California Sea Grant

Program Directory 2010

Sea Grant
California

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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 …

Each year I use the occasion of writing the Message from the Director found in this Program Directory to review the accomplishments of California Sea Grant for the past year and to look forward to where our program might be headed. Perhaps if there is one constant among the past few years, it is that events have unfolded in a manner that was almost impossible to predict. While the spotlight shined brightly on the state of California in regard to coastal and resource use and planning a year ago, events that swept historic change into the federal government in November 2008 also brought renewed federal interest in the environment.

Legislation long stalled in Congress on climate change is now forging ahead. Marine spatial planning has moved from a generic idea to become a viable concept with active players and Marine Protected Areas are being designated in coastal waters around the country. As this directory goes to press, the federal government is forming a new national ocean policy. These events have shifted the spotlight away from the state and toward the national stage, and have had a substantial impact on the activities of California Sea Grant.

As it has each of the past few years, California Sea Grant has evolved with the changing dynamics of federal and state government. Climate change has grown in prominence in federal government and remains prominent in state government, and it will continue to exert a greater influence over our program's research and outreach portfolio. Studies on topics such as ocean acidification, changes in sea levels, shifts in upwelling, thermal regime changes and phenology are now among our funded activities. No doubt these topics will continue to shape our program even more in the coming year. Likewise, the California Sea Grant Extension Program is responding more frequently to questions about how climate change might impact the California coastal environment.

These new focus areas build upon California Sea Grant's core mission—we continue to study coastal processes, sustainable fisheries, invasive species, recruitment in coastal organisms, marine biotechnology and aquaculture, among many others. In most cases the consequences of climate change make these studies all the more relevant and urgent. Further, we find continued motivation to address these topics through a regional approach of West Coast collaboration.

The challenges to understand and carefully use our coastal and marine resources remain as large as ever. Whether those challenges are addressed on a local, state, regional or federal level, California Sea Grant strives to play an important role. As always, we invite you to join us as we chart our future path.

Russell A. Moll
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 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 32 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 2010 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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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

COPC California Ocean Protection Council
Oakland, California 94612

COST California Ocean Science Trust
Oakland, California 94612

CSGEP California Sea Grant Extension Program

CSUMB California State University, Monterey Bay
Seaside, California 93955

CSUSM California State University, San Marcos
San Marcos, California 92096

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

MBNMS Monterey Bay National Marine Sanctuary

MLML Moss Landing Marine Laboratories
Moss Landing, California 95039

NOAA National Oceanic and Atmospheric Administration
Washington, DC 20230

NOAA NMFS NOAA National Marine Fisheries Service

NOAA NOS, MDP NOAA National Ocean Service, Marine Debris Program

NOAA OAR NOAA Oceanic and Atmospheric Research

NOAA PPI NOAA Program Planning and Integration

NOAA WCRO NOAA West Coast Regional Office
Oakland, California 94612

ORMP CNRA Ocean Resources Management Program
California Natural Resources Agency
Sacramento, California 95814

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

SU Stanford University
Stanford, California 94305

SUNY/ ESF State University of New York College of Environmental Science and Forestry
Syracuse, New York 13210

SWFSC Southwest Fisheries Science Center
Santa Cruz, California 95060

UCB University of California, Berkeley
Berkeley, California 94720

UCD University of California, Davis
Davis, California 95616

UCLA UCLA
Los Angeles, California 90095

UCSB University of California, Santa Barbara
Santa Barbara, California 93106

UCSC University of California, Santa Cruz
Santa Cruz, California 95064

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

USGS U.S. Geological Survey
Reston, Virginia 20192

UW University of Washington
Seattle, Washington 98195

WSU Washington State University
Vancouver, Washington 98686

- **The Role of Symbiotic Bacterial Metabolites in the Development of Toxic Phytoplankton Blooms**
  R/CONT-205 Feb. 2008–Jan. 2011
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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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In the fall of 2009, a team of researchers undertook a series of field experiments at Imperial Beach in southern San Diego, an area with a history of beach closures following heavy rain, to learn more about how pollutants get diluted in water and are transported in the surf zone. If all goes as planned, the data will ultimately lead to fine-scale models of water quality for ocean users, similar to online wave and surf reports. For the field work, researchers deployed floats to measure the speed at which pollutants might spread along the shore. A nontoxic pink dye was also released into the surf zone to detect slower, more subtle cross-shore motions. The dye plume was then tracked by Jet Skis equipped with sensors. Instruments mounted on tripod frames in the surf gathered data, and biological sampling was also conducted to permit studies of bacteria and phytoplankton dynamics and how they are affected by sunlight, mixing and nutrient inputs.

