate Change drivers will affect coral reefs and what factors influence resistance and resilience; (d) develop and test general ecological theory; (e) continue to improve our information management system to more fully meet the needs of the LTER network and broader scientific community; and (f) enhance our outreach components.

Broader Impacts: Coral reefs are not just ecologically important - they yield upwards of $375 billion annually in goods and services (most of it in the developing world) that are vulnerable to human activities and climate forcing. Hence our research has relevance and application to resource managers, policy makers and stakeholders worldwide. Broader impacts arising from our educational activities include postdoctoral mentoring, research that integrates undergraduate and graduate training, progress towards an ethnically diverse MCR student community, active participation of K-12 teachers in MCR research, incorporation of MCR findings in teaching curricula, participation of MCR faculty and graduate students in the Three Seas Program, and involvement of faculty and students from predominately undergraduate and minority-serving institutions. Additional impacts are realized by our outreach efforts, including partnerships with three local schools that serve socio-economically disadvantaged and minority students, and with the Atitia Center on Moorea to reach Tahitians. While our information-rich web site will continue to be a primary outreach portal, we plan to develop a partnership with another web-based entity to target middle-school students.

Stephen Schroeter **1/1/2012 to 12/31/2013** **$3,453,551**
Mark Page, Dan Reed
Simpson and Simpson Business and Personnel Services, Inc. SB120101

San Onofre Nuclear Generating Mitigation Project Monitoring Program

The following tasks will be undertaken by the Principal Scientists and contract wetland biologists: a. Conduct field surveys and use aerial photographs to assess the performance standards pertaining to topography and habitat areas. Observations by the Principal Scientists during construction monitoring indicate that noticeable sediment erosion and deposition can occur within a period of a few months. Therefore, field observational surveys will be done monthly throughout the restored San Dieguito wetland to monitor for any sign of substantial erosion or sediment deposition that could impede tidal flow within the wetland. Additional surveys will be done following extreme climatic events. Annual ground surveys using RTK GPS and low level aerial photographs taken in the spring will be used to determine whether the areas of planned wetland habitats (subtidal, intertidal mudflat, vegetated marsh) have changed from areas specified in the Final Plan. Commission staff

has defined 4.5' NGVD as the upper limit of tidally influenced habitat for the calculation of acreage credit for this restoration project. Because of this, the upper edge of the 4.5' contour is of special interest and will be checked annually to evaluate compliance with the acreage requirement and performance standard on habitat areas. Professional surveyors will be engaged as needed to assist in this evaluation. b. Conduct field sampling and use environmental data loggers to assess the performance standards pertaining to water quality and tidal prism. Because of its documented importance to wetland health, the concentration of dissolved oxygen will be used to evaluate water quality within the restored wetland. Measurements of dissolved oxygen will be made using continuously recording environmental data loggers deployed in the restored and reference wetlands at sites that encompass average conditions. A reduction in the tidal prism of the restored wetland can have detrimental effects on water quality and alter the area of inundated habitat. Tidal prism will be calculated by integrating measurements of tidal discharge taken near the inlet using a portable acoustic Doppler profiler/discharge measurement system over predicted tides of 4.5' NGVD. The twice yearly tidal prism measurements will be supplemented with surveys of flow further within the restored wetland at channels leading to the large basin (W1) and the large intertidal area of W4 and W16 to proactively identify impeded tidal flow into or out of these areas and inform maintenance action. c. Survey fish, macroinvertebrates, and birds to assess the performance standards pertaining to biological communities and food chain support. During pre-restoration monitoring, the Principal Scientists developed and refined methods to sample fish and macroinvertebrates. These methods were published in the scientific literature and will be used to evaluate the performance standards pertaining to biological communities. Sampling fish in the restored and reference wetlands, in particular, is a labor intensive task that will require the employment of temporary field assistants to help with enclosure trap and seine sampling during the summer. The methods developed for fish sampling employ the minimum number of personnel for completing the task and a sampling design that balances the conflicting goals of adequate spatial and temporal sample replication to evaluate wetland performance with the time, cost and impacts of sampling in the restored and reference wetlands. The performance standard pertaining to food chain support will be evaluated by measuring bird feeding activity during the same period that bird densities are measured, and using bird species that are present in both restored and reference wetlands. Bird specialist will be retained to assist the Principal Scientists to determine the abundance and number of species of birds and assess bird feeding activity. Taxonomic specialist will be retained to assist with invertebrate identification and establishment of a reference collection. d. Use aerial photographs and ground surveys to assess the performance standards pertaining to the cover of wetland vegetation and open space and the coverage of algal mats. The use of low-level multi-spectral aerial photography provides a means of obtaining a whole wetland estimate of the cover of vegetation, bare space and macroalgae in the restored and reference wetlands. Multi-spectral photographs also allow the identification of plant species assemblages throughout the wetlands, which is useful in locating the presence of exotic species. The photographs are ground-truthed by limited field sampling of vegetation cover during each aerial survey. Aerial photographs will be taken in the restored and reference wetlands in late spring to early summer, which is the period of maximum growth of marsh plants and algae. Ground surveys for the presence of unusually thick algal mats, which typically indicates poor tidal flushing or excessive nutrient enrichment, will also be made during routine water quality monitoring. e. Assess the performance standard pertaining to Spartina canopy architecture. This task will be accomplished through the measurement of the height of cordgrass stems in sampling quadrats located in stands of cordgrass. Sampling of cordgrass will be done in late spring to early summer concurrently with the monitoring of wetland vegetation. f. Sample seeds of salt marsh plants to evaluate the performance standard pertaining to the reproductive success of these plants. The reproductive success of salt marsh plants will be evaluated by measuring the set of viable seed in at least three plant species in the restored wetland. Sampling will be done annually in late summer-fall when seed set is expected to be greatest. The viability of seed from each species will be confirmed by the germination of seeds in culture. g. Evaluate sampling data and conduct a survey to assess the performance standard pertaining to exotic species. Monitoring data collected for fish, invertebrates, birds, and plants will be used to evaluate this standard. In addition, a special survey of exotic species that covers as much of the restored wetland as possible will be conducted once a year during the summer to adaptively manage for exotic species. This special survey will focus on plants and visible invertebrates and incorporate a snorkeling survey of the subtidal portion of the main basin (W1).

Stephen Schroeter | **7/1/2006 to 6/30/2016** | **$103,978**
California Sea Urchin Commission | SB070019

Studies of Sea Urchins Settlement in Southern and Northern California

The patterns of settlement of red (Strongylocentrotus franciscanus) and purple (S. purpuratus) sea urchins may have important impacts on the commercial fishery and provide an important fishery-independent measure of stock health. The investigators have monitored weekly to bi-weekly sea urchin settlement at multiple sites in southern and northern California since February 1990. Studies to date have identified spatial and temporal patterns in sea urchin settlement (including the effects of periodic El Niños and La Niñas) and have identified some of the likely mechanisms responsible for these patterns. They have added value to their work by volunteering their time and collaborating with University researchers and private industry. In particular, work done in collaboration with Jan Svejkovsky of Ocean Imaging has given important insights into the effects of large-scale oceanographic forcing on sea urchin settlement patterns, while collaborative work on population genetics with Dr. Ron Burton has shed light on the structure of parental source populations during a heavy settlement event. Perhaps most importantly, their long-term and geographically extensive record of sea urchin settlement continues to provide the only integrated, fishery independent index of the condition of the breeding stock, since larval supply and settlement are a function of the effective breeding population. The value of this inexpensive tool for monitoring the health of the sea urchin resource in California increases each year the study is continued.

Thomas Turner	**8/1/2011 to 5/31/2016**	**$1,151,408**
NIH General Medical Sciences	5R01 GM098614-04	

Evolutionary Behavioral Genomics of Drosophila Courtship

Genome-wide association studies hold the promise of comprehensive and systematic identification of the genetic basis of natural trait variation. By quantifying how genetic polymorphisms induce large, small, precise, general, or conditional effects on traits, we can unlock a vast reservoir of natural variation that will help us understand how biological systems function and evolve. However, good statistical power to identify variants with low population frequencies or modest effects requires sample sizes that are generally prohibitive. Here, we develop a new approach, "Evolve and Resequence" (E&R), that overcomes this barrier using the genetic model system Drosophila. We have re-purposed experimental evolution of D. melanogaster, which has been used for over 100 years to address fundamental questions in population genetics, and adapted it for use in genome-wide mapping. Together with high-throughput behavioral quantification and various statistical approaches, our technique will be used to build models of behavior based on genotype. The predictive power of these models will tell us a great deal about the nature of genetic information and the molecular systems that translate this information into behavioral output. The long-term goal of this research is to characterize the genetic and environmental influences that result in variation in courtship behavior, for both males and females, in multiple Drosophila species. This work begins with characterization of male courtship song production: during courtship, a Drosophila male extends a single wing and "twangs" this wing repeatedly to produce a wing vibration song consisting of a series of pulses. These traits are among the best characterized of Drosophila behaviors, both in D. melanogaster and across the genus, and they are currently the focus of intensive efforts in neurobiology and molecular genetics. As such, these traits serve as a model system for studying the genetic basis of behavior in animals. Specifically, this proposal aims to 1) locate and characterize the genetic variants affecting courtship song in D. melanogaster, 2) do the same for the closely related D. simulans, to compare and contrast results from multiple species, and 3) begin molecular genetic investigation of the genes and gene systems discovered in aims 1 and 2.

David Valentine	**12/10/2012 to 2/28/2016**	**$231,724**
University of Rochester	416111-G	

Investigating the Chemical and Isotopic Kinetics of Aerobic Methane Oxidation

Year 1: The research team at UCSB will participate on the planned cruise to the Gulf of Mexico and will coordinate the sampling for bacterial identity and for oxidation rate measurements using the tritium method. The research team at UCSB will initiate the molecular analyses for microbial community structure on samples collected during the two cruises. This will include sequencing of 16SrRNA genes using a clone library approach. Year 2: The research team at UCSB will complete the molecular analyses for microbial community structure on samples collected during the first cruise, and select other samples provided by the lead PI from incubation studies. Year 3: The research team

at UCSB will participate on the planned cruise to the Atlantic Ocean and will coordinate the sampling for bacterial identity and for oxidation rate measurements using the tritium method, should the latter be needed. The research team at UCSB will complete the molecular analyses for microbial community structure on samples collected during the second cruise, and select other samples provided by the lead PI from incubation studies. We budgeted for sequencing of 1000 clones in total, to be used on the initial samples and on time points of the incubation time series. The depth of sequencing for each of the ~24 samples expected will be determined based on initial T-RFLP results, as we have done previously, allowing us to best allocate the funds for sequencing across the time series.

David Valentine | **3/21/2013 to 3/31/2016** | **$335,419**
California Institute of Technology | 65Q-1094175

Cracking the Microbial Sulfur Cycle with Novel Cell- and Metabolite-Specific Stable Isotope Approaches

Personnel at UCSB will work closely with the collaborating scientists on the following topical areas: 1) Contribute experimental expertise to develop techniques to measure low abundance sulfur-containing compounds from whole cells, as well as metabolic intermediates using novel inductively coupled plasma mass spectrometry (ICP-MS) techniques. 2) Contribute to the development of experimental methods to link phylogenetic identity to metabolic activity of sulfur cycling microbes using fluorescence in situ hybridization coupled to mass spectrometry (FISH-nanoSIMS) 3) Conduct collaborative experiments to track the flow of isotope labeled sulfur through extracellular metabolite pools as well as within intracellular pools. 4) Conduct aerobic and anaerobic pulse chase time course experiments using seafloor incubation chamber at Coal Oil Point. 5) Contribute to the development of new methods for using molecules containing more than one rare isotope species to track multiple sources and sinks of methane in cultures of microbes 6) Contribute to a synthesis paper on tracking activity and interactions of sulfur cycling microbes at the cellular level. 7) Contribute toward in-situ incubations involving for sulfur isotope tracking and metaproteomics.

