Program Directory 2012

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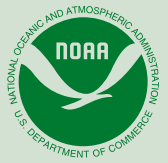
Sea Grant is a unique partnership of public and private sectors, combining research, education, and outreach for public service. It is a national network of universities meeting changing environmental and economic needs of people in our coastal, ocean, and Great Lakes regions.



Report No. R-061
2012

Message from the Director …

As I approach the end of my first year as Director of California Sea Grant, I realize what an incredible period of education and professional growth these past 12 months have provided me. With the benefit of a great staff and well-functioning program, I have had the luxury to learn, solicit advice and guidance along the way, and initiate some significant changes that I believe will improve the program.

First and foremost, we are starting to grow our extension and outreach program. During the next year we will initiate a two-year extension fellowship program. We will begin by hiring up to two fellows selected from the pool of "junior-level" scientists with a demonstrated interest in applying science to solving California's coastal issues. With the help of a mentor assigned from our pool of current Extension Advisors, each fellow will develop and implement an individualized extension/outreach program. In addition, we will also start the process of hiring new Extension Advisors to fill a forthcoming vacancy and to expand into underserved geographic areas of our state. These and related actions will in time significantly increase the impact of our program.

Second, we have changed our proposal solicitation strategy. We will offer large, multi-year awards only in alternating years, and in years in between we will solicit proposals only for smaller, one-year awards focused on a narrow range of topics of interest to the program. This strategy will allow us to target impacts on topics of high importance and relevance to California's coastal citizens, while allowing for a larger number of substantial awards to be administered as a result of the proposal review process.

During this past year our program played a key role in establishing new baseline research programs that will address California's South Coast Marine Protected Areas (MPAs). We value the partnership we have forged with the MPA Monitoring Enterprise, the Ocean Protection Council, and other state agencies with interests in and responsibilities for coastal marine issues.

Despite my optimism regarding recent accomplishments and plans for the future, I would be remiss if I failed to address the looming beast of budget uncertainty. The elevated disharmony we all see in Congress, coupled with the nation's generally weak economic conditions and widespread calls for spending cuts, suggest that we cannot expect significant growth, or even assume stability, in any of the nation's Sea Grant programs. We don't know what is ahead with either federal or state support for Sea Grant, but we must prepare for the possibility of a significantly leaner program, at least in the short term. Thus, our planning is made with an eye toward ensuring that implemented changes cannot be derailed by a temporary downturn in our fortunes. This is not an enjoyable exercise, but it is a prudent one. Let us hope a possible downturn does not materialize. Yet whatever we must face in the short term, I have faith in the value and importance of this program to the citizens we serve, and in the talent and enthusiasm that abounds in our marine scientific and public service sectors. I greatly look forward to the years ahead.

Dr. James E. Eckman
Director

Contents

What is Sea Grant?

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

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

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

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

The research funded is selected on the basis of competitive, peer-reviewed proposals and addresses a wide range of problems and opportunities. This Program Directory provides summaries of the projects funded in 2012 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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AG Analysis Group
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BIOS Bermuda Institute Ocean Science
St. George's, Bermuda

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

CCC California Coastal Commission
San Francisco, California 94105

CDFG California Department of Fish and Game
Sacramento, California 95814

CDPR California Department of Parks and Recreation
Sacramento, California 95814

CNRA California Natural Resources Agency
Sacramento, California 95814

COPC California Ocean Protection Council
Oakland, California 94612

COST California Ocean Science Trust
Oakland, California 94612

CASGEP California Sea Grant Extension Program

CPSLO California Polytechnic State University
San Luis Obispo, California 93407

CSLC/ MISP/ DEPM California State Lands Commission
Marine Invasive Species Program
Dept. Env. Planning & Management
Sacramento, California 95825

CSUDH California State University, Dominguez Hills
Dominguez Hills, California 90747

CSUF California State University, Fullerton
Fullerton, California 92831

CSUMB California State University, Monterey Bay
Seaside, California 93955

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

EF Ecotrust Fisheries
Portland, Oregon 97209

FIAER Farallon Institute for Advanced Ecosystem Research
Petaluma, California 94954

FMSA Farallones Marine Sanctuary Assn.
San Francisco, California 94129

HMS Hopkins Marine Station
Pacific Grove, California 93950

HSU Humboldt State University
Arcata, California 95521

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

I-ATTC Inter-American Tropical Tuna Comm.
La Jolla, California 92037

MARE Marine Applied Research & Exploration
Richmond, California 94801

MLML Moss Landing Marine Laboratories
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NE/NMS NaturalEquity/National Marine Sanctuaries
Santa Cruz, California 95060

NOAA National Oceanic and Atmospheric Administration
Washington, DC 20230

NOAA/ CINMS Channel Islands National Marine Sanctuary
Santa Barbara, California 93109

NOAA/ SWFSC NOAA Southwest Fisheries Science Center
Santa Cruz, California 95060

OC Occidental College
Los Angeles, California 90041

OI Ocean Imaging
Solana Beach, California 92075

PRBOCS PRBO Conservation Science
Petaluma, California 94954

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

RCF Reef Check Foundation
Pacific Palisades, California 90272

SDOF San Diego Oceans Foundation
San Diego, California 92109

SDSU San Diego State University
San Diego, California 92182

SDZIC San Diego Zoo Institute for Conservation
Escondido, California 92027

SFBCDC San Francisco Bay Conservation and Development Commission
San Francisco, California 94111

SFSU San Francisco State University
San Francisco, California 94132

SIO Scripps Institution of Oceanography
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SSU Sonoma State University
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SU Stanford University
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SWRCB State Water Resources Control Board
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UCB University of California, Berkeley
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UCD University of California, Davis
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UCLA UCLA
Los Angeles, California 90095

UCM University of California, Merced
Merced, California 95343

UCR University of California, Riverside
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USDA/ ARS U.S. Department of Agriculture
Agriculture Research Division
Washington, DC 20250

UCSB University of California, Santa Barbara
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UCSC University of California, Santa Cruz
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UI/ARI University of Idaho
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USC University of Southern California
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USDOC, NOAA, NMFS, OIA
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USDOC, NOAA, NMFS, PRD
Protected Resources Division
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USDOC, NOAA, NMFS, OST
Office of Science and Technology
Washington, DC 20230

USF University of San Francisco
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USFWS U.S. Fish and Wildlife Service
Washington, DC 20240

USGS U.S. Geological Survey
Reston, Virginia 20192

UW University of Washington
Seattle, Washington 98195

Healthy Coastal and Marine Ecosystems

- **Patch Dynamics of Nutrients, Fecal Indicator Bacteria and Chlorophyll near the Tijuana River**
  R/CONT-207 Feb. 2009–Jan. 2013
  Falk Feddersen, UCSD/SIO, 858.534.4345, ffeddersen@ucsd.edu
  Peter Franks, UCSD/SIO, 858.534.7528, pjfranks@ucsd.edu
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With California Sea Grant support, researchers collected biological data (fecal indicator bacteria, chlorophyll and dinoflagellate counts) as a supplement to an extensive large-scale field project conducted in 2009 at Imperial Beach near the mouth of the Tijuana River with funding from the Nati onal Science Foundation and the Office of Naval Research to study how waves, currents and tides affect ocean pollution. While the physics study has focused on understanding how pollutants are diluted and advected in the surf-zone, the biological study is centered on identifying the sources of fecal indicator bacteria (FIB) and the effects of solar irradiance, particle attachment and microbial food web dynamics on the fate of pathogenic bacteria at the beach. Exchange from the surfzone to inner-shelf waters farther offshore is also being studied, which has important implications for pollution dilution, nutrient delivery, phytoplankton and larval exchange. Among the intended outcomes of the project is a better characterization of the biological and physical processes that create highly “patchy” distributions of pollutants, including fecal indicator bacteria, along the coast. Findings are of relevance to improving coastal water quality.

- **Is C/N Decoupling Caused by Harmful Algal Blooms in Santa Monica Bay?**
  R/CONT-209 Feb. 2010–Jan. 2013
  Anita Leinweber, UCLA, 310.267.5165, leinweber@igpp.ucla.edu
  Rebecca Shipe, UCLA, 310.794.4903, rshipe@ucla.edu

A long-standing oceanographic mystery is the apparent decoupling of dissolved inorganic carbon and nitrogen cycles in the summer mixed layer of both the open ocean and marginal seas. The project’s hypothesis is that vertical migrations of dinoflagellates (a type of algae) link the cycles. The theory is that dinoflagellates living in sunlit surface waters descend below the mixed layer at night to obtain nitrogen (needed for growth) and re-ascend to the same shallow waters by day to photosynthesize, up-taking carbon as they grow. The result is a lowering of dissolved inorganic carbon in the mixed layer. The researchers are conducting a series of baseline cruises in the bay to measure vertical profiles of the water column.

- **Gonadal Gene Expression to Characterize Responses of Longjaw Mudsucker to Contaminated Environments**
  R/CONT-212 Sep. 2010–Aug. 2012
  Chris Vulpe, UCB, 510.642.1834, vulpe@berkeley.edu
  Doris Vidal-Dorsch, SCCWRP, 714.755.3216, dorisv@sccwrp.org

The California Natural Resources Agency, in partnership with the EPA, is actively looking to assess wetland health through its California Coastal Wetlands Monitoring Venture. This project’s contribution is examining the toxicity of complex contaminant mixtures commonly discharged into coastal ecosystems (e.g., municipal effluent that contains pharmaceutical residues, personal care products and industrial chemicals). To do this, scientists are investigating whether gene expression patterns in gonadal fish tissue can be used to detect and assess the subtle, initial effects of endocrine disruptors on marine life. In the next few months, researchers will be completing an analysis of gene expression patterns and interpreting the data.

- **Cellular Mechanisms of Toxin Release in Harmful Algae**
  R/CONT-213 Aug. 2010–Feb. 2012
  Wei-Chun Chin, UCM, 209.228.8668, wchin2@ucmerced.edu

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

- **Making Restoration More Efficient: Testing the Contributions of Planting Diversity and Tamarisk Legacy Effects to Recovering Tidal Marshes**
  R/ENV-209 Feb. 2009–Jul. 2012
  Paul K. Dayton, UCSD/SIO, 858.534.6740, pdayton@ucsd.edu
  Theresa S. Talley, UCSD/SIO, 530.220.0818, tstalley@ucsd.edu

There is often little funding for restoration of coastal wildlife areas, once they have been cleared of non-native plant species, such as tamarisk (also known as salt cedar). The absence of follow-up, scientists say, can leave habitats vulnerable to reinvasion. This project looks at whether inexpensive strategies, such as planting native species and/or mulching with removed weeds, can speed habitat and wildlife recovery of young coastal sage scrub ecosystems in Southern California. After three years of field study, scientists report that the development of these ecosystems (progression of young to mature ecosystems) is mainly structured by the presence and quantity of living and dead plant biomass and, to a lesser degree, by the kinds of plants present. This may be due to the low primary productivity of newly cleared and replanted sites. Researchers recommend that managers prioritize planting natives with large biomass and using left-over plant litter from invasive plant eradication as mulch. Findings were shared with the public, docents and managers at NOAA's Tijuana River National Estuarine Research Reserve and are of relevance to wetland restoration projects in the south San Diego Bay.

