California Sea Grant

Program Directory 2009

Sea Grant
California

Published by the California Sea Grant College Program
Additional single or multiple copies are
available free of charge from:
California Sea Grant College Program
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9500 Gilman Drive, Dept. 0232
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This document was supported by the
National Sea Grant College Program of the
U.S. Department of Commerce's
National Oceanic and Atmospheric Administration,
by the University of California,
the California State Resources Agency,
the California Ocean Protection Council
and the CALFED Bay-Delta Program.
This publication was produced under
NOAA grant number NA08OAR4170669,
project number C/P-1 through the
California Sea Grant College Program.
The views expressed herein do not
necessarily reflect the views of any of those organizations.

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.

Report No. R-058
Printed on recycled paper
2009

Message from the Director …

In preparing my annual message this year, I went back and looked at my messages from the past few years. It is amazing how fast things have changed and how we could have never predicted the events of today three years ago. Whereas back then the state of California and the national government seemed to share the stage on marine research, the balance has now tilted much toward the state. Further, regional activities were barely a consideration in 2005 and yet now occupy center stage in coastal ocean governance. Climate change, which seemed a looming but distant concern three years ago, is now foremost in terms of issues that impact our oceans.

California Sea Grant has been evolving with each of these changes. The research portfolio of the program is larger and includes many projects dealing with climate change. Likewise, we are engaged with the other Sea Grant programs on the West Coast of the United States in creating a regional research and outreach plan. Sea Grant is involved in making the West Coast Governor's Agreement on Ocean Health a reality by participating in the development of a West Coast Regional Action Plan. Ideas on how to manage coastal resources that once were developed on a state-by-state basis are now quickly shared among West Coast states and a common approach is becoming more prevalent.

Perhaps the largest change that we have seen in our California state waters is the effort invested in creating a network of marine protected areas (MPAs). From a process that was largely stalled a few years ago, now a rapid pace of MPA development is underway. Just as with climate change and regional governance, the issue of MPAs has its own complex suite of research and outreach topics. California Sea Grant is deeply engaged with the state on the evaluation of the newly created MPA network.

All of these worthwhile activities require substantial efforts. Today more than ever California Sea Grant relies on partners to achieve our objectives. Working with entities such as the California Ocean Protection Council, California Department of Fish and Game, University of California Cooperative Extension, California Resources Agency, Coastal Conservancy and California Ocean Science Trust, we pool resources and talent to achieve common goals.

This is a time of substantial opportunity for those involved in coastal issues in California. It is also a time for quick action that requires informed decision-making. California Sea Grant is pleased to participate in shaping the future of our coasts through the many activities we support.

Russell A. Moll
Director

Contents

What is Sea Grant?

The National Sea Grant College Program, a network of 31 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 development 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, the largest of these 31 programs, draws on the talents of scientists and engineers at public and private universities throughout the state. It is administered by the University of California and is based at Scripps Institution of Oceanography 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. Our Extension personnel, in partnership with UC Cooperative Extension (UCCE), 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 2009 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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BML Bodega Marine Laboratory
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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

CICESE Centro de Investigación Científica y de Educación Superior de Ensenada
Ensenada, Mexico

CSGEP 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

FIAER Farallon Institute for Advanced Ecosystem Research
Petaluma, California 94975

HMS Hopkins Marine Station
Pacific Grove, California 93950

H-SWRI Hubbs-SeaWorld Research Institute
San Diego, California 92109

HSU Humboldt State University
Arcata, California 95521

MLML Moss Landing Marine Laboratories
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NOAA National Oceanic and Atmospheric Administration
Washington, DC 20230

NMFS National Marine Fisheries Service
La Jolla, California 92037

PRBOCS PRBO Conservation Science
Petaluma, Callifornia 94954

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

SAMS Scottish Assn. for Marine Science
Oban, Scotland

SIO Scripps Institution of Oceanography
La Jolla, California 92093

SBU Stony Brook University
Stony Brook, New York 11794

SDSU San Diego State University
San Diego, California 92182

SERC Smithsonian Environmental Research Center
Edgewater, Maryland 21037

SFSU San Francisco State University
San Francisco, California 94132

SSU Sonoma State University
Rohnert Park, California 94928

SU Stanford University
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SUNY-ESF State University of New York College of Environmental Science and Forestry
Syracuse, New York 13210

SWFSC Southwest Fisheries Science Center
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UCB University of California, Berkeley
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UCD University of California, Davis
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UCR University of California, Riverside
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UCSB University of California, Santa Barbara
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UCSD	University of California, San Diego La Jolla, California 92093
UI/ARI	University of Idaho Aquaculture Research Institute Hagerman, Idaho 83332
USDA/ ARS	U.S. Department of Agriculture Agriculture Research Service Washington, D.C. 20250
USC	University of Southern California Los Angeles, California 90033
USGS	U.S. Geological Survey Reston, Virginia 20192
UW	University of Washington Seattle, Washington 98195
WSU	Washington State University Vancouver, Washington 98686

- **Tracer Dispersion in the Surf Zone: Water Quality and Ecology**
  R/CZ-196 Mar. 06–Feb. 09
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  James Leichter, UCSD/SIO, 858.822.5330, jleichter@ucsd.edu
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The overall project goal is to better understand nutrient delivery to the near shore and the biological and physical factors causing phytoplankton patchiness. A Sea Grant-funded Huntington Beach 2006 experiment successfully achieved the first continuous *in situ* measurements of chlorophyll in the surf zone. The scientists modified a JetSki to use as a mobile platform for collecting samples. Additional small boat sampling occurred within a few kilometers of shore, and the Southern California Coastal Ocean Observing System provided mooring data. In collaboration with the Orange County Sanitation Districts and Orange County Health Care Agency, the scientists added a bacterial sampling program to better understand the history of chronic beach closures in the area.

- **Understanding Submarine Groundwater Discharge and Its Influence on Coastal Water Quality Along the California Coast**
  R/CZ-197 Mar. 06–Sept. 09
  Alexandria Boehm, SU, 650.724.9128, aboehm@stanford.edu
  Adina Paytan, UCSC, 831.459.1437, apaytan@ucsc.edu

Researchers have completed fieldwork and laboratory work to investigate summertime and wintertime submarine groundwater discharge at Stinson Beach in Northern California. They have measured radium isotopes, salinity, and silicate as tracers of submarine groundwater, as well as nutrients, fecal bacteria, F^+ coliphage (an indicator of viral pollution) and chlorophyll in the surf zone and sand. In the last year, they analyzed winter data and found that the beach aquifer in the Calles district was contaminated with human waste, as it had been in summer, too. Fresh groundwater, which includes septic tank discharge, appears to be a source of fecal bacteria and nutrients in coastal waters.

- **The Effects of Current Velocity and Creek Morphology on the Population Dynamics of Spionid Polychaetes in the Tijuana Estuary**
  R/CZ-199 Mar. 06–Feb. 09
  Brian Hentschel, SDSU, 619.594.0358, hentsche@sunstroke.sdsu.edu

The overall objective is to evaluate the effects of creek velocities on the population dynamics of spionid polychaete worms. To do this, the scientists are manipulating flows through channels of the NOAA Tijuana River National Estuarine Research Reserve, where efforts are underway to restore hundreds of acres of salt marsh. In the spring and summer of 2008, the scientists began a series of transplantation experiments, measuring the growth rates of individual spionids at three tidal elevations. Findings from this project should help with designing, constructing and managing rare salt marsh habitats.

- **The Role of Symbiotic Bacterial Metabolites in the Development of Toxic Phytoplankton Blooms**
  R/CONT-205 Feb. 08–Jan. 11
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Building on previous Sea Grant research (R/CZ-198), the chemists continue to explore the structure and iron-binding characteristics of the siderophore vibrioferrin, produced by members of the *Marinobacter algicola* clade of the gamma-proteobacteria and others associated with harmful algal bloom producing dinoflagellates. They have found that vibrioferrin is an unusually weak, extremely photosensitive iron binder that degrades in sunlight to produce reduced iron (Fe(II)), a molecule incapable of binding iron. They theorize that phytoplankton hijack iron from the bacteria either directly by using the iron-vibrioferrin complex, as the bacteria do, or by using the reduced iron produced by exposure to sunlight. Uptake experiments to test this are underway.

- **Climate Change and Restoration Factors Affecting Fecal Pathogen Dynamics in Wetland Systems**
  R/CONT-206 Feb. 08–Jan. 11
  Woutrina A. Miller, UCD, 530.219.1369, wamiller@ucdavis.edu
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Through a combination of field and laboratory studies, researchers are probing the implications of climate change and wetland restoration on the fate and transport of fecal pathogens along the coast. The fieldwork is being conducted at the Molera wetland in Monterey County, built in 2005 by the researchers leading this project. Both field and laboratory studies will focus on understanding how flows, vegetation, water temperature and salinity affect pathogen loads. The pathogens to be investigated include clinically relevant *Cryptosporidium parvum*, *Toxoplasma gondii* and *Giardia duodenalis*. Findings from this project will advance the science of constructed wetland mitigation as a means of optimizing their natural filtering function. Research summaries will be posted on the NOAA Monterey Bay National Marine Sanctuary's SIMoN Web site. The researchers also plan to develop curricular material for schools.