David Valentine | **1/1/2011 to 12/31/2016** | **$924,127**
National Science Foundation | OCE-1046144

Dimensions: The Role of Viruses in Structuring Biodiversity in Methanotrophioc Marine Ecosystems

The proposal first seeks to assess viral activity in situ by extending established stable isotope probing techniques to quantify rates of viral production at sea floor methane seeps. The same techniques will be used to track the flow of carbon from methane to microbes to viruses and to isolate genetic material from just those organisms that actively cycle methane-derived carbon, enabling the production of microbial and viral metagenomes that are anchored in ecosystem function. Comparisons among these metagenomes will reveal any functional sequences in transit between organisms, providing the basis for an evaluation of the relationships between functional and genetic diversity. At the same time, single-cell whole-genome amplification will pinpoint individual cells for comparison with the microbial and viral assemblages, permitting assessment of the relationships between taxonomic and genetic diversity. Last, the comparison of genomic and metagenomic data both within and across distinctive marine methanotrophic ecosystems will enable analysis of the relationship between functional and taxonomic diversity.

David Valentine | **6/1/2010 to 5/31/2014** | **$327,457**
National Science Foundation | EAR-0950600

Collaborative Research: Experimental Determination of Petroleum Biodegradation Patterns from Genomically-Informed Analytical Vista

This proposal describes a series of laboratory studies designed to assess the genomic and molecular patterns of petroleum biodegradation under a range of conditions relevant to the Earth's surface and subsurface. The concerted application of comprehensive, two-dimensional gas chromatography, Fourier transform ion cyclotron resonance mass spectrometry, and pyrosequencing-based metagenomics will provide unparalleled insight into petroleum biodegradation and the responsible microbes, and distinguishes this work from any previous studies.

David Valentine | **4/15/2010 to 3/31/2014** | **$373,024**
National Science Foundation | OCE-0961725

Collaborative Research: Chemical Changes Accompanying Petroleum Weathering in the Coastal Ocean

This proposal addresses the weathering of petroleum hydrocarbons in the coastal ocean. While there have been countless studies on this topic, advances have stalled due to the narrow analytical windows provided by traditional analytical techniques, leaving fundamental questions unanswered. This proposal involves a concerted application of two advanced approaches: comprehensive, two-dimensional gas chromatography and Fourier transform ion cyclotron resonance mass spectrometry, to provide an unprecedented level of detail on the weathering of hundreds to thousands of petroleum hydrocarbons. Specifically, this research will identify and apportion the role of photolysis, evaporation, dissolution, and biodegradation associated with oil weathering at the natural oil seeps off Santa Barbara, CA, where more than 5 million liters of oil seep annually into the ocean.

David Valentine | **10/1/2013 to 9/30/2016** | **$341,714**
National Science Foundation | OCE-1333162

Collaborative Research: Oxygenation of Hydrocarbons in the Ocean

Collaborative Research: Oxygenation of Hydrocarbons in the Ocean Overview More than 400,000 tons of petroleum hydrocarbons are released annually into the ocean, with human activities and natural seepage contributing comparable amounts. Once in marine environments, hydrocarbons are subject to physical, chemical and biological processes, collectively referred to as weathering, that are well established to remove select hydrocarbons from the ocean. However, little attention has been given, mainly due to analytical limitations, to the ubiquitous residues left by oil's weathering. Recent studies from oil spills point to the importance of hydrocarbon oxygenation, the incorporation of oxygen into hydrocarbons, as an important process in forming major constituents of recalcitrant tar. Furthermore, other oxyhydrocarbons could dissolve into ocean water, and several studies suggest that oxygenated hydrocarbon compounds can be toxic. This proposal seeks to lay a scientific foundation for understanding which processes control the formation of oxygenated hydrocarbons, the rates of these processes, the identity of the major products, the rates at which they are formed and destroyed, and for distinguishing photochemical oxygenation from biological oxygenation. The primary hypotheses driving this study are that (i) hydrocarbon oxygenation in the ocean is controlled by a balance between photooxidation and biodegradation, with each process leading to distinct suites of products and (ii) oxygenation produces both terminal recalcitrant products, which dominate the mass of tar in the environment, and lesser amounts of dissolved organic carbon. The approach involves a series of field and laboratory studies that include using hydrocarbon seeps as natural laboratories and oil spills (Deepwater Horizon oil spill 2010, and Cosco Busan spill 2007) as individual experiments. Laboratory experiments will isolate photochemical and biological oxygenation, whereas field studies will assess changes and patterns of oxygenation in natural slicks at the sea surface and biodegraded oils from underlying natural seeps. To identify specific oxidation processes and recalcitrant products, labile and recalcitrant oxygenation products will be identified using ultra-high resolution mass spectrometry (FT-ICR-MS) and comprehensive two-dimensional gas chromatography (GCGC), and changes in the stable oxygen isotopic composition characteristic of biological and photooxidation will be determined. These are novel approaches not previously applied to oxygenation of hydrocarbons. Intellectual Merit: The results from these experiments will contribute to a better understanding of the petroleum oxygenation processes and the environmental fate of understudied oxygenation products. Thereby, characteristic changes in bulk, molecular, and isotopic composition of weathered petroleum seep and spill samples collected by the PIs will be linked to photooxidation and biodegradation processes. Overall, this study promises to reveal the composition, source, and fate of oxygenated hydrocarbons that result from petroleum released in marine systems by natural seepage or anthropogenic discharge. Broader Impact: This study provides for several undergraduates and two postdoctoral scholars to be trained in innovative analytical and experimental techniques. The proposed oceanographic expedition in the Gulf of Mexico will double as a course offered at UCSB that will bring undergraduates to sea and provide a rich and integrated research and learning experience; undergraduate students from the University of Mary Washington will also be incorporated into the laboratory and oceanographic phases. Furthermore, the results of this effort will help regulatory agencies to define new analytical methods and target compounds for oil spill research. The involved PIs have built a strong relationship with federal and industry oil spill

scientists in order to communicate and apply these results. Last, the iconic 2010 Deepwater Horizon spill has drawn attention to a wider audience of marine scientists studying cycling of organic matter in the ocean, beyond traditional oil spill research. The proposed study will add to their efforts to understand the fate and impacts of hydrocarbons released into the ocean.

David Valentine **7/1/2013 to 1/1/2016** **$400,000**
Exxon Mobil Upstream Research Company
EM08119

Development and Testing of Sampling Tools for the Collection of Microbes and Chemicals from Marine Seeps

Based on the limitations of the existing technologies used by the petroleum industry, there are clear opportunities for the development of new cost effective sampling, analyses, and interpretation techniques. Moreover, the ability to collect uncontaminated samples is critical in order to use the chemical and microbial signatures of seeps to reduce the uncertainty of hydrocarbon occurrence materially in the subsurface. This project will develop tools and methods to collect pristine chemical and microbiological samples from hydrocarbon seeps in the marine environment (i.e. fluids and sediments). Of particular interest are samples of the seep fluids (gas, oil, and water) and the microbes contained therein. The primary sampling challenge is to minimize contamination during sample collection and retrieval (e.g. air intrusion or through the involvement of seawater rich in atmospheric noble gases, anthropogenic bio-contamination, etc.). Development of tools will be led by UCSB, with the fabrication being conducted jointly with ExxonMobil Upstream Research Company, and initial testing performed by UCSB at the shallow (~20 m deep) hydrocarbon seeps at Coal Oil Point, Santa Barbara Channel, using SCUBA divers. The apparatus and methods developed here will be designed for eventual deployment by remotely operated vehicles (ROVs), for sampling of seeps in the deep marine environment. The goal of this activity is to successfully collect samples for chemical and microbiological analyses, with minimal levels of contamination. UCSB Objectives: This project aims to: (1) develop appropriate devices and protocols for sampling gas and oil from hydrocarbon seep environments, in a manner that avoids unacceptable levels of chemical and microbial contamination, and (2) demonstrate the utility of the developed devices and protocols for collecting samples free of contamination.

David Valentine **6/1/2012 to 5/31/2016** **$388,632**
National Science Foundation OCE-1155855

Development and Application of a Radiotracer Rate Method for Ethane and Propane Consumption

Ethane and propane are released in abundance to the ocean through natural seepage, as byproducts of photosynthesis, and by the petroleum industry. For example, ethane and propane together constituted greater than 5% of the total mass release during the Deepwater Horizon event, and were the primary drivers of oxygen decline in the deep waters of the NE Gulf of Mexico during the spill. Despite the importance of these gases, little is known about their release into the ocean, the capacity of marine bacteria to consume them, or the fate and impacts of the carbon and energy they store. This proposal will specifically address the consumption of ethane and propane in the ocean by developing, validating and applying highly sensitive tracer techniques to quantify consumption rates for these gases in ocean waters. Two specific hypotheses will be tested with the goal to better understand the factors controlling ethane and propane consumption in the ocean. Hypothesis 1: The capacity for ethane and propane oxidation is ubiquitous throughout the upper ocean and along continental margins, with constitutive rates that depend on regional input and total bacterial abundance; Hypothesis 2: Propane and ethane consumption are readily inducible beyond a basal level on the timescale of days, propane consumption more so than ethane consumption. The proposed research will address these hypotheses in two steps. The first step will entail the development of a method to quantify the consumption rates for ethane and propane, including the laboratory synthesis of radiolabeled ethane and propane, purification of the products, systematic investigations of tracer storage to minimize effects of autoradiolytic exchange, and validation of the measurement through inter-comparison. The second step is the application of the method to interrogate the rates of ethane and propane consumption in the ocean, including the coastal ocean and along the continental margin off California. The field component of the research will take place during a series of short cruises in the Santa Barbara Basin, and during one value added cruise aboard a UNOLS vessel.

Herb Waite, Kollbe Ahn **7/1/2012 to 3/31/2014** **$159,165**
United Soybean Board 2430