- **Beaches as Threatened Ecosystems: An Evaluation of Status and Trends in the Ecology of California's Sandy Beaches**
  R/ENV-210 Feb. 2009–Feb. 2012
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Preliminary field surveys suggest that beach grooming and other human activities may be extirpating some wrack-associated invertebrates, which are often prime food for shorebirds. There is also evidence that dune plants and strand habitat are being pushed to the brink and that the loss of native plants has implications for sand transport on beaches. This project compiles new, recent and historic datasets on beach wildlife to, among other things, identify species in decline that may need greater protection. The biologists are also gathering information on the physical attributes of beaches—beach width, slope and sand dynamics—to search for patterns that might explain sand loss or beach narrowing and/or accretion. The wildlife study focuses on documenting trends in intertidal macroinvertebrate communities; however, a handful of beaches will also be surveyed for shorebirds and wrack abundance. All this is of relevance to the state's efforts to prepare for climate change and maintain the ecosystem services of sandy beaches.

- **Effects of Marine Reserves on Behaviorally Mediated Changes in Spawning Success of California Sheephead**
  R/ENV-214 Jun. 2010–May 2012
  Scott L. Hamilton, UCSB, 805.893.7397, s_hamilton@lifesci.ucsb.edu
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In the first year of this project, researchers assessed the effects of the Catalina Island marine reserve on fish density, biomass, size structure, sex ratios and habitat preferences. For the period 2011–12, they plan to document territorial, courtship and spawning behaviors to test whether the reserve is restoring normal social behavior and enhancing reproductive output. Within the reserve, the hypotheses to be tested are: (1) males will spend more time courting females; (2) the rate of spawning success will be greater; and (3) territory sizes will be different. The Sea Grant trainee on the project is leading manipulated predation experiments inside and outside the marine reserve to document sheephead prey preferences and predation rates on sea urchins as a function of sheephead size. Preliminary findings suggest that sheephead do not begin consuming urchins until the fish are at least 30-centimeters long, the minimum size limit for the sheephead fishery. Diver surveys also show that urchin predation rates are higher in protected areas. Findings suggest sheephead may not be able to control herbivory by urchins at heavily fished sites and that marine reserves could preserve sheephead's historical role as an urchin predator. Findings were shared with managers and the scientific community at a Sea Grant-sponsored sheephead workshop held at UC Santa Barbara in April 2011.

- **Biogeographical Variation in Trophic Interactions on Temperate Reefs of the Southern California Bight**
  R/ENV-216 Jun. 2010–Mar. 2012
  Kevin A. Hovel, SDSU, 619.594.6322, hovel@sciences.sdsu.edu

The working hypothesis of this project is that the no-take fishing zones established recently in Southern California under the Marine Life Protection Act will alter, perhaps significantly, food-web dynamics within kelp forests. This is predicted because two of the region's major fisheries—California spiny lobster and California sheephead—are predators of sea urchin, also a major fishery. This project explores the trophic relationships between these species and how they adjust when fishing pressure is removed. Results will be of relevance to marine reserve science, fisheries managers and urchin fishermen interested in co-management.

- **Modeling Interannual Krill Availability (MIKA) in the Central-Northern California Current, 1990-2009**
  R/ENV-220 Feb. 2012–Jan. 2014
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Several studies have shown that food shortages probably played a major role in the collapses or reproductive failures of rockfishes, seabirds and salmon off Northern California and Southern Oregon from 2003 to 2007. In this project, researchers will attempt to develop a model for predicting when, where and how much krill are available to marine predators off the central-northern California Current ecosystem, based on direct measurements of oceanic conditions and nutrient, plankton and zooplankton concentrations. Krill availability will then be used to predict the recruitment and survivorship of rockfish, squid, salmon, sardine and other krill con-

sumers that are important commercial fisheries. In the first phase of the project, an existing "oceanographic-ecosystem-krill" model will be adapted and calibrated with field observations to hindcast year-to-year variation in krill availability between 1990 and 2009. Model predictions will then be compared with direct observations of predator recruitment and survival to test the hypothesis that model outputs and measured krill parameters are positively correlated with each other and to higher trophic level (i.e., fisheries) productivity. Results will be of direct application to ecosystem-based fisheries management.

- **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

The distribution of fish eggs in the ocean provides valuable insights into the location and timing of fish spawning. Fish egg counts are also used to estimate spawning biomass, a key component of a commercial fishery's stock assessment. The full value of egg and larvae surveys, however, is currently compromised by the fact that some species have eggs that are morphologically similar if not identical. This project has exploited an existing DNA barcoding database (mitochondrial DNA sequences) for West Coast fishes to develop oligonucleotide probes for 23 marine fish species. The probes target species whose eggs are abundant in California waters but are difficult to identify at the species level morphologically. In the coming year, scientists will use the probes (and others to be added to a bead array) to identify fish eggs in archived samples collected during CalCOFI and other cruises, in collaboration with NOAA Southwest Fisheries Science Center. The ultimate goal is to deploy an automated shipboard instrument for rapidly identifying species of fish eggs and larvae collected by nets and a continuous fish-egg sampler.

- **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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  Ed Parnell, UCSD/SIO, 858.822.2701, edparnell@ucsd.edu

A small group of commercial urchin divers has long expressed interest in developing community-based, co-management of the red sea urchin fishery, which is worth about $7 million a year ex-vessel in California. As part of this plan, urchin divers have been voluntarily taxing themselves to support the collection of urchin data that might help maintain the fishery's sustainability and ultimately help craft a co-management plan. This project was funded as a collaborative fishery research project to gather spatially explicit data within the Point Loma kelp bed off San Diego that might both further the fishermen's goals and contribute to basic ecological understanding of a key kelp forest herbivore. In the first year of the project, biologists acoustically mapped bottom elevations in the kelp forest at horizontal resolutions of 10 to 15 meters and tagged urchins so as to be able to map their movement patterns and habitat usage within the fishing grounds. Fishermen, meanwhile, continue to collect and share detailed (usually proprietary) information on where they are gathering urchins. In the coming year, biologists will combine the acoustic and fishermen's data to estimate local rates of movement and growth. 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–Dec. 2012
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  Marissa Baskett, UCD, 530.752.1579, mlbaskett@ucdavis.edu
  Alan Hastings, UCD, 530.752.8116, amhastings@ucdavis.edu

The project scientists are developing computer models for evaluating the performance of California's Central Coast marine protected areas (MPAs) for commercially and recreationally important species such as blue rockfish, black rockfish, lingcod and cabezon. The spatial population models will incorporate what is known about larval dispersal, adult movement patterns and key species' interactions to more fully understand how fish populations respond to the MPAs, and how other factors, such as fishery regulations outside the MPAs, affect this response. Model output will provide insights into what to expect from the monitoring data in the period after MPA implementation. Such information is critical for adaptively managing the state's network of MPAs and meeting the intended conservation goals. In 2011, the scientists published a paper aimed at resource managers that describes international progress in the monitoring and modeling required for adaptively managing MPAs. The research group is currently preparing a manuscript on the effects of larval dispersal distances, adult home-range sizes, and exploitation intensities on optimal monitoring protocols (i.e., when and where to sample). A species' initial response to a new MPA may be transient and a poor indicator of the eventual trends in its abundance, the scientists report.

- **Molecular Identification of Fish Eggs and Larvae: Enhancing the Value of Icthyoplankton Surveys in Monitoring and Management**
  R/FISH-216 Feb. 2012–Jan. 2014
  Ron Burton, UCSD/SIO, 858.822.5784, rburton@ucsd.edu

Many species of fish eggs in the California Current are spherical, transparent and about the same size. Because of this, morphological identification is prone to error and, more problematically, these errors may propagate into estimates of spawning fish biomass, used to develop harvesting guidelines. This project seeks to employ molecular genetics to speciate fish eggs in environmental samples. The approach allows for a greater number of marine fishes to be identified, and it lowers errors of hard-to-identify species, such as chub mackerel and hake. The first objective of the project will be to use a PCR-based fluorescent probe array (developed in an earlier Sea Grant project) to identify fish eggs and larvae in a 15-year archive of ichthyoplankton samples collected during CalCOFI cruises. By identifying a broad collection of species over a period of time, researchers will be able to investigate questions that are typically not addressed, such as whether the timing of fish spawning is changing in response to changes in the ocean's thermal structure. The second phase of this project will address yet another gap in current ichthyoplankton survey work, that of collecting data inshore. To do this, scientists will deploy a plankton pump (a modified Continuous Underway Fish Egg Sampler) at the end of the Scripps Pier in La Jolla, to initiate what is hoped will become a long-term, high-frequency sampling program in support of MPA monitoring. In addition, scientists will continue to develop more probes for more fish species, particularly select larval rockfishes, to expand the array's identification capacity.

- **Match-Mismatch in the Timing of Hatchery Chinook Salmon Releases and Favorable Ocean Conditions**
  R/FISH-217 Feb. 2012–Jan. 2014
  Stephanie Carlson, UCB, 510.643.9704, smcarlson@berkeley.edu
  William Satterthwaite, UCSC, 831.459.4942, satterth@darwin.ucsc.edu
  Brian Wells, NOAA/SWFSC, 831.420.3969, brian.wells@noaa.gov

California's commercial salmon fishery has collapsed and what remains is sustained mostly by the release of Chinook salmon into the San Francisco Estuary and Sacramento-San Joaquin River system. This project will investigate whether salmon numbers could go up, and the wild swings in their numbers reduced, by changing when and where young salmon are set free. The theory to be explored is that releasing fish over a longer period of time will increase the odds that at least some fish reach the ocean when food is available to them. Several hatcheries in the Central Valley currently truck large numbers of salmon directly to the San Francisco Estuary so that the fish do not have to swim through the rivers in the Central Valley and Sacramento-San Joaquin Delta. Many fish die on this journey. Scientists hypothesize that these trucked fish enter the estuary over a narrower range of dates than do fish outmigrating through the river system. As a result, stocks may be subjected to boom-bust cycles in their numbers. To test these ideas, researchers will synthesize hatchery reports on when and where fish are released to compute average release times, variability in release times, and return rates for each hatchery. These statistics will be compared to estimates of year-to-year differences in the amount of krill available to predators such as juvenile salmon. Results will be shared with NOAA Southwest Fisheries Science Center, the Pacific Fisheries Management Council, and hatchery managers.

- **Realistic Behavioral-Physical Models of Connectivity for a Network of Marine Protected Areas**
  R/FISH-218 Feb. 2012–Jan. 2014
  Steven Morgan, UCD, 707.875.1920, sgmorgan@ucdavis.edu
  Christopher Edwards, UCSC, 831.459.3734, cedwards@ucsc.edu

Certain species of marine larvae appear capable of controlling their movement patterns and distance from shore. Most likely, these larvae do this by moving vertically in the water column, taking advantage of changes in ocean currents with depth to "catch a ride" to or "stay put" within a preferred developmental or settlement habitat. Researchers have identified six different behaviors, strategies really, by which 45 species of crustacean larvae (including the commercially valuable Dungeness crab) control their locations, even during periods of strong upwelling. The most common technique is for larvae to remain below the wind-driven Ekman layer. The main goal of this project is to model projected trajectories of larvae (i.e., larval dispersal distances) for crustacean larvae and the six major behaviors they employ to affect their transport, using a particle transport model within a Regional Ocean Modeling System for the California Current. Results will offer realistic scenarios of the distances over which different crustacean populations are connected, not just in the average sense but for a specific bathymetry and inner-shelf circulation. Such information can be used to identify marine populations that export their larvae (i.e., are net contributors to fisheries production) and is of direct application to the siting of networks of marine reserves that are truly interconnected at a population level.