- **The Effects of Terrestrial Nutrient Inputs on Nearshore Planktonic Ecosystems**
  R/CONT-207 Feb. 09–Jan. 12
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In 2009, an experiment at Imperial Beach will study the complex set of physical processes controlling water quality during the warm, dry season, when people are most likely to come in contact with contaminated beach water. The specific goals of the project are: (1) determine where nearshore nutrients are coming from and how these sources relate to nearshore phytoplankton "patchiness" and episodic blooms, including harmful algal blooms; (2) quantify the effects of nearshore conditions (i.e., tides, waves, currents and mixing) on distributions of phytoplankton and fecal indicator bacteria; (3) quantify the relative concentrations of free-living fecal indicator bacteria and diagnose the conditions under which they attach to phytoplankton. Determine whether attachment affects rates of bacterial loss; (4) address the degree to which sunlight and dilution reduce viable fecal indicator counts in the surf zone.

- **Investigating the Limits of Native Oyster Recovery and Restoration**
  R/ENV-203 Feb. 07–Jan. 10
  Edwin Grosholz, UCD, 530.752.9151, tedgrosholz@ucdavis.edu
  Chela Zabin, SERC, 415.435.7128, zabinc@si.edu

Why does one oyster restoration project succeed while a seemingly identical one fails? This project seeks to answer the question using native oyster populations in San Francisco and Tomales Bays as case studies. To do this, scientists are studying spatial and temporal variability of oyster recruitment, measuring predation by Atlantic oyster drills and European green crabs, and quantifying effects of fouling organisms and "space competitors" like tunicates and sponges. The long-term viability of native oysters will also be examined. Resource managers will use the project's results to decide where and how to conduct oyster habitat restoration.

- **Connectivity of West Coast Marine Sanctuaries: Tracking Sooty Shearwaters Throughout Dynamic Upwelling Ecosystems in the California Current System**
  R/ENV-204 Feb. 08–Jan. 11
  James T. Harvey, MLML, 831.771.4434, harvey@mlml.calstate.edu
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Sooty shearwaters are attracted to upwelling retention zones off California, but why? The theory is that these areas team with northern anchovy, Pacific sardine and juvenile rockfishes, favorite foods for the birds. The objective of this project is to test this theory and to determine the birds' responses to environmental variables defining primary productivity, food-web structure and energy transfer within the California Current ecosystem. It is anticipated that shearwaters will be observed to avoid or quickly pass through upwelling areas in which cold (9–11° C) waters are rapidly transported offshore.

Sunset over the Bolsa Chica wetlands. Photo: ©1999 Kenneth Kao

- **Nematode Community Analysis for Monitoring Meiofaunal Response to the Bolsa Chica Wetlands Restoration Project**
  R/ENV-207 Feb. 08–Jan. 10
  Paul De Ley, UCR, 951.827.2280, paul.deley@ucr.edu

Though not particularly charismatic, nematodes (roundworms) are usually the most common organism in marine sediments and because of this their diversity and community structure might very well depict the general health of a marine benthic community. More to the point, nematodes, the researcher theorizes, may be used to gauge the progress of the Bolsa Chica Wetlands Restoration Project in recreating a natural habitat for bottom dwellers. The researcher is currently taking a census of all nonparasitic nematodes at six key sites at Bolsa Chica and at three control sites in the Santa Maria Estuary to create a baseline for monitoring future changes at Bolsa Chica, associated with things such as renewed tidal action and nutrient enrichment.

- **Detecting, Localizing and Resolving Regime Shifts Along the California Coast**
  R/ENV-208 Feb. 08–Jan. 10
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This project will utilize long-term temperature records to study regime changes and their relationship to coastal ecology and warming. The project has five main goals:
(1) to describe how regime change occurs;
(2) to search past climate records for as-of-yet unidentified regime shifts;
(3) to determine the extent to which regime shifts contribute to warming;
(4) to correlate sea surface temperature to ecosystem change, such as changes in the distribution and relative abundance of different types of plankton; and
(5) to establish procedures for monitoring the coastal ocean to detect regime shifts and other abrupt processes in near real time.

- **Making Restoration More Efficient: Testing the Contributions of Planting Diversity and Tamarisk Legacy Effects to Recovering Tidal Marshes**
  R/ENV-209 Feb. 09–Jan. 12
  Paul K. Dayton, UCSD/SIO, 858.534.6740, pdayton@ucsd.edu
  Theresa S. Talley, UCSD/SIO, 858.534.2059, tsinicrope@mac.com

Southern California has lost most of its coastal wetlands, and much of the remaining habitat is very much altered by the presence of non-native plants, many of which are escapees of the ornamental plant trade. One such plant is the salt cedar tree, also known as tamarisk. Towering above native low-lying species, tamarisk shades succulents, accretes sediment and sheds woody debris, ultimately transforming rare wetland marshes into not-so-rare upland woods. Because of the ecological significance of coastal wetlands, managers at NOAA's Tijuana River National Estuarine Research Reserve in San Diego are chopping down as many of the tamarisk trees as they can, in the hope that native plants will re-vegetate cleared areas. This project will examine whether this control strategy is effective, given that other invasive plants (e.g., giant reed, black locust and non-native cordgrasses) re-engineer their physical surroundings, thwarting native re-growth. Scientists will conduct field experiments at the Tijuana River reserve to answer whether tamarisk leaves similar "legacy effects." If so, they will explore options for undoing them. It is hoped that what is learned will help the reserve improve the cost-effectiveness of ongoing wetland restoration.

- **Beaches as Threatened Ecosystems: An Evaluation of Status and Trends in the Ecology of California's Sandy Beaches**
  R/ENV-210 Feb. 09–Jan. 11
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California's beaches are often framed in terms of their value to recreation and tourism. Less appreciated is that these land-sea boundaries are also important habitats to an amazing diversity of invertebrate, bird and marine life. What, though, is the fate of California's beloved beaches in the face of rising sea levels and continuing population growth? An interdisciplinary team of scientists will address this topic by compiling several historical datasets and re-sampling several historical study sites. From this, they will construct a 30-year history of the ecology and physical characteristics of the sandy beaches between Morro Bay and San Diego. They will then analyze this record to look for meaningful trends that might explain processes affecting sand supply, beach width, biological diversity and community structure. The historical record will also be analyzed to look for potentially rare, declining or even locally extinct intertidal species that may be important prey items for birds and other higher trophic level organisms. The findings will be shared with managers to improve beach management and conservation.

Sustainable Resource Use

- **Collecting Sea Palms: Planning for Sustainable Use in a Variable Environment**
  R/CZ-200 Mar. 06–Feb. 09
  Karina Nielsen, SSU, 707.664.2962, karina.nielsen@sonoma.edu
  Carol Blanchette, UCSB, 805.893.5144, blanchet@lifesci.ucsb.edu

Sea palm harvesting is a largely unregulated cottage industry centered along the rugged rocky coast of Sonoma County. In this project, scientists have been testing different harvesting practices to identify those that are most sustainable given the plant's growth and reproductive cycles. Researchers have communicated their results to sea palm harvesters and plan to work with Sea Grant Communications on an educational brochure for the edible kelp industry. Results are also being communicated to undergraduates enrolled in a new course at Sonoma State University, "Communicating Ocean Sciences," and UC Santa Barbara's Marine Science Institute via its Outreach Center for Teaching Ocean Science and the Research Experience and Education Facility.

- **Determination of Red and White Abalone Age and Growth Using Bomb Radiocarbon Signal and Lead Dating**
  R/F-202 Mar. 07–Jun. 09
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  Robert Leaf, MLML, 831.771.4400, rleaf@mlml.calstate.edu

Two of the state's native abalone species, both of which were once commercially harvested, are now in danger of extinction. In this project, researchers are developing a technique for aging abalone via their shells—something that has been tried in the past with no success. A new approach—applied successfully to fish otoliths in previous Sea Grant projects—shows promise in obtaining new, independent lifespan data for abalone. The approach employs radiocarbon markers from atomic bomb detonations in the 1950s and 1960s, as well as Pb-210 dating to age shells. Radiocarbon estimates will be compared to those from traditional methods to determine, among other things, if large abalones are as old, or older than, predictions from growth models. Accurate lifespan data are crucial for developing state and federal abalone fishery management and recovery plans.