Marine-Inspired High Performance Soybean Oil-Based Pressure-Sensitive Adhesives

Acrylic soybean oil (ASO) or acrylated methyl oleate (AMO) has been studied and patented for pressure-sensitive adhesives by Prof. Wool (Univ. of Delaware), 3M (St. Paul, MN), and Avery Dennison (Pasadena, CA). To increase their bio-contents with the stronger government policies on environmental concerns, greener PSAs with 97% bio-contents from epoxidized soybean oil (ESO) have been developed by Dr. Ahn (Co-PI) in Prof. Sun's mentorship in 2011 at the Kansas State University with the USB's financial support; now, the PSA is in the process of commercialization. However, all previous soybean oil-based PSAs showed relatively lower adhesion properties than the commercial PSA (i.e., Scotch tape), and do not contain moisture-resistance that is important for medical and label applications. Commercial petroleum-based acrylic PSAs have also been studied and patented to improve their moisture-resistance by modulating surfactant (Prof. Severtson, Univ. of Minnesota) and solid (3M, St. Paul, MN) contents in the emulsions, but they still perform poorer in moist conditions than in dry conditions. Prof. Waite (PI) has over 30 years of experience in marine-inspired adhesives beginning with the discovery of the involvement of catechols in the strong wet-adhesion of mussel proteins (Science 1981, 212, 1038 in addition to 175 total publications). Many bio-mimetic researchers have been inspired by his research, and improved the moisture-resistance of their adhesive system with aid of Prof. Waite's inputs on their research. Importantly, only Prof. Waite's group has recognized the antioxidant effects on DOPA (mussel)-adhesives (Nature Chemical Biology 2011, 7, 588). Meanwhile, Prof. Li (Oregon State Univ.) has reported increased wet-adhesion strength of soy protein wood adhesives using Prof. Waite's mussel-mimetic concept; however, perhaps because of his focus only on oxidative effects, the wet-strength of his mussel-inspired adhesives was still much lower than the dry strength. In this project, Prof. Waite (PI and an expert in marine-mimetic adhesion) will use his extensive experience in marine-adhesives in the development of the mussel-inspired soybean oil-based high performance/moisture-resistant PSA collaborating with Dr. Ahn (Co-PI, +10 years experience in the soybean oil modifications for adhesive applications with 4 patents and 15 publications), Ashland, Henkel and Avery Dennison (the world largest adhesive companies, recently patented the plant oil-based PSAs). Our synergized latest cutting-edge technology and know-how greatly enhances the probability of breakthroughs in this project. This project will be much more straightforwardly accomplished and commercialized compared to the previous soy oil-PSA project (spending time mostly to elucidate the synthetic pathways) at Kansas State University because we will use all well-established synthetic protocols with our cutting-edge soy oil-PSA and marine-mimetic technologies at the University of California, Santa Barbara (the world's top ranked materials research facilities, #1 at the National Research Council Ranking and #2 at US News in 2012). Towards the end, we will synthesize mussel adhesion-mimetic fatty acid amide, followed by acrylation of unsaturated sites using well-established, inexpensive, commercially viable chemistry. The acrylic compounds will then be polymerized via UV initiated free radical reaction. The adhesion/cohesion balance of the polymer will be optimized for high performance PSAs. The force-distance profiles and adhesion/cohesion energies will be demonstrated with surface forces apparatus (SFA) as a function of bio-mimetic contents. Based on the fundamental adhesion studies, the peel/tack/shear/moisture-resistant properties will be optimized by modulating ratio of the functional groups such as catecholic amino acid 3,4-dihydroxyphenylalanine (DOPA)/SH-/NH2-. In addition, wet-strength will be improved by commercial antioxidants, or analogs of thiol-rich peptides found in mussels.

Herb Waite **8/4/2008 to 6/30/2014** **$2,224,158**
Jacob Israelachvili
National Institutes of Health, NIH Dental and NIH Research R01 DE018468

Translating Mussel Adhesion

Moisture is the nemesis of strong polymer adhesion to metals and minerals. Most engineered adhesive polymers require extensive prior surface cleaning, drying, and sometime even chemical modification for effective adhesion to polar surfaces. Such surface preparation is difficult in vivo since biomineralized tissues and implant material surfaces are necessarily hydrated within the body. Various marine organisms have evolved highly effective adhesive strategies for wet surfaces. The broad goal of this proposal is to obtain mechanistic information about marine adhesion in order to translate it into effective applications for restoration and repair of hard tissues. While the

discovery of 3,4-dihydroxyphenylalanine (Dopa)-protein involvement in adhesion has already inspired several new biomedical materials, Dopa is not the only bioinspired theme. The specific aims here are to determine using mass spectrometry whether and to what extent phosphoserine and 4-hydroxyarginine are linked to mussel adhesion on different surfaces, characterize the specific protein-protein interactions during adhesive cross-linking, and to explore how factors such as mass, primary sequence, and side-chain functionalization influence the coating or bridging behavior of mfp-1 on surfaces such as titanium and hydroxyapatite using the surface forces apparatus. Bio-inspired adhesives and sealants are much needed in dentistry and orthopedics not just to improve the strength and durability of bonding to hard tissues, but also to emancipate the present technology, particularly in dentistry, from reliance on highly reactive and toxic organic formulas.

Herbert Waite **9/1/2013 to 8/31/2016** **$1,283,964**
Jacob Israelachvili
National Institutes of Health, NIH Dental and NIH Research 2R01DE018468-08

Translating Mussel Adhesion

Polymer adhesion to wet mineral surfaces is typically limited by the lack of polymer-surface interactions strong enough to compete with water. Marine mussels overcome this limitation by using a suite of specific DOPA-containing proteins that chemically bind even to wet, atomically smooth surfaces. Protein biochemistry and surface physics are combined in this proposal to investigate the adhesive strategies of mussels on surfaces of hydroxyapatite - the mineral of tooth and bone. In the first aim, mass spectrometry and molecular surface sensors will be used to interrogate the proteins, pH, redox, and water fastness of adhesive secretions deposited onto hydroxyapatite. In aim 2, hydroxyapatite-specific proteins will be tested for adhesion in the surface forces apparatus using the pH and redox conditions used in mussel adhesion. In the third aim, a 3-dimensional surface forces apparatus will be introduced to measure the effect of multidirectional motion on the dynamic adhesion of mussel-derived proteins to dentinal and enamel surfaces.

Herbert Waite, Kollbe Ahn **7/31/2013 to 1/29/2016** **$577,836**
Department of Navy, Miscellaneous Bases & Agencies N00014-13-1-0867

Mussel-Inspired Underwater Acrylic Adhesives/Coatings

Mussels have evolved their adhesion to wet mineral, metal, and metal oxide surfaces over 500 million years. Beginning in 1981 with the characterization of the first mussel adhesive protein by Waite (PI), the structure-properties relationships of more than 20 mussel- and sandcastle worm-derived adhesive proteins have been determined. Translation of these relationships is providing new insights for designing and engineering the next generation of polymers for wet adhesion. In our preliminary work, the technical feasibility of our experimental approach has been demonstrated and emphasizes the potential for marine and submarine applications. Briefly, 1) mussel-inspired catechol-acrylate monomers were synthesized using eugenol (inexpensive sustainable precursor); 2) the monomers were UV polymerized and exhibited excellent wet-tack strength (2.6 N/cm2) underwater comparable to dry-tack strength (2.5 N/cm2) of commercial Scotch tape (3M, St. Paul, MN) under ambient conditions. We will also investigate surface physics of this new polymeric material using the surface forces apparatus (SFA) and will optimize its adhesion/cohesion properties by controlling catechol activation rates and pre-polymerization techniques. Finally, we will develop underwater adhesives/coatings that adhere to/coat marine surfaces using our expertise in mussel-inspired wet-adhesion technology at UCSB. This innovation will empower the Navy (1) to perform naval boat/ship maintenance at sea without dry docking, (2) to adhere devices to surfaces undersea, and (3) to coat/paint/seal and/or mark/note to surfaces undersea with a possible extended application of invisible magic marker (only visible in certain wavelength of light) using fluorescent dyes.

Herb Waite **5/1/2010 to 4/30/2014** **$375,000**
Human Frontier Science Program Organization (Intl) 0004/2010

The Calcified Byssus of Anomia: A Unique Solution to Underwater Adhesion

Sedentary animals attach to substrates with glues that work underwater, a feat we do not master in our technology. A well-known example is the blue mussel whose beard, called the byssus, is used to attach the soft mussel tissue to the hard substrates the animal lives on. The blue mussel

byssus is made of protein. In contrast to the multi-thread pure protein byssus of the blue mussel, its cousins called the Anomiidae attach via a byssus plug made from a single thread that is calcified, i.e., contains calcium carbonate crystals in addition to proteins. Almost nothing is known about this strange attachment system and in particular the adhesive. We will investigate this intriguing solution to sticking in place using an interdisciplinary approach where we will understand both the mechanical function and the biomolecules involved in the adhesion. This is done by joining the forces of materials chemists and biochemists.

Barbara Walker, Carolynn Culver, Kimberly Selkoe
University of Washington

2/1/2012 to 3/31/2015
R/SOC-2-F-1/2

$164,072

Toward Resilience and Sustainable Seafood Supply: Assessing Direct Marketing Approaches for the West Coast Fishing Communities

The overarching project goals are to contribute to the social science literature on fisheries and social change in local food systems, and generate information and tools to better enable West Coast fishing communities to determine whether and how they might use various types of DMAs. Project objectives are to: 1) rigorously evaluate the patterns, processes, and impacts associated with seafood DMAs, and 2) integrate this knowledge into practical tools for use by West Coast communities in DMA decision-making. Combining applied social science research and engagement with fishing communities, we will produce a comparative case study of selected DMAs in two regions of the U.S. (the Carolinas, Washington State), and develop and pilot test a DMA assessment toolkit in two West Coast communities (Santa Barbara, CA, Coos Bay, OR). These products are expected to increase knowledge and inform decision-making about DMAs in the pilot test communities, supporting their resilience and contributing to sustainable seafood supply in the short term, and other such communities over the long term. In addition, the project will help build social science research capacity that can be used to further document and explore the social processes underlying coastal community change.

Robert Warner
Boston University

3/1/2013 to 2/28/2017
4500001274

$29,317

An Integrative Investigation of Population Connectivity Using a Coral Reef Fish

A central question of marine ecology is how far do marine fish larvae disperse? Most reef fishes have a bipartite life cycle composed of a reef resident phase and dispersing larval phase. To date, we do not know what the distribution of larval dispersal distances looks like for a single species. Yet, it is recognized that, this information is central to our understanding of population dynamics, population divergence, how to manage fish stocks and where to place marine reserves. The aim of this project is to measure directly the distribution of larval dispersal distances, otherwise known as the larval dispersal kernel, for a species of coral reef fish. Achieving this aim will transform our understanding of marine population ecology.

Currently, there are three basic methods for studying how far marine fish larvae disperse. First, coupled bio-physical models can be used to predict larval destinations, given their origins. Second, genetic and otolith population assignment tests can be used to infer larval origins, given their destinations. Third, intensive genotyping effort and parentage analyses can be used to identify larval origins and destinations. The latter method has only been employed in three species but has huge potential for advancing our understanding, because i) it is the only method that yields direct measures of individual dispersal trajectories, and ii) it creates potential to test predictions and inferences made using other methods.

The method of precisely identifying larval origins and destinations has been employed most effectively in the anemonefish, Amphiprion percula, in Papua New Guinea. A. percula has a suite of traits (habitat specificity, monogamous mating system, and short pelagic larval duration) that make the work tractable. The work of Jones, Planes, Thorrold and their collaborators has shown that i) larvae can be traced back to their parents on the same reef, ii) larvae occasionally travel as far as 35 km between reefs, and iii) the relative likelihood of larval dispersal declines tenfold over 1 km. However, because the work has only been done in one species, the generality of the results and conclusions has been questioned.

This project will use the sponge goby, Elacatinus lori, in Belize, to test the generality of results emerging from studies of A. percula and come up with some new insights. E. lori has the same suite of traits that make the work tractable. The project will use intensive fieldwork, in conjunction with parentage analyses, to identify larval origins and destinations with precision. Initially, the project will focus on testing the robustness of the results emerging from A. percula, by demonstrating that recruits can be traced back to their parents and that the relative likelihood of dispersal declines rapidly at small spatial scales. Once the repeatability of these results is confirmed, this project will focus on generating new insights.

Libe Washburn **10/1/2011 to 9/30/2014** **$195,928**
CODAR Ocean Sensors SB120053

HF Radar Calibration with Automatic Identification System Ships of Opportunity

In collaboration with Codar Ocean Sensors, Ltd., we will develop an operational product by implementing methods developed in our SBIR Phase I project to obtain HF radar antenna pattern calibrations by using backscatter from ships and position data from Automatic Information System broadcasts. The UCSB work plan for this research is outlined in the Phase II objectives: 1) Refine algorithms to calibrate antenna patterns automatically in real-time as a substitute for expensive, infrequent ship-based calibrations; 2) Develop quantitative indicators of the quality of the ship-derived antenna patterns; 3) Expand the azimuthal coverage of antenna pattern measurements and increase the number of patterns produced over time. 4) Apply the ship-based antenna pattern method to other commonly used frequency bands including those operating at frequencies around 5 MHz, 25 MHz, 42 MHz. UCSB personnel Brian Emery (Computer Network Technologist II) and Libe Washburn (Professor of Oceanography) will participate in the SBIR Phase II project. Emery will be responsible for the computer programming, algorithm development, and analysis of results. Washburn will work with Emery to develop algorithms and analyze results of the software for automatic measurement of antenna patterns.