- **Estimating the Impact of Invasive *Spartina densiflora* on Primary Productivity in Humboldt Bay**
  R/ANS-213 Jul. 2010–Mar. 2012
  Alison Purcell, HSU, 707.826.3438, Alison.Purcell@humboldt.edu

Four species of non-native Spartina, commonly called "cordgrass," are found along the West Coast of the United States and Canada. Where established, these invaders convert estuarine mudflats and salt-marsh ecosystems into uniform expanses of dense grass. Aggressive control efforts in San Francisco Bay and elsewhere on the West Coast have demonstrated the feasibility of eradication (or near eradication) with adequate funding, political will and coordinated efforts. But eradication is costly and at some sites, particularly those that face other severe threats, restoration funds might be better spent elsewhere or on other things. This question is being asked for sites within Humboldt Bay in Northern California, where the price tag of removing Spartina has been estimated at up to $20 million. Scientists are now attempting to quantify the effects of removing the most problematic of the cordgrasses, *Spartina densiflora*, from the bay's tidal marshes, on above-ground net primary productivity. The methods and design of the study were presented at the 2010 Spartina Summit, hosted by the Coastal Conservancy. Findings will be shared with the U.S. Fish and Wildlife Service, which is in the process of removing cordgrass in the Humboldt Bay National Wildlife Refuge to recreate the diversity of native vegetation that sustains native wildlife.

- **Understanding Roles of Competing Bacterial Endosymbionts in Abalone Health, Management and Restoration**
  R/FISH-208 Feb. 2010–Jan. 2013
  Carolyn Friedman, UW, 206.543.9519, carolynf@u.washington.edu
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Several years ago, a new rickettsia-like organism (RLO) was observed in the tissues of farmed abalone. Since then, transmission electron microscopy has show that the "new" parasite is probably just the original withering syndrome rickettsia-like organism infected with a phage hyperparasite. With Sea Grant support, scientists have identified a set of potential phage genes and are in the process of testing PCR primers that can be used to fully characterize the organism and document its geographical distribution in both wild and farmed animals, and in seawater. Withering syndrome is a lethal, contagious water-borne abalone disease that seems to be triggered by El Niño, or El Niño-like, coastal warming. In recent years, outbreaks have become less frequent and severe, and it is not known whether this is due to cooler water temperatures or because the pathogen now includes the phage parasite, which appears to confer disease protection. As part of this project, scientists will test the RLO's protective value, and its link to water temperatures, as well as efficacies of various antibiotic therapies. Five of the state's eight abalone species are categorized as "species of concern" or are protected by the Endangered Species Act. Results from this project will be shared with NOAA Fisheries managers charged with developing recovery plans for the abalone, and with abalone farmers vulnerable to withering syndrome outbreaks. The Abalone Farm in Central California, the state's largest abalone producer, is a collaborator on the 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–Dec. 2012
  Mark A. Drawbridge, H-SWRI, 619.226.3943, mdrawbridge@hswri.org
  Frederick A. Barrows, USDA/ARS, 405.587.9265, rbarrows@montana.campuscwix.net
  Ronald W. Hardy, UI/ARI, 208.837.9096, rhardy@micron.net

Hubbs-SeaWorld Research Institute is partnering with the USDA, University of Idaho and Universidad Autónoma de Baja California to develop fish feeds with little or no fish protein and fish

oil. In the project's first two years, scientists showed the feasibility of rearing white seabass and California yellowtail on a diet in which the fishmeal was replaced with a combination of poultry by-products, corn protein and Spirulina. Neither fish growth nor feed conversion rates were compromised. Fish oil could be reduced by 75% in the fishmeal-free seabass feed with a mix of 50% poultry oil and 25% of either soy, corn or flax oil. For yellowtail, 87% of the fish oil could be replaced with poultry oil. Currently, scientists are studying the phosphorous requirements of seabass and yellowtail on fishmeal-free diets. The long-term challenge, to be revisited in this project or a subsequent one, will be to maintain the desirable omega-3 fatty acid content of farmed fish, without using fish oil.

- **Development of Sustainable Tuna Aquaculture in the United States Using Yellowfin Tuna as a Model**
  R/AQ-133 Feb. 2012–Jan. 2015
  Mark Drawbridge, H-SWRI, 619.226.3943, mdrawbr@hswri.org
  Dan Margulies, I-ATTC, 858.546.7120, dmargulies@iattc.org

With global tuna fisheries in decline, aquaculture is becoming a viable option for sustainably meeting consumer demand for tuna without further depleting wild stocks. Currently, the major obstacle to mass production of yellowfin tuna—a model species for tuna aquaculture—is the high variability of larval survival, with mortality rates frequently (but not always) exceeding 99 percent. The goal of this project is to boost the consistency of egg-to-juvenile stage survivorship to at least 3 percent, and hopefully 10 percent or 15 percent, by the project's end. To do this, scientists will seek to identify the times during a spawning season in which adults produce the highest quality eggs and larvae. If problematic bacteria are found, the culture environment will also be tested for pathogenic bacteria and different disinfection techniques explored. In the project's final stages, researchers will experiment with feeding and nutritional programs for optimizing larval health and survival. As yellowfin tuna are currently bred in Central America and their larvae are flown to North America, yet another component of this project is to study the effects of air travel on the animal's overall survivorship.

- **Noroviruses in Coastal Waters: Implications for Seafood Cultivation and Human Health**
  R/CONT-216 Feb. 2012–Jan. 2014
  Stefan Wuertz, UCD, 530.754.6407, swuertz@ucdavis.edu
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Fragments of single-stranded RNA known as noroviruses are the leading cause of food-borne disease outbreaks in United States, according to the Centers for Disease Control. Though outbreaks usually occur in small areas of high population density, such as a nursing home or cruise ship, the scientists leading this project have detected the virus in all types of freshwater discharges, including rural runoff. This project will investigate whether livestock or other animals may be capable of carrying and spreading the viruses. Researchers will also test whether noroviruses are present in coastal waters of Central California at concentrations that pose a human health risk. Field work will focus on detecting the viruses in seawater and suspended aggregates formed in estuaries and the marine environment. Also of interest is the degree to which local mussels accumulate the viruses and their correlation with concentrations of zoonotic pathogens (e.g., Cryptosporidium, Giardia, and Salmonella) and fecal indicator bacteria. The anticipated outcome of the project is an improved assessment of the presence, or absence, of noroviruses along Central California, and a first estimate of the level of risk the pathogens pose to those who consume raw shellfish grown or harvested locally.

Effective Response to Climate Change

- **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

Since 1950, the average surface water temperature at the Scripps Pier in La Jolla has risen by about 3 degrees. During this period, coastal waters have also become more corrosive and more stratified (layered by density), limiting the movement of some species. Many species of fish are now spawning earlier, or in some cases later. In this project, analyses of CalCOFI data showed that 18 of the region's 43 most abundant fish species are now spawning between 14 days and 62 days earlier than in the early 1950s. Some of the earlier-spawning species include: jack mackerel, chub mackerel, hake, señoritas and medusafish. Chilipepper rockfish, blacksmith, two species of flatfishes and three species of mid-water fishes are among eight species now spawning 15 to 35 days later. In the next phase of the project, scientists will study the observed shifts in fish phenology in relationship to the availability of food (plankton) needed to support larval fish growth and development. The broad concern is that climate change might undermine the biological productivity of the California Current, one of planet's richest marine ecosystems and the reason that California is home to dozens of commercial fisheries that hauled in some 373 million pounds worth more than $150 million in 2009.

- **Development of Proxies to Evaluate pH and Oxygen Exposures**
  R/CC-02 Jan. 2011–Jun. 2012
  Lisa A. Levin, UCSD/SIO, 858.534.3579, llevin@ucsd.edu

The working hypothesis of this project is that low pH/low oxygen conditions generate distinctive chemical signatures in the carbonate structures of marine invertebrates and thus can be used as proxies for detecting exposure to ocean acidification/low-oxygen conditions that may occur off upwelling coasts such as California. In the project's final year, scientists will conduct controlled tank experiments to compare the effects of ambient and low pH/low oxygen conditions on larval mussels and market squid embryos. The tank conditions will simulate scenarios for San Diego coastal waters. Trace element fingerprinting and boron isotope analyses of mussel shells and squid statoliths (carbonate structures similar to otoliths in fish) will establish whether chemical fingerprinting can be done and is suitable for environmental monitoring.

- **Paradigm or Paradox: Can We Attribute Species Changes to Global Climate Change in Light of Decreasing Water Temperatures in Central California?**
  R/CC-03 Jul. 2010–Jun. 2012
  Laurence C. Breaker, MLML, 831.771.4498, lbreaker@mlml.calstate.edu
  Greg Cailliet, MLML, 831.771.4432, cailliet@mlml.calstate.edu

Overall and since the late 1970s, there has been a warming of upper waters of the California Current off California, a decline in its biological productivity (i.e., phytoplankton abundance), and an increase in the number of warm-water species. Superimposed on this warming trend, waters off Central California have experienced a period of cooling since 2000. The goal of this project is to explore the effects of basin-scale climatic variability on pelagic species abundances in Central California. To date, scientists have collected nine datasets that describe relative fish abundances in the region and are in the process of comparing trends to a basin-scale climate index developed by the CeNCOOS (Central and Northern California Ocean

Observing System) program. The index combines sea surface temperature, salinity and chlorophyll-a measurements to estimate ocean productivity. Preliminary results show high correlations between the index and fish abundances. In the final months of the project, researchers will finalize their analyses and present their findings at the 2012 Western Groundfish Conference.

- **Consequences of Nearshore Low Oxygen and Low pH for Coastal Resources of Southern California**
  R/CC-04 Feb. 2012–Jan. 2014
  Lisa Levin, UCSD/SIO, 858.534.3579, llevin@ucsd.edu
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The upper boundary of the ocean's oxygen-minimum zone has shoaled by at least 90 meters in the last several decades in the Southern California Bight. Observations of dissolved oxygen and pH suggest that these waters are now being advected into nearshore habitats during intense upwelling events, exposing commercially important species—crabs, lobster, urchin, rockfishes and squid—to potentially hypoxic, corrosive waters. This project will investigate: (1) the effects of low-oxygen, low-pH conditions on nearshore biota in Southern California, using monitoring data off San Diego County; and (2) the market squid (California's most valuable commercial fishery) as a case study of the region's potential vulnerability. From the monitoring data, scientists will, among other things, assess the frequency, duration, and severity of low-oxygen, low-pH episodes off the coast (to 200-meters depth). Laboratory experiments will be conducted to evaluate the effects of these conditions on benthic squid egg development. GIS maps of oxygen and pH "stress" will then be superimposed onto benthic habitat maps showing where squid typically lay their eggs to identify areas where squid reproductive success may be compromised. Results from this project begin the process of using monitoring data to make highly localized species-specific predictions on the potential consequences of hypoxia and acidification to biological resources.