- **Is C/N Decoupling Caused by Harmful Algal Blooms in Santa Monica Bay?**
  R/CONT-209 Feb. 2010–Jan. 2012
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This project explores a long-standing oceanographic mystery: the apparent decoupling of dissolved inorganic carbon and dissolved inorganic nitrogen cycles in the summer mixed layer of both open ocean and marginal seas. The hypothesis to be tested is that dinoflagellates migrating vertically in the water column link the two cycles. In particular, the theory is that algae living in sunlit surface waters obtain the nitrogen they need by descending below the mixed layer at night. They then ascend back into these 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 will test the theory in Santa Monica Bay in Los Angeles. Findings will have relevance to understanding causes of harmful algal blooms in low-nitrate surface waters.

- **Connectivity of West Coast Marine Sanctuaries: Tracking Sooty Shearwaters Throughout Dynamic Upwelling Ecosystems in the California Current System**
  R/ENV-204 Feb. 2008–Jan. 2011
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The flight patterns of sooty shearwaters are being tracked with satellite telemetry across the Pacific Ocean. The tagging, besides adding to what is known about the ecology of the species, is an innovative attempt to use an extremely abundant predator as a means of studying the upwelling dynamics in the California Current ecosystem and understanding how these dynamics influence the distributions of prey species such as anchovy and sardine. In the first year of the project, about 30 birds were captured and tagged off the U.S. West Coast and tracked as they flew in near beelines to New Zealand. As more birds are tagged and tracked in the coming year, the bird data will be integrated with physical data (i.e., measurements of sea surface temperature, chlorophyll and wind stress) so as to correlate hotspots of bird activity with convergence/divergence zones and frontal boundaries. Maps of the tracking data are publically available at www.seaturtle.org.

A small flock of sooty shearwaters take advantage of abundant, shoaling anchovy.
Photo: Josh Adams, USGS/MLML

- **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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The invasive non-native tamarisk tree—an escapee of the ornamental plant trade also known as salt cedar—has invaded wetland marshes at NOAA's Tijuana River National Estuarine Research Reserve, transforming rare wetland marshes into not-so-rare upland woods. To control their spread, managers are chopping down the exotic trees, in the hope that cleared areas will regrow with native vegetation. This project explores whether this is indeed happening and if not, why and how it can be fixed. Findings will be shared with managers to help them improve ongoing wetland restoration in rare marsh habitats and reduce costs.

- **Beaches as Threatened Ecosystems: An Evaluation of Status and Trends in the Ecology of California's Sandy Beaches**
  R/ENV-210 Feb. 2009–Jan. 2011
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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 study sites to construct a 30-year history of the ecology and physical characteristics of sandy beaches from Morro Bay to San Diego. This record will be analyzed for meaningful trends and processes affecting sand supply, beach width, biodiversity and community structure. It will also be used to identify potentially rare, declining or locally extinct intertidal species. Findings will be shared with beach management and conservation managers.

- **Cross-Shelf Larval Migrations Regulating Larval Supply and Connectivity in a Network of Marine Reserves**
  R/FISH-206 Feb. 2009–Jan. 2012
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Contrary to prevailing view, invertebrate larvae are not mere passive floats swept hither and yon by ocean currents, say the scientists leading this project. Instead, surprisingly, invertebrate larvae appear to exert considerable control over their movements, as seen by the fact that they usually remain near shore, even during strong upwelling events. The point of this project is to test the degree to which ocean currents can be accurately seen as a forcing mechanism for larval transport and settlement. In the first year, larvae were surveyed at two locations with persistent upwelling, including Point Arena, the strongest upwelling center in California, and Bodega Head. Findings will augment what is known about larval transport mechanisms, connectivity and self-recruitment, and the role of physical forcing on larval supply.