- **Two Decades of Fishing the Santa Barbara Channel: An Examination of Effort and Catch with Regard to Serial and Localized Depletions of Reef Fishes**
  R/FISH-203 Feb. 07–Mar. 09
  Milton Love, UCSB, 805.893.2935, love@lifesci.ucsb.edu

From 1979 to 2001, the owner of a sportfishing boat painstakingly recorded his passengers' landings, the weather and the reef habitat where they fished off Santa Barbara. This logbook is now in the hands of scientists and is being mined for evidence of serial depletions of rockfishes and lingcod. If these depletions are evident, the scientists will examine whether they can be correlated with anglers' access to fishing areas. Inferences will be compared to peer-reviewed, published fisheries research findings.

- **Transport of Ghost Shrimp as Live Bait: Potential Effects on Impacted Southern California Populations**
  R/FISH-204 Feb. 08–Jan. 10
  Bruno Pernet, CSULB, 562.985.5378, bpernet@csulb.edu
  James Archie, CSULB, 562.985.4902, jarchie@csulb.edu

The bait industry in Southern California imports live ghost shrimp, *Neotrypaea californiensis,* from Oregon and Washington. Though ghost shrimp occur naturally in Southern California, southern populations may be genetically different from northern ones. This project examines whether this is so and, if it is, whether imports might be spreading northern genes into southern populations. Another topic to be studied is whether non-native ghost shrimp parasites are at risk of being introduced to Southern California. Several techniques will be employed to address these topics, including genetic analyses, testing imported ghost shrimp adults and larvae survival and surveying bait shrimp for parasites.

- **Exploring the Impact of Avian Predators on Central California Salmonids**
  R/FISH-205 Feb. 08–Jan. 11
  Scott A. Shaffer, UCSC, 831.459.1291, shaffer@biology.ucsc.edu
  Jonathan W. Moore, UCSC, 831.459.5358, jwmoore@biology.ucsc.edu
  Sean A. Hayes, NOAA/SWFSC, 831.420.3937, sean.hayes@noaa.gov

Recent tagging data suggest that birds such as the western gull feed on Central California juvenile salmon. Using out-migrating coho and steelhead smolt in Scott Creek and Wadell Creek as a case study, biologists are identifying key avian predators, locating predation "hot spots" and monitoring movements of passive integrated transponder (PIT) tagged smolts. They will also scan bird nests and roosts for PIT tags and collect stomach pellets to compute the contribution of salmon to the total diet. Because it is expected that avian predation will be significant in some places, the final component of the project will explore the feasibility and effectiveness of bird-exclusion devices to reduce salmon predation.

- **Cross-Shelf Larval Migrations Regulating Larval Supply and Connectivity in a Network of Marine Reserves**
  R/FISH-206 Feb. 09–Jan. 12
  Steven G. Morgan, BML, 707.875.1920, sgmorgan@ucdavis.edu
  John Largier, BML, 707.875.1930, jlargier@ucdavis.edu

Contrary to prevailing view, invertebrate larvae are not swept hither and yon by ocean currents, the scientists leading this project report. Instead, surprisingly, they appear to exert considerable control over their movements and usually remain near shore, even during strong upwelling events. In this project, the scientists will continue to scrutinize the degree to which ocean currents can be viewed as a forcing mechanism for larval transport and settlement. In the project's first year, larvae will be surveyed at two locations with persistent upwelling, including Point Arena, the strongest upwelling center in California, and Bodega Head. The findings will add to what is known about larval transport mechanisms, connectivity and self-recruitment, and the role of physical forcing on larval supply.

Point Arena headland. Photo: ©2002–2008 Kenneth & Gabrielle Adelman, California Coastal Records Project, www.Californiacoastline.org

- **Initial Steps Towards Evaluating Potential Disease Impacts of Propagated Marine Fish on Wild Stocks**
  R/AQ-127 Feb. 07–Jan. 10
  Ron Hedrick, UCD, 530.752.3411, rphedrick@ucdavis.edu
  Kristen Arkush, BML, 707.875.2062, kdarkush@ucdavis.edu
  Mark Okihiro, CDFG, 760.726.8170, ms.okihiro@att.net

Marine aquaculture has the potential to spread diseases to wild species. In collaboration with the California Department of Fish and Game and the Hubbs-SeaWorld Research Institute, researchers are studying fish health at a hatchery for stock enhancement. A significant redirection of effort was proposed and approved for year two. Due to a sudden disappearance of the white seabass herpesvirus among propagated populations of white seabass, there was no longer adequate material for pursuing year-two objectives. Instead, the same basic hypothesis will be tested using a new sporozoan infection recently detected in hatchery stocks of white seabass. The scientists have developed a new tool for detecting fish pathogens and are applying it to prevent released fish from spreading disease. Techniques are in development to use brood stock selection, water treatments and other husbandry approaches to reduce pathogen levels in cultured fish.

- **Seaweed Strain Selection and Preservation to Optimize Harvest Yields for Abalone Culture**
  R/AQ-128 Feb. 08–Jan. 11
  Michael H. Graham, MLML, 831.771.4481, mgraham@mlml.calstate.edu

In collaboration with the Monterey Abalone Company, the scientist has demonstrated the feasibility of growing red algae for abalone aquaculture, as a highly nutritious, shell-color-enhancing supplement to wild-harvested giant kelp. Some of these beds are now off limits to harvesting due to recent creation of no-take marine reserves along the Central Coast. The abalone company now has a small red algae garden, and it is expected to begin commercial operations by late 2009. The scientist, meanwhile, continues to conduct experiments to optimize growth rates and lower harvesting costs. California Sea Grant Extension Program plans to adapt project findings into a user-friendly manual for industry.

- **Soft-Egg Syndrome in Farmed White Sturgeon**

  R/AQ-129 Feb. 08–Jan. 11
  Kenji Murata, UCD, 530.752.9024, kmurata@ucdavis.edu
  Serge Doroshov, UCD, 530.752.7603, sidoroshov@ucdavis.edu
  Fred Conte, UCD, 530.752.7689, fsconte@ucdavis.edu

Soft-egg syndrome is an undesirable caviar trait, frustrating the bottom line of a white sturgeon caviar producer in California. Researchers are looking to identify husbandry techniques that might be to blame for the syndrome, which has appeared only recently out of apparently nowhere. They are now studying the links between water temperature, diet and stress (caused by handling and transporting fish) on egg-burst force, egg texture and incidence of ovarian follicular degeneration at harvest. They will also compare the biochemical composition of the egg envelope and egg lysate, which contains cell debris and cellular fluid, for soft and firm eggs. 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. 09–Jan. 12
  Mark A. Drawbridge, HSWRI, 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

The overall goal of this project is to reduce the amount of fishmeal and fish oil in yellowtail and white seabass feeds, without impeding fish growth rates or otherwise compromising fish health. In the first phase of the project, the scientists will develop a replacement protein based on a combination of fishmeal alternatives such as soy, canola, corn, barley, poultry-by-product meal and blood meal. Scientists will experiment with adding mineral supplements to compensate for fishmeal losses. These “protein shakes” will be added to feeds at graded levels to progressively reduce fishmeal content. Once appropriate protein sources, amino acid balances, and mineral supplements are determined, scientists will conduct experiments to optimize the feed’s protein to energy (calorie) content. They will then begin investigating alternatives to fish oil. It is hoped that the project will result in commercially viable fish feeds with 75 percent less fishmeal and 50 percent less fish oil.

- **Understanding Connectivity to Maintain and Manage Coastal Resources**

  R/ANS-209 Feb. 08–Jan. 10
  Lisa A. Levin, UCSD/SIO, 858.534.5108, llevin@ucsd.edu
  Linda L. Rasmussen, UCSD/SIO, 858.822.1816, llrasmussen@ucsd.edu

This study looks at ways to prevent the introduction and spread of invasive species with planktonic larvae using the invasive mussels (*Mytilus galloprovincialis* and *Musculista senhousia*) and a native species (*M. californianus*) as a case study. The biologists seek to determine larval dispersal distances and whether dispersal leads to hybridization and further species. Other questions being explored: How much larval exchange occurs between populations and is this a vehicle for maintaining population structure along the rocky shore? Can scientists identify common larval sources and sinks and quantify rates of self-seeding to more effectively manage coastal resources?

New Zealand mud snails in Piru Creek, California. Photo: Tom L. Dudley, UCSB

- **Development of Biological Control for the New Zealand Mud Snail**

  R/ANS-210 Nov. 08–Oct. 09
  Tom L. Dudley, UCSB, 805.893.8062, tdudley@msi.ucsb.edu
  Kevin Lafferty, USGS, 805.893.8778, lafferty@lifesci.ucsb.edu
  Armand Kuris, UCSB, 805.893.3998, kuris@lifesci.ucsb.edu

The ultimate goal of this project is to investigate the feasibility of releasing parasites to control New Zealand mud snail populations in the Great Lakes and Western states, including California, where the snail has invaded the American River, Lake Shasta, Alameda, Piru and Malibu creeks, among others. In the first year of the project, scientists will test the host specificity of the trematode parasites they hope to release to ensure their safety to native species. In other words, they want to rigorously verify that the parasites won't infect native snails. They will also determine whether the parasites, a type of castrator, curb invasive mud snail population growth enough to warrant their release. Field experiments will be conducted in California and also in the mud snail's native New Zealand habitat.