Libe Washburn **6/1/2010 to 5/31/2016** **$1,582,297**
Mark Brzezinski
UC San Diego NA11NOS0120029

Southern California Regional Coastal Ocean Observing System: Surface Current Mapping, Harmful Algal Bloom, and Sub-Surface Water Sections

A network of HF radar systems for measuring ocean surface currents is being developed and operated with funding from the California State Coastal Conservancy and NOAA which leverages several preexisting HF hardware and data management systems. The surface current mapping network will aid in remotely sensed measurement of ocean surface currents for purposes of assessing and mitigating impacts of impaired water quality, tracking oil spills, assisting search and rescue efforts, and monitoring the physical environment for purposes of understanding ecosystem change. The Southern California Coastal Ocean Observing System (SCCOOS) proposes to maintain and improve the network to ensure continued distribution of near real-time surface currents along the coast of Southern California. Funds obtained from this program will support continued operation and maintenance of HF Radar systems including supporting infrastructure. This Statement of Work is the UCSB component of the SCCOOS HF radar system. The systems operated by Washburn's research group at UCSB are deployed from Nicholas Canyon in the south (site to be installed in 2010) to Point Sal in the north as shown in the table below. Currently, two of the sites are maintained jointly with Cal Poly, San Luis Obispo (SLO, PI is Mark Moline): Pt. Sal and Pt. Conception. A third jointly-operated site will be installed at Pt. Arguello in 2010. The overall objective of the UCSB group will be to maintain HF radar operations of all sites. Site inspections will be conducted routinely to evaluate and maintain system health. Activities during the inspections include replacement of local backup data storage; inspection of antennas and cables; and maintenance of data acquisition computer, air conditioners, data transmission equipment, and power supply equipment such as UPSs and transformers. Antenna pattern measurements will be conducted in coordination with other groups to reduce costs. HF radar data will be transmitted to the central SCCOOS data management system at SIO/UCSD.

Libe Washburn | **9/15/2010 to 8/31/2016** | **$698,120**
National Science Foundation | OCE-1031893

Collaborative Research: The Propagating Response of the Inner Shelf to Wind Relaxations in a Coastal Upwelling System

Poleward flows that rapidly develop over the continental shelf and slope following relaxations of upwelling-favorable winds (relaxation flows) are common but intermittent features of wind-driven upwelling systems in eastern boundary currents. These buoyant flows are important in coastal upwelling systems because they advect momentum, heat, dissolved materials, and water-borne particles poleward, opposite to the direction of mean transport. The relaxation flows may also produce significant cross-shelf exchange of these quantities. Existing studies of buoyant coastal currents focus on flows resulting from persistent buoyancy inputs with large density contrasts, such as river outflows [Hickey, 1998b; Hill, 1998; Lentz and Limeburner, 1995; Lentz et al., 2003; Rennie et al., 1999] or flows driven by low-salinity water masses originating far from the coastal currents they drive (e.g. Shcherbina and Gawarkiewicz, 2008; Sutherland and Pickart, 2008). Previous observations of relaxation flow have been based on serendipitous observations from sparse cross-shelf arrays of moorings for observing other shelf processes. We propose a comprehensive observational and analytical program to examine the dynamics and source waters of the relaxation flows in a coastal upwelling system on the central California coast. Using autonomous vehicles, high-frequency radars, moorings, and drifters, we will acquire pressure, density, and velocity data relevant to the relaxation flows. The spatial and temporal coverage will be sufficient to determine spatial scales of the flows, cross-shore density structure, cross-shore and alongshore velocity fields, pressure gradients, and the region of contact with the sea floor. Our study will extend previous results since the propagating relaxation flows fall in a buoyant flow regime that has only been described in numerical modeling and laboratory studies. Our research will: 1) evaluate the roles of barotropic and baroclinic pressure gradient forcing, 2) identify regions where ageostrophic flows dominate the cross-shore and alongshore momentum balances, 3) determine source waters for the relaxation flows, and 4) examine the inner shelf circulation response to wind relaxations over an extensive coastal region (the northern part of the Southern California Bight) by analyzing extensive regional data sets collected over many years. The proposed work is also timely and important because ocean circulation models have increasing resolution and are better able to resolve flows, such as these relaxation flows, very near coastal boundaries.

Syee Weldeab, David Lea | **7/1/2013 to 12/31/2016** | **$366,804**
National Science Foundation | OCE-1260696

Data Synthesis and Evaluation of the Salinity Influence on Mg/Ca Paleothermometry in the Low Latitudes

Intellectual Merit: Foraminiferal Mg has become an important tool that paleoceanographers use to deduce past ocean temperatures. It is one of three methods that can be used in the low latitudes, and it has proven especially powerful in deducing changes in the tropical warm pools over time scales of hundreds to tens of millions of years. The co-occurrence of Mg and oxygen isotopes in foraminifera links these two important proxies in time and space, extending their usefulness. Recently three papers based on core-top data have argued that salinity is an overlooked and dominant influence on foraminiferal Mg. If correct, this inference would require recalibration of Mg paleothermometry as well as reinterpretation of existing and future paleoceanographic records, because salinity has varied sufficiently in the past, in concert with ice volume and hydrological shifts, to significantly shift the magnitude and timing of reconstructed temperature changes. The large magnitude of the hypothesized salinity influence from these three studies, however, is in conflict with a much smaller influence in published foraminifera culturing data, and therefore is not well established within the paleoceanographic literature. The goal of this proposal is to test the magnitude of the salinity influence using a three-pronged strategy: 1) a targeted analysis of sediment trap and core-top samples from three key regions with large salinity gradients – Arabian Sea, Bay of Bengal and NW Africa; 2) a synthesis of available core-top, plankton tow and sediment trap Mg/Ca data from the low latitudes, harmonized for differences in species morphotype, size fraction and sample preparation; and 3) an evaluation of the potential contribution of secondary diagenetic (i.e., post-depositional) Mg to foraminifera in high salinity regions. These three research products will then be used to systematically evaluate the magnitude of the salinity influence relative to temperature and other known influences – such as seasonality and seafloor dissolution – on foraminiferal Mg, by elucidating

individual mechanisms and through the use of multivariate techniques to assess their influence. The culminating component of the proposal is a community workshop to be held in the second year, with the goal of developing a community paper that can guide the Mg paleotemperature community forward on this challenging problem. The workshop will also facilitate data and knowledge sharing. Although this proposal addresses an established, widely used climate proxy, if successful it will be as transformative for the paleoceanographic community as the development of a completely novel proxy.

Broader Impacts: The proposed project broadens the participation of underrepresented groups by providing an opportunity for a young black faculty member at UCSB to pursue his first NSF-funded project. It integrates research and education … by promoting teaching, training, and learning by 1) pairing a senior and junior PI, with ample opportunity for sharing of experience and mentorship; and 2) by giving a post-doctoral scholar a central role in the project, which will enable him/her to broaden their skills by combining analytical work with database integration, analysis and interpretation. Furthermore, the proposed project will enhance research networks, and partnerships by including a community workshop that will enable the paleoceanographic community to use the Mg/Ca proxy more effectively. The results of the project will be disseminated broadly to enhance scientific and technological understanding through publication in leading journals, development of a searchable online sediment trap and core-top Mg/Ca database, and archiving of data at NOAA's National Climatic Data Center. The potential benefits of the proposed activity to society at large include increased confidence in low latitude temperature reconstructions for the past; such reconstructions are an integral part of model assessments of past climate sensitivity.

Allison Whitmer **10/1/2008 to 9/30/2015** **$2,379,943**
Colorado State University G-3062-7

MSP: Culturally Relevant Ecology, Learning Progressions, and Environmental Literacy

Implement an environmental education program for middle and high school students at Goleta Valley Junior High School, Santa Barbara Junior High School, and Santa Barbara High School. As a component of this programming, we will administer assessments connected with research objectives associated with our environmental literacy framework development and culturally relevant, place-based education assessments. We will recruit one teacher per year to serve as our teacher-in-residence who will assist in mentoring graduate and undergraduate students placed in K12 classrooms. We will recruit teachers to participate in our Research Experience for Teachers summer program. We will also be responsible for recruiting scientists and students from the Santa Barbara Coastal Long-term Ecological Research (SBC LTER) program and the Marine Science Institute to support and participate in local programming.

Douglas Wilson **4/14/2011 to 4/1/2014** **$45,158**
Consortium for Ocean Leadership T335A44

IODP Expedition 335 Shipboard Geologist

The proposed work builds on work already started on analyzing the downhole field measured as of Exp 312 (Fig. 1). Objectives include extending the depth range using the new Exp 335 measurements, and careful testing of models for magnetization as a function of depth using polygonal source models. The new GPIT measurements require calibration of the combination of fluxgate magnetometer bias and the non-zero field of the adjacent logging tools. The new Exp 335 profile will be a valuable constraint on the magnetic field deep in the hole, as it spans the entire depth range of the hole, unlike the Exp 312 measurements, which only covered the deeper ranges. Inference of in-situ magnetization from downhole field uses simple cylinder models following Worm et al. [1996], among others. In-situ magnetization, however, is a combination of the primary magnetization, which records reversals and therefore contributes strongly to sea-surface magnetic anomalies, and present-field overprint, which being relatively uniform contributes little to sea-surface magnetic anomalies.

Hillary Young **6/1/2014 to 5/30/2016** **$107,954**
Morris Animal Foundation D14ZO-308

Effects of Land-Use on Tick-Burden and Tick-Borne Diseases in Wild Dogs (Lycaon pictus)

Study Design: This project will take place in northern Kenya, where we have extensive preliminary

data and a well-instrumented field team, and where there is a mosaic of different land-use types in close proximity. The first part of the project will examine variation in questing tick abundance and infection prevalence in ticks in known wild dog habitats with differing human use. We will conduct stratified random sampling of habitats by land-use type for tick abundance and infection prevalence, allowing us to assess landscape level risk across habitats. We will screen ticks and dogs for a suite of tick-borne pathogens that preliminary data show are present in wild dogs in this region. The second part of this project will estimate tick burdens and prevalence of tick-borne pathogens in wild dogs, and examine the effects of land-use and livestock density on these response metrics. We will use existing blood and tick samples, supplemented with additional tick collections from new dogs captured during this period (~15 animals) for these analyses. We will screen blood samples from the dogs and engorged ticks taken off the dogs for both tick transmitted pathogens as well as other pathogens for comparison. We will then analyze the relationships between individual habitat usage and both tick burden and pathogen prevalence.