- **Response of Calcified and Fleshy Macroalgae to Warming and Ocean Acidification: from Single Species to Community Interactions**
  R/CC-05 Feb. 2012–Jan. 2014
  Jennifer Smith, UCSD/SIO, 858.246.0803, jes013@ucsd.edu
  Scott Hamilton, MLML, 805.893.7397, shamilton@mlml.calstate.edu
  Michael Graham, MLML, 831.771.4481, mgraham@mlml.calstate.edu

Do plants like CO_2? Researchers generally expect land plants to grow larger as CO_2 levels rise. The responses of marine algae, kelp and seaweeds are more difficult to predict, however, since the ocean will become more acidic as it absorbs more of the gas from the atmosphere. This project will test the responses of coralline (calcified) algae and fleshy seaweeds (red and brown) to an ocean that is both warming and more corrosive. Experiments will be conducted on individual species to quantify changes in growth, calcification and photosynthetic performance, and on assemblages of species to investigate competition effects. Because coralline algae are often settlement habitat, researchers will also examine whether acidification alters the chemical cues emitted by the algae and their detection by red abalone larvae. Results further both state and federal goals of managing marine ecosystems in the face of climate change. In addition, scientists plan to develop K-12 classroom curricula about climate change in marine ecosystems.

Resilient Coastal Communities

- **Beach Evolution on Scales from Storms to Years**
  R/RCC-01 Feb. 2012–Jan. 2014
  Robert Guza, UCSD/SIO, 858.534.0585, rtg@coast.ucsd.edu
  William O'Reilly, UCSD/SIO, 858.534.6258, woreilly@ucsd.edu

Beaches in Southern California typically accrete sand in summer and lose sand during winter storms. This project seeks to more fully understand the effects of single storms, series of storms and lulls between storms on mean sea level and on sand volume above mean sea level at multiple time scales. The ultimate goal is to be able to predict sandy beach profiles based on ocean wave conditions (as constructed from buoy data) and sediment properties (e.g., sand grain size). To this end, researchers will gather new beach survey data at Torrey Pines State Beach, mine existing beach elevation data for San Diego County and use these data sets along with buoy data to begin developing a model for predicting beach erosion under normal and El Niño weather patterns. As the first winter storms tend to remove the most sand from beaches, this sand is swept away and a beach transitions from an accreted to an eroded state, and progressively more wave energy is required to keep moving sand. A core scientific objective of this project is to model the physics of these erosion-resistant layers and to use what is learned to advance existing "equilibrium" models.

New Technologies and Products

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

Significant progress has been made in understanding the evolution of secondary metabolite genes associated with a group of pharmaceutically promising marine bacteria known as MAR4, collected off the coast of California. Scientists have also, notably, described the biosynthesis of hybrid isoprenoids (including the promising anti-inflammatory compound cycloma-rin) and characterized novel biosynthetic enzymes associated with producing them. In experiments with halogenated meroterpenoids, enzymes that add chlorine to molecules, chemists discovered three new chloroperoxidases. These compound are of pharmacological interest because of their ability to enhance the bioactivity of molecules, meaning they can enhance the efficacy of medicines. Current efforts are centering on their in vivo and in vitro characterizations, with the goal being to apply novel marine enzymes as biocatalysts. Such work opens the door to being able to engineer, new antibiotics or anticancer therapies.

Program Development

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

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

California Ocean Protection Council

California's Ocean Protection Council (OPC), which was created in accordance with the 2004 California Ocean Protection Act, has awarded funds to California Sea Grant to administer peer-reviewed, scientific research to address OPC research priorities. The projects below were selected for 2012 funding.

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

How healthy is that wetland? Count the parasites in common snails to find out. The more species of parasites, the healthier the marsh, as it implies the presence of all requisite hosts. The goal of this project is to test the practical validity of the concept in the field and whether it can be adapted into a tool for inexpensively monitoring wetland biodiversity. To date, biologists have collected common horn snails and counted the number and kinds of trematode (fluke) parasites infecting them at more than 30 wetlands in California. They are in the process of calibrating these snail-parasite counts with traditional field surveys of fishes and benthic invertebrates at 16 of those wetlands. Scientists presented their work at the most recent Ballona Wetlands Science and Research Symposium, hosted by the Santa Monica Bay Restoration Commission, and are in continuing dialog with wetland managers about their findings. UC Berkeley's Lawrence Hall of Science is incorporating aspects of this project into its public science curriculum and will soon be taking students in its East Bay Academy of Young Scientists program out into the field to collect and dissect horn snails.

- **Ecology and Trophic Interactions of Jumbo Squid (*Dosidicus gigas*) in the California Current Ecosystem**
  R/OPCFISH-06 Mar. 2008–Feb. 2012
  William F. Gilly, HMS/SU, 831.655.6219, lignje@leland.stanford.edu
  John Field, NOAA/SWFSC, 831.420.3907, John.Field@noaa.gov

The original goal of this project was to assemble a picture of the jumbo squid's life history in the California Current. At the time, huge numbers of *Dosidicus gigas* had taken up residence off California, and there were concerns that the squid might be reproducing locally and competing with fishermen and marine predators for species such as sardine, hake and salmon. In 2010, the jumbo squid off California suddenly and mysteriously vanished, and the scientists' field work, supported by NSF, has subsequently relocated to the Gulf of California, where jumbo squid are still present but are much smaller than usual and are spawning at ages as young as 6 months. Biologists believe the changes are temporary and related to the brief and weak 2009–2010 El Niño event, which was expressed in the gulf but not off California. Although that El Niño ended more than a year ago, and at least two generations of squid have come and gone, the squid's life history characteristics remain perturbed in the gulf. In the last year of the project, biologists hope to learn exactly how and why warmer-than-normal water affects the squid's migration patterns and other life history traits. The collaborating groups, which include NOAA Fisheries, will attempt to identify parallels between the situation in the gulf and California Current, in an effort to understand why the squid vanished off California, and to predict when the species might return.

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

This project has established the feasibility of using intertidal nudibranchs (brightly colored, shell-less mollusks) as fine-scale indicators of basin-scale climate variability and its effects on California's coastal ecology locally. Among the project's findings, total nudibranch abundance was highly correlated with warming—i.e., El Niño events, elevated sea surface height and temperature, and the warm phase of the Pacific Decadal Oscillation (PDO). It was negatively correlated with La Niña events, the cold phase of the PDO, enhanced coastal upwelling and the "positive" phase of the North Pacific Gyre Oscillation. Superimposed on this variability, biologists also documented a northward range expansion of one species of nudibranch, consistent with global-warming trends. In terms of the work's applicability to management, nudibranch populations on rocky intertidal habitats (some of which are already currently being monitored) could be included in population dynamics models of species with long pelagic larval periods, notably the commercially important red sea urchin. The larger, more conspicuous nudibranch species would be appropriate for monitoring by biologists and citizen scientists, especially in marine protected areas.

- **Ocean Acidification Exacerbated by Coastal Upwelling: Monitoring of CO_2 and O_2 on the California Shelf, and Studies of Their Effects on Red Sea Urchins, California Mussels and Abalone**
  R/OPCENV-09 Dec. 2009–Nov. 2012
  Victoria Fabry, CSUSM, 760.750.4113, fabry@csusm.edu
  Andrew Dickson, UCSD, 858.822.2990, adickson@ucsd.edu
  Gretchen Hofmann, UCSB, 858.893.6175, hofmann@lifesci.ucsb.edu
  Jeffrey Abell, HSU, 707.826.5621, ja49@humboldt.edu

In Oregon and Washington, ocean acidification (OA) is already impacting oyster hatcheries by corroding the shells of young bivalves. This project explores whether upwelling exacerbates acidification of California's shelf waters and the thresholds at which changes in ocean pH will impair calcification rates of native bivalves. In the first year of the project, scientists built a

prototype OA control tank that will be "tuned" to observe the susceptibility of juvenile abalone to more acidic waters. Direct measurements of ocean pH will also be collected at a site in northern California, to document the current state of acidification and its variation with depth and upwelling intensity. Eventually, molecular tools will be used to link calcification rates with gene expression and document changes in gene expression with acidity. This project has led to a $300,000 National Science Foundation grant to build a large-scale version of the prototype OA tank developed for this project. Researchers are also now pursuing the installation of an OA observing system along the West Coast to gather the needed field data for measuring acidification and its link to ocean dynamics.

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

  This project seeks to provide managers with tools for weighing the pros and cons of various restoration options for Central Valley and Klamath run Chinook salmon. In the project's first phase, scientists are conducting a retrospective analysis of the correlations between climate variation, human activities and salmon numbers, and are using these results to model the relationships between various environmental conditions and fish growth, maturation and distribution. The second phase will be a prospective analysis to determine the life-history stages that most pointedly determine total fish production. An overarching theme to be explored is whether promoting a more diverse population structure for Chinook salmon (through hatchery practices) could be a management strategy for boosting California salmon survival rates. Specific hypotheses to be examined include: salmon survival is becoming increasingly variable; climate variability is increasing; genetic diversity within and among salmon populations is diminishing; improving population structure diversity will reduce swings in salmon survival, and improving diversity will improve the economic viability of fishes.

- **Forecasts and Projections of Environmental and Anthropogenic Impacts on Harmful Algal Blooms in Coastal Ecosystems**
  R/OPCCONT-12 Dec. 2010–Jan. 2013
  Raphael Kudela, UCSC, 831.459.3290, kudela@ucsc.edu
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After years of studying and monitoring harmful algal blooms (HAB) in California's coastal waters, researchers are now testing and refining semi-operational HAB forecasting models for Monterey Bay and the Santa Barbara Channel. In the project's first phase, the models were run in hindcast mode and validated with real data from the California Department of Public Health and the California Program for Regional Enhanced Monitoring for Phycotoxins. The researchers subsequently conducted a "common garden" experiment in which the Santa Barbara model was applied to Monterey and vice versa. More recently, six years of data from the Naval Research Laboratory's Regional Ocean Modeling System biological submodel was extracted and compared with model forecasts. The comparisons show progress in forecasting HABs but that the statistical methods need to be massaged somewhat for compatibility with the Navy data. Eventually, the two regional models will be expanded to encompass the entire California coast and made available on the web for state agencies and wildlife managers.

- **Integrating the MLMA and MLPA—Developing New Ways to Manage California's Nearshore Fisheries Using Catch Data from Marine Protected Area Monitoring**
  R/OPCFISH-13 Feb. 2012–Jan. 2014
  Dean Wendt, CPSLO, 805.756.2988, dwendt@calpoly.edu
  Rick Starr, CASGEP, 831.771.4442, RickStarr@ucsd.edu

The state of California has convened several workshops in the past few years with fisheries scientists, managers and stakeholders to explore best management strategies for nearshore fisheries with limited basic biological and fisheries data. This project continues and enhances this dialog by developing and strengthening collaborations among fishermen, agency staff and academic scientists, and by continuing funding of a collaborative fishery project that has already gathered five years of data for the Central Coast MPA monitoring program. As part of this new project, scientists will apply this collaborative fisheries data to new fishery models for setting catch levels in data-limited situations. The models' performance will be compared to each other and traditional stock assessments. Researchers will also conduct "a management strategy evaluation" to determine the new models' performance over time and under various control rules, including bio-economic modeling to project the long-term costs and benefits for both conservation (stock sustainability) and fishery profit. Results and recommendations will be shared with state resource managers and the public.

North Central Coast MPA Baseline Data Collection Project

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

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

In the first year of the project, researchers refined protocols for monitoring five species of seabirds that scientists expect to benefit from the North Central Coast MPAs—the pigeon guillemot, pelagic cormorant, Brandt's cormorant, common murre and black oystercatcher. (Western gulls were also studied as time permitted.) They have since documented each species' population size, breeding success and foraging effort at several sites in Sonoma, Marin and San Mateo counties, and are investigating whether the region's Special Closures are indeed protecting breeding colonies from human activities such as boating. A comprehensive tally of all the region's nearshore breeding colonies is also underway. The end result of the project will be an overview of how seabirds are using coastal habitats inside and outside the MPAs, and the effectiveness of Special Closures in preventing nest abandonment and other behaviors that can reduce breeding success.

