
Sea Grant
California
Program
Directory
2011

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Sea Grant is a unique partnership of public and private sectors, combining research, education, and outreach for public service. It is a national network of universities meeting changing environmental and economic needs of people in our coastal, ocean, and Great Lakes regions.

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Message from the Director …

For first time in more than a decade, California Sea Grant has a new director; and I write these comments feeling very much "the new kid on the block." I arrive at the helm with more enthusiasm and optimism than vision or the perspective of a seasoned "insider." My goal is to develop a rich vision and perspective while retaining both enthusiasm and hope. Given what I have seen so far, I am certain this will be the case.

I am by training and interest a scientist with a 25-year history of studying West Coast marine ecosystems—primarily kelp forests along Washington—but also the deep-sea ecology of the Southern California Bight. For the past 13 years, I have worked as a federal program manager at the Office of Naval Research, managing its biological and chemical oceanography and marine mammals programs. I also served for many years as the Navy's "point person" for research supported by the federal inter-agency National Oceanographic Partnership Program. Through these diverse federal activities, I have been engaged with researchers at the University of California and California State University systems, and other nonprofit and for-profit entities in the state. Thus, I come to California with solid experience in the federal science system, important to us all, and with a sound basis for understanding the value, complexity and beauty of California's coastal ecosystems and how they interact with the ocean's physical and geochemical environments, and the natural patterns and fluctuations in the atmosphere and climate. I am sure this background will be important as I lead California Sea Grant's investments in coastal research, extension and education.

It is my good fortune to inherit a program that is thriving, despite the tough economic circumstances at both national and state levels. The program's vitality is largely due to the dedicated efforts of my predecessor, Dr. Russell Moll, as well as to the efforts of the incredibly dedicated, energetic and enthusiastic staff, who really run this program. I would like to offer my sincere gratitude to them all in this introductory message (and, no, they did not make me write this). I know they will make this transition as easy as possible for me.

All medical students are taught *Primum non nocere*, "First, do no harm." Taking this to heart, my first task will be to listen, learn and network with the critical state and federal agencies and persons with strong interest in and responsibility for the health and vitality of California's coastal environments and human communities. These are the people who can positively affect the program and whom we can best serve. I have my own ideas of technologies and areas of research that we might promote in ways that can benefit the people and marine environments of this state, but I will be circumspect in moving in these directions.

I welcome your input and advice as I begin leading this special program. I look forward to the many challenges ahead and am committed to helping improve our understanding of and the health of California's marine environments, and in helping people interact with them in a balanced manner.

Dr. James E. Eckman
Director

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What is Sea Grant?

The National Sea Grant College Program, a network of 32 university-based programs, is dedicated to enhancing the understanding, conservation, and sustainable use of the nation's coastal and marine resources. It has facilities and staff in every coastal and Great Lakes state, with activities funded by the National Oceanic and Atmospheric Administration of the U.S. Department of Commerce. Matching funds come from the individual states, and additional support from a variety of private sources.

The Sea Grant programs of today focus on making this country a world leader in marine research and the sustainable use of marine and coastal resources. To this end, they produce and make available a wealth of information on these topics, from school curriculum materials to the most advanced scientific research.

California Sea Grant College Program draws on the talents of scientists and engineers at public and private universities throughout the state. It is administered by Scripps Institution of Oceanography at the University of California in La Jolla.

California Sea Grant contributes to the growing body of knowledge about coastal and marine resources and helps solve contemporary marine-related problems through its sponsored research. It supports graduate education by funding trainees who work with marine scientists and engineers on a diversity of subject areas. Through its outreach and communications components, developments in information and technology are transferred to stakeholders. Its Extension personnel play a major role in the link between university, industry and the public.

The research funded is selected on the basis of competitive, peer-reviewed proposals and addresses a wide range of problems and opportunities. This Program Directory provides summaries of the projects funded in 2011 by California Sea Grant. Further information on any of these projects is available by contacting our offices, or visiting the program Web site—http://www.csgc.ucsd.edu.

Other Web Resources:

National Sea Grant Office	http://www.seagrant.noaa.gov/
National Sea Grant Library	http://nsgl.gso.uri.edu/
UC Digital Library	http://repositories.cdlib.org/csgc/

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Staff listings and contact numbers may also be found at http://www.csgc.ucsd.edu/ABOUTUS/CSGStaff.html

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Participating Institutions 2011

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BML	Bodega Marine Laboratory Bodega Bay, California 94923
CAS	California Academy of Sciences San Francisco, California 94103
CASG	California Sea Grant College Program La Jolla, California 92093-0232
CDFG	California Department of Fish and Game Sacramento, California 95814
CDPR	California Department of Parks and Recreation Sacramento, California 95814
CNRA	California Natural Resources Agency Sacramento, California 95814
CINMS	Channel Islands National Marine Sanctuary Santa Barbara, California 93109
COPC	California Ocean Protection Council Oakland, California 94612
COST	California Ocean Science Trust Oakland, California 94612
CASGEP	California Sea Grant Extension Program
CSULB	California State University, Long Beach Long Beach, California 90840
CSUMB	California State University, Monterey Bay Seaside, California 93955
CSUSM	California State University, San Marcos San Marcos, California 92096
DOC	Department of Commerce Washington, D.C. 20230
DOC/ OAFCG	Commerce Subcommitee on Oceans Atmosphere, Fisheries, and Coast Guard Washington, D.C. 20230
EF	Ecotrust Fisheries Portland, Oregon 97209
FIAER	Farallon Institute for Advanced Ecosystem Research Petaluma, California 94954
FMSA	Farallones Marine Sanctuary Association San Francisco, California 94129
HMS	Hopkins Marine Station Pacific Grove, California 93950
HSU	Humboldt State University Arcata, California 95521
H-SWRI	Hubbs-SeaWorld Research Institute San Diego, California 92109
MARE	Marine Applied Research & Exploration Richmond, California 94801
MBNMS	Monterey Bay National Marine Sanctuary
MLML	Moss Landing Marine Laboratories Moss Landing, California 95039
NE/NMS	NaturalEquity/National Marine Sanctuaries Santa Cruz, California 95060
NOAA	National Oceanic and Atmospheric Administration Washington, DC 20230
NOAA/ FS	NOAA Fisheries Service Silver Spring, Maryland 20910
NOAA NMPAC	NOAA National Marine Protected Areas Center
NOAA/ SWFSC	NOAA Southwest Fisheries Science Center Santa Cruz, California 95060
OI	Ocean Imaging Solana Beach, California 92075

PRBOCS PRBO Conservation Science
Petaluma, California 94954

PSC Paul Smith's College
Paul Smiths, New York 12970

PWA Philip Williams & Associates, Ltd.
San Francisco, California 94108

RCF Reef Check Foundation
Pacific Palisades, California 90272

SAMS Scottish Assn. for Marine Science
Oban, Scotland

SCCWRP Southern California Coastal Water Research Project
Costa Mesa, California 92626

SEN Office of Senator Maria Cantwell
Washington, D.C. 20230

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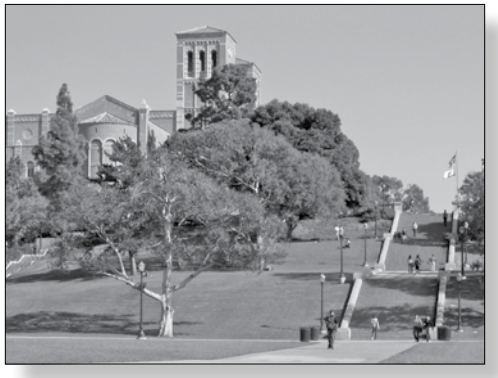
USDA/ ARS U.S. Department of Agriculture
Agriculture Research Service
Washington, D.C. 20250

USF University of San Francisco
San Francisco, California 94117

USFWS U.S. Fish and Wildlife Service
Washington, D.C. 20240

USGS U.S. Geological Survey
Reston, Virginia 20192

UW University of Washington
Seattle, Washington 98195



Healthy Coastal and Marine Ecosystems

- **Extending the Use of Solid Phase Adsorption Toxin Testing (SPATT) to the Land-Sea Interface**
  R/CONT-101 Jul. 2010–Jun. 2011
  Raphael Kudela, UCSC, 831.459.3290, kudela@ucsc.edu
  Melissa Miller, CDFG, 831.212.7007, mmiller@ospr.dfg.ca.gov

This project explores an ever-growing problem in coastal ecosystems: the proliferation of harmful algal blooms that can be lethal to both marine life and people. By using a sampling technique known as Solid Phase Adsorption Toxin Tracking (SPATT), developed in a previous Sea Grant project, the researcher and his team will identify and quantify cyanotoxins in seawater. Although in the past cyanotoxins have primarily affected freshwater ecosystems, this project hypothesizes that cyanotoxins are being transferred from land to sea, with negative consequences for shoreline marine environments. The objective of this project is to expand testing for microcystins and to track their transportation via rainfall or other potential pathways to the coast. Findings will be applicable to reducing contamination of marine life by harmful toxins.

- **The Role of Symbiotic Bacterial Metabolites in the Development of Toxic Phytoplankton Blooms**
  R/CONT-205 Feb. 2008–Jan. 2012
  Carl Carrano, SDSU, 619.594.5929, carrano@sciences.sdsu.edu
  Frithjof Kuepper, SAMS, 011.44.01631.559216, fck@sams.ac.uk
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What if some harmful algal blooms are triggered by certain kinds of bacteria? These bacteria, as the theory goes, spark algal blooms by helping algae acquire iron, which is often in short supply in the marine realm and is a prerequisite for cell growth. Consistent with this theory, chemists leading the project have isolated a group of bacteria, associated with phytoplankton worldwide, that produce vibrioferrin—a compound that binds to inorganic iron in seawater and then under sunlight degrades into a highly bioavailable iron form. Experiments show that after photolysis, iron uptake increases in bacteria and algae, suggesting that bacteria “share” their iron products with neighboring algae. Scientists are investigating the degree to which interactions between bacteria and algae facilitate nutrient acquisition and how this relates to primary productivity and harmful algal bloom formation.

- **The Effects of Terrestrial Nutrient Inputs on Nearshore Planktonic Ecosystems**
  R/CONT-207 Feb. 2009–Jan. 2012
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How are pollutants in the surf zone transported and diluted? To address this, scientists are studying the patchiness of phytoplankton and human pathogenic bacteria in coastal waters of Imperial Beach, an area in southern San Diego County with a history of beach closures following heavy rain. Analyses of water samples collected in the fall of 2009 revealed large fluctuations in phytoplankton concentrations below the sea surface, depending on the strength of mixing. The theory is that mixing—driven by processes such as the local winds and internal tides—brings nutrients from depth to sunlit surface waters, stimulating phyto-

plankton growth. Fecal indicator bacteria counts were patchy offshore, and increased during periods of extreme tides. Two possible sources of the bacteria are tidal scouring of beach sands and/or submarine groundwater discharges. In the coming year, scientists will synthesize the biological and physical data gathered during the fieldwork.

- **Is C/N Decoupling Caused by Harmful Algal Blooms in Santa Monica Bay?**
  R/CONT-209 Feb. 2010–Jan. 2012
  Anita Leinweber, UCLA, 310.267.5165, leinweber@igpp.ucla.edu
  Rebecca Shipe, UCLA, 310.794.4903, rshipe@ucla.edu

This project explores a long-standing oceanographic mystery: the apparent decoupling of dissolved inorganic carbon and nitrogen cycles in the summer mixed layer of both the open ocean and marginal seas. The hypothesis to be tested during this project is that vertical migrations of dinoflagellates (a type of algae) link the cycles. The theory is that dinoflagellates living in sunlit surface waters descend below the mixed layer at night to obtain nitrogen (needed for growth) and re-ascend to the same shallow waters by day to photosynthesize, uptaking carbon as they grow. The result is a lowering of dissolved inorganic carbon in the mixed layer. Researchers in the summer of 2010 began conducting field surveys in Santa Monica Bay in Los Angeles to test the concepts. Findings may help explain occurrences of harmful algal blooms in low-nitrate surface waters.