Hillary Young | **5/1/2014 to 5/1/2015** | **$13,980**
National Geographic Society | 9320-13

Impacts of Fishing on Facilitated Foraging of Seabirds in the Central Tropical Forest

BACKGROUND & OBJECTIVES The Central Tropical Pacific (CTP), by virtue of its relative isolation from both terrestrial and at-sea human influences, is suggested to be one of the word's healthiest ecosystems (Stevenson et al. 2007, Allain et al. 2011). It provides critical nesting habitat for at least 19 seabird species, including an approximate 4.5 million nesting birds, in addition to being a primary foraging region for many migratory species (Maxwell & Morgan in review). Yet, in comparison to most other oceanic environments, the CTP is highly oligotrophic and resource availability is both patchy and highly unpredictable (Bertrand et al 2002, Young et al 2010a), a combination of factors that create significant foraging challenges for these seabirds. As a result, all the resident seabird species in the CTP are predominantly surface (or shallow subsurface) foragers and many have physiological or behavioral adaptations for extremely long distance foraging (Spear et al 2007). Furthermore, in the CTP, seabirds are hypothesized to be particularly dependent on subsurface predator facilitated foraging - in which large pelagic predators, drive prey to the surface where they are made available to seabirds. At least 14 of the resident seabird species in the CTP have been observed to forage in association with subsurface predator aggregations (e.g. tuna, sharks, cetaceans) and many species may have obligate commensal relationships with subsurface predators (Ashmole and Ashmole 1967, Au and Pitman 1986, Jaquemet et al. 2005, Spear and Ainley 2005, Spear et al. 2007, Hebshi et al. 2008). It has further been suggested that subsurface predator facilitated foraging in the CTP is driven almost exclusively by tuna species (quite different from other regions such as the Eastern Tropical Pacific and Indian Ocean where the interaction is driven by a number of dolphin, whale, and shark species in addition to tunas) (Burger 1988, Jaquemet et al. 2005, Ballance et al. 2006).Strong and growing fisheries demand for large pelagic predators - particularly high value tuna and shark - is increasingly pushing these fisheries into remote parts of the CTP, and threatening the long-term persistence of seabird-tuna interaction (Juan-Jorda et al 2011, Maxwell & Morgan 2011). Yet, the likely impact for seabirds from increased fishing pressure on other pelagic predators in this region is unclear. While in many fisheries, seabirds are thought to be able to sustain normal populations with upwards of 60% declines in prey fish (Cury et al 2011), in the low-productivity, unpredictable, and heterogenous environment of the CTP, seabirds may be particularly vulnerable to changes in subsurface predators. Following a recent review conference on seabirds in the CTP, better information on the importance, nature, and identity of species involved in these interactions has been identified as a major conservation priority for seabird in the CTP (Maxwell & Morgan 2011). In this project we will (1) examine the extent to which seabird foraging in the CTP is obligately related to subsurface predators, (2) determine if tuna are the primary or exclusive commensal subsurface predator species in the CTP using Crittercams to capture imagery of feeding events, (3) identify if there are characteristic subsurface predator foraging behaviors that can be identified through GPS tracking, and (4) compare the importance of subsurface facilitated foraging across seabird species. To achieve these objectives we will use high-resolution tracking and monitoring equipment combined with the use of NGS developed "Crittercams" to identify subsurface predators. We will then complement this tracking data with more standard gut content analysis and stable isotope analysis for both seabirds and subsurface predators. All work will be done from Palmyra Atoll National Wildlife Refuge, located in the minimally impacted Pacific Remote Islands Marine National Monument.

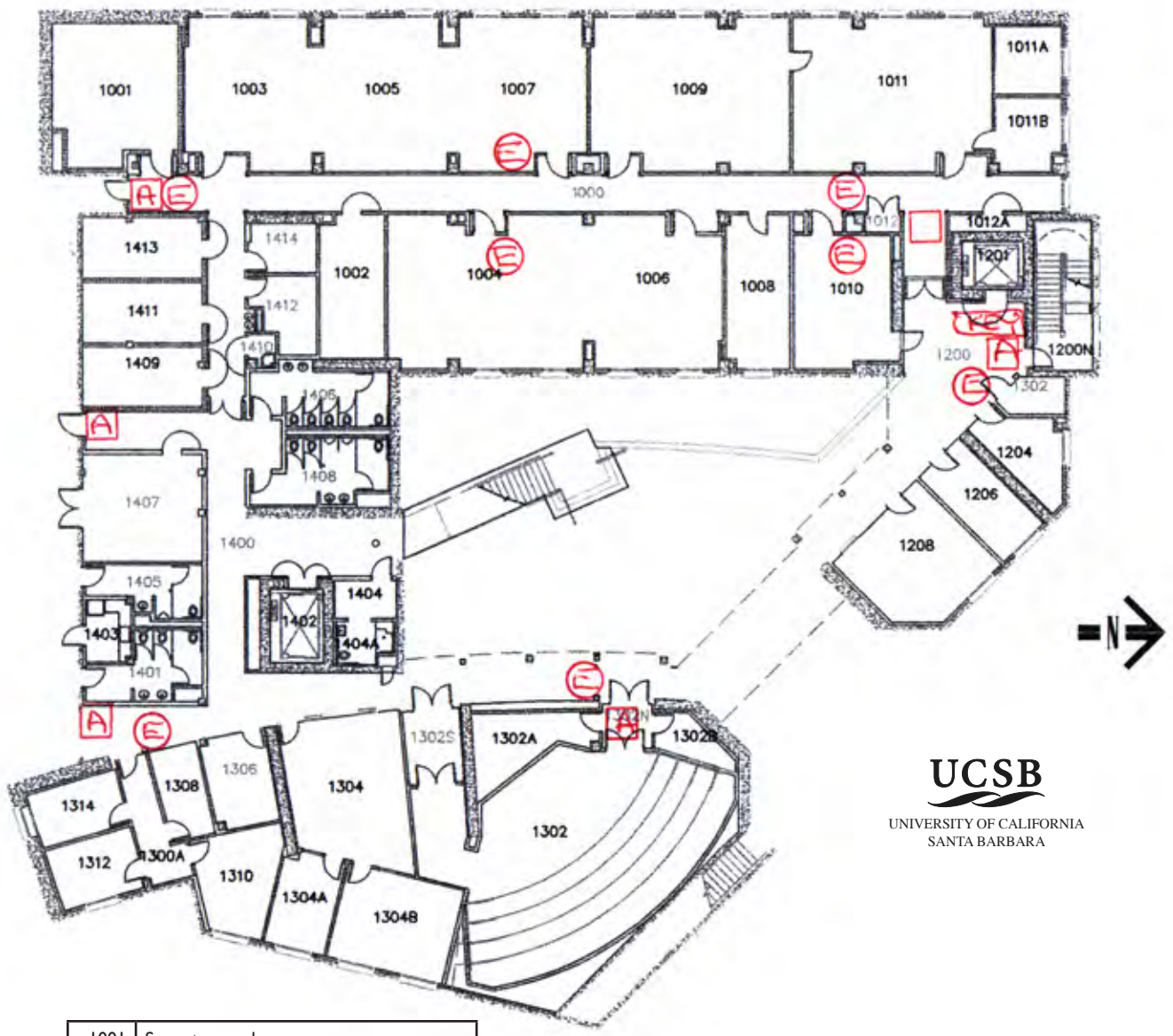
Pauline Yu **8/15/2010 to 7/31/2013** **$10,000**
Gretchen Hofmann
National Science Foundation ANT-1019340

Postdoctoral Fellowship in Polar Regions Research: Effects of Ocean Acidification on Developmental Physiology of an Antarctic Sea Urchin, Sterechinus neumayeri

The primary research objective of this project is to study the effects of ocean acidification on developmental physiology in an ecologically dominant calcifying invertebrate, the Antarctic sea urchin Sterechinus neumayeri. An integrative experimental approaches will be employed to assess the effects of CO2-acidified seawater resulting from increased levels of atmospheric CO2 projected for future climatic regimes. Organismal approaches including physiological and biochemical measurements will be combined with proteomic analyses to investigate the metabolic costs and sub-lethal perturbations of development under conditions of increased environmental acidity. This locally abundant echinoid species is a key benthic herbivore in the shallow benthos of Antarctica (Clarke et al., 2007, Pearse and Giese, 1966), and has been extensively studied for its unique metabolic adaptations to the polar environment (Leong and Manahan, 1999, Marsh et al., 1999, Marsh et al., 2001, Pace and Manahan, 2007a, Shilling and Manahan, 1994). Its slow metabolism and high rate of protein synthesis make it an ideal system in which to study both the environmental effects of ocean acidification during the sensitive developmental stages when the larval skeleton is forming, and the basic biology of cold adaptation in lipid composition and metabolic enzymes. Notably the physiological response of contemporary benthic Antarctic invertebrates to acidification stress is nearly completely unexplored, with the few studies that have been conducted focusing on calcification and shell dissolution (Comeau et al., 2009, McClintock et al., 2009). Since the Southern Ocean is expected to reach critically under-saturated conditions sooner than other parts of the world's oceans (McNeil and Matear, 2008), and there is still substantial debate about the ability of Antarctic fauna to adapt to expected environmental change (Clarke et al., 2007), characterizing the plasticity and resilience of Antarctic calcifying organisms is a critical research objective for polar regions (Fabry et al., 2009) The primary research objectives of this proposal are: 1) To characterize the lipid profile and utilization of developing urchin larvae, and determine how acidification may alter their energetic budget of lipid usage 2) To investigate how metabolism and metabolic enzyme activity are altered under acidification conditions, and 3) To measure changes in protein expression patterns of genes involved in metabolism, development, biomineralization and acid/base-regulation because of lowered pH.

Space

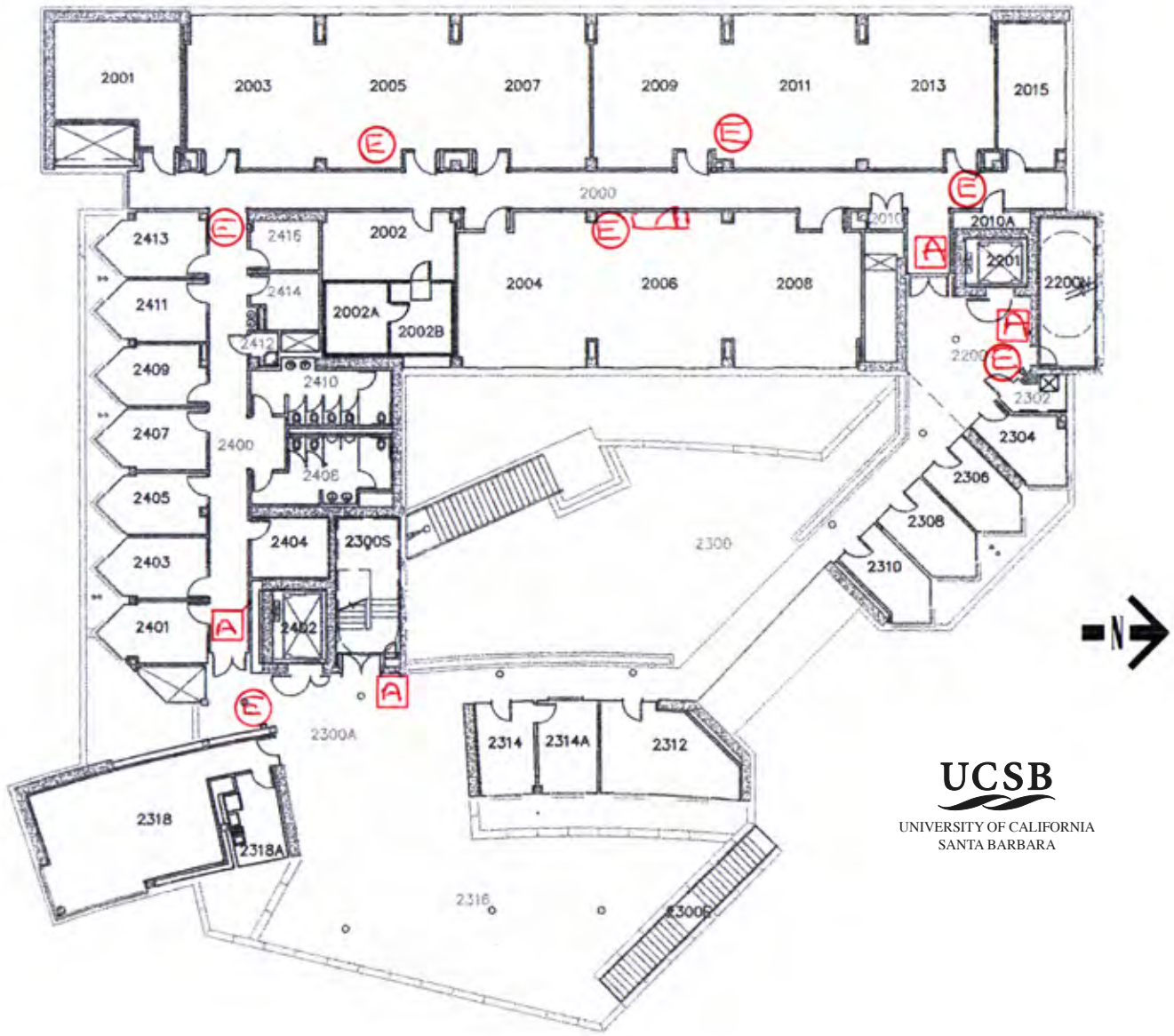
Marine Science Research Building
Bldg. No. 520 - 1st floor
06/2014