Ron Burton. Photo: Kristen Gruenthal, SIO

- **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

This project's ultimate goal is to develop an automated shipboard device 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, which was demonstrated in a recent NSF-funded project as 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.

- **Sustainability and Fine-Scale Management of a California Sea Urchin Fishery and the Ecology of Exploitation**
  R/FISH-209 Feb. 2010–Jan. 2013
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This project's overarching goal is 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. Another primary goal: 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 models 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 ecosystem-based management of the Pt. 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
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In this project, scientists will develop computer models for evaluating the performance of Central Coast marine protected areas (MPAs) for several representative exploited species, including blue rockfish, black rockfish, lingcod and cabezon. The spatial population models will incorporate what is known about larval dispersal, adult movement and key species interactions. Model output will allow managers to compare the results of monitoring to the expectations and goals of the existing Central Coast MPAs. This information can be used for adaptive management purposes. The two main objectives are to understand how marine populations respond to the implementation of MPAs and to develop methods for quantifying, analyzing and comparing these responses to monitoring data. To fully understand the results of monitoring California MPAs, the scientists will develop an understanding of what the range of possible responses are and how they depend on management outside the MPAs, the environment and biology.

- **Development of Biological Control for the New Zealand Mud Snail**
  R/ANS-212 Feb. 2010–Jan. 2011
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This project investigates the potential use of a castrating trematode parasite (Microphallus spp.) as a biological control agent for New Zealand mud snails, which have invaded rivers and streams in the Western United States. In the first phase of the project (R/ANS-210), scientists evaluated the parasite's effectiveness at halting the snail's reproduction. The second year's objectives are to further investigate the parasite's efficacy and host specificity. To do this, they will travel to Australia, where both the mud snail and parasite were introduced inadvertently, to verify that increased infection is associated with reduced snail populations in the field. They will also investigate whether the parasite is infecting non-target native Australian snails. In a secure laboratory, North American mollusks will be exposed to the parasite to ensure it cannot infect native biota. A public outreach campaign will be launched if biological control proves justifiable.

- **Exploring the Impact of Avian Predators on Central California Salmonids**
  R/FISH-205 Feb. 2008–Jan. 2011
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The working hypothesis of this project is that predatory birds, principally Western gulls, take a significant toll on federally listed coho and steelhead in Scott and Waddell Creeks. To test this, scientists captured, tagged, and radio-tracked 65 Western gulls, three common mergansers, a snowy egret and a kingfisher. Stable isotope signatures from blood and feather samples from these birds and 100 others (captured but not radio tagged) are being used to evaluate their diets. More than 6,000 salmonids have been tagged with PIT tags in the two creeks. In Scott Creek, down-stream movements and mortality rates are being monitored by PIT tag antennae arrays for hatchery and wild fish. On five trips to Año Nuevo Island, more than 200 egested PIT tags were recovered from seabird breeding areas. The tags are providing insights into the time of year salmon are most vulnerable to predation, as well as the age classes targeted by birds. Other seabird colonies are being scanned for egested tags, including the Caspian tern colony on Brooks Island in San Francisco Bay. The results, to date, reveal that gulls, but also other birds, are indeed impacting salmon. The researchers will soon begin testing the degree to which bird-exclusion devices can protect the fishes.

- **Understanding Roles of Competing Bacterial Endosymbionts in Abalone Health, Management and Restoration**
  R/FISH-208 Feb. 2010–Jan. 2013
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A newly discovered rickettsial bacterium (RLO) appears to reduce the lethality of the abalone disease, 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. 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 listed 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 vulnerable to outbreaks. The Abalone Farm in Central California is a collaborator on the project.