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

Through the LiMPETS program, students, educators and volunteers routinely monitor Pacific mole crabs at sandy beaches within the Gulf of the Farallones and Monterey Bay National Marine Sanctuaries. They are also taught to recognize 33 species associated with rocky intertidal habitats and to enter these data online, where they are archived for long-term studies. This project extends the LiMPETS program beyond its normal boundaries within the sanctuaries to contribute to baseline monitoring of the North Central Coast MPAs. Funding also supports a compilation of LIMPETS data gathered in 2010–11 for benchmark characterization of the MPAs, as well as an historical analysis of LiMPETS data to identify significant ecological trends. LiMPETS, short for Long-term Monitoring Program and Experiential Training for Students, is a program of the San Francisco-based, nonprofit Farallones Marine Sanctuary Association.

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

Researchers have completed the first of two remotely operated vehicle (ROV) surveys of the North Central Coast's deep-sea habitats. During this, about 8,600 still photographs and more than 141 hours of video were shot at eight MPAs and reference sites (depths ranging from 20 meters to 116 meters) to document bottom-dwelling fish and invertebrate communities. A second year of sampling is underway. The final baseline characterization will include summary descriptions of benthic ecosystem structure, processes and habitat characteristics, as well as species assemblages in the protected areas and adjacent reference sites. In the project's last months, scientists will evaluate and offer recommendations on the draft plan for long-term monitoring of subtidal communities.

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

The Farallones Marine Sanctuary Association's "Beach Watch" is a long-term shoreline-monitoring project conducted by volunteers who regularly survey an assigned beach within the Gulf of the Farallones and Monterey Bay National Marine Sanctuaries. Volunteers collect data on live and dead species of birds and marine mammals. They also report violations, detect oil pollution, and collect oil samples, and document what people are doing at the beach (i.e., "human-use patterns"). The goal of this project is to compile Beach Watch data to produce a picture of bird and marine mammal life before and around the time of the implementation of the MPAs. Researchers are also analyzing the time series—the Beach Watch began in 1993—for meaningful trends and to better understand regional variations in commonly seen bird and marine mammal species.

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

This project is characterizing rocky intertidal habitats along the North Central Coast, following the same standardized protocols for monitoring rocky habitats along the Central Coast and more recently the South Coast study regions. These protocols are based on the biodiversity and target-species survey methods developed by the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) and Multi-Agency Rocky Intertidal Network (MARINe), respectively, for long-term monitoring of the West Coast's intertidal habitats. In fact, more than a dozen of the sites being surveyed for this project are already monitored regularly through the PISCO and MARINe projects, a fact that will greatly facilitate efforts to distinguish long-term trends from changes associated with the MPAs. The surveys conducted in the project's first year have uncovered previously unknown pockets of black abalone, an endangered species that thrives in rocky intertidal crevices. The locations of these animals have been shared with the NOAA Fisheries biologists who are developing a recovery plan for the abalone. Scientists are also currently working with Ocean Imaging to help it ground-truth its multi-spectral, aerial images of substrate and nearshore communities with field observations.

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

This project is using diver surveys to produce a baseline snapshot of kelp forests at five North Central Coast MPAs and associated reference sites. The five MPAs are: Salt Point State Marine Park, Stewart's Point State Marine Reserve (SMR), Del Mar Landing SMR, Saunders Reef State Marine Conservation Area and Point Arena SMR. Diver protocols replicate those used for the Central Coast study region and are based on standardized protocols developed by the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO). In this, divers document fish, kelp and benthic invertebrate densities as well as fish-size distributions and percent seafloor cover of small invertebrates and algae along transects. They also record substrate type (e.g., sand, cobble, bedrock and boulder) and vertical relief to establish species-habitat relationships. All the data collected during the first round of diver surveys has been transcribed from the field datasheets into a database with requisite metadata. In the project's final year, scientists will compare species abundances, guild abundances (e.g., trophic guilds) and community structure within the protected areas and reference sites.

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

Reef Check California's network of volunteer divers has been monitoring reefs along the North Central Coast for six years. Funding from the Ocean Protection Council is providing support to continue and enhance these surveys inside and outside the area's MPAs. In the last 18 months, Reef Check retrained many of its existing volunteers in the region and an additional 62 divers have been taught to carry out surveys of nearshore reefs through either Reef Check's training courses or the Humboldt State University's scientific diver program. Reef Check California is also partnering with UC Santa Cruz to expand its monitoring repertoire to include abalone and sea urchin surveys. To date, its volunteers have surveyed 34 sites (all part of the PISCO survey program) for abalone and urchin abundances, densities and sizes. Reef Check also hired a consultant to develop metadata standards that are consistent with those of the MPA Monitoring Enterprise. This work will greatly facilitate the integration of the citizen-science data into the larger dataset. The long-term vision is to develop the human capital and scientifically rigorous protocols for long-term citizen-science monitoring of the new reserves.

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

This project is establishing a snapshot of sandy-beach ecology along the North Central Coast around the time of the implementation of the MPAs. To do this, scientists are surveying sand crabs and wrack-associated macro-invertebrates at 10 beaches, five sites within the MPAs and five reference sites. They are also surveying seven "extra" beaches outside the MPAs to more thoroughly assess the region's sandy beach ecology, which is relatively undocumented for the North Central Coast. The researchers have completed a year's worth of monthly surveys of birds, wrack and human activities along beaches, and are now developing the citizen-science and biodiversity components of the project. Future survey work will include a collaborative recreational fisheries project to gather information on surf-zone fishes.

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

The goal of this project is to use existing physical oceanographic and biological data to depict the region's background climatic conditions at the time of the MPAs' implementation. In the project's first phase, the emphasis has been on obtaining and compiling physical data—time series of temperature, salinity and water density, upwelling intensity, and climate indices such as ENSO (El Niño Southern Oscillation) and PDO (Pacific Decadal Oscillation). These are being studied through a statistical technique known as Principal Components Analyses to generate multivariate ocean-climate indices that reflect both the processes and outcomes of climate variability. This baseline will help managers and scientists distinguish basin-scale and regional climatic trends from changes attributable to the MPAs.

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

The final deliverable of this project will be a baseline snapshot of key consumptive and non-consumptive activities along the North Central Coast. The focus is to characterize three sectors of the coastal economy that stand to be affected by the MPAs: (1) coastal recreation (i.e., snorkeling, surfing, spear fishing); (2) commercial fishing and (3) commercial charter boating (i.e., sportfishing and whale watching). To date, scientists have conducted 100 interviews with recreational abalone divers, completed 2,500 surveys of coastal recreation and are in the process of interviewing commercial fishermen and charter boat captains. In the project's final year, scientists plan to estimate the economic impacts of the MPAs on these activities.

- **Baseline Monitoring of Ecosystem and Socioeconomic Indicators for MPAs along the North Central Coast of California—High-Resolution Nearshore Substrate Mapping and Persistence Analysis with Multispectral Aerial Imagery**
  R/MPA-17 Mar. 2010–Feb. 2013
  Jan Svejkovsky, OI, 858.792.8529, jan@oceani.com

The project's Year 1 milestone was to collect nearshore multi-spectral images for the North Central Coast. Processing of this data is ongoing but will ultimately yield a set of GIS-compatible habitat maps, as well as fully calibrated and assembled raw-data images files. These maps will depict bottom substrates and vegetation in subtidal, intertidal and estuarine ecosystems, including kelp canopy coverage, at 1-meter, or better, spatial resolution. Besides mapping all these habitats, scientists will also conduct time-series analyses to estimate persistent (average) and variable components of kelp, eelgrass, surf grass and pickleweed distributions. Substrate and habitat classifications are currently being validated in the field.

South Coast MPA Baseline Data Collection Project

The MPA Baseline Program is a collaboration among the State Coastal Conservancy, California Sea Grant, Ocean Protection Council, Department of Fish and Game, Ocean Science Trust and MPA Monitoring Enterprise to provide summary descriptions of marine ecosystems and human activities along the South Coast around the time of the establishment of the new MPAs, and to document initial socioeconomic and ecological changes after the MPAs take effect.

- **Citizen-Scientist Monitoring of Rocky Reefs and Kelp Forests: Creating a Baseline for the South Coast MPAs**
  R/MPA-21 Sep. 2011–Jun. 2014
  Jan Freiwald, RCF, 310.230.2371, jfreiwald@reefcheck.org
  Gregor Hodgson, RCF, 310.230.2371, gregorh@reefcheck.org

Through the Reef Check California (http://www.reefcheck.org/) Program, citizen scientists and Reef Check staff will conduct scuba-based surveys of the South Coast MPAs and reference sites. Surveys consist of eighteen 30-meter transects to count and estimate the lengths of key fishes (35 species), invertebrates (32 species) and algae (9 species) and to characterize the physical habitat in rocky-reef ecosystems from depths of 5 meters to 20 meters. Reef Check and its trained, volunteer divers have been monitoring reefs in Southern California for five years and are currently collecting monitoring data for the North Central Coast MPAs. As part of this project, Reef Check scientists will analyze their pre-MPA monitoring data for the South Coast to extend the time series of kelp-forest monitoring and potentially identify appropriate, meaningful ecosystem indicators. The citizen divers who will be trained during this project, as well as the existing volunteer network, will establish human capital for cost-effective, long-term MPA monitoring and lead to greater public support for science-based coastal management.

- **Baseline Characterization and Monitoring of Rocky Intertidal Ecosystems for MPAs in the South Coast Region**
  R/MPA-22 Sep. 2011–Jun. 2014
  Carol Blanchette, UCSB, 805.893.5144, blanchette@msi.ucsb.edu
  Peter Raimondi, UCSC, 831.459.5674, raimondi@biology.ucsc.edu
  Jennifer Burnaford, CSUF, 657.278.2382, jburnaford@fullerton.edu
  Jayson Smith, CSUF, 657.278.4233, jasmith@fullerton@edu
  Julie Bursek, NOAA/CINMS, 805.382.6141, julie.bursek@noaa.gov

Researchers will construct a baseline snapshot of rocky-intertidal habitats within the South Coast MPAs and associated reference sites to evaluate ecosystem change over time. The biodiversity component of the sampling program will characterize sessile and mobile invertebrates and algae, based on the protocols developed by the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) for its West Coast coastal monitoring program. In addition to the biodiversity studies, sites will be surveyed for specific species believed to be of relevance to key biogenic or trophic attributes and of potential utility as indices for long-term monitoring. Details on the protocols for the biodiversity and target-species surveys are available at the SWAT Coastal Biodiversity Survey webpage (http://cbsurveys.ucsc.edu/) and MARINe webpage (http://www.marine.gov/), respectively.

- **Integrative Assessment of Baseline Ecological and Socioeconomic Conditions and Initial Changes within the South Coast MPA Region**
  R/MPA-23 Sep. 2011–Jun. 2014
  Jennifer Caselle, UCSB, 805.893.5144, caselle@msi.ucsb.edu
  Carol Blanchette, UCSB, 805.893.5144, blanchette@msi.ucsb.edu

Researchers will combine survey data from the nine other baseline monitoring projects into integrated and standardized data sets. Of particular interest is to combine survey data from the beach, intertidal, shallow-reef and deep-sea habitats so that they can be analyzed cohesively to assess ecosystem-level effects. This packaging of the monitoring data into an integrated, consistent, standardized unit will enable a more meaningful and comprehensive analysis of the monitoring results by the other South Coast investigators. The researchers will also spend time administering the other monitoring projects, to make sure the researchers are coordinating field activities (for example, by co-locating field sites) and working collaboratively when practicable. Administrative duties will include organizing and hosting two data analysis workshops for the other investigators.