New Technologies

- **Biomedical Development of New Marine Microbial Resources**
  R/NMP-98 Feb. 07–Jan. 10
  Paul Jensen, UCSD/SIO, 858.534.7322, pjensen@ucsd.edu
  Bradley Moore, UCSD/SIO, 858.822.6650, bsmoore@ucsd.edu

Significant progress has been made in efforts to understand the evolution of secondary metabolite genes of marine actinomycetes, and the mechanisms by which actinomycetes adapt to the marine environment. Scientists have characterized novel biosynthetic enzymes associated with the natural products cyclomarin and cyclomarazine. Ongoing experiments are shedding light on the molecular basis of this biosynthetic pathway. Further work on halogenated meroterpenoids has identified three unique chloroperoxidases. Current efforts are centering on their in vivo and in vitro characterizations, with the goal being to apply novel marine enzymes as biocatalysts.

- **Harnessing the Pharmaceutical Potential of Marine Cyanobacteria**
  R/NMP-99 Feb. 08–Jan. 11
  William H. Gerwick, UCSD/SIO, 858.534.0578, wgerwick@ucsd.edu
  Lena G. Gerwick, UCSD/SIO, 858.534.0566, lgerwick@ucsd.edu

Blue-green algae produce a range of secondary metabolites with interesting pharmaceutical potential. The tiny algae, however, produce tiny amounts of these compounds, making testing of their biomedical potential extremely laborious and slow. This project seeks to find small molecules that can be added to algae cultures to boost their yields and to trigger production of novel compounds. Once such elicitor compounds are found, the biologists will scale up their production and begin assaying compounds for antimicrobial, anticancer, anti-inflammatory and anti-malarial activity.

- **Sizing Fish with an Acoustic System**
  R/OE-40 Feb. 06–Mar. 09
  Jules Jaffe, UCSD/SIO, 858.534.6101, jjaffe@ucsd.edu

This project has demonstrated the ability to use acoustic scatter from fish at multiple angles to estimate in situ fish size and orientation. The experiments, conducted in an acoustics laboratory at Scripps Institution of Oceanography, have led to a new multiple-angle broadband scattering data set for 10 species of fish, and several taxa of zooplankton. Specimens were euthanized and preserved for future comparative studies. The techniques under development have application in stock assessment and zooplankton classification.

Coastal Community Development

- **Exposure of Santa Cruz Wharf Anglers to Domoic Acid**
  R/MA-45 Feb. 06–Feb. 09
  Mary Silver, UCSC, 831.459.2908, msilver@ucsc.edu
  Caroline Pomeroy, CSGEP, 831.763.8002, cmpomeroy@ucdavis.edu

Sport fish caught off the Santa Cruz Wharf have been shown to be contaminated with a toxin known as domoic acid, the causative agent of amnesic shellfish poisoning. This discovery raises concerns that certain groups of people may be consuming too much of the toxin. This project will characterize seafood catch and consumption statistics for wharf anglers to determine whether certain subpopulations are indeed at risk. In 2008, scientists completed primary data collection and analysis, and are pursuing lipid analyses of commonly consumed species, in collaboration with California EPA staff, to collect nutritional information and to compute domoic acid risks for these species.

Special Competitions: Oyster Disease

- **Building Gene Expression-Based Predictors of Oyster Summer Mortality Syndrome**
  R/OD-1 Jun. 07–May 09
  Andrew Gracey, USC, 213.740.2288, gracey@usc.edu

Oyster summer mortality syndrome is a devastating, unpredictable disease that has major economic implications for the Pacific's bivalve industry. The goal of this project is to identify functional genomic sequences (via DNA microassays) correlated with the disease and to develop a method for early disease detection, which could reduce growers' losses. The lead researcher of the project is characterizing the gene expression patterns exhibited by oysters during the early stages of disease, to establish gene expression-based outbreak predictors. The scientist will also identify the environmental conditions associated with outbreaks. Results will be tested at oyster beds throughout the nation. This project was extended because oysters did not contract the disease in summer 2008.

Program Development

- **Program Development**
  M/NP-1
  R.A. Moll/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, outreach and education projects.

CALFED Science Fellows Program

The CALFED Science Fellows Program was established to bring together junior scientists with CALFED Program agency scientists and senior research mentors in collaborative data analysis and research projects relevant to ecosystem management and water supply reliability questions, including analyses of the immense monitoring data collected and maintained by the implementing agencies. California Sea Grant administers the fellowship program. Due to uncertainty in state funding sources, the end dates for ongoing projects may change and start dates for new projects are to be determined.

- **Development of a Simulation Model of Juvenile Salmon Movement in the Sacramento-San Joaquin Delta**
  R/SF-7 Sept. 05–May 09
  Annjanette Dodd, HSU, 707.733.9462, amd2@humboldt.edu

How do juvenile salmon move through the Sacramento-San Joaquin Delta? This question is important as it affects the probability of fish successfully migrating to the ocean in a variety of ways. Time spent in different regions of the delta, for example, affects growth potential and predation, changes exposure to entrainment in diversion pumps and influences the time to out-migrate. The project's goal is to combine a hydrodynamic model of particle transport and a biological model of fish behavior to simulate the effects of water operations (e.g., reservoir release rates, pumping rates and other operations of the Delta Cross Channel gates) on juvenile salmon migration patterns. The strategy is to find the simplest model consistent with observational data, not to produce a "realistic" model of fish movement. The observational data have shown that juveniles as small as 3 and 4 inches in length do not behave as passive particles. The results of the project will improve the ability to predict the effects of different flow regimes on fish and in this way may assist in efforts to manage channel gate operations.

- **Modeling Nutrient and Organic Carbon Loads and Sources in Central Valley Watersheds: Taking Existing Monitoring Data to the Next Stage**
  R/SF-8 Sept. 05–Oct. 09
  John Harrison, WSU, 360.546.9210, harrisoj@vancouver.wsu.edu

In the Central Valley, high levels of dissolved inorganic nitrogen are associated with low levels of dissolved oxygen in the lower San Joaquin River. As a result, nitrogen levels are linked to aquatic health in the region. The CALFED Fellow is using a computer model to estimate nitrogen inputs from land-based sources, nitrogen losses in terrestrial and aquatic ecosystems, and downstream nitrogen transport. Preliminary model results suggest that more than 90 percent of dissolved inorganic nitrogen inputs in sub-watersheds of the Sacramento and San Joaquin rivers is not transported downstream. Consumptive water use, though, appears to be an important factor for nitrogen transport. In particular, nonpoint source pollution (i.e., fertilizer and manure) appear to be major sources of nitrogen in the Central Valley.

- **Effects of Water Temperature, Stream Flow and Flood Availability on the Growth, Survival and Movement of Central Valley Juvenile Steelhead (*Oncorhynchus mykiss*) with Implications for Water Management**
  R/SF-11 Sept. 05–Aug. 09
  Walter Heady, UCSC, 831.459.5783, heady@biology.ucsc.edu

The CALFED Fellow reports that two man-made side channels on the lower Mokelumne River provide rearing habitat for juvenile chinook and steelhead, and enhance aquatic macro-invertebrate abundance and diversity. In collaboration with the East Bay Municipal Utilities District and

the California Urban Water Association, the fellow has acoustically tracked 126 wild steelhead as of June 2008. Preliminary results from the acoustic telemetry monitoring show: (1) the majority of fish do not move much; (2) when "resident" steelhead do move, they typically venture less than 10 kilometers; (3) fish that move more often have higher rates of mortality, presumably due to predation; (4) as a population, fish move most frequently in March and August.

- **Addressing Stakeholder Concerns: Pests and Pest Control in the Sacramento River Conservation Area**
  R/SF-12 Sept. 05–Aug. 09
  Suzanne Langridge, UCSC, 831.459.3902, sml@ucsc.edu

Could restoration plans for the Colusa-Sacramento River Recreation Area exacerbate agricultural pests at nearby walnut orchards, as some farmers fear? According to the CALFED Science Fellow, the preliminary answer is, "No." The fellow compared pest bird and insect abundances at 23 walnut orchards along the Sacramento River surrounded by various amounts of riparian habitat and found no link between the number of pest birds (e.g., American crow, Brewer's blackbird and European starling) and the amount of nearby riparian wilderness. In some cases, there were fewer problem birds and more beneficial insect-eating ones in orchards surrounded by larger tracts of wilderness. Two major walnut nuisances, the navel orangeworm and codling moth, were also observed to be slightly less common at farms with greater proximity to restored habitats.