1001	Seawater workroom
1002	Common support laboratory
1003	Valentine laboratory
1004	Page/Dugan laboratory
1005	Valentine laboratory
1006	SONGS
1007	Siegel laboratory
1008	Hacker laboratory
1009	Analytical laboratory
1010	Hacker laboratory
1011	Analytical laboratory
1204	Graduate Student office space
1206	Graduate Student office space

1208	Graduate student office space
1302	Auditorium
1304	Graduate student office space
1304a	Graduate student office space
1304b	Graduate student office space
1308	Copier room
1310	Carrie Culver & Monique Myers
1312	Postdoc office space
1314	Postdoc office space
1409	Seawater workroom
1411	Seawater workroom
1413	Seawater workroom

Marine Science Research Building
Bldg. No. 520 - 2nd floor
06/2014

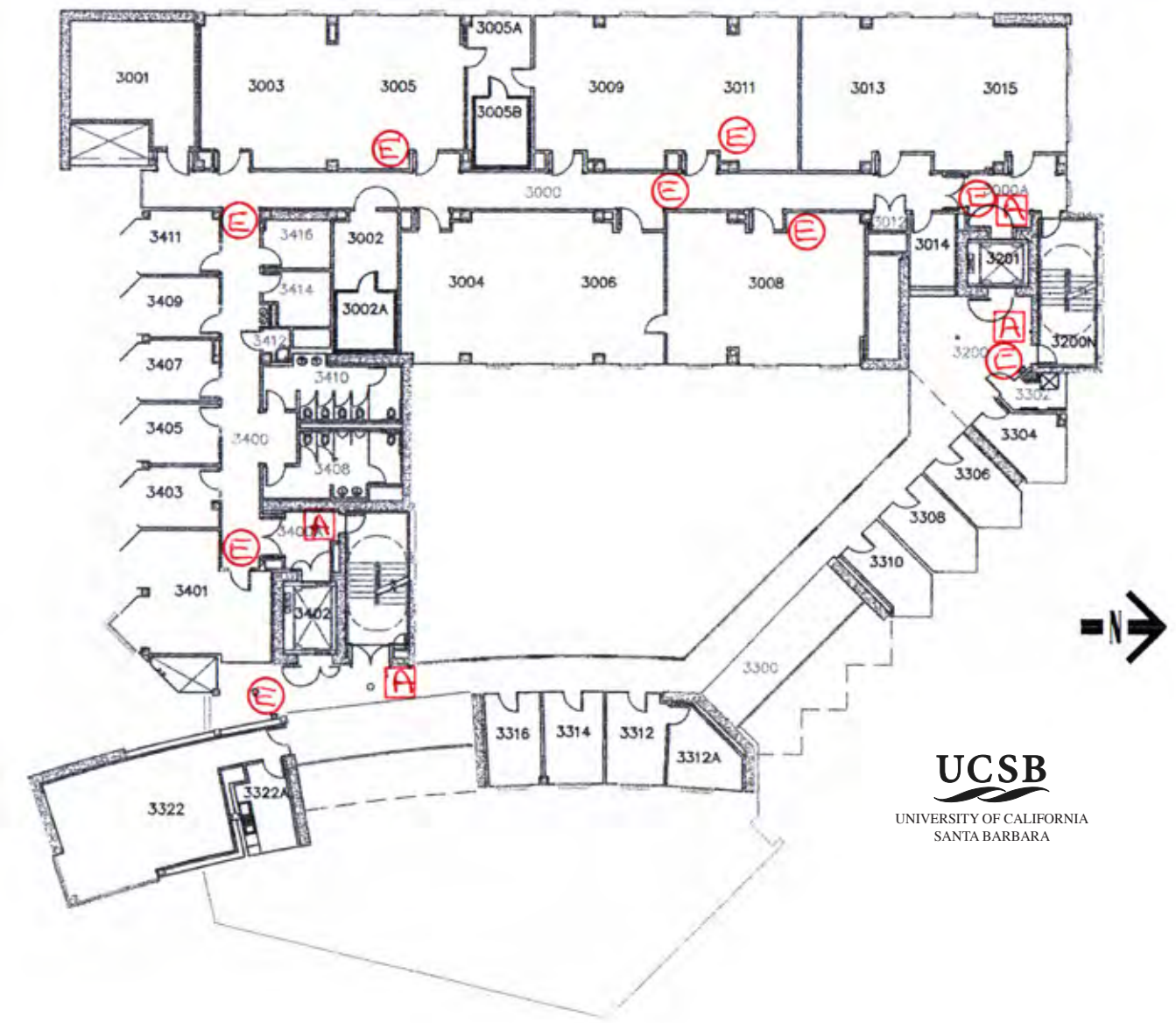


2001	Seawater workroom
2002	Common support laboratory
2002a	Environmental room
2002b	Environmental room
2003	Hofmann laboratory
2004	Miller laboratory
2005	Hofmann laboratory
2006	Ocean Acidification
2007	Hofmann laboratory
2008	Shared laboratory
2009	Burkepile laboratory
2011	Burkepile laboratory

2013	Burkepile laboratory
2015	SONGS project
2304	Postdoc office
2306	Postdoc office
2308	Kevin Lafferty
2310	Bob Miller
2312	Natural Reserve System/ Donna Moore
2314	Natural Reserve System/ Trish Holden
2314a	Natural Reserve System/ Sue Swarbrick
2318	Conference room

2401	Mark Page
2403	Jenifer Dugan
2404	Storage
2405	Langdon Quetin
2407	Robin Ross
2409	Todgham/Place
2411	Gretchen Hofmann
2413	Postdoc office

Marine Science Research Building
Bldg. No. 520 - 3rd floor
06/2014



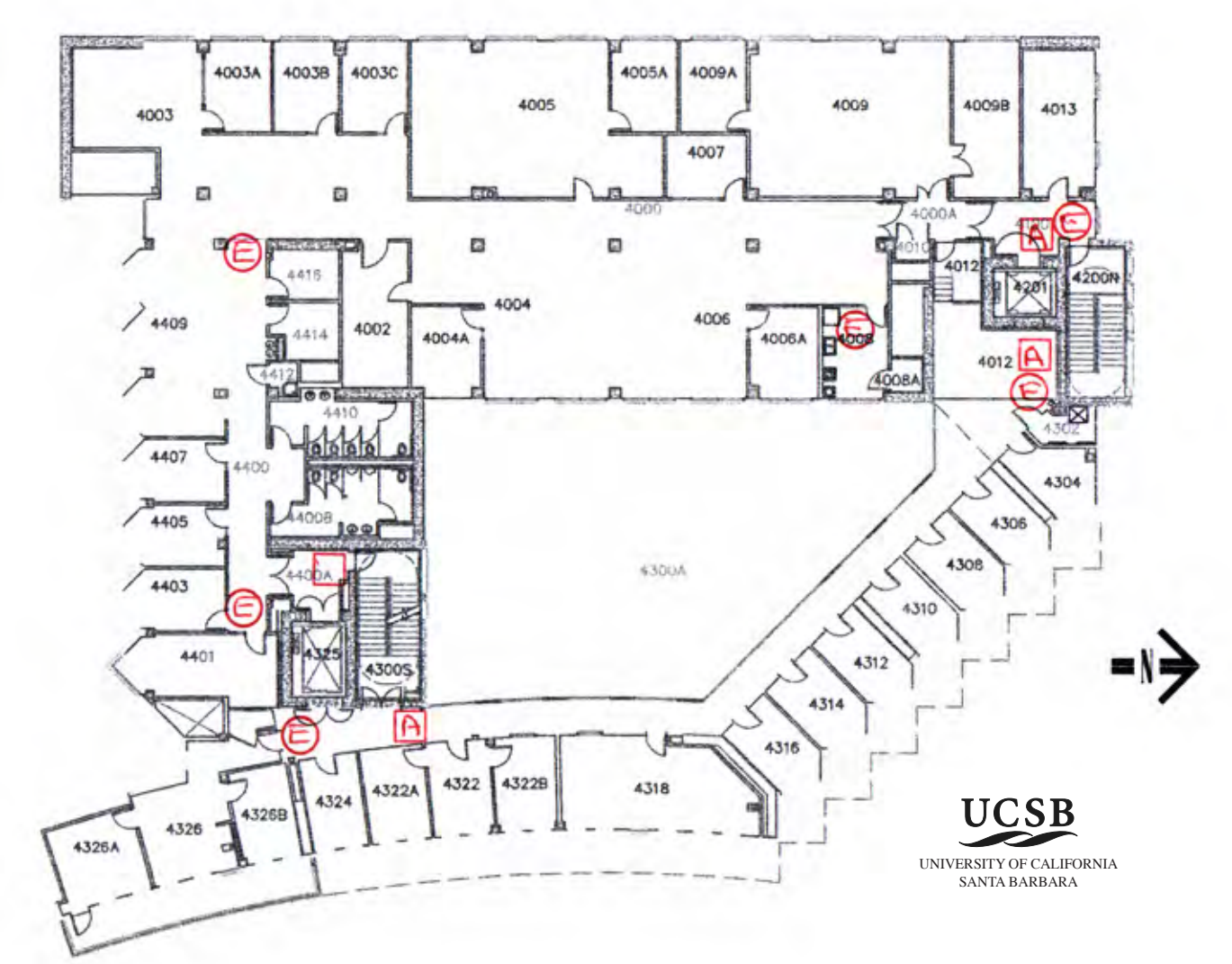
UCSB
UNIVERSITY OF CALIFORNIA
SANTA BARBARA

3001	Seawater workroom
3002	Common support laboratory
3003	Reed laboratory
3004	Holbrook laboratory
3005	Reed laboratory
3005a	Common support laboratory
3006	Schmitt laboratory
3008	Blanchette laboratory
3009	Warner laboratory
3011	Caselle laboratory
3013	Washburn laboratory

3014	Storage
3015	MacIntyre laboratory
3304	Postdoc office
3306	Postdoc office – Rassweiler
3308	Dan Reed
3310	Andrew Brooks
3312	Postdoc office
3312a	Postdoc office
3314	Russell Schmitt
3316	Sally Holbrook
3322	Conference room

3401	Margaret O'Brien – Mary Gastil-Buhl
3403	Kolbe Ahn
3405	BON
3407	BON
3409	Ross-Quetin
3411	Researcher office

Marine Science Research Building
Bldg. No. 520 - 4th floor
06/2014



4002	Receiving
4003a	Ocean o'Graphics – Monica Pessino
4003b	Mike O'Neil
4003c	Development
4004a	File Room
4004c	Casey Morse
4004d	Melia Cutcher
4005a	Nicole Zavala
4005a	Marisol Hernandez
4005b	Veronica Torres
4005c	Lyndi Swanson
4006a	India Morgan
4006a	Laura Susin
4006b	Jenny Chu
4007	Mail room

4008	Break room
4009a	Jim Woods
4009b	Marine Map
4009d	Brian Emery
4012	Server room
4013	Marine Map
4304	Will McClintock
4306	Libe Washburn
4308	Sally Macintyre
4310	Gretchen Hoffman
4312	Deron Burkepile
4314	Jen Caselle
4316	Carol Blanchette
4318	Conference Room
4322	Michaela Clemence