- **Sandy Beach Ecosystems: Baseline Characterization and Evaluation of Monitoring Metrics for MPAs along the South Coast of California**
  R/MPA-24 Sep. 2011–Jun. 2014
  Jenifer Dugan, UCSB, 805.893.2675, j_dugan@lifesci.ucsb.edu
  Henry Page, UCSB, 805.893.2675, page@lifesci.ucsb.edu
  Karina Nielsen, SSU, 707.664.2962, karina.nielsen@sonoma.edu
  Julie Bursek, NOAA/CINMS, 805.382.6141, julie.bursek@noaa.gov

This project will produce a comprehensive baseline of the biodiversity of sandy beach ecosystems along the South Coast. Metrics for this include kelp-wrack coverage and composition; abundances and species diversities of marine birds, pinnipeds and macroinvertebrates, and population abundances, biomasses and sizes of target species, including sand crabs, Pismo clams, talitrid amphipods and wrack-associated invertebrates, which preliminary investigations show may be rare or absent on groomed beaches. Human activities at the beach will also be documented, and scientists will partner with citizen-science groups to develop and test protocols for long-term beach monitoring by trained volunteers. In addition to the survey work, researchers plan to document the ecological linkages between beaches and other coastal and nearshore ecosystems.

- **California Spiny Lobsters and South Coast MPAs: A Partnership to Quantify Baseline Levels of Abundance, Size Structure, Habitat Use and Movement**
  R/MPA-25 Sep. 2011–Jun. 2014
  Kevin Hovel, SDSU, 619.594.6322, hovel@sciences.sdsu.edu
  Ed Parnell, UCSD/SIO, 858.822.2701, eparnell@ucsd.edu
  John Valencia, SDOF, 619.523.1903, john@sdoceans.org

In this project, researchers will attempt to quantify spiny lobster densities within six South Coast MPAs and adjacent reference sites. The lobster-density estimates will be evaluated in relation to various bottom features. Commercial lobster fishermen will help tag and recapture lobsters (in their traps) to assess "spillover" from closed to open areas, lobster movement patterns, and home range sizes. Spatially explicit landings data will be compiled to calculate CPUE (catch-per-unit effort) inside and outside the MPAs prior to and immediately following their implementation. The following six MPAs and adjacent reference sites will be monitored: (1) Point Vicente State Marine Conservation Area (SMCA); (2) Laguna Beach State Marine Reserve (SMR); (3) Swami's Beach (SMCA); (4) Matlahuayl (SMR); (5) South La Jolla (SMR); and (6) Cabrillo SMR. Spiny lobsters are a priority species for protection in Southern California, as the region is the center of the state's $8-million-a-year (ex-vessel) commercial fishery. Results from this project will help assess the stability of the fishery to current harvesting practices to both natural variability and fishing pressure.

- **Baseline Characterization and Monitoring of the MPAs along the South Coast: ROV Surveys of the Subtidal (20–500 m)**
  R/MPA-26 Sep. 2011–Jun. 2014
  James Lindholm, CSUMB, 831-582-4662, jlindholm@csumb.edu
  Dirk Rosen, MARE, 510.232.1541, dirk@maregroup.org

A remotely operated vehicle (ROV) will be "flown" half a meter above the seafloor at depths ranging from 20 meters to 500 meters. The slowly moving ROV will take video and still images of soft-and hard-bottom biological communities in two annual surveys, each lasting about 20 days. This imagery, collected along fully geo-referenced transects, will characterize the region's bathymetry and the species associated with different seafloor features. Researchers will identify and count fishes and larger invertebrates captured on film. Four study sites will be surveyed during the project, from north to south: (1) Point Conception State Marine Conservation Area (SMCA); (2) Point Vicente SMCA and Abalone Cove State Marine Reserve (SMR); (3) the two Farnsworth Bank SMCAs; and (4) San Diego-Scripps Coastal SMCA and Matlahuayl SMR. The final baseline characterization will include summary descriptions of benthic ecosystems, habitat characteristics and species assemblages in the South Coast MPAs and reference sites.

- **Kelp and Shallow-Reef Ecosystems: Baseline Data and Long-Term Trends Using Historical Data for the South Coast**
  R/MPA-27 Sep. 2011–Jun. 2014
  Daniel Pondella, OC, 323.259.2955, pondella@oxy.edu
  Jennifer Caselle, UCSB, 805.893.5144, caselle@msi.ucsb.edu

The goal of this project is to produce a baseline characterization of kelp and shallow (less than 30-meters depth) ecosystems inside and outside the South Coast MPAs. To do this, scuba divers will survey kelp forests and associated reference sites for two years beginning in 2011. From the survey data, scientists will estimate fish, kelp and benthic invertebrate densities, fish-size distributions and percent cover of smaller invertebrates and algae. They will also document substrate type (e.g., sand, cobble, bedrock and boulder) and vertical relief to establish species-habitat relationships. From these, they will calculate a variety of population-level (e.g., density, percent cover and biomass) and community-level (e.g., species composition and trophic-guild biomass) metrics. These will be compared across the MPAs and reference sites. The sampling design and protocols are based on the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) survey program, employed for baseline monitoring of the Central Coast and North Central Coast MPAs.

- **Use of Estuarine, Intertidal and Subtidal Habitats by Seabirds within the MLPA South Coast Study Region**
  R/MPA-28 Jun. 2011–Sep. 2014
  Dan Robinette, PRBOCS, 805.735.7300, drobinette@prbo.org
  Jaime Jahncke, PRBOCS, 707.781.2555, ext. 335, jjahncke@prbo.org

In this project, ornithologists will evaluate whether the new MPAs are adequately protecting key seabird species—pelagic cormorants, Brandt's cormorants, Western gulls, black oystercatchers, pigeon guillemots, California least terns and California brown pelicans—and if not, how to fix this. Researchers plan to identify trends and/or patterns in the annual sizes of seabird breeding populations (and subsequent chicks) as documented in existing reports in the years prior to the MPAs. In addition, new fieldwork will be conducted along the South Coast to establish rates of seabird foraging and roosting in various nearshore habitats inside and outside the MPAs. The MPAs and special closures have been established, in part, to protect roosting and breeding seabirds from disturbances from passing ships, fishing lines and other human activities. Scientists will study the effectiveness of these activities in reducing seabird behaviors that suggest disturbance, such as nest abandonment.

- **Establishing Consumptive and Nonconsumptive Human-Use Baseline Indicators for MPAs in the South Coast of California**
  R/MPA-29 May 2012–Jun. 2014
  Astrid Scholz, EF, 503.467.0758, ascholz@ecotrust.org
  Charles S. Steinback, EF, 503.467.0758, charles@ecotrust.org
  Chris LaFranchi, NE/NMS, 415.602.7302, chris@naturalequity.com

The overarching goal of this project is to document changes in how people use the ocean in response to the new South Coast MPAs, focusing on three sectors of the coastal economy: (1) private recreation, consumptive and nonconsumptive activities such as clamming and surfing; (2) commercial fishing, and (3) commercial charter boat for activities such as sport fishing and whale watching. The core outcome of the project will be a series of standardized, fully documented, geo-referenced, quantitative socioeconomic data sets that will be used to assess the initial impacts of the MPAs on the spatial distribution of human activities and the associated economic implications. These changes will be related, if possible, to ecological indicators of MPA performance. Scientists will also attempt to identify key socioeconomic metrics and a modeling framework for understanding the cause-and-effect relationship between ecosystem features, human-use patterns and MPAs.

- **Nearshore Substrate Mapping and Change Analysis Using Historical and Contemporary Multi-Spectral Aerial Imagery**
  R/MPA-30 Sep. 2011–Jun. 2014
  Jan Svejkovsky, OI, 858.792.8529, jan@oceani.com

The San Diego County-based remote sensing company Ocean Imaging Corp. (http://www.oceani.com/) will produce benthic habitat maps for the South Coast's shallow subtidal and intertidal zones. The maps will depict features such as surf-grass meadows, kelp canopy, algae-covered rock and bare-rock habitats at very high spatial resolution (40 centimeters to 1 meter). Substrate classifications derived from aerial and multi-spectral imaging will be validated with field data. Raw image data files (calibrated and mosaicked) and GIS-compatible substrate classification files, among other metadata packages, will be available for distribution on DVD media and eventually will be downloadable from the currently under-construction data server of MPA Monitoring Enterprise.

Regional Social Science Research

The four West Coast Sea Grant Programs of California, University of Southern California, Oregon and Washington jointly funded regional projects that addressed social science issues.

- **Social and Economic Effects of ITQs on the West Coast Groundfish Fishery: Solving the Weak Stock/Bycatch Problem**
  R/SOC-01 Feb. 2012–Jan. 2014
  Christopher Costello, UCSB, 805.893.5802, costello@bren.ucsb.edu
  Steven Gaines, UCSB, 805.893.7363, gaines@bren.ucsb.edu

In early 2011, the West Coast trawl fishery transitioned to a catch-shares management system that gives fishermen exclusive rights to a portion of the overall catch. The rationalization program was designed in the hopes it would reduce groundfish discards, increase ex-vessel prices, and incentivize strategies for reducing by-catch of overfished stocks such as widow and canary rockfishes. These long-lived, slow-growing, deep-sea fishes have been so depleted that a single "bad" tow by one boat can exceed the fleet-wide quota and hence trigger closure for all fishery participants. This project examines, among other things, the ability of "risk pools" to prevent ruinous accidental catches of weak stocks while allowing fishermen to catch full quotas of healthy groundfish species. As part of this, scientists will study the short-term social and economic consequences, pro and con, of the new management system, and model longer-term consequences on total landings, by-catch, fleet consolidation, ex-vessel prices and voluntary spatial closures.

- **Toward Resilience and Sustainable Seafood Supply: Assessing Direct Marketing Approaches for the West Coast Fishing Communities**
  R/SOC-02 Feb. 2012–Jan. 2014
  Barbara Walker, UCSB, 805.893.3576, walker@research.ucsb.edu
  Caroline Pomeroy, CASGEP, 831.459.4173, cpomeroy@ucsd.edu
  Carolyn Culver, CASGEP, 805.893.4530, cculver@ucsd.edu
  Kimberly Selkoe, UCSB, 805.966.1677, selko@nceas.ucsb.edu

Social scientists, in collaboration with marine scientists, commercial fishermen and the West Coast Sea Grant programs, will explore whether and how direct marketing might benefit West Coast fishermen and fishing communities. In the project's first phase, researchers will study direct marketing programs (e.g., off-the-boat sales, web-based sales, and community-supported fishery programs) in North and South Carolina and Washington to identify key factors necessary for success. In the project's second phase, what has been learned will be used to craft a direct marketing assessment toolkit to help fishing communities avoid costly mistakes and other pitfalls that can beset direct marketing programs. More specifically, the toolkit will help communities recognize the full range of potential direct marketing approaches and from these identify ones most applicable to their fishing community. The researchers will study the conditions necessary to direct marketing arrangements' success, and the social and economic implications of those changes for fishery participants and consumers. This toolkit will be tested in Coos Bay, Oregon and Santa Barbara, California, both of which are struggling to organize or develop broadly successful direct marking programs. In the project's final stage, the team will convene outreach seminars to disseminate the toolkit and share study results with West Coast fishing communities.