- **Prey Selection of Larval and Juvenile Planktivorous Fish in the San Francisco Estuary**
  R/SF-15 Jan. 07–Dec. 09
  Lindsay Sullivan, SFSU, 415.435.7127, ljswr@sfsu.edu

In the last two decades, the zooplankton community in the San Francisco Estuary has shifted from being dominated by calanoid copepods (i.e., *Eurytemora affinis* and *Pseudodiaptomus forbesi*) to one being dominated by the small, cyclopoid copepods, *Limnoithona tetraspina*. In recent years, this invasive species has been observed to be as much as 10 times more abundant than any other copepod in brackish waters of the estuary. To understand what this shift means for the total zooplankton biomass, the fellow conducted feeding experiments to quantify the relative consumption of the copepods by larval delta smelt and striped bass. These revealed that although both fish species consume the invasive copepod, its peak abundance does not overlap spatially or temporally with either fish species' larval period. Continuing studies on differential prey consumption and feeding mechanisms will help identify the effects of the zooplankton shift on planktivorous fishes.

- **Role of Exotics as Ecosystem Engineers Affecting Estuarine Food Webs in Suisun Marsh**
  R/SF-17 Feb. 07–Feb. 09
  Christine Whitcraft, SFSU, 415.338.3704, cwhitcra@gmail.com

Invasive species are arguably one of the most formidable obstacles to restoring marsh habitats in the San Francisco Bay-Delta. To improve the chances of restoration success, this project is comparing the efficacies and nontarget impacts of multiple herbicides in eradicating perennial pepperweed in Suisun Marsh. The CALFED Fellow and partners at the Solano Land Trust report that both the type of herbicide and the timing of spraying are critical to success. The fellow has also been studying the ecological impacts of pepperweed in different habitats at the marsh. Among the findings of this component of the project: Plants growing in the transition zone between grassland and marsh have a profound impact on native plant and insect communities, potentially related to an observed increase in soil humidity; pepperweed poses much less of an environmental problem in areas of greater tidal inundation.

- **The Impacts of Global Climate Change on Delta Fishes: Predicting Fish Abundance, Distribution and Community Changes**
  R/SF-18 Jun. 07–May 10
  Christa Woodley, UCD, 530.400.5871, cmwoodley@ucdavis.edu

Global warming is predicted to reduce rainfall, raise sea level and enhance evaporation in the San Francisco-Sacramento region. This project looks at what this may mean to the distribution, foraging opportunities, growth and reproduction of the region's native and invasive fishes. The CALFED Fellow is also studying the physiological responses of select fishes to various scenarios of future climate conditions. This research complements CALFED's Computational Assessments of Scenarios of Change for the Delta Ecosystem project, the goal of which is to understand how the regional ecosystem might respond to a few plausible scenarios of climate change. In 2008, the fellow and colleagues evaluated the possible effects of year 2020 water demand coupled with climate change on future runs of Sacramento River salmon. Their model output suggests that maintaining winter-run and spring-run chinook salmon, which spawn from July to mid-October, will be "extremely difficult" by about 2070.

- **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. 06–Aug. 09
  Robert Schroeter, UCD, 530.219.9693, reschroeter@ucdavis.edu

The goal of this project is to find answers to what has caused plummeting species abundances in the upper San Francisco Estuary. Taking advantage of multiple data sets, the CALFED Fellow is comparing habitats with extensive population declines (e.g., Suisun, Honker and Grizzly Bays and lower reaches of the Sacramento and San Joaquin Rivers) to those that have maintained relatively high numbers (e.g., Suisun Marsh) to identify environmental conditions and biological factors that may explain differences. As part of this investigation, the fellow will study the feeding ecology of several non-native invasive species (e.g., gelatinous zooplankton, caridean shrimp, various polychaetes and clams) that may be contributing to the observed decline of both estuary zooplankton and fishes.

- **Estimating Route-Specific Survival and Distribution of Juvenile Salmonids Migrating Through the Sacramento-San Joaquin River Delta**
  R/SF-20 Nov. 06–Oct. 09
  Russell Perry, UW, 206.221.5455, rperry@u.washington.edu

A model has been developed to predict the survival statistics for migrating salmon along different routes in the Sacramento-San Joaquin Delta. Based on the model, salmon have a 35 percent chance of being entrained into the interior delta when the Delta Cross Channel is open and a 9 percent chance during times when it is closed. Although standard errors were large, estimated fish mortality rates through the interior delta were higher than in the Sacramento River, consistent with previous research. The interior, however, was less important than other routes to total fish survival, due to the small number of fish braving the passage. To date, few studies have combined simultaneous measurements of water and smolt movements. The Department of Water Resources will use the model to evaluate the effects of various water export options on salmon populations.

- **Heterotrophic Bacteria and the Food Web of the Low Salinity Zone and Salt Marsh Habitats of the San Francisco Estuary**
  R/SF-21 Nov. 06–Mar. 09
  Alexander Parker, SFSU, 415.338.3746, aeparker@sfsu.edu

This project explores the fate of phytoplankton biomass within salt marsh sloughs of the San Francisco Estuary. This topic is relevant to estimating the supply of organic matter for foodwebs, as well as to understanding biogeochemical cycling and nutrient exchange in estuaries. The plausible fates for primary productivity include: 1) phytoplankton are metabolized by marsh bacteria; 2) they are consumed by foraging fish and invertebrates; 3) they are exported to the estuary. The CALFED Fellow is presently studying the spatial and temporal patterns in nutrients, primary production and organic matter in Suisun Marsh. Nutrient and organic matter exchange between restored marsh habitats and sloughs is also being investigated. Findings to date show that phytoplankton and bacterial production is higher in Suisun Marsh than in Suisun Bay. There were also differences in these parameters between the eastern and western sides of the marsh.

- **Mercury Interactions with Algae: Effects on Mercury Bioavailability in the San Francisco Bay-Delta**
  R/SF-22 Jun. 07–May 10
  Allison Luengen, SBU, 631.632.3128, aluengen@notes.cc.sunys

The CALFED Fellow will develop a biogeochemical model for predicting the bioavailability of mercury in the San Francisco Bay-Delta. She is particularly interested in the extent to which dissolved organic matter limits the uptake of mercury by phytoplankton—the entry point for mercury contamination in the marine food web. Initial findings show that higher levels of dissolved organic matter reduce mercury uptake in phytoplankton. The model under development should be of great benefit to the Regional Water Quality Control Boards in evaluating the potential for the high levels of mercury in the Bay-Delta to enter the food chain.

- **Measuring and Predicting the Success of Riparian Restoration for Wildlife Populations**
  R/SF-23 May 07–Apr. 10
  Nathaniel Seavy, PRBOCS/UCD, 415.868.0655 x311, nseavy@prbo.org

How do bird populations respond to riparian habitat restoration and what can be done to improve bird conservation in restored areas? What kind of information on bird populations,

within the context of riparian habitat restoration, would be most useful to managers? To answer this, the CALFED Fellow distributed a questionnaire to riparian habitat managers and posted the results of the survey online at http://nseavy.googlepages.com/riparian_dst. The fellow has also engaged in dialogs with River Partners, the Sonoma Ecology Center, The Nature Conservancy and the California Department of Fish and Game, as well as researchers at UC Davis, to develop a better understanding of managers' perspectives and needs. In response to what he has learned, he is developing seasonal fecundity models that can, among other things, enable evaluations of the relative effects of nest predators and brood parasites on bird reproduction. He is also analyzing recapture rates of tagged and released birds to calculate population growth rates in restored areas. In 2008, he used LiDAR scanning data to map bird habitats in the Cosumnes River Preserve in southeastern Sacramento County.

- **Validation of a New Method for Population Assessment of Pacific Salmonids Using Genetic Markers**
  R/SF-24 Jun. 07–May 10
  Anthony Clemento, UCSC, 831.420.3906, anthony.clemento@noaa.gov

The CALFED Fellow is developing a method for tracing the parentage of Central Valley chinook. If successful, this virtual-tagging method will be a powerful new tool for monitoring the effects of hatchery practices, water policy, climate change and fisheries management on salmon populations. To date, the fellow has developed 10 single nucleotide polymorphism markers for chinook that have been included in a Pacific Salmon Commission-funded project to identify genetic stocks of West Coast and Alaska salmon. In collaboration with California Department of Fish and Game, he has sampled fin clips from the entire 2006 and 2007 spring-run broodstock from the Feather River Hatchery. DNA has been extracted from almost 4,000 individuals, and he is now genotyping the broodstock with the most informative nucleotide markers.