- **Seaweed Strain Selection and Preservation to Optimize Harvest Yields for Abalone Culture**
  R/AQ-128 Feb. 2008–Jan. 2011
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Biologists developed a small red algae garden in Monterey Harbor, which the Monterey Abalone Company is using to supplement the diet of its red abalone. Feeding experiments suggest that relatively small amounts of red algae boost abalone growth rates and improve shell color, as compared to abalone fed giant kelp, a brown alga, almost exclusively. In a blind-taste event, food critics also said they preferred the "super abs" almost four-to-one over abalone raised on a standard giant-kelp diet. The abalone company is interested in expanding its pilot algae garden to help reduce the farm's reliance on wild-harvested kelps. Biologists are exploring the ability to dry and store, or silage, kelp for use in winter. California Sea Grant Extension Program plans to adapt findings from this project into a user-friendly manual for industry.

- **Soft-Egg Syndrome in Farmed White Sturgeon**
  R/AQ-129 Feb. 2008–Jan. 2011
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  Serge Doroshov, UCD, 530.752.7603, sidoroshov@ucdavis.edu
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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 caviar 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-harvesting processing techniques were ruled out as a cause. In the coming year, 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 farming sturgeon for better caviar, 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
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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, scientists are developing 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 attempt to identify mineral supplements that can compensate for nutrients lost by reducing fishmeal. 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, experiments will be conducted to optimize the feed's protein to energy (calorie) content. Researchers will then begin investigating fish oil alternatives. It is hoped that the project will result in commercially viable fish feeds with 75 percent less fishmeal and 50 percent less fish oil.

- **Climate Change and Restoration Factors Affecting Fecal Pathogen Dynamics in Wetland Systems**
  R/CONT-206 Feb. 2008–Jan. 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

Climate change is warming surface waters in the California Current and increasing stratification of the upper water column. This project examines its effect on the region's biology, especially as it relates to the timing of the spring plankton bloom and spawning of Northern anchovy,

Pacific sardine and jack mackerel. The theory to be explored is that global warming has altered, perhaps through upwelling dynamics, the timing of the spring bloom and availability of spawning habitat for these species. Four types of satellite data will be used to monitor seasonal fluctuations in oceanographic conditions and primary productivity in the California Current. Scientists will also develop a monthly spawning habitat index for species using data collected by a continuous underwater fish egg sampler, developed in previous Sea Grant-funded work by the lead investigator. They will then examine whether the reproductive success of fishes and the timing of their spawning are related to variations in the timing of the spring bloom and/or other oceanographic processes. Findings will shed light on the effects of climate change on regional food webs and the relationship between seasonal oceanography and yearly fish recruitment success.

New Technologies and Products

- **Harnessing the Pharmaceutical Potential of Marine Cyanobacteria**
  R/NMP-99 Feb. 2008–Jan. 2011
  William H. Gerwick, UCSD/SIO, 858.534.0578, wgerwick@ucsd.edu
  Lena G. Gerwick, UCSD/SIO, 858.534.0566, lgerwick@ucsd.edu

The far-reaching goal of this project is to manipulate the inner chemical machinery of blue-green algae to boost yields of compounds they produce with potentially high therapeutic value. The working hypothesis under investigation is that transcriptional promoters can do this, by altering the expression of secondary metabolite pathways. In the first year of the project, scientists used a beta galactosidase assay to determine promoter and ribosomal binding site regions in the Jamaicamide pathway from a Jamaican strain of *Lyngbya majuscula*. Two transcription factors that bind to the regulatory region of the pathway were also identified via mass spectrometry. Another noteworthy milestone was achieved with a large-scale culture of a Phormidium species that up-regulated its production of a brominated natural product at m/z 933 under special "grow lights." The novel compound of mass m/z 933 is undergoing isolation by high performance liquid chromatography; its structure will be determined via nuclear magnetic resonance and other mass spectrometry methods.

- **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

Scientists recently cultured and identified a new group of marine bacteria called MAR4, which are capable of producing a rare class of secondary metabolites called hybrid isoprenoids. In this project, researchers will use molecular techniques to screen a large collection of marine bacteria for new strains in the MAR4 group and explore these bacteria as a source of new hybrid isoprenoid antibiotics. These bacteria will also be screened for prenyltransferase genes, which are associated with hybrid isoprenoid biosynthesis, to gain a better understanding of the diversity and distributions of these genes among marine bacteria. Specific objectives of the project include the experimental characterization of gene clusters associated with the biosynthesis of hybrid isoprenoid secondary metabolites, the cloning and heterologous expression of prenyltransferases, and the application of these enzymes as biochemical tools for developing new structural diversity.