- **Investigating Sources and Fates of Brominated Compounds in the Coastal Environment**
  R/CONT-210 Jul. 2010–Jun. 2011
  Lihini Aluwihare, UCSD/SIO, 858.822.4886, laluwihare@ucsd.edu

NOAA's Mussel Watch Program recently reported high concentrations of polybrominated diphenyl ether (PBDE) flame retardants in mussels from the Anaheim Pier. In this project, scientists will detect the presence and radiocarbon content of mussels from the pier and at a control site in La Jolla (where PBDE concentrations were much lower) for levels of brominated and brominated-related compounds. The purpose is to distinguish compounds of natural origin from those that are industrially synthesized. Results will help evaluate whether brominated compounds related to PBDEs have a common source and are transformed from one to another, or whether they are derived from a significant mixture of natural and anthropogenic sources.

- **Gonadal Gene Expression to Characterize Responses of Longjaw Mudsucker to Contaminated Environments**
  R/CONT-212 Sep. 2010–Aug. 2012
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  Doris Vidal-Dorsch, SCCWRP, 714.755.3216, dorisv@sccwrp.org

The California Natural Resources Agency, in partnership with the EPA, is actively looking to assess wetland health through its California Coastal Wetlands Monitoring Venture. This project will contribute to the effort by examining the consequences of anthropogenic contamination (e.g., legacy contaminants such as PCBs and DDT, pharmaceuticals, personal care products, pesticides and industrial chemicals) on coastal wetland ecosystems. To do this, scientists will investigate the possibility of using gene expression patterns in gonadal fish tissue to assess the subtle effects of endocrine disruptors, which initially may manifest themselves in gene expression only. If successful, the approach could lead to a new tool for evaluating the cumulative toll of low-level chronic chemical pollutants on marine life.

- **Cellular Mechanisms of Toxin Release in Harmful Algae**
  R/CONT-213 Aug. 2010–Jul. 2011
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The goal of this project is to test the hypothesis that calcium ions within the cells of harmful algae trigger toxin release. (In animal cells, calcium ions cue the release of hormones.) Scientists will also attempt to show that harmful algae can sense environmental changes, process the information via cellular signaling and regulate cell physiology accordingly. The algae to be studied for the project include: the diatom *Pseudo-nitzschia multiseries* (which produces domoic acid); the dinoflagellate *Karenia brevis* (which produces brevetoxins) and *Alexandrium fundyense* (which produces saxitoxins). Findings have direct relevance to understanding harmful algal blooms at their most fundamental physiological level.

- **Making Restoration More Efficient: Testing the Contributions of Planting Diversity and Tamarisk Legacy Effects to Recovering Tidal Marshes**
  R/ENV-209 Feb. 2009–Jan. 2012
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Although scientists and managers are often keen to eradicate non-native plants such as tamarisk, funding is often lacking for post-eradication restoration, meaning that cleared areas may be vulnerable to reinvasion. This project looks at whether inexpensive strategies, such as planting native species and/or mulching with removed weeds, can speed habitat and wildlife recovery. In the first year of the study, scientists were able to conclude that the development of young coastal scrub ecosystems is mainly structured by the presence and quantity of living and dead plant biomass and, to a lesser degree, by the kinds of plants present. This may be due to the low primary productivity of newly cleared and replanted sites. The management implication is that priority should be given to planting natives with large biomass and using introduced plant litter as mulch. Findings were shared with the public, docents and managers at NOAA's Tijuana River National Estuarine Research Reserve and are of relevance to wetland restoration projects in the south San Diego Bay.

- **Beaches as Threatened Ecosystems: An Evaluation of Status and Trends in the Ecology of California's Sandy Beaches**
  R/ENV-210 Feb. 2009–Feb. 2012
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What is the fate of California's beloved beaches in the face of rising sea levels and continuing population growth? To address the question, an interdisciplinary team of scientists is compiling historical datasets and re-sampling historical beach study sites to construct a 30-year record of the ecology and physical characteristics of sandy beaches from Morro Bay to San Diego. These datasets will be compared to detect meaningful trends and processes affecting sand supply, beach width, biodiversity and community structure. They will also be used to identify potentially rare, declining or locally extinct intertidal species. Findings will be shared with beach management and conservation managers.

- **Reefs That Rock and Roll: Critical Assessment of Rhodolith Bed Habitat at Catalina Island to Inform the California South Coast Region MPA Process**
  R/ENV-212 Jul. 2010–Jun. 2011
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A new habitat type has been discovered around the Channel Islands. The habitat consists of coral-like red algae that grow on rocks that are sometimes small enough to roll around on the seafloor with currents. These mobile rhodolith "red stone" beds transform sandy areas into a complex grazing habitat, as other algae become enmeshed within the rhodolith nodules attracting fishes and other animals like sea hares. This proposal aims to combine diver survey and acoustic data to map rhodolith beds around Catalina Island and characterize their biodiversity. Findings will inform the marine reserve process for the South Coast study region, as potentially a new habitat type that needs to be protected.

- **Trophic Ecology of the Gopher Rockfish (*Sebastes carnatus*): Providing Baseline Information for Evaluation of Marine Protected Areas**
  R/ENV-213 Jul. 2010–Jun. 2011
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How are the California Central Coast marine protected areas (MPAs), which were established in 2007, affecting gopher rockfish? This project will compare gopher rockfish diets inside and outside four MPAs: Año Nuevo, Piedras Blancas, Point Buchon, and the Point Lobos State Marine Conservation Areas. Previous studies have shown MPAs can increase the number of predators inside the protected areas and that this can alter the local trophic structure. The overall goal of this project is to discover the ecological impacts of no-take marine reserves, using the gopher rockfish as a case study. Since 2007, researchers have collected more than a thousand gopher rockfishes. Over the course of the next two years, their stomach contents will be analyzed for typical prey items. In addition, isotope samples will be analyzed from white muscle tissue, adding to the overall dietary information. Findings will provide ecological information on how these four MPAs affect the food web along the Central Coast.

- **Effects of Marine Reserves on Behaviorally Mediated Changes in Spawning Success of California Sheephead**
  R/ENV-214 Jun. 2010–May 2011
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  Robert Warner, UCSB, 805.893.2941, warner@lifesci.ucsb.edu

This project builds on previous Sea Grant research showing that sport fishing of California sheephead selectively removes large males and triggers earlier sex change in females, resulting in smaller sizes of both males and females. Research divers will study the effects of fishing on fish behavior by comparing fish behaviors inside and outside marine reserves. A central question to be explored is whether fishing disrupts the ability of males to establish territories and court females. To do this, divers will document aggressive interactions among males, courtship behaviors and the number of spawning attempts (successful or not) at fished and nonfished sites. It is hypothesized that males will be more successful at attracting and spawning with females inside marine reserves, where they may establish stable territories. Ultimately, scientists will examine whether the fish's reproductive output is greater within marine reserves than anticipated, due to behavioral modifications associated with fishing pressure.

- **Development of Novel Stable Isotope Approaches to Evaluate Carbon Flow in a Restored Coastal Wetland in Southern California**
  R/ENV-215 Jul. 2010–Jun. 2011
  Jesse G. Dillon, CSULB, 562.985.4824, jdillon@csulb.edu
  Andrew Mason, CSULB, 562.985.5266, zedmason@csulb.edu

This project's ultimate goal is to understand the role of microorganisms involved in decomposition pathways of salt marshes in a Huntington Beach wetland. Through stable isotope probing, the researcher and his team will be able to more directly characterize the major players in salt marsh food webs at the microbial level. The team will first quantify the plant, algal and faunal diversity in the wetland. Then, they will identify microbes active in important environmental processes, such as the decomposition of marsh vegetation. Findings will show the importance of salt marshes to the greater coastal ecosystem. Of particular interest is to elucidate the role of wetlands in removing carbon from the atmosphere and how sea level rise might, by submerging wetlands, alter the global carbon cycle.

- **Biogeographical Variation in Trophic Interactions on Temperate Reefs of the Southern California Bight**
  R/ENV-216 Jun. 2010–May 2011
  Kevin A. Hovel, SDSU, 619.594.6322, hovel@sciences.sdsu.edu

This project will, among other things, examine the effects of marine protected areas (MPAs) on sea urchin predation and hence kelp forest persistence in the Southern California Bight. To do this, scientists will continue a region-wide sampling program and expand an experimental field predation study in San Diego to quantify: 1) top predator, urchin and macroalgae abundances inside and outside marine reserves; 2) urchin habitat uses and urchin size distributions inside and outside marine reserves; and, 3) density-dependent urchin mortalities inside and outside marine reserves. Findings have relevance to designing MPAs and understanding urchin, lobster and fish population dynamics.

- **Developing the Capability to Monitor and Predict Upwelling Along the California Coast Using an Ocean Circulation Model**
  R/ENV-217 Jul. 2010–Jun. 2011
  Xiaochun Wang, UCLA, 818.393.7231, xcwang@jifresse.ucla.edu

In this project, the scientist will adapt output from a nested regional 3D ocean model to forecast upwelling along the coast 48 hours in advance. Because the ocean model incorporates local bathymetry, atmospheric forcing and lateral boundary conditions at a 3-kilometer (or better) spatial scale, its output has the potential to improve upon the upwelling index for the California Current region in use today. Satellite and land-based high-frequency radar, as well as in-situ observations, will be used to ground truth the forecasts. Results will be publicly available at the Jet Propulsion Laboratory's Our Ocean portal (http://ourocean.jpl.nasa.gov).

- **Cross-Shelf Larval Migrations Regulating Larval Supply and Connectivity in a Network of Marine Reserves**
  R/FISH-206 Feb. 2009–Jan. 2012
  Steven G. Morgan, BML, 707.875.1920, sgmorgan@ucdavis.edu
  John Largier, BML, 707.875.1930, jlargier@ucdavis.edu

Perhaps surprisingly, invertebrate larvae do not float passively with ocean currents and instead seem to exert considerable control over their movements, as seen by the observation that the larvae usually remain near shore, even during strong upwelling events. This project explores the degree to which ocean currents can be accurately viewed as a forcing mechanism for larval transport and settlement. To accomplish this, invertebrate larvae are being surveyed along transects through the upwelling cells off Stewards Point, the strongest upwelling center in California, and Bodega Head. Preliminary data show that: 1) larvae are present in high concentrations along both transects; 2) more larvae are not found off Stewards Point than Bodega Head, and 3) recruitment is light at both sites, suggesting that a process besides upwelling is limiting recruitment. Results are of relevance to understanding the population connectivity of marine reserves.

- **High-Throughput Molecular Identification of Fish Eggs and Larvae**
  R/FISH-207 Feb. 2010–Jan. 2012
  Ron Burton, UCSD/SIO, 858.822.5784, rburton@ucsd.edu

Ultimately, this project seeks to develop the technology for an automated shipboard instrument for rapidly identifying species of fish eggs and larvae collected by a continuous underway fish-egg sampler. The scientific underpinning of the project is the use of DNA barcoding methods, coupled with a bead array technology that is capable of simultaneously identifying multiple specimens of marine microbes. The DNA barcoding techniques will draw on a database of DNA sequences from more than 400 of the region's fish species, developed during previous Sea Grant-funded research. Once the bead array is developed, it will be used to identify fish eggs in a 12-year archive of samples collected during CalCOFI cruises, in collaboration with NOAA Southwest Fisheries Science Center. In the first year of the project, scientists focused on identifying fish eggs from pairs of species that are difficult to distinguish morphologically and have, to date, designed 22 species-specific oligonucleotide probes for 15 California fishes.