- **Modeling Physical Drivers and Age Structure of Cottonwood Forest Habitat: An Integrated Systems Approach**
  R/SF-25 Mar. 08–Feb. 11
  Alex Fremier, SUNY-ESF, 315.470.4902, fremier@gmail.com

The ultimate goal of this project is to improve the long-term prospects for restoring and protecting one of the signature species of the Central Valley's riparian ecosystem—the Fremont cottonwood. The CALFED Fellow will model the physical processes driving river channel migration and cottonwood habitat creation along a 100-mile stretch of the Sacramento River from Red Bluff to Colusa. The Nature Conservancy, resource agencies and other stakeholders view this stretch of river as a prime site for conservation and restoration because the river still migrates naturally and is not confined by levees. If the modeling effort is successful, the model will be used to generate predictions of how cottonwood forests will fare in the future under various physical states, including different climate scenarios, flow regimes and floodplain sedimentation rates. The results could help identify high-value habitat and plan corridor-wide conservation efforts. In the first year of the project, the fellow used LiDAR imagery to examine floodplain heterogeneity and forest structure. Among the findings: Progressive meander migration accounted for 70 to 90 percent of the surfaces created in the last century, as compared to channel abandonment. Abandoned channel surfaces, though, are less likely to be converted to farm fields and thus are over-represented in remnant stands.

- **Investigating the Lower Trophic Levels of Suisun Bay Food Web: A Biomarker-Specific Isotope Approach**
  R/SF-26 Sept. 07–Aug. 10
  Susan Lang, UCSD, 858.634.7094/206.920.6607, sqlang@ucsd.edu

Living organisms produce unique organic molecules that can be detected in the environment posthumously. This project is based on the premise that the isotopic composition of compounds unique to a wide range of primary producers will allow the CALFED Fellow to identify sources of organic carbon supporting zooplankton in Suisun Bay. Chlorophyll isotopes, for example, may distinguish phytoplankton growing in the Sacramento River from those in the San Francisco Estuary. In the first year of the project, the fellow went on several trips to collect samples and is currently in the process of analyzing them for biomarker concentrations and isotopic signatures. The hope is that new biomarkers will enable managers to more clearly recognize, in advance, the consequences of various water management options on pelagic species.

- **Endocrine Disruption in the Delta: Confirming Sites' Known Estrogenicity with Outplants, Histology, and Choriogenin Level Measurements**
  R/SF-27 Sept. 07–Aug. 10
  Susanne Brander, UCD, 707.875.1974, smbrander@ucdavis.edu

In parallel with an ongoing CALFED study of feminization of salmon in the San Francisco Bay-Delta, this project will examine the effects of endocrine disrupting contamination on the ubiquitous inland silverside fish (*Menidia beryllina*). By comparing the effects of endocrine disrupting compounds on different fish species, the CALFED Fellow hopes to identify which compounds are most harmful. She will conduct "outplanting" experiments to compare the effects of contamination at different sites to laboratory controls. In July 2008, in collaboration with U.S. Fish and Wildlife staff, she began sampling silverside fish at a number of sites to determine if endocrine disrupting compounds are detectable and if so, where. She has also identified an antibody that cross-reacts with the protein choriogenin. She plans to use this protein as a biomarker of exposure to estrogenic chemicals in future work.

- **Tidal Wetland Vegetation Response to Climate Change in the San Francisco Bay-Delta**
  R/SF-28 Sept. 07–Aug. 10
  Lisa Schile, UCB, 415.378.2903/510.642.8322, lmschile@gmail.com

In the San Francisco Bay-Delta, global warming (i.e., sea level rise and altered precipitation patterns) is expected to lead to more saline conditions and higher water levels. How will these changes affect wetland plants in the Bay-Delta? Which species will persist under changing conditions and where? To address these and other questions, the CALFED Fellow is mapping the region's current distribution of dominant plant species (e.g., California cordgrass, tule, bulrush, pickleweed and cattails). The fellow will also conduct transplant and greenhouse experiments to establish plant tolerances to salinity and inundation. After these experiments are done, she and other CALFED-funded researchers will use GIS analyses to spatially model the predicted vegetation patterns in the estuary under future climate scenarios. It is predicted that freshwater marshes will become scarce in the future and that as a result, brackish marshes will become the region's most common tidal wetland ecosystem.

- **Nutrients and Benthic Invasion Dynamics in San Francisco Bay**
  R/SF-29 Oct. 07–Mar. 10
  Heidi Weiskel, UCD, 530.902.0878, hwweiskel@ucdavis.edu

In the first year of the project, the CALFED Fellow examined the potentially critical relationship between nutrient pollution in the San Francisco Bay-Delta and invasion-related disturbance by the invasive mud snail (*Ilyanassa obsoleta*) on the native mud snail (*Cerithidea californica*). Preliminary findings suggest that where both species coexist, the invasive snail displaces the native one through "behavioral interactions." Adding nutrients to open mudflats increased microalgal biomass and increased native, but not invasive, snail growth. When snails were present at high densities, adding nutrients reduced mortality rates of both species, suggesting that nutrients somehow alleviate interspecies competition. The next step of the project will be to test the results in different estuarine habitats.

- **Environmental Water: Developing Indicators and Identifying Opportunities**
  R/SF-30 Jan. 08–Dec. 10
  Sara Hughes, UCSB, 805.893.5892, shughes@bren.ucsb.edu

This project examines the policies and practices that influence how water is used in the Bay-Delta. Specifically, the CALFED Fellow is comparing urban water management policies in San Francisco and Sacramento, as they relate to the goals of CALFED's Environmental Water Account project—a conservation-oriented project to help protect at-risk fish species by main-

taining sufficient water for them. The water account establishes a mechanism for purchasing water rights to build a water bank for the express purpose of maintaining sufficient flows for target, vulnerable fish species. One anticipated outcome of this project is improved awareness, coordination and communication between cities and the Environmental Water Account. It is hoped that this will encourage cities, CALFED and decision-makers to improve intergovernmental coordination to better address current and future water policy challenges.

- **Linking Freshwater Sources of California Chinook Salmon to Their Ocean Distribution Using Physical and Natural Tags of Origin**
  R/SF-31 Jun. 09–May 11
  Rachel Barnett-Johnson, UCSC, 831.239.8782, barnett-johnson@biology.ucsc.edu

How can fishermen harvest abundant salmon populations without driving at-risk salmon species to extinction? This question is addressed by looking at the degree to which fish from different natal rivers or hatcheries aggregate at sea. This will be done by integrating multiple fish markers—based on isotope ratios, genetics and otolith microstructure, as well as from historical records of coded wire-tag data. The CALFED Fellow leading this project has preliminary results suggesting that there are seven Evolutionarily Significant Units (ESUs) in ocean salmon, and that the vast majority of fish in the Central Valley Fall ESU are hatchery born with most originating from the Coleman National Fish Hatchery. Her preliminary findings suggest that young salmon exhibit a spatial population structure in the ocean, until about age three. Continuing analyses will look closely at the degree to which different salmon populations mix at sea.

- **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 Sept. 08–Aug. 10
  Kristen Buck, UCSD, 858.534.4550, kbuck@ucsd.edu

This project seeks to identify sources and bioavailability of dissolved copper in San Francisco Bay and to test the hypothesis that freshwater diversions in the Bay-Delta might exacerbate copper toxicity. The first phase of the project will determine the chemical speciation and toxicity of dissolved copper in San Francisco Bay and its watershed, including Suisun Bay, Suisun Slough, Carquinez Strait, and Sacramento and San Joaquin Rivers. The CALFED Fellow will then determine relative contributions of copper-binding organic ligands from Sacramento and San Joaquin Rivers, Suisun Slough and Sulphur Springs Creek, among others. These freshwater data will be used to compare urban and marsh runoff. The fellow's goal is to be able to predict how changes in water management and land-use practices might affect copper-binding ligand sources, copper bioavailability and copper toxicity in the Bay-Delta.

- **Effects of Freshwater Flow and Population Connectivity on Benthic Community Dynamics in the San Francisco Estuary**
  R/SF-33 May 09–Apr. 11
  Andrew Chang, UCD, 530.400.9410, andchang@ucdavis.edu

After heavy winter storms, the Bay-Delta's salinity levels may drop precipitously, stressing organisms with low tolerances to fresh water. For the native Olympia oyster, *Ostrea conchaphila* and the non-native Mediterranean mussel, *Mytilus galloprovincialis*, freshwater pulses actually trigger massive die-offs. Conversely, rising salinity levels seem to favor their proliferation. With an eye on improving native oyster restoration and to better understand the spread of non-native mussels, the CALFED Fellow will lead field surveys to monitor changes in abundances and size classes of Ostrea and Mytilus spp. at 12 sites in brackish waters of the Bay-Delta. Trace elemental fingerprinting will be used to determine natal regions of newly settled juveniles throughout the San Francisco Estuary. Toward the end of the project, the fellow will conduct laboratory experiments to further investigate and quantify the stress effects of low salinity on mollusk heart rate, reproduction and survival.