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.

- **Modeling Nutrient and Organic Carbon Loads and Sources in Central Valley Watersheds: Taking Existing Monitoring Data to the Next Stage**
  R/SF-8 Sept. 2005–May. 2010
  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.

- **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

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.

- **Mercury Interactions with Algae: Effects on Mercury Bioavailability in the San Francisco Bay-Delta**
  R/SF-22 Jun. 2007–May 2010
  Allison Luengen, SBU, 631.632.3128, aluengen@notes.cc.sunysb.edu

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 help 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 2007–Apr. 2010
  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. 2007–May 2010
  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. 2008–Feb. 2011
  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. 2007–Aug. 2010
  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. 2007–Aug. 2010
  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. 2007–Aug. 2010
  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. 2007–Mar. 2010
  Heidi Weiskel, UCD, 530.902.0878, hwweiskel@ucdavis.edu

In the first phase 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. 2008–Dec. 2010
  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 maintaining 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. 2009–May 2011
  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 differ-

ent 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. 2008–Aug. 2010
  Kristen Buck, UCSD, 858.534.4550, kristen.buck@bios.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 2009–Jul. 2011
  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. 2008–Sept. 2010
  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. 2008–Aug. 2010
  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. 2008–Sept. 2010
  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. 2008–Aug. 2010
  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. 2008–Aug. 2010
  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.

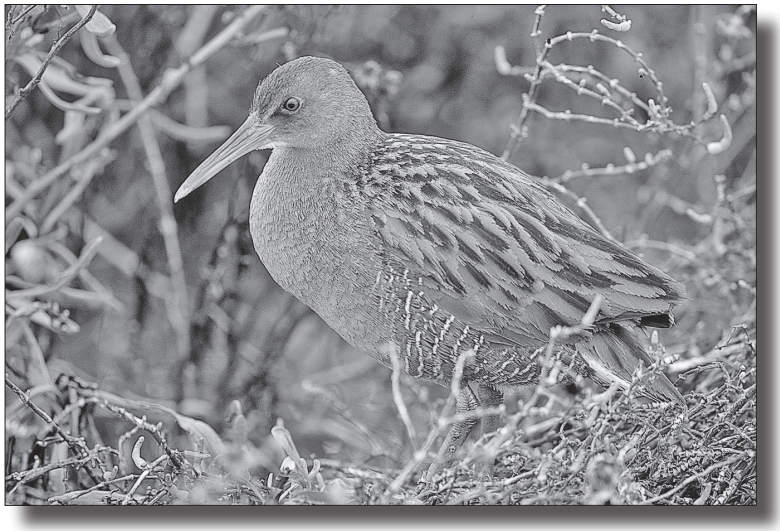
- **Scenarios for Restoring Ecologically Functional Floodplains and Providing Flood Control Services in the Sacramento-San Joaquin Delta**
  R/SF-39 Sept. 2008–Aug. 2010
  Mary Matella, UCB, 510.643.1136, mmatella@nature.berkeley.edu

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. 2009–Dec. 2010
  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 ago), 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.



California clapper rail (*Rallus longirostris obsoletus)* Baylands Nature Preserve, Palo Alto.
Photo: ©1992 Peter LaTourrette

- **Pilot-Scale Evaluation of an Iron Sediment Amendment for Control of Mercury Methylation in Tidal Wetlands**
  R/SF-41 Jan. 2009–Dec. 2010
  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. 2009–Dec. 2010
  Kemal Ali Ger, UCD, 530.400.6269, aligerger@gmail.com

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. 2008–May 2011
  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. The projects below were selected for 2010 funding.