- **Sustainability and Fine-Scale Management of a California Sea Urchin Fishery and the Ecology of Exploitation**
  R/FISH-209 Feb. 2010–Jan. 2013
  Paul Dayton, UCSD/SIO, 858.534.6740, pdayton@ucsd.edu
  Stephen Schroeter, UCSB, 760.438.5953, schroeter@lifesci.ucsb.edu
  Ed Parnell, UCSD/SIO, 858.822.2701, edparnell@ucsd.edu

Researchers are seeking to better understand, at fine spatial scales, the dynamics of red sea urchin populations and their ecological role within the Point Loma kelp forest in San Diego. They also hope to demonstrate that the sea urchin fleet can collect data needed for managing the urchin fishery at the same spatial scale as the natural processes influencing the species locally. To do this, biologists will develop fine-scale habitat and spatially explicit population models at ecologically relevant scales, to be determined during the project. Sea urchin fishermen and scientific divers will collect data for estimating sea urchin recruitment and growth rates, movement, fishing mortality and foraging behavior. This information is critical in fostering the development of community-based, co-management of the urchin fishery, as well as furthering ecosystem-based management of the Point Loma kelp forest. The group

will collaborate with local educational organizations such as Ocean Discovery Institute, Science Education Foundation and San Diego Oceans Foundation to facilitate public outreach and participation in the project.

- **Adaptive Management of Marine Protected Areas: Predicting Responses to MPA Implementation for Comparison to Monitoring Data**
  R/FISH-211 Feb. 2010–Jan. 2012
  Louis Botsford, UCD, 530.752.6169, lwbotsford@ucdavis.edu
  Marissa Baskett, UCD, 530.752.1579, mlbaskett@ucdavis.edu
  Alan Hastings, UCD, 530.752.8116, amhastings@ucdavis.edu

In this project, scientists are developing computer models for evaluating the performance of California's Central Coast marine protected areas (MPAs) for commercially important species such as blue rockfish, black rockfish, lingcod and cabezon. The spatial population models will incorporate what is known about larval dispersal, adult movement patterns and key species interactions to more fully understand how fishes respond to the MPAs and how other factors such as regulatory decisions outside the MPAs affect fish populations. Model output will help provide greater meaning and context to monitoring data. Such information is critical for adaptively managing the state's network of MPAs and meeting the state's conservation goals.

- **MPA-Based Collaborative Techniques to Improve Management of Nearshore Fisheries**
  R/FISH-213 Jul. 2010–Jun. 2011
  Hunter Lenihan, UCSB, 805.893.8629, lenihan@bren.ucsb.edu

The goal of this project is to gather information needed to improve the management of the spiny lobster and nearshore grass rockfish fisheries. This will be achieved by refining estimates for key demographic parameters and conducting "management strategy evaluations" for setting rockfish catch limits and estimating harvest rates for lobster (needed for stock assessments). Both species are commercially exploited and economically important to fishing communities. The research team plans to calculate natural and fishing mortality rates, as well as spatially specific growth rates, for both species by comparing populations inside marine protected areas to adjacent fishing areas with similar environmental conditions. Data will be collected collaboratively with fishermen. Once these estimates are formulated, scientists will explore model approaches for improving the assessment of the effects of different fishery management options on stocks.

- **Development of Biological Control for the New Zealand Mud Snail**
  R/ANS-212 Feb. 2010–Jul. 2011
  Tom Dudley, UCSB, 805.893.8062, tdudley@msi.ucsb.edu
  Ryan Hechinger, UCSB, 805.893.3998, hechinger@lifesci.ucsb.edu
  Armand Kuris, UCSB, 805.893.3998, kuris@lifesci.ucsb.edu

Could the release of a parasite (Microphallus spp.) reduce populations of the invasive New Zealand mud snail in waterways of the Western United States? In previously funded Sea Grant work, scientists evaluated the parasite's effectiveness at halting the snail's reproduction and its host specificity (i.e., its ability to infect animals besides the target for eradication) in the field in Australia, where the parasite was introduced along with the mud snail. In the coming year, they will conduct additional laboratory tests to confirm that the parasite cannot infect native North American mollusks. They are also currently documenting the snail's distribution, population growth and impacts to native biota in California streams. The survey data will allow them to monitor the effectiveness of the control agent in lowering mud snail populations, if and when the parasite is released in the future.

- **Estimating the Impact of Invasive *Spartina densiflora* on Primary Productivity in Humboldt Bay**
  R/ANS-213 Jul. 2010–Jun. 2011
  Alison Purcell, HSU, 707.826.3438, Alison.Purcell@humboldt.edu

Biologists will be investigating the role of an invasive aquatic species, *Spartina densiflora*, on ecosystem primary productivity in Humboldt Bay, California. A major question is whether the estuarine ecosystem produces more or less carbon in the presence of *S. densiflora*. This work is timely as, in early 2010, the Humboldt Bay National Wildlife Refuge received a $1 million grant to eradicate *S. densiflora* from its property. The California Sea Grant Extension Program established and coordinates an ecosystem-based management program, the Humboldt Bay Initiative, which includes development of innovative approaches to aquatic invasive species eradication. The West Coast Governors' Agreement on Ocean Health, meanwhile, has set an ambitious goal of completely eradicating invasive cordgrass by 2018. Findings will be of direct relevance to these efforts, their cost-effectiveness and implications for coastal ecosystem health.

- **Understanding Roles of Competing Bacterial Endosymbionts in Abalone Health, Management and Restoration**
  R/FISH-208 Feb. 2010–Jan. 2013
  Carolyn Friedman, UW, 206.543.9519, carolynf@u.washington.edu
  Peter Raimondi, UCSC, 831.459.5674, raimondi@biology.ucsc.edu
  Glenn VanBlaricom, UW, 206.543.6475, glennvb@u.washington.edu

A newly discovered rickettsial-like organism (RLO) appears to reduce mortality rates of the abalone disease known as withering syndrome. In this project, scientists will determine the geographic distribution of the new pathogen in wild abalone, farmed abalone and seawater. They will also attempt to identify all RLOs in California and quantify their pathogenic potential alone and in combinations with each other, as functions of water temperature. One hypothesis to be tested: transmission of the new RLO and subsequent infection are positively correlated with ambient water temperature (i.e., warm water). It is also hypothesized that susceptibility to infection by the new RLO, and subsequent disease, varies among the state's eight native abalone species. Five of these eight species are categorized as "species of concern" or are protected under the Endangered Species Act. A better understanding of the factors influencing disease will assist in species' recovery efforts, as well as provide potentially valuable information to abalone farms that are vulnerable to outbreaks. The Abalone Farm in Central California is a collaborator on the project.

- **Soft-Egg Syndrome in Farmed White Sturgeon**
  R/AQ-129 Feb. 2008–Jul. 2011
  Kenji Murata, UCD, 530.752.6789, kmurata@ucdavis.edu
  Serge Doroshov, UCD, 530.752.7603, sidoroshov@ucdavis.edu
  Fred Conte, UCD, 530.752.7689, fsconte@ucdavis.edu

Scientists are in the process of confirming their hypothesis that white sturgeon husbandry practices (in particular the environmental conditions under which fish are kept, their diet, and

perhaps stress levels) are the root cause of soft-egg syndrome, an undesired caviar trait that has become common in some cultured fish in recent years. In a series of controlled experiments, soft eggs were shown to be the result of physiological problems in the oocyte and/or ovary during egg envelope formation and oocyte maturation; post-harvest processing techniques could be a contributing factor. Scientists will analyze eggs collected from sturgeon raised under different environmental conditions and fed different diets to pinpoint husbandry practices that might alleviate the problem. Besides the project's applications to sturgeon farming, the findings will also provide insights into endangered green sturgeon recovery strategies.Sterling Caviar and The Fishery are collaborating on this project.

- **Minimizing the Use of Fishmeal and Fish Oil in the Diet of California Yellowtail, *Seriola lalandi*—A Top Candidate for Offshore Aquaculture**
  R/AQ-130 Feb. 2009–Jan. 2012
  Mark A. Drawbridge, H-SWRI, 619.226.3943, mdrawbridge@hswri.org
  Frederick A. Barrows, USDA/ARS, 405.587.9265, rbarrows@montana.campuscwix.net
  Ronald W. Hardy, UI/ARI, 208.837.9096, rhardy@micron.net

This project seeks to reduce the amount of fishmeal and fish oil in feeds for yellowtail (*Seriola lalandi*) and white seabass (*Atractoscion nobilis*) without slowing fish growth rates or otherwise compromising fish health. The results, to date, exceed the original goal of reducing fishmeal protein by 75%, as scientists have already developed a feed for seabass without any fish protein in it. Corn, poultry and Spirulina can replace fishmeal protein effectively. Notably, fish on the low- or no-fishmeal diets fared as well or better than those on traditional and commercial feeds, in terms of growth, survival and feed conversion rates. Attention is now being focused on reducing fish oil by at least 50%. Once practical replacements for fish oil are identified, researchers will investigate whether there is a need to optimize mineral supplements in the new feeds.

- **Parentage in White Sturgeon**
  R/AQ-131 Jul. 2010–Jun. 2011
  Bernie May, UCD, 530.754.8123, bpmay@ucdavis.edu

Scientists will develop the tools necessary for more accurately identifying the parentage of farmed white sturgeon, raised for meat and caviar. This objective is more challenging than might be thought because the sturgeon have eight sets of chromosomes rather than the more usual two. Scientists will add six microsatellite loci to an existing set of eight and will then attempt to assign the correct sire and dam to offspring of known parentage. The main goal is to identify the minimum number of markers needed to assign parentage with 95% accuracy within each sturgeon family. Results of this project will be used to examine the causes of ovarian adiposity, a condition that reduces the yield and quality of farmed caviar. The heritability of other traits could also be further examined following the completion of this project.

Effective Response to Climate Change

- **Climate Change and Restoration Factors Affecting Fecal Pathogen Dynamics in Wetland Systems**
  R/CONT-206 Feb. 2008–Oct. 2011
  Woutrina A. Miller, UCD, 530.219.1369, wamiller@ucdavis.edu
  Fred Watson, CSUMB, 831.582.4402, fred_watson@csumb.edu
  Patricia A. Conrad, UCD, 530.752.7210, paconrad@ucdavis.edu

As part of a broad effort to understand how climate change may affect pathogen pollution along the coast, researchers are exploring the fate and transport of fecal pathogens through different types of wetlands. Fieldwork is being conducted at constructed and tidal wetlands in Elkhorn Slough in Monterey County, as well as at a nearby wetland adjacent to a dairy farm. Experiments are testing the influence of water flows, vegetation, water temperatures, salinities, sediment dynamics and the hydrophobicity of protozoa on pathogen loads. The pathogens under study include clinically relevant *Cryptosporidium parvum*, *Toxoplasma gondii* and *Giardia duodenalis*. Findings from this project will help to build and restore wetlands so as to maintain their natural filtering capacity. Research summaries will be posted on the NOAA Monterey Bay National Marine Sanctuary's SIMoN Web site and are expected to be of interest to California's nine Regional Water Quality Control Boards, the Southern Sea Otter Alliance and local watershed-protection groups.

- **Climate Change and the Phenology of Plankton and Fish Production in the California Current**
  R/FISH-210 Feb. 2010–Jan. 2013
  David Checkley, UCSD/SIO, 858.534.4228, dcheckley@ucsd.edu

Surface waters in the California Current are warming and becoming more stratified. This project examines what this means to the timing of the spring plankton bloom and spawning of northern anchovy, Pacific sardine and jack mackerel. The hypothesis being explored is that climate change is altering, perhaps through upwelling dynamics, the timing of the spring bloom and availability of spawning habitat. Four types of satellite data will be used to monitor seasonal fluctuations in oceanographic conditions and chlorophyll concentration in the California Current. Scientists will also develop a monthly spawning habitat index for species using data collected by a continuous, underway fish egg sampler. They will then examine the relationship between fish reproduction and the timing of the spring bloom and other oceanographic processes. A preliminary analysis of larval fish abundances shows that about 40% of species are now spawning earlier than they did in the 1950s. These species appear to be tracking seasonal changes in sea surface temperature, but not upwelling intensities or zooplankton abundances. As a result, the seasonal peak in zooplankton—the main food for larval fishes—may be out of sync with the new spawning season.