4322a	Sarah Lester
4322b	Robert Warner
4326b	Gay Larsen
4326	Development
4326a	MSI Director
4401	Tim Schmidt
4403	Joyce Wolever
4405	Luisa Velez
4407	Bonnie Williamson
4409a	Judy McCaslin
4409b	Deanna Cervantes
4409C	Donna Dobis

Marine Science Institute
Trailers

319-a	Jack Engle
319-b	Jack Engle
319-c	Jack Engle
319-d	Herb Waite
319-e	Herb Waite
325-a	John Richards
325-b	Craig Nicholson
325-c	Craig Nicholson
325-d	Jack Engle
325-e	Jack Engle
334-a	Scott Simon
334-b	REEF
334-c	REEF

Statistical Summary

Research Support Summary
2013-2014

	Awards	Percentage of Total
Federal Agencies		
National Aeronautics and Space Administration (NASA)`	$60,000	0.29%
National Science Foundation-NSF	6,684,414	32.58%
National Institutes of Health (NIH)	896,597	4.37%
USDC National Oceanic and Atmospheric Administration (NOAA)	$278,720	1.36%
US Navy, Office of Naval Research	$140,482	0.68%
USDI Bureau of Ocean Energy Management	$847,188	4.13%
USDI Fish and Wildlife Service	$192,950	0.94%
USDI Geological Survey	$195,100	0.95%
USDI National Park Service	$114,337	0.56%
	50,000	0.24%
Federal Totals	**$ 9,409,788**	**45.86%**
State		
Lahontan Regional Water Quality Control Board	$295,200	1.44%
UC MEXUS	$10,000	0.05%
UC San Diego	$348,100	1.70%
UC Santa Cruz	$82,163	0.40%
UC Sea Grant College Program	$735,639	3.59%
State Totals	**$ 1,471,102**	**7.18%**

Private

Australian Museum, Lizard Island Research Station	$9,654	0.05%
California Institute of Technology – Cal Tech	$109,897	0.54%
California Sea Urchin Commission	$8,400	0.04%
Conservation International Foundation	$200,000	0.97%
Dauphin Island Sea Lab	$36,219	0.18%
David and Lucile Packard Foundation (The)	$65,000	0.32%
ExxonMobil Upstream Research Company	$200,000	0.97%
Gordon and Betty Moore Foundation	$1,079,606	5.26%
Marisla Foundation	$175,000	0.85%
Morris Animal Foundation	$107,954	0.53%
Nature Conservancy (The)	$25,000	0.12%
Oregon State University	$232,045	1.13%
Rare. Inspiring Conservation	$158,146	0.77%
Simpson & Simpson Business and Personnel Services	$4,715,399	22.98%
UNESCO (United Nations Educational, Scientific & Cultural Org.)	$160,133	0.78%
United Water Conservation District	$32,400	0.16%
University of Arizona	$227,592	1.11%
University of Miami	$125,187	0.61%
University of Michigan	$206,410	1.01%
University of Minnesota	$144,856	0.71%
University of Mississippi	$245,599	1.20%
University of New Mexico	$735,267	3.58%
University of Southern California (So. Calif. Earthquake Center)	$35,000	0.17%
Waitt Family Foundation	$600,000	2.92%
Private Totals	**$ 9,634,764**	**46.96%**
Total	**$20,515,654**	**100.00%**

Statistical Summary for the Marine Science Institute 2013-2014

	MSI	NCEAS	NRS	TOTAL
1. Academic personnel on payroll				
a. Faculty	15	2	1	18
b. Professional Researchers (including Visiting)	31	3	0	34
c. Project Scientists	16	4	0	20
d. Specialists	28	6	1	35
e. Postdoctoral Scholars	28	8	0	36
f. Postgraduate Researchers	0	0	0	0
g. Academic Coordinators	3	2	0	5
TOTAL	**121**	**25**	**2**	**148**

2. Graduate Students on payroll				
a. Employed on contracts and grants	45	2	0	47
b. Employed on other sources of funds	0	0	0	0
c. Participating through assistantships	0	0	0	0
d. Participating through traineeships	0	0	0	0
e. Other- students at other campuses	0	0	0	0
TOTAL	**45**	**2**	**0**	**47**

3. Undergraduate Students on payroll				
a. Employed on contracts and grants	117	12	11	140
b. Employed on other funds	0	0	0	0
c. Number of volunteers, & unpaid interns	0	0	0	0
TOTAL	**117**	**12**	**11**	**140**

4. Participation from outside UCSB: (optional)				
a. Academics (without Salary Academic Visitors)	0	0	0	0
b. Other (specify)	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**

5. Staff (Univ. & Non-Univ. Funds):				
a. Technical	128	16	23	167
b. Administrative/Clerical	22	10	14	46
TOTAL	**150**	**26**	**37**	**213**

6. Seminars, symposia, workshops sponsored	-	-	-	0
7. Proposals submitted	137	22	0	159
8. Number of different awarding agencies dealt with*	-	-	-	
9. Number of extramural awards administered	241	21	-	262
10. Dollar value of extramural awards administered during year**	$85,852,762	$33,598,315	-	$119,451,077
11. Number of Principal Investigators***	-	-	-	
12. Dollar value of other project awards ****	$1,847,780	$274,029	$1,831,704	$3,953,513
13. Number of other projects administered		5	29	34
14. Total base budget for the year (as of June 30, 2010)	$1,406,831	$540,921	$1,122,698	$3,070,450
15. Dollar value of intramural support	$87,676	-	$1,302	$88,978
16. Total assigned square footage in ORU	38,807	-	-	38,807
17. Dollar value of awards for year (2010 Total)	$16,573,250	$3,942,404	$0	$20,515,654

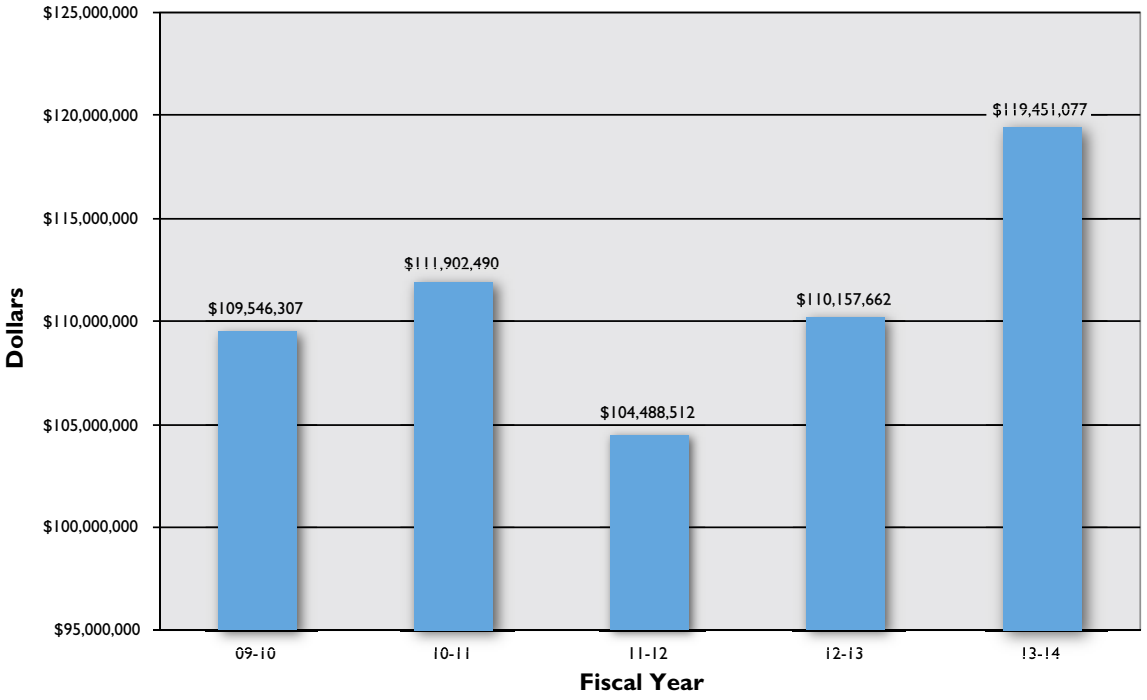
* Count each agency only once (include agencies to which proposals have been submitted).
** If the award was open during the year, even if for only one month, please include in total.
*** Number of PIs, Co-PIs and Proposed PIs (count each person only once.)
**** Other projects - such as donation, presidential awards, fellowships, anything that isn't core budget, extramural, or intramural.

Five-Year Statistical Summary 2010-2014

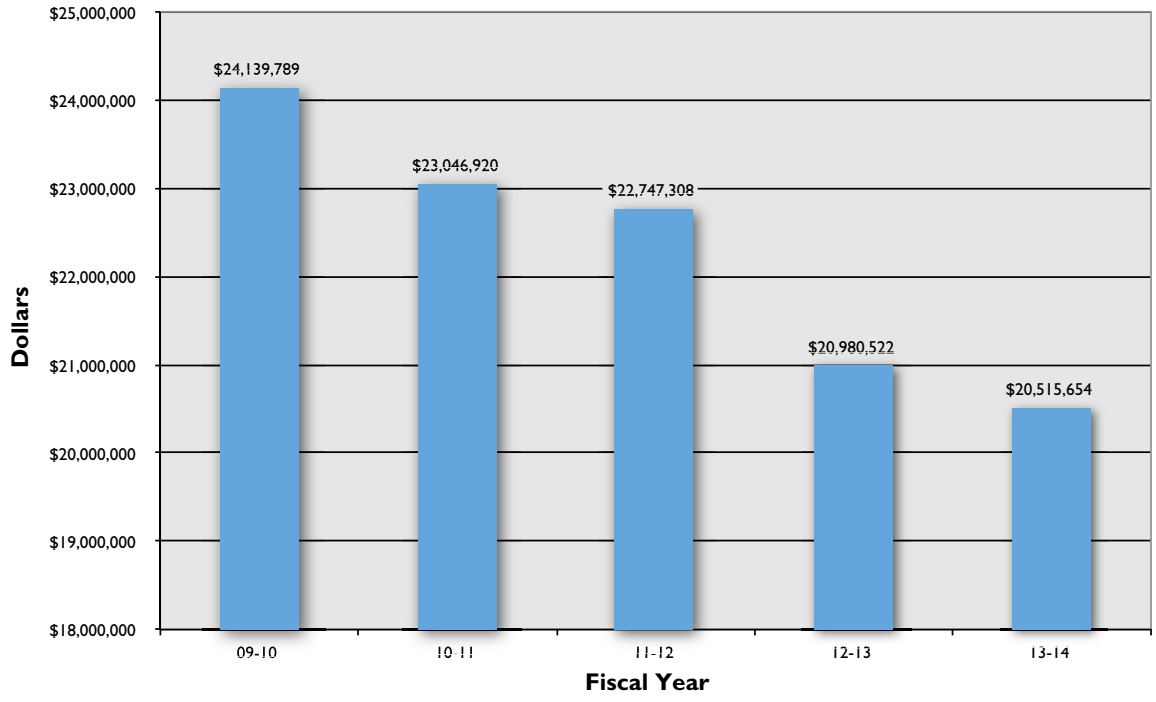
	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
1. Academic personnel engaged in research					
a. Faculty	38	24	25	19	18
b. Researchers / Project Scientists	45	52	47	58	58
c. Visiting Researchers					
d. Specialists / Academic Coord / Academic Admin.	41	49	48	46	40
e. Postdoctorals / Postgraduates	56	50	47	37	36
Total	**180**	**175**	**167**	**160**	**148**
2. Staff (Univ. & Non-Univ. Funds)					
a. Technical	207	174	167	175	167
b. Administrative / Clerical	64	68	58	58	46
Total	**271**	**242**	**225**	**233**	**213**
3 Graduate students employed by MSI	67	53	45	54	47
4. Undergraduate students employed by MSI	175	154	147	146	140
5. Publications	1**	1**	1**	1**	1**
6. Seminars, symposia, workshops, etc., sponsored by MSI					
7. Proposals submitted	204	181	187	142	159
8. Annual extramural awards	$24,139,789	$23,046,920	$22,747,308	$20,980,522	$20,515,654
9. Extramural awards administered	278	257	251	247	262
10. Other project awards	$4,175,455	$3,156,683	$4,479,085	$4,042,529	$3,953,513
11. Other projects administered	121	95	99	80	34
12. MSI base budget	$1,084,520	$1,238,532	$1,085,010	$919,082	$1,406,831
13. Intramural support	$331,430	$993,488	$623,925	$726,518	$88,978
14. Total Funds Administered	**$109,546,307**	**$119,525,463**	**$112,733,656**	**$117,642,277**	**$126,564,018**