- **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

Swarms of jumbo squid invaded Monterey Bay about a decade ago and have not disappeared since. Are they reproducing in the bay? Probably not, biologists report. Instead, the invertebrates likely are migrants, principally attracted to the region from August to February because of ample foraging opportunities and desirable water temperatures. Stomach content analyses show the squid's diet consists largely of small mesoscale lampfishes, as well as of hake, sardine, market squid and various rockfishes. The impact to local fisheries of this relatively new and presumably huge predatory biomass is not yet known. NOAA Fisheries is a collaborator on the project because of its concerns about what the squid might be doing to already beleaguered groundfish stocks. Historically, the squid was a denizen of the eastern tropical Pacific Ocean. In the last 50 years, large numbers have moved into the Gulf of California. Biologists attribute its more recent expansion into coastal waters of California and the Pacific Northwest to a spreading of the mid-depth oxygen minimum zone, the squid's foraging habitat. The lead scientist on this project also suspects that overfishing of squid predators, such as the big-eye tuna in the eastern tropical Pacific and large yellowfin tuna further to the north, may have played a role in the squid's ability to capitalize on the expansion of its hunting grounds. In the coming year, the scientists hope to estimate the squid's biomass in the Monterey Bay area and its impact on commercially important species. They will also continue to tag and track squid via satellite.

- **The Future of the California Chinook Salmon Fishery: Roles of Climate Variation, Habitat Restoration, Hatchery Practices and Biocomplexity**
  R/OPCFISH-10 Dates to be determined
  Brian Wells, NOAA/SWFSC, 831.420.3969, brian.wells@noaa.gov
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The collapse of West Coast salmon populations led to sweeping closures of both sport and commercial salmon fishing in 2008 and 2009 and to the subsequent appropriation of $170 million in federal disaster relief aid. The focal points of salmon restoration efforts in California are the Klamath River and Central Valley runs, where dams and water use conflicts, along with oceanographic and climatic variability, continue to push species to the brink. 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 impacting 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: 1) salmon survival is becoming increasingly variable 2) climate

variability is increasing 3) genetic diversity within and among salmon populations is diminishing 4) improving population structure diversity will reduce swings in salmon survival, and 5) improving diversity will improve the economic viability of fisheries.

- **Long-Term Faunal Changes in California Nudibranchs: Climate Change and Local Ocean Health**
  R/OPCENV-08 Dec. 2007–Nov. 2010
  Jeffrey H.R Goddard, UCSB, 805.688.7041, goddard@lifesci.ucsb.edu
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The brightly colored, shallow-water mollusks known as nudibranchs come and go along the coast in response to changes in ocean conditions, thescientists in this project report. 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. The apparent decline of nudibranchs in recent years may be reversed in 2010, depending on the strength of the developing El Niño, they predict. Biologists believe this project¹s 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
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In California's coastal waters, carbon dioxide levels are rising in rough concert with atmospheric carbon dioxide concentrations. The chemistry of seawater is such that the added carbon dioxide has the effect of lowering the ocean's pH. More acidic seawater can, among other things, corrode the calcium carbonate shells of organisms such as corals, oysters, sea urchins, lobsters and abalone. The larval or juvenile stages of shell-building organisms are particularly vulnerable to corrosion. 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 and upwelling is further exacerbating acidification along the shelf. 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 selected 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 aquariums.

NOAA Fisheries/Sea Grant Fellowships

NOAA Fisheries Service and National Sea Grant collaborate to offer Joint Graduate Fellowships in Population Dynamics and Marine Resource Economics. Fellows are selected through a national competition and work on topics of public interest and relevance to NOAA under the guidance of mentors at participating NOAA Fisheres Science Centers or Laboratories. (For details, see http://www.csgc.ucsd.edu/EDUCATION/SeaGrantFellows.html)

- **NMFS-Sea Grant Graduate Fellowship in Population Dynamics: Determining Status of the Great White Shark (*Carcharodon carcharias*) and Common Thresher Shark (*Alopias vulpinus*) off California**
  E/PD-3 Jun. 2008–May 2010
  Taylor Chapple, UCD, 530.754.8644, tkchapple@ucdavis.edu

In this project, the biologist is attempting to estimate the number of great white sharks off California with fishery-independent "mark-and-recapture" data, collected at aggregation sites in the Eastern Pacific. The goal is to generate a reliable baseline from which changes in the population can be detected. Thresher sharks are the project's second focus. Commercial fishing in the 1980s sharply reduced the number of these top predators. Although the population appears to be rebounding due to regulatory actions, the researcher's preliminary work suggests that threshers are susceptible to severe declines even with moderate fishing pressure. Current assumptions about the species' tolerance to fishing pressure may be incorrect.