- **Development of Proxies to Evaluate pH and Oxygen Exposures**
  R/CC-02 Jan. 2011–Dec. 2011
  Lisa A. Levin, UCSD/SIO, 858.534.3579, llevin@ucsd.edu

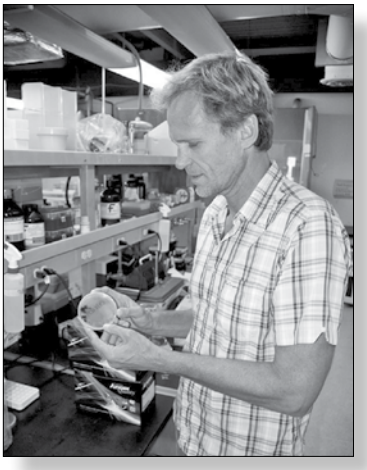
In this project, market squid embryos and early stage mussels will be raised under controlled pH and oxygen conditions to test the hypothesis that variations in seawater acidity and/or oxygen exposure leave distinctive chemical fingerprints in the animals' carbonate structures. Researchers will also examine differences in squid statoliths (balance organs comparable to otoliths in fish) and larval mussel shells to further investigate the possibility of assessing the exposure of these animals to low pH or low oxygen levels. There is increasing evidence that Eastern Boundary coastlines such as California's are more vulnerable to ocean acidification than Western Boundary coastlines, because of the role that upwelling plays in bringing relatively acidic water to the surface. What is learned during this project will help managers identify specific regions and/or populations experiencing stress from acidification.

- **Paradigm or Paradox: Can We Attribute Species Changes to Global Climate Change in Light of Decreasing Water Temperatures in Central California?**
  R/CC-03 Jul. 2010–Jun. 2011
  Laurence C. Breaker, MLML, 831.771.4498, lbreaker@mlml.calstate.edu
  Greg Cailliet, MLML, 831.771.4432, cailliet@mlml.calstate.edu

There are more warm-water fishes off the Central California coast today than there were three or four decades ago. Their presence is often assumed to be caused by an overall warming of coastal waters since the late 1970s. This project seeks to determine whether historical records of water temperatures and fishes (including fish larvae) show a compelling waxing and waning of warm-water species in concert with temperature changes, caused by, for example, El Niño events and the Pacific Decadal Oscillation. The preliminary analysis for Monterey Bay will guide a larger effort to predict the effects of climate change on species assemblages in California. Findings have relevance to both fisheries management and ocean conservation.

New Technologies and Products

- **Exploiting Marine Actinomycete Diversity for Natural Product Discovery**
  R/NMP-100 Feb. 2010–Jan. 2013
  Paul Jensen, UCSD/SIO, 858.534.7322, pjensen@ucsd.edu
  Bradley Moore, UCSD/SIO, 858.822.6650, bsmoore@ucsd.edu



Up until recently, few bacteria were known to make a group of pharmaceutically promising compounds called hybrid isoprenoids. Notably, the scientists leading this project have discovered a unique group of marine bacteria, which they have named MAR4, that make these compounds. In this project, they will collect marine sediments around the Channel Islands off the coast of Santa Barbara to look for new strains of MAR4 bacteria. These bacteria will then be examined for the production of new versions of these rare isoprenoid compounds. Besides prospecting for new microbes and molecules, molecular techniques will be used to identify the genes in the MAR4 bacteria that code for the enzymes that make hybrid isoprenoids. The isolation of these genes opens the door to being able to engineer new antibiotics or anticancer therapies.

- **Harnessing the Pharmaceutical Potential of Marine Cyanobacteria Through Gene Regulatory Approaches**
  R/NMP-103 Jul. 2010–Jun. 2011
  William Gerwick, UCSD/SIO, 858.534.0578, wgerwick@ucsd.edu
  Lena Gerwick, UCSD/SIO, 858.534.0566, lgerwick@ucsd.edu

This project builds on a previous Sea Grant project to study the biosynthetic pathways in marine cyanobacteria that produce novel metabolites with therapeutic potential. Scientists will continue to study the processes regulating metabolite production in these organisms, with the goal being to figure out how to manipulate and increase metabolite production. The ability to genetically manipulate gene clusters in a secondary, easily cultured, faster growing host could be groundbreaking in solving the “supply” problem of natural products from marine cyanobacteria, therapies that would otherwise be impossible to create using traditional techniques.

Program Development

- **Program Development**
  M/NP-1
  J.E. Eckman/CASG

Conditions in the marine sphere can change rapidly because of both human and natural causes, and problems that need immediate attention can arise unexpectedly. The program development project allows prompt support for short-term, marine-related research and other specific activities. See http://csgc.ucsd.edu/Program_Development for funding details.

California Ocean Protection Council

California's Ocean Protection Council (OPC), which was created in accordance with the 2004 California Ocean Protection Act, has awarded funds to California Sea Grant to administer peer-reviewed, scientific research to address OPC research priorities. The projects below were selected for 2011 funding.

- **Parasites as Indicators of Coastal Wetland Health**
  R/OPCENV-01 Feb. 2007–Feb. 2012
  Ryan Hechinger, UCSB, 805.893.3998, hechinger@lifesci.ucsb.edu
  Armand Kuris, UCSB, 805.893.3998, kuris@lifesci.ucsb.edu
  Kevin Lafferty, USGS, 805.893.8778, jafferty@lifesci.ucsb.edu

How healthy is that wetland? Count the parasites in common snails to find out. The more species of parasites, the healthier the marsh. In this project, scientists are testing the validity of this idea for larval trematode parasites in common horn snails collected from California's wetlands. Their hope is that they can develop a snail-parasite index of wetland biodiversity to supplement or in some cases replace traditional field surveys of fishes and benthic invertebrates. Such a cost-effective, integrative tool would help managers monitor and adaptively manage the progress of various wetland restoration sites in the state. To date, scientists have processed field data on the density of fishes and benthic invertebrates and their relationship to snail parasites at 13 estuaries and are in continuing dialogs with wetland managers about their findings. As they finish their analyses, they will establish the most efficient sampling strategy to calibrate the parasite-as-indicator tool and combine it with standard assessment methods to translate the results into a characterization of wetland biodiversity. The scientists will then develop training materials for end-users.

- **Ecology and Trophic Interactions of Jumbo Squid (*Dosidicus gigas*) in the California Current Ecosystem**
  R/OPCFISH-06 Mar. 2008–Feb. 2011
  William F. Gilly, HMS/SU, 831.655.6219, lignje@leland.stanford.edu
  John Field, NOAA/SWFSC, 831.420.3907, John.Field@noaa.gov

This project is assembling a picture of the jumbo squid's life history in the California Current ecosystem, including an understanding of what its success might mean for other species in the region—particularly commercial species and/or species of concern that may be part of the squid's diet. Findings to date suggest that the squid is probably not reproducing in large numbers in the California Current, if at all, as laboratory experiments suggest that the cool waters north of Point Conception impair early development of embryos. The squid likely migrate to the region seasonally to feed on a group of highly abundant mid-depth fishes known collectively as lanternfish, and to a lesser extent on commercially important species such as Pacific hake and rockfishes, and then—it is theorized but not yet proven—migrate south in fall and winter to spawn in warmer water. The scientists plan to combine dietary, habitat and movement/diving data to model interactions between the squid and other important species.

- **Long-Term Faunal Changes in California Nudibranchs: Climate Change and Local Ocean Health**
  R/OPCENV-08 Dec. 2007–Feb. 2012
  Jeffrey H.R Goddard, UCSB, 805.688.7041, goddard@lifesci.ucsb.edu
  John S. Pearse, UCSC, 831.648.9245, pearse@biology.ucsc.edu
  Terrence M. Gosliner, CAS, 415.379.5269, gosliner@calacademy.org

The brightly colored, shallow-water mollusks known as nudibranchs come and go along the coast in response to changes in ocean conditions, as reported by the project scientists. Populations of larger, more conspicuous species grow during El Niño episodes and warm phases of the Pacific Decadal Oscillation (i.e., when sea surface temperatures rise), when coastal sea levels are above average, and when coastal upwelling is weak. Consistent with observed, long-term warming of coastal waters since 1977, biologists have documented northward range expansions of some species. The observed faunal shifts are likely caused by how warming affects currents along the coast and thus larval advection. Biologists believe this project's results are relevant to forecasting population fluctuations of other species with long pelagic larval periods, including the commercially important red sea urchin.

- **Ocean Acidification Exacerbated by Coastal Upwelling: Monitoring of CO_2 and O_2 on the California Shelf, and Studies of Their Effects on Red Sea Urchins, California Mussels and Abalone**
  R/OPCENV-09 Dec. 2009–Nov. 2012
  Victoria Fabry, CSUSM, 760.750.4113, fabry@csusm.edu
  Andrew Dickson, UCSD, 858.822.2990, adickson@ucsd.edu
  Gretchen Hofmann, UCSB, 858.893.6175, hofmann@lifesci.ucsb.edu

In California's coastal waters, carbon dioxide levels are rising in rough concert with atmospheric carbon dioxide concentrations and are acidifying coastal waters (lowering its pH). Greater acidity can, among other things, corrode the calcium carbonate shells of organisms such as corals, oysters, sea urchins, lobsters and abalone. This shell corrosion is most likely to occur during the animals' larval and juvenile stages. Above and beyond the effects of rising carbon dioxide on ocean pH, decomposing organic matter also releases carbon dioxide. Because of this, deeper waters off California are more acidic than the rest of the water column, with upwelling thus having the effect of exacerbating acidification in shallower waters. This project will explore these concepts and their implications for shelf ecosystems in the California Current. In particular, a multi-disciplinary team will conduct field and laboratory experiments to: (1) investigate the extent of ocean acidification at a site in coastal California; (2) examine the effects of elevated carbon dioxide on calcification rates in red sea urchins, mussels and abalone at different life stages; (3) use molecular tools to link calcification rates with gene expression, and (4) document changes in gene expression at elevated seawater carbon dioxide levels. Findings will be published in peer-reviewed journals and shared with the public through exhibits at California aquaria.

- **The Future of the California Chinook Salmon Fishery: Roles of Climate Variation, Habitat Restoration, Hatchery Practices and Biocomplexity**
  R/OPCFISH-10 Feb. 2010–Jan. 2013
  Brian Wells, NOAA/SWFSC, 831.420.3969, brian.wells@noaa.gov
  David Hankin, HSU, 707.826.3447, dgh1@humboldt.edu
  Louis Botsford, UCD, 530.752.6169, lwbotsford@ucdavis.edu

This project seeks to provide managers with tools for weighing pros and cons of various restoration options for Central Valley and Klamath run chinook salmon. The project's first phase will involve a retrospective analysis of the links between climate variation, human activities and salmon numbers. The second phase will be a prospective analysis to determine critical stages in the life history of salmon that impact fish production. An overarching theme to be explored is whether promoting a more diverse population structure for chinook salmon could be a management strategy for boosting salmon survival rates. Specific hypotheses to be examined include: salmon survival is becoming increasingly variable; climate variability is increasing; genetic diversity within and among salmon populations is diminishing; improving population structure diversity will reduce swings in salmon survival, and improving diversity will improve the economic viability of fishes.