- **Investigating the Frequency and Magnitude of Floods in the Sacramento-San Joaquin Valleys Under Changing Climate**
  R/SF-34 Oct. 08–Sept. 10
  Tapash Das, UCSD, 858.822.3582, tadas@ucsd.edu

Climate change scenarios predict an increased risk of winter and springtime flooding in the Sacramento-San Joaquin Valley, caused by earlier snowmelt and by a decrease in the portion of precipitation falling as snow. In this computer-modeling project, the fellow will investigate the potential effects of climate change on extreme precipitation and flooding in the region. Some of the questions to be addressed: (1) To what extent do simulated flood statistics mirror historical observations? (2) How and why do extreme events of simulated streamflows change under current climate change scenarios? (3) How does uncertainty in computer model simulations affect extreme event statistics?

- **Environmental Controls on the Distribution of Harmful Algae and Their Toxins in San Francisco Bay**
  R/SF-35 Sept. 08–Aug. 10
  Cecile Mioni, UCSC, 541.515.0425, cmioni@ucsc.edu

Climate change could alter the ecology of harmful algae in the Bay-Delta system by changing air and water temperatures, ocean stratification and nutrient and trace metal loading. To better understand the distribution of harmful algae and environmental conditions controlling their toxin production, the fellow leading this project will examine three primary hypotheses: (1) future environmental changes will favor dinoflagellates in the South Bay and cyanobacteria in the delta, as opposed to diatoms, resulting in more frequent blooms of these species; (2) increases in available light to delta waters, due to reductions in turbidity, will lower or otherwise alter nutrient inputs, resulting in enhanced toxicity of harmful algae; (3) changing environmental conditions in the bay during the last decade have and will continue to increase the intensities and frequencies of harmful algal blooms.

- **Plankton Dynamics in the Sacramento-San Joaquin Delta: Long-Term Trends and Trophic Interactions**
  R/SF-36 Oct. 08–Sept. 10
  Monika Winder, UCD, 530.754.9354, mwinder@ucdavis.edu

This project makes use of a 33-year record of plankton taxonomy in the Bay-Delta to study long-term trends, patterns and interactions among the region's phytoplankton and zooplankton. A variety of statistical and modeling techniques will be used to address several important topics of relevance to the observed decline in pelagic organisms, the first three of which are to: (1) describe spatial and temporal trends in zooplankton, the major food source for native fish species; (2) describe linkages between phytoplankton biomass and zooplankton production; (3) determine how changes in phytoplankton and zooplankton functional groups relate to biotic interactions and environmental changes.

- **Frequency, Distribution and Ecological Impact of Cryptic Hybrid Invaders: Management Tools for Eradication of Invasive Spartina**
  R/SF-37 Sept. 08–Aug. 10
  Laura Feinstein, UCD, 530.204.8325, lfeinstein@ucdavis.edu

The exotic cordgrass *Spartina alterniflora* is a perennial deciduous grass found in salt marshes of San Francisco and San Pablo Bays that hybridizes with native cordgrass, *S. foliosa*, producing a highly invasive plant known for re-engineering intertidal wetlands. This project is based on the premise that any successful eradication program for *S. alterniflora* must also address the control of its hybrids, even "cryptic hybrids" morphologically similar to

the native. In this spirit, the first goal of this project is to use microsatellite markers and Bayesian statistical algorithms to develop a better DNA test for hybrids. The fellow will then use this tool to: (1) determine the frequency and distribution of cryptic hybrids; (2) identify spatial and environmental variables that favor hybrid colonization; and (3) measure the ecological impact of cryptic hybrids. The cumulative benefit of this project will be to provide tools and information to managers that may help them weigh the cost-benefits of attempting to eradicate every cryptic hybrid in the region.

- **Climate Change and In-Stream Flows: Methods for Application of Risk Analysis to Modeling of Environmental Water Supplies**
  R/SF-38 Sept. 08–Aug. 10
  Michael Kiparsky, UCB, 415.806.6656, kiparsky@berkeley.edu

Climate models predict a variety of changes 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 ecosystem-based objectives, such as maintaining adequate flows for fishes? To answer these, the fellow will interview water managers in the Stanislaus, Tuolumne and Merced River basins, for their perceptions of the future supply of water for environmental, agricultural and urban uses. The interview data will be combined with output from a hydrological model to compare the risks of different water management strategies.

- **Scenarios for Restoring Ecologically Functional Floodplains and Providing Flood Control Services in the Sacramento-San Joaquin Delta**
  R/SF-39 Sept. 08–Aug. 10
  Mary Matella, UCB, 510.643.1136, mmatella@nature.berkeley.edu

Employing existing climate change models for the Bay-Delta, the fellow will study the effects of predicted hydrological shifts on potential floodplain restoration sites. Also to be studied is the extent to which levee setbacks could increase the amount of available floodplain habitat and improve public safety from flooding. In particular, the fellow will attempt to answer: (1) What criteria define an ecologically functional floodplain? (2) What is the area of floodplain that might feasibly be restored through levee setbacks? (3) Can flood management strategies such as levee setbacks confer ecological benefits in the same places? The findings will help managers develop a cost-efficient strategy for deciding which levels are most suited to setbacks, in terms of meeting ecological and public safety goals.

- **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. 09–Dec. 10
  Joseph Street, SU, 415.298.2543, jstreet@stanford.edu

The CALFED Fellow will produce a 19,000-year timeline of rainfall and water availability in the Sierra Nevada and Sacramento-San Joaquin watershed, based on isotope analyses of organic material in a sediment core from Swamp Lake, in northwestern Yosemite National Park. A primary focus will be to examine decadal, multi-decadal and centennial climate patterns. Another key goal is to study the climate regime during the mid-Holocene (about 3,500 to 8,000 years before present), when other evidence suggests that the mid-Holocene climate was warmer and dryer. The fellow will also examine the climate record during the last glacial maximum (18,000 to 20,000 years ago) and the glacial termination (10,000 to 15,000 years ago). The findings, besides furthering basic understanding of California's paleoclimate, will provide insights into the state's future climate and water budget challenges.

- **Pilot-Scale Evaluation of an Iron Sediment Amendment for Control of Mercury Methylation in Tidal Wetlands**
  R/SF-41 Jan. 09–Dec. 10
  Patrick Ulrich, UCB, 510.430.8544, ulrich@berkeley.edu

Mercury contamination is a recognized public health hazard throughout the United States, as fully 76 percent of all fish consumption advisories issued by the EPA are due, at least in part, to elevated levels of methyl mercury. Fetuses and young children, whose neurological systems are still developing, are particularly susceptible to mercury exposure. The bioavailable form of the heavy metal also poses a significant threat to the reproductive success and survivability of piscivorous bird and mammal species, as well as benthic omnivores in tidal wetlands, such as the endangered California clapper rail. Several previous studies have shown that mercury cycling in the Bay-Delta System is extremely complex and can be exacerbated by human activities, including wetland restoration projects. Building on previous research led by the CALFED Fellow's research mentor, this project will examine a potential method for decreasing methyl mercury releases from restored wetlands. In particular, the fellow will evaluate the efficacy of using an iron sediment amendment to control net methyl mercury production in tidal wetlands of the Bay-Delta. Preliminary experiments have shown, compellingly, that high iron doses can decrease methyl mercury concentrations ten-fold. If the same holds in the field, iron amendments could offer a technique for reducing methyl mercury contamination during wetland restoration.

- **Trophic Impacts of Microcystis on Crustacean Zooplankton Community of the Delta**
  R/SF-42 Jan. 09–Dec. 10
  Kemal Ali Ger, UCD, 530.400.6269, kager@ucdavis.edu

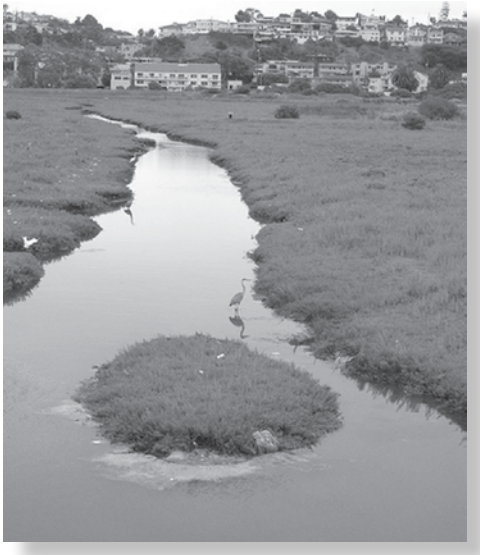
In the last decade, there has been an inexplicable rise in the incidence of toxic cyanobacteria blooms in the Delta. Scientists now wonder whether these blooms (of the species *Microcystis aeruginosa*) might be changing the base of the pelagic food web enough to contribute to the decline in the region's pelagic fishes. Of particular interest in this project is to examine how the toxic blue-green algae might be affecting copepods, a main food for several fishes, including the endangered Delta smelt. In this project, the fellow will use recent advances in genetic markers to calibrate a PCR-based method for tracking in-situ ingestion of Microcystis by zooplankton.