**Only Departmental Publications

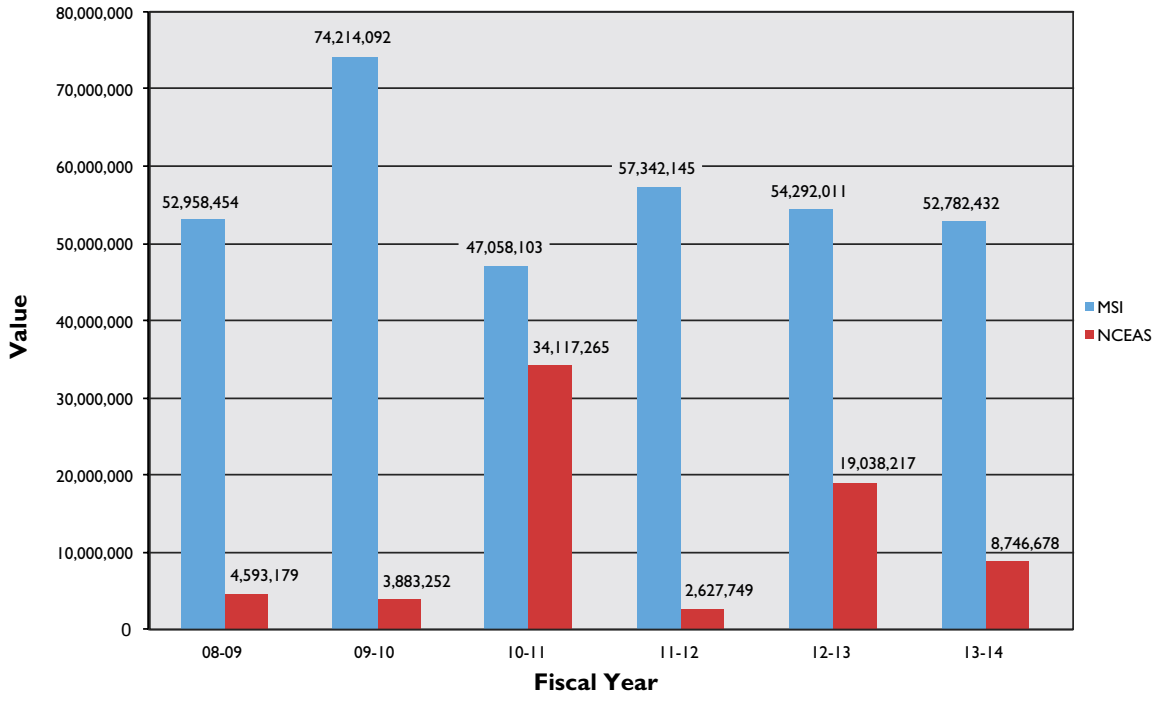
Marine Science Institute - Total Value of Awards Administered



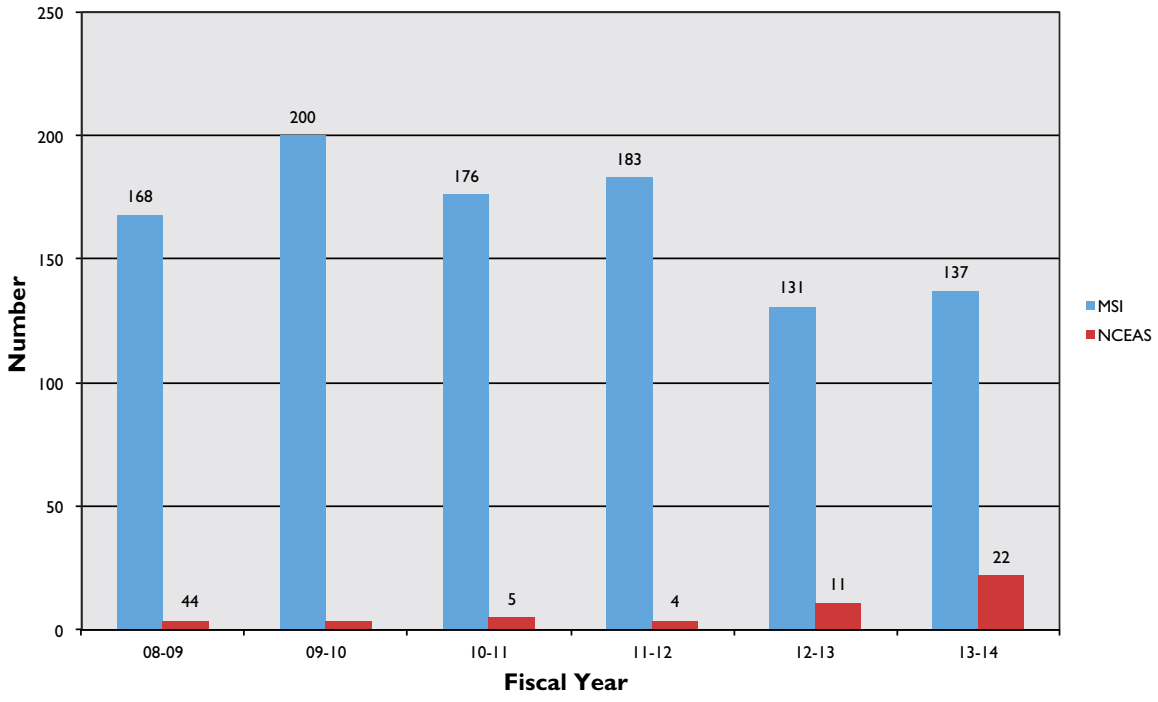
Marine Science Institute - Value of Extramural Awards Received Annually



Value of Proposals Submitted Annually by MSI & NCEAS



Number of Proposals Submitted Annually by MSI & NCEAS



Funding Agencies 2013-2014

Arizona State University, Tempe

Australian Museum

Boston University

California Coastal Commission

California Coastal Conservancy

California Department of Fish and Wildlife

California EPA Water Resources Control Board

California Landscape Contractors Association

California Sea Urchin Commission

Coastal Fund (UCSB Assoc. Students)

CODAR Ocean Sensors

Colorado State University

Conservation International Foundation

Consortium for Ocean Leadership

Coral Reef Alliance, The (CORAL)

Dauphin Island Sea lab

David and Lucile Packard Foundation (The)

Desert Botanical Garden

ExxonMobil Upstream Research Company

Gila Watershed Partnership

Gordon and Betty Moore Foundation

Gulf of Mexico Research Initiative

Human Frontier Science Program In'tl

Louisiana State University

Marisla Foundation

Morris Animal Foundation

National Aeronautics and Space Administration

National Coastal Resources Research & Development Institute (NCRI)

National Fish and Wildlife Foundation

National Geographic Society

National Institutes of Health, NIH Allergy & Infectious Diseases

National Institutes of Health, NIH General Medical Sciences

National Institutes of Health, NIH Research

National Institutes of Health, Public Health Services

National Science Foundation-NSF

Nature Conservancy, The

North Pacific Research Board

Oregon State University

Prince William Sound Science Center (Incl Oil Spill Recovery Inst)

Rare

Save Our Seas

Sierra Business Council

Simpson and Simpson Business and Personnel Services, Inc.

Swiss Federal Inst Of Technology-Dba Eth (Switzerland)

Syracuse University

Texas A&M Universoity

UC Agriculture and Natural Resources

UC MEXUS

UC Office of The President

UC San Diego

UC Santa Cruz

UC Sea Grant College Program

United Nations Educational, Scientific & Cultural Org (UNESCO)

United Soybean Board/Smith Bucklin & Assoc., L.L.C.

United Water Conservation District

University of Arizona

University of Colorado

University of Georgia

University of Hawaii

University of Houston

University of Idaho

University of Massachusetts

University of Miami

University of Michigan

University of Minnesota

University of Mississippi

University of Nebraska

University of New Mexico

University of Rochester

University of South Florida

University of Southern California

University of St. Thomas

University of Tromso, Norway

University of Washington

US Department of Energy

US Dept of Commerce, National Marine Fisheries Service

US Dept of Commerce, National Oceanic and Atmospheric Administration

US DoD Army Corps of Engineers, San Francisco District

US DoD Navy

USDA Forest Service

USDA National Institute for Food and Agriculture

USDI Bureau of Ocean Energy Management, Regulation (formerly Minerals Management Service)

USDI Fish and Wildlife Service

USDI Geological Survey

USDI National Park Service

USDI, NPS, Channel Islands National Park

USDI, NPS, Kings Canyon and Sequoia National Parks

USDI, NPS, Yosemite National Park

US Environmental Protection Agency

Waitt Family Foundation

Woods Hole Oceangraphic Institution

MSI Advisory Committee, Administrative, Professional & Technical Staff

Marine Science Institute
2013-2014

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Executive Vice Chancellor	Gene Lucas
Vice Chancellor for Research	Michael Witherell
Director	Mark A. Brzezinski
Deputy Director	Dan Reed

Advisory Committee

Jenn Caselle, MSI
Frank Doyle, Chemical Engineering
Ben Halpern, Bren
Sally Holbrook, EEMB
David Lea, Earth Science
Hunter Lenihan, Bren
Sally MacIntyre, Committee Chair, EEMB
Uta Passow, MSI

Ex-Officio Members –

Mark Brzezinski, Director, MSI
Frank Davis, Director, NCEAS
Gretchen Hofmann, Director, Ocean Acidification Center
Patricia Holden, Director, Natural Reserve System
Daniel Morse, Director, Marine Biotech Center
Dan Reed, Deputy Director, MSI
Tim Schmidt, Manager, MSI
Russell Schmitt, Director, Coastal Research Center

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Director, Mark Brzezinski

Deputy Director, Dan Reed

Manager, Tim Schmidt

Budget Unit Manager, Luisa Velez

Budget Analyst, Donna Dobis

Budget Analyst, Joanna Kettmann

Budget Analyst, Michael O'Neil

Contracts & Grants Manager, Bonnie Williamson

Contracts & Grants Officer, Judy McCaslin

Contracts & Grants Officer, Deanna Cervantes

Development Officer, Gay Larsen

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Personnel Unit Coordinator, Elvira Rose

Personnel Analyst, India Morgan

Personnel Analyst, Veronica Perez

Purchasing Analyst, Kayla Jackson

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Marine Science Institute Principal Investigators 2013-2014

Marine Science Institute Principal Investigators 2013-2014

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Brzezinski, Mark	Professor	Ecology, Evolution & Marine Biology
Carlson, Craig	Professor	Ecology, Evolution & Marine Biology
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Costello, Christopher	Professor	Bren School of Envir. Sci. & Management
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Wilson, Emily	Undergraduate Researcher	Marine Science Institute

Wood, Chelsea	Postdoctoral Researcher	Marine Science Institute
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