- **Forecasts and Projections of Environmental and Anthropogenic Impacts on Harmful Algal Blooms in Coastal Ecosystems**
  R/OPCCONT-12 Dec. 2010–Jan. 2013
  Raphael Kudela, UCSC, 831.459.3290, kudela@ucsc.edu
  Burt Jones, USC, 213.740.5765, bjones@usc.edu
  David A. Caron, USC, 213.740.0203, dcaron@usc.edu
  Yi Chao, UCLA, 818.354.8168, yi.chao@jpl.nasa.gov

After years of studying and monitoring harmful algal blooms in California's coastal waters, a team of researchers will begin developing tools for predicting when toxin-producing algae will strike again.The first forecasts will be for the diatom *Pseudo-nitzschia*, which produces domoic acid, the neurotoxin that causes amnesic shellfish poisoning, as forecasting models for these algae already exist for Monterey Bay and Santa Barbara. Researchers will expand these two existing models to the entire coast and develop capabilities for forecasting blooms of the algae responsible for paralytic shellfish poisoning. The final product will be a web-based tool that can provide real-time forecasts for state agencies and wildlife managers.

Raphael Kudela. Photo: T. Stevens, UCSC

North Central Coast MPA Baseline Data Collection Project

This is a collaborative effort between the State Coastal Conservancy, Ocean Protection Council, California Department of Fish and Game, California Ocean Science Trust, MPA Monitoring Enterprise and California Sea Grant Program. The following projects are collecting baseline data for the North Central Coast marine protected areas designated by the Fish and Game Commission under the Marine Life Protection Act.

- **Baseline Characterization of Newly Established Marine Protected Areas within North Central Coast Study Region—Seabird Colony and Foraging Studies**
  R/MPA-6 Mar. 2010–Feb. 2013
  Dan Robinette, PRBOCS, 805.735.7300, drobinette@prbo.org
  Gerry McChesney, USFWS, 510.792.0222, ext. 222, gerry_mcchesney@fws.gov

The Farallon Islands—"California's Galapagos"—support nearly a third of the state's nesting seabirds. By protecting seabirds' foraging grounds, prey populations and breeding colonies, the North Central Coast marine protected areas stand to benefit seabirds such as the pigeon guillemot, pelagic cormorant, Brandt's cormorant, common murre and black oystercatcher. Several special closure areas, established as part of the marine protected areas network, will require that vessels keep at least 300 feet or 1,000 feet (depending on the closure) from important breeding colonies. It is hoped that the special closures will protect birds from disturbances that can cause breeding failure and even colony abandonment. The goal of this project is to expand existing seabird monitoring programs, led by U.S. Fish and Wildlife Service and PRBO Conservation Science, to create a baseline of seabird population sizes, reproductive success and foraging distributions relative to the newly established marine protected areas, including the special closures. Expanding these studies will allow scientists to test whether the protected areas are indeed benefiting seabirds and if not, how to adaptively manage the protected areas so that they do.

- **Baseline Characterization of Newly Established Marine Protected Areas within North Central Coast Study Region—LiMPETS Intertidal Citizen Science**
  R/MPA-7 Mar. 2010–Feb. 2013
  Amy Dean, FMSA, 415.561.6625 ext. 303, adean@farallones.org

In this project, an existing citizen-science data set, collected through Long-term Monitoring Program and Experiential Training for Students (LiMPETS), will be analyzed and integrated into the baseline data being collected by the other research teams. The LiMPETS data include surveys of the Pacific mole crab, a denizen of sandy beaches, at 16 sites within the North Central Coast study region, including beaches in and around two of the new marine protected areas. It also includes a more diverse and complex data set of rocky intertidal ecology at four sites in the region, including areas in and around two of the new marine protected areas. The rocky intertidal survey data follow trends in 33 key invertebrate and algae species/taxa. Each of the 33 is surveyed for one or more of the following reasons: it is abundant, easily recognized, near the boundaries of its distribution limits and/or sensitive to trampling, harvesting and pollution. In addition to the existing LiMPETS survey sites, Farallones Marine Sanctuary Association staff and student volunteers will receive funding to monitor two existing sites for two years, to further enhance the creation of a meaningful benchmark for the North Central Coast. The LiMPETS program, by its very nature, prioritizes the teaching of science literacy and ocean stewardship. The data collected by volunteers, however, are also scientifically meaningful and complement the baseline studies being conducted by professional scientists.

- **Baseline Characterization of Newly Established Marine Protected Areas within North Central Coast Study Region—ROV Surveys of Deep Water Habitats**
  R/MPA-8 Mar. 2010–Feb. 2013
  James Lindholm, CSUMB, 831.582.4662, jlindholm@csumb.edu
  Dirk Rosen, MARE, 510.232.1541, dirk@maregroup.org

A remotely operated vehicle (ROV) will be "flown" 75 centimeters above the seafloor in deep habitats (between depths of 20 meters and 116 meters) along the North Central Coast. The slowly moving ROV will take video and still images of soft- and hard-bottom biological communities in two annual surveys, each lasting about 20 days. This imagery, collected along fully geo-referenced transects, will characterize the region's bathymetry and species associated with various seafloor features. Researchers will also identify and count fishes, as well as both sessile and mobile larger invertebrates, captured on film. Four study sites will be surveyed during the project: 1) Montara State Marine Reserve and Pillar Point State Marine Conservation Area; 2) South East Farallon Island State Marine Reserve and State Marine Conservation Area; 3) Bodega Head Marine Reserve and State Marine Conservation Area, and 4) Point Arena Reserve and State Marine Conservation Area. The final baseline characterization will include summary descriptions of benthic ecosystem structure, processes and habitat characteristics, as well as species assemblages in the protected areas and adjacent reference sites. In the analysis phase of the project, scientists will evaluate the draft long-term monitoring plan for the area and offer recommendations for future monitoring of deep subtidal communities.

- **Baseline Characterization of Newly Established Marine Protected Areas within North Central Coast Study Region—Coastal Beach Citizen Science**
  R/MPA-9 Mar. 2010–Feb. 2013
  Kirsten Lindquist, FMSA, 415.561.6625, ext. 302, klindquist@farallones.org

Data collected by the citizen-science Beach Watch program at sites inside and outside of the new North Central Coast marine protected areas will be analyzed to understand regional variation in monitored species. The Beach Watch program is a public-private partnership of NOAA's Gulf of the Farallones National Marine Sanctuary and the Farallones Marine Sanctuary Association to study and protect the shoreline of the Gulf of the Farallones and northern portion of Monterey Bay. Through Beach Watch, volunteers are trained to collect a wide variety of shoreline data, including beach deposition rates of seabirds and marine mammals (i.e., counts of dead animals), bird and mammal species composition and abundance, and estimates of coverage by beach wrack. Beach Watch volunteers have been surveying the Gulf of the Farallones and Monterey Bay since 1993. The foremost goal of this project is to produce a benchmark for the diversity and abundance of birds and marine mammals along the North Central Coast. A subsequent data analysis will illuminate historical trends in bird and mammal species of interest. Other project goals include summarizing human-use data, contributing to an assessment of ecosystem conditions, and educating the public about scientific methods and marine conservation.

- **Baseline Monitoring of Ecosystem and Socioeconomic Indicators for MPAs along the North Central Coast of California—Rocky Intertidal Ecosystems**
  R/MPA-11 Mar. 2010–Feb. 2013
  Peter Raimondi, UCSC, 831.459.5674, raimondi@biology.ucsc.edu

The goal of this project is to produce a baseline characterization of rocky intertidal ecosystems in all of the marine protected areas and associated reference sites along the North Central Coast, to enable future comparisons of marine life inside and outside the protected

areas. Surveys will be conducted in 2010 and 2011, following the same protocols used for benchmark characterization of the Central Coast study region. These protocols, in turn, replicate those used by two ongoing long-term monitoring programs: Multi-Agency Rocky Intertidal Network (MARINe) for assessing communities of target species such as abalone, sea palms, mussels and sea grass; and Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) for assessing biodiversity. Thirteen of the sites to be included in the baseline characterization are already part of these two monitoring programs. The data to be collected during this project will greatly facilitate efforts to understand the impacts of the new marine protected areas. Following the data collection stage of the project, statistical analyses and geospatial modeling will be conducted to compare species abundances, patterns of diversity and community structure among protected areas and reference sites. To better understand the effects of the protected areas on a broader spatial scale, scientists will analyze the regional data within the context of rocky intertidal survey data collected along the entire West Coast. The analysis will explore species and species complexes as ecosystem indicators.

- **Baseline Monitoring of Ecosystem and Socioeconomic Indicators for MPAs along the North Central Coast of California—Kelp Forest Ecosystem Surveys**
  R/MPA-12 Mar. 2010–Feb. 2013
  Mark Carr, UCSC, 831.459.3958, carr@biology.ucsc.edu

In this project, scuba divers will survey kelp forests in Salt Point State Marine Park, Stewart's Point State Marine Reserve, Del Mar Landing State Marine Reserve, Saunders Reef State Marine Conservation Area and Point Arena State Marine Reserve and associated reference sites for two years beginning in 2010. From the survey data, scientists will estimate fish, kelp and benthic invertebrate densities, fish size distributions and percent cover of smaller invertebrates and algae. To better explore species-habitat relationships, they will also document substrate type (e.g., sand, cobble, bedrock and boulder) and vertical relief. Statistical analyses of the data will compare species abundances, guild abundances (e.g., trophic guilds) and community structure within the protected areas and reference sites. From the analyses, researchers hope to identify ecosystem indicators that might facilitate future monitoring efforts. The final deliverable will be a baseline characterization of kelp forest ecosystems in the five marine protected areas and associated reference sites. The project's design is modeled after the highly successful Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) survey program, which was also used for initial monitoring of kelp forests within the Central Coast study region.

- **Baseline Monitoring of Ecosystem and Socioeconomic Indicators for MPAs along the North Central Coast of California—Kelp Forest Ecosystem Surveys**
  R/MPA-13 Mar. 2010–Feb. 2013
  Gregor Hodgson, RCF, 310.230.2371, ghodgson@reefcheck.org
  Jan Freiwald, RCF, 310.230.2371, jfreiwald@reefcheck.org

Through the Reef Check Foundation's California program, experienced recreational scuba divers are taught, tested and certified to collect scientifically robust survey data for 73 rocky reef indicator species. Its monitoring program, ongoing along the North Central Coast since 2006, is a highly cost-effective means of gathering economically and ecologically important data, and is invaluable in educating the public about scientific methods and environmental stewardship. For the baseline project, Reef Check California volunteers will continue to monitor key indicator species annually at their existing five sites within and outside the new marine protected areas and will add abalone and urchin surveys to four of the protected areas and

associated reference sites to be surveyed by Mark Carr's group at the University of California, Santa Cruz. Fish surveys will also be added to four ongoing abalone and urchin surveys, conducted by the California Department of Fish and Game. During the course of the project, the Los Angeles-based nonprofit plans to train about 32 new citizen-scientist divers in partnership with the Bodega Marine Laboratory's scientific diver class and Sonoma State University's recreational diver program. Data collected by the highly trained volunteers will be integrated into the final scientific report and compared to data collected by academic and agency staff to identify the most appropriate role for citizen science in monitoring protected areas.