- **Sustaining Fishing Communities by Enhancing Value in a Landings-Constrained Environment**
  R/SOC-03 Feb. 2012–Jan. 2014
  Ariana Pitchon, CSUDH, 310.243.3479, pitchon@csudh.edu
  Georgina Moreno, AG, 213.896.4500, gmoreno@analysisgroup.com

The vast majority of seafood consumed by Americans is imported. Yet, West Coast fishermen, by and large, still export most of what they catch. In the case of the iconic Pacific sardine, about 75 percent of the state's landings are exported overseas, as far as Australia, for bait, fish feed and pet food. Why isn't there a domestic market for fresh, whole, locally and sustainably caught product? The project's goal is to address this type of question for the sardine and other fisheries in different stages of developing high-value products and markets (e.g., trap spot prawn, live fin-fish and Dungeness crab). Researchers will collaborate with members of the fishing industry, academia and California Department of Fish and Game to look at marketing approaches and product forms that have been successful (or unsuccessful) at adding value to West Coast fisheries. They will also investigate whether there are regulatory policies and/or organizational approaches that facilitate sustainable and prosperous fishing communities.

Delta Science Fellows Program

Through the Delta Science Fellows Program (formerly the CALFED Science Fellows Program), postdoctoral and graduate researchers collaborate with community and scientific mentors on targeted Bay-Delta research priorities.

- **Mercury Interactions with Algae: Effects on Mercury Bioavailability in the San Francisco Bay-Delta**
  R/SF-22 Jun. 2007–Aug. 2012
  Allison Luengen, USF, 415.422.4332, aluengen@usfca.edu

This project seeks to more clearly understand the entry and movement of mercury into and through the San Francisco Bay-Delta's food chain. The key idea being explored is that dissolved organic matter (DOM) binds to mercury, decreasing its bioavailability to the base of the food chain. Consistent with this, the fellow has measured an inverse relationship between DOM concentrations in water and methylmercury accumulation in algae. She has also shown that amphipods (bug-like invertebrates that feed on algae) assimilate 65–70% of the methylmercury in the algae. Ongoing work to be reported soon examines the effects of chlorine (and other factors) on mercury availability and uptake.

- **Nutrients and Benthic Invasion Dynamics in San Francisco Bay**
  R/SF-29 Oct. 2007–Feb. 2012
  Heidi Weiskel, UCD, 530.902.0878, hwweiskel@ucdavis.edu

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

- **Copper-Binding Organic Ligands in the San Francisco Bay Estuary: Evaluating Current and Future Likelihood of Copper Toxicity Events in a Perturbed Ecosystem**
  R/SF-32 Sep. 2008– Aug. 2012
  Kristen Buck, BIOS, 441.297.1880, ext. 711, kristen.buck@bios.edu

This project seeks to characterize copper toxicity in the San Francisco Bay-Delta by analyzing total dissolved copper and copper-binding organic ligand concentrations. Preliminary findings suggest that dissolved copper is strongly complexed by organic ligands in all samples collected. In North San Francisco Bay-Delta, these ligands reduce current bioavailable copper (Cu^{2+}) concentrations to levels that are likely harmless to local aquatic microorganisms. Preliminary field sampling also suggests that Suisun Slough is a much larger source of copper-binding ligands to North San Francisco Bay, on a per-volume basis, than either the San Joaquin or Sacramento rivers. Among the objectives of the project's final year: to assess the photolability of copper-binding ligands and analyze samples for dissolved iron speciation. Iron

speciation has never been documented for San Francisco Bay, and may provide additional insight into trace metal cycling in these waters.

- **Effects of Freshwater Flow and Population Connectivity on Benthic Community Dynamics in the San Francisco Estuary**
  R/SF-33 May 2009–Mar. 2012
  Andrew Chang, UCD, 530.400.9410, andchang@ucdavis.edu

Heavy rains last winter and spring caused mass die-offs of some of the largest populations of native Olympia oysters in the northern part of the San Francisco Estuary. The fellow and colleagues are now tracking the recovery of these and other beds bimonthly. This work includes documenting the abundances and sizes of oysters at each of the 12 survey sites. Findings to date show that the areas in which there are typically the largest oyster populations are not self-recruiting. Researchers plan to use trace-elemental fingerprinting to identify the source populations and their dispersion patterns.

- **Plankton Dynamics in the Sacramento-San Joaquin Delta: Long-Term Trends and Trophic Interactions**
  R/SF-36 Oct. 2008–Aug. 2012
  Monika Winder, UCD, 530.754.9354, mwinder@ucdavis.edu

This project describes long-term zooplankton trajectories in the San Francisco Bay-Delta, in terms of the amount of carbon available for higher trophic levels. Findings are of relevance to understanding whether shortages in zooplankton populations, or shifts in their community structure, may be at least partially to blame for the region's pelagic organism decline. To date, the Delta Science Fellow reports that several non-native copepod and mysid species appear to have been introduced between 1987 and 1994—a period of prolonged drought. These species seem to have displaced the larger local calanoid and rotifer species. The sudden drop in fish populations in 2000 did not coincide with a similar decrease in the quantity of carbon from zooplankton. In the last year of the project, the fellow will be investigating the effects of the species composition of zooplankton on the quality of food for fishes.

- **Frequency, Distribution and Ecological Impact of Cryptic Hybrid Invaders: Management Tools for Eradication of Invasive Spartina**
  R/SF-37 Sep. 2008–Jun. 2012
  Laura Feinstein, UCD, 530.204.8325, lfeinstein@ucdavis.edu

Spartina alterniflora is an exotic weed that has prolifically interbred with the native cordgrass (*S. foliosa*) in the San Francisco Bay's marshlands. Its hybrids have elbowed out parent species and are colonizing habitats beyond the ranges of either parent species. This project seeks to document hybrids' fitness advantage, through "common garden experiments." The fellow has planted hybrids and parental species across a range of intertidal elevations and is monitoring survivorship and growth. To date, all taxa have grown best at mid elevations, under favorable environmental conditions, with the hybrids growing fastest in this optimal habitat. As environmental conditions became stressful in late autumn, all taxa performed poorly at mid elevation, and the parental species perished at low elevations. The hybrid was able to survive in both mid and low habitats. It appears that hybrids are effective invaders because they can colonize new habitat and capitalize on optimal growing conditions.

- **Endocrine Disruption in the Sacramento-San Joaquin Watershed: Laboratory and Field Experiments on a Resident Fish, *Menidia audens*, the Mississippi silverside**
  R/SF-44 Jun. 2011–May 2013
  Bryan Cole, UCD/BML, 707.875.1935, bjcole@ucdavis.edu

Endocrine disrupting compounds (EDCs) are widely recognized as being highly toxic to aquatic life and capable of impairing normal sexual development, behavior and fertility in fish. This project examines whether EDCs could also be contributing to population declines of some fishes in the Bay-Delta. To do this, the fellow is characterizing the cellular-detox defense mechanism of the Mississippi silverside and conducting field surveys and outplanting experiments to test for evidence of large-scale, population-level toxicity. The final deliverable of the project will be a model incorporating the effects of EDCs on fish survivorship, relative to other human-activities (e.g., entrainment into the state and federal water diversion systems).

- **Saving San Francisco Bay-Delta Native Fishes: Hatchery Management and Reintroduction Strategies**
  R/SF-45 Jun. 2011–Jun. 2013
  Kathleen Fisch, UCSD/SDZICS, 562.972.5283, kfisch@sandiegozoo.org

There are several species of fishes in the San Francisco Estuary that are highly vulnerable to extinction or endangered status. These include the longfin smelt, Sacramento splittail, Sacramento perch, green sturgeon, delta smelt, Chinook salmon and steelhead trout. A leading conservation strategy for preserving these species is to rear fish in hatcheries for release in the wild—restocking. This approach, however, has its own set of environmental risks, including the risk of spreading disease and/or reducing genetic diversity. In this project, the fellow is studying various stocking strategies to identify those that might best maintain the genetic integrity of supplemented wild fishes. Findings may be of assistance to ongoing, mandated and proposed hatchery operations in the Central Valley.

- **The Effect of Bifenthrin, Under Hypersaline Conditions, on the Long-Term Reproductive Health and Embryonic Development of *Oncorhynchus mykiss***
  R/SF-46 Apr. 2011–Mar. 2013
  Kristy Forsgren, UCR, 562.773.8378, kristy.forsgren@ucr.edu

This project investigates the effects of the pyrethroid insecticide bifenthrin on salmon reproduction in the San Francisco Bay-Delta. The insecticide is frequently detected in runoff in Northern California and, like most pyrethroids, is highly toxic to fish. (Its use is banned in the European Union). Motivating this project is the concern that migrating salmon might be exposed to the pesticide in areas of the Bay-Delta where the fish are already subjected to high-saline conditions. The goal of this project is to examine whether high salinities exacerbate the insecticide's toxicity. In project's first year, the fellow conducted laboratory experiments with rainbow trout (a type of salmonid) to show that acute toxicity was indeed enhanced by exposure to high-salinity conditions. Continuing work will focus on documenting the combined effects of the toxin and salinity on a fish's reproductive physiology. In the process of exploring this idea, the fellow hopes to identify biomarkers of reproductive dysfunction that might be able to detect whether a spawning adult was exposed to unhealthy levels of pesticide as a juvenile.

- **Current and Past Trophic Relationships Among Dominant Zooplankton Species in the San Francisco Estuary Determined Using Stable Isotope Analysis**
  R/SF-47 May 2011–Apr. 2013
  Julien Modéran, SFSU, 415.435.7113, jmoderan@sfsu.edu

This project examines the principle "you are what you eat" for zooplankton in the San Francisco Estuary. To do this, the fellow is documenting the natural abundances of carbon, nitrogen and sulfur isotopes in zooplankton collected from the estuary today and comparing them to those of archived zooplankton samples. The goal is to document shifts in the diets of zooplankton over time, with particular emphasis being given to the relative dietary contributions of phytoplankton vs. terrestrial-derived organic matter. Results are of immediate relevance to evaluating whether there are sufficient food resources for species such as the delta smelt.

- **In-Situ Measurement of Differential Nutrient Utilization by Phytoplankton and Bacteria: Impacts of Nutrient Loading on the Base of the Delta Food Web**
  R/SF-48 Oct. 2011–Sep. 2013
  Calla Schmidt, UCSC, 360.927.0365, cschmidt@ucsc.edu

High levels of ammonium (NH_4^+) may limit the growth of larger phytoplankton (diatoms) by inhibiting nitrate (NO_3^-) uptake. The primary objectives of this project are to use stable isotope analyses to track the degree to which phytoplankton in the San Francisco Estuary absorb ammonium vs. nitrate and the sources of these nutrients (i.e., effluent from a nearby treatment plant, dissolved organic matter or river inputs). Of particular interest is whether the phytoplankton community switches from using NO_3^- to NH_4^+, as NH_4^+ concentrations rise, and whether diatoms are more sensitive to changes in NH_4^+ concentration than smaller phytoplankton species. Findings will have implications for determining the food resources available for pelagic fishes and for regulating the sources of nutrient pollution.