- **NMFS-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 short fin mako sharks in the Northeastern Pacific Ocean. To do this, scientists have collected several hundred mako skin biopsy samples, many of which are archived at NOAA's Southwest Fisheries Science Center in La Jolla. The researcher is currently working with the Chatsworth, California company, Genetic Molecular Identification Services, to develop microsatellite markers for a forthcoming population genetics analysis. They are building a conceptual framework for a population dynamics model, too.

- **NMFS-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

There is ongoing debate over the economic and social costs and benefits to commercial fishers, fishery managers and the public when harvest rights are allocated to groups or to individuals via tradable quota systems. In this project, the fellow is reviewing and analyzing information from two New England groundfish cooperatives that formed between 2004 and 2006, in which commercial fishers organized themselves into co-ops and divided the catch allocated to their co-op. The insights the fellow hopes to provide include: What are the differences in benefits and costs of voluntary cooperatives vs. status quo management systems? Can self-organized fishing cooperatives result in increased profit to participating fishers? Will monitoring and enforcement costs increase or decrease? How will cooperatives manage excess fishing capacity?

- **NMFS-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 to be 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.

Education, Training & Public Information

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

Sea Grant graduate students participate in research and work on problems relating to marine resources while fulfilling thesis 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
  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.

Knauss Sea Grant Fellows 2010

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.

Karen Carlson, NOAA Program Planning and Integration
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California Sea Grant State Fellows 2010

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.

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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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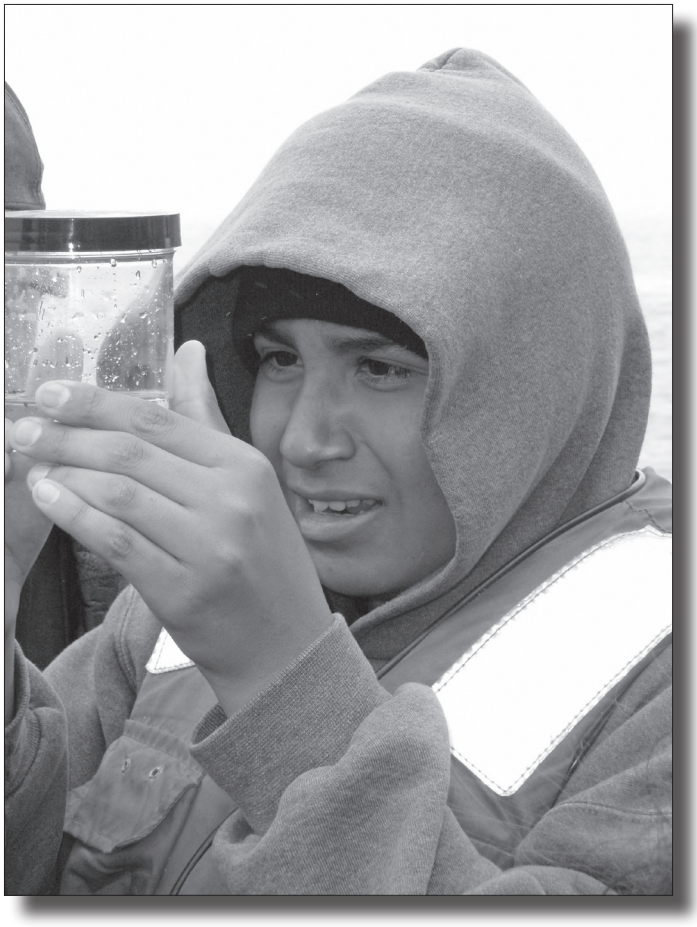

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