- **Baseline Monitoring of Ecosystem and Socioeconomic Indicators for MPAs along the North Central Coast of California—Sandy Beaches and Adjacent Surf Zones**
  R/MPA-14 Mar. 2010–Feb. 2013
  Karina Nielsen, SSU, 707.664.2962, karina.nielsen@sonoma.edu
  Steven G. Morgan, BML, 707.875.1920, sgmorgan@ucdavis.edu
  Jenifer E. Dugan, UCSB, 805.893.2675, j_dugan@lifesci.ucsb.edu

Researchers will collect a comprehensive baseline description of sandy beach biodiversity along the North Central Coast. To accomplish this, several marine protected areas (Saunders Reef, Salt Point and Duxbury State Marine Conservation Areas, and Bodega Head and Montara Marine Reserves) and six reference sites will be surveyed for abundances of shorebirds and macrophyte wrack seven times annually for the first two years of the project. Larger invertebrates will be surveyed, though less frequently. Recreational fishers (using standardized gear and catch-and-release) will gather information on the abundance, diversity and size structure of surf-zone fishes. A pilot citizen-science project will also be launched in the hopes of establishing long-term monitoring of target invertebrate species, shorebirds and beach wrack. In addition, the project has a socioeconomic component in which scientists will document common recreational activities (i.e., surfing, dog walking and beach fishing) and their effects on beach plants and animals. As scientists involved in this project have documented, sandy beaches provide vital foraging grounds for shorebirds and are an important source of small invertebrates for several species of surf-zone fishes.

- **Baseline Monitoring of Ecosystem and Socioeconomic Indicators for MPAs along the North Central Coast of California—Integrated Ecosystem Assessment and Multivariate Indicators**
  R/MPA-15 Mar. 2010–Feb. 2013
  William Sydeman, FIAER, 707.478.1381, wsydeman@comcast.net

A vast amount of new biological and socioeconomic data will be gathered during the North Central Coast baseline program. In this project, a researcher will conduct statistical analyses of existing physical and biological data in the study region to assess the status of the ecosystem at the time of the establishment of the marine protected areas. Mathematical techniques such as Principal Components Analyses will be used to derive indicators of marine life and oceanic conditions. The primary goal is to place the benchmark data, inside and outside the marine protected areas, within the context of climate variability such as El Niño/La Niña episodes and flip-flops of the Pacific Decadal Oscillation. The results of this project will facilitate future monitoring efforts by creating a template for compiling and analyzing groups of datasets, while the contextual analysis will help distinguish broad climatic trends from changes associated with the new regulations.

- **Baseline Monitoring of Ecosystem and Socioeconomic Indicators for MPAs along the North Central Coast of California—Consumptive and Nonconsumptive Human Use**
  R/MPA-16 Mar. 2010–Feb. 2013
  Astrid Scholz, EF, 503.467.0758, ascholz@ecotrust.org
  Christopher LaFranchi, NE/NMS, 415.602,7302, chris@naturalequity.com

The types and intensities of activities that people engage in along the North Central Coast—be it surfing, dog walking, fishing or boating—will greatly influence the region's ecological response to the new marine protected areas. The purpose of this project is to characterize human activities, within and outside the protected areas, in terms of their prevalence, spatial distribution and economic impact. This benchmark of human uses will then be integrated into the ecological indicators of the protected areas' performance. Besides the overarching theme of characterizing coastal-use patterns, specific data to be collected include: vessel operation costs, trip expenditures, and demographic characteristics of consumptive and nonconsumptive users. The three major sectors of coastal user communities to be studied are: 1) private recreation, consumptive and nonconsumptive; 2) commercial fishing, and 3) commercial charter, including consumptive and nonconsumptive activities, such as commercial passenger sport fishing and whale watching. The core outcome of this project will be a series of standardized, fully documented, georeferenced, quantitative socioeconomic datasets, which together create a benchmark for the current extent, pattern and importance of consumptive and nonconsumptive human activities along the North Central Coast. The approach will be such that it may be easily replicated for future long-term monitoring.

- **High-Resolution Nearshore Substrate Mapping and Persistence Analysis with Multispectral Aerial Imagery**
  R/MPA-17 Mar. 2010–Feb. 2013
  Jan Svejkovsky, OI, 858.792.8529, jan@oceani.com

Aerial imaging technology, coupled with multispectral analyses, will be employed to map habitats and coverage of macroalgae, plants and bottom substrates in subtidal and intertidal ecosystems along California's North Central Coast, at resolutions ranging from 40 centimeters to 2 meters. The high-resolution, geo-referenced maps will make it possible to evaluate changes in kelp coverage and other indicators over time, within and outside the marine protected areas. Because kelp cover and other indicators may vary on seasonal cycles unrelated to the new regulations, scientists will conduct time-series analyses to estimate persistent (average) and variable components of kelp, eelgrass, surf grass and pickleweed distributions. Substrate will be classified and then validated in the field. The final products will include a set of raw-image data files, calibrated and assembled, as well as GIS-compatible habitat maps.

Delta Science Fellows Program

Through the Delta Science Fellows Program (formerly the CALFED Science Fellows Program), postdoctoral and graduate researchers collaborate with community and scientific mentors on targeted Bay-Delta research priorities. As of August 2010, there were 21 active fellowship projects continuing into 2011.

- **Restoring Non-Equilibrium Riparian Communities in Disturbance-Altered Ecosystems: Implications for River Management and Climate Change**
  R/SF-14 Dec. 2006–Jun. 2011
  John Stella, SUNY/ESF, 315.470.4902, stella@esf.edu

The Fremont cottonwood (*Populus fremontii*) stabilizes riverbanks, fixes carbon, produces woody debris, creates complex floodplain habitat for fish and wildlife and is, in short, an important component of the Central Valley's native riparian ecosystem. The project's objective is to better understand the ecological factors influencing the health, growth and sustainability of these forests. Data collected have been used to develop conceptual models that incorporate the climate, hydrologic and topographic factors needed for tree recruitment and surival. This research is intended to help policymakers and managers prioritize restoration efforts to reverse the decline of cottonwood populations.

- **Temporal and Spatial Patterns in Abundance and Production in Pelagic Organisms in the Low Salinity Zone (Suisun Marsh, Bay and Delta) of the San Francisco Estuary with Insight into Trophic Position and Impacts of Alien Invasive Species**
  R/SF-19 Dec. 2006–Feb. 2012
  Robert Schroeter, UCD, 530.219.9693, reschroeter@ucdavis.edu

This project is exploring the possible ecological factors that may be contributing to species declines in the upper San Francisco Estuary. In particular, the Delta Science Fellow is comparing habitats with extensive population declines (e.g., Suisun, Honker and Grizzly bays and the lower reaches of the Sacramento and San Joaquin rivers) to similar habitats in Suisun Marsh, where species declines have been much less pronounced. In the first year of the project, the fellow determined the spatial and temporal distributions of jellyfishes and key pelagic fishes in and around Suisun Bay. In the spring and summer of 2011, the fellow plans to quantify the most abundant invertebrates in and around the marsh.

- **Mercury Interactions with Algae: Effects on Mercury Bioavailability in the San Francisco Bay-Delta**
  R/SF-22 Jun. 2007–Aug. 2011
  Allison Luengen, USF, 415.422.4332, aluengen@usfca.edu

This project seeks to more clearly understand how mercury enters and moves through the food chain within the San Francisco Bay-Delta. The Delta Science Fellow has shown that the presence of dissolved organic matter (DOM) in the water decreases methylmercury uptake by phytoplankton. It is theorized that DOM binds to the mercury, preventing its absorption. The fellow has also studied the combined effects of DOM and chlorine (and other factors) on the availability of mercury to algae and also small invertebrates known as amphipods. Preliminary results show an inverse relationship between methylmercury accumulation and DOM concentrations in algae, and that amphipods appear to assimilate 65–70% of the methylmercury in the algae they consume.

- **Measuring and Predicting the Success of Riparian Restoration for Wildlife Populations**
  R/SF-23 May 2007–Jun. 2011
  Nathaniel Seavy, PRBOCS/UCD, 415.868.0655, x311, nseavy@prbo.org

The most recent component of the Delta Science Fellow's research focuses on determining the costs and benefits of different riparian restoration options along the Sacramento River. In particular, he and colleagues attempted to quantify the degree to which planting trees, at different densities and with different species, created habitat for six common riparian bird species, and then examined the relative costs of the different restoration approaches. Findings show that planting more trees and more species of trees (i.e., willows, cottonwoods and valley oaks, among others) pays off, in terms of markedly improving habitats for birds. Future work will continue to look at where and how to most cost effectively restore riparian bird habitats in the Central Valley.

- **Validation of a New Method for Population Assessment of Pacific Salmonids Using Genetic Markers**
  R/SF-24 Jun. 2007–Jun. 2011
  Anthony Clemento, UCSC, 831.420.3906, anthony.clemento@noaa.gov

The Delta Science Fellow has identified more than 110 new single nucleotide polymorphism markers for chinook salmon. In combination with other markers from the peer-reviewed literature, a panel of 96 optimal markers was assembled. This panel of markers allows scientists to establish a fish's parentage (its hatchery and cohort) with exceedingly high accuracy (approximately one incorrect parent-offspring trio in a trillion comparisons). Scientists are in the process of genotyping chinook salmon at the 96 markers to more accurately identify stocks and parentage. This identification dataset currently includes genetic information from more than 2,700 salmon from 30 populations in California, Oregon, Idaho, Washington, British Columbia and Alaska. Researchers plan to use the genetic information as a means of tracking salmon to more fully understand the effects of water policy decisions, fisheries management and climate change on salmon populations.

- **Modeling Physical Drivers and Age Structure of Cottonwood Forest Habitat: An Integrated Systems Approach**
  R/SF-25 Mar. 2008–Jun. 2011
  Elizabeth Harper, PSC, 518.354.8090, eharper@paulsmiths.edu

This project seeks to improve the long-term prospects for restoring one of the signature species of the Central Valley's riparian ecosystem—the Fremont cottonwood. To better prepare for the potential effects of climate change and water policies on the trees, the Delta Science Fellow is modeling the physical processes driving river channel migration and cottonwood habitat creation along the 100-mile stretch of the Sacramento River from Red Bluff to Colusa that is under restoration by the Nature Conservancy. Findings may help protect cottonwood forests and the many bird and mammal species that rely on them for food, cover and nesting. To date, the fellow has conducted a sensitivity analysis showing that physical and not biological variables have the greatest impact on the fate of the trees. In particular, the timing, volume and velocity of water flowing through the river and the rate of floodplain accretion all ultimately determine the success or failure of cottonwood germination, growth and survival. The model will be used to make predictions about the consequences of climate change on river dynamics and its implications for the future of its cottonwoods.

- **Endocrine Disruption in the Delta: Confirming Sites' Known Estrogenicity with Outplants, Histology, and Choriogenin Level Measurements**
  R/SF-27 Sep. 2007–Aug. 2011
  Susanne Brander, UCD, 707.875.1974, smbrander@ucdavis.edu

In laboratory experiments, endocrine disrupting compounds (EDCs) are easily shown to cause health and reproductive problems for fish. Documenting the impacts of chronic, low-level contamination in the field, however, is more challenging. In this project, the Delta Science Fellow is investigating the effects of EDCs on the ubiquitous silverside fish (*Menidia audens*) at two sites in Suisun Marsh. One site is exposed to treated wastewater effluent and urban runoff, the other to ranch runoff. EDCs in water samples from both sites have been shown to bind to the estrogen and androgen receptors in cell-based assays. Immunoanalyses, meanwhile, reveal that wild male fish exposed to EDCs produce greater amounts of choriogenin (an eggshell protein normally produced by only females) than control fish. In field experiments in 2009, there were relatively fewer males and they were smaller at the ranch site, as compared to the urban site. The opposite

was observed with the females, which were larger and more abundant, relatively speaking, at the ranch site. The same trends were observed in the first half of 2010.

- **Tidal Wetland Vegetation Response to Climate Change in the San Francisco Bay-Delta**
  R/SF-28 Sep. 2007–Jun. 2011
  Lisa Schile, UCB, 415.378.2903, lmschile@gmail.com

If predictions of future sea level rise come true, freshwater marshes in the San Francisco Estuary stand to be flooded with saltier water and presumably replaced by brackish marshes. This project explores the potential effects of sea level rise on the distributions of wetland plants (e.g., California cordgrass, tule, bulrush, pickleweed and cattails). In conjunction with field surveys to map plant locations as a function of present topography, the Delta Science Fellow is installing marsh organs—planters set in marsh channels at predetermined elevations—to simulate higher sea levels and their implications for plant growth and survival. A series of greenhouse experiments will also be conducted to measure plants' responses to different salinities and inundation levels. The final product will be a set of GIS maps of predicted vegetation patterns in the estuary under future climate scenarios.