- **The Effects of Flow Releases on the Joaquin River on Abiotic Drivers of Chinook Salmon (*Oncorhynchus tshawytscha*) Habitat**
  R/SF-49 Apr. 2011–Mar. 2013
  Erin Bray, UCSB, 805.893.4886, ebray@bren.ucsb.edu

Plans are underway to release water from Friant Dam on an interim, experimental basis, as part of an effort to restore the San Joaquin River ecosystem. This project investigates the effects of these releases on the physical properties, such as water temperature, that create viable habitat for Chinook salmon. The fellow seeks to develop a model to analyze the sensitivity of channel water temperatures to heat fluxes associated with near-stream temperature gradients. Ultimately, this research seeks to determine the degree to which, and how, flow releases regulate thermal minima and maxima and restore salmon habitats for a given length of stream.

- **The Toxic Effects of Key Pesticides on the Calanoid Copepods, *Eurytemora affinis* and *Pseudodiaptomus forbesi*, of the San Francisco Estuary**
  R/SF-50 Apr. 2011–Mar. 2013
  Sarah Lesmeister, UCD, 530.752.1967, salesmeister@ucd.edu

This project investigates the effects of pesticide pollution on the copepods *Eurytemora affinis* and *Pseudodiaptomus forbesi*, both important prey for larval fishes and pelagic organisms in the San Francisco Estuary. The fellow is currently identifying ambient pesticide contamination levels in the estuary. Laboratory experiments will test whether these ambient conditions are toxic to copepods and copepod predators. Results will help managers develop strategies for protecting sensitive aquatic organisms from nonpoint source pollution.

- **Tracking Migration Patterns and Mortality of Juvenile Spring, Winter and Fall Run Chinook Salmon in the Sacramento River and Delta**
  R/SF-51 Jan. 2012–Dec. 2013
  Jason Hassrick, UCSC, 831.430.6551, hassrick@biology.ucsc.edu

California Chinook salmon are in a state of crisis. Several runs in the Central Valley and Central Coast are in danger or threatened by extinction, and the remnant commercial Chinook fishery is maintained only through the rearing and release of huge numbers of Central Valley fall-run juveniles. All hopes of recovering wild stocks in the Sacramento River system are challenged by various forms of habitat degradation and mortality, direct and indirect, caused by water diversions. In this project, the fellow will implant miniaturized acoustic transmitters into sub-yearling winter-run Sacramento River Chinook. The smolts will be tracked on their outmigration to sea, using an existing array of monitors, updated with receivers capable of detecting the signals from the new miniaturized tags. The survivorship data gathered during this project will be combined and compared with a parallel tracking study of fall- and spring-run Chinook. Findings will allow managers to better evaluate the effects of different flow conditions and water management practices on salmon survival. Of particular interest will be to compare salmon survivorship when the Delta Cross Channel gates are open and closed.

- **Linking Freshwater Sources of California Chinook Salmon to Their Ocean Distribution Using Physical and Natural Tags of Origin**
  R/SFBR-31 Jun. 2009–May 2012
  Rachel Barnett-Johnson, UCSC, 831.239.8782, barnett-johnson@biology.ucsc.edu

Salmon stocks in California collapsed in 2007, likely because of high mortality rates of juveniles entering the sea in 2005. In this project, fish ear bones (otoliths) are being analyzed to estimate the sizes and growth rates of Chinook salmon. In particular, the otoliths of salmon caught in San Francisco Bay are being compared with otoliths from salmon caught six months later in coastal waters. Among this sample, larger juveniles entering the sea were more likely to survive another six months than the smaller, slower growing ones. This size advantage was most pronounced during periods of low ocean productivity, when food was in short supply. In the last year of the project, the fellow will investigate whether survival rates of hatchery and wild juveniles are also markedly different when marine food resources are scarce. Results will, among other things, help identify the rivers or hatcheries that produce salmon most likely to survive during poor oceanic conditions.

- **Sacramento River Steelhead Trout: An Assessment of Behavioral Differences and Contributions of Hatchery and Wild Stocks**
  R/SFBR-43 Sep. 2008–May 2012
  Philip Sandstrom, UCD, 803.466.3172, ptsandstrom@ucdavis.edu

More than 625 Sacramento River steelhead trout (wild and hatchery, and juvenile and adult) were tagged and tracked in 2008-2011 to document their outmigration speeds, preferred outmigration routes and survivorship on these routes. Among the patterns to emerge: (1) Hatchery-born smolts (juveniles) take longer to outmigrate to sea than wild fish of the same age; (2) The main stem of the Sacramento River and Georgiana Slough are the two most common outmigration routes for both wild and hatchery fish; and (3) more than half of the adult hatchery steelhead released into the Sacramento River in 2010-2011 reached the San Francisco Estuary. In the project's final year, the fellow will calculate survival rates along the full range of routes taken by fish, as well as return rates of adults. Preliminary analyses have already revealed surprisingly low rates of survival along the upper and middle sections of the Sacramento River, near where hatchery fish are released in Colusa.

Sea Grant Aquaculture Research Program

- **Genomically Enabled Crossbreeding to Improve Yields of Farmed Pacific Oysters**
  R/AQ-132NSI Oct. 2010–Sep. 2012
  Dennis Hedgecock,USC, 213.821.2091, dhedge@usc.edu
  Donal Manahan, USC, 213.740.5793, manahan@usc.edu
  Paul Olin, CASGEP, 707.565.3449, polin@ucsd.edu

Oyster farming contributes more than $72 million to the West Coast's economy every year, and Sea Grant researchers are trying to boost that production even more by breeding a faster growing Pacific oyster. The oyster being tested is a double-cross hybrid, with fecund parents and superior growth. With NOAA support, scientists will identify genes and metabolic processes responsible for so-called "hybrid vigor" and use what is learned to develop a tag for identifying, within the first few hours of birth, offspring with desired traits. California Sea Grant Extension is overseeing farm trials with the new oyster, to document its growth rates in the field and susceptibility to disease. The Hog Island Oyster Company in Tomales Bay, Grassy Bar Oyster Company in Morro Bay and Carlsbad Aquafarm in northern San Diego County are participating in these trials. Preliminary results suggest that the bred oyster can outperform both wild and farmed oysters.

NOAA Fisheries/Sea Grant Fellowships

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

- **NOAA Fisheries-Sea Grant Graduate Fellowship in Population Dynamics: Integrating Molecular Data into a Robust Population Framework for an Apex Predator**
  E/PD-4 Jun. 2008–May 2012
  David Kacev, SDSU, 858.717.0942, dkacev@sunstroke.sdsu.edu

This project seeks to identify the population structure of the shortfin mako shark in the northeastern Pacific Ocean. To this end, the fellow and colleagues have developed a set of custom microsatellite markers and are now analyzing nearly a thousand mako skin samples, archived at NOAA's Southwest Fisheries Science Center in La Jolla. This analysis will determine whether there is one large or many smaller mako shark populations in the region. This is of interest to managers, as the quota for the shark fishery (a secondary target of the swordfish gillnet fishery) is currently set under the assumption that the species exists as a single population and that because of this, the spatial distribution of fishing effort in federal waters is irrelevant. Besides addressing the validity of these assumptions, the fellow plans, in the final stage of the project, to build a conceptual framework for a population dynamics model.

- **NOAA Fisheries-Sea Grant Graduate Fellowship in Population Dynamics: Understanding the Influence of a Variable Ocean Environment on Chinook Salmon (*Oncorhyncus tshawytscha)***
  E/PD-6 Jun. 2009–May 2012
  D. Patrick Kilduff, UCD, 530.754.8644, dpkilduff@ucdavis.edu

All along the West Coast, chinook salmon returns are highly variable and extremely difficult to predict from year to year. The goal of this project is to identify primary oceanographic drivers of salmon survival and their spatial extent. This is being done through a retrospective study of more than three-decades worth of coded wire-tag data (available from the Regional Mark Processing Center, http://www.rmpc.org), analyzed in relation to physical oceanographic data over the same period (i.e., sea-surface temperature, upwelling intensity, the Pacific Decadal Oscillation [PDO] and North Pacific Gyre Oscillation [NPGO]). The fellow reports that salmon survival is most strongly correlated with the NPGO (positively) and PDO (negatively) for runs between Southern Oregon and West Vancouver Island in British Columbia. Such a correlation was absent for salmon in the Central Valley. In the coming months, the fellow will refine his analysis to better quantify the general patterns he has found. Findings should help managers better understand the role of oceanic conditions on regional variations in salmon survival.

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

Stock assessments are based on many assumptions about a species' life history characteristics and population dynamics. Many of these assumptions cannot be directly observed (e.g., natural mortality rate, average lifespan, or reproductive success) and so are estimated, and in some cases probably estimated poorly. Given the inherent errors, stock assessment models and the harvesting guidelines derived from them should be relatively insensitive to small deviations in life history and population dynamics parameters. The project examines whether or not this assumption about model sensitivity is valid under several scenarios for Pacific salmon. In work to date, the fellow has used a life-history simulator for Pacific salmon to test the sensitivity of the cohort reconstruction (stock assessment model) to a range of natural mortality rates. Results show that current assumptions about salmon mortality from predation and disease tend to produce overestimates of stock size by as much as 20 percent on average.

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

This project seeks to clarify the conditions under which predator-prey relationships and interspecies competition should be included in fisheries models. In the first year of the project, the fellow used a simplified, hypothetical three-species food-web model, consisting of two competing prey species and one predator. The model was then "run" to simulate the effects of fishing on nontarget species, under varying levels of bycatch, competition and predation. The goal was to determine thresholds at which the harvesting of one species would benefit the other two and cease to benefit them because of high incidental takes. Results suggest that

when competition and predation are strong, a moderate intensity of fishing pressure increases abundances of nontarget species, even with moderate levels of bycatch. Preliminary results underscore the importance of including predator-prey relationships and interspecies competition in ecosystem-based fisheries models. In the coming year, the fellow will be studying the selective pressure (Darwinian sense) of fishing on the age of maturity and growth rates of the target species, as well as the implications for fish communities.

- **NOAA Fisheries-Sea Grant Graduate Fellowship in Population Dynamics: Development of Novel Stock Assessment Methods for Market Squid (*Doryteuthis opalescens*)**
  E/PD-9 Jun. 2011–May 2014
  Charles Perretti, UCSD/SIO, 858.534.3892, cperretti@ucsd.edu

The California market squid is the state's most valuable fishery, worth an estimated $56 million ex-vessel in 2009, compared with a combined $96 million for all other fisheries that year. There is, however, is no formal stock assessment and no biomass estimate for the squid; it is a data-poor fishery. The goal of this project is to investigate whether the sizes of squid spawning aggregations can be used to make inferences on the stock's health, and to predict squid landings for the following year. In the first year of the project, the fellow will mine and compile logbook data for catches off La Jolla to test whether traditional school-size models apply to spawning aggregations. If they do, he will then modify one such model to incorporate the life-history characteristics of spawning squid. The last stage of the project will be to compare model output to real data. Results from this project are of direct and immediate relevance to fisheries managers and may alleviate concerns that heavy fishing of forage species is depleting resources for marine predators.

Education, Training & Public Information

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

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

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

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

Knauss Sea Grant Fellows 2012

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, DC area for a one-year paid fellowship.

Deborah Fauquier • Protected Resources Division, U.S. Department of Commerce • dfauquie@ucsc.edu

Alexis Rife • Office of International Affairs, U.S. Department of Commerce • arife@ucsd.edu

Tali Vardi • Office of Science and Technology, U.S. Department of Commerce • tvardi@ucsd.edu

California Sea Grant State Fellows 2012

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.

Christy Bowles • California Department of Parks and Recreation • cmbowles@ucdavis.edu

William Cecil • California Department of Fish and Game • willcecil27@gmail.com

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