- **Sacramento River Steelhead Trout: An Assessment of Behavioral Differences and Contributions of Hatchery and Wild Stocks**
  R/SF-43 Sept. 08–Aug. 10
  Philip Sandstrom, UCD, 803.466.3172, ptsandstrom@ucdavis.edu

The CALFED Fellow will study the movements and behavioral differences of wild and hatchery-born Sacramento River steelhead trout. Both adults and juveniles of this endangered species will be acoustically tagged and tracked using the extensive, existing array developed for the California Fish Tracking Consortium. In the first phase, the movement patterns of fish will be characterized. The fellow will then characterize the behavioral differences in wild and hatchery fish. The goal is to complete a model capable of estimating the contributions of wild and hatchery adults and juveniles, based on fish success rates and environmental conditions.

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 (see "No. 2, Special Solicitation …" at www.csgc.ucsd.edu/FUNDING/APPLYING/PRELIMINARY/IndxPrelim.html). The projects below were selected for 2009 funding.



- **Parasites as Indicators of Coastal Wetland Health**
  R/OPCENV-01 Feb. 07–Jan. 10
  Kevin Lafferty, USGS, 805.893.8778, lafferty@lifesci.ucsb.edu
  Armand Kuris, UCSB, 805.893.3998, kuris@lifesci.ucsb.edu

Scientists are counting the number and diversity of trematode parasites in common marsh snails to evaluate biodiversity. The hypothesis is that a trematode tally can be used as a proxy for monitoring a marsh's ecological health—the more parasites and the greater variety of them, the healthier the marsh. Because trematodes require multiple hosts, the presence or absence of a trematode encapsulates the predator-prey relationships present in the area. Parasite counts could, theoretically, help managers identify which animals are missing from a wetland habitat and prioritize restoration projects that might create habitats to attract these missing species. The difficulty in identifying the trematodes will be addressed through the creation of a parasite "field guide."

- **Evaluating Current Ocean Management Systems to Facilitate the Development of Ecosystem-Based Management**
  R/OPCENV-02 Feb. 07–Jan. 10
  Oran Young, UCSB, 805.893.8747, young@bren.ucsb.edu

This project is based on the premise that ocean health would be improved by streamlining and coordinating the complex web of regulations governing industries as diverse as shipping, fishing and coastal development. To do this, the lead scientist is completing three major tasks: 1) to identify marine-related laws that overlap in function and space; 2) to identify inconsisten-

cies in ocean management; and 3) to identify areas where agency and/or legal coordination can be improved. In 2008, the scientists had completed selecting and compiling laws and regulations relevant to the California Current and, with the input of experts, had identified redundancies in some laws. Findings were presented at the Digital Government Research Conference 2008. A new digital library of laws and regulations germaine to the California Current marine ecosystem is available at www.cclme.org.

- **Spiny Lobster Movement, Habitat Use and Abundance in Southern California: Bottom-Up and Top-Down Interactions in Kelp and Seagrass Habitats**
  R/OPCFISH-03 Mar. 07–Feb. 09
  Kevin Hovel, SDSU, 619.594.6322, hovel@sciences.sdsu.edu
  Christopher Lowe, CSULB, 562.985.4918, clowe@csulb.edu

Scientists are acoustically tagging and tracking spiny lobsters in San Diego to investigate two hypotheses: 1) that the invertebrates' movements are governed by a combination of forces acting from the bottom-up (i.e., food availability) and from the top-down (i.e., risk of predation); and 2) that the animals strongly influence the structure of kelp forest and seagrass benthic communities. In the summer of 2008, they also began studying the effects of lobsters on sea urchin densities and mortalities in the Point Loma kelp bed.

- **Binational Studies Leading to Ecosystems-Based Management Strategy for the Common Thresher Shark and Other Fishery Resources in the Southern California Bight**
  R/OPCFISH-04 Jan. 07–Feb. 09
  Jeffrey Graham, UCSD/SIO, 858.534.8044, jgraham@ucsd.edu
  Oscar Sosa-Nishizaki, CICESE, 646.175.0500, ososa@cicese.mx
  Suzanne Kohin, NMFS, 858.546.7104, suzanne.kohin@noaa.gov

Scientists have organized a binational effort to assess the impact of fishing on shark populations in the Southern California Bight, which straddles both Mexico and Southern California. The scientists, working with graduate students in Baja California, have established what amounts to a mini-observer program for the drift gillnet thresher shark fishery in Ensenada, Mexico. The biologists are also describing artisanal fisheries in Baja California and identifying essential habitat areas for juvenile thresher sharks. For sharks with native ranges beyond the waters of one nation, binational research of this kind is essential in establishing ecosystem-based management plans that can protect the long-term viability of these vulnerable long-lived species.

- **Ecology and Trophic Interactions of Jumbo Squid (*Dosidicus gigas*) in the California Current Ecosystem**
  R/OPCFISH-06 Mar. 08–Feb. 11
  William F. Gilly, HMS/SU, 831.655.6219, lignje@leland.stanford.edu
  John Field, NOAA/SWFSC, 831.420.3907, John.Field@noaa.gov

The lead biologist of this project theorizes that the population boom in jumbo squid off the West Coast in recent years is due to the spread of a mid-depth layer of oxygen-depleted waters. He and colleagues are now interested in quantifying the biomass of the squid in the California Current and their prey consumption patterns to estimate their potential impact on existing fisheries. The traditional view of jumbo squid has been that they feed primarily on myctophids and other fishes in the gloomy bathy-pelagic zone. Shoaling of oxygen-poor waters off the coast may be changing this pattern, however, and increasing the squid's ability to forage on commercially important species.

- **Tackling Ecological Complexity and Climate Change: Matches and Mismatches in the Seasonal Cycle of California's Marine Flora and Fauna**
  R/OPCENV-07 Jan. 08–Dec. 09
  William J. Sydeman, FIAER, 707.478.1381, wsydeman@comcast.net
  Steven J. Bograd, NOAA/NMFS, 831.648.8314, Steven.Bograd@noaa.gov

In this project, biologists are exploring the trophic interactions regulating the number of top predators. They theorize that matches and mismatches in predator needs and prey availability drive the sometimes dramatically variable reproductive success of seabirds, salmon and other predators. Scientists are analyzing existing physical and biological data and conducting field studies to produce a cohesive dataset for the period from 1997 to 2009. This will then be used to study linkages between ocean upwelling, ocean circulation and trophic level productivity (primary, zooplankton, rockfish, seabird and salmon). The findings will have direct application for ecosystem-based fisheries management.

- **Long-Term Faunal Changes in California Nudibranchs: Climate Change and Local Ocean Health**
  R/OPCENV-08 Dec. 07–Nov. 10
  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, 415.321.8300, gosliner@calacademy.org

The premise of this project is that the abundance, diversity and geographic distribution of nudibranchs (brightly colored, short-lived mollusks) will reflect broad-scale changes in coastal ocean conditions such as temperature and productivity. Researchers are resurveying three rocky intertidal sites in Central California with historical records of nudibranch populations dating back to the 1930s to examine the response of nudibranchs to warm and cold phases of the Pacific Decadal Oscillation (PDO) over the course of several PDO cycles. This analysis should make it possible to distinguish the cyclical effects of PDO cycles from the long-term trend of global warming. With their annual to subannual life spans and planktonic larval dispersal, nudibranchs are hypothesized to reflect environmental changes at finer temporal scales than longer-lived species.

- **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 Start date to be determined–Jan. 12
  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

Ocean acidification is arguably one of the most significant threats to the long-term sustainability of calcifying organisms such as sea urchins, oysters and abalone. To date, much of the research on ocean acidification has focused on high-latitude ecosystems. In this project, a multi-disciplinary team of scientists will conduct field and laboratory experiments to: (1) investigate the extent of ocean acidification at select sites in coastal California; (2) examine the effect of elevated pCO_2 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 how they respond to changes in seawater pCO_2. The scientists will also partner with California's public aquaria to increase public awareness about ocean acidification and its relationship to California's coastal ecosystem.

Education, Training & Public Information

- **Sea Grant Trainees**
  R/G-2
  R.A. Moll/CASG

Sea Grant's commitment to furthering marine-oriented education is met by the Sea Grant trainee project. Graduate students participate in research and work on problems relating to marine resources while fulfilling thesis requirements. This experience prepares them to enter positions in the academic community, government and industry.

- **California Sea Grant State Fellowship Program**
  E/G-9
  R.A. Moll/CASG

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.

- **John D. Isaacs Marine Undergraduate Research Assistant Program**
  E/UG-4
  R.A. Moll/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.

California Sea Grant Committees

Sea Grant Advisory Board

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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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Index of Researchers/Fellows

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