- **Nutrients and Benthic Invasion Dynamics in San Francisco Bay**
  R/SF-29 Oct. 2007–Jun. 2011
  Heidi Weiskel, UCD, 530.902.0878, hwweiskel@ucdavis.edu

This project explores the consequences of nutrient pollution in San Francisco Bay on two mud snails. One is an invasive species, *Ilyanassa obsoleta*; the other is the bay's only native mud snail, *Cerithidea californica*. Findings to date suggest that nutrients, at low levels, are a resource to the snails because the nutrients feed microalgae upon which the snails graze. At higher levels, a transition occurs and nutrients become harmful to the animals. That at least is the theory being tested. In a separate but related study, the fellow observed a sudden rise in the number of *Batillaria attramentaria* (a relatively new invasive mud snail) and is now studying the causes and impacts of its population explosion; the effectiveness of different eradication methods and their environmental safety will be tested.

- **Environmental Water: Developing Indicators and Identifying Opportunities**
  R/SF-30 Jan. 2008–Jun. 2011
  Sara Hughes, UCSB, 805.893.7064, shughes@bren.ucsb.edu

As Twain's famous saying goes, "Whiskey is for drinking; water is for fighting over." In this project, the Delta Science Fellow is compiling 20 years of survey data from more than 300 urban water municipalities in California, collected by the California Department of Water Resources. The survey collects information about a community's sources of water (i.e., groundwater, recycled water or purchased water); the amount of water used by the community, and the community's size (i.e., number of residents, businesses and farms). The fellow plans to use the survey data to track communities' responses to droughts, legal decisions, regulations and political will, in terms of where and at what price they obtain water. Los Angeles will be used as a case study of how a city responds when it loses access to some of its traditional sources of water. What is learned may lead to new approaches for meeting future water-related challenges in urban areas of the state.

- **Linking Freshwater Sources of California Chinook Salmon to Their Ocean Distribution Using Physical and Natural Tags of Origin**
  R/SF-31 Jun. 2009–May 2011
  Rachel Barnett-Johnson, UCSC, 831.239.8782, barnett-johnson@biology.ucsc.edu

How can fishermen harvest healthy salmon stocks without catching endangered salmon species? This question is being explored by looking at the degree to which salmon from different natal rivers or hatcheries aggregate at sea. The Delta Science Fellow is integrating multiple fish markers—based on isotope ratios, genetics and otolith microstructure—with historical coded wire-tag data. Based on preliminary findings, ocean salmon appear to be composed of seven Evolutionarily Significant Units (ESUs), with the vast majority of fish in the Central Valley Fall ESU originating from the Coleman National Fish Hatchery. Until about the age of three, salmon appear to maintain a spatial population structure at sea. Continuing analyses will probe the degree to which different salmon populations mix at sea as the fish age.

- **Copper-Binding Organic Ligands in the San Francisco Bay Estuary: Evaluating Current and Future Likelihood of Copper Toxicity Events in a Perturbed Ecosystem**
  R/SF-32 Sep. 2008–Jun. 2011
  Kristen Buck, BIOS, 441.297.1880 ext. 711, kristen.buck@bios.edu

Where are the different chemical forms, toxicities and sources of copper in San Francisco Bay and might freshwater diversions exacerbate the heavy metal's toxicity? To answer these questions, the Delta Science Fellow is studying the relative contributions of copper-binding organic ligands from the Sacramento and San Joaquin rivers, Suisun Slough and Sulphur Springs Creek. The ligands are of interest because they have been shown to reduce the bioavailability of dissolved copper. In the early stages of the project, the fellow observed high concentrations of leachable particulate copper and zinc, as well as dissolved copper, in all estuarine water samples. As expected, the presence of strong organic ligands dramatically reduced the toxicity of the dissolved copper. Notably, however, high concentrations of weaker organic ligands were also effective at reducing the metal's bioavailability, particularly at elevated levels of copper contamination.

- **Effects of Freshwater Flow and Population Connectivity on Benthic Community Dynamics in the San Francisco Estuary**
  R/SF-33 May 2009–Aug. 2011
  Andrew Chang, UCD, 530.400.9410, andchang@ucdavis.edu

Following heavy rains, the salinity of the San Francisco Estuary can drop precipitously, stressing and sometimes even killing native Olympia oysters (*Ostrea conchaphila*) and non-native Mediterranean mussels (*Mytilus galloprovincialis*). As part of a broader effort to restore native oyster beds and control invasive species that may hinder oyster recovery, the Delta Science Fellow and colleagues are conducting bimonthly field surveys of the bivalve populations and their size classes at 12 sites in the estuary's brackish waters. Scientists now have good estimates of the species' populations and have demonstrated the ability to use trace elemental fingerprinting to determine the birth grounds of newly settled juveniles. They are currently in the process of trying to determine the spatial scale at which the fingerprinting technique is valid. In the project's final months, the fellow will conduct laboratory experiments to further quantify the stress effects of low salinity water on the animals' heart rates, reproduction and survival.

- **Investigating the Frequency and Magnitude of Floods in the Sacramento-San Joaquin Valleys Under Changing Climate**
  R/SF-34 Oct. 2008–Jun. 2011
  Tapash Das, UCSD, 858.822.3572, tadas@ucsd.edu

How might climate change alter California's risk of floods in the future? The Delta Science Fellow is investigating this question by simulating flooding under a range of climate-change scenarios for the western Sierra Nevada. All three of the General Circulation Models predict larger floods (with 50-year return intervals) from 2051 to 2099. More intense floods appear to be a consequence of several factors—bigger storms, more frequent big storms and more days of precipitation falling as rain instead of snow. Moister winter soils, which are less able to absorb added water, also play a role in some areas. Results underscore the fact that different areas of the state will be exposed to very different degrees of flooding, depending on their drainage basins and local topography. As a result, forecasts must be made at a local scale if they are to help communities appropriately plan for and protect themselves from flood events and changes in water supply.

- **Plankton Dynamics in the Sacramento-San Joaquin Delta: Long-Term Trends and Trophic Interactions**
  R/SF-36 Oct. 2008–Aug. 2011
  Monika Winder, UCD, 530.754.9354, mwinder@ucdavis.edu

In this project, a 33-year record of plankton taxonomy in the San Francisco Bay-Delta is being analyzed to identify long-term trends, patterns and interactions among the region's phytoplankton and zooplankton. To date, the Delta Science Fellow reports that a major shift in the zooplankton community occurred during the extended drought of 1987–1994, when several non-native copepods and mysid species were introduced. These non-native species displaced local calanoid and rotifer species, resulting in a zooplankton community dominated by cyclopoids with low mysid biomass. The average size of zooplankton simultaneously decreased. The changes imply a major reworking of pelagic food-web processes, including diminished food quality for foraging fish and increased carbon recycling in the microbial food web. Findings suggest that persistent climatic shifts such as long droughts can dramatically alter zooplankton communities, facilitate non-native species invasions, and perhaps contribute to pelagic species declines.

- **Frequency, Distribution and Ecological Impact of Cryptic Hybrid Invaders: Management Tools for Eradication of Invasive Spartina**
  R/SF-37 Sep. 2008–Jun. 2011
  Laura Feinstein, UCD, 530.204.8325, lfeinstein@ucdavis.edu

The current strategy for eradicating the exotic cordgrass *Spartina alterniflora* from salt marshes of San Francisco Bay is to apply herbicide to plants that visibly resemble the invasive or its hybrids. The Delta Science Fellow is investigating whether this management approach is resulting in the selection of hybrids that bear no external resemblance to the invasive plant but carry non-native genes that could continue to cross with native cordgrass. Genotyping of 92 plants in four marshes has shown that 78% of plants were cryptic hybrids (i.e., they did not look like hybrids but were). Among these nonobvious hybrids, only 29% of their genes were of exotic origin, compared with 55% in the obvious hybrids. Resampling in 2011 will show if cryptic hybrids are becoming more common in treated marsh areas, while a controlled garden experiment will look at whether they can thrive under as great a range of intertidal conditions as the obvious hybrids.

- **Climate Change and In-Stream Flows: Methods for Application of Risk Analysis to Modeling of Environmental Water Supplies**
  R/SF-38 Sep. 2008–Jun. 2011
  Michael Kiparsky, UCB, 415.806.6656, kiparsky@berkeley.edu

Climate models predict a variety of impacts to the hydrology of the Central Valley in coming decades. But, what do these changes mean for water managers? How can they best prepare and respond to uncertainties in water supply? What is an acceptable level of risk for meeting environmental objectives (e.g., maintaining adequate flows for fishes) and securing a reliable water source? To address these topics, the Delta Science Fellow and colleagues modeled the hydrology and water operations in the Stanislaus, Tuolumne and Merced rivers, incorporating projections of urbanization and population growth through 2099. Consistent with other studies, climate change alone appears to lead to a greater demand for water and a diminished water supply by 2050. In the face of continued population growth and urbanization, water demand declines and the reliability of the water supply increases as farmland is developed. A second model under development is attempting to simulate resource managers' risk tolerances to uncertainties in water supply.

- **Scenarios for Restoring Ecologically Functional Floodplains and Providing Flood Control Services in the Sacramento-San Joaquin Delta**
  R/SF-39 Sep. 2008–Jul. 2011
  Mary Matella, UCB, 510.643.1136, mmatella@nature.berkeley.edu

Are there places in the Central Valley where levees could be set back or bypassed to both reduce the risk of flooding and improve ecological functioning of riparian systems? How might climate change alter patterns of flooding and restoration opportunities? The Delta Science Fellow is using the Hydrologic Engineering Center-Ecosystems Functions Model to simulate possible future changes in inundation and resulting benefits to floodplains in the south Delta. Model output will show the viability of restoring floodplain habitats, based on adjustments of flood stage and topography. The findings may help managers plan and evaluate floodplain restoration projects—to meet conservation goals, advance flood control strategies and, in some cases, improve water supply reliability.

- **Reconstructing Climate Variability, Acidity and Water Availability in the Sacramento-San Joaquin Watershed Based on Isotopic Evidence in Sediments from Swamp Lake, Yosemite**
  R/SF-40 Jan. 2009–Aug. 2011
  Joseph Street, SU, 415.298.2543, jstreet@stanford.edu

This project explores the potential to use hydrogen isotope ratios preserved in leaf material in lake sediments to back out a timeline of the region's hydrology. The approach is being applied to a 20,000-year-old, 10-meter sediment core from Swamp Lake in Yosemite National Park. Motivating the research is concern that climate change will alter the availability of water by, for example, melting the snowpack in the Sierra Nevada. In the first year of the project, the Delta Science Fellow showed that hydrogen isotope ratios are sensitive to the size of the spring snowpack, and documented a long-term decline in the ratio of deuterium to hydrogen during the Holocene, coincident with gradual increases in wintertime precipitation. Large oscillations in the isotope ratio over the last 12,000 years were observed and interpreted as evidence of centuries-long cycles in the size of the snowpack. These natural cycles lend further credence to the idea that droughts in California are linked to oceanic and atmospheric conditions in the North Pacific. Interestingly, the isotope record also suggests that climate variability in the Sierra Nevada has intensified during the last 6,000 years, possibly in conjunction with the intensification of El Niño cycles over this same period.

- **Pilot-Scale Evaluation of an Iron Sediment Amendment for Control of Mercury Methylation in Tidal Wetlands**
  R/SF-41 Jan. 2009–Jun. 2011
  Patrick Ulrich, UCB, 510.439.8544, ulrich@berkeley.edu

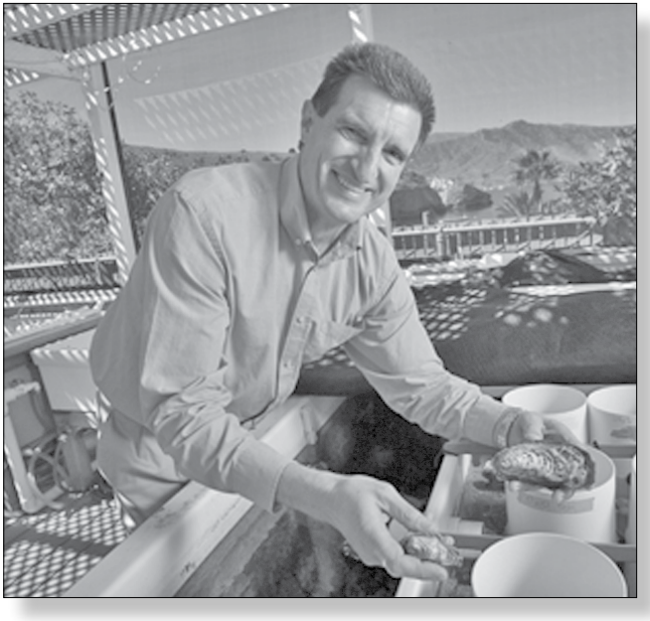
About 40,000 acres of tidal wetlands in the Bay-Delta are slated for restoration in the next two decades. Though the restoration will greatly benefit wildlife, there are concerns that all the earth moving (to build the wetlands) could release methylmercury into the aquatic environment and cause the Bay-Delta basin to exceed allowable mercury levels. This project is examining a novel and potentially powerful method for decreasing methylmercury releases from restored wetlands—the application of an iron-containing sediment amendment to limit the action of methylating bacteria. Preliminary laboratory experiments have shown, compellingly, that high iron doses can decrease methylmercury concentrations tenfold. The Delta Science Fellow is now examining whether the results can be replicated in the field—at a tidal salt marsh along the Petaluma River. To accomplish this, pore water from pickleweed-dominated sediments on the high marsh plain is being analyzed for iron, sulfur and methylmercury before and after iron is added to the sediments.

- **Sacramento River Steelhead Trout: An Assessment of Behavioral Differences and Contributions of Hatchery and Wild Stocks**
  R/SF-43 Sep. 2008–May 2011
  Philip Sandstrom, UCD, 803.466.3172, ptsandstrom@ucdavis.edu

The Delta Science Fellow is tracking acoustically the migratory movements and survival rates of both wild and hatchery steelhead trout in the Sacramento River watershed, using the California Fish Tracking Consortium's telemetry array. In December 2008 and January 2009, about 300 tagged smolts (yearlings) from the Coleman National Fish Hatchery were tagged and released at three different locations on the Sacramento River above Sacramento. The tracking data show that 47–63% of wild and hatchery steelhead migrated along the main stem of the Sacramento River, with 20–28% of fish swimming through Georgiana Slough. About 5–12% of fish migrated through Steamboat Slough; 5–19% through Sutter Slough, and 0–9% through Miner Slough. On average, it took the hatchery fish 20 days (December fish) and 23 days (January fish) to reach the Golden Gate Bridge in San Francisco. The wild smolts' migration, in contrast, took only 12 days on average. As more tracking data is accumulated, the fellow will calculate survival rates along different routes and return rates of released fish. The goal, ultimately, is to be able to estimate the contributions of hatchery-born fish to wild stocks.

- **Genomically Enabled Crossbreeding to Improve Yields of Farmed Pacific Oysters**
  R/AQ-132NSI Jan. 2011–Feb. 2013
  Dennis Hedgecock,USC, 213.821.2091, dhedge@usc.edu
  Donal Manahan, USC, 213.740.5793, manahan@usc.edu
  Paul Olin, CASGEP, 707.565.3449, polin@ucsd.edu

The ultimate goal of this project is to increase domestic oyster production by breeding a higher-yielding Pacific oyster hybrid. To do this, researchers will employ genomic (gene-mapping) and transcriptomic (gene-expression profiling) methods to identify genes that can serve as biomarkers for the detection of superior hybrids in oyster larvae. The benefit of this genetically based early detection system will be in reducing the time it takes to find (i.e., cross-breed) a suitable hybrid. The scientific objectives are to test whether the genes controlling protein metabolism are associated with hybrid vigor (i.e., growth) and whether faster growth is associated with low variance in expression of certain genes. Three commercial shellfish farms collaborating on the project will rear hybrid seed alongside standard, commercial seed to gather data on the differences in yields, production costs and return on investment.



Dennis Hedgecock. Photo: ©2009 Phil Channing, USC

NOAA Fisheries/Sea Grant Fellowships

NOAA Fisheries and the National Sea Grant Office jointly offer Graduate Fellowships in Population Dynamics and Marine Resource Economics. Fellows, all doctoral students, are selected through a national competition to study topics of relevance to fisheries management under the guidance NOAA Fisheries scientists. Research conducted during the fellowships is consistent with NOAA's mission to "protect, restore and manage the use of coastal and ocean resources through ecosystem-based management." (For details, see http://www.csgc.ucsd.edu/EDUCATION/SeaGrantFellows.html)

- **NOAA Fisheries-Sea Grant Graduate Fellowship in Population Dynamics: Integrating Molecular Data into a Robust Population Framework for an Apex Predator**
  E/PD-4 Jun. 2008–May 2011
  David Kacev, SDSU, 858.717.0942, dkacev@sunstroke.sdsu.edu

The primary goal of this project is to better understand the population structure and dynamics of shortfin mako sharks in the northeastern Pacific Ocean. To accomplish this, several hundred mako skin biopsy samples have been collected, many of which are archived at NOAA's Southwest Fisheries Science Center in La Jolla. The researcher is currently working with Genetic Identification Services in Chatsworth, California, to develop custom microsatellite markers for a population genetics analysis. The researcher also plans to build a conceptual framework for a population dynamics model.

- **NOAA Fisheries-Sea Grant Graduate Fellowship in Marine Resource Economics: The Role of Voluntary Fishing Cooperatives in U.S. Fisheries Management: Costs, Benefits and Economic Efficiency**
  E/MRE-5 Jun. 2010–May 2011
  Benjamin T. Gilbert, UCSD, 858.405.9239, btgilbert@ucsd.edu

What are the socioeconomic costs and benefits of transferable fishing quotas to commercial fishers, fishery managers and the public? In this project, the fellow is reviewing and analyzing information from two New England groundfish cooperatives that divide the catch allocated to their respective co-ops. Analyses thus far have shown that these co-ops (created between 2004 and 2006) have accomplished significant productivity gains relative to other vessels in the fleet. In addition, there was a significant decrease in the use of capital in the co-ops, meaning fishing efficiency had improved. Fishermen in the co-ops were also observed to be shifting from specializing in cod harvest to a more diversified portfolio with other fish stocks.

- **NOAA Fisheries-Sea Grant Graduate Fellowship in Population Dynamics: Understanding the Influence of a Variable Ocean Environment on Chinook Salmon (*Oncorhyncus tshawytscha)***
  E/PD-6 Jun. 2009–May 2011
  D. Patrick Kilduff, UCD, 530.754.8644, dpkilduff@ucdavis.edu

A number of environmental factors influence the size and health of salmon populations. On the West Coast, chinook salmon are a favorite species among sport anglers; fish up to six years of age and weighing up to 60 pounds have been documented in Northern California. In this project, the scientist will look at how changing oceanic conditions affect chinook salmon populations along the West Coast of North America. He will analyze coded wire-tag data collected from chinook salmon since the 1980s and maintained by the Regional Mark Processing Center (http://www.rmpc.org). These data permit investigation of the temporal and

spatial patterns in both survival and age of spawning with respect to variable and cyclical ocean conditions over a large portion of their range. Among the variables being analyzed are sea-surface temperature, upwelling, the Pacific Decadal Oscillation, and the El Niño Southern Oscillation. The results should help fishery resource managers and others better understand annual chinook salmon survival in the ocean.

- **NOAA Fisheries-Sea Grant Graduate Fellowship in Population Dynamics: Assessing the Robustness of the Salmon Stock Assessment Process via a Life History Simulator**
  E/PD-7 Jun. 2010–May 2012
  Valerie Brown, UCSC, 925.876.8947, vbrown@soe.ucsc.edu

Stock assessments provide an evaluation of the status of a particular fish population and are vital to the development of sustainable fishing practices. They are, however, based on many assumptions about the data and their meaning. In this project, the fellow will use a simulator to analyze stock assessments of Pacific salmon species. The goal is to test the robustness of the assumptions used to make stock assessments and to determine an appropriate level of data necessary for accurate results.

- **NOAA Fisheries-Sea Grant Graduate Fellowship in Population Dynamics: Modeling the Effects of Interspecies Facilitation on Recruitment Success and Population Stability in Dwarf Rockfishes (Sebastes spp.)**
  E/PD-8 Jun. 2010–May 2012
  Emilius Aalto, UCD, 203.809.6376, aalto@ucdavis.edu

The objective of this project is to develop and utilize community models for analyzing population data for the California dwarf rockfish. The fellow will first investigate the evolution of the dwarf rockfish in response to fishing pressure and marine protected areas. Later in the project, the focus will shift to analyzing interspecies interactions. In the past, much of the research done by fisheries scientists has focused on single-species dynamics; however, to manage California fisheries in the context of the greater ecosystem, scientists must know the role of each species in the community. Part and parcel with this, the fellow will analyze predator-prey interactions and competition and their effects on community stability.

Education, Training & Public Information

- **Sea Grant Trainees**
  R/G-2
  J.E. Eckman/CASG

Sea Grant graduate students participate in research and work on problems relating to marine resources while fulfilling theses requirements. This prepares them to enter positions in the academic community, government and industry.

- **John D. Isaacs Marine Undergraduate Research Assistant Program**
  E/UG-4
  J.E. Eckman/CASG

This grants program provides undergraduate students with the opportunity to work closely with established marine scientists, develop their research skills, and better define their career goals in marine science. The program honors the memory of John D. Isaacs, a world-renowned figure in marine science.

Knauss Sea Grant Fellows 2011

The federal Knauss Marine Policy Fellowship Program matches highly qualified graduate students with hosts in the legislative branch, the executive branch, or appropriate associations/institutions located in the Washington, D.C. area for a one-year paid fellowship.

Kristin Carden • Program Coordination, Office of the Undersecretary, Department of Commerce • carden@lifesci.ucsb.edu

Katie Cramer • Commerce Subcommittee on Oceans, Atmosphere, Fisheries, and Coast Guard • kcramer@ucsd.edu

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Amanda Keledjian • NOAA Fisheries Service, Office of Protected Resources • amandakeledjian@gmail.com

Nicole Teutschel • Office of Washington Senator Maria Cantwell • nteutsch@ucsc.edu

California Sea Grant State Fellows 2011

The program, modeled after the federal Knauss Marine Policy Fellowship, provides graduate students with training in the development and implementation of policy. Fellows are assigned to a state agency, legislative committee, or office concerned with marine resource issues.

Sarah Flores • California Ocean Protection Council • scflores@ucdavis.edu

Oren Frey • Monterey Bay National Marine Sanctuary • orenfrey@gmail.com

Kristen Hislop • Channel Islands National Marine Sanctuary • kristenhislop@gmail.com

Aaron McGregor • California Ocean Science Trust • aaron.r.mcgregor@gmail.com

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Resources Agency Sea Grant Advisory Panel

The state of California interacts with California Sea Grant through the Resources Agency Sea Grant Advisory Panel. The panel prioritizes California Sea Grant research in terms of the needs of the